APPENDIX L

FISHERY REPORT: *DISSOSTICHUS ELEGINOIDES* SOUTH GEORGIA (SUBAREA 48.3)

CONTENTS

FISHERY REPORT: *DISSOSTICHUS ELEGINOIDES* SOUTH GEORGIA (SUBAREA 48.3)

1. Details of the fishery

1.1 Reported catch (time series)

In 2004, the Commission agreed to subdivide Subarea 48.3 into one area containing the South Georgia–Shag Rocks (SGSR) stock and other areas, to the north and west, that do not include the SGSR stock. Within the SGSR area, the Commission defined three Management Areas (A, B and C) (Conservation Measure 41-02/A).

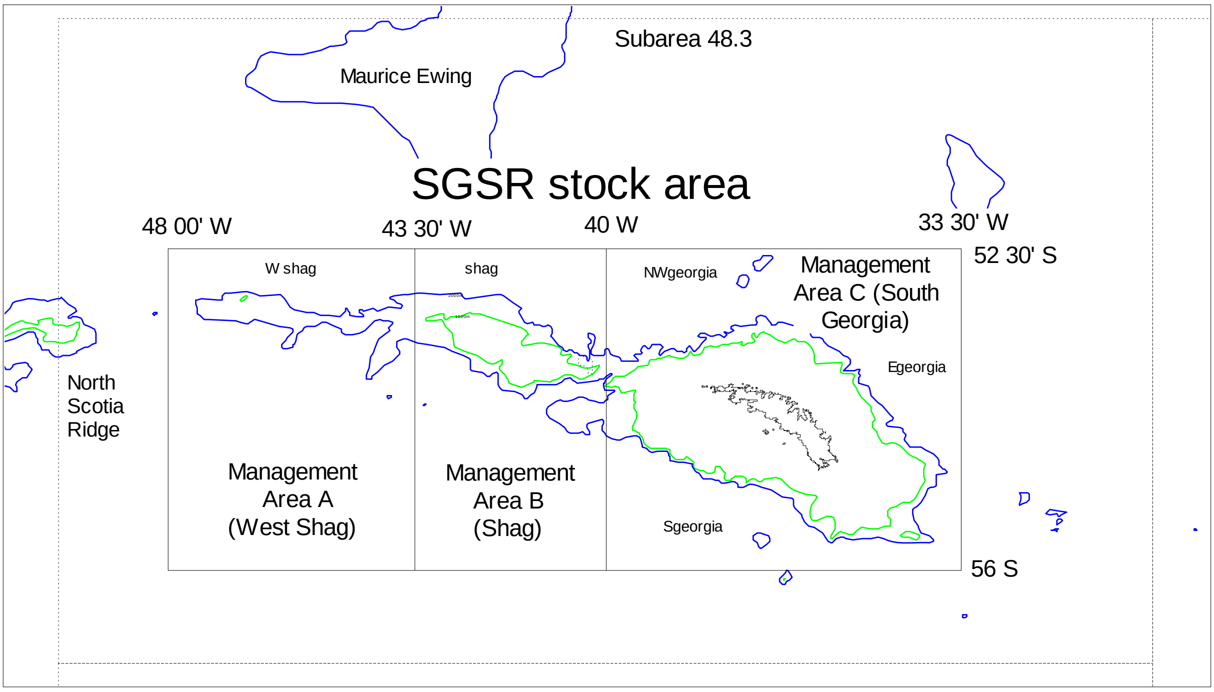


Figure 1: Definition of the SGSR stock area, with its three Management Areas A, B and C.

2. The catch limits in the 2008/09 season for Management Areas A, B and C were 0, 1 176 and 2 744 tonnes respectively, with an overall catch limit for SGSR of 3 920 tonnes. The total declared catch was 3 383 tonnes. Catches in Management Areas B and C were 1 183 tonnes and 2 201 tonnes respectively.

3. Most catch has been taken by longlines, but 66 tonnes were taken by pots in 2000/01, 24 tonnes in 2005/06 and 55 tonnes in 2007/08. These data are included in the total catch. With respect to the distribution of effort, previous reports have displayed the spread of the effort in the fishery over time. Current effort is spread evenly over the fished areas.

1.2 Total removals

4. The catch series is shown in Table 1. There has been no evidence of IUU fishing in Subarea 48.3 since 2005/06.

Table 1: Catch history for *Dissostichus eleginoides* in Subarea 48.3. (Source: STATLANT data for past seasons, and catch and effort reports for current season, WG-FSA-09/5 Rev. 1 and past reports for IUU catch.) SGSR: South Georgia–Shag Rocks stock; West: area outside the SGSR stock area.

Season	Regulated fishery			Estimated IUU catch (tonnes)	Total removals (tonnes)		
	Effort (no. vessels)	*D. eleginoides* catch (tonnes)			SGSR	West	Subarea
		Limit	Reported				
1984/85	1	-	521	0	517	4	521
1985/86	1	-	733	0	733	0	733
1986/87	1	-	1954	0	1954	0	1954
1987/88	2	-	876	0	876	0	876
1988/89	3	-	7060	144	6963	241	7204
1989/90	2	-	6785	437	6838	384	7222
1990/91	1	2500	1756	1775	3531	0	3531
1991/92	23	3500	3809	3066	6864	11	6875
1992/93	18	3350	3020	4019	7039	0	7039
1993/94	4	1300	658	4780	5246	191	5438
1994/95	13	2800	3371	1674	4972	73	5045
1995/96	13	4000	3602	0	3530	72	3602
1996/97	10	5000	3812	0	3808	4	3812
1997/98	9	3300	3201	146	3347	0	3347
1998/99	12	3500	3627	667	4293	0	4293
1999/00	17	5310	4904	1015	5910	9	5919
2000/01	18	4500	4047	196	4232	11	4243
2001/02	17	5820	5742	3	5717	29	5745
2002/03	19	7810	7528	0	7510	18	7528
2003/04	17	4420	4497	0	4460	37	4497
2004/05	8	3050	3034	23	3057	0	3057
2005/06	11	3556	3535	0	3535	0	3535
2006/07	11	3554	3539	0	3537	2	3539
2007/08	12	3920	3864	0	3864	0	3864
2008/09	11	3920	3383	0	3383	0	3383

5. WG-FSA-09/16 presented an analysis of cetacean depredation on longlines. Adding the fish taken by cetaceans to the total catches would increase them by the following percentages over the reported figures for that year: 2.9%, 2.6%, 5.8%, 4.9%, 2.0%, 0.9% and 2.6%. Assumptions were made about cetacean depredation in earlier years: 0% up to 1990, 1% for 1991–1995, 2% for 1996–1999, 3% for 2000–2002. The resultant catch series is shown in Table 2.

Table 2: Total removals taking into account cetacean depredation.

Year	Total removals	Year	Total removals
1985	517	1998	3410
1986	732	1999	4387
1987	1954	2000	6087
1988	876	2001	4358
1989	6962	2002	5887
1990	6828	2003	7727
1991	3566	2004	4576
1992	6933	2005	3239
1993	7109	2006	3709
1994	5297	2007	3606
1995	5021	2008	3892
1996	3607	2009	3503
1997	3888		

1.3 Size distribution of catches (time series)

6. Catch-weighted length frequencies for *D. eleginoides* from 1984/85 to 2008/09 are shown in Figure 2.

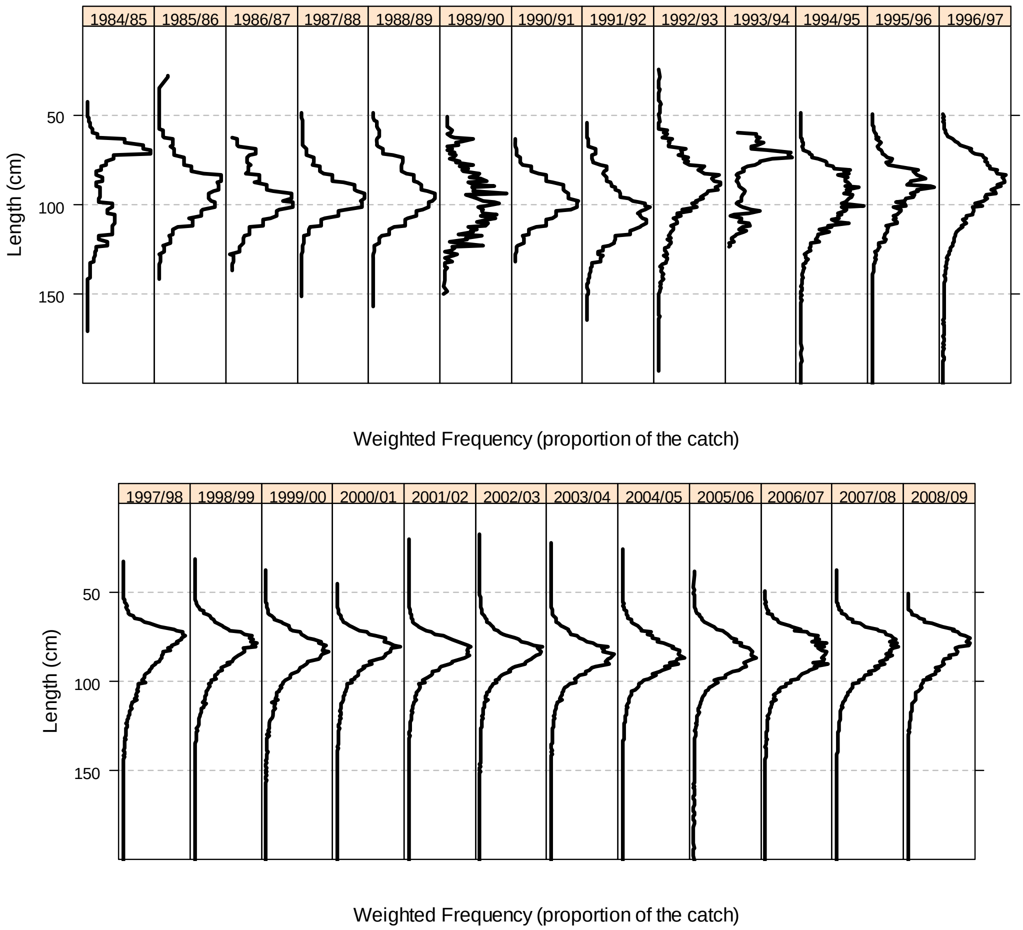


Figure 2: Catch-weighted length frequencies for *Dissostichus eleginoides* in Subarea 48.3 for the early time series (1984/85 to 1996/97) and later time series (1996/97 to present). (Source: observer, fine-scale and STATLANT data)

7. The age distribution of catches has been determined by simple random sampling of fish in the catch for all years since 1998 (Table 3; WG-FSA-09/28 Rev. 1).

Table 3: Sample size for age determination of fish caught in Subarea 48.3.

Year	Sample size for age determination
1998	250
1999	259
2000	298
2001	467
2002	200
2003	200
2004	418
2005	251
2006	250
2007	250
2008	249
2009	262

2. Stocks and areas

8. It has been demonstrated that there is genetic separation of those fish present in Subarea 48.3 from those found on the Patagonian Shelf (FAO Area 41). The SGSR stock, occurring within Management Areas A, B and C (Figure 1), is genetically separate from fish taken in the extreme north and west of Subarea 48.3.

9. All assessments consider only the SGSR stock.

3. Parameters and available data

3.1 Standardised CPUE

10. The GLM (catch weight as the response variable; season, nationality, depth class and month as effects) standardised CPUE analysis was updated only for the later part of the fishery, so as to be coincident with the CASAL model structure. An additional GLM, utilising only sets where cetaceans were not present, was run for the years in which data on cetacean interactions is available (see WG-FSA-09/16). Figure 3 shows that CPUE has continued to decline in recent years.

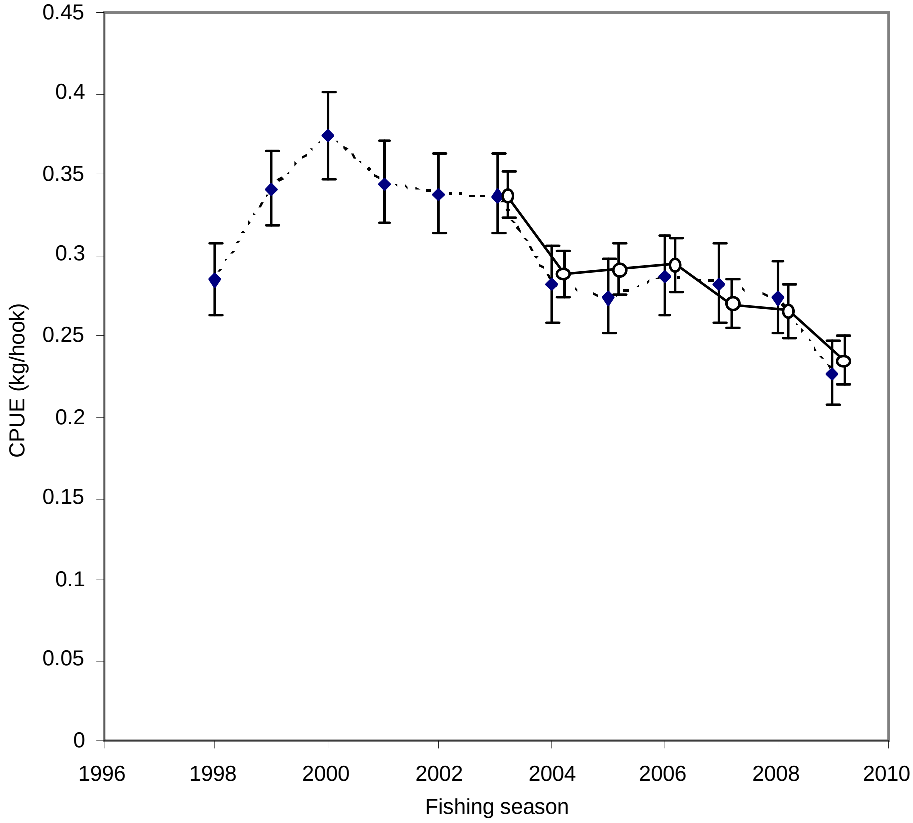


Figure 3: Standardised longline CPUE by fishing season for Subarea 48.3 calculated using a GLM fitted only to the second period in the fishery development, which is consistent with the CASAL model structure (see below). Dotted line uses all the data from the fishery, solid line uses only data from hauls which had no cetacean interaction.

3.2 Recruitment

11. Estimates of juvenile toothfish abundance, and length density, are available from a number of surveys in shallow water (<400 m) around Shag Rocks, which is the primary juvenile area in Subarea 48.3 (Table 4). A single strong (2001) cohort has been observed in the survey, starting at 30 cm long in 2004 (Table 5).

Table 4: Average density and bootstrap CV estimates for juvenile toothfish caught in the groundfish survey hauls shallower than 400 m around Shag Rocks.

Survey year	Average numbers/km^2	Bootstrap CV
1987	301.8	0.302
1988	727.3	0.680
1990	5142.6	0.567
1991	771.5	0.353
1992	1379.8	0.359
1994	1467.5	0.506
2000	502.5	0.452
2002	758.2	0.362
2004	323.3	0.407
2005	410.2	0.351
2006	392.9	0.393
2007	15.4	0.578
2008	79.8	0.433

Table 5: Proportions-at-length of juvenile toothfish caught in the groundfish survey hauls shallower than 400 m around Shag Rocks.

Year	Length (cm)												
	10	15	20	25	30	35	40	45	50	55	60	65	70
1987	0.01	0.05	0.02	0.08	0.03	0.52	0.22	0.07	0.01	0.00	0.00	0.00	0.00
1988	0.05	0.41	0.09	0.32	0.04	0.01	0.02	0.02	0.01	0.02	0.01	0.00	0.00
1990	0.00	0.06	0.38	0.12	0.12	0.01	0.03	0.14	0.01	0.12	0.01	0.00	0.00
1991	0.01	0.11	0.01	0.12	0.61	0.10	0.01	0.00	0.01	0.00	0.01	0.00	0.00
1992	0.00	0.00	0.01	0.06	0.03	0.40	0.48	0.03	0.00	0.00	0.00	0.00	0.00
1994	0.00	0.42	0.25	0.13	0.06	0.03	0.05	0.03	0.02	0.01	0.00	0.00	0.00
2000	0.00	0.22	0.04	0.05	0.36	0.10	0.20	0.02	0.00	0.00	0.00	0.00	0.00
2002	0.00	0.00	0.01	0.09	0.51	0.13	0.13	0.05	0.04	0.03	0.01	0.00	0.00
2004	0.00	0.00	0.00	0.02	0.61	0.21	0.02	0.10	0.03	0.00	0.00	0.00	0.00
2005	0.00	0.00	0.00	0.00	0.01	0.21	0.64	0.10	0.02	0.02	0.00	0.00	0.00
2006	0.00	0.00	0.00	0.02	0.09	0.03	0.05	0.51	0.27	0.01	0.01	0.00	0.00
2007	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.27	0.08	0.39	0.11	0.00	0.00
2008	0.04	0.00	0.00	0.00	0.00	0.00	0.01	0.08	0.12	0.08	0.36	0.21	0.09

3.3 Mark–recapture data

12. In total, 25 842 fish have been tagged in Subarea 48.3 since the program started in 2000 (Table 6). Tagging effort, fishing effort and recaptures have been well distributed over the whole of the fishable grounds in Subarea 48.3 since 2004.

Table 6: Tagging results from Subarea 48.3. Tags released and recaptured in the same season are not included in this table. These data are used as an input to the CASAL model, and therefore also exclude tags released on research cruises and recaptures of animals greater than 110 cm in length.

Release year	Numbers released	Recapture year								
		2001	2002	2003	2004	2005	2006	2007	2008	2009
2000	134	1	1	3	1	2			1	2
2001	346		29	38	14	4	10	6	6	8
2002	397			42	8	16	15	10	9	4
2003	450				27	18	17	13	13	6
2004	3181					100	131	115	110	52
2005	3925						193	152	147	116
2006	4803							228	201	137
2007	4603								241	167
2008	4509									228
2009	3282									

3.4 Biological parameters

13. WG-SAM-09/13 reported the results of a re-estimation of the growth parameters for toothfish in Subarea 48.3. Immediate tagging survivorship was also re-estimated in the paper, applied as a vector to adjust the number of tags effectively released (see WG-SAM-09/13 for details). Lognormal recruitment SD was estimated from the CASAL assessment. Other biological parameters were the same as those used in the 2007 assessment.

Table 7: Biological parameter values 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	Single tag loss rate		0.06
VBGF	t_0	–0.3	Immediate tagging survivorship		Applied as a vector to length-based tag-release data
VBGF	L_∞	132	Tag probability of detection		1
Length-to-mass	a (mm to tonne)	2.5e-9			
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, see section 4.7

4. Stock assessment

14. WG-FSA-09/28 presented an updated assessment of *D. eleginoides* in Subarea 48.3. The major changes to the model were that survey data were included, and that the catch-at-length proportions used in the 2007 assessment were replaced by catch-at-age proportions derived from direct random sampling of fish from the fishery. WG-FSA noted that WG-SAM

had considered an earlier version of this model (WG-SAM-09/13) and results of the additional work requested by WG-FSA in 2007 (SC-CAMLR-XXVI, Annex 5, paragraph 5.115 and Appendix J, paragraph 43).

15. The Working Group agreed that this model provided a good overall fit to the data, and should be used as the basis for the assessment. Model input files and runs were validated by the Secretariat and the Working Group.

4.1 CASAL model structure and assumptions

Population dynamics

16. The CASAL population model used in the assessment of toothfish in Subarea 48.3 was a combined-sex, single-area, three-season model. The annual cycle was defined as follows: the first season (1 December to 31 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 1985 to 2009, with an initial unexploited equilibrium age structure, and with a Beverton-Holt stock-recruit relationship with fixed steepness.

Model estimation

17. The following data were used in the model estimation:

- GLM standardised CPUE for all data, 1998–2002, treated as a relative index of abundance;
- GLM standardised CPUE for hauls without cetacean interactions, 2002–2009, treated as a relative index of abundance;
- proportional catches-at-length for the early fishery 1988–1997;
- proportional catches-at-age for the later fishery 1998–2009;
- survey density of juvenile fish at Shag Rocks, treated as a relative index of abundance;
- survey proportional density-at-length for juvenile fish (Table 5 above);
- tag-recaptures-at-length from tagging events in 2003–2008 and tag-recapture events in 2006–2009.

18. Relative indices of abundance were assumed to be lognormally distributed about the model-predicted vulnerable biomass, for CPUE halfway through the fishing season and for survey abundance in the first quarter of the year, via a constant catchability *q*.

19. Within-season recapture events were eliminated from the tagging data. Initial tag-induced mortality was used to adjust the number of released tags prior to adding them to the model, according to the following vector (determined during the tag survivorship experiment; Agnew et al., 2006):

Table 8: Tagging instantaneous survivorship.

Lower length bin (cm)	Survivorship proportion
40	1
50	0.95
60	0.95
70	0.95
80	0.9
90	0.85
100	0.83
110	0.83

20. Exploratory runs and sensitivity analyses were run using a point estimate Bayesian analysis (MPD: maximum posterior density). MCMC samples were obtained by first running the sampler for a ‘burn-in’ period of 100 000 iterations, and a further 1 000 000 iterations of the sampler were obtained, which were then thinned by a factor of 1 000, to yield a parameter sample of length 1 000. Chain behaviour was good.

Process error and data weighting

21. As well as process error being estimated for the CPUE observations, the appropriate effective sample sizes to be used to weight the length-frequency data 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. Levels of over-dispersion in the tag data were assumed to be similar to the 2007 assessment, and a value of 2 was used.

Penalties

22. 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 0.999 (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

23. Within a Bayesian model, all free parameters estimated require both the definition of a prior and bounds that constrain the estimation. Table 9 shows the free parameters estimated in the CASAL models, along with their respective bounds and prior parameterisations.

Table 9: Free parameters, and their priors and bounds in the CASAL assessment models.

Parameter	Prior	Lower bound	Upper bound
B_0 (virgin SSB)	Uniform-log	20 000	1e+6
q (catchabilities)	Uniform-log	1e-8	1e-1
m (max. sel. age)	Uniform	1	50
l (left sel. decay)	Uniform	0.55	500
r (right sel. decay)	Uniform	0.55	500
CV (CPUE obs.)	Uniform-log	0.01	5

4.2 Selectivity

24. Selectivity-at-age was expressed as a double-normal curve, i.e. with a declining right-hand limb.

4.3 CASAL runs

25. A single assessment model was run for WG-FSA. Table 10 summarises the estimated parameter values of the MPD.

Table 10: Review of parameter estimates for the four CASAL models, using the MPD estimation results.

Model	B_0 (thousand tonnes)	Selectivity parameters for the early fleet, the later fleet, and the survey	Process error CV (unadjusted CPUE and cetacean- adjusted CPUE)
Reference	98.197	11.21, 1.79, 24.94 13.57, 3.37 70.49 4.16, 1.98, 2.00	0.067, 0.157

4.4 Point-estimate (MPD) results

26. Model-fit diagnostics and goodness-of-fit achieved by the reference model are shown in Figures 4 to 11.

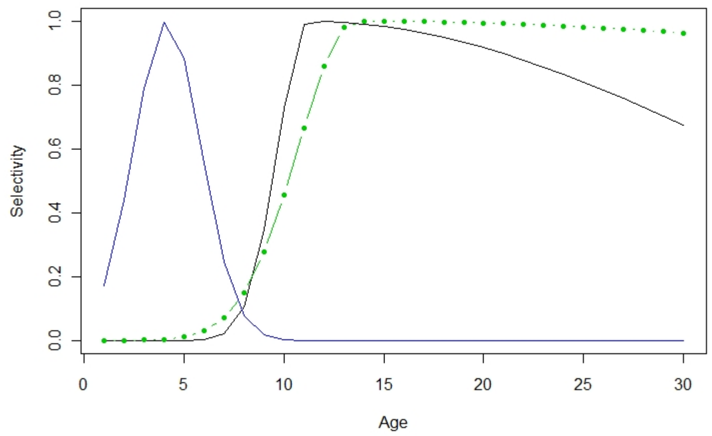


Figure 4: Estimated selectivity curves in the reference model for the survey (blue), old fleet (black) and new fleet (broken green).

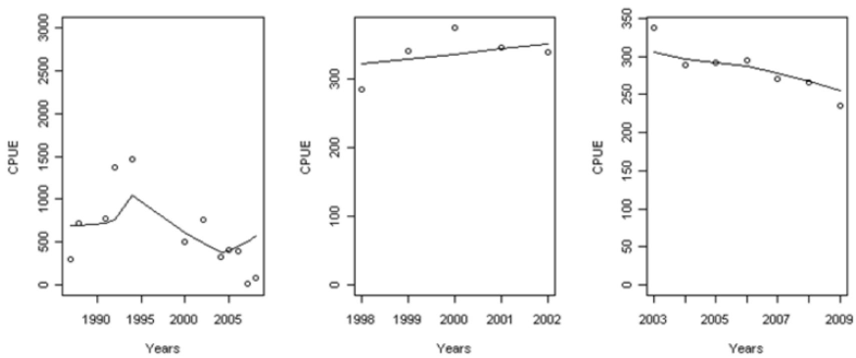


Figure 5: Fits to the survey (left), non-cetacean corrected new fleet (middle) and cetacean-corrected new fleet CPUE series of the reference model (right).

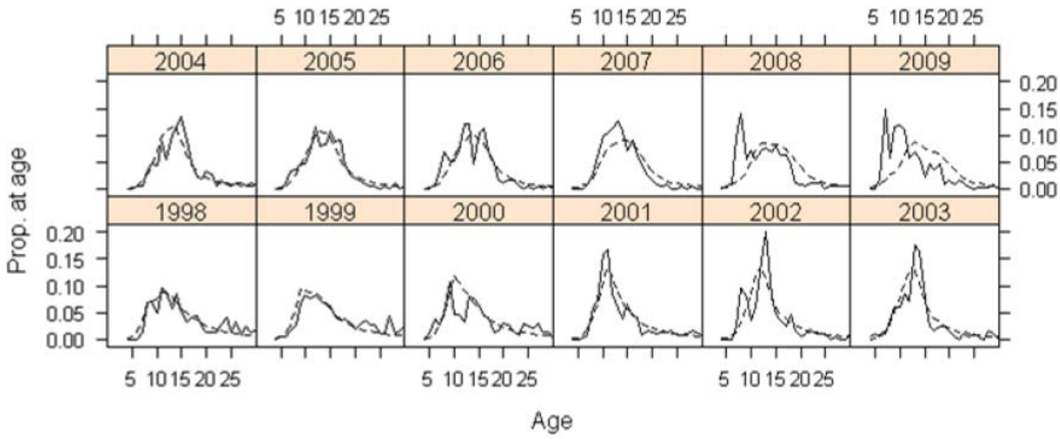


Figure 6: Fit to second-fleet catch-age frequencies for the reference model. The full and dotted lines represent the observed and predicted length frequencies respectively.

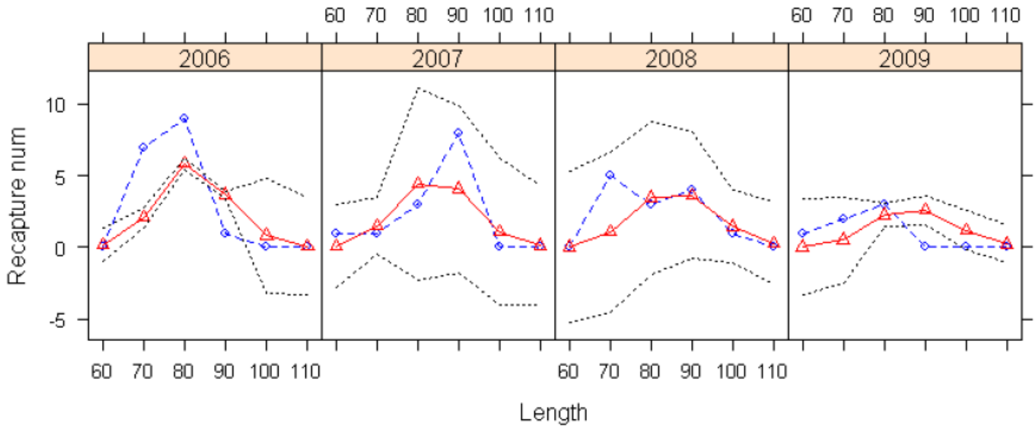


Figure 7: Fits to the 2003 tag-release data – observed recapture probabilities are the blue lines with circles, expected recapture probabilities are the red lines with triangles with s.e.'s shown.

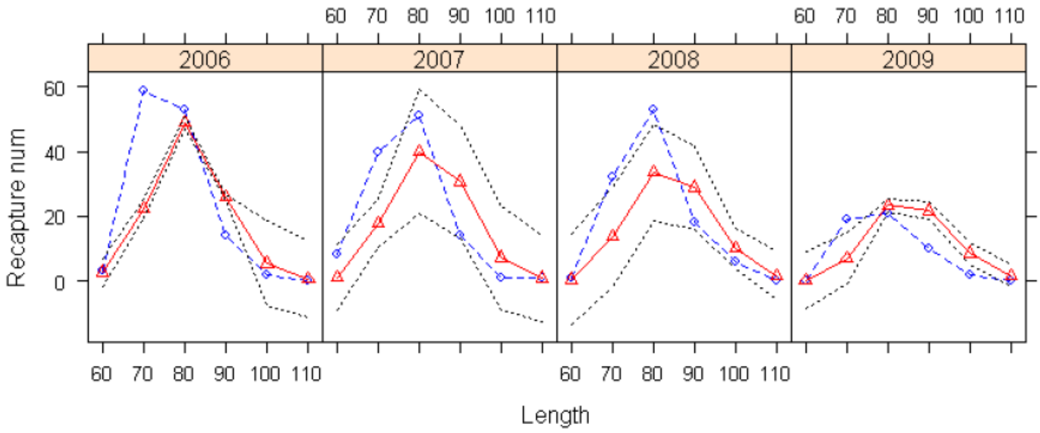


Figure 8: Fits to the 2004 tag-release data – observed recapture probabilities are the blue lines with circles, expected recapture probabilities are the red lines with triangles with s.e.'s shown.

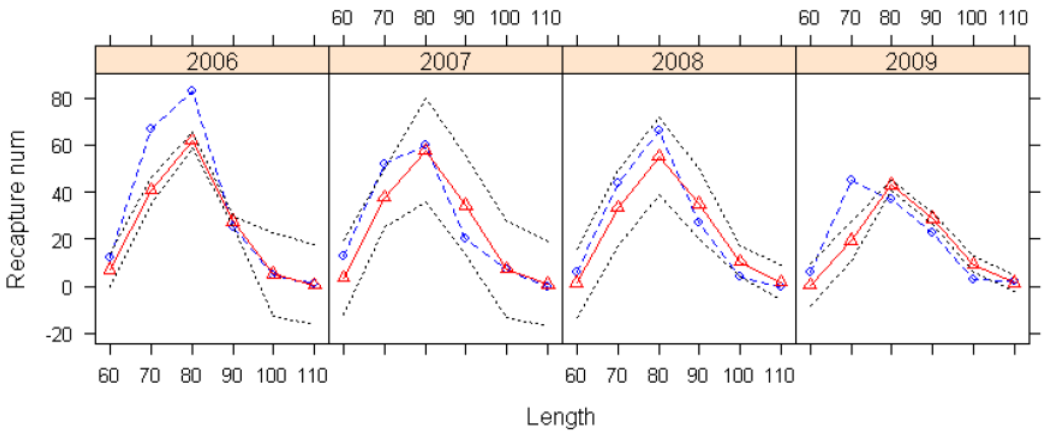


Figure 9: Fits to the 2005 tag-release data – observed recapture probabilities are the blue lines with circles, expected recapture probabilities are the red lines with triangles with s.e.'s shown.

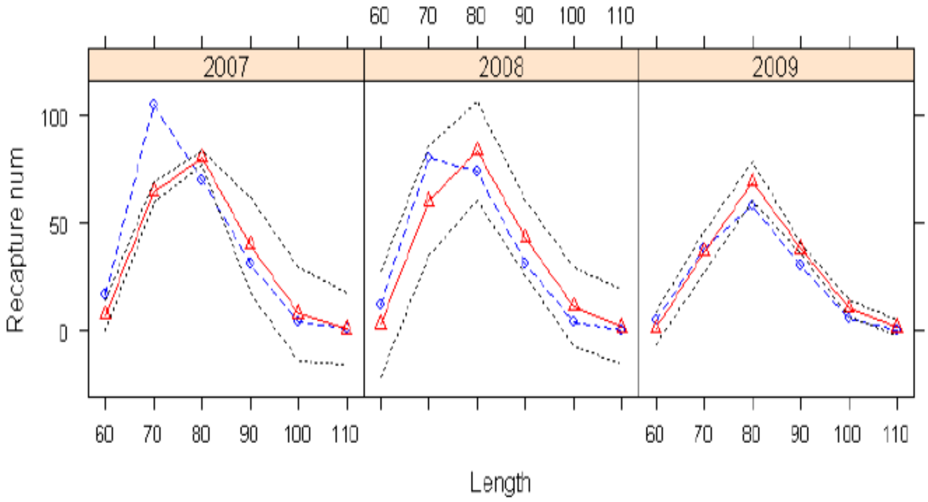
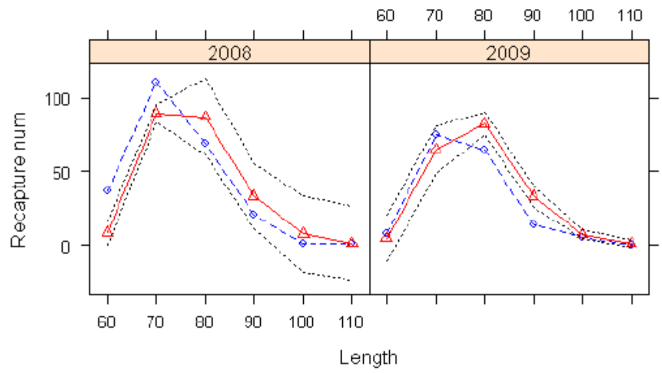


Figure 10: Fits to the 2006 tag-release data – observed recapture probabilities are the blue lines with circles, expected recapture probabilities are the red lines with triangles with s.e.'s shown.



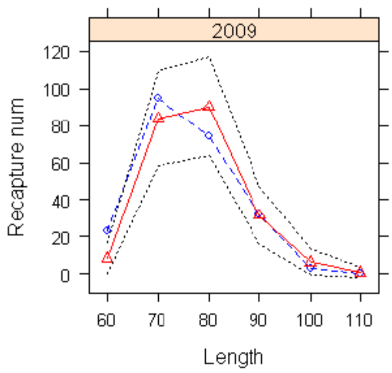


Figure 11: Fits to the 2007 (left) and 2008 (right) tag-release data – observed recapture probabilities are the blue lines with circles, expected recapture probabilities are the red lines with triangles with s.e.'s shown.

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

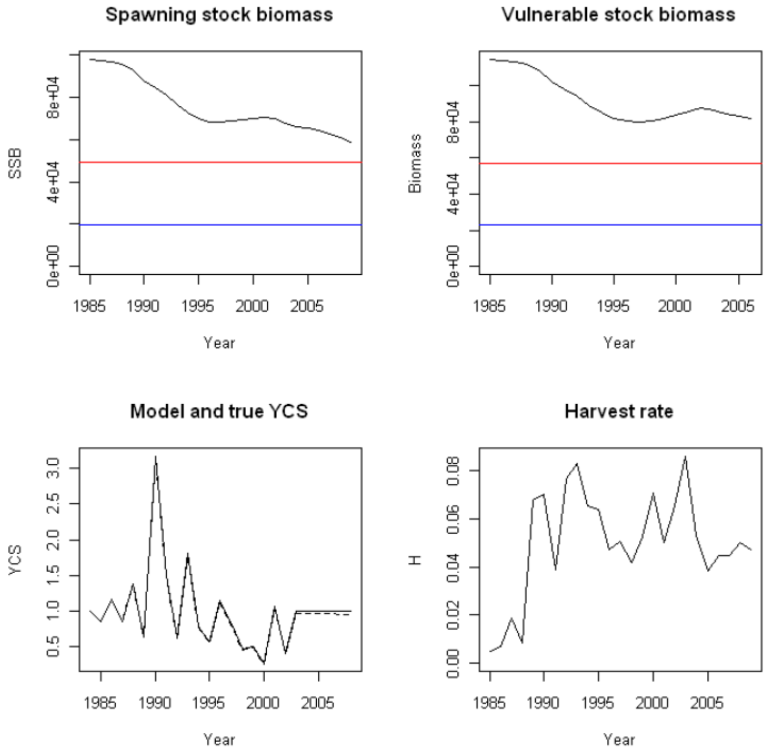


Figure 12: Stock trajectories for the reference model.

28. As can be seen, good fits are achieved to all datasets except catch-at-length data for 2009. In particular, fits to the tag data are much improved over the 2007 assessment model.

29. There are several possible explanations for the lack of fit to the 2009 catch-at-age data. Either recruitment (to the 2001 cohort) has been exceptionally high; or sampling from the fishery has not been representative; or the behaviour of the fishery has changed. Regarding the latter, Dr Agnew reported that several features of the Subarea 48.3 fishery had been different in 2009, including the lack of krill (WG-EMM-09/23), reported large numbers of small fish and a change in the market value of small and large fish. There is a possibility that sampling for age determination did not randomly represent the whole catch, because in the time available for preparation of the analysis prior to WG-FSA only a subset of the catch could be sampled for otoliths.

30. The Working Group agreed that distinguishing between these hypotheses was difficult at the moment but will become clearer when the 2001 cohort has fully recruited to the fishery in one or two years.

31. Figure 13 shows the likelihood profile for the current assessment model for B_0. Catch-at-length data from the early fleet, tag data from 2003 and the survey abundance index are relatively uninformative. Tag data from 2004 onwards and the catch-at-age data are highly informative. Catch-at-age data and the later CPUE possess information on where the minimum levels of B_0 should be, but little, if no, information on the relative likelihood of higher levels of virgin biomass. This information comes from the tagging data, with the recapture data from the 2004 and 2005 release events giving the strongest such indications. The tag-related preferred values of virgin biomass all lie close to each other.

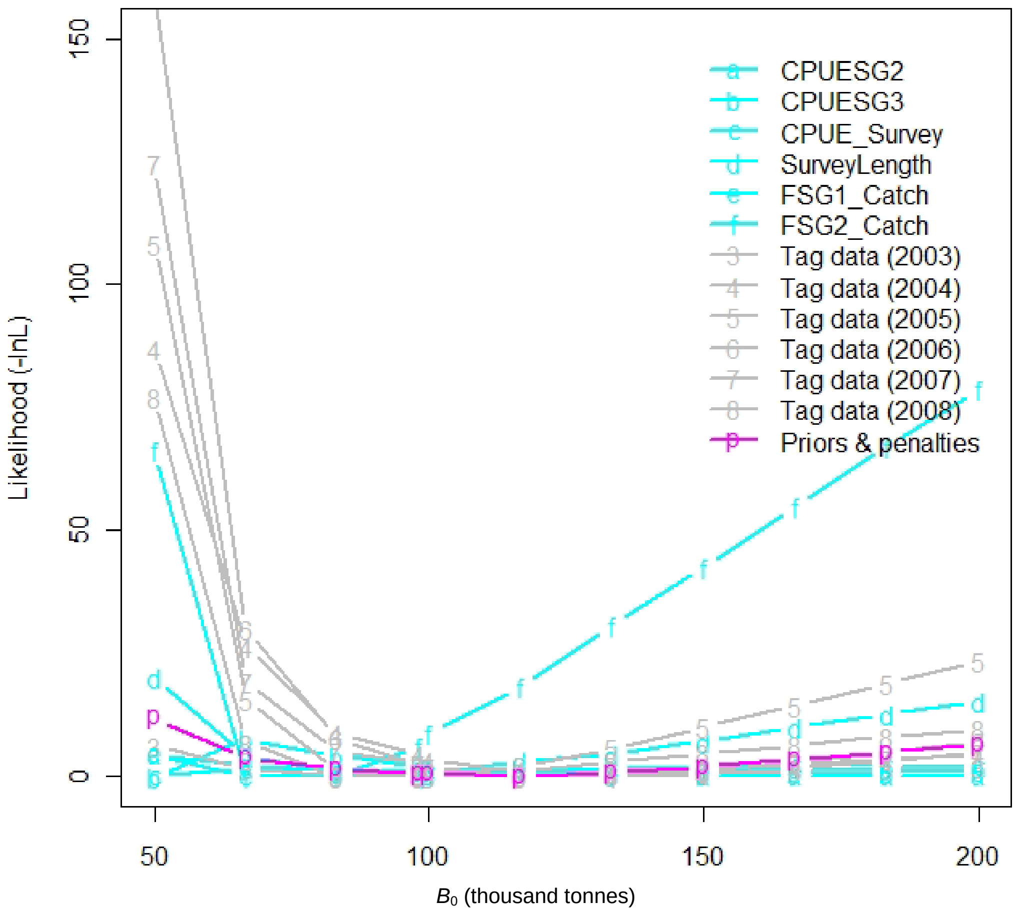


Figure 13: Likelihood profiles for the update model. The legend refers the particular lettered curve in the figure to the relevant dataset etc. used in the assessment.

4.5 MCMC results

32. As can be seen from Table 11, the uncertainty in the MCMC samples about the posterior median is small, due to the continuing precision coming from the tagging data and a similar level of depletion (with associated uncertainty) as was calculated in 2007– around 61%.

Table 11: Median biomass and 95% CIs for the initial equilibrium SSB (B_0), the current SSB ($B_{current}$ (2007 or 2009)), the ratio of current to initial SSB ($B_{current}/B_0$). The results of the 2007 assessment are provided for comparison as well as the new (2009) assessment.

Model	B_0 (thousand tonnes)	$B_{current}$ (thousand tonnes)	$B_{current}/B_0$
2007 assessment	112 (98.7–125)	67.1 (52.9–79.9)	0.59 (0.54–0.64)
2009 assessment	98.5 (93.6–103.8)	60.2 (55–65.7)	0.61 (0.58–0.64)

4.6 Sensitivity runs

33. No sensitivity runs were suggested by the Working Group this year.

4.7 Yield calculations

34. 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.

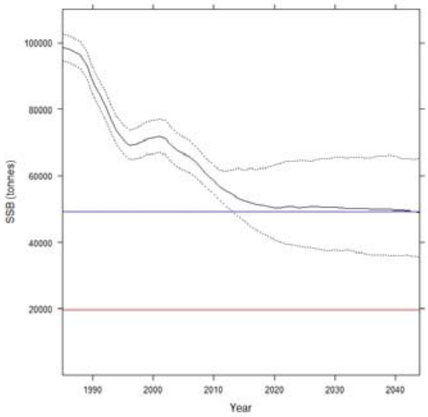
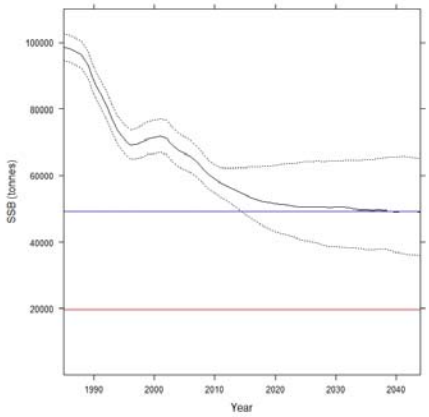
35. The depletion probability was calculated as the proportion of samples from the Bayesian posterior, where the predicted future spawning biomass (SSB) was below 20% of B_0 in the respective sample of any one year, for each year in the 35-year projection period.

36. 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.

37. The current assessment shows very little uncertainty over current stock size (Table 10) but there is some uncertainty about future recruitment. The poor fit of the model to the 2009 catch-at-age data (see paragraphs 28 to 30) can be interpreted either as indicating that the 2001 cohort is one of the largest on record and is not estimated well by the model; or that it is relatively modest, as suggested by Figure 13. It is not possible, with current data, to distinguish between these two hypotheses but it will be possible to do this with one or two years of additional catch-at-age data.

38. The Working Group therefore considered two plausible scenarios for future recruitment in projections. The first assumes that future recruitment will be similar to the entire time series of past recruitment, and uses lognormal mean recruitment (CV 0.59) for the projections. The second assumes that future recruitment will be similar to the recent historically estimated recruitment, and uses the lognormal empirical time series of recruitments from 1991–2001 for the projections. This latter recruit series had both a lower overall recruitment level and lower variance (CV 0.56) than the former because of the removal of the very large 1990 cohort from the series. Results are shown in Table 12.

Table 12: Results of projections. The performance with respect to the γ_1 decision rule is shown by the position of the lower bound of the 80% credible interval compared to the B_0 = 20% line (red); the performance with respect to γ_2 is shown by the position of the median trajectory after 35 years of projections with respect to the B_0 = 50% line (blue).

Basis	Lognormal mean recruitment	Lognormal empirical recruitment 1991–2001
Yield	3950 tonnes	2750 tonnes
Trajectory (median and 80% credible interval)		

4.8 Future work

39. With regard to future developmental work for the stock assessment model used for this stock, the Working Group noted that the new model presented in WG-FSA-09/28 Rev. 1 was a marked improvement on the model used in 2007. Further work will be required to understand the lack of fit of the 2009 catch-at-age data in the model.

5. By-catch of fish and invertebrates

5.1 Estimation of by-catch removals

40. The priority by-catch taxa for which assessments of status are required are macrourids and rajids (SC-CAMLR-XXI, Annex 5, paragraphs 5.151 to 5.154). Catches of by-catch species groups (macrourids, rajids and other species) reported in fine-scale data, their respective catch limits, and number of rajids cut from lines and released alive are summarised in Table 13. Both macrourid and rajid catches were well within the catch limits.

Table 13: Catch history for by-catch species (macrourids, rajids and other species), catch limits and number of rajids released alive in Subarea 48.3. Catch limits are for the whole fishery (see Conservation Measure 41-02 for details). (Source: fine-scale data)

Season	Macrourids		Rajids			Other species	
	Catch limit (tonnes)	Reported catch (tonnes)	Catch limit (tonnes)	Reported catch (tonnes)	Number released	Catch limit (tonnes)	Reported catch (tonnes)
1987/88	-	0	-	1	-	-	0
1988/89	-	1	-	11	-	-	0
1989/90	-	0	-	1	-	-	0
1990/91	-	1	-	4	-	-	0
1991/92	-	1	-	2	-	-	0
1992/93	-	2	-	0	-	-	0
1993/94	-	0	-	12	-	-	0
1994/95	-	12	-	90	-	-	10
1995/96	-	37	-	54	-	-	0
1996/97	-	34	-	43	-	-	2
1997/98	-	21	-	13	-	-	2
1998/99	-	21	-	19	-	-	9
1999/00	-	18	-	12	-	-	3
2000/01	-	21	-	27	-	-	1
2001/02	291	51	291	25	-	-	29
2002/03	390	75	390	38	-	-	14
2003/04	221	82	221	38	-	-	10
2004/05	152	121	152	9	-	-	20
2005/06	177	137	177	7	21 056	-	38
2006/07	177	130	177	4	9 265	-	27
2007/08	196	162	196	12	19 558	-	37
2008/09	196	110	196	22	23 709	-	33

5.2 Assessments of impact on affected populations

41. A preliminary assessment of rajid populations in Subarea 48.3 using a surplus production model implemented in a Bayesian framework was presented at WG-SAM-07 (WG-SAM-07/11). In 2007 the Working Group noted that there were currently insufficient data to inform the assessment and that the results were strongly dependent on the informative priors for the two catchability parameters, and the intrinsic rate of increase, *r*. Nevertheless, these preliminary results suggested that the catch limit in Subarea 48.3 for rajids would be sustainable.

42. A rajid tagging program has been under way for three years in Subarea 48.3. The results of the program should enable an update of the 2007 assessment to be made in 2010.

5.3 Mitigation measures

43. By-catch limits and move-on rules are included in the annual conservation measure established for this fishery (Conservation Measure 41-02). In addition, mitigation measures for rajids include using Year-of-the-Skate protocols for releasing skates caught alive.

6. By-catch of birds and mammals

44. Two seabird mortalities were observed in 2008/09, a grey-headed albatross and a black-browed albatross (taken from SC-CAMLR-XXVIII, Annex 7, Table 4). No new estimates of potential seabird removals by IUU fishing were calculated in 2009. Previous estimates are summarised in SC-CAMLR-XXVI/BG/32 and SC-CAMLR-XXVI, Annex 6, Part II, Table 20.

Table 14: Observed seabird mortality rate and total estimated mortality of seabird by-catch in Subarea 48.3 (from SC-CAMLR-XXVIII, Annex 7, Table 4).

Season	Mortality rate (birds per thousand hooks)	Total estimated mortality (number of birds)
1996/97	0.23	5 755
1997/98	0.032	640
1998/99	0.013*	210*
1999/00	0.002	21
2000/01	0.002	30
2001/02	0.0015	27
2002/03	0.0003	8
2003/04	0.0015	27
2004/05	0.0015	13
2005/06	0	0
2006/07	0	0
2007/08	0	0
2008/09	0.0005	2

* Excluding *Argos Helena* line weighting experiment cruise.

45. WG-IMAF assessed the level of risk of incidental mortality of seabirds in Subarea 48.3 as category 5 (high) (SC-CAMLR-XXVIII, Annex 7, Table 14 and Figure 2).

46. There were three observed marine mammal mortalities in the toothfish fishery in Subarea 48.3 for the 2008/09 season: one elephant seal, one killer whale and one sperm whale (WG-IMAF-09/6 Rev. 2, Table 2). It was reported that the sperm whale was already dead when it became tangled in the line.

6.1 Mitigation measures

47. Conservation Measure 25-02 applies to this subarea.

6.2 Interactions involving marine mammals with longline fishing operations

48. Interactions with cetaceans continue to be reported by observers in Subarea 48.3 and are comprehensively analysed in WG-FSA-09/16.

7. Ecosystem effects

49. The Working Group did not examine the ecosystem effects of the longline fishery for toothfish in Subarea 48.3.

8. Harvest controls and management advice

8.1 Conservation measures

50. The limits on the fishery for *D. eleginoides* in Subarea 48.3 are defined in Conservation Measure 41-02. The limits in force applying to 2008/09 and 2009/10 and the Working Group's advice to the Scientific Committee are summarised in Table 15.

Table 15: Limits on the fishery for *Dissostichus eleginoides* in Subarea 48.3 in 2008/09 and 2009/10 (Conservation Measure 41-02) and advice to the Scientific Committee.

Element	Limits in force	Advice
Access (gear)	Longlines and pots only	Carry forward
Subdivision of Subarea 48.3	Definition of area open to the fishery	Carry forward
Closure of other areas of Subarea 48.3	Closure of fishing outside the area of the fishery	Carry forward
Catch limit	Catch limit for *D. eleginoides* was 3 920 tonnes for the subarea, applied as follows: Management Area A: 0 tonnes Management Area B: 1 176 tonnes Management Area C: 2 744 tonnes.	Revise
Season: longline	1 May to 31 August Extension possible to 14 September for vessels complying fully with CM 25-02 in the previous season.	Review
pots	1 December to 30 November	Carry forward
seabirds	During extension period (1–14 September) any vessel catching three (3) seabirds to cease fishing.	Revise
By-catch: crabs	By-catch of crabs to be counted against crab catch limit.	Carry forward
finfish	Total combined catch of skates and rays 196 tonnes. Total catch of *Macrourus* spp. 196 tonnes.	Revise
any species	Move-on rule	Carry forward
Mitigation	In accordance with CM 25-02.	Carry forward
Observers	Each vessel to carry at least one CCAMLR scientific observer and may include one additional scientific observer.	Carry forward
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.	Carry forward Carry forward Carry forward

(continued)

Table 15 (continued)

Element	Limits in force	Advice
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.*	Carry forward
Jellymeat	Number and weight of *D. eleginoides* discarded, including those with jellymeat condition, to be reported. These catches count towards the catch limit.	Carry forward
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.	Carry forward
Environmental protection	Regulated by CM 26-01.	Carry forward

8.2 Management advice

51. Given the uncertainty surrounding recent recruitment to the stock, the Working Group recommended that the catch limit should be towards the lower end of the range 2 750–3 950 tonnes.

Reference

Agnew, D.J., J. Moir Clark, P.A. McCarthy, M. Unwin, M. Ward, L. Jones, G. Breedt, S. Du Plessis, J. Van Heerdon and G. Moreno. 2006. A study of Patagonian toothfish (*Dissostichus eleginoides*) post-tagging survivorship in Subarea 48.3. *CCAMLR Science*, 13: 279–289.