

APPENDIX R

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

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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 *Champscephalus gunnari* (Table 1). In 2008/09, the fishing season was from 15 November 2008 to 14 November 2009, with a catch limit for *C. gunnari* of 3 834 tonnes (Conservation Measure 42-01). The catch of *C. gunnari* reported to October 2009 was 1 837 tonnes.

Table 1: Catch history for *Champscephalus gunnari* in Subarea 48.3 (source: STATLANT data for past seasons, and catch and effort reports for current season).

Season	Reported effort (number of vessels)	Catch limit (tonnes)	Reported catch (tonnes)
1976/77	-	-	93 595
1977/78	-	-	7 472
1978/79	-	-	809
1979/80	-	-	8 795
1980/81	-	-	27 903
1981/82	-	-	54 040
1982/83	-	-	178 824
1983/84	-	-	35 743
1984/85	-	-	628
1985/86	-	-	21 008
1986/87	-	-	80 586
1987/88	1	35 000	36 054
1988/89	-	0	3
1989/90	-	8 000	8 135
1990/91	-	26 000	44
1991/92	-	0	5
1992/93	-	9 200	0
1993/94	-	9 200	13
1994/95	-	0	10
1995/96	-	1 000	0
1996/97	-	1 300	0
1997/98	1	4 520	6
1998/99	1	4 840	265
1999/00	2	4 036	4 114
2000/01	5	6 760	960
2001/02	5	5 557	2 667
2002/03	4	2 181	1 986
2003/04	7	2 887	2 683
2004/05	7	3 574	200
2005/06	5	2 244	2 169
2006/07	5	4 337	4 345
2007/08	5	2 462	2 491
2008/09	5	3 834	1 837

1.2 IUU catch

2. There has been no evidence of IUU activity in this fishery.

1.3 Size distribution of the catches

3. Catch-weighted length frequencies for *C. gunnari* from 1986/87 to 2008/09 are presented in Figure 1.

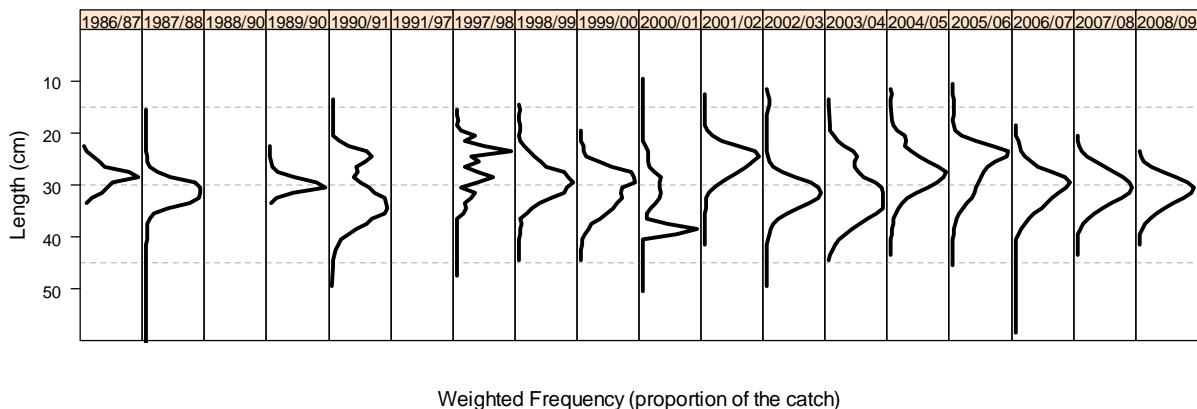


Figure 1: Catch-weighted length frequencies for *Champsocephalus gunnari* in Subarea 48.3 (source: observer, fine-scale and STATLANT data).

2. Stocks and areas

4. Within Subarea 48.3, *C. gunnari* is restricted to the shelf area generally shallower than 350 m. Differences in length distribution have been noted between Shag Rocks and South Georgia (WG-FSA-06/51). In the January 2009 survey, there was little evidence of recruitment of a strong 2+ year class to the survey and catches across the region were dominated by a single length class whose mean length varied between South Georgia and Shag Rocks and was assumed to be 3+ (WG-FSA-09/9). These differences are not thought to represent separate stocks and, for purposes of stock assessment, it is assumed that there is a single stock present. *Champsocephalus gunnari* is considered a semi-pelagic species, young (0+ and 1+) fish are found in the pelagic zone, but with increased age (size) fish become more demersal in habit (WG-FSA-02/7).

3. Parameter estimation

3.1 Estimation methods

Acoustic surveys

5. No new estimates of standing stock were available from acoustic surveys. Previous acoustic investigations have demonstrated that *C. gunnari* of all sizes/ages spend time in midwater and reinforced the belief that a bottom trawl survey significantly underestimates *C. gunnari* biomass (see WG-FSA-SAM-04/20).

Trawl surveys

6. In January 2009 the UK undertook a random stratified bottom trawl survey of the South Georgia and Shag Rocks shelves (WG-FSA-09/9). The survey employed the same trawl gear and survey design as previous UK surveys in Subarea 48.3.

Standing stock

7. Following the procedure agreed at WG-FSA-03, estimates of standing stock were obtained using a bootstrap on calculated icefish densities from the UK survey. Trawl densities were weighted by the correction factor of 1.241, which takes account of the presence of a proportion of the icefish stock above the relatively low headline height of the UK trawl. Trawl densities were then weighted by the proportion of the total survey area in the stratum and inverse weighted by the proportion of the total hauls in the stratum:

$$D_C = D \times \frac{A_S}{A_T} \times \frac{H_T}{H_S}$$

where D_C = corrected density; D = trawls density; A_S = stratum area; A_T = total area; H_T = total number of hauls; and H_S = number of hauls in that stratum.

8. Sea-floor areas derived from detailed bathymetric data (WG-SAM-08/10 Rev. 2) were used in the analysis. Ten strata were used (Figure 2; Table 2), with two depth strata (50–200 and 200–300 m, except in NW where 200–350 m were used) and five geographic strata (Shag Rock, plus NW, NE, SW and SE South Georgia). The 2009 survey (Figure 3) sampled 71 random and representative hauls, giving good geographic coverage. WG-FSA-09/9 detailed the sampling distribution among area and depth strata.

9. An estimate of the one-sided lower 95% CI of biomass was calculated for the assessment and is tabled below. The estimated mean value of the standing stock decreased from 76 000 tonnes in April 2008 to 32 000 tonnes in January 2009. The one-sided lower CI was 18 904 tonnes.

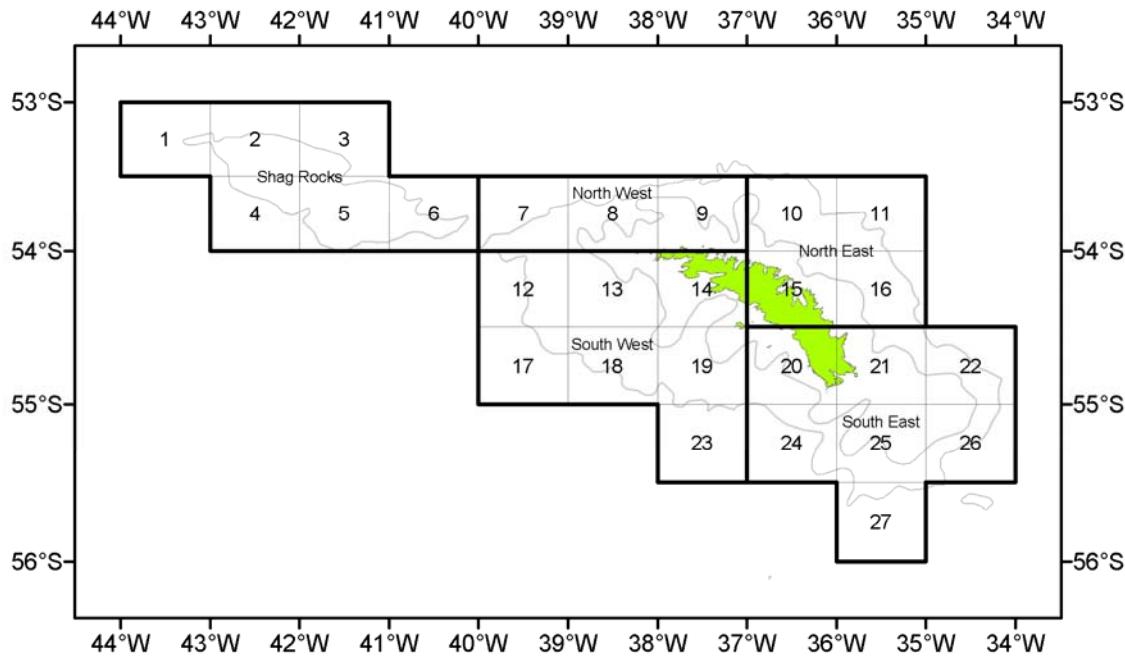


Figure 2: Strata and grid squares used in the 2009 UK survey of Subarea 48.3.

Table 2: Seabed areas of survey strata used to estimate biomass within the bootstrap procedure and results of bootstrap.

Component	Description	Value
Nominal date of survey	Mid-point	16 Jan 2008
Survey timing (days since start of year)		16
Seabed area of survey strata	Strata (m)	km ²
	1. SR 50–200	2 553
	2. SR 200–300	1 438
	3. NW 50–200	3 371
	4. NW 200–350	2 059
	5. NE 50–200	2 766
	6. NE 200–300	3 576
	7. SW 50–200	4 276
	8. SW 200–300	6 637
	9. SE 50–200	6 617
	10. SE 200–300	3 828
Bottom trawl survey	Bottom to 6 m	tonnes
Biomass estimates from bootstrap procedure	Mean	31 753
	SE	8 473
	Lower CI	16 961
	Upper CI	49 753
	One-sided lower 95% CI	18 904

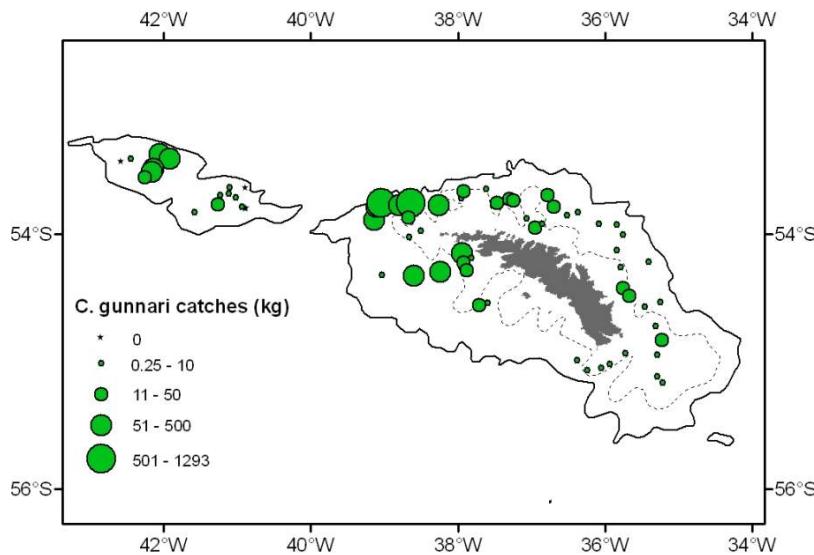


Figure 3: *Champscephalus gunnari* catches from the survey in Subarea 48.3 in April 2008.

Population structure

10. The distribution of densities-at-age was derived using the CMIX program. Standard deviations were linearly related to the mean on all runs. The length classes were constrained from 70–460 mm for the initial CMIX run, and bounds for means were estimated from von Bertalanffy growth parameters but these did not fit the observed data well. A second CMIX run used bounds on the cohorts estimated from the length-density plot and slight modifications to the intercept and slope start and step values; input parameters used for this run are given in Table 3. For the final run, means from the mixture components of the second run were used to set bounds on cohorts and length classes were constrained from 200–240 mm, in order to remove length classes not considered to be sampled effectively (gear and behaviour) by the trawl. Results are of the final run are given in Table 4.

Table 3: Input parameters for the CMIX analysis of *Champscephalus gunnari* length density in Subarea 48.3.

Parameter	Value
Size range included	70–460 mm
Initial bounds:	
Age 0:	100–130
Age 1:	170–200
Age 2:	230–260
Age 3:	280–300
Age 4:	330–360
Survey date	na*
Bounds on intercept (start, step)	0.1, 1.1 (0.2, 0.05)
Bounds on slope (start, step)	0.02, 0.6 (0.05, 0.01)
No. function calls	1 000
Reporting frequency	100
Stopping criteria	1E-6
Freq. for convergence testing	5
Simplex expansion coefficient	1

* Survey only applicable when von Bertalanffy growth parameters used to set bounds on cohorts.

Table 4: Results generated from CMIX for the truncated length-density distribution.

	Component 1	Component 2	Component 3
Means of mixture components (mm)	244	298	356
Standard deviations of mixture components	19.1	23.3	27.8
Total density of each mixture component	256	3012	509
SD of each mixture component density	76	613	107
Density %	6.8	79.7	13.5
Sum of the observed densities = 3677.9			
Sum of the expected densities = 3773.9			

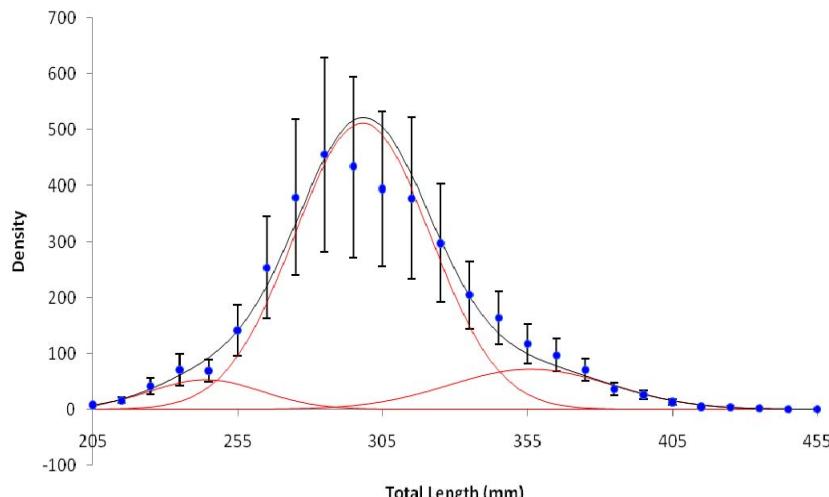


Figure 4: CMIX analysis of truncated length-density distribution from the 2009 bottom trawl survey in Subarea 48.3. The blue circles represent observed density with error bars for \pm standard errors, the black line represents the expected density, and the red lines represent the normal mixture distributions.

3.2 Parameter values

Fixed parameters

11. The fixed parameters used in the assessment remained unchanged from previous years (SC-CAMLR-XXVI, Annex 5, Appendix O, Table 5).

Removals

Fishing mortality (catches since survey)

12. Catches taken after the assessment of biomass from the bottom trawl survey (i.e. 16 January 2009) must be included within the assessment. Following the survey, 3 573 tonnes of catch limit remained to be taken in Subarea 48.3.

Initial age structure

13. The proportion of density-at-age was derived from the CMIX program for ages 2+ to 4+ (Table 4).

Selectivity

14. A knife-edge selectivity vector was used for *C. gunnari*, starting at 2.5 years and fully selected at age 2.5.

4. Stock assessment

4.1 Model structure and assumptions

15. The GYM was used to perform the short-term projection of the *C. gunnari* biomass. 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.

4.2 Model configuration

Table 5: GYM configuration for the assessment of *Chamsocephalus gunnari* in Subarea 48.3.

Category	Parameter	Value
Age structure	First age class in stock	1
	Last age class in stock	10
	Oldest age in last class	11
Natural mortality	M	0.71
Length-at-age	K	0.17 y ⁻¹
	t_0	-0.58 y
	L_∞	557 mm
	Growth period (start and end dates)	1 Dec–30 Nov
Weight-at-age (kg, mm) (W = aL ^b)	Reference date (Start growth period)	1 Dec
	'a'	5.47E-10
	'b'	3.42
Maturity (age based)	L_{m50}	0 mm*
	Range over which maturity occurs	0 mm
	Age 0	Maturity 1
Spawning season	Start–End date	30 Nov–30 Nov
Fishery information	Upper bound to annual F	5

(continued)

Table 5 (continued)

Category	Parameter	Value
Future projections	Tolerance for finding F in each year	1E-08
	Tolerance for resolving catches	0.01
	Age first selected	2.5
	Age fully selected	2.5
	Relative fishing effort	Date: 1 Dec, Effort: 1
2007	Selectivity varied from last	✓
	Catch (mass)	3 573 000**
	Age first selected	2.5
	Age fully selected	2.5
	Relative fishing effort	Date: 1 Dec, Effort: 0 Date: 16 Jan, Effort: 1
Initial population structure	Age class	Density (%)
	1+1	7
	2+2	80
	3+3	13
	Date of survey	16 Jan 09
Simulation specifications	Biomass to scale	1.8904+ E07
	Number of runs in simulation	1
Characteristics of a trial	Depletion level for test	0.2
	Years to remove initial age structure	0***
	Estimate median SB_0	Deterministic
	Observations to use in median SB_0	2
	Year 0 of projection	2008
	Reference start date	1 Dec
	Increments in year	365
Evaluation of yield	Years to project stock	2
	Type	Fishing mortality
	Vector of F	0, 0.1, 0.144, 0.2

* Maturity is not used in the short-term projection. It is set to 0 to allow the GYM to monitor the whole population.

** Catch taken or potentially taken after the survey, but before the end of the year (14 November 2009).

*** Set to 0 since catches were made after the survey, else set to 1.

4.3 Model results

16. A single short-term projection of yield (tonnes) in 2009/10 (Year 1) and 2010/11 (Year 2), was computed:

Catch limit (tonnes)	
Year 1	1 548
Year 2	949

4.4 Discussion of model results

17. The catch limits have decreased since the 2008/09 season. The reduced biomass of icefish obtained by the survey reflected in this decrease in yield is likely in part to have been a result of the anomalous conditions experienced at South Georgia (paragraph 26) and the small proportion of 2+ aged fish in the survey catches.

4.5 Future research requirements

18. The Working Group identified a number of future research requirements for the intersessional period:

- (i) The CCAMLR assessment method for *C. gunnari* uses CMIX to disaggregate length-density data into age density before applying CCAMLR decision rules in GYM. An alternative methodology, which works entirely on length data and utilises a growth-transition matrix, gave similar yields to the traditional assessment method when tested on 2006, 2007, 2008 and 2009 data from Subarea 48.3 (WG-SAM-09/27). The Working Group endorsed recommendations made by WG-SAM, which were to investigate alternative methods of estimating the growth-transition matrix, and that with these refinements the new assessment framework should be considered for future development of assessment advice for *C. gunnari* in Subarea 48.3.
- (ii) The Working Group noted that the utility of diet, feeding rates, fish condition and predation in modifying natural mortality rates in projections has been investigated a number of times with limited success. However, the Working Group noted that the issue of ensuring sufficient icefish escapement for predators under conditions of variable natural mortality and ecosystem productivity warrants further consideration.

5. By-catch of fish and invertebrates

5.1 By-catch removals

19. Catches of by-catch species (*Gobionotothen gibberifrons*, *Notothenia rossii*, *Lepidonotothen squamifrons*, *Pseudochaenichthys georgianus* and *Chaenocephalus aceratus*) reported in fine-scale data, and their respective catch limits, are summarised in Table 6. None of these species were caught as by-catch during 2008/09.

Table 6: Catch history for by-catch species (*Gobionotothen gibberifrons*, *Notothenia rossii*, *Lepidonotothen squamifrons*, *Pseudochaenichthys georgianus* and *Chaenocephalus aceratus*) and catch limits in the fishery for *Champscephalus gunnari* in Subarea 48.3 (see Conservation Measure 33-01 for details). (Source: fine-scale data.)

Season	<i>Gobionotothen gibberifrons</i> (tonnes)		<i>Notothenia rossii</i> (tonnes)		<i>Lepidonotothen squamifrons</i> (tonnes)		<i>Pseudochaenichthys georgianus</i> (tonnes)		<i>Chaenocephalus aceratus</i> (tonnes)	
	Limit	Reported	Limit	Reported	Limit	Reported	Limit	Reported	Limit	Reported
1998/99	1470	0	300	0	300	0	300	0	2200	0
1999/00	1470	0	300	0	300	0	300	0	2200	0
2000/01	1470	0	300	0	300	0	300	6	2200	0
2001/02	1470	0	300	0	300	0	300	5	2200	5
2002/03	1470	0	300	0	300	0	300	5	2200	1
2003/04	1470	0	300	0	300	0	300	3	2200	0
2004/05	1470	0	300	0	300	0	300	25	2200	1
2005/06	1470	0	300	1	300	0	300	6	2200	0
2006/07	1470	0	300	0	300	0	300	1	2200	0
2007/08	1470	0	300	0	300	0	300	1	2200	1
2008/09	1470	0	300	0	300	0	300	0	2200	0

5.2 Mitigation measures

20. 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

21. Seabird mortality in this trawl fishery is summarised in Table 7. The number of seabirds caught (11) was a slight increase from 2007/08, which was the lowest since recording began in the 2000/01 season. The birds caught were six black-browed albatrosses (*Thalassarche melanophrys*) and five white-chinned petrels (*Procellaria aequinoctialis*). It should be noted that not all the catch has been taken this seasons, thus further seabird mortality may occur. However, it is unlikely that any further fishing will occur.

Table 7: Number of seabirds killed in the trawl fishery in Subarea 48.3.
DIC – *Thalassarche chrysostoma*, DIM – *Thalassarche melanophrys*, PRO – *Procellaria aequinoctialis*.

Fishing season	Trawls observed	DIC	DIM	PRO	Other
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
2005/06	457	1	11	20	1
2006/07	111	1	2	3	
2007/08	206			3	2
2008/09	154		6	5	

22. WG-IMAF assessed the level of risk of incidental mortality of seabirds in Subarea 48.3 as a category 5 (high) (SC-CAMLR-XXVIII, Annex 7, Table 13 and Figure 2).

6.1 Mitigation measures

23. Conservation Measure 25-03 applies to this fishery.

24. Conservation Measure 42-01 has a further mitigation measure in that should any vessel catch a total of 20 seabirds, it shall cease fishing and shall be excluded from further participation in the fishery in the 2008/09 season.

7. Ecosystem implications/effects

25. 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. *Champscephalus 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 (WG-FSA-08/30). Icefish may also be consumed by juvenile toothfish in years of high icefish abundance at Shag Rocks.

26. 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. In January 2009, South Georgia was subject to an ecosystem anomaly (WG-EMM-09/23) driven by increased sea-surface temperature which caused a rapid and marked decline in krill abundance in the region. This in turn had an impact on predator performance, including significant changes to icefish diet which was dominated by amphipods rather than krill and is likely in part to have resulted in the decrease in yield in 2008/09.

8. Harvest controls and management advice

8.1 Conservation measures

27. The limits on the fishery for *C. gunnari* in Subarea 48.3 are defined in Conservation Measure 42-01. The limits in force and the Working Group's advice to the Scientific Committee for the forthcoming season are summarised in Table 8.

Table 8: Limits on the fishery for *Champscephalus gunnari* in Subarea 48.3 in 2008/09 (Conservation Measure 42-01) and advice to the Scientific Committee for 2009/10.

Element	Limits in force	Advice for 2009/10
Access (gear)	Trawling only Bottom trawl prohibited	Carry forward
Access (area)	Fishing prohibited within 12 n miles of South Georgia from 1 March to 31 May.	Carry forward
Catch limit	3 834 tonnes	Revise to 1 548 tonnes
Move-on rule	Move on if >100 kg caught of which >10% by number are <240 mm TL.	Carry forward
Season	15 November to 14 November	Review
By-catch	By-catch rates as in CM 33-01 to apply, plus move-on rule.	Carry forward
Mitigation	In accordance with CM 25-03. Use of net binding and additional weights to codend. Limit of 20 seabirds per vessel.	Carry forward
Seabirds	Any vessel catching 20 seabirds to cease fishing.	Carry forward
Observers	Each vessel to carry at least one CCAMLR scientific observer and may include one additional scientific observer.	Carry forward
Data	Five-day catch and effort reporting Haul-by-haul catch and effort data Biological data reported by the CCAMLR scientific observer.	Carry forward Carry forward Carry forward
Target species	<i>Champscephalus gunnari</i> By-catch is any species other than <i>C. gunnari</i> .	Carry forward
Research	No requirement.	Carry forward
Environmental protection	Regulated by CM 26-01. No offal discharge.	Carry forward

8.2 Management advice

28. The Working Group recommended that the catch limit for *C. gunnari* should be set at 1 548 tonnes in 2009/10 and 949 tonnes in 2010/11 based on the outcome of the short-term assessment.

29. The Working Group recommended that the season start date be altered to 1 December to reflect the start dates of other CCAMLR fishing seasons.