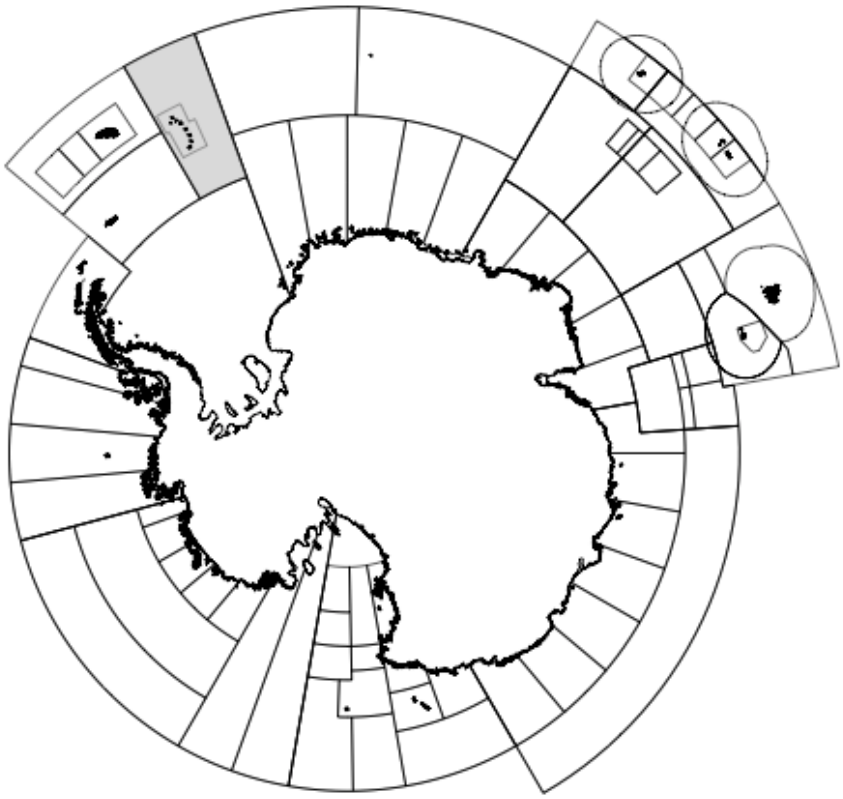
CCAMLR

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 2015: *Dissostichus* spp. South Sandwich Islands (Subarea 48.4)

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 2015: *Dissostichus* spp.
South Sandwich Islands (Subarea 48.4)

Introduction to the fishery

1. This report describes the longline fishery for Patagonian (*Dissostichus mawsoni*) and Antarctic (*D. eleginoides*) toothfish in Subarea 48.4.

2. The fishery for *D. eleginoides* in Subarea 48.4 was initiated as a new fishery in 1993 following notifications from Chile and the USA (SC-CAMLR-XI, Annex 5, paragraph 6.22), and the adoption of Conservation Measure (CM) 44/XI, which set a precautionary catch limit for *D. eleginoides* of 240 tonnes for that season. Subsequently, the USA withdrew from the fishery and the Chilean longline vessel abandoned fishing after one week of poor catches (SC-CAMLR-XII, Annex 5, paragraph 6.2). In addition, a Bulgarian-flagged longliner fished in November and December 1992 and reported a catch of 39 tonnes of *D. eleginoides* (SC-CAMLR-XII, Annex 5, paragraph 6.1).

3. There was no further fishing activity in Subarea 48.4 until 2005 when a mark-recapture experiment was initiated.

4. In 2008, the Commission agreed to divide Subarea 48.4 into a northern area (Subarea 48.4N) and a southern area (Subarea 48.4S) with directed longline fisheries of *D. eleginoides* in Subarea 48.4N and *Dissostichus* spp. in Subarea 48.4S.

5. In 2013, the Commission changed the management regime in the subarea and agreed to remove the northern and southern areas. Instead, separate subarea-wide catch limits were set by species.

Reported catch

6. In 2015, the catch limits were 42 tonnes for *D. eleginoides* and 28 tonnes for *D. mawsoni* and the reported total catches were 42 and 28 tonnes respectively (Table 1).

Illegal, unreported and unregulated (IUU) fishing

7. Data on potential illegal, unreported and unregulated (IUU) fishing in this subarea is limited to sightings from licenced vessels (including fishing vessels, expedition yachts and research ships). These vessels have not detected IUU activity in this subarea (Table 1).

Table 1: Catch history for *Dissostichus* spp. in Subarea 48.4 since 2004. Prior to 2014, when a species-specific catch limit was introduced, there was a combined catch limit for the subarea. (Source: STATLANT data for past seasons, catch and effort reports for the current season and past reports for IUU catch.)

Season	Catch limit (tonnes)	Reported catch (tonnes)			Estimated IUU catch (tonnes)
		D. eleginoides	*D. mawsoni*	Total	
2004	28	0	0	0	-
2005	100	27	0	27	-
2006	100	18	0	19	-
2007	100	54	0	54	-
2008	100	98	0	98	-
2009	150	74	59	133	-
2010	116	57	56	114	-
2011	70	39	15	54	-
2012	81	55	22	78	-
2013	115	70	40	110	-
2014	44, 24*	44	24	68	-
2015	42, 28*	42	28	70	-

* Catch limits for *D. eleginoides* and *D. mawsoni* respectively.

Data collection

8. Catch limits for *D. eleginoides* for Subarea 48.4 are set by CCAMLR using fully integrated CASAL assessments. Less mark-recapture data is available for *D. mawsoni* and so a less data demanding approach (Chapman biomass estimate) is used to set precautionary catch limits. The data collection requirements are set out in the relevant conservation measures. Further details on the stock assessment are provided in Appendix 1.

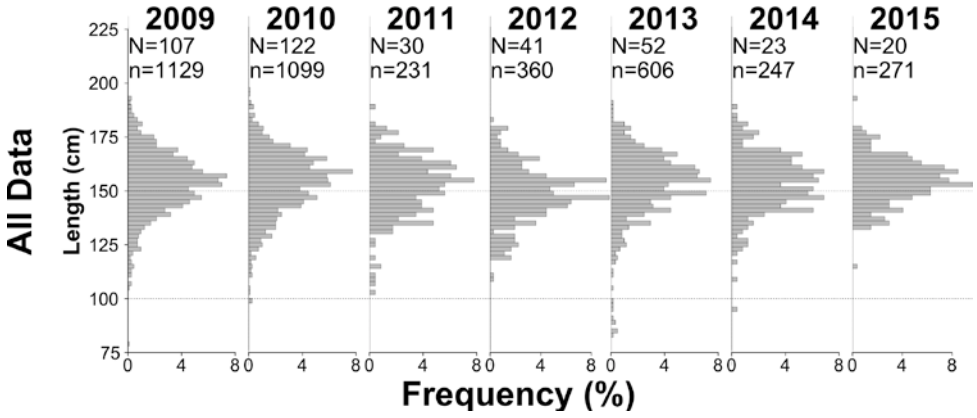
Biological data

9. The collection of biological data is conducted as part of the CCAMLR Scheme of International Scientific Observation. For fisheries targeting *D. mawsoni* and *D. eleginoides,* biological data collection includes representative samples of length, weight, sex and maturity stage of the target and most frequently taken by-catch species, as well as collection of toothfish otoliths for age determination.

Length distributions of catches

10. The length-frequency distributions of *D. mawsoni* and *D. eleginoides* caught in this fishery are presented in Figure 1 for all years in which the number of that species measured was more than 150 fish. These length-frequency distributions are unstandardised (i.e. they have not been adjusted for factors such as the size of the catches from which they were collected). The interannual variability exhibited in the figure may reflect differences in the fished population but could also reflect changes in the gear used, the number of vessels in the fishery and the spatial and temporal distribution of fishing.

(a)



(b)

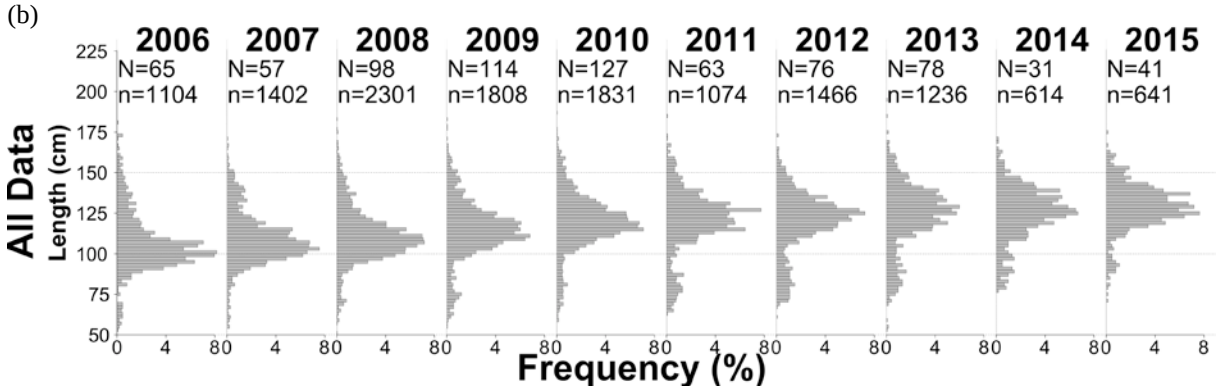


Figure 1: Annual length-frequency distributions for: (a) *Dissostichus mawsoni*, and (b) *D. eleginoides* in Subarea 48.4. The number of hauls from which fish were measured (N) and the number of fish measured (n) in each year are provided.

11. The length-frequency distribution of *D. eleginoides* caught in Subarea 48.4 shows a shifting mode from 80–100 cm at the beginning of the time series to 105–140 cm in 2013, 2014 and 2015 (Figure 1b). A second mode of smaller fish (60–80 cm) becomes evident in 2009 and persists throughout the remainder of the time series, indicating a recruitment pulse.

12. The length-frequency distribution of *D. mawsoni* is dominated by a single strong mode around 150 cm and does not show a clear progression between years; small fish (<100 cm) are rare (Figure 1a).

Tagging

13. In 2005, the UK conducted a pilot tagging program using a longline fishing vessel. Following the pilot study, the Commission agreed to continue the mark-recapture experiment in Subarea 48.4.

14. Since 2012, vessels have been required to tag and release *Dissostichus* spp. at a minimum rate of 5 fish per tonne of green weight caught (Table 2). All vessels which have fished in Subarea 48.4 have exceeded the minimum required tagging rate (Table 2). Tagging data now underpin stock assessments for Subarea 48.4.

Table 2: Annual tagging rate, reported by vessel, operating in the fishery for *Dissostichus* spp. in Subarea 48.4.

Flag State	Vessel name	Season										
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
New Zealand	*San Aspiring*		7.9	5.2	5.1	5.8	5.4	5.8	6.5	6.5	5.4	7.1
UK	*Argos Froyanes*				5.2		5.5			5.1		
UK	*Argos Georgia*					5.4		5.7	5.2		7.1	16.2
UK	*Argos Helena*	1.6	7.2	6.4								
Required tagging rate (fish/tonne)		1	3	3	3	3	3	3	5	5	5	5

15. The tag-overlap statistic estimates the similarity between the size distributions of those fish that are tagged by a vessel and of all the fish that are caught by that vessel. In exploratory fisheries since 2015, each vessel releasing more than 30 tagged fish of each species of *Dissostichus* is required to achieve a minimum tag-overlap statistic of 60% (Annex 41-01/C). Vessels fishing in Subarea 48.4 have also followed this requirement, and both vessels fishing in 2015 achieved tag-overlap statistics of 83–90%.

16. Since 2005 a total of 1 601 *D. mawsoni* have been tagged with 55 recaptured (Table 3a) and 3 394 *D. eleginoides* have been tagged with 313 recaptured (Table 3b). Eleven *D. eleginoides* tagged in Subarea 48.4 have been recaptured in Subarea 48.3, indicating some movement between areas. One tagged *D. eleginoides* has also moved into Subarea 48.4 from Subarea 48.3 (WG-FSA-14/29 Rev. 1). One *D. mawsoni* tagged in Subarea 48.4 was reported recaptured in Subarea 88.2 after three years at liberty.

Table 3: Number of individuals of (a) *Dissostichus mawsoni*, and (b) *D. eleginoides* tagged in each year. The number of fish recaptured by each vessel/year is provided in brackets.

(a)

Flag State	Vessel name	Season									
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
New Zealand	*San Aspiring*	10 (0)	1 (0)		123 (2)	148 (7)	25 (3)	28 (5)	124 (0)	72 (1)	139 (2)
UK	*Argos Froyanes*					54 (15)			55 (0)		
UK	*Argos Georgia*				70 (0)		58 (4)	119 (1)		130 (2)	445 (13)
UK	*Argos Helena*										
Total		10 (0)	1 (0)		193 (2)	202 (22)	83 (7)	147 (6)	179 (0)	202 (3)	584 (15)

(b)

Flag State	Vessel name	Season										
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
New Zealand	*San Aspiring*		88 (0)	251 (2)	252 (11)	309 (15)	162 (17)	110 (22)	218 (24)	239 (21)	112 (21)	106 (26)
UK	*Argos Froyanes*				252 (12)		256 (16)			231 (33)		
UK	*Argos Georgia*					249 (14)		115 (17)	85 (10)		111 (22)	120 (30)
UK	*Argos Helena*	42 (0)	46 (0)	40 (0)								
Total		42 (0)	134 (0)	291 (2)	504 (23)	558 (29)	418 (33)	225 (39)	303 (34)	470 (54)	223 (43)	226 (56)

17. WG-FSA-09/17 and 09/18 provided a comprehensive analysis of the catch distribution of the two *Dissostichus* species in Subarea 48.4 (Figure 2).

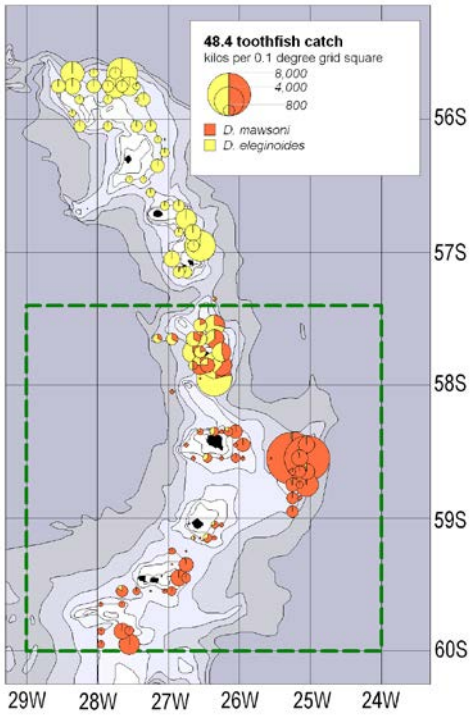


Figure 2: Catch distribution of the two *Dissostichus* species in Subarea 48.4.

Life-history parameters

18. *Dissostichus* spp. are large long-lived species, belonging to the family Nototheniidae, or 'Antarctic cods'. Toothfish show distinct depth preferences with age, with juveniles living on the continental shelf and moving into deeper water as they reach maturity. Toothfish are predators, primarily feeding on fish, cephalopods and crustaceans, and they may also scavenge. The two species of toothfish occurring in Subarea 48.4 have a similar biology, however, *D. mawsoni* grows larger than *D. eleginoides* and tends to inhabit cooler, more southerly waters.

Parameter estimates

19. The biological parameters assumed in the stock assessment (Table 4) are taken from the scientific literature where available. These values are derived from analyses of the biological data collected by scientific observers on board fishing vessels (see below). Where derived values are not available (e.g. natural mortality and the steepness of the stock and recruit relationship), values have been assumed that are consistent with the assumed values for other toothfish assessments conducted by CCAMLR.

Table 4: Biological parameters assumed for *Dissostichus eleginoides* in Subarea 48.4.

Component	Parameter	Value
Natural mortality	M	0.13
VBGF	K	0.092
VBGF	t_0	0.0
VBGF	L_∞	153
Length to mass (cm to tonnes)	a	4.091E-09
Length to mass	b	3.196
Maturity range: 0 to full maturity		1–23
Tag-related growth retardation		0.75
CASAL tag-loss rate		0.0064
Immediate tagging survivorship		0.9
Tag probability of detection		1
Stock-recruit relationship steepness	h	0.75
Lognormal recruitment SD		estimated

By-catch of fish

20. Catch limits for by-catch species groups (macrourids, skates (Rajiformes) and other species) are defined in CM 41-03. In 2015, the macrourid by-catch limit was 11.2 tonnes (16 % of the total catch of *Dissostichus* spp.), while the skate by-catch limit was 3.5 tonnes (5% of the total catch of *Dissostichus* spp.).

21. If the by-catch of skates exceeded 5% of the catch of *Dissostichus* spp. in any one haul or set, or if the catch of *Macrourus* spp. reached 150 kg and exceeds 16% of the catch of *Dissostichus* spp. in any one haul or set, then the fishing vessel must move at least 5 n miles away for a period of at least five days.

22. In addition to the mitigation measures in CM 41-03, skates are handled and released following 'Year-of-the-Skate' protocols to maximise their survival.

23. The by-catch in Subarea 48.4 consists predominantly of macrourids, with a maximum of 26 tonnes being recorded in 2009.

24. Catches of by-catch species groups (macrourids, skates and other species) and number of skates released alive, are summarised in Table 5. The by-catch limits in Subarea 48.4 (as set out in CM 41-03) have changed with the development of the fishery research: from 2005 to 2008 there were no specified limits, from 2009 to 2013 there was an overall by-catch limit for macrourids and skates in Subarea 48.4N and a move-on rule provision in Subarea 48.4S, and in 2014, with the introduction of species-specific catch limits for the two target species, whole-fishery catch limits for macrourids and skates were introduced.

Table 5: Catch history for by-catch species (macrourids, skates and other species), including catch limits and number of skates released alive, in Subarea 48.4. Catch limits are for the whole fishery (see CM 33-03 for details). (Source: fine-scale data.)

Season	Macrourids		Skates (Rajiformes)			Other species	
	Catch limit (tonnes)	Reported catch (tonnes)	Catch limit (tonnes)	Reported catch (tonnes)	Number released	Catch limit (tonnes)	Reported catch (tonnes)
2005	-	3	-	0	-	-	0
2006	-	5	-	1	4359	-	0
2007	-	14	-	2	6515	-	0
2008	-	16	-	4	8276	-	0
2009	-	26	-	2	9767	-	1
2010	-	16	-	2	6183	-	1
2011	-	5	-	1	4680	-	0
2012	-	7	-	1	5582	-	0
2013	-	6	-	1	3115	-	0
2014	11	3	3.5	0	1124	-	0
2015	11.2	4	3.5	0	624	-	0

Assessments of impacts on affected populations

25. The distribution of skates and macrourids in Subarea 48.4 has been investigated and initial results of their distributions were provided in WG-FSA-09/17 and 09/18. In 2015, 175 skate were tagged in Subarea 48.4 so that a total of 1 660 skate have now been tagged in this subarea, to date, eight tagged skate have been recaptured from this subarea.

26. Catch rates for macrourids in Subarea 48.4N were high at the start of the fishery. Vessels subsequently altered their fishing techniques and areas to avoid macrourid by-catch and rates dropped (Table 5).

27. Macrourid catches were previously thought to almost entirely comprise Whitson's grenadier (*Macrourus whitsoni*). Recent taxonomic studies (including genetic analyses) now indicate that the *Macrourus* population comprises two species, including *M. whitsoni* and the recently described species Caml grenadier (*M. caml*) (WG-FSA-10/33; McMillan et al., 2012).

Invertebrate by-catch including VME taxa

28. CM 22-07 does not apply to this subarea and there are no registered vulnerable marine ecosystems (VMEs) or VME Risk Areas in Subarea 48.4.

Incidental mortality of seabirds and marine mammals

Incidental mortality

29. In 2009, one chinstrap penguin (*Pygoscelis antarctica*) was injured in the fishery in Subarea 48.4. In 2015, there were two mortalities of prions (Procellaria) due to collision with the vessel during hauling. There have been no other observed bird or mammal mortalities in this fishery.

30. The level of risk of incidental mortality of birds in Subarea 48.4 is category 3 (medium) (SC-CAMLR-XXX, Annex 8, paragraph 8.1).

Mitigation measures

31. CM 25-02 on minimisation of the incidental mortality of birds in longline fishing applies to this subarea. CM 24-02 also stipulates a limit of three (3) birds per vessel during daytime setting.

Ecosystem implications and effects

32. There is no formal evaluation available for this fishery.

Current management advice and conservation measures

33. The limits on the fishery for *Dissostichus* spp. in Subarea 48.4 are defined in CM 41-03. The limits in force are summarised in Table 6.

Table 6: Limits on the fishery for *Dissostichus eleginoides* and *D. mawsoni* in Subarea 48.4 in force (CM 41-03).

Element	Limit in force
Access	Subarea 48.4 is open to a fishery for *Dissostichus* spp.
Catch limit	The precautionary catch limit for *D. eleginoides* is 47 tonnes. The precautionary catch limit for *D. mawsoni* is 39 tonnes.
Season	1 December to 30 November
By-catch	The by-catch of finfish shall not exceed 4.3 tonnes for skates and rays and 13.8 tonnes for *Macrourus* spp. By-catch move-on rules are in place if the catch of skates and rays exceeds 5% of the catch of *Dissostichus* spp. in any one haul or set, or if the catch of *Macrourus* spp. reaches 150 kg and exceeds 16% of the catch of *Dissostichus* spp. in any one haul.
Bird mitigation	In accordance with CM 25-02 Limit of three (3) birds per vessel during daytime setting. Any vessel catching a total of three (3) birds shall immediately be required to set longlines at night only.

(continued)

Table 6 (continued)

Element	Limit in force
Observers	At least one (1) scientific observer appointed in accordance with the CCAMLR Scheme of International Scientific Observation
Data	Five-day catch and effort reporting Haul-by-haul catch and effort data Biological data reported by the CCAMLR scientific observer
Research	Each vessel taking part in the fishery for *D. eleginoides* shall undertake a tagging program in accordance with the CCAMLR tagging protocol. Toothfish tagged at a rate of at least 5 fish per tonne of green weight caught. Fish should be tagged in proportion to the species composition and length-frequency distribution of the catch.
Environmental protection	Regulated by CM 26-01

Reference

McMillan, P., T. Iwamoto, A. Stewart and P.J. Smith. 2012. A new species of grenadier, genus *Macrourus* (Teleostei, Gadiformes, Macrouridae) from the southern hemisphere and a revision of the genus. *Zootaxa*, 3165: 1–24.

Appendix 1

Stock assessment for 2015

Antarctic toothfish (*Dissostichus mawsoni*)

A1. The fishery Antarctic toothfish (*Dissostichus mawsoni*) in Subarea 48.4 has been in operation for only a few years. Catches are generally small and there is little or no ageing information at present. Consequently, the stock is assessed using a simple Chapman biomass estimate to which a harvest rate is applied to determine appropriate catch limits. The biomass estimates are quite variable, ranging from around 500 to 1 000 tonnes.

Patagonian toothfish (*D. eleginoides*)

A2. The stock of Patagonian toothfish (*D. eleginoides*) in Subarea 48.4 was assessed using an age-structured CASAL integrated stock assessment model for both sexes combined with ages from 1 to 50, the last age being a plus group. The model was run from 1990 to 2015 and was initialised assuming an equilibrium age structure at an unfished equilibrium biomass.

A3. The assessment model assumes a single-area and single-fleet fishery with a single sigmoid selection pattern estimated for the full time series. The use of a double normal selection pattern, to allow for potential dome-shaped selection in the fishery, was investigated in 2012, however, it was concluded that a sigmoid selection pattern provided a more robust model fit and gave more precautionary estimates of stock abundance.

A4. The assessment model includes tag-release and tag-recapture events for which data are available from 2005. The model assumes that tagging was applied to a cohort of fish simultaneously and that tagging from each year was applied as a single tagging event. The model applies the same population processes to both the tagged and untagged components of the modelled population. In addition, tagged fish were assumed to suffer a growth retardation equal to 0.5 years of zero growth following tagging. All fish are double-tagged with tag shedding estimated at 0.0064 $year^{-1}$ and an additional post-tagging mortality rate of 0.9.

A5. Model parameters are initially estimated by maximising the composite likelihood of the data, priors and penalties (the MPD estimates) and subsequently by estimating the Bayesian posterior distributions using Monte Carlo Markov Chains (MCMC). Model fits were evaluated at the initial MPD by investigating fits to observations and likelihood profiles of key parameters estimated by the model, specifically B_0.

A6. Likelihood profiles for B_0 from the 2015 assessment (Figure A1) show generally consistent estimates of B_0 from each of the datasets used in the assessment, particularly from the tag-release and recapture information which is included in the assessment primarily to provide an estimate of total abundance.

A7. Parameter uncertainty was estimated using MCMC analyses. The posterior distribution was sampled from 1 000 000 iterations, following an initial burn-in of 100 000 iterations, and thinned by a factor of 1 000, to achieve a final sample length of 1 000. Estimates of initial biomass levels and current biomass levels (Table A1) show the stock to be around 84% of B_0 in 2015.

A8. Stochastic long-term projections conducted in accordance with the CCAMLR procedures for yield calculations (Figure A2) indicate that a constant yield of 42 tonnes will maintain SSB above 50% of B_0 over the next 35 years with 50% probability. MCMC-estimated recruitment and trace plots are shown in Figures A3 and A4.

Table A1: *Dissostichus eleginoides* in Subarea 48.4: median spawning biomass for the initial equilibrium SSB (B_0), the current SSB ($B_{current}$) and the ratio of current to initial SSB for the 2015 assessment.

Assessment year	B_0 (tonnes)	$B_{current}$ (tonnes)	$B_{current}/B_0$
2012	1697.13	1488.72	0.87
2013	1275.61	1008.93	0.79
2014	1259.59	1046.74	0.83
2015	1462.87	1230.21	0.84

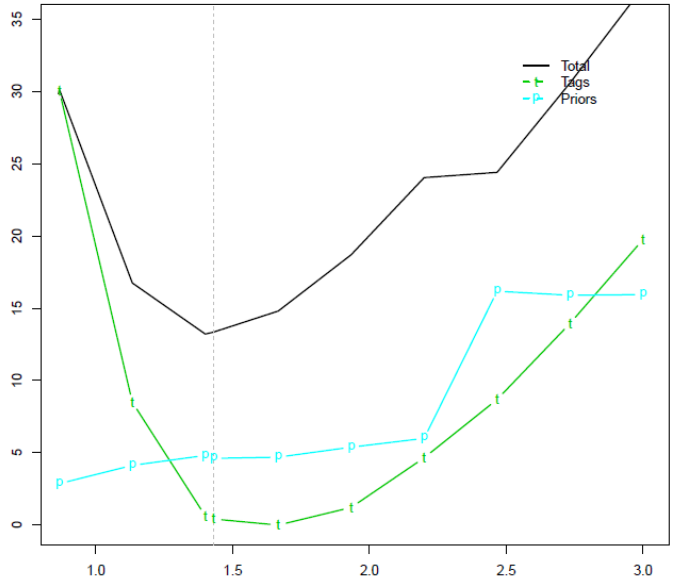


Figure A1: *Dissostichus eleginoides* in Subarea 48.4: Likelihood profiles for values of B_0. Negative log likelihood values have been rescaled to have minimum 0 for each dataset. Vertical line indicates the overall MPD estimate of B_0.

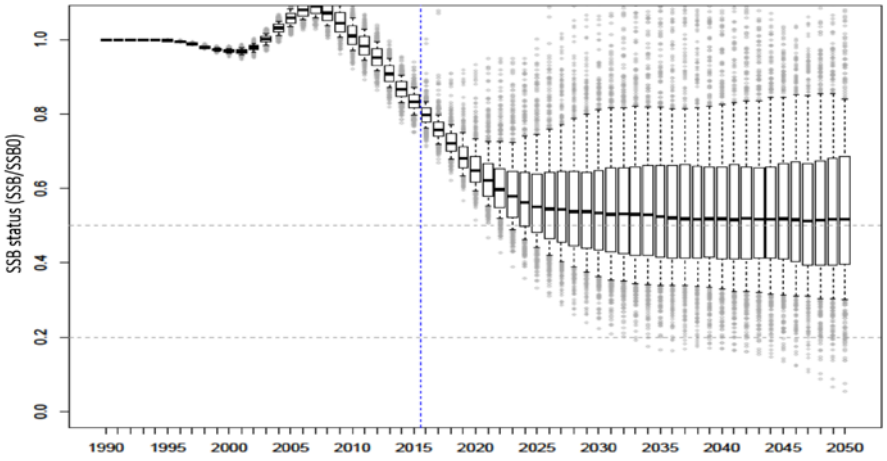


Figure A2: *Dissostichus eleginoides* in Subarea 48.4: Estimated spawning stock biomass status based on a 35-year projection at a constant yield of 47 tonnes. Boxes show median and 25th and 75th percentiles. Whiskers extend to the 5th and 95th percentiles.

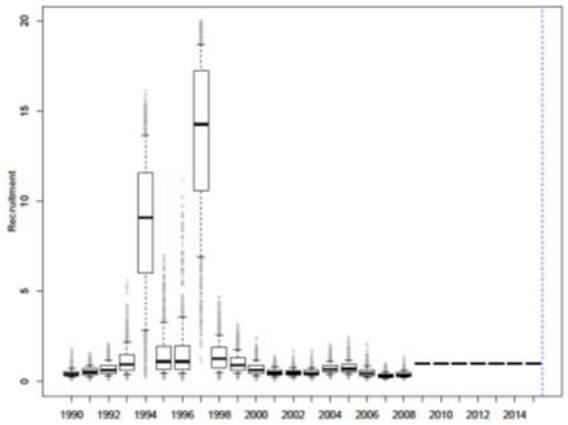


Figure A3: *Dissostichus eleginoides* in Subarea 48.4: MCMC-estimated recruitment with fixed year-class strength for 2009–2015.

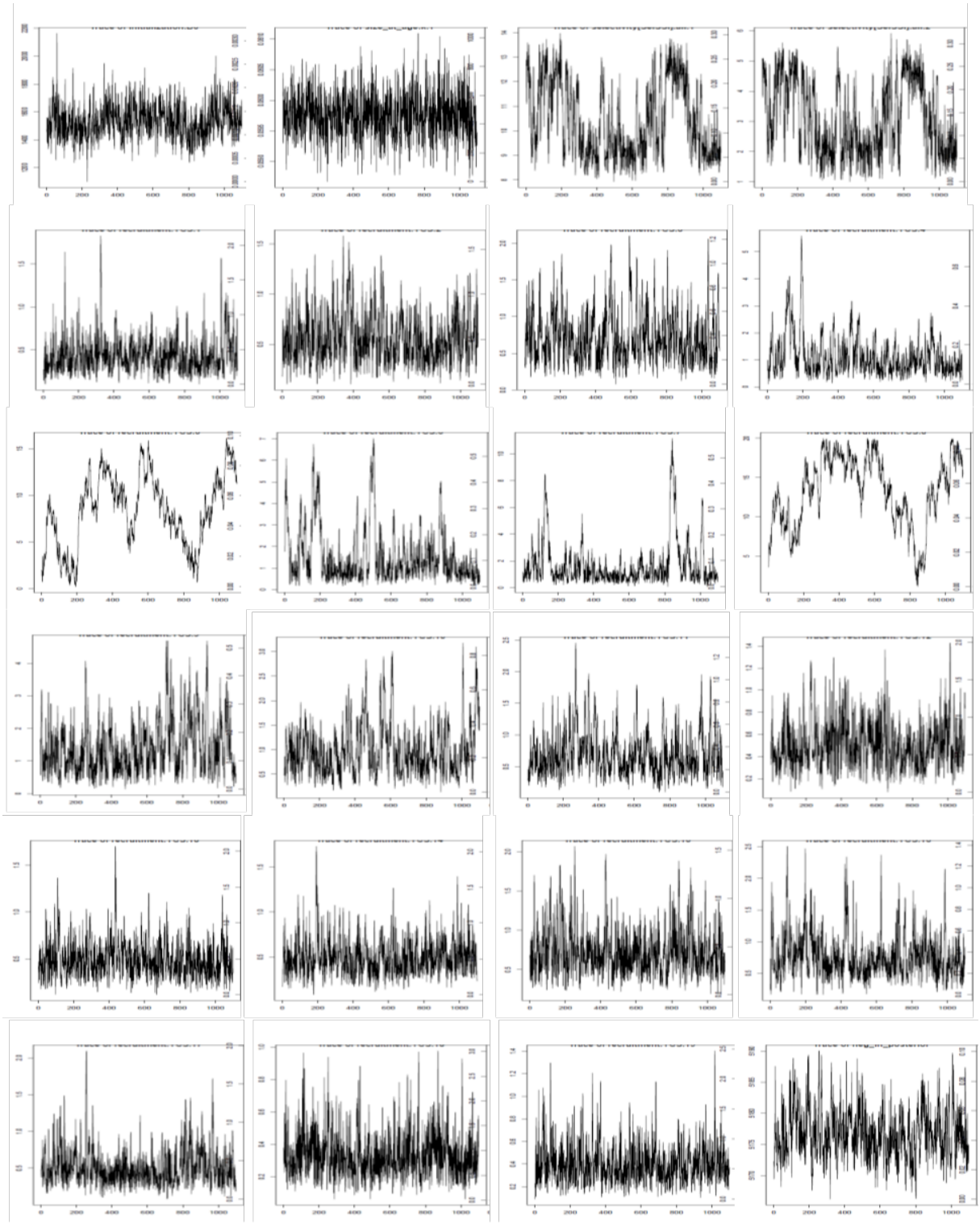


Figure A4: *Dissostichus eleginoides* in Subarea 48.4: MCMC trace plots for the different parameters. From left to right: Initialisation of B_0, size at age, and selectivity (top row). Second row: Recruitment year-class strength 1–19 (20–26 not shown, as fixed). Posterior in final panel.