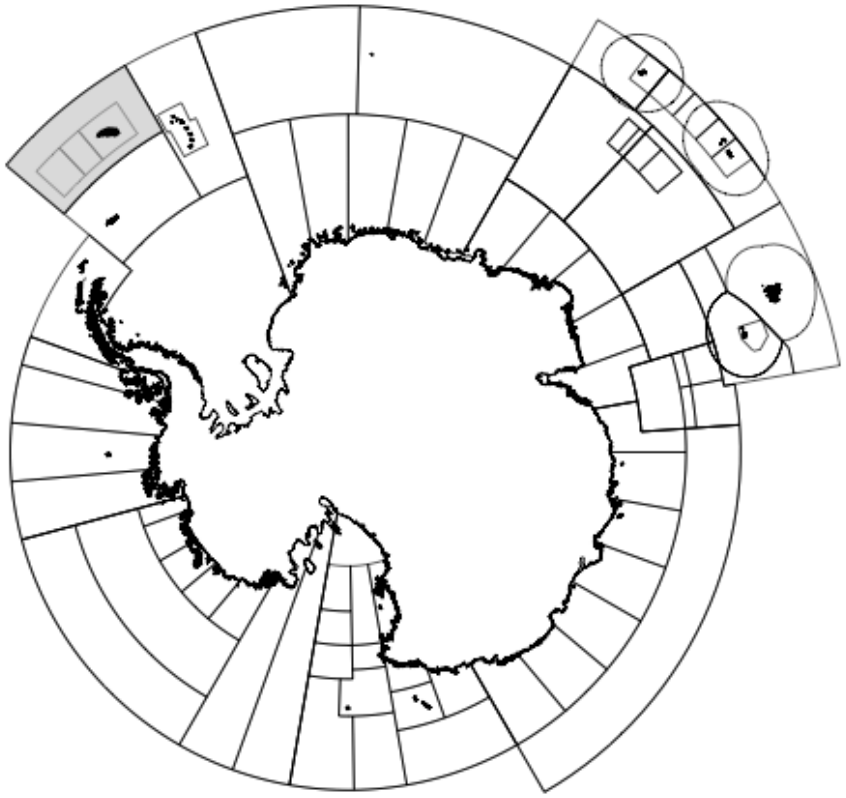
CCAMLR

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

Fishery Report 2015: *Dissostichus eleginoides* South Georgia (Subarea 48.3)



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 eleginoides*
South Georgia (Subarea 48.3)

Introduction to the fishery

1. The fishery for Patagonian toothfish (*Dissostichus eleginoides*) in Subarea 48.3 began in the 1980s and expanded rapidly during the early 1990s, when considerable illegal, unreported and unregulated (IUU) catches were also taken (Table 1). The initial fishery also caused high rates of incidental mortality (this is a term used by CCAMLR to describe bird mortality resulting from interactions with fishing gear), with relatively large numbers of albatross and petrels attracted to the baited hooks and being caught and drowned. In response to these issues, CCAMLR introduced strict regulations designed to reduce bird by-catch. These regulations, including seasonal closures, streamer lines, line-weighting regimes and night-setting requirements, greatly reduced bird by-catch in this fishery.

2. The current toothfish fishery uses demersal longlines in which lines of baited hooks are deployed close to the sea floor at depths down to 2 000 m. Surface buoys indicate the presence of lines, and vessels typically recover lines after a soak time of 24–48 hours. Bait is usually squid, mackerel or sardines which are all sustainably sourced. The Marine Stewardship Council conditionally certified the fishery in 2004. It was recertified without conditions in 2009 and again in 2014.

3. In 2004, CCAMLR agreed to subdivide Subarea 48.3 into three Management Areas (A, B and C) (Figure 1) defined in Conservation Measure (CM) 41-02, Annex 41-02/A.

4. In 1998, the fishery was restricted to the winter months (1 May to 31 August) to minimise interactions with foraging birds during their breeding season. Since 2010, CCAMLR has applied a gradual extension to the season. These extensions were accompanied with a number of additional measures to prevent significant bird by-catch, as set out in CM 41-02.

5. In 2015, the fishery opened on 16 April (first catches reported for 17 April) and closed on 31 August (last catch reported for 31 August). The total reported catch of *D. eleginoides* for 2015 in Subarea 48.3 was 2 195 tonnes. Catches in Management Areas B and C were 615 and 1 578 tonnes respectively. In addition, a bottom trawl survey conducted in Subarea 48.3 in 2015 caught <1 tonne of *D. eleginoides*.

Reported catches

6. The catch series is shown in Table 1, and with the exception of 36 tonnes in 2004 and 2 tonnes in 2007, all catches have been from within Management Areas B and C.

Table 1: Catch history for *Dissostichus eleginoides* in Subarea 48.3. (Source: STATLANT data for past seasons, and catch and effort reports for the current season, past reports for IUU catch.)

Season	Regulated fishery		Estimated IUU catch (tonnes)
	Catch limit (tonnes)	Reported catch (tonnes)	
1985	-	521	0
1986	-	733	0
1987	-	1954	0
1988	-	876	0
1989	-	7060	144
1990	-	6785	437
1991	2500	1756	1775
1992	3500	3809	3066
1993	3350	3020	4019
1994	1300	658	4780
1995	2800	3371	1674
1996	4000	3602	0
1997	5000	3812	0
1998	3300	3201	146
1999	3500	3627	667
2000	5310	4904	1015
2001	4500	4047	196
2002	5820	5742	3
2003	7810	7528	0
2004	4420	4497	0
2005	3050	3034	23
2006	3556	3535	0
2007	3554	3539	0
2008	3920	3864	0
2009	3920	3382	0
2010	3000	2519	0
2011	3000	1763	0
2012	2600	1806	0
2013	2600	2094	0
2014	2400	2180	0
2015	2400	2195	0

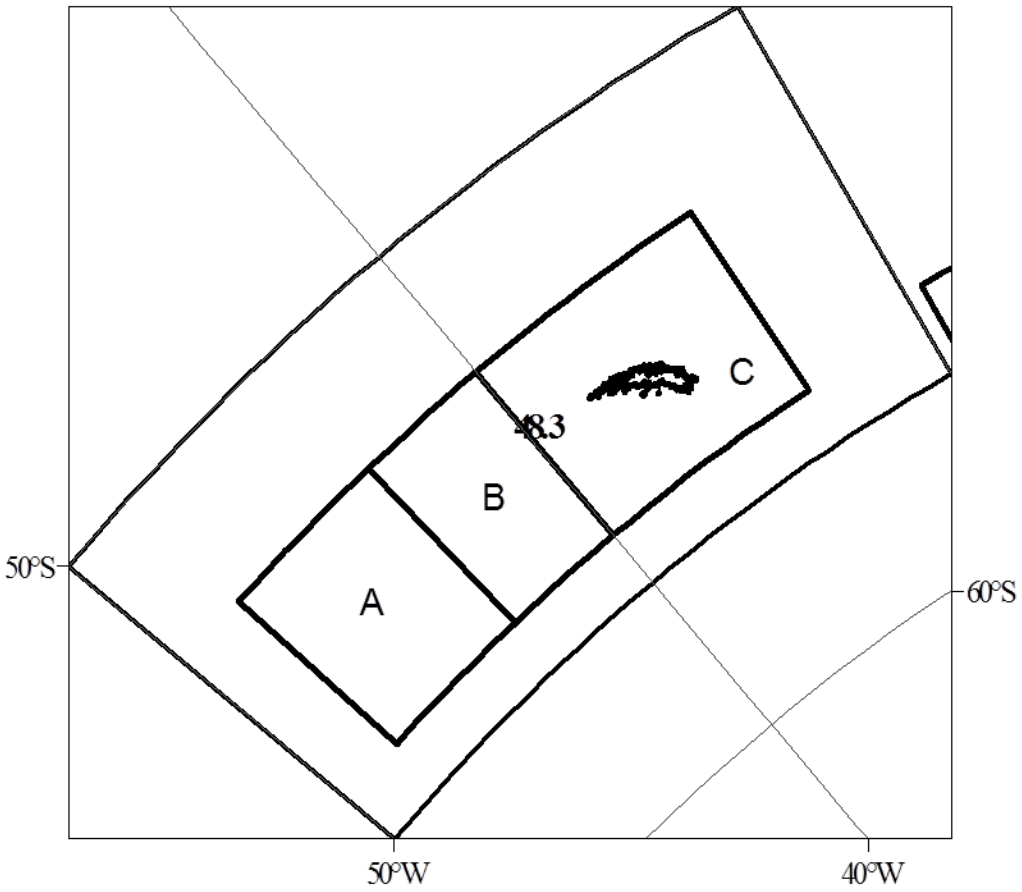


Figure 1: The location of Management Areas A, B and C in Subarea 48.3.

7. Fishing for *D. eleginoides* in Subarea 48.3 has predominantly used longlines. Occasional potting trials yielded the following catches: 66 tonnes (2001), 24 tonnes (2006) and 55 tonnes (2008). There have been no recent trials using pots. Prior to 1992, fishing focused around Shag Rocks and to the northeast of South Georgia. Since 1992, fishing effort has been distributed more widely over the South Georgia and Shag Rocks shelves and slopes.

Illegal, unreported and unregulated (IUU) fishing

8. There is no evidence of IUU fishing since 2006 (Table 1).

Data collection

9. Catch limits for the assessed *D. eleginoides* fisheries in Subareas 48.3 and 48.4 and Division 58.5.2 are set by CCAMLR using fully integrated assessments; more basic approaches are used for the 'data-poor' fisheries (e.g. in Subarea 48.6 and in Area 58 outside the exclusive economic zones (EEZs)). The data collection requirements are set out in the relevant conservation measures.

Biological data

10. The collection of biological data under CM 23-05 is conducted as part of the CCAMLR Scheme of International Scientific Observation (see below).

Length-frequency distribution of catches

11. The length frequencies for catches of *D. eleginoides* from 2005 to 2015 are shown in Figure 2. These length-frequency distributions of catches are unstandardised. Interannual variability shown in Figure 2 may therefore reflect differences in the fished population and changes in the fishing fleet and its behaviour.

Life-history parameters

12. *Dissostichus eleginoides* is a large long-lived species belonging to the family Nototheniidae, or Antarctic cods. Toothfish show distinct depth preferences with age, with juveniles (<50 cm) living on the continental shelf and moving into deeper water (>500 m) as they reach maturity (~90 cm). Toothfish are important predators, feeding primarily on fish, cephalopods and crustaceans; they also scavenge.

Data collection

13. In January 2015, the UK undertook a random stratified bottom trawl survey of South Georgia and Shag Rocks (see WG-FSA-15/30). The survey is the 17th of its type (the trawl series starting in 1986) and employed the same trawl gear and survey design as previous UK surveys in Subarea 48.3 (see WG-FSA-10/38 and WG-FSA-15/26). The 2015 survey covered the whole shelf area, covering depths of 100–350 m. The primary aim of the survey was to estimate stocks of mackerel icefish (*Champsocephalus gunnari*) but juvenile *D. eleginoides* are also captured. Numbers and lengths of *D. eleginoides* provide an index of recruitment for stock assessments.

14. *Dissostichus eleginoides* were caught in 27 of the 77 hauls in the 2015 survey and were present in greatest numbers around the eastern end of Shag Rocks. The total catch of toothfish was similar to the 2013 survey catch, totalling 289 kg (206 individuals). Toothfish ranged in length from 30 to 74 cm, and the majority were 40–60 cm. There was evidence of a cohort of 3+ fish (modal length of 45 cm). There was little evidence of younger year classes on the South Georgia or Shag Rocks shelf.

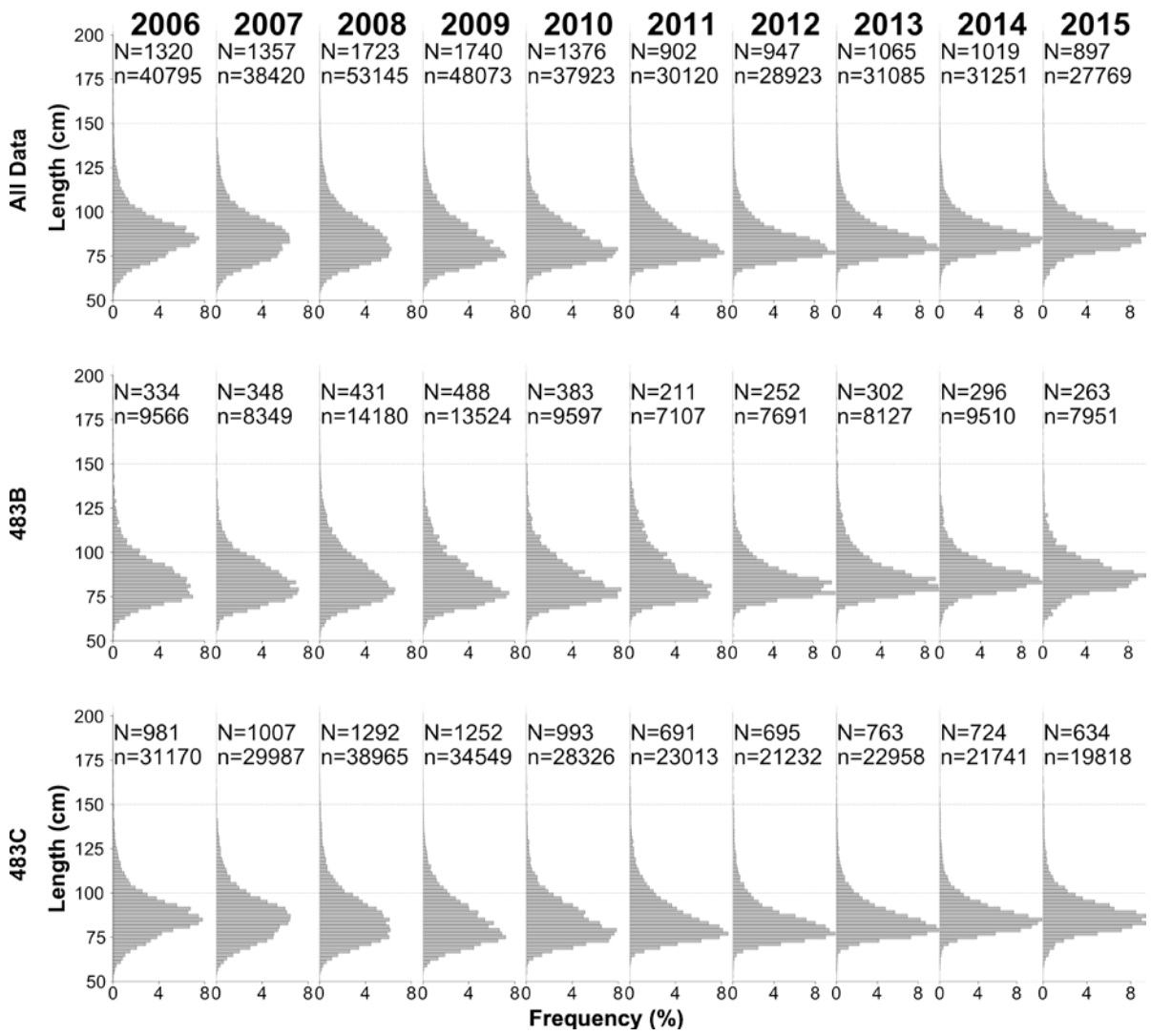


Figure 2: Length frequencies for *Dissostichus eleginoides* in Subarea 48.3 from 2006 to 2015 using observer data. The number of hauls (N) and the number of fish measured (n) in each year are given at the top of each panel. Letters to the left of the panel (B and C) refer to the management areas shown in Figure 1.

15. All toothfish vessels in Subarea 48.3 carry a CCAMLR scientific observer who collects a range of data on toothfish and common by-catch, including conversion factors, length frequencies, weights and maturity. Toothfish otoliths are collected by observers for an ageing program that provides length-at-age data for assessments. Observers also record whale depredation rates that are included in stock assessments. Observers work with vessels to tag toothfish and skates and collate recapture data. Tagging of *D. eleginoides* continued at a rate of 1.3 fish per tonne in 2014, with a total of 4 332 fish tagged and 527 recaptures (including within-season recaptures).

Parameter estimates

16. The biological parameters used in the stock assessment (Table 2) 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. 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 values used in other toothfish assessments conducted by CCAMLR.

Table 2: Biological parameters assumed for *Dissostichus eleginoides* in Subarea 48.3.

Component	Parameter	Value	Component	Parameter	Value
Natural mortality	M	0.13	Tag-related growth retardation		0.75
VBGF	K	0.08	CASAL tag-loss rate		0.006377
VBGF	t_0	–0.7	Immediate tagging survivorship		See below
VBGF	L_∞	126	Tag probability of detection		1
Length to mass (cm to t)	A	2.54E-09			
Length to mass	B	2.8	Stock-recruit relationship steepness	H	0.75
Maturity range: 0 to full maturity		1–23	Lognormal recruitment SD		Estimated

17. Immediate tagging survivorship is applied as a length-specific tag-mortality ogive in which larger fish are assumed to experience a higher rate of mortality as a consequence of the tagging procedure than smaller fish (Table 3). Since CASAL can only apply a single tag mortality across all sizes, the correction to the tagged fish proportions at length and numbers of tagged fish must be applied externally.

Table 3: Length-specific tagging survival rates used in the assessment for *Dissostichus eleginoides* in Subarea 48.3.

	Length class (cm)						
	40	50	60	70	80	90	100 +
Proportion surviving	1.0	0.96	0.95	0.95	0.94	0.83	0.8

18. Since the length-specific tag-mortality rates are calculated externally to the assessment, the tagging mortality parameters in the CASAL input files are set to zero in all instances.

Stock assessment status

19. *Dissostichus eleginoides* in Subarea 48.3 are genetically distinct from those found on the Patagonian shelf (FAO Area 41). The stock, occurring within Management Areas A, B and C, is genetically separate from fish taken in the extreme north and west of Subarea 48.3 and the assessments consider only the stock within Management Areas A, B and C (further details of the stock assessment are provided in Appendix 1).

20. The stock of *D. eleginoides* in Subarea 48.3 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 1985 to 2015 and was initialised assuming an equilibrium age structure at an unfished equilibrium biomass.

21. The assessment model assumes a single-area and single-fleet fishery with separate selection patterns estimated for two distinct time periods, the first from 1985 to 1997, the second from 1998 to 2015. A fishery-independent index of abundance, derived from a first-quarter bottom trawl survey, is available for most years for the period 1987 to 2015 and an index of catch-per-unit-effort (CPUE), determined from the commercial fishery, is also available for use in the assessment for the period 1998 to 2015. The CPUE index is corrected for cetacean depredation (i.e. CPUE is increased to account for removal of catch by sperm whales and killer whales) for the period that cetacean observations are available (2004 onwards), using a generalised linear model analysis. A similar correction is also applied to the total catch. The correction for cetacean depredation varies annually but is typically in the range of a 3% to 5% increase.

22. Double-normal selection patterns were fitted in all instances to allow for any potential reduction in selection at older ages, although, in all instances, the model estimated sigmoid selection patterns.

23. The assessment model includes tag-release and tag-recapture events for which data are available from 2003. 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 nine months of no growth following tagging. All fish are double tagged with tag shedding estimated at 0.0064 per year.

24. 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 Markov Chains Monte Carlo (MCMCs). 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.

25. Likelihood profiles for B_0 from the 2015 assessment (Figure 3) showed that estimates of B_0 were most strongly influenced by the tag-release and recapture information which is included in the assessment primarily to provide an estimate of total abundance, compared to survey biomass and commercial CPUE that provide information about stock trends.

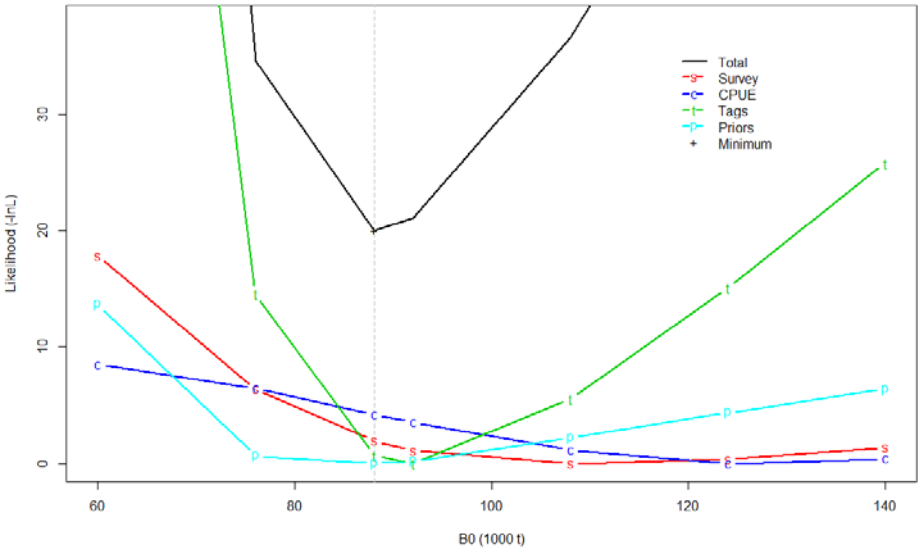


Figure 3: Likelihood profiles for values of B_0. Negative log likelihood values have been rescaled to have minimum 0 for each dataset. Vertical line indicates the overall MPD estimate of B_0.

26. 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 4) show that the stock remained at around 52% of B_0 in 2015.

Table 4: Median spawning biomass and 95% confidence intervals (CIs) for the initial equilibrium SSB (B_0), the current SSB ($B_{current}$) and the ratio of current to initial SSB for the 2007, 2009, 2011 and 2013 assessments.

Assessment year	B_0 (thousand tonnes)	$B_{current}$ (thousand tonnes)	$B_{current}/B_0$
2007	112 (98.7–125.0)	67.1 (52.9–79.9)	0.59 (0.54–0.64)
2009	98.5 (93.6–103.8)	60.2 (55.0–65.7)	0.61 (0.58–0.64)
2011	85.1 (78.9–92.1)	44.9 (38.9–51.9)	0.53 (0.49–0.56)
2013	85.9 (81.6–90.8)	45.4 (41.3–49.7)	0.53 (0.50–0.55)
2015	85.9 (81.6–91.3)	44.7 (41.4–48.7)	0.52 (0.50–0.54)

27. Stochastic long-term projections conducted in accordance with the CCAMLR procedures for yield calculations (Figure 4) indicate that a constant yield of 2 750 tonnes will maintain spawning stock biomass (SSB) above 50% of B_0 over the next 35 years with 50% probability.

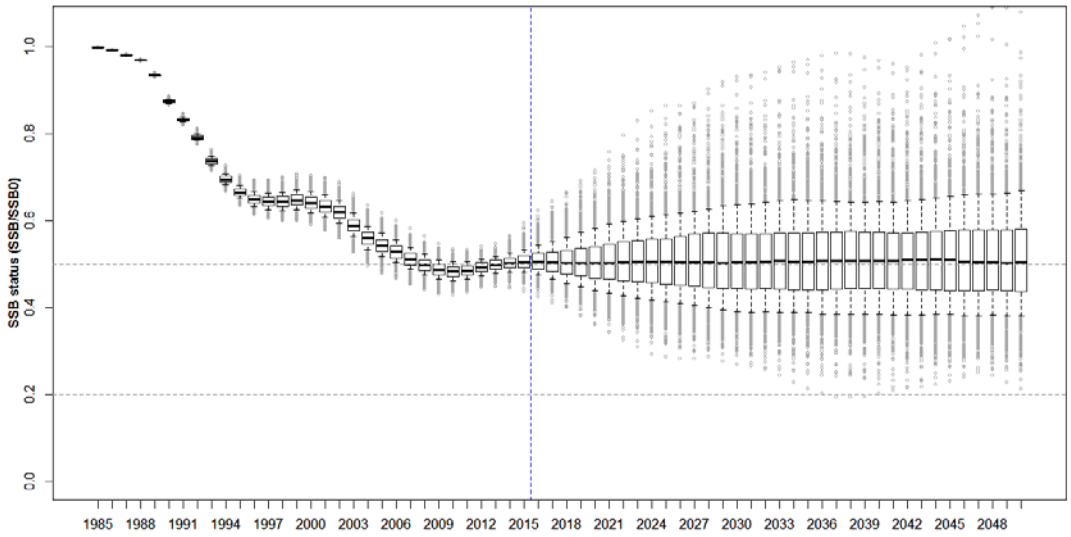


Figure 4: Estimated spawning stock biomass relative to B_0 based on a 35-year projection at a constant yield of 2 750 tonnes. Boxes show median and 25th and 75th percentiles. Whiskers extend to the 5th and 95th percentiles.

By-catch of fish and invertebrates

Fish by-catch

28. Annual catch limits for by-catch species groups (macrourids, skates (Rajiformes) and other species) are defined in CM 41-02. The macrourid by-catch limit is 120 tonnes and the skate by-catch limit is also 120 tonnes.

29. If the by-catch of skates or macrourids exceeds 1 tonne 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.

30. Catches of by-catch species groups (macrourids, skates and other species), their respective catch limits and number of skates released alive are summarised in Table 5. Both macrourid and skate catches were well within the catch limits in 2015.

31. A preliminary assessment of skate populations in Subarea 48.3 using a surplus production model implemented in a Bayesian framework was presented in 2007 (WG-SAM-07/11), at which time it was considered that there were insufficient data to inform the assessment. Nevertheless, these preliminary results suggested that the catch limit in Subarea 48.3 for rajids would be sustainable.

32. A skate tagging program has been under way since 2006 in Subarea 48.3 and a preliminary assessment of skates in Subarea 48.3 using tagging data was presented in 2014 (WG-FSA-14/48). This assessment indicated a stable biomass.

33. An analysis of the by-catch of skate and grenadiers in Subarea 48.3 (WG-FSA-14/47 Rev. 1) indicated that by-catch was greater for vessels using autoline than for those using the 'Spanish'-system and varied with water depth.

Table 5: Catch history for by-catch species (macrourids, skates and other species), catch limits and number of skates released alive in Subarea 48.3. Catch limits are for the whole fishery (see CM 41-02 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)
2004	221	82	221	38	-	-	10
2005	152	121	152	9	-	-	19
2006	177	137	177	7	21056	-	35
2007	177	130	177	4	9265	-	26
2008	196	162	196	12	19558	-	36
2009	196	110	196	22	23709	-	33
2010	150	70	150	7	15810	-	16
2011	150	74	150	4	12832	-	9
2012	130	54	130	2	13503	-	9
2013	130	59	130	2	14005	-	11
2014	120	61	120	4	12969	-	15
2015	120	56	120	2	10937	-	10

Invertebrate by-catch including VME taxa

34. There are no registered vulnerable marine ecosystems (VMEs) or VME Risk Areas in Subarea 48.3.

Incidental mortality of seabirds and marine mammals

Incidental mortality

35. A single white-chinned petrel (*Procellaria aequinoctialis*) was caught in 2015 (Table 6).

Table 6: Number of reported birds killed in the longline fishery in Subarea 48.3.

Season	*Macronectes giganteus*	*Procellaria aequinoctialis*	*Thalassarche melanophrys*	Other
2005	4			2
2006				
2007				
2008				
2009			1	1
2010			1	1
2011				1
2012	1		1	
2013		1		
2014		77		
2015		1		

36. A summary of the bird mortality by longline in Subarea 48.3 over the past 10 seasons is presented in Table 6. The three most common species injured or killed in the fishery since 2005 were white-chinned petrel, southern giant petrel (*Macronectes giganteus*) and black-browed albatross (*Thalassarche melanophrys*).

37. Over the last 10 years, four mammal mortalities associated with longline fishing have occurred in Subarea 48.3.

Mitigation measures

38. The requirements of CM 25-02 'Minimisation of the incidental mortality of birds in the course of longline fishing or longline fishing research in the Convention Area' apply to this fishery in addition to the seasonal closure and the night-setting requirements described in CM 41-02.

39. Additional measures, including a vessel catch limit of three birds and the requirement for 100% prior compliance with CM 25-02, apply to vessels fishing in season-extension periods and these are set out in CM 41-02.

40. The risk level of birds in this fishery in Subarea 48.3 is category 5 (high) (SC-CAMLR-XXX, Annex 8, paragraph 8.1)

Ecosystem implications and effects

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

Current management advice and conservation measures

42. The limits on the exploratory fishery for *D. eleginoides* in Subarea 48.3 are defined in CM 41-02. The limits in force are summarised in Table 7.

Table 7: Limits on the fishery for *Dissostichus eleginoides* in Subarea 48.3 in force (CM 41-02).

Element	Limits in force
Access (gear)	Longlines or pots only
Subdivision of Subarea 48.3	See Figure 1
Catch limit	Catch limit for *Dissostichus eleginoides* of 2 750 tonnes for the subarea, applied as follows: Management Area A: 0 tonnes Management Area B: 825 tonnes Management Area C: 1 925 tonnes

(continued)

Table 7 (continued)

Element	Limits in force
Season: Longline	16 April to 31 August No season extension in 2016
Pots	1 December to 30 November
By-catch: Crabs	Any by-catch of crab shall, as far as possible, be released alive.
Finfish	Total combined catch of skates and rays 120 tonnes Total catch of *Macrourus* spp. 120 tonnes
Any species	Move-on rule
Mitigation	In accordance with CM 25-02
Observers	Each vessel to carry at least one CCAMLR scientific observer and may include one additional scientific observer
Data	Five-day catch and effort reporting under CM 23-01 Haul-by-haul catch and effort data under CM 23-03 Biological data reported by the CCAMLR scientific observer
Target species	For the purposes of CMs 23-01 and 23-04, *D. eleginoides* is the target species and the by-catch is any species other than *D. eleginoides*.
Jellymeat	Number and weight of *D. eleginoides* discarded, including those with jellymeat condition, to be reported. These catches count towards the catch limit.
Research fishing	Catches of *D. eleginoides* taken under CM 24-01 in the area of the fishery shall be considered as part of the catch limit.
Environmental protection	Regulated by CM 26-01

Appendix 1

Stock assessment

A1. The CASAL model framework was used to create a combined-sex, single-area, three-season model fitted to tagging data, survey biomass and length structure, catch age (post 1996/97) and length structure (prior to 1997/98). Estimates of spawning stock biomass (SSB), recruitment and harvest rate from the model are shown in Figure A1. The model fit (Figure A2) is most strongly influenced by the tag-recapture data, as shown in Figure A3, to which there is a good fit. The model fits poorly to the survey length distributions shown in Figure A4.

A2. Figure A5 shows projections under a catch limit of 2 750 tonnes, which is consistent with the CCAMLR Decision Rule which requires the stock to be at 50% of B_0 after 35 years, with a probability of less than 10% of dropping below 20% of B_0.

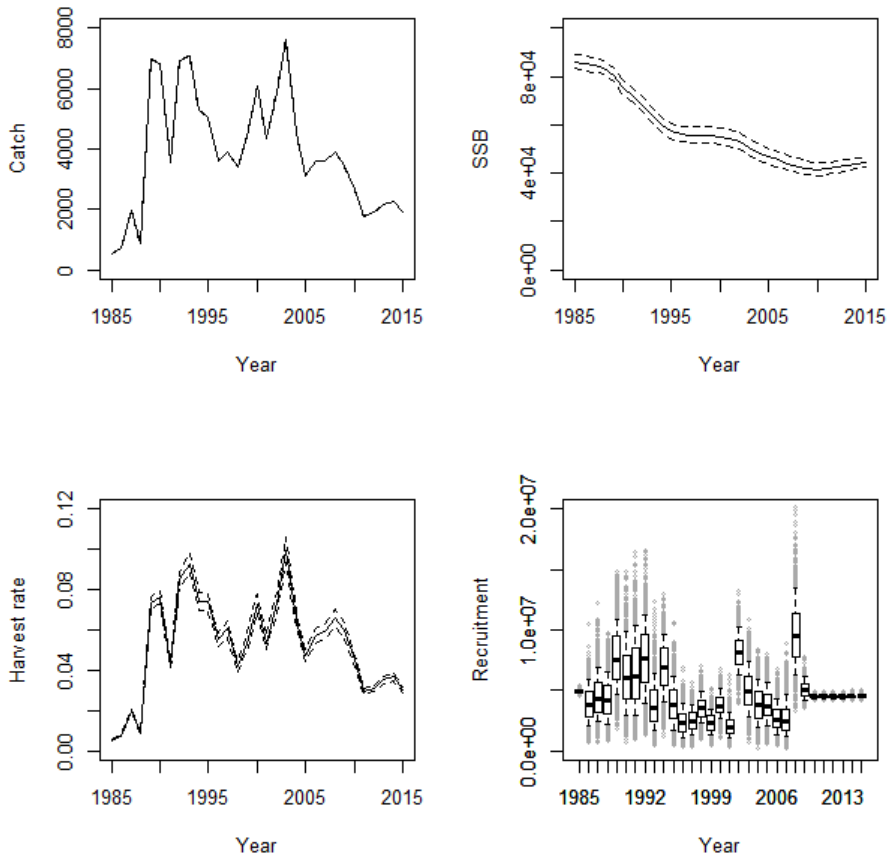


Figure A1: Patagonian toothfish in Subarea 48.3: Time series of catch, SSB, harvest rate and recruitment, with uncertainty estimated from MCMC resampling. Solid lines indicate the median value, dotted lines and the extent of whiskers indicate 10 and 90th percentiles and boxes extend from 25th to 75th percentiles.

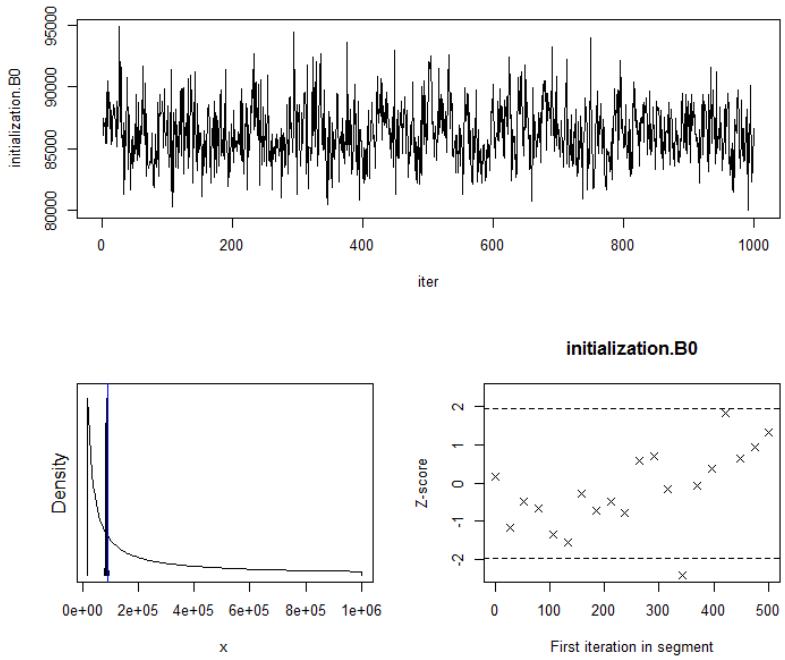


Figure A2: Patagonian toothfish in Subarea 48.3: MCMC diagnostics for B_0, showing a lack of trend in the trace (top), substantial difference between prior (black) and posterior (blue) distributions (bottom left) and low auto-correlation (bottom right).

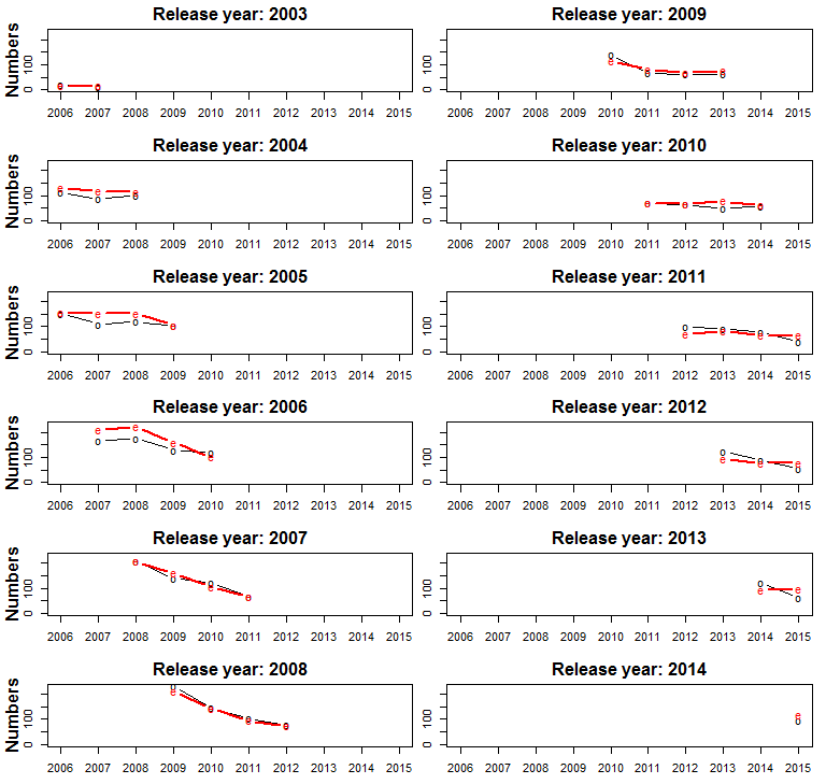


Figure A3: Patagonian toothfish in Subarea 48.3: Observed tag recaptures (black) and model fits (red) by release year.

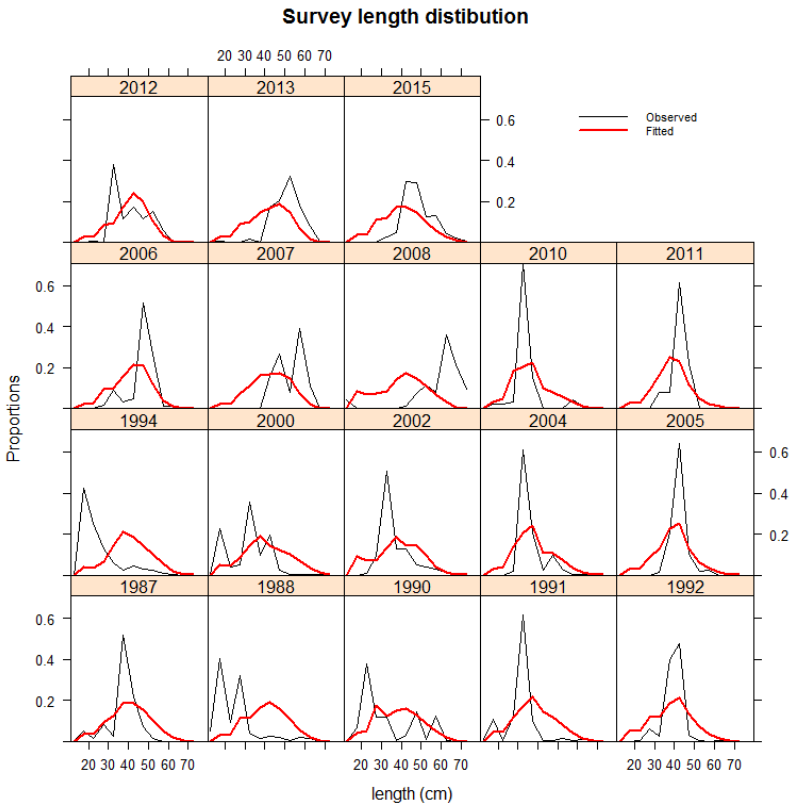


Figure A4: Patagonian Toothfish in Subarea 48.3: Observed length distributions (black) and model fits (red) to survey data.

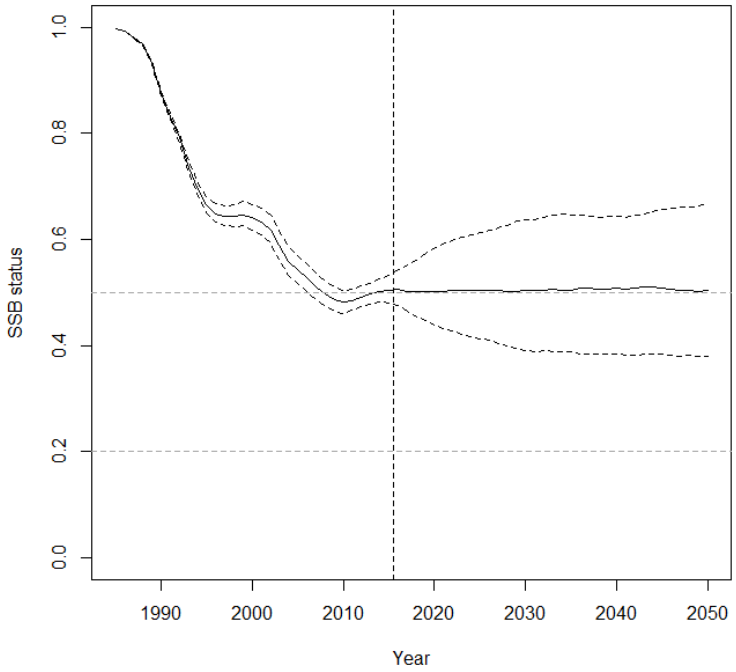


Figure A5: Patagonian toothfish in Subarea 48.3: projection of SSB relative to virgin biomass for 35 years based on a constant catch of 2 750 tonnes per year. Confidence intervals at 10% and 90% shown as dashed lines. Vertical dashed line indicates the split between model fit to past data and projection. Horizontal lines indicate 50% and 20%