FISHERY REPORT: *CHAMPSOCEPHALUS GUNNARI*
SOUTH GEORGIA (SUBAREA 48.3)

CONTENTS

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1. Details of the fishery

1.1 Reported catch

In Subarea 48.3, a pelagic or semi-pelagic trawl fishery targets *Champsocephalus gunnari* (Table 1). In the 2004/05 season the fishery opened on 15 November 2004 with a catch limit of 3 574 tonnes. The fishery caught 200 tonnes in December 2004 and early January 2005, and at the time of writing (October 2005) the fishery had resumed. The fishery will close on 14 November 2005.

Table 1: Catch history for *Champsocephalus gunnari* in Subarea 48.3 (source: STATLANT data available from 1977 to 2003; 2004 from catch and effort reports).

Fishing season	Catch (tonnes)	Catch limit (tonnes)	Vessels	Fishing season	Catch (tonnes)	Catch limit (tonnes)	Vessels
1976/77	93 595		-	1991/92	5*	0	
1977/78	7 472			1992/93	0	9 200	
1978/79	809			1993/94	13*	9 200	
1979/80	8 795			1994/95	10*	0	
1980/81	27 903			1995/96	0	1 000	
1981/82	54 040			1996/97	0	1 300	
1982/83	178 824			1997/98	6*	4 520	
1983/84	35 743			1998/99	265	4 840	1
1984/85	628			1999/00	4 114	4 036	2
1985/86	21 008			2000/01	960	6 760	6
1986/87	80 586			2001/02	2 667	5 557	7
1987/88	36 054	35 000		2002/03	1 986	2 181	5
1988/89	3*	0		2003/04	2 686	2 887	6
1989/90	8 135	8 000		2004/05	200**	3 574	7
1990/91	44*	26 000					

*   Fishery closed, catch information from surveys.
**   To 1 October 2005

1.2 IUU catch

2.   There was no evidence of IUU activity in this fishery.

1.3 Size distribution of the catches

3.   Catch-weighted length frequencies from observer, fine-scale and STATLANT data for 1986 to 2005 are presented in Figure 1.
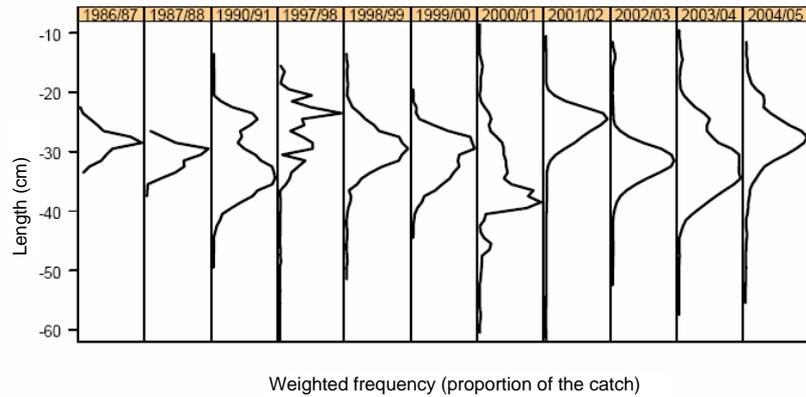
Figure 1:   Catch-weighted length frequencies for *Champsocephalus gunnari* in Subarea 48.3 derived from observer, fine-scale and STATLANT data reported by 1 October 2005.

2. Stocks and areas

4.   Within Subarea 48.3 *C. gunnari* is restricted to the shelf area generally shallower than 500 m deep. Differences in length distribution have been noted between Shag Rocks and South Georgia (WG-EMM-03/7, WG-FSA-04/40 and 04/85). These differences are not thought to represent separate stocks. So for purposes of stock assessment it is assumed that there is a single stock present. *Champsocephalus gunnari* is considered a semi-pelagic species.

3. Parameter estimation

3.1 Estimation methods

Trawl surveys

5.   There was no new stock assessment survey for this species in 2005. The most recent survey is that of January 2004, reported in SC-CAMLR-XXIII, Annex 5, paragraphs 5.219 and 5.220, which yielded a lower one-sided 95% CI of 44 369 tonnes.

Table 2:   Bootstrap estimated biomass from the UK 2004 survey.

Component	Description	Value
Biomass estimates from bootstrap procedure	Mean	139 010
	SE	67 759
	Lower CI	26 165
	Upper CI	287 917
	One-sided lower 95% interval	44 369

Population structure

6.   The distribution of densities-at-age in the January 2004 survey was analysed at WG-FSA-04 using the CMIX program, with bounds for means estimated from von Bertalanffy growth parameters (SC-CAMLR-XXIII, Annex 5, Table 5.47) and the standard deviations linearly related to the means. The Working Group had, however, raised two points of concern over the results of the mixture analysis. First, the magnitude of the mean length densities of the age 1+ cohort was considerably higher than that observed in the total length-density distribution. This was caused by the relatively poor sampling of the age 1+ cohort in the trawl survey. Second, the fit to the age 1+ cohort was poor and had a very large standard deviation associated with it (Figure 2). High values of length densities within individual length classes from a few hauls in the survey were thought to have contributed to this issue.
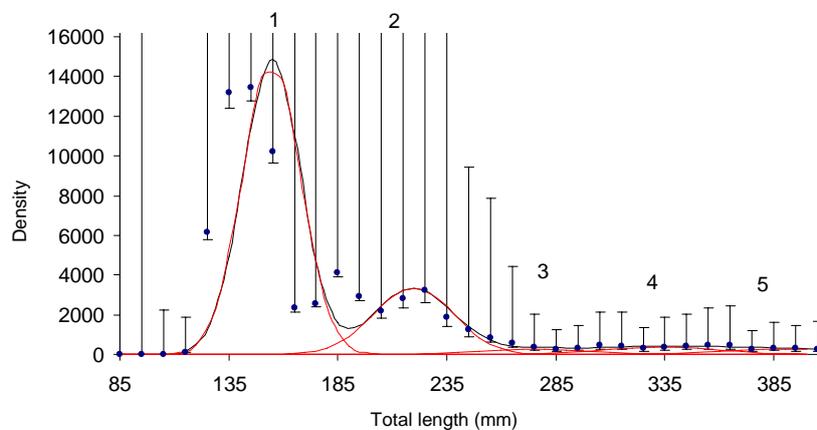

Figure 2:   CMIX analysis of truncated length-density distribution from the 2004 bottom trawl survey in Subarea 48.3.

7.   In consequence, last year the Working Group had undertaken some calculations of yield both including and excluding these 1+ animals, to arrive at the following estimates of yield (SC-CAMLR-XXIII, Annex 5, paragraph 5.232):

	Year 1 (2004/05) (tonnes)	Year 2 (2005/06) (tonnes)
Yield age 2+ fish only	3 574	2 262
Yield including age 1+ fish		5 935

8.   New information from the fishery and an acoustic research survey was available to the Working Group in 2005. It therefore decided to revisit the calculations of yield for this fishery.

9.   The catches taken in the 2004/05 fishing season had a modal length of 28 cm, and a spread consistent with being composed of animals of age 3 with some also of ages 2 and 4 (Figure 1). There was no evidence of a major peak at 22 cm, which would indicate a large biomass of age-2 fish, and which would have been consistent with the large biomass of age-1 fish in 2004 indicated by the January 2004 survey. Therefore, age-1 fish were not included in any calculations by the Working Group this year.

10.   Following the recommendation of the Working Group in 2004 (SC-CAMLR-XXIII, Annex 5, paragraph 5.235), in January 2005 the UK conducted research aimed, *inter alia*, at investigation of discrimination of *C. gunnari* from other acoustic scatterers and exploration of methods of combining trawl and acoustic indices for stock assessment. The results of this research are discussed in the WG-FSA report, paragraphs 3.31 and 3.32 and WG-FSA-05/79.

11.   The Working Group noted that this research survey had not found concentrations of icefish sufficient for its work. Although it covered the major fishing grounds and strata where feeding aggregations are normally found, it did not cover all the southern strata that are included in stock assessment surveys. Spawning fish were observed around Shag Rocks and in the northeast of South Georgia.

12.   The Working Group also noted that although fishing vessels had been able to catch some icefish, large midwater concentrations of a type favoured by the fishery were not common.

13.   The bottom trawl research results showed length frequency peaks at 14–17 cm (consistent with age-1 fish) in both areas, 22–40 cm at Shag Rocks (ages 2–4) and 20–34 cm at South Georgia (ages 2–3) (Figure 2). The commercial fishery did not appear to catch many animals larger than about 33 cm (age 4) (Figure 3), but it was restricted to South Georgia.
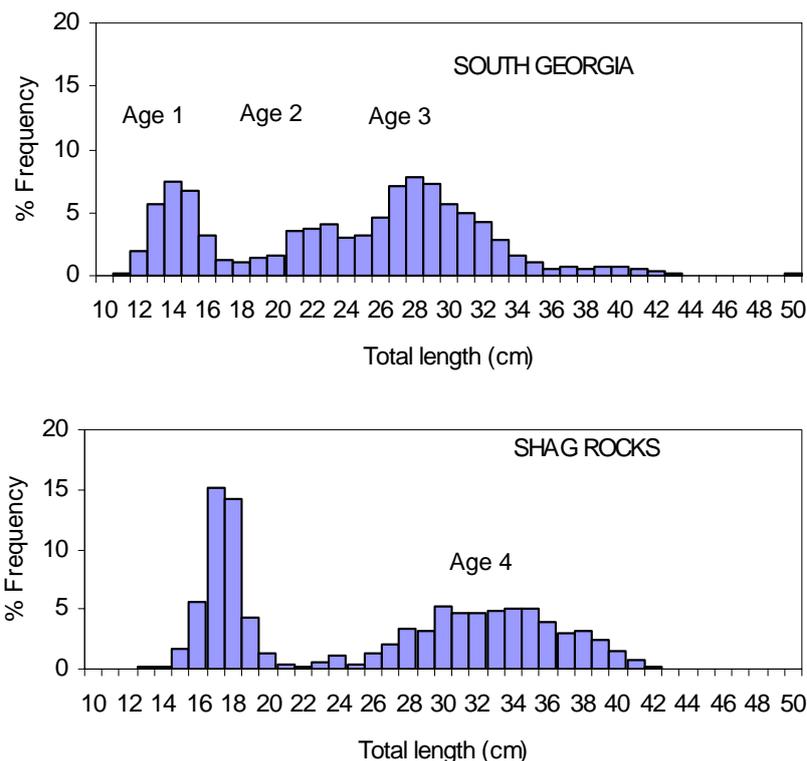
Figure 3:   Length frequency of *Champsocephalus gunnari* obtained during the course of the acoustic research cruise in January 2005 in Subarea 48.3. Figure from WG-FSA-05/79.

14.   The research had found a high proportion of adults (>23 cm TL) to be in, or close to, spawning condition (maturity stages 3–5). At two locations to the east of South Georgia, more than 75% of adult fish were either running or had recently spawned (maturity

stages 4–5). The results suggest that an unusually high proportion of adults were reproductively active during January 2005. This might explain differences in behaviour or distribution of the stock that explain the lack of major concentrations of fish in January 2005. Dr K. Reid (UK) reported that there had been unusually high quantities of icefish (predominantly size 140–180 mm) in fur seal diet sampled at Bird Island, South Georgia, in the 2004/05 fishing season.

15. The Working Group considered that there were at least two explanations for the observations from the fishery and the research survey:

Hypothesis 1: Through some change in behaviour or distribution, possibly related to spawning, concentrations of icefish were not available to the fishery or the acoustic research survey, but icefish were dispersed over Subarea 48.3. Periodic dispersion of icefish has been noted before in Subarea 48.3, for instance in 1998/99. In this year, CPUE and catches were low. It was followed by a year in which CPUE and catches were much higher and included fish that should have been present in 1998/99 (Table 1, Figure 1). Furthermore, spawning behaviour and factors affecting distribution are not well understood for this species.

or

Hypothesis 2: The difference in commercial length frequencies between 2003/04 and 2004/05 might indicate that most age-4+ fish were no longer present in the population at South Georgia, whether due to a mortality or other event. This event did not apply to age-3 fish (which were age-2 in the January 2004 survey).

16. Two starting populations were used for the analysis, corresponding to these two alternate hypotheses. The first used the complete age-2+ population from the January 2004 survey (34 841 tonnes of ages 2–5 animals: see SC-CAMLR-XXIII, Annex 5, paragraph 5.225). The second used only age-2 animals from the January 2004 survey (applying the biomass proportion in Table 5.49 of SC-CAMLR-XXIII, Annex 5, of 0.276 for age-2 fish, the resulting starting biomass was 12 245 tonnes).

17. The Working Group noted that there are additional hypotheses consistent with the observation from the fishery and research survey in 2004/05. One hypothesis is that there has been a decline in the population across all age classes, whether due to an increase in mortality or other events.

3.2 Parameter values

Fixed parameters

18. The fixed parameters remain unchanged from 2003 and are presented in Table 3.

Table 3:   Fixed parameters used in the 2004 assessment of *Champsocephalus gunnari* in Subarea 48.3.

Component	Parameter	Value	Units
Natural mortality	M	0.71	y^{-1}
VBGF	K	0.17	y^{-1}
VBGF	t_0	−0.58	y
VBGF	L_∞	557	mm
	Date '0'	245	d
Length to mass	'a'	5.47E-10	kg, mm
Length to mass	'b'	3.42	

Removals

Fishing mortality (catches since survey)

19.   Some catches were taken in the 2003/04 fishing season after the bottom trawl survey (i.e. 23 January 2004), which were included in the assessment. Catches up to 1 October 2005 were 200 tonnes.

20.   The Working Group considered the possibility that additional catches would be taken by the vessels currently fishing. It agreed that the simplest way to account for these unknown catches was to count them against any catch limit set for the 2005/06 fishing season.

Initial age structure

21.   The proportion of density-at-age was identical to that used by the Working Group in 2004, derived from the CMIX program for ages 1+ to 5+ in the survey of January 2004, as relevant to the two different hypotheses described above (Hypothesis 1 used densities-at-ages 2–5, Hypothesis 2 used densities only at age 2; see SC-CAMLR-XXIII, Annex 5, Table 5.49). VBGF parameters were selected to calculate mean length-at-age.

22.   Initial (2004) biomass:

Hypothesis 1: 34 841 tonnes of ages 2–5 animals in January 2004.
Hypothesis 2: 12 245 tonnes of age-2 animals in January 2004.

Selectivity

23.   A linear selectivity vector was used for *C. gunnari,* starting at 2.5 years and fully selected at age 3.

4. Stock assessment

4.1 Model structure and assumptions

24.   The GYM was used to perform the short-term projection of the *C. gunnari* biomass, updated with the two alternative hypotheses for catch in 2004/05 and without the survey estimates of age-1 animals in January 2004. Estimates of yield were derived by determining the maximum catch level (fishing mortality) that had a less than 5% chance of reducing the spawning stock biomass to below 75% of the level that would occur in the absence of fishing in the two years following a survey biomass estimate (i.e. over the period 15 November 2004 to 15 November 2006 in the absence of fishing in either 2004/05 or 2005/06).

Model configuration

Table 4:   GYM model configuration for the assessment of *Champsocephalus gunnari* in Subarea 48.3.

Category	Parameter	Value
Recruitment age	Start	2.5 years
	Fully selected	3 years
Plus class accumulation		10 years
Oldest age in initial structure		10 years
Maturity	L_{m50}	0 mm***
	Range: 0 to full maturity	0 mm
Spawning season	Set so that the status of the stock is determined at the start of each year.	30 Nov–30 Nov
Simulation specification	Number of runs	1
Individual trial specifications		
	Years to remove initial age structure*	0
	Year prior to projection**	2003
	Reference start date	01/12
	Years to project stock in simulation	2
	Reasonable upper bound for annual F	5.0
	Tolerance for finding F in each year	0.000001

*   Set to 0 since catches were made after the survey, else set to 1.
**   GYM requires first year of 2003/04 split-year.
***   Maturity is not used in the short-term projection. It is set to 0 to allow the GYM to monitor the whole population.

4.2 Model results

25.   A single short-term projection of yield in 2004/05 (year 1) and 2005/06 (year 2), excluding age-1+ fish in the initial biomass, was computed.

Table 5:   Yield calculations from assessments of *Champsocephalus gunnari* in Subarea 48.3.

Hypothesis	2004 starting biomass	2004/05 known catch (tonnes)	2005/06 yield (tonnes)
1	34 841 tonnes, age 2–5 fish	200	4 760
2	12 245 tonnes, age-2 fish	200	2 244

4.3 Sensitivity analyses

26.   The Working Group did not consider any additional sensitivity analyses.

4.4 Discussion of model results

27.   Dr P. Gasyukov (Russia) reported that his paper WG-FSA-05/78 proposed an alternative method of separating ages within length-density data from bottom trawl surveys of icefish in Subarea 48.3. This alternative method, when applied to the UK survey in January 2004, had confirmed lower numbers of age-1 fish and much higher numbers of age-2 fish than was estimated by the CMIX analysis presented in section 3.1. In this calculation the total number proportion of age groups 2–5 became 0.733 as compared with 0.305 estimated by WG-FSA, and the proportion of age 2 was 0.617. The biomass associated with age 2–5 fish was 39 841 tonnes (compared to the 34 841 tonnes used in Hypothesis 1). Therefore, in his view, the upper yield limit would be more appropriate.

28.   The Working Group noted that the results of Hypothesis 1 suggested an increase in yield over that calculated for 2004/05 by WG-FSA (3 574 tonnes). The increase was explained by the low catches in 2004/05, and therefore a higher projected stock at the end of 2004/05 than would have been the case had the catch been 3 574 tonnes. However, it noted that the combined yield from the two years of fishing (2004/05 and 2005/06) would still be lower under the present assessment (4 960 tonnes) than that of last year's assessment (5 836 tonnes).

29.   Some members noted that given the inability of the commercial fishery and the acoustic research survey to find concentrations of icefish in 2004/05, the higher yield suggested by Hypothesis 1 would be inappropriate.

30.   The Working Group noted that it would be desirable in the future to apply the same decision rules to estimating yield of icefish to both Heard Island (Division 58.5.2) and South Georgia (Subarea 48.3). In both cases, projections were undertaken for two fishing seasons following the survey rather than projecting for two fishing seasons from the current meeting. This has meant a different application of the decision rules to the two stocks given that both stocks would be expected to have older fish at the time of the assessments compared to the time of the surveys. The South Georgia assessment is approximately equivalent to the Heard Island assessment that has the catch taken in one year followed by a zero catch in the second year. There are other differences between the two areas in these assessments, such as a biennial survey at South Georgia compared to an annual survey around Heard Island, and that at South Georgia age class 5 and 6 fish are still present in the fishery in some numbers in

some years while age classes 3 and 4 predominate in the fishery at Heard Island. This needs to be taken into consideration when discussing the matter further at the meeting of WG-FSA in 2006.

4.5 Future research requirements

31.   The research requirements identified by the Working Group are as follows:

(i)   Further work on developing a management procedure for *C. gunnari* is a high priority.

(ii)   Continue to investigate the feasibility of acoustic methods for assessing *C. gunnari* in Subarea 48.3, including:

(a)   discrimination of C. gunnari from other acoustic scatterers
(b)   improvements in target strength estimates for *C. gunnari*
(c)   age-specific patterns in daily vertical distribution of *C. gunnari*
(d)   combining trawl and acoustic indices for stock assessment.

(iii)   Investigate the utility of the revised von Bertalanffy growth parameters in North (2005), including the use of alternative parameters for Shag Rocks and South Georgia.

(iv)   Investigate the influence of temperature and oceanography on the distribution of *C. gunnari*.

(v)   Develop reliable age reading protocols for *C. gunnari* otoliths. This will be facilitated by the proposed age determination workshop for *C. gunnari* (WG-FSA report, paragraphs 9.7 to 9.11).

5. By-catch of fish and invertebrates

5.1 By-catch removals

32.   The total reported by-catch of fish taken in recent years is indicated in Table 6. The by-catch of icefish in South Georgia was higher in proportion to target fish than in previous years, but was still below the catch limit set by Conservation Measure 33-01.

Table 6: Total reported by-catch (tonnes) for five species: NOG – *Gobionotothen gibberifrons*; SSI – *Chaenocephalus aceratus*; SGI – *Pseudochaenichthys georgianus*; NOR – *Notothenia rossii*; NOS – *Lepidonotothen squamifrons*.

Fishing season	NOG	Limit	SSI	Limit	SGI	Limit	NOR	Limit	NOS	Limit
1998/99	0	1470	0	2200	0	300	0	300	0	300
1999/00	0	1470	0	2200	0	300	0	300	0	300
2000/01	0	1470	0	2200	4	300	0	300	0	300
2001/02	0	1470	5	2200	5	300	0	300	0	300
2002/03	0	1470	1	2200	5	300	0	300	0	300
2003/04	0	1470	0	2200	2	300	0	300	0	300
2004/05	0	1470	1	2200	25	300	0	300	0	300

5.2 Mitigation measures

33.   The by-catch limits are set out in Conservation Measure 33-01. Move-on rules are included in the annual conservation measure set for this fishery, e.g. Conservation Measure 42-01.

6. By-catch of birds and mammals

34.   Seabird mortality in this trawl fishery is summarised in Table 7 (taken from Table O16).

Table 7: Number of seabirds killed in the trawl fishery in Subarea 48.3. DIC – grey-headed albatross; DIM – black-browed albatross; PRO – white-chinned petrel; PWD – Antarctic prion; MAH – northern giant petrel; MAI – southern giant petrel.

Fishing season	Trawls observed	DIC	DIM	PRO	PWD	MAH	MAI
2000/01	315	5	46	41			
2001/02	431		18	49	1		
2002/03	182	1	7	28			
2003/04	221	1	26	59			1
2004/05	253		9	1		1	

6.1 Mitigation measures

35.   Conservation Measure 25-03 applies to this fishery. For discussion of the problems of avoidance of seabird by-catch see paragraphs O204 to O207.

7. Ecosystem implications/effects

36.   The current pelagic trawl fishery for *C. gunnari* in Subarea 48.3 has minimal impact on the benthic ecosystem.   There is a small by-catch of other icefish species, but this is typically much smaller than the catch limits for these species. *Champsocephalus gunnari* play an important role in the ecosystem of the South Georgia shelf as predators of krill, *Themisto* and other euphausiids, and as prey of fur seals and gentoo penguins (see Everson et al., 1999).   Icefish may also be consumed by juvenile toothfish in years of high icefish abundance at Shag Rocks. Estimates of icefish standing stock have been shown to vary with variability in krill abundance at South Georgia, and in years of poor krill availability, icefish condition is poorer and larger quantities are likely to be consumed by both fur seals and gentoo penguins, which are normally krill dependent.

8. Harvest controls for the 2004/05 season and advice for 2005/06

8.1 Conservation measures

Table 8:   Summary of provisions of Conservation Measure 42-01 for *Champsocephalus gunnari* in Subarea 48.3 and advice to the Scientific Committee for the 2005/06 season.

	Paragraph and topic	Summary of CM 42-01 for 2004/05	Advice for 2005/06	Paragraph reference
1.	Access (gear)	Trawling only Bottom trawl prohibited		
2.	Access (area)	Fishing prohibited within 12 n miles of South Georgia from 1 March to 31 May.		
3.	Catch limit	3 574 tonnes	2 244 or 4 760 tonnes	38
		894 tonnes between 1 March and 31 May	Revise	
4.	Move-on rule	Move on if >100 kg caught of which >10% by number are <240 mm TL.		
5.	Season	15 November 2004 to 14 November 2005	Update	
6.	By-catch	By-catch rates as in CM 33-01 to apply, plus move-on rule.		
7.	Mitigation	In accordance with CM 25-03.		
8.	Seabirds	Any vessel catching 20 seabirds to cease fishing.		
9.	Observers	Each vessel to carry at least one CCAMLR scientific observer and may include one additional scientific observer.		
10.	Data: catch and effort	(i) Five-day reporting system as in CM 23-01 (ii) Monthly fine-scale reporting system as in CM 23-04 on haul-by-haul basis.		
11.	Target species	*Champsocephalus gunnari* By-catch is any species other than *C. gunnari*.		
12.	Data: biological	Monthly fine-scale reporting system as in CM 23-05. Reported in accordance with the Scheme of International Scientific Observation.		
13.	Research	20 research trawls to be conducted as described in Annex 42-01/A between 1 March and 31 May.		

8.2 Management advice

37.   The Working Group did not have sufficient scientific information to determine which hypothesis on changes in the distribution and/or abundance of icefish was the most plausible.

38.   Based on the results of the two hypotheses in paragraph 15, the Working Group recommended that the catch limit for icefish in Subarea 48.3 in the 2005/06 fishing season could be 2 244 or 4 760 tonnes.

39.   Any catch taken between 1 October 2005 and the end of the 2004/05 fishing season (14 November 2005) should be counted against the catch limit for the 2005/06 fishing season.

40.   All other components of Conservation Measure 42-01 should remain.

41.   Dr Gasyukov noted that his alternate analysis of age-class densities indicated a higher proportion of age-2 fish in the January 2004 survey than had been estimated by CMIX. As a consequence of this analysis, Dr Gasyukov considered that the upper yield limit would be more appropriate.

42.   Some members noted that, given the inability of the commercial fishery and the acoustic research survey to find concentrations of icefish in 2004/05, the yield suggested by Hypothesis 1 (4 760 tonnes) would be inappropriate.

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