APPENDIX N

FISHERY REPORT:
DISSOSTICHUS ELEGINOIDES AND *DISSOSTICHUS MAWSONI*
SOUTH SANDWICH ISLANDS (SUBAREA 48.4)

CONTENTS

	Page
1. Details of the fishery	1
1.1 Reported catch	2
1.2 Total removals	3
1.3 Size distribution of catches	4
2. Stocks and areas	5
3. Assessment of the northern stock of *D. eleginoides*	5
3.1 Mark-recapture data	5
3.2 Length frequency	7
3.3 Stock assessment	7
3.4 CASAL model structure and assumptions	8
Population dynamics	8
Model estimation	8
Data weighting	9
Penalties	9
Priors	9
3.5 Selectivity and growth	9
3.6 Point-estimate (MPD) results	10
3.7 MCMC results	15
3.8 Sensitivity runs	15
3.9 Yield calculations	16
3.10 Future work	17
4. Assessment of toothfish in Subarea 48.4 South	17
5. By-catch of fish and invertebrates	18
5.1 By-catch removals	18
5.2 Assessment of impacts on affected populations	19
5.3 Identification of levels of risk	19
5.4 Mitigation measures	19
6. By-catch of birds and mammals	20
6.1 By-catch removals	20
6.2 Mitigation measures	20
7. Ecosystem implications/effects	20
8. Harvest controls and management advice	20
8.1 Conservation measures	20
8.2 Management advice	21
Reference	22

FISHERY REPORT:
DISSOSTICHUS ELEGINOIDES* AND *DISSOSTICHUS MAWSONI
SOUTH SANDWICH ISLANDS (SUBAREA 48.4)

1. Details of the fishery

The fishery for *Dissostichus eleginoides* in Subarea 48.4 was initiated as a new fishery in 1992/93 following notifications from Chile and the USA (SC-CAMLR-XI, Annex 5, paragraph 6.22), and the adoption of 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).

2. Haul-by-haul data from the Chilean and Bulgarian vessels were submitted to CCAMLR, and WG-FSA used these data to estimate an annual yield of 28 tonnes of *D. eleginoides* for the subarea (SC-CAMLR-XII, Annex 5, paragraph 6.3, Table 1). The Commission adopted a precautionary catch limit for *D. eleginoides* of 28 tonnes per season. In addition, the taking of *D. mawsoni*, other than for scientific research purposes, was prohibited. These limits remained in force until 2004.

3. In 2004/05, the UK conducted a pilot tagging program using a fishing vessel. The vessel caught 27 tonnes of *D. eleginoides* and tagged 42 individuals, and the results of this research fishing were reported to WG-FSA (SC-CAMLR-XXIV, Annex 5, paragraphs 5.140 and 5.141).

4. Following the pilot study, the Commission agreed to an extensive mark-recapture experiment in Subarea 48.4 during the period from 2005/06 to 2007/08, with fishing conducted in accordance with CM 24-01 (CCAMLR-XXIV, paragraphs 11.46 and 11.47; SC-CAMLR-XXIV, paragraphs 4.113 to 4.117). The experiment resulted in a CASAL assessment of toothfish in the northern part of Subarea 48.4 in 2009.

5. In 2008, the Commission agreed to a continuation of the tagging experiment initiated in 2004/05 and to dividing Subarea 48.4 into a northern area (Subarea 48.4 North) and a southern area (Subarea 48.4 South), with a directed longline fishery on *D. eleginoides* in Subarea 48.4 North and *Dissostichus* spp. in Subarea 48.4 South.

6. The catch and by-catch limits in 2009/10 were as follows:

Subarea 48.4 North –

(i) a catch limit of 41 tonnes for *D. eleginoides*, derived from the CASAL assessment;

(ii) the continued prohibition of the taking of *D. mawsoni* other than for scientific research purposes;

(iii) the introduction of catch limits for by-catch species, with a limit for macrourids of 6.5 tonnes (16% of the catch limit for *D. eleginoides*) and a limit for rajids of 2.0 tonnes (5% of the catch limit for *D. eleginoides*).

Subarea 48.4 South –

(i) an experimental precautionary catch limit of 75 tonnes for *Dissostichus* spp. (*D. eleginoides* and *D. mawsoni* combined);

(ii) the introduction of a move-on rule for by-catch species, if the catch of rajids exceeds 5% of the catch of *Dissostichus* spp. in any one haul or set, or if the catch of macrourids reaches 150 kg and exceeds 16% of the catch of *Dissostichus* spp. in any one haul or set.

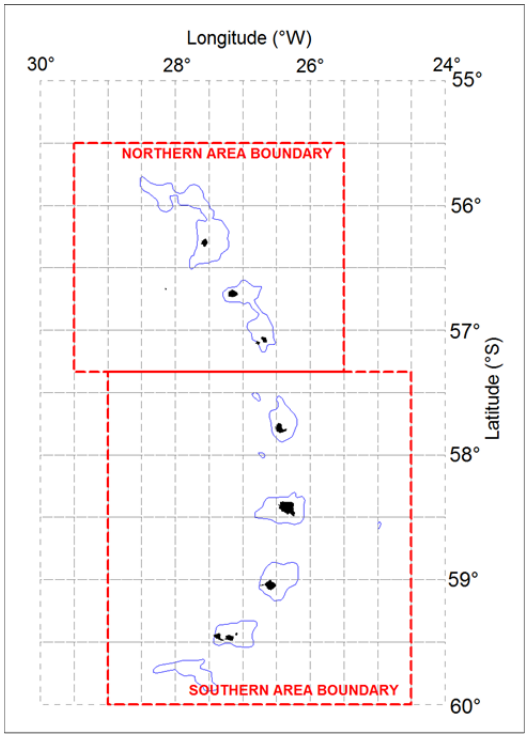

Figure 1: Positions of the boundaries of the northern area (Subarea 48.4 North) and southern area (Subarea 48.4 South) in Subarea 48.4. The 1 000 m depth contour is indicated.

1.1 Reported catch

7. Licensed longline vessels commenced fishing for *D. eleginoides* in Subarea 48.4 in 1991/92 and 1992/93; fishing was abandoned following poor catches. Fishing resumed in Subarea 48.4 North in 2004/05 with the implementation of the mark-recapture experiment which was extended to Subarea 48.4 South in 2008/09. In 2009/10, one New Zealand-flagged vessel and one UK-flagged vessel conducted research fishing and reported a total catch of 114 tonnes of *Dissostichus* spp. from Subarea 48.4 (Table 1(a)).

8. Subarea 48.4 North was closed on 14 April 2010 (catch limit for *D. eleginoides*: 41 tonnes; final reported catch: 40 tonnes). Subarea 48.4 South was closed on 4 May 2010 (catch limit for *Dissostichus* spp.: 75 tonnes; final reported catch: 74 tonnes).

1.2 Total removals

9. There is no information to derive an estimate of the level of IUU fishing in Subarea 48.4 (Table 1(a)).

Table 1(a): Catch history for *Dissostichus* spp. in Subarea 48.4 (Subarea 48.4 North and Subarea 48.4 South combined, source: STATLANT data for past seasons, and catch and effort reports for current season, WG-FSA-10/6 Rev. 1 and past reports for IUU catch).

Season	Regulated fishery						Estimated IUU catch (tonnes)	Total removals (tonnes)
	Effort (number of vessels)		*Dissostichus* spp.					
			Catch limit (tonnes)*	Reported catch (tonnes)				
	Limit	Reported		*D. eleginoides*	*D. mawsoni*	Total		
1991/92	-	1	-	30	0	30	-	30
1992/93	-	1	240[a]	10	0	10	-	10
1993/94	-	0	28[a]	0	0	0	-	0
1994/95	-	0	28[a]	0	0	0	-	0
1995/96	-	0	28[a]	0	0	0	-	0
1996/97	-	0	28[a]	0	0	0	-	0
1997/98	-	0	28[a]	0	0	0	-	0
1998/99	-	0	28[a]	0	0	0	-	0
1999/00	-	0	28[a]	0	0	0	-	0
2000/01	-	0	28[a]	0	0	0	-	0
2001/02	-	0	28[a]	0	0	0	-	0
2002/03	-	0	28[a]	0	0	0	-	0
2003/04	-	0	28[a]	0	0	0	-	0
2004/05	-	1	100[b]	27	<1	27	-	27
2005/06	-	2	100[b]	18	<1	19	-	19
2006/07	-	2	100[b]	54	<1	54	-	54
2007/08	-	2	100[b]	98	<1	98	-	98
2008/09	-	2	150[c]	74	59	133	-	133
2009/10	-	2	116[d]	57	56	114	-	114

[a] Applies to *D. eleginoides* in the subarea
[b] Applies to *D. eleginoides* in Subarea 48.4 North only
[c] 75 tonnes for *D. eleginoides* in Subarea 48.4 North and 75 tonnes for *Dissostichus* spp. in Subarea 48.4 South
[d] 41 tonnes for *D. eleginoides* in Subarea 48.4 North and 75 tonnes for *Dissostichus* spp. in Subarea 48.4 South

Table 1(b): Catch of *Dissostichus* spp. in Subarea 48.4 North (N) and Subarea 48.4 South (S) (source: fine-scale data pro-rated by total reported catch in Table 1(a)). Subarea 48.4 South was closed to fishing between 2004/05 and 2007/08.

Season	*D. eleginoides*		*D. mawsoni*	
	N	S	N	S
2004/05	27			
2005/06	18		<1	
2006/07	54		<1	
2007/08	98		<1	
2008/09	59	15	<1	59
2009/10	40	17	<1	56

1.3 Size distribution of catches

10. Most *D. eleginoides* caught in the fishery ranged from 80 to 140 cm in length, with a broad mode at approximately 90–115 cm (Figure 2). *Dissostichus mawsoni* caught in Subarea 48.4 South had a mode at approximately 140–170 cm.

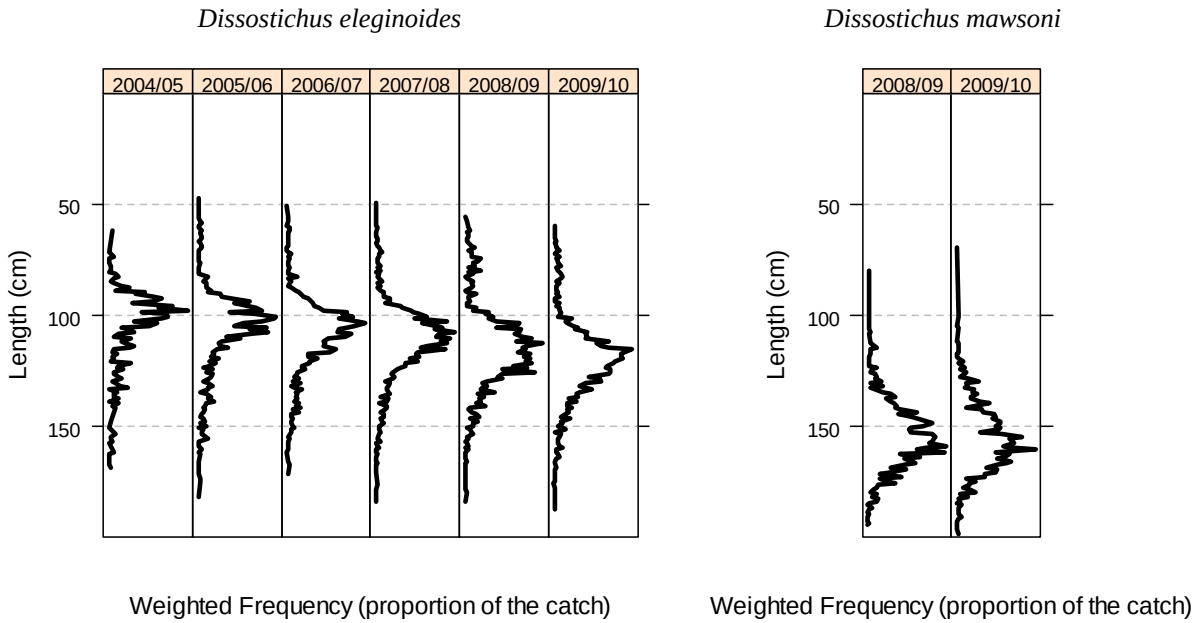

Figure 2: Catch-weighted length frequencies for *Dissostichus eleginoides* and *Dissostichus mawsoni* in Subarea 48.4 (source: observer, fine-scale and STATLANT data, and the length–weight relationships were taken from observations on *D. eleginoides* in Subarea 48.3 and *D. mawsoni* in Subarea 88.1).

2. Stocks and areas

11. WG-FSA-09/17 and 09/18 provided a comprehensive analysis of the distribution of the two species in Subarea 48.4 (Figure 3).

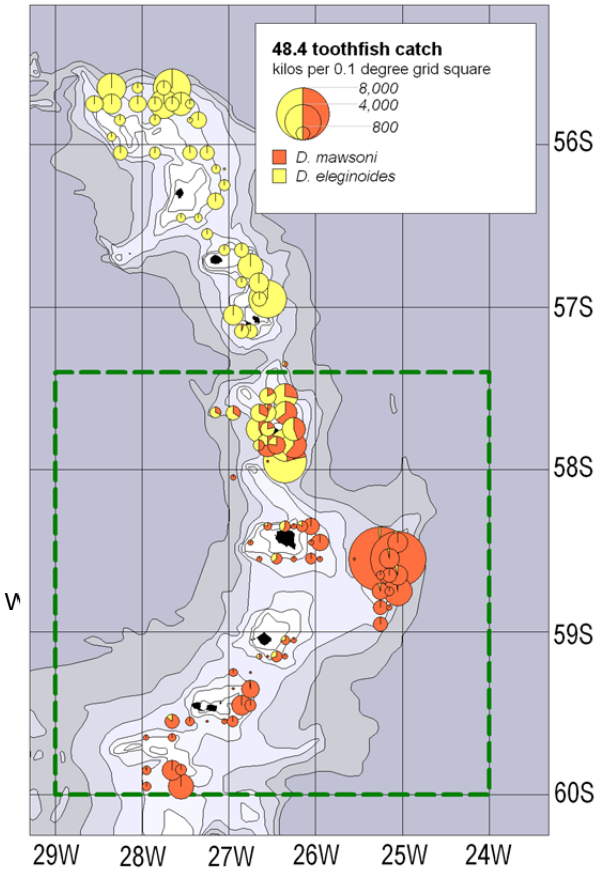

Figure 3: Catch distribution of the two *Dissostichus* species in Subarea 48.4.

3. Assessment of the northern stock of *D. eleginoides*

3.1 Mark-recapture data

12. Since 2005/06, vessels operating in this fishery have been required to tag and release *Dissostichus* spp. at a rate of five fish per tonne of green weight caught. A total of 1 947 *D. eleginoides* and 406 *D. mawsoni* have been tagged and released, and 86 *D. eleginoides* and 24 *D. mawsoni* have been recaptured in that subarea (Tables 2 and 3). In addition, one *D. eleginoides* tagged in Subarea 48.4 was recaptured in Subarea 48.3.

13. A small error in the tag release–recapture matrix for Subarea 48.4 North in the relevant paper to WG-FSA (WG-FSA-10/39) is updated here (Table 3).

Table 2: Number of individuals of *Dissostichus* spp. tagged and released (a) and tagging rates (b) reported by vessels operating in the exploratory fishery for *Dissostichus* spp. in Subarea 48.4 since 2005/06, and total number of tagged fish released and recaptured (c). (Source: observer data and catch and effort reports)

(a) Number of individuals of *Dissostichus* spp. tagged and released. The number of *D. eleginoides* is indicated in brackets.

Flag State	Vessel name	Season				
		2005/06	2006/07	2007/08	2008/09	2009/10
New Zealand	*San Aspiring*	98 (88)	252 (251)	252 (252)	432 (309)	310 (162)
UK	*Argos Froyanes*			252 (252)		310 (256)
	Argos Georgia				319 (249)	
	Argos Helena	46 (46)	40 (40)			

(b) Tagging rate (number of fish tagged per tonne of green weight caught) of *Dissostichus* spp.

Flag State	Vessel name	Season				
		2005/06	2006/07	2007/08	2008/09	2009/10
New Zealand	*San Aspiring*	7.93	5.25	5.12	5.84	5.38
UK	*Argos Froyanes*			5.17		5.52
	Argos Georgia				5.36	
	Argos Helena	7.16	6.44			
Required rate		5	5	5	5	5

(c) Total number of tagged *Dissostichus* spp. released and recaptured in Subarea 48.4.

Season	Number tagged and released			Number recaptured		
	D. eleginoides	*D. mawsoni*	Total	*D. eleginoides*	*D. mawsoni*	Total
2004/05	42	0	42	0	0	0
2005/06	134	10	144	0	0	0
2006/07	291	1	292	2	0	2
2007/08	504	0	504	23	0	23
2008/09	558	193	751	29	2	31
2009/10	418	202	620	32	22	54
Total	1947	406	2353	86	24	110

Table 3: Release and recapture data from Subarea 48.4 North.

Release season	Number of releases (tag rate)	Recaptures by season (catches (tonnes) in parentheses)						
		2004/05 (26.8)	2005/06 (18.3)	2006/07 (54.0)	2007/08 (97.5)	2008/09 (58.9)	2009/10 (39.6)	All seasons
2004/05	42 (1.6)	0	0	0	2	2	0	4
2005/06	134 (7.1)	-	0	2	8*	4	2	15
2006/07	291 (5.4)	-	-	0	13*	12	1	24
2007/08	504 (5.2)	-	-	-	0	8	8	8
2008/09	344 (5.8)	-	-	-	-	3	7	3
2009/10	232 (5.9)	-	-	-	-	-	0	0
All seasons	1547 (5.2)	0	0	2	22	29	18	72

* One tag recapture in 2007/08 re-allocated to the tag release year 2006/07 (previously 2005/06).

3.2 Length frequency

14. Length-frequency data from the fishery suggests the presence of a single modal length class progressing each year (Figure 4). The 2008/09 data suggested the recruitment of a new strong year class into the fishery (70–80 cm length class). This was also observed in the 2009/10 length-frequency data, although it will be difficult to estimate the relative size of this year class before it has fully recruited in to the fishery.

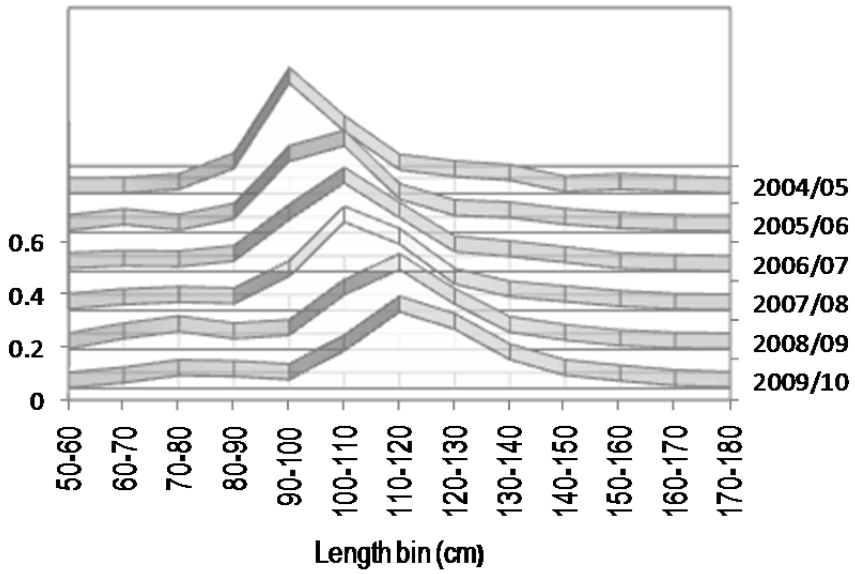

Figure 4: Catch length frequencies in Subarea 48.4 by season.

3.3 Stock assessment

15. WG-FSA-09/17 presented an updated assessment for Subarea 48.4 *D. eleginoides* using CASAL software. The assessment model is for Subarea 48.4 North only. The model was based on the catch-at-length-based Subarea 48.3 CASAL model (Hillary et al., 2006), although with two important differences:

- CPUE data were not included in the model. Fishing masters were initially unfamiliar with the fishing grounds, hence the CPUE series was not deemed to be a useful estimate of population abundance.

- A single-fleet structure was used, covering the period of the experiment only (earlier catches in 1991 and 1992 were not included in the model).

16. Data from the fishery in Subarea 48.4 were used to estimate biological parameters for the stock, although some parameter values were taken from the Subarea 48.3 model if insufficient data were available to estimate the parameter values for the Subarea 48.4 stock. These were:

- natural mortality – 0.13;

- stock recruitment parameters – steepness 0.75;

- maturation parameters – maturation proportion-at-length from the Subarea 48.3 assessment;
- the L_∞ used in the 2007 Subarea 48.3 assessment appeared, from an analysis of tag-return data, to be more appropriate for this stock than the smaller L_∞ recently estimated for the Subarea 48.3 stock, so the following growth parameters were used to initiate the model: L_∞ 152.8, k 0.067. t_0 was fixed at 1.49;
- tag loss rate – 0.0036;
- tagging mortality rate – 0.1, at the upper end of estimates of those available for Subarea 48.3 to reflect the large size of animals in Subarea 48.4;
- tag detection probability – 1.

17. The Working Group agreed that this model should be used to assess the *D. eleginoides* stock in Subarea 48.4 North.

3.4 CASAL model structure and assumptions

Population dynamics

18. The CASAL population model used in the assessment of toothfish in Subarea 48.4 was a combined-sex, single-area, three-season model. The annual cycle was defined as follows: the first season (December to April) is where only recruitment (at the start) and natural mortality occurs; the second season, ranging from the beginning of May to the end of August, includes both natural mortality and fishing and contains the spawning period – half the mortality in that particular season being accounted for before spawning occurs; the final season runs from the beginning of September to the end of November, thus completing the annual cycle, with only natural mortality occurring. It was assumed throughout that the proportions of natural mortality and growth that occurred within each season were equal to that season's length as a proportion of a year. The models were run over the years 1990 to 2010, with an initial unexploited equilibrium age structure, and with a Beverton-Holt stock-recruit relationship with fixed steepness.

Model estimation

19. The catch proportions-at-length data were fitted to the model-expected proportions-at-length composition, using a multinomial likelihood.

20. Tag-release events for the years 2005 to 2009 were incorporated into the model with recaptures used from 2006 to 2010. Within-year/season recaptures were omitted from the observations to allow for possible incomplete mixing in the first few months after release. Tag-release and recapture events occurred during the fishing season (season 2), with a probability of detection of recaptured tags of 1. The estimated numbers of scanned fish for each length class relevant to those in the recapture data were calculated using the total catch biomass, the catch-at-length proportions and the mean weight of the fish.

21. In each year, the length frequencies of releases and recaptures ranged from 20 to 220 cm in 10 cm length bins.

Data weighting

22. The appropriate effective sample sizes to be used to weight the length-frequency data, and the levels of possible over-dispersion apparent in the estimated tagged populations, were investigated. For both sets of observations, standard formulae were used to estimate these quantities after an initial MPD run of the model with the original sample sizes/dispersion values. The actual effective sample sizes/dispersion values predicted by the model's fit to the relevant dataset were then adopted, and a secondary MPD run was performed.

Penalties

23. Two types of penalties were included within the model. First, a penalty on the catch constrained the estimated harvest rate in any year from exceeding a specified maximum, set at 1.0 (see the *U_max* parameter in the fishery definition in the population.csl file) in the CASAL assessment models. Second, a tagging penalty discouraged population estimates that were too low to allow the correct number of fish to be tagged.

Priors

24. Table 4 shows the free parameters estimated in the CASAL model, along with their respective bounds and prior parameterisations.

Table 4: Free parameters, and their priors and bounds in the CASAL assessment models.

Parameter	Prior	Lower bound	Upper bound
B_0 (virgin SSB)	Uniform-log	500	5000
k (von Bertalanffy)	Uniform	0.05	0.15
L_∞ (von Bertalanffy)	Uniform	110	250
l_{50} and l_{to95} (logistic selectivity parameters)	Uniform	1	50
YCS	Lognormal	0.001	20

3.5 Selectivity and growth

25. A logistic selectivity was assumed because of the potential interaction between growth and selectivity, particularly in a model with such a short data series as this. Furthermore, the fleet fishing in Subarea 48.3 has an approximately flat-topped selectivity, despite being estimated as a double-normal. Since the same vessels are fishing in Subareas 48.3 and 48.4, a logistic selectivity-at-age was assumed for the Subarea 48.4 assessment, of the form:

$$s(l) = 1/\left(1+19^{(l_{50}-l)/l_{to95}}\right) \quad (1)$$

where $s(l)$ is the selectivity at length l, l_{50} is the length at 50% selectivity and l_{to95} the length for which 95% selectivity is obtained at length $l_{50} + l_{to95}$.

3.6 Point-estimate (MPD) results

26. A single assessment model was run for WG-FSA. CASAL estimates of biomass and selectivity parameters were similar to those from the previous season, though the shape of the VB growth curve was slightly different, with an increased L_∞ and decreased k in the updated model (Table 5).

Table 5: Summary of selected parameter values estimated by the CASAL model, comparing updated values with those from the previous season. Values given to four significant figures.

Final season	B_0 (tonnes)	Selectivity parameters (see equation 1)	Growth parameters
2008/09	1127	a_{50} 11.54, a_{to95} 4.151	k 0.06628, L_∞ 153.7
2009/10	1114	a_{50} 11.41, a_{to95} 4.266	k 0.06255, L_∞ 160.3

27. Model-fit diagnostics and goodness-of-fit achieved by the reference model are shown in Figures 5 to 11.

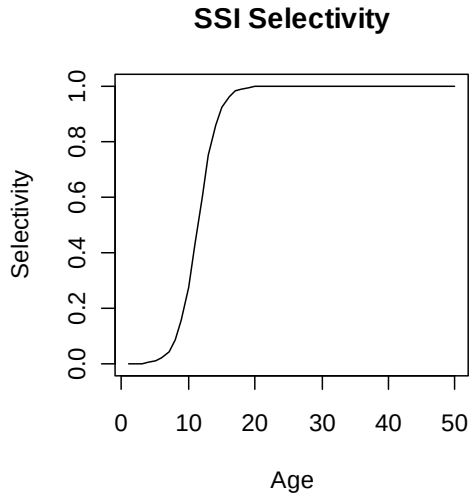

Figure 5: Estimated logistic selectivity curve in the assessment model.

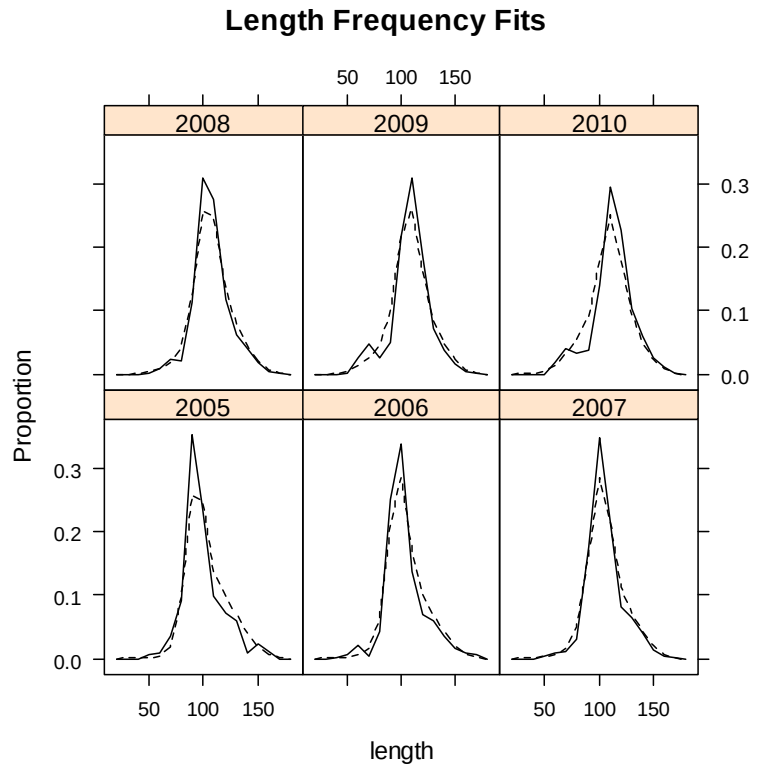

Figure 6: Fit to fleet catch-length frequencies for the assessment model. The full and dotted lines represent the observed and predicted length frequencies respectively.

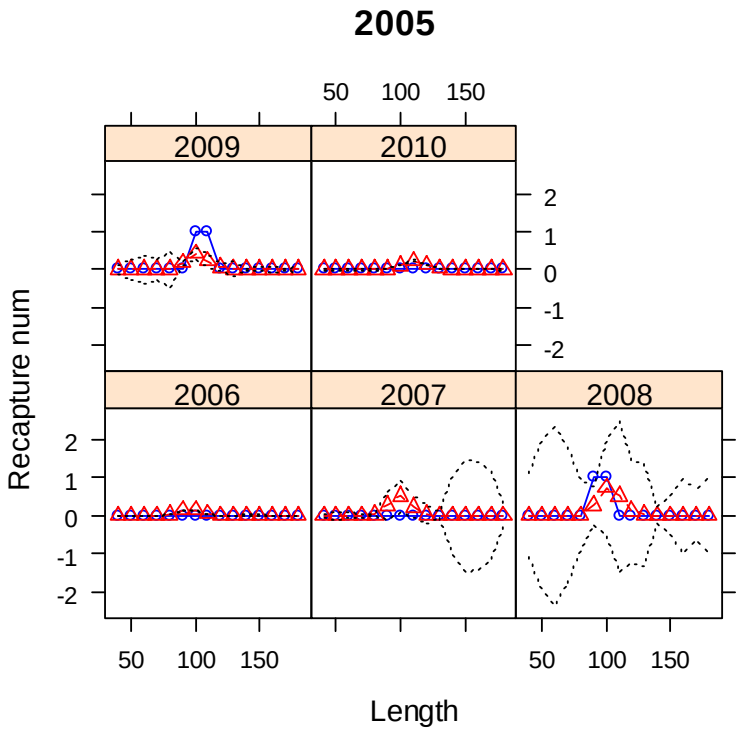

Figure 7: Fits to the 2005 tag-release data – observed recapture probabilities are the circles, expected recaptures are the broken red lines with triangles (s.e's also shown by dotted lines).

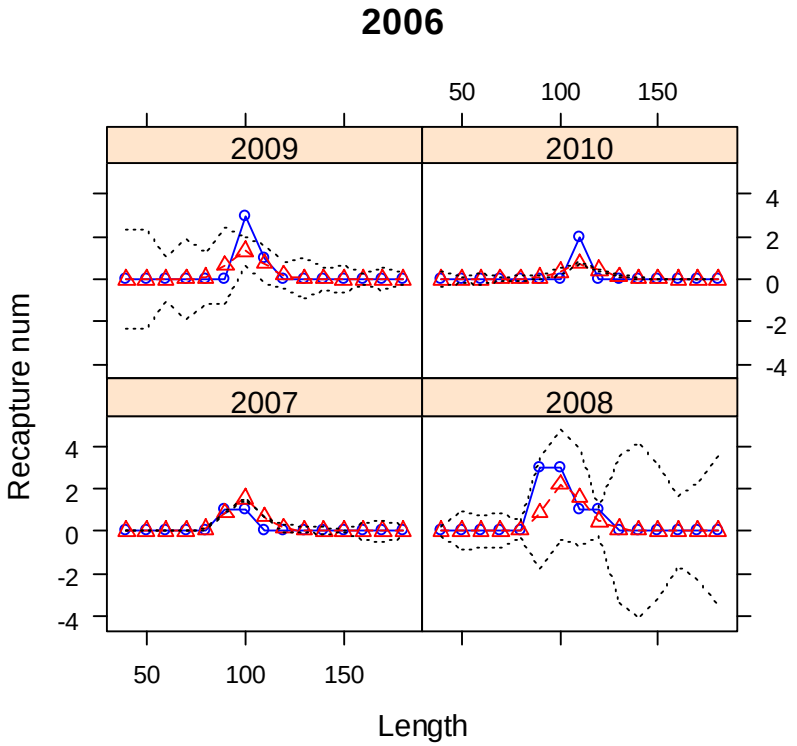

Figure 8: Fits to the 2006 tag-release data – observed recapture probabilities are the circles, expected recaptures are the broken red lines with triangles (s.e's also shown by dotted lines).

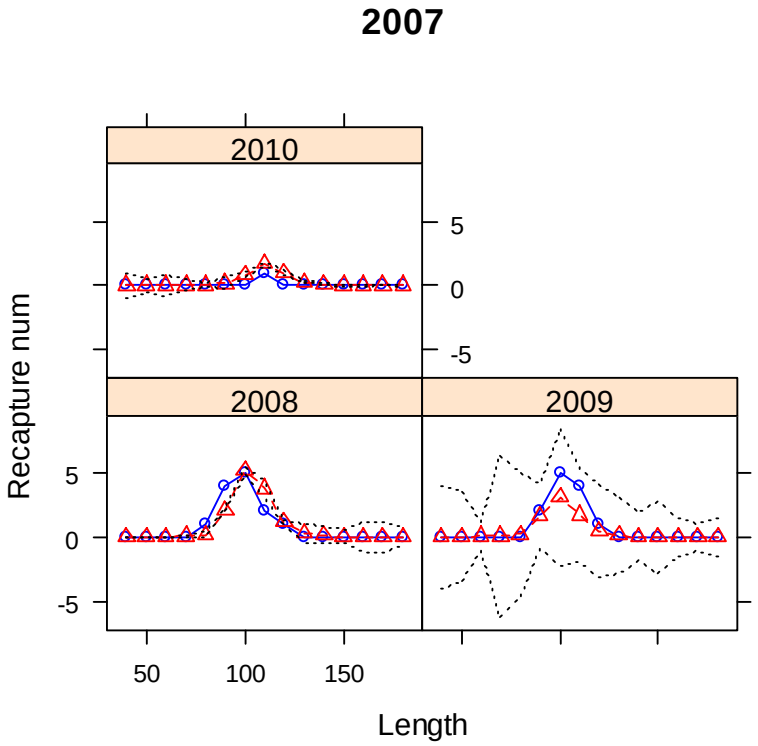

Figure 9: Fits to the 2007 tag-release data – observed recapture probabilities are the circles, expected recaptures are the broken red lines with triangles (s.e's also shown by dotted lines).

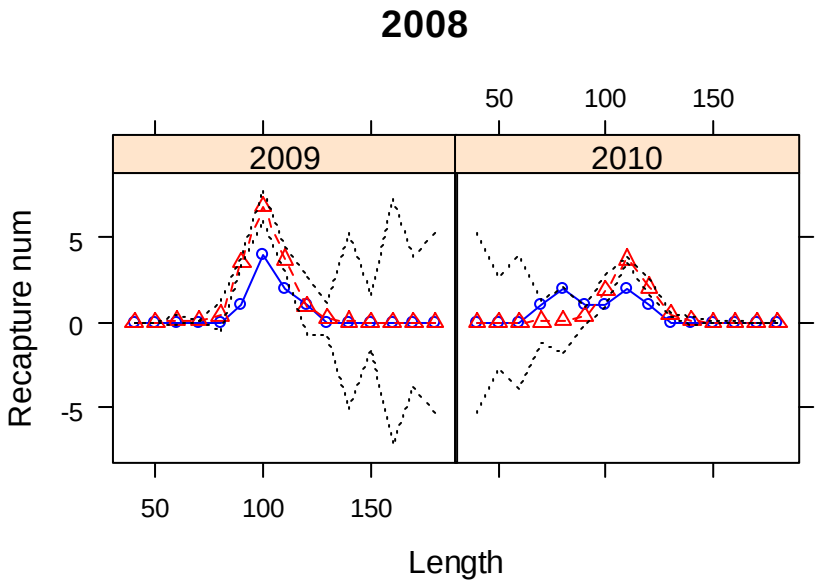

Figure 10: Fits to the 2008 tag-release data – observed recapture probabilities are the circles, expected recaptures are the broken red lines with triangles (s.e's also shown by dotted lines).

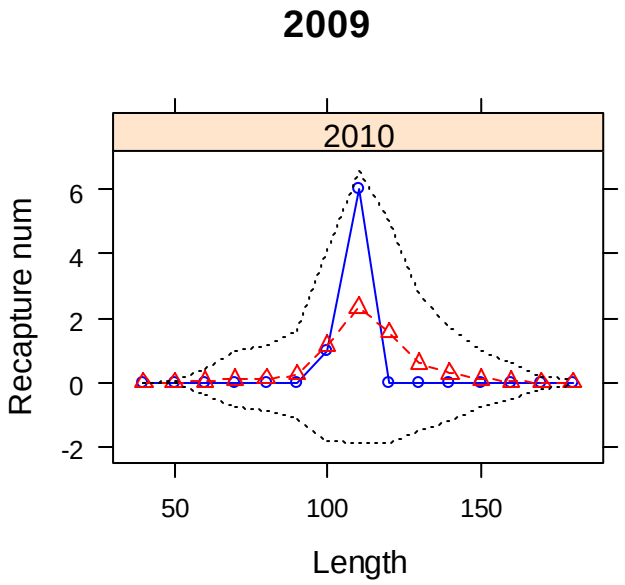

Figure 11: Fits to the 2009 tag-release data – observed recapture probabilities are the circles, expected recaptures are the broken red lines with triangles (s.e's also shown by dotted lines).

28. Stock trajectories and key indices are shown in Figure 12.

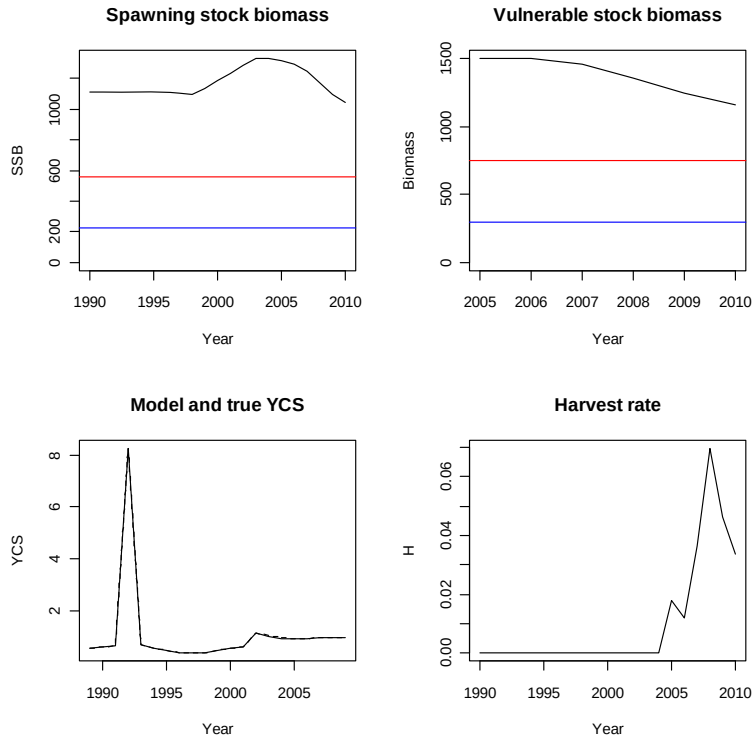

Figure 12: Stock trajectories for the assessment model.

29. As can be seen, good fits were achieved to both the tag-recapture and catch-at-length datasets. The fits are particularly good considering the short time series available for the datasets.

30. Figure 13 shows the likelihood profile for the current assessment model for the virgin biomass parameter. Overall likelihood levels are low (for instance compared with the Subarea 48.3 assessment), reflecting the low quantities of data currently available from this fishery. Nevertheless, the tag data from the early years (2005–2007 and 2009) suggest B_0 in the range 800–1 400 tonnes. The tag data from 2008 suggest a higher biomass, and the catch-at-length data suggest a lower biomass, mostly driven by the lognormal prior.

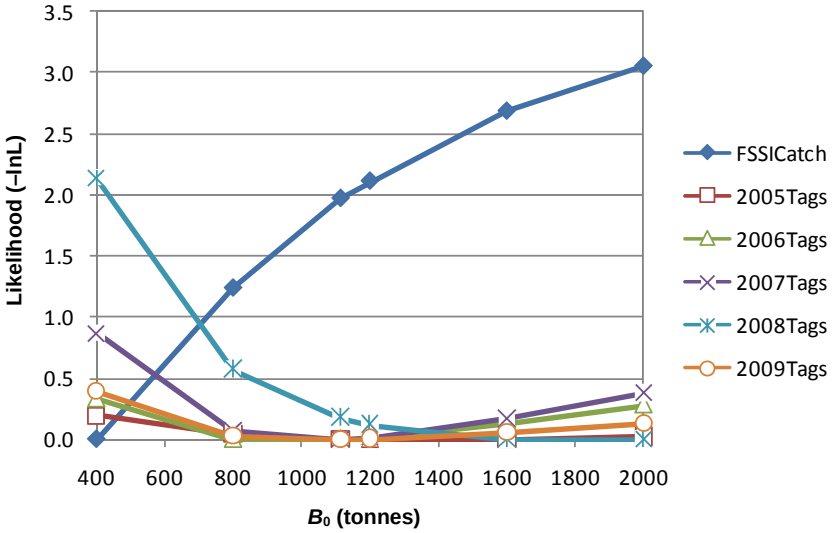

Figure 13: Likelihood profiles for the reference model for Subarea 48.4. The legend refers the particular curve in the figure to the relevant dataset etc. used in the assessment. FSSICatch is the catch-at-length proportions.

3.7 MCMC results

31. As can be seen from Table 6, the uncertainty in the MCMC samples about the posterior median is large, primarily due to the low levels of data available. The convergence of the MCMC chains was assessed using the methods already outlined in WG-FSA-05 (SC-CAMLR-XXIV, Annex 5).

Table 6: Median biomass and 95% CIs for the initial equilibrium SSB (B_0), the current SSB (B_{2010}) and the ratio of current to initial SSB (B_{2010}/B_0).

Model	B_0 (tonnes)	B_{2010} (tonnes)	B_{2010}/B_0
Reference	991.4 (552.1–2122.3)	1160.7 (597.9–2587.4)	1.14 (0.90–1.51)

3.8 Sensitivity runs

32. The single-assessment model was rerun omitting 2008 tag releases, which had a lower than expected number of tag returns in 2008/09 and 2009/10. This estimated a reduced B_0 of 963 tonnes and a B_{2010}/B_0 of 0.897, compared to 1 114 tonnes and 0.928 when 2008 tag-releases were included. Given that similar estimates of depletion were obtained, WG-FSA recommended that the model including 2008 tags be used to estimate yield for this stock.

3.9 Yield calculations

33. CASAL allows the historic stock dynamics to be projected into the future, for a variety of future scenarios. A constant catch projection allows calculation of the long-term yield that satisfies the CCAMLR decision rules:

(i) Choose a yield γ_1, so that the probability of the spawning biomass dropping below 20% of its median pre-exploitation level, over a 35-year harvesting period, is 10% (depletion probability).

(ii) Choose a yield γ_2, so that the median escapement in the SSB over a 35-year period is 50% of the median pre-exploitation level, at the end of the projection period.

(iii) Select the lower of γ_1 and γ_2 as the yield.

34. The depletion probability was calculated as the proportion of samples from the Bayesian posterior, where the predicted future SSB was below 20% of B_0 in the respective sample of any one year, for each year in the 35-year projection period.

35. The level of escapement was calculated as the proportion of samples from the Bayesian posterior, where the projected future status of the SSB was below 50% of B_0 in the respective sample, at the end of the 35-year projection period.

36. Lognormal recruitment was used for the projection, calculated from the MCMC results to have a CV of 1.25. The reason for this very high variability is the identification in the current assessment of a single dominating cohort. Because of this very high recruitment variability, the future catch limit was constrained by the first (γ_1) decision rule. Figure 14 shows the historic and future SSB dynamics for a constant yield of 40 tonnes projected from 2011 to 2044.

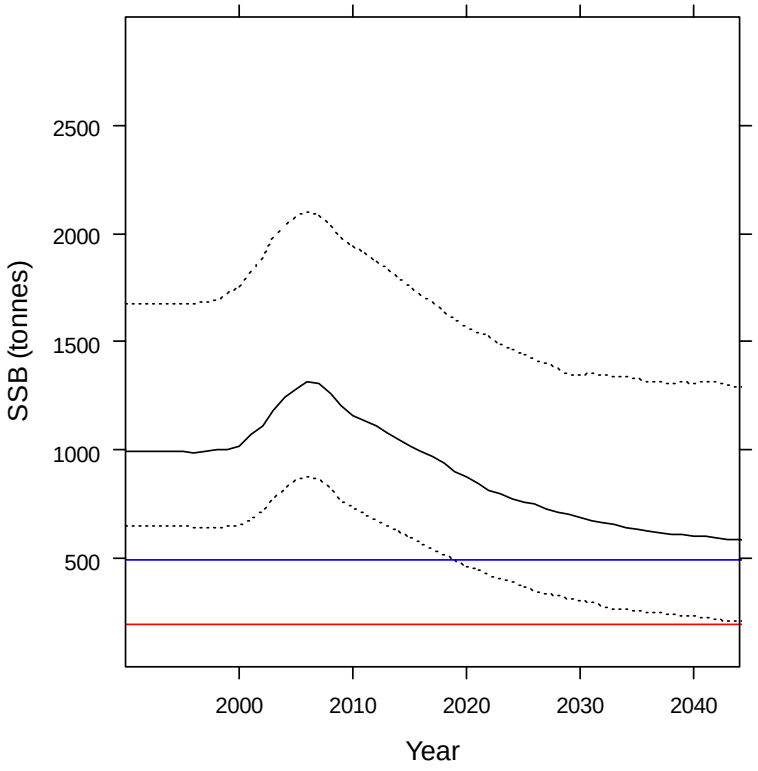

Figure 14: Historic and projected SSB dynamics for a constant future (2011–2044) yield of 40 tonnes. The solid line represents the median with the dotted lines representing the 80% credible interval. The blue and red lines are the medians of 50% and 20% of virgin biomass respectively. The yield associated with γ_1 was 40 tonnes, and with γ_2 was 46 tonnes.

3.10 Future work

37. Important future work will be to move from proportions-at-length to proportions-at-age in the model. In addition, WG-FSA recommended that the model be developed to include data from fishing in Subarea 48.4 South, such that the sub-population of *D. eleginoides* in the north of this area is incorporated into the assessment.

4. Assessment of toothfish in Subarea 48.4 South

38. Subarea 48.4 South is in the second year of a three-year experiment. No full assessment is currently available. However, a preliminary assessment, using the limited number of tag-recaptures to date and CPUE/area comparisons with Subarea 48.4 North, suggests a vulnerable population of between 600 and 1 500 tonnes. This is about half the size of the estimate that was made in 2009, after the first season of fishing, which was based only

on CPUE/area comparison (WG-FSA-09/18). In addition, there was some evidence of significant depletion around particular islands and seamounts close to the northern boundary of Subarea 48.4 South (WG-FSA-10/40).

39. Taking into account the revised preliminary population assessment, the Working Group recommended a reduced 30 tonne catch limit during the third year of the experiment. Given that the stock is still likely to be close to its unexploited biomass, the Working Group agreed that such a catch would be unlikely to deplete *Dissostichus* spp. in Subarea 48.4 South to the point where they would need recovery.

40. WG-FSA-10/40 proposed to complete the tagging experiment initiated in Subarea 48.4 South in 2008/09. The Working Group agreed that this was a useful approach and an extension of the experiment for one more year was recommended, with the revised catch limit of 30 tonnes.

5. By-catch of fish and invertebrates

5.1 By-catch removals

41. Catches of by-catch species groups (macrourids, rajids and other species) reported in fine-scale data, and number of rajids cut from lines and released alive, are summarised in Tables 7 and 8. The by-catch in this fishery consists predominantly of macrourids (up to 26 tonnes per season) and rajids (up to 9 767 released alive). In 2009/10, catch limits for by-catch species were introduced in Subarea 48.4 North and by-catch move-on rules were introduced in Subarea 48.4 South.

Table 7: Catch history for by-catch species in Subarea 48.4 North (macrourids, rajids and other species) and number of rajids released alive in Subarea 48.4 (source: fine-scale data).

Season	Catch limit		Catches taken		Rajids – number released	Other species reported catch (tonnes)
	Macrourids (tonnes)	Rajids (tonnes)	Macrourids (tonnes)	Rajids (tonnes)		
2004/05	-	-	3	0	0	<1
2005/06	-	-	5	1	4359	<1
2006/07	-	-	14	2	6515	<1
2007/08	-	-	16	4	8276	<1
2008/09	12	4	12	1	6501	<1
2009/10	6.5	2	4	1	3742	<1

Table 8: Catch history for by-catch species in Subarea 48.4 South (macrourids, rajids and other species) and number of rajids released alive in Subarea 48.4 (source: fine-scale data).

Season	Catches taken		Rajids – number released	Other species reported catch (tonnes)
	Macrourids (tonnes)	Rajids (tonnes)		
2008/09	14	<1	3266	<1
2009/10	12	<1	2441	<1

5.2 Assessment of impacts on affected populations

42. The distribution of rajids 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. To date, 366 skates have been tagged in Subarea 48.4 North, including 97 in 2009/10. Rajids are generally distributed to the east, compared to toothfish being generally distributed to the north and west. In Subarea 48.4 South, rajids are not so common, although 338 have now been tagged, including 141 in 2009/10. The potential for significant impacts on rajids may therefore be limited.

43. Although catch rates for macrourids in Subarea 48.4 North were initially high at the start of the fishery, vessels have altered their fishing techniques and rates have subsequently dropped to 16% of the catch weight for *D. eleginoides*. In 2009/10, the macrourid catch (approximately 20% of the *D. eleginoides* catch) limited the northern fishery (the catch limit for macrourids was reached before the catch limit of toothfish), although catch rates decreased to less than 11% of *D. eleginoides* catch in 2009/10.

44. In Subarea 48.4 South, a move-on rule for macrourids operated (at 16% of the toothfish catch where more than 150 kg of macrourids were caught).

45. Macrourid catches were previously thought to almost entirely comprise *Macrourus whitsoni.* Genetic analyses now suggest that the macrourid population may comprise two species, including *M. whitsoni* and a new undescribed *Macrourus* species (WG-FSA-10/33).

5.3 Identification of levels of risk

46. None available for this fishery.

5.4 Mitigation measures

47. By-catch limits and move-on rules are included in the annual conservation measure established for this fishery (CM 41-03). In addition, mitigation measures for rajids include using Year-of-the-Skate protocols for releasing skates caught alive.

48. The move-on rule for macrourids in Subarea 48.4 South was modified at the end of the 2008/09 season, so that the 16% of toothfish catch trigger would only operate on lines where at least 150 kg of macrourids were caught. In 2009/10, the total catch of macrourids was lower than that of the previous season (11.6 tonnes compared to 14.1 tonnes in the previous season) and the proportion of macrourid move-on trigger sets was considerably lower than would have occurred with the 2008/09 move-on rule (8% sets compared to 70%). The rajid by-catch was 0.9 tonnes, 1.3% of the toothfish catch, and the 5% of toothfish catch move-on rule was triggered on 15% of sets. WG-FSA recommended that the move-on rules for macrourids and rajids should remain unchanged in 2010/11.

6. By-catch of birds and mammals

6.1 By-catch removals

49. There have been no observed seabird mortalities in the Subarea 48.4 fishery (Table 9).

Table 9: Seabird by-catch limit, observed mortality rate and total estimated mortality in Subarea 48.4.

Season	Mortality rate (birds per thousand hooks)	Total estimated mortality (number of birds)
2004/05	0	0
2005/06	0	0
2006/07	0	0
2007/08	0	0
2008/09	0	0
2009/10	0	0

50. There have been no observed marine mammal mortalities in the Subarea 48.4 fishery.

51. WG-IMAF did not meet in 2010, however, in 2009 it assessed the risk level of seabirds in this fishery in Subarea 48.4 as category 3 (average) (SC-CAMLR-XXVIII, Annex 7, Table 14 and Figure 2).

6.2 Mitigation measures

52. CM 25-02 applies to this fishery, except paragraph 5, if requirements of CM 24-02 are met. There is a limit of three (3) seabirds per vessel during daytime setting. Fishing in December, January, February, March, October and November shall be in accordance with CM 24-02.

7. Ecosystem implications/effects

53. No evaluation available for this fishery.

8. Harvest controls and management advice

8.1 Conservation measures

54. The limits on the fishery for *D. eleginoides* and *D. mawsoni* in Subarea 48.4 are defined in CM 41-03. The limits in force and the Working Group's advice to the Scientific Committee for the forthcoming season are summarised in Table 10.

Table 10: Limits on the fishery for *Dissostichus eleginoides* and *D. mawsoni* in Subarea 48.4 in 2009/10 (CM 41-03) and advice to the Scientific Committee for 2010/11.

Element	Limit in force	Advice for 2010/11
Access	Subarea 48.4 North: directed longline fishery on *Dissostichus eleginoides*	Carry forward
	Subarea 48.4 South: directed longline fishery on *Dissostichus* spp.	Carry forward
Catch limit	Subarea 48.4 North: precautionary catch limit for *D. eleginoides* was 41 tonnes and the taking of *D. mawsoni*, other than for scientific research purposes, is prohibited.	Revise
	Subarea 48.4 South: precautionary catch limit for *Dissostichus* spp. was 75 tonnes	Revise
Season	1 December to 30 November	Carry forward
By-catch	Subarea 48.4 North: precautionary catch limits for *Macrourus* spp. (6.5 tonnes) and rajids (2.0 tonnes).	Carry forward
	Subarea 48.4 South: By-catch move-on rules for *Macrourus* spp. (more than 150 kg and 16% of toothfish catch in one haul) and rajids (5%).	Carry forward
Mitigation	In accordance with CM 25-02, except paragraph 5, if requirements of CM 24-02 are met.	Carry forward
	Fishing in December, January, February, March, October and November shall be in accordance with CM24-02.	
	Limit of three (3) seabirds per vessel during daytime setting.	
Observers	At least one (1) scientific observer appointed in accordance with the CCAMLR Scheme of International Scientific Observation.	Carry forward
Data	Five-day catch and effort reporting	Carry forward
	Haul-by-haul catch and effort data	Carry forward
	Biological data reported by the CCAMLR scientific observer.	Carry forward
Research	Each vessel taking part in the fishery for *D. eleginoides* shall undertake a tagging program in accordance with the CCAMLR tagging protocol.	Carry forward
	Toothfish tagged at a rate of at least five fish per tonne green weight caught.	Carry forward
Environmental protection	Regulated by CM 26-01.	Carry forward

8.2 Management advice

55. The Working Group recommended the following limits for toothfish and by-catch in Subarea 48.4:

Subarea 48.4 North –

(i) a catch limit of 40 tonnes for *D. eleginoides*;

(ii) the continued prohibition of the taking of *D. mawsoni* other than for scientific research purposes;

(iii) maintenance of catch limits for by-catch species, with a limit for macrourids of 6.5 tonnes (16% of the catch limit for *D. eleginoides*) and a limit for rajids of 2 tonnes (5% of the catch limit for *D. eleginoides*).

Subarea 48.4 South –

(i) a catch limit of 30 tonnes for *Dissostichus* spp. (*D. eleginoides* and *D. mawsoni* combined);

(ii) maintenance of a move-on rule for by-catch species, with a macrourid trigger of 150 kg and 16% of the catch of *Dissostichus* spp., and a trigger for rajids set at 5% of the catch of *Dissostichus* spp.

56. The Working Group recommended that the mark-recapture experiment in Subarea 48.4 South be continued for the 2010/11 season with a reduced catch limit of 30 tonnes. Further, the Working Group noted that it would be desirable to discourage any possible concentration of effort on the northern islands in Subarea 48.4 South.

57. The Working Group recommended that where *D. mawsoni* and *D. eleginoides* are caught on the same line in Subarea 48.4 South, the majority of the tags released within the required tagging rate should be on *D. mawsoni*.

Reference

Hillary, R.M., G.P. Kirkwood and D.J. Agnew. 2006. An assessment of toothfish in Subarea 48.3 using CASAL. *CCAMLR Science*, 13: 65–95.