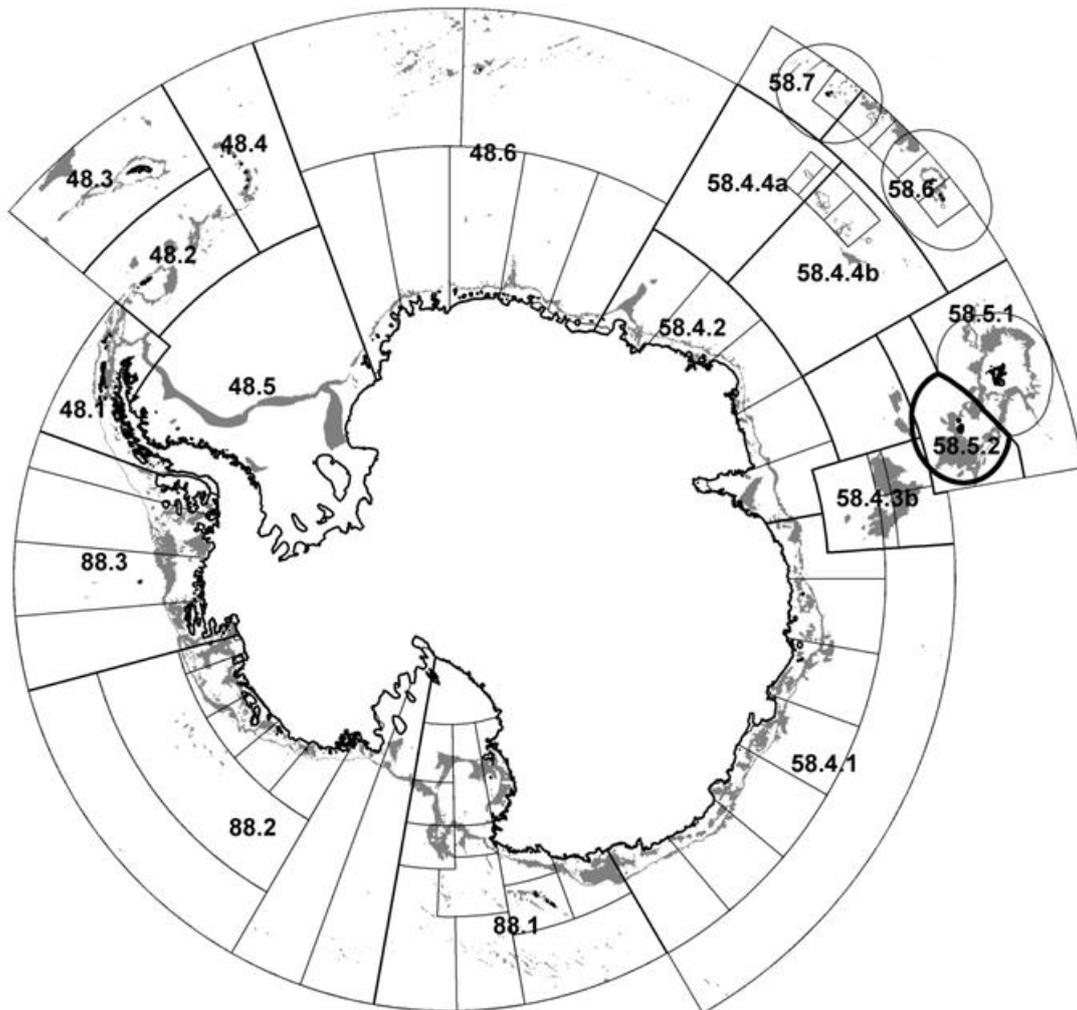


**Fishery Report 2014: *Chamsocephalus gunnari*  
Heard Island (Division 58.5.2)**



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The map on the cover page shows the management areas within the CAMLR Convention Area, the specific region related to this report is outlined in bold. Depths between 600 and 1 800 m are shaded.

Throughout this report the CCAMLR fishing season is represented by the year in which that season ended, e.g. 2014 represents the 2013/14 CCAMLR fishing season (from 1 December 2013 to 30 November 2014).

## **Fishery Report 2014: *Champsocephalus gunnari* Heard Island (Division 58.5.2)**

### **Introduction to the fishery**

1. An Australian licensed trawl fishery in Division 58.5.2 for mackerel icefish (*Champsocephalus gunnari*) began in 1997. Other nations fished in these waters during the 1970s until the declaration of the Australian Fishing Zone (AFZ) in 1979. This division, located between 50°–56°S and 60°–80°E, includes the Australian AFZ at Heard Island, and to the north borders the French exclusive economic zone (EEZ) around Kerguelen Island. The fishing methods used in this fishery are midwater and bottom trawl.
2. *Champsocephalus gunnari* is a member of the family Channichthyidae. It is most abundant at depths of less than 350 m in the waters surrounding Heard Island. In this area they grow to a maximum length of around 45 cm and a maximum age of 6 years. Size at first maturity for females is 26.5 cm and for males is 28.5 cm total length (Williams et al., 2001).
3. The limits on the trawl fishery for *C. gunnari* in Division 58.5.2 are described in Conservation Measure (CM) 42-02. In 2014, the fishing season started on 1 December 2013 and ended on 30 November 2014. The catch limit of *C. gunnari* for 2014 was 1 267 tonnes.

### **Reported catches**

4. In 2014, fishing was conducted by one vessel and the total reported catch was 1 123 tonnes. Historical reported catches of *C. gunnari*, along with catch limits and number of vessels active in the fishery, are shown in Table 1.

### **IUU catch**

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

### **Length distribution of the catches**

6. Length frequencies for *C. gunnari* from 2005 to 2014 are presented in Figure 1. These length-frequency distributions of catches are unweighted and the interannual variability shown in the figure may reflect differences in the fished population, but is also likely to be affected by changes in factors such as the characteristics of the gear, the number of vessels in the fishery and the spatial and temporal distribution of fishing. In the case of Division 58.5.2, an additional factor to consider is whether commercial fishing or only research survey data predominated in any season. Nevertheless, the length frequencies for *C. gunnari* in Division 58.5.2 typically show a single dominant age/size cohort progressing through the population over consecutive years.

Table 1: Catch history for *Champscephalus gunnari* in Division 58.5.2. (Source: STATLANT data for past seasons, and catch and effort reports for current season.)

Season	Vessels fishing	Catch limit (tonnes)	Reported catch (tonnes)
1972	-	-	5 860
1974	-	-	7 525
1975	-	-	9 710
1977	-	-	15 201
1978	-	-	5 166
1990	-	-	2
1992	-	-	5
1993	-	-	3
1995	-	311	0
1996	-	311	0
1997	1	311	227
1998	3	900	115
1999	1	1 160	2
2000	2	916	137
2001	2	1 150	1 136
2002	2	885	865
2003	2	2 980	2 345
2004	2	292	78
2005	2	1 864	1 851
2006	1	1 210	660
2007	1	42	1
2008	1	220	199
2009	1	102	83
2010	1	1 658	352
2011	1	78	1
2012	-	0*	4
2013	1	679	644
2014	1	1267	1123

\* 30 tonne research and by-catch limit applied.

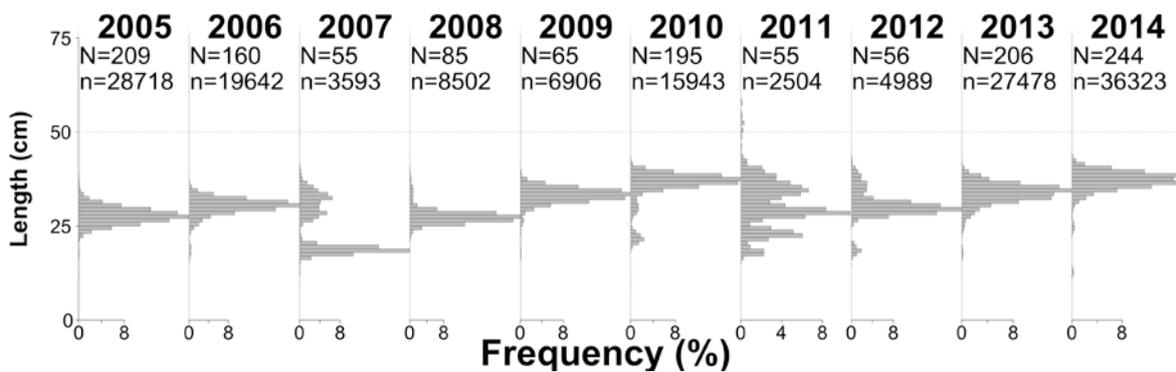


Figure 1: Length frequencies for *Champscephalus gunnari* in Division 58.5.2 from 2005 to 2014, using observer data from both the commercial fishery and research trawl surveys with the number of hauls (N) and the number of fish measured (n) in each year at the top of each pane.

7. Only catch-weighted length-frequency data derived from a random stratified trawl survey are used in assessments in this fishery, as provided in the relevant section of this report.

### **Stock identification and stock hypothesis**

8. Within Division 58.5.2, *C. gunnari* is restricted to the shelf area in the vicinity of Heard Island in water generally shallower than 500 m, and a non-contiguous area at Shell Bank to the northeast of the islands. The Heard Plateau and Shell Bank populations have different size structures and recruitment patterns. In 1997, WG-FSA agreed that in light of this, the two areas should be treated as separate stocks for assessment purposes (see SC-CAMLR-XVI, Annex 5, paragraph 4.277). Shell Bank has been closed to fishing since 1997 due to low population densities observed in annual surveys from 1997 to 2005.

### **Life-history parameters**

#### **Data collection**

##### Survey results

9. The results of the bottom trawls undertaken during the annual random stratified trawl survey for the assessment of *C. gunnari* stocks in June 2014 were presented in WG-FSA-14/41. The survey sampled the stocks in the Gunnari Ridge, Plateau West and Plateau Southeast strata, areas known to have high *C. gunnari* abundance. The survey was undertaken to the same design as previous surveys for this region. The location of sample stations in the three main icefish strata and catch-per-unit-effort in relation to Heard Island and McDonald Islands is shown in Figure 2. Outside of the three main icefish strata, only those stations where icefish were caught are shown. Unusually, some icefish were found in the area northwest of Heard Island, around Pike Bank.

10. The survey showed that abundance of *C. gunnari* was less than half of that of the 2013 survey, but still higher than the long-term average from 2006 to 2013.

#### **Parameter estimates**

##### Fixed parameters

11. The length–weight parameters were re-estimated using the fish sampled during the 2014 survey. The analysis resulted in estimates of weight at length that were slightly higher than the previous years' estimates.

12. Growth parameters were re-evaluated in 2011 from the size at age for cohorts that were sufficiently large for their modal length and well characterised in assessments. These values were used in the assessment for the 2014 season. Other fixed parameters remain unchanged from previous assessments (Table 2).

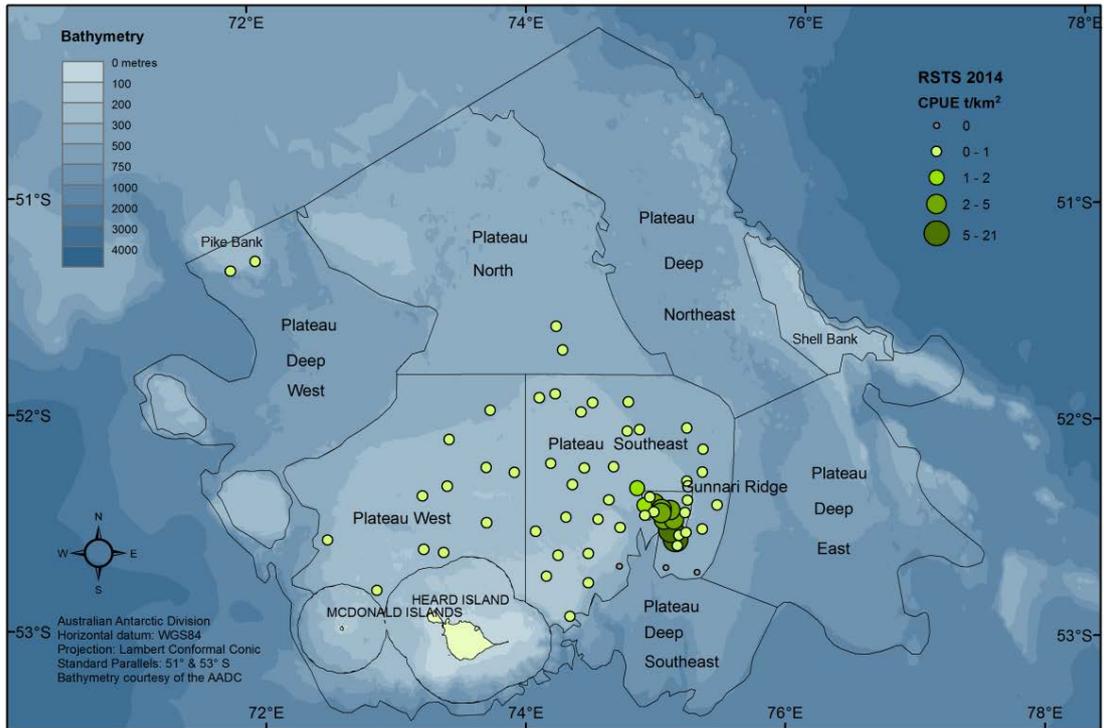


Figure 2: Strata and sampling hauls from the 2014 random stratified trawl survey in Division 58.5.2 used in the 2014 *Champscephalus gunnari* assessment. Points are locations of hauls, with 10 stations in Plateau West, 18 stations in Gunnari Ridge and 30 stations in Plateau Southeast. Points outside these strata show stations only where icefish were caught.

Table 2: Fixed parameters used in the 2014 assessment of *Champscephalus gunnari* in Division 58.5.2.

Component	Parameter	Value	Units
Natural mortality	$M$	0.4	$y^{-1}$
VBGF	$K$	0.379	$y^{-1}$
VBGF	$t_0$	0.057	$y$
VBGF	$L_\infty$	438	mm
Length-to-weight	' $a$ '	$8.123 \times 10^{10}$	kg/mm
Length-to-weight	' $b$ '	3.34	

### Standing stock

13. Estimates of standing stock biomass for the Heard Island Plateau were made using a bootstrap procedure to calculate the one-sided lower 95% confidence bound on the trawl survey estimate (method outlined in WG-FSA-10/12, Appendix 1), using data from the most recent (2014) survey. The estimates of the mean and one-sided lower 95% confidence intervals (CI) of biomass are shown in Table 3.

Table 3: Abundance (tonnes) of *Champscephalus gunnari* in the vicinity of Heard Island in Division 58.5.2 estimated by bootstrapping hauls from the trawl survey in June 2014. SE = standard error; Lower CI, Upper CI = lower and upper confidence intervals respectively; LOS 95% CI = lower one-sided 95% confidence interval.

Stratum	Mean	SE	Lower CI	Upper CI	LOS 95% CI
Gunnari Ridge	2237	759	955	3826	1118
Plateau SE	2264	499	1375	3287	1499
Plateau W	4501	380	1272	6403	1376
Pooled	6457	2669	5457	8555	4861

### Selectivity

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

### Recruitment

15. The short-term projection of *C. gunnari* does not include recruitment data.

### Initial age structure and proportion of biomass-at-age

16. Estimates of the age structure and the proportion of biomass at age (Table 4) show that the 3+ age class was dominant in the population in 2014, forming 92% of the biomass present across the survey area.

### **Stock assessment status**

17. A full stock assessment is carried out for *C. gunnari* at Heard Island and McDonald Islands every year. The generalised yield model is used routinely for the assessment of long-term yield of *C. gunnari* in the CAMLR Convention Area. The precautionary approach developed by CCAMLR requires the calculation of the level of mortality that would result in a probability not greater than 0.05 that the spawning stock would be less than 75% of the level it would have been if fishing had not occurred. This estimate is calculated using the bootstrap one-sided lower 95% confidence bound on the trawl survey biomass estimate, giving a two-year projection of the catch.

Table 4: Calculation of the proportion of biomass at age derived from the 2014 survey length density, using length–weight parameters re-estimated in 2014.

Age class	Mean length (mm)	Density (n km <sup>-2</sup> )	Mean weight (kg)	Proportion of biomass (%)
0+	85	2.8	0.002	0.0
1+	207	508.3	0.043	5.0
2+	314	244.4	0.174	9.6
3+	365	417.5	0.288	27.2
4+	394	570.7	0.369	47.7
5+	420	103.2	0.446	10.4

### Discussion of model results

18. WG-FSA-13 recommended fishing yields in 2013/14 estimated under a one-year projection in WG-FSA-13/23 would ensure 75% escapement of the 3+ cohort present in the 2013 survey, with the expectation that there will be no further commercial fishing on this cohort in 2014/15 (SC-CAMLR-XXXII, Annex 6, paragraphs 4.8 to 4.15). Consequently, the assessment scenarios run this year (2014) only included the biomass estimated to be made up by the 1+ to 3+ cohorts that have yet to be exploited commercially.

19. The scenarios used for the 2014 stock assessment used the approach employed in previous years (see ‘Decision rules’ in Appendix 1), with the exception noted in the previous paragraph and using updated length–weight parameters. Estimates of yield indicate that 309 tonnes of icefish could be taken in 2014 and 275 tonnes in 2015, allowing 75% escapement of biomass over two years.

### Future research requirements

20. There were no additional future research requirements recommended at WG-FSA-14.

### By-catch of fish and invertebrates

#### Fish by-catch reported

21. The total reported by-catch (tonnes) of fish taken in the trawl fishery for *C. gunnari* in recent years is indicated in Table 5 from fine-scale C2 data. By-catch of unicorn icefish (*Channichthys rhinoceratus*) reached a historical high in 2013/14, apparently associated with the increasing biomass of this species observed in recent surveys, and the tendency for aggregations of *C. rhinoceratus* to form in the same areas where *C. gunnari* is targeted.

Table 5: Total reported by-catch (tonnes) of four species in the *Champscephalus gunnari* trawl fishery. Limits apply to all fisheries in Division 58.5.2. (Source: fine-scale data.)

Season	<i>Channichthys rhinoceratus</i> (tonnes)		<i>Lepidonotothen squamifrons</i> (tonnes)		<i>Macrourus</i> spp. (tonnes)		Rajids (tonnes)		Other catch (tonnes)	
	Limit	Reported	Limit	Reported	Limit	Reported	Limit	Reported	Limit	Reported
1998	80	2	325	3		0	120	<1	50	2
1999	150	<1	80	<1		<1		<1	50	<1
2000	150	2	80	<1		<1		<1	50	<1
2001	150	1	80	<1	50	0	50	<1	50	<1
2002	150	3	80	<1	50	<1	50	<1	50	<1
2003	150	21	80	<1	465	<1	120	20	50	5
2004	150	6	80	<1	360	<1	120	3	50	1
2005	150	34	80	<1	360	<1	120	5	50	3
2006	150	29	80	<1	360	<1	120	7	50	2
2007	150	3	80	<1	360	0	120	<1	50	<1
2008	150	8	80	<1	360	<1	120	2	50	7
2009	150	7	80	<1	360	<1	120	7	50	8
2010	150	52	80	<1	360	<1	120	12	50	6
2011	150	1	80	1	360	<1	120	<1	50	2
2012	150	0	80	0	360	0	120	0	50	0
2013	150	48	80	2	360	<1	120	16	50	15
2014	150	144	80	5	360	<1	120	9	50	16

### Assessments of impact on affected populations

22. No stock assessments of individual by-catch species were undertaken in 2014. The catch limits of *C. rhinoceratus* and grey rockcod (*Lepidonotothen squamifrons*) are based on assessments carried out in 1998 (SC-CAMLR-XVII, Annex 5, paragraphs 4.204 to 4.206) and by-catch limits of the ridge-scaled grenadier (*Macrourus carinatus*) are based on assessments carried out in 2002 and 2003 (SC-CAMLR-XXII, Annex 5, paragraphs 5.244 to 5.249).

### Mitigation measures

23. A number of conservation measures, which ensure that impacts on the target and other species are minimised, currently apply to this fishery. CM 42-02 defines the boundaries of the fishery area, the season, the catch limit and the move-on rules if large quantities of *C. gunnari* smaller than the specified minimum legal length of 240 mm are caught in a single haul. CM 33-02 specifies that there should be no directed fishing for species other than the target species, the by-catch limits for incidentally caught species and the move-on rules if the limits for any one haul are exceeded (Table 7).

## Incidental mortality of birds and mammals

### Incidental mortality reported

24. Seabird by-catch in the fishery targeting *C. gunnari* in Division 58.5.2 remains low with no observed seabird mortality for the 2014 season. The mortalities of grey-headed albatross (*Thalassarche chrysostoma*), black-browed albatross (*T. melanophrys*) and white-chinned petrel (*Procellaria aequinoctialis*) since 2002 are summarised in Table 6.

Table 6: Number of seabirds killed in the trawl fishery in Division 58.5.2.

Fishing season	Trawls observed	<i>Thalassarche chrysostoma</i>	<i>T. melanophrys</i>	<i>Procellaria aequinoctialis</i>	Other
2002	186				
2003	332		1	1	
2004	49				3
2005	249		6	2	
2006	198				
2007	83				
2008	92				
2009	39				
2010	180				1
2011	61				
2012	58				
2013	209				
2014	249				

25. No incidents of marine mammal by-catch have been observed while fishing for *C. gunnari*.

### Identification of levels of risk

26. The level of risk of incidental mortality of seabirds in Division 58.5.2 is category 4 (average-to-high) (SC-CAMLR-XXX, Annex 8, paragraph 8.1).

### Mitigation measures

27. CM 25-03 is in force to minimise the incidental mortality of seabirds and marine mammals. Measures include the prohibition on the discharge of offal and discards during the shooting and hauling of trawl gear, and developing gear configurations which minimise the chance of birds encountering the net.

### Ecosystem implications/effects

28. Bottom trawl and midwater trawl gear is used to target both *C. gunnari* and Patagonian toothfish (*Dissostichus eleginoides*) in Division 58.5.2. The potential impacts of fishing gear on benthic communities are limited by the small area of commercial trawl grounds, a strategy

of fishing trawling gear lightly and the protection of large areas sensitive to the effects of bottom trawling within the Heard Island and McDonald Islands Marine Reserve, an IUCN Category 1a reserve, where fishing is prohibited. This marine reserve covers a total area of 71 200 km<sup>2</sup>, which in March 2014 was extended by 6 200 km<sup>2</sup>.

29. Research is currently being undertaken by Australia to develop ecosystem models for the Heard Island Plateau, including *C. gunnari* and their main predators, which will subsequently be used to inform management strategy evaluations on the *C. gunnari* fishery (SC-CAMLR-XXVI/BG/06, paragraph 21).

### Current management advice and conservation measures

30. In 2011 it was agreed that, where the stock assessment of *C. gunnari* in Division 58.5.2 indicated a stock biomass of less than 1 000 tonnes, or where the decision rules indicated a catch limit of less than 100 tonnes, a commercial catch limit would not be set. Instead, a 30 tonne combined research and by-catch limit would apply, which would allow the annual trawl survey to continue to allow monitoring the stock, and accommodate the incidental catch of *C. gunnari* that may occur in the *D. eleginoides* trawl fishery in this division.

31. The limits on the fishery for *C. gunnari* in Division 58.5.2 are defined in CM 42-02 and are summarised in Table 7.

Table 7: Limits on the fishery for *Champscephalus gunnari* in Division 58.5.2 in force (CM 42-02).

Element	Limits in force
Access (gear)	Trawling only
Access (area)	Definition of area open for fishing Chart illustrating area open (Annex 42-02/A)
Catch limit	309 tonnes
Move-on rule	Move on if >100 kg <i>Champscephalus gunnari</i> caught of which >10% by number are less than minimum size (24 cm)
Season	1 December to 30 November
By-catch	By-catch rates as in CM 33-02 to apply: <i>Channichthys rhinoceratus</i> <150 tonnes, <i>Lepidonotothen squamifrons</i> <80 tonnes, <i>Macrourus</i> spp. <360 tonnes and skates and rays <120 tonnes
Mitigation	In accordance with CM 25-03, minimisation of risk of the incidental mortality of seabirds and marine mammals
Observers	Each vessel to carry at least one CCAMLR scientific observer and may include one additional scientific observer
Data	Ten-day reporting system as in Annex 42-02/B Monthly fine-scale reporting system as in Annex 42-02/B on haul-by-haul basis Fine-scale reporting system as in Annex 42-02/B. Reported in accordance with the Scheme of International Scientific Observation

(continued)

Table 7 (continued)

Element	Limits in force
Target species	<i>C. gunnari</i> By-catch is any species other than <i>C. gunnari</i>
Environmental protection	Regulated by CM 26-01 Includes no offal discharge or dumping of discards

## Reference

Williams, R., E. van Wijk, A. Constable and T. Lamb. 2001. The fishery for *Champscephalus gunnari* and its biology at Heard Island (Division 58.5.2). Document WAMI-01/04. CCAMLR, Hobart, Australia: 26 pp.

## Stock assessment

### Population structure

A1. The distribution of densities at age was derived using the CMIX program (using input parameters in Table A1) consisting of six year classes from 0+ to 5+ and substantial recruitment of juvenile (<3+) cohorts (Figure A1). Unusually, some very small fish, with an estimated modal length of ~85 mm were present in small numbers in the survey. Details of the fit are presented in Table A2.

Table A1: Input parameters for the CMIX analysis of *Champocephalus gunnari* length density in Division 58.5.2 for 2014.

Parameter	Value
Size range included	80–450 mm
Bounds	Age 0+: 70–90mm Age 1+: 190–210 mm Age 2+: 300–330 mm Age 3+: 345–365 mm Age 4+: 366–400 mm Age 5+: 401–420 mm
SDs related linearly to the mean	Yes
Bounds on intercept (start, step)	1, 10 (3, 1.0)
Bounds on slope (start, step)	0.0, 0.03 (0.01, 0.001)
No. of function calls	10 000
Reporting frequency	100
Stopping criteria	1E-10
Frequency for convergence testing	5
Simplex expansion coefficient	1

Table A2: Results generated from CMIX analyses for *Champocephalus gunnari* from the 2014 random stratified trawl survey in Division 58.5.2.

	Mixture components					
	1 (0+)	2 (1+)	3 (2+)	4 (3+)	5 (4+)	6 (5+)
Mean length (mm)	84	207	314	36.5	393	416
SD (mm)	6.5	10.0	13.1	14.5	15.3	16.0
Intercept of CV	4.1					
Slope of CV	0.02					
Total density (n km <sup>-2</sup> )	2.8	508.3	244.4	417.5	570.7	103.2
SD (n km <sup>-2</sup> )	2.9	123.1	52.3	134.4	231.2	243.3
Sum of observed densities	1891.8					
Sum of expected densities	1845.9					

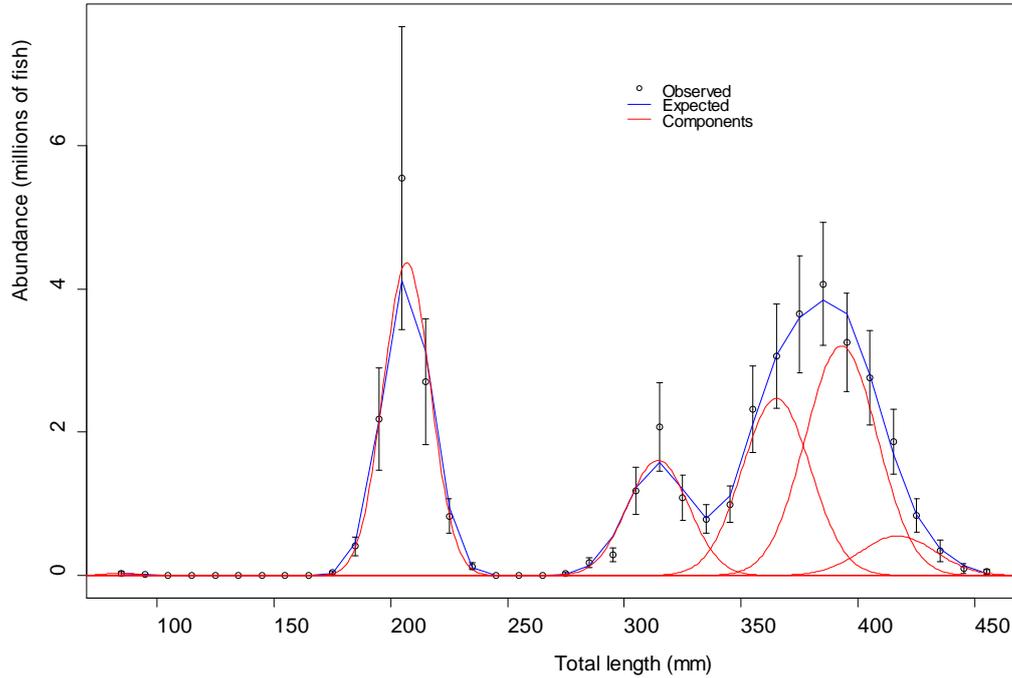


Figure A1: Size distribution of *Champsocephalus gunnari* from the 2014 random stratified trawl survey in Division 58.5.2 with standard errors. Cohorts were present in ages 0+ to 5+.

### Stock assessment model

A2. The generalised yield model (GYM), used routinely for the assessment of long-term yield of this species in the CAMLR Convention Area, was configured to perform the short-term projection. The model configuration is provided in Table A3.

Table A3: GYM model configuration for the assessment for 2014 of *Champsocephalus gunnari* in Division 58.5.2.

Category	Parameter	Values
Age structure	Recruitment age	2 years
	Plus class accumulation	10 years
	Oldest age in initial structure	11 years
Initial population structure	Age-class density	See Table A2
Weight-at-length	Weight-length parameter – A (kg)	$8.123 \times 10^{-10}$ kg
	Weight-length parameter – B	3.34
Maturity	$L_{m50}$ (set so that the status of the whole stock is being monitored)	0 mm <sup>1</sup>
	Range: 0 to full maturity	0 mm
Spawning season	Set so that status of the stock is determined at the end of each year	30 Nov–30 Nov
Fishery information	Upper bound to annual $F$	5
	Tolerance to finding $F$	1E-05

(continued)

Table A3 (continued)

Category	Parameter	Values
Future projection	Age first selected	2.5
	Age fully selected	3.0
	Relative fishing effort	Date: 1 Dec, Effort: 1
Fishery parameters	Age first selected	2.5
	Age fully selected	3.0
Simulation specifications	Number of runs in simulation	1
Individual trial	Years to remove initial age structure	1 <sup>2</sup>
Specifications	Year prior to projection	2013 <sup>3</sup>
	Reference start date in year	1 Dec
	Increments in year	365
	Years to project stock in simulation	2
	Reasonable upper bound for annual $F$	5.0
	Tolerance for finding $F$ in each year	0.000001

<sup>1</sup> Maturity is not used in the short-term projection. It is set to 0 to allow the GYM to monitor the whole population.

<sup>2</sup> Set to 0 when no icefish were captured after the survey, else set to 1.

<sup>3</sup> GYM requires first year of the 2013/14 split-year.

## Decision rules

A3. To assess a catch level such that fishing should not, without any substantial risk (specified in this instance as no more than 5% probability):

reduce the spawning stock biomass to below 75% of the level that would occur in the absence of fishing within the two years following an abundance biomass estimate provided by a survey.

A4. To achieve this, the lower one-sided 95% confidence bound of the biomass estimate was used as the estimate of the standing stock biomass at the start of the projection period. To allow the fishery to exploit abundant age classes prior to their disappearance from the population, past management advice has included provisions to take a higher catch in the first year of the two-year projection frame, while still satisfying the decision rule requiring 75% escapement over two years (e.g. SC-CAMLR-XXVIII, paragraph 4.132). In that case, two scenarios can be run:

- (i) using the typical two-year projection of all cohorts in the population, and estimating the catch, spread across two years, that would ensure 75% escapement
- (ii) estimating the catch from the current 3+ cohort that would ensure 75% escapement over one year, combined with that for the 1+ and 2+ cohorts with catch that would allow ensure 75% escapement over two years.

A5. In 2014 only scenario (i) was considered.

## **Sensitivity analyses**

A6. Sensitivity tests indicated that the convention of using the lower one-sided 95th percentile of the survey biomass estimate is effective in accounting for uncertainty in mortality and growth rates.