

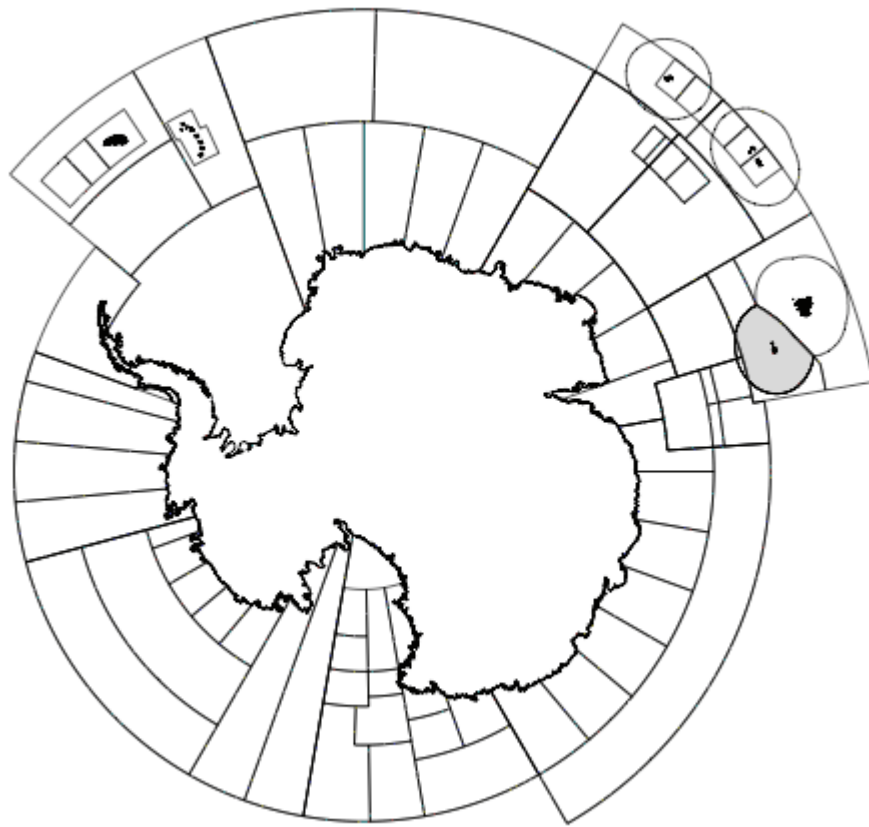


CCAMLR

Commission for the Conservation of Antarctic Marine Living Resources
Commission pour la conservation de la faune et la flore marines de l'Antarctique
Комиссия по сохранению морских живых ресурсов Антарктики
Comisión para la Conservación de los Recursos Vivos Marinos Antárticos

Fishery Report 2016: *Chamsocephalus gunnari* Heard Island (Division 58.5.2)

FISHERY REPORT



The map above shows the management areas within the CAMLR Convention Area, the specific region related to this report is shaded.

Throughout this report the CCAMLR fishing season is represented by the year in which that season ended, e.g. 2015 represents the 2014/15 CCAMLR fishing season (from 1 December 2014 to 30 November 2015).

**Fishery Report 2016: *Champscephalus 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 (*Champscephalus 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 exclusive economic zone (EEZ) at Heard Island, and to the north borders the French EEZ around Kerguelen Island. The fishing methods used in this fishery are midwater and bottom trawl.
2. *Champscephalus 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.

Reported catches

3. The limits on the trawl fishery for *C. gunnari* in Division 58.5.2 are described in Conservation Measure (CM) 42-02. The catch limit of *C. gunnari* for 2016 was 482 tonnes.
4. In 2016, fishing was conducted by one vessel and the total reported catch was 469 tonnes. Historical reported catches of *C. gunnari*, along with catch limits and number of vessels active in the fishery, are shown in Table 1.

Illegal, unreported and unregulated (IUU) fishing activity

5. There has been no recorded evidence of illegal, unreported and unregulated (IUU) fishing activities in this fishery.

Length distribution of the catches

6. Length frequencies for *C. gunnari* from 2007 to 2016 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 *Champsocephalus gunnari* in Division 58.5.2. (Source: STATLANT data for past seasons, and catch and effort reports for the current season.)

Season	Vessels fishing	Catch limit (tonnes)	Reported catch (tonnes)
1972	-	-	5860
1974	-	-	7525
1975	-	-	9710
1977	-	-	15201
1978	-	-	5166
1990	-	-	2
1992	-	-	5
1993	-	-	3
1995	-	311	0
1996	-	311	0
1997	1	311	227
1998	3	900	115
1999	1	1160	2
2000	2	916	137
2001	2	1150	1136
2002	2	885	865
2003	2	2980	2345
2004	2	292	78
2005	2	1864	1851
2006	1	1210	660
2007	1	42	1
2008	1	220	199
2009	1	102	83
2010	1	1658	352
2011	1	78	1
2012	-	0*	4
2013	1	679	644
2014	1	1267	1123
2015	2	309	96
2016	1	482	469

* 30 tonne research and by-catch limit applied.

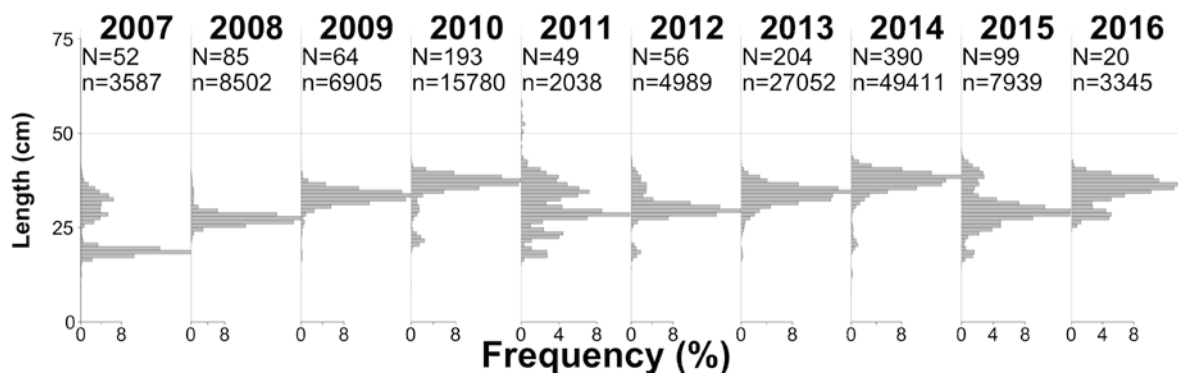


Figure 1: Length frequencies for *Champsocephalus gunnari* in Division 58.5.2 from 2007 to 2016, using observer data from both the commercial fishery and research trawl surveys with the number of hauls (N) and the number of fish measured (n) in each year at the top of each pane (data for 2016 incomplete).

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, the Working Group on Fish Stock Assessment (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 April 2016 were presented in WG-FSA-16/23. 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 locations of sample stations in the three main icefish strata and catch-per-unit-effort in relation to Heard Island and the McDonald Islands are shown in Figure 2.

10. The survey showed that abundance of *C. gunnari* was five times that of the 2015 survey, and nearly three times the long-term average from 2006 to 2014.

Parameter estimates

Fixed parameters

11. The length-weight parameters were re-estimated using the fish sampled during the 2015 survey. The analysis resulted in estimates of weight at length that were slightly lower 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 2016 season. Other fixed parameters remain unchanged from previous assessments (Table 2).

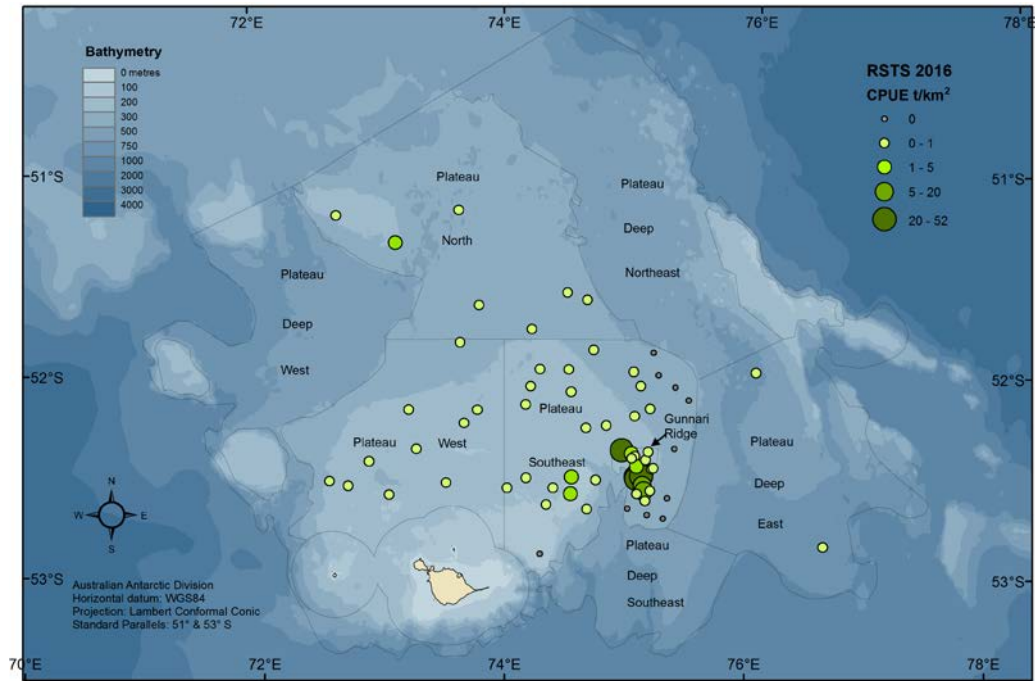


Figure 2: Strata and sampling hauls from the 2016 random stratified trawl survey in Division 58.5.2 used in the 2016 *Champocephalus gunnari* assessment. Points are locations of hauls, with 10 stations in Plateau West, 18 stations in Gunnari Ridge and 30 stations in Plateau Southeast.

Table 2: Fixed parameters used in the 2015 assessment of *Champocephalus 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_∞	438	mm
Length-to-weight	' a '	1.32×10^9	kg/mm
Length-to-weight	' b '	3.247	

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 (2015) 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 April 2016. 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	4397	1438	1864	7426	2180
Plateau Southeast	3240	1491	1209	6640	1346
Plateau West	1044	261	572	1588	632
Pooled	8681	2081	5031	13121	5490

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 2+ age class was dominant in the population in 2016, forming 69% of the biomass present across the survey area. The age classes 3+ and 4+ were also in high abundance, at 30% and 27% of the biomass respectively.

Table 4: Calculation of the proportion of biomass at age derived from the 2016 survey length density, using length–weight parameters re-estimated in 2016.

Age class	Mean length (mm)	Density (n km ⁻²)	Mean weight (kg)	Proportion of biomass (%)
1+	190	3.5	0.03	0.03
2+	281	1437.9	0.12	42.13
3+	351	495.8	0.24	29.89
4+	381	344.3	0.32	27.08
5+	430	7.5	0.47	0.87

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.

Discussion of model results

18. The stock projection used the proportion of overall biomass made up by the 1+, 2+ and 3+ cohorts (72.05%, Table 4). This means that with an overall lower 95% CI of 5 490 tonnes (Table 3), the initial biomass used in the projection was 3 955 tonnes.

19. The scenarios used for the 2016 stock assessment used the approach employed in previous years (see ‘Decision rules’ in Appendix 1), using updated length–weight parameters. Estimates of yield indicate that 561 tonnes of icefish could be taken in 2017 and 402 tonnes in 2018, allowing 75% escapement of biomass over two years.

Future research requirements

20. The Working Group (2016) noted that it was useful to provide side-by-side length-frequency plots for Divisions 58.5.1 and 58.5.2 to investigate comparative trends in length-frequencies of catches of *C. gunnari* in these divisions over time.

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 rhinoceros*) reached a historical high in 2014, apparently associated with the increasing biomass of this species observed in recent surveys, and the tendency for aggregations of *C. rhinoceros* to form in the same areas where *C. gunnari* is targeted.

Assessments of impact on affected populations

22. Quantitative risk assessments of *C. rhinoceros* and Caml grenadier (*Macrourus caml*) were undertaken in 2015 and presented in WG-FSA-15/50 and 15/63 respectively. WG-FSA recommended the catch limits be set to 1 663 tonnes for *C. rhinoceros*. It also recommended that the limit derived from the risk assessment in WG-FSA-15/63 of 409 tonnes should apply for *M. caml* and Whitson’s grenadier (*M. whitsoni*) combined, and the limit derived from the previous assessment of 360 tonnes should apply for bigeye grenadier (*M. holotrachys*) and ridge-scaled grenadier (*M. carinatus*) combined. The catch

limits of grey rockcod (*Lepidonotothen squamifrons*) are based on assessments carried out in 1998 (SC-CAMLR-XVII, Annex 5, paragraphs 4.204 to 4.206). Catch limits for rajids (*Bathyraja* spp.) were set in 1997 (SC-CAMLR-XVI, paragraphs 5.119 to 5.122).

Table 5: Total reported by-catch (tonnes) of four species in the *Champsoccephalus 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
2015	150	6	80	<1	360	<1	120	<1	50	2
2016	1663	119	80	<1	769 ¹	<1	120	28	50	10

¹ The catch limits for Macrourids are 409 tonnes for *M. caml* and *M. whitsoni* combined and 360 tonnes for *M. holotrachys* and *M. carinatus* combined. Since few macrourids are caught in this fishery, the catch limits have been added together in this table.

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 seabirds and marine mammals

Incidental mortality reported

24. Bird by-catch in the fishery targeting *C. gunnari* in Division 58.5.2 remains low with no observed bird mortality since the 2010 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 birds 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				
2015	165				
2016	160				

25. No incidents of mammal by-catch have been observed while fishing for *C. gunnari* in Division 58.5.2.

Identification of levels of risk

26. The level of risk of incidental mortality of birds 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 birds and 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 km², including an additional 6 200 km² that was added in March 2014.

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	2017 – 561 tonnes and 2018 – 402 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	Fishing shall cease if the by-catch limit of any species, as set out in CM 33-02, is reached: <i>Channichthys rhinoceratus</i> 1 663 tonnes <i>Lepidonotothen squamifrons</i> 80 tonnes <i>Macrourus carinatus</i> and <i>M. holotrachys</i> 360 tonnes <i>Macrourus caml</i> and <i>M. whitsoni</i> 409 tonnes Skates and rays 120 tonnes

(continued)

Table 7 (continued)

Move-on-rule	<p>If the catch limits for any one haul, as set out in CM 33-02, are reached, the vessel must not fish using that method within 5 n miles of the location for at least 5 days:</p> <p><i>Channichthys rhinoceratus</i> 5 tonnes <i>Macrourus</i> spp. combined 3 tonnes <i>Lepidonotothen squamifrons</i> 2 tonnes <i>Somniosus</i> spp. 2 tonnes Skates and rays 2 tonnes Other by-catch species 1 tonne</p>
Mitigation	In accordance with CM 25-03, minimisation of risk of the incidental mortality of birds and mammals
Observers	Each vessel to carry at least one CCAMLR scientific observer and may include one additional scientific observer
Data	<p>Ten-day reporting system as in Annex 42-02/B</p> <p>Monthly fine-scale reporting system as in Annex 42-02/B on haul-by-haul basis</p> <p>Fine-scale reporting system as in Annex 42-02/B. Reported in accordance with the Scheme of International Scientific Observation</p>
Target species	<p><i>C. gunnari</i></p> <p>By-catch is any species other than <i>C. gunnari</i></p>
Environmental protection	<p>Regulated by CM 26-01</p> <p>Includes no offal discharge or dumping of discards</p>

Stock assessment

Population structure

A1. The distribution of densities at age was derived using the CMIX program (using input parameters in Table A1.1) consisting of four year classes from 1+ to 4+ and substantial recruitment of juvenile (<3+) cohorts (Figure A1.1). Details of the fit are presented in Table A1.2.

Table A1.1: Input parameters for the CMIX analysis of *Champscephalus gunnari* length density in Division 58.5.2 for 2016.

Parameter	Value
Size range included	170–470 mm
Bounds	Age 1+: 190–210 mm Age 2+: 260–310 mm Age 3+: 315–380 mm Age 4+: 381–399 mm Age 5+: 400–430 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
Stopping criteria	1E-10
Frequency for convergence testing	5
Simplex expansion coefficient	1

Table A1.2: Results generated from CMIX analyses for *Champscephalus gunnari* from the 2016 random stratified trawl survey in Division 58.5.2.

	Mixture components				
	1 (1+)	2 (2+)	3 (3+)	4 (4+)	5 (5+)
Mean length (mm)	190	281	351	381	430
SD (mm)	12.4	13.9	15.1	15.6	16.4
Intercept of CV	9.3				
Slope of CV	0.02				
Total density (n.km ⁻²)	3.5	1437.9	495.8	344.3	7.5
SD (n.km ⁻²)	6.4	331.3	222.8	121.1	8.3
Sum of observed densities	2361.5				
Sum of expected densities	2288.6				

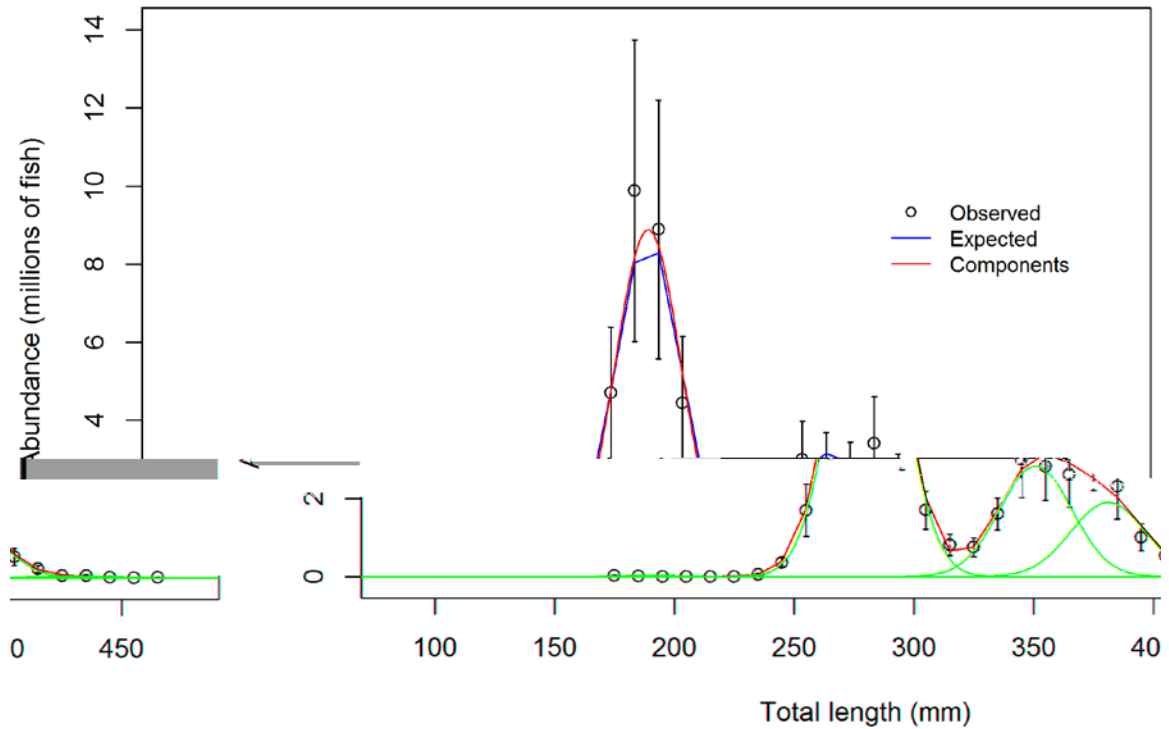


Figure A1.1: Size distribution of *Champsocephalus gunnari* from the 2016 random stratified trawl survey in Division 58.5.2 with standard errors. Cohorts were present in ages 1+ to 5+.

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 A1.3.

Table A1.3: GYM model configuration for the assessment for 2016 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 A1.2
Weight-at-length	Weight-length parameter – A (kg)	1.97×10^{-10} kg
	Weight-length parameter – B	3.336
Maturity	L_{m50} (set so that the status of the whole stock is being monitored)	0 mm ¹
	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 A1.3 (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 specifications	Years to remove initial age structure	1 ²
	Year prior to projection	2015 ³
	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

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

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

³ GYM requires first year of the 2015/16 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 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 less than 4+ 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 ensure 75% escapement over two years.

A5. In 2016 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.