

Fishery Report: *Champscephalus gunnari* South Georgia (Subarea 48.3)

1. Details of the fishery

1.1 Reported catch

5.213 In Subarea 48.3, a pelagic or semi-pelagic trawl fishery targets *C. gunnari* (Table 5.45). During the 2003/04 season the fishery caught 2 686 tonnes between 9 December 2003 and 25 April 2004. The catch limit for the 2003/04 season was 2 887 tonnes (Conservation Measure 42-01).

Table 5.45: Catch history for *Champscephalus 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		-	1990/91	44*	26 000	
1977/78	7 472			1991/92	5*	0	
1978/79	809			1992/93	0	9 200	
1979/80	8 795			1993/94	13*	9 200	
1980/81	27 903			1994/95	10*	0	
1981/82	54 040			1995/96	0	1 000	
1982/83	178 824			1996/97	0	1 300	
1983/84	35 743			1997/98	6*	4 520	
1984/85	628			1998/99	265	4 840	1
1985/86	21 008			1999/00	4 114	4 036	2
1986/87	80 586			2000/01	960	6 760	6
1987/88	36 054	35 000		2001/02	2 667	5 557	7
1988/89	3*	0		2002/03	1 986	2 181	5
1989/90	8 135	8 000		2003/04	2 686	2 887	6

* Fishery closed, catch information from surveys.

1.2 IUU catch

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

1.3 Size distribution of the catches

5.215 Catch-weighted length frequencies from observer, fine-scale and STATLANT data are presented in Figure 5.20 for 1986 to 2004. These plots include data from both the commercial fishery and research trawl surveys.

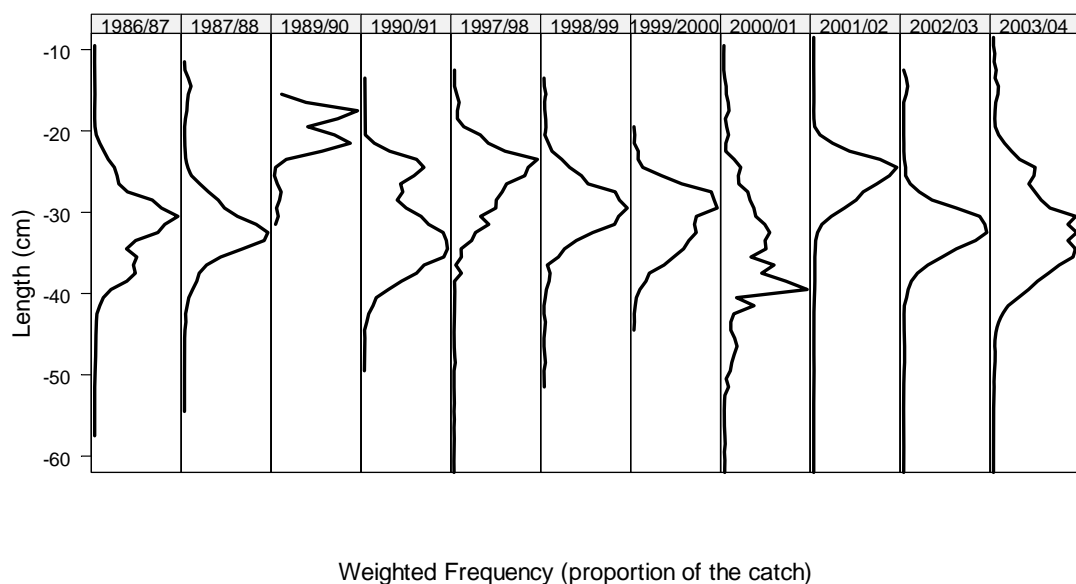


Figure 5.20: Catch-weighted length frequencies for *Champsocephalus gunnari* in Subarea 48.3 derived from observer, fine-scale and STATLANT data reported by 6 October 2004.

2. Stocks and areas

5.216 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. *C. 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

Standing stock

5.217 During WG-FSA-03, the Working Group agreed to use a combination of bottom trawl and acoustic surveys to estimate the standing stock of *C. gunnari* in Subarea 48.3. The Working Group also agreed that the UK standing stock estimate should be raised by a factor of 1.241 to account for differences in catchability (related to trawl headline height) of the UK and Russian surveys (SC-CAMLR-XXI, Annex 5, paragraphs 5.103 and 5.104).

Acoustic surveys

5.218 No new estimates of standing stock were available from acoustic surveys. The Working Group continues to investigate methods to combine acoustics with trawl survey data

to estimate the standing stock of icefish in line with recommendations in WG-FSA-03 (SC-CAMLR-XXII, Annex 5, paragraph 3.41) and discussions at WG-FSA-SAM (WG-FSA-SAM-04/10) (paragraphs 3.33 to 3.39). During the UK survey in Subarea 48.3, four additional days were allocated to acoustic survey work in conjunction with pelagic trawling. This work showed that *C. gunnari* of all ages spend time in midwater and reinforced the belief that a bottom trawl survey significantly underestimates *C. gunnari* biomass (WG-FSA-SAM-04/20), corroborating the results of the Russian trawl-acoustic survey in 2002 (WG-FSA-02/44, WG-FSA-SAM-04/10).

Trawl surveys

5.219 In January 2004 the UK undertook a random stratified bottom trawl survey of the South Georgia and Shag Rocks shelves (WG-FSA-04/85). The survey employed the same trawl gear and survey design as previous UK surveys in Subarea 48.3.

5.220 Following the procedure agreed at WG-FSA-03, estimates of standing stock were obtained using the bootstrap procedure, with the UK survey estimates (within 12 strata; Table 5.46) adjusted by a correction factor of 1.241, applied prior to the bootstrap procedure. An estimate of the lower one-sided 95% CI of biomass was calculated for the assessment and tabled below.

Table 5.46: Seabed areas of survey strata used to estimate biomass within the bootstrap procedure.

Component	Description	Value
Nominal date of survey	Mid-point	23 Jan 2004
Survey timing (days since start of year)		15
Seabed area of survey strata		km ²
1. Shag Rocks	1. 50–150 m	1 473.5
	2. 150–250 m	1 870.5
	3. 250–500 m	1 610
2. Northwest South Georgia	4. 50–150 m	1 816
	5. 150–250 m	2 189
	6. 250–500 m	2 068
3. Northeast South Georgia	7. 50–150 m	1 037
	8. 150–250 m	4 113
	9. 250–500 m	994
4. South South Georgia	10. 50–150 m	6 008
	11. 150–250 m	12 902
	12. 250–500 m	5 141
Bottom trawl survey	Bottom to 6 m	tonnes
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

5.221 The distribution of densities-at-age was derived using the CMIX program, with bounds for means estimated from von Bertalanffy growth parameters (Table 5.47) and the standard deviations linearly related to the means. Initial CMIX runs did not converge using data from the entire length-density distribution, so the CMIX analysis was re-run excluding fish greater than 400 mm from the analysis (age 6+ and over) and using the input parameters detailed in Table 5.47. The results (Table 5.48 and Figure 5.21) indicate a high density of 1+ fish. The Working Group noted that previous surveys had rarely caught 1+ fish, and the bottom trawl survey is considered to underestimate the 1+ age class. As a result, fish from the trawl survey did not provide a reliable estimate of biomass.

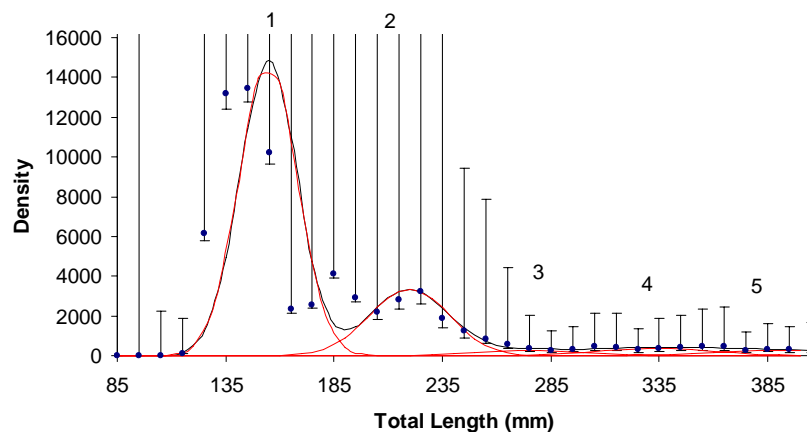


Figure 5.21: CMIX analysis of truncated length-density distribution from the 2004 bottom trawl survey in Subarea 48.3.

Table 5.47: Input parameters for the CMIX analysis of *Champscephalus gunnari* length density in Subarea 48.3.

Parameter	Value
Size range included	80–410 mm
Survey date	15
Birthday	245
t_0	-0.58
k	0.17
L_∞	557 mm
Proportion between cohorts	0.5
Number of cohorts	5
Bounds on intercept (start, step)	1, 50 (15, 1.0)
Bounds on slope (start, step)	0.0, 0.4 (0.07, 0.01)
No. function calls	1 000
Reporting frequency	100
Stopping criteria	1E-6
Freq. for convergence testing	5
Simplex expansion coefficient	1

Table 5.48: Results generated from CMIX for the truncated length-density distribution.

	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Comp. 5
Mean length (mm)	154.7	219.7	275.0	332.0	392.4
Standard deviations (mm)	12.9	18.0	22.3	26.7	31.4
Total density	49 476	15 284	1 618	2 458	2 236
SD of component density	64 027	10 851	1 238	1 785	1 170
Sum of observed densities =	72 891.8				
Sum of expected densities =	70 424.9				

5.222 The Working Group raised two points of concern over the results of the current 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. The large number of hauls with zero catch, a low number of samples, and the presence of high densities within few hauls led to higher mean length densities and very high standard errors.

5.223 Second, the fit to the age 1+ cohort was poor and had a very large standard deviation associated with it (cf. Figure 5.21). High values of length densities within individual length classes from a few hauls in the survey were thought to contribute to this issue. The patchy sampling of the 1+ (and to a lesser extent 2+) fish may be due to several factors, including variable gear selectivity and horizontal and vertical patchiness of fish distribution. These concerns warrant further intersessional investigation of the sensitivity of the recommended yield to the attribution of biomass to the age 1+ cohort.

5.224 The Working Group agreed that age 1+ fish should be excluded from the biomass estimate in the 2004/05 yield calculation. However, since age 1+ could be available to the fishery in the second year of the projection (as age 3+ fish), it was agreed to produce two estimates of yield in 2005/06 to either include or exclude these fish.

5.225 The 1+ fish were subtracted from the standing stock estimate by multiplying the biomass estimate by the proportion (by mass) of 1+ fish calculated in the CMIX output (Table 5.49). Due to the poor fit of the mixture analysis, the allocated biomass for age 1+ fish is believed to be an overestimate. The proportion of age 1+ fish removed from the total biomass can therefore be considered precautionary. The one-sided lower 95% CI of biomass of fish aged between 2+ and 5+, estimated from the 2004 UK bottom trawl survey, was 34 841 tonnes. The initial age structure was also revised to exclude age 1+ fish.

Table 5.49: Calculation of the proportion of biomass-at-age derived for the truncated length-density distribution.

Age	Density %	Mean length (mm)*	Mean weight (kg)	Density (numbers/km ²)	Prop. biomass
1	69.6	131	0.009	48 857	0.215
2	21.5	198	0.039	15 404	0.276
3	2.2	254	0.092	1 769	0.074
4	3.5	301	0.165	2 552	0.193
5	3.2	341	0.252	2 101	0.243

* Derived from VBGF

3.2 Parameter values

Fixed parameters

5.226 As in previous years, the Working Group noted several discrepancies between the length-frequency distributions of *C. gunnari* sampled at Shag Rocks and South Georgia (WG-FSA-04/85). Recent studies have analysed length-frequency data for each area (WG-EMM-03/7). The results indicate that *C. gunnari* at Shag Rocks have a similar growth rate to fish at South Georgia, but are approximately five months older. The Working Group agreed that this information could be helpful in resolving the length-frequency distribution and should be investigated within the intersessional period.

5.227 The fixed parameters remain unchanged from 2003 and are presented in Table 5.50.

Table 5.50: Fixed parameters used in the 2004 assessment of *Champscephalus 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)

5.228 Catches taken after the assessment of biomass from the bottom trawl survey (i.e. 23 January 2004) must be included within the assessment. These are detailed below.

Season	Catch (tonnes)
2003/04	1 114

Initial age structure

Total density of each mixture component

5.229 The proportion of density-at-age was derived from the CMIX program for ages 1+ to 5+. VBGF parameters were selected to calculate mean length at age (Table 5.50).

Selectivity

5.230 A linear selectivity vector was used for *C. gunnari*, starting at 2.5 years and fully selected at age 3. In 2003, the assessment used a linear selectivity vector starting at 2.0 years.

This value had been used because no age 1+ fish had been caught in the previous bottom trawl survey. Sensitivity analysis was used to explore the effect of changing the starting value in the current assessment (paragraph 5.233).

4. Stock assessment

4.1 Model structure and assumptions

5.231 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.

Model configuration

Table 5.51: GYM model configuration for the assessment of *Champscephalus 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

5.232 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. A short-term projection of yield was also derived for 2005/06 (Year 2) using 1+ fish:

	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

4.3 Sensitivity analyses

5.233 The appearance of age 1+ fish in the trawl survey prompted a review of the selectivity vector employed within the GYM. The effect of changing the starting age of the linear selectivity vector from 2.0 to 2.5 and 2.95 (knife-edge) was examined where all age 1+ fish were included in the assessment. The Working Group agreed to run the assessment using a starting age of 2.5, similar to that used for Division 58.5.2. Further investigation of the properties of the selectivity vector was recommended during the intersessional period.

4.4 Discussion of model results

5.234 The projection of age 2+ fish from 2003/04 gives a projected yield of 3 574 tonnes in the 2004/05 season. This value is considered to be very precautionary since the assessment does not take into account the pelagic component of the population. The Working Group agreed to recommend this catch limit.

4.5 Future research requirements

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

- (i) The acoustic protocol for assessing *C. gunnari* in Subarea 48.3, including:
 - (a) discrimination of *C. gunnari* from other acoustic scatterers
 - (b) further improvements in target strength estimates for *C. gunnari*
 - (c) age-specific patterns in daily vertical distribution of *C. gunnari*
 - (d) combination of trawl and acoustic indices for stock assessment.
- (ii) Explore the effect of using alternative growth parameters for Shag Rocks and South Georgia in the assessment.
- (iii) Examine in more detail why the mixture analysis had a poor fit to age 1+ fish.
- (iv) The proposed age determination workshop for *C. gunnari* in 2005 is expected to benefit the assessment in Subarea 48.3 (paragraphs 9.8 to 9.12).

5. By-catch of fish and invertebrates

5.1 By-catch removals

5.236 The total reported by-catch of fish taken in recent years is indicated in Table 5.52.

Table 5.52: Total reported by-catch (tonnes) for five species between 1998/99 and 2003/04. 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

5.2 Mitigation measures

5.237 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

5.238 Details of seabird by-catches this year are reported in paragraphs 7.205 to 7.212.

5.239 Seabird mortality in this trawl fishery is summarised in Table 5.53 (taken from Table 7.18).

Table 5.53: Number of seabirds killed in the trawl fishery in Subarea 48.3. DIC – *Diomedea chrysostoma*, DIM – *Thalassarche melanophrys*, PRO – *Procellaria aequinoctialis*, PWD – *Pachyptila desolata*, MAI – *Macronectes giganteus*.

Fishing season	Trawls observed	DIC	DIM	PRO	PWD	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

5.240 The species concerned are all listed as globally threatened; given the increased level and rate of seabird by-catch in 2003/04, consideration of a reduction in by-catch limits at both the vessel level and for the whole icefish trawl fishery in Subarea 48.3 was recommended (paragraphs 7.213 to 7.217).

6.1 Mitigation measures

5.241 Conservation Measure 25-03 applies to this fishery. For discussion of the problems of avoidance of seabird by-catch see SC-CAMLR-XXII, Annex 5, paragraphs 6.237 to 6.240. Further discussion of this year's approaches to mitigation in this fishery are provided in paragraphs 7.218 and 7.219. A proposal for further experiments, requiring relaxation of the current vessel seabird by-catch limit, was supported (paragraph 7.220).

7. Ecosystem implications/effects

5.242 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. *C. 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 2003/04 season and advice for 2004/05

8.1 Conservation measures

Table 5.54: Summary of provisions of Conservation Measure 42-01 for *Champocephalus gunnari* in Subarea 48.3 and advice to the Scientific Committee for the 2004/05 season.

Paragraph and topic	Summary of CM 42-01	Advice for 2004/05	Paragraph reference
1. Access (gear)	Trawling only Bottom trawl prohibited	Review	5.26–5.39
2. Access (area)	Fishing prohibited within 12 n miles of South Georgia from 1 March to 31 May.		
3. Catch limit	2 887 tonnes 722 tonnes between 1 March and 31 May	Revise to 3 574 tonnes	5.232
4. Move-on rule	Move on if >100 kg caught of which >10% by number are <240 mm TL.		
5. Season	1 December 2003 to 30 November 2004		
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.	Review	7.214– 7.217
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	<i>Champocephalus gunnari</i> By-catch is any species other than <i>C. gunnari</i> .		
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.		