OREOS – OEO 1 AND OEO 6 BLACK OREO AND SMOOTH OREO

1. FISHERY SUMMARY

This is presented in the Fishery Summary section at the beginning of the Oreos report.

2. BIOLOGY

This is presented in the Biology section at the beginning of the Oreos report.

3. STOCKS AND AREAS

This is presented in the Stocks and Areas section at the beginning of the Oreos report.

4. STOCK ASSESSMENT

4.1 Introduction

A new assessment is reported here for Pukaki Rise black oreo, while the previously reported assessments for Southland (OEO 1/OEO 3a) and Pukaki smooth oreo are repeated. A preliminary assessment from 2008 is reported for Bounty Plateau smooth oreo (only MPD results).

4.2 Southland smooth oreo fishery

This assessment was developed in 2004 and applies only to the study area as defined in Figure 1 and does not include areas to the north (Waitaki) and east (Eastern canyon) of the main fishing grounds.

This fishery is mostly in OEO 1 on the east coast of the South Island but catches at the northern end of the fishery straddle and cross the boundary line between OEO 1 and OEO 3A at 46ºS. This is an old fishery with catch and effort data available from 1977–78 and mean annual catches of about 1000 t of smooth oreo. There were no fishery-independent abundance estimates, so relative abundance estimates from pre- and post-GPS standardised CPUE analyses and length frequency data collected by MFish (SOP) and Orange Roughy Management Company (ORMC) observers were used. Two fisheries were modelled: an early fishery (before 1989–90) that was mainly carried out by Soviet vessels and a late fishery (1989–90 on) consisting mainly of New Zealand vessels.

The following assumptions were made in this analysis.

1. The CPUE analysis indexed the abundance of smooth oreo in the study area of OEO 1/3A.
2. The length frequency samples were representative of the population being fished.
3. The ranges used for the biological values covered their true values.
4. Recruitment was deterministic and followed a Beverton & Holt relationship with steepness of 0.75.
5. The population of smooth oreo in the study area was a discrete stock or production unit.
6. Catch overruns were 0% during the period of reported catch.
7. The catch histories were accurate.
8. The maximum fishing pressure (U_{MAX}) was 0.58.

An age-structured CASAL model employing Bayesian statistical techniques was developed. A two-fishery model was employed by defining and analysing an early fishery, up to and including 1988–89 (pre-GPS), and a late fishery from 1989–90 onwards (post-GPS). This was required because the depth distribution of the catches was very different between the pre-GPS and post-GPS periods, so the CPUE indices needed different selectivity values because depth is related to fish length and therefore the age distribution of the catch. Data inputs for the early and late fisheries models included catch history, relative abundance estimates from standardised CPUE analyses, and length data from SOP and ORMC observers. The model was partitioned by the sex and maturity status of the fish and used population parameters previously estimated from fish sampled on the Chatham Rise and Puysegur Bank fisheries. The maturity ogive used was estimated from Chatham Rise research samples.

4.2.1 Estimates of fishery parameters and abundance

Catch history

A catch history (Table 1) was derived using declared catches of OEO from OEO 1 (see Table 2 in the Fishery Summary section at the beginning of the Oreos report) and tow-by-tow records of catch from the study area (Figure 1). The tow-by-tow data were used to estimate the species ratio (SSO/BOE) and therefore the SSO taken. It was assumed that the reported landings provided the best information on total catch quantity and that the tow-by-tow data provided the best information on the species and area breakdown of catch.

Table 1: Catch history of smooth oreo from Southland. Rounded to the nearest 10 t.

Year	1978–79	1979–80	1980–81	1981–82	1982–83	1983–84	1984–85	1985–86
Catch	200	10	30	0	10	1130	690	4230
Year	1986–87	1987–88	1988–89	1989–90	1990–91	1991–92	1992–93	1993–94
Catch	190	990	240	640	830	910	660	370
Year	1994–95	1995–96	1996–97	1997–98	1998–99	1999–00	2000–01	
Catch	230	1100	500	550	1090	1130	1010	

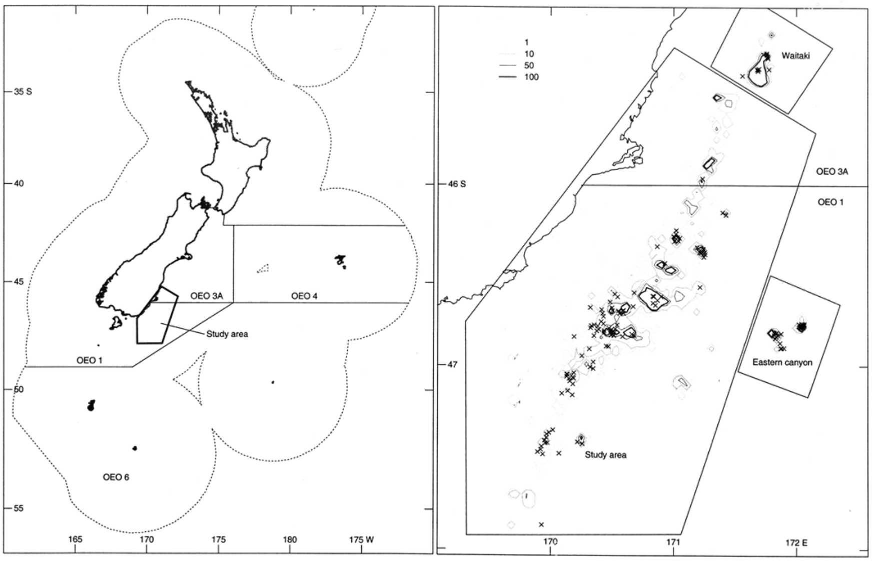

Figure 1: The Southland fishery study area in relation to management areas (left panel) and expanded (large polygon, right panel) with small polygons around the Waitaki and eastern canyon areas (not included in this study). Smooth oreo catch contours from 1977–78 to 2000–01 were plotted by summing the catches over a roughly square grid with cell size of about 10km^2. The contours are at 1, 10, 50 and 100 t per cell (therefore approximately 0.1, 1, 5, and 10 t per km^2). The study area polygon has corners at 45º 13.6' S, 171º 0.3' E; 45º 42.3' S, 172º 9.4' E; 47º 55.2' S, 171º 3.7' E; 47º 55.6' S 169º 19.2' E; 46º 45.8' S 169º 18.5' E. Xs mark the location of length frequency samples of smooth oreo.

Length data

Smooth oreo length frequency data collected by SOP and ORMC observers were stratified by depth (less than 975 m and greater than or equal to 975 m) and weighted by the sample catch (Table 2). The variability of the length data was expressed as CVs by length class derived from a linear regression of log CV (bootstrap CV values from the 1999–2000 length data) versus proportion at length. Process error was always applied to all the length frequency inputs to the extent that the residuals became approximately standardised normal. Because process error was large relative to the above bootstrap derived CVs, the precise derivation of the latter was not critical. Length samples collected by ORMC observers from one vessel for 2000–01 appeared to be biased upwards and could not be reconciled with the other data, so data collected by ORMC observers on that vessel were eliminated from the analysis.

Table 2: Summary of length frequency data for smooth oreo available for the study area. The table shows the number of tows sampled by year, source, and depth zone (deep >= 975 m). Note that ORMC samples from one vessel were excluded. –, no data.

		SOP		ORMC
Year	Shallow	Deep	Shallow	Deep
1986–87	–	1	–	–
1988–89	–	2	–	–
1993–94	2	–	–	–
1994–95	3	–	–	–
1995–96	2	–	–	–
1996–97	4	–	–	–
1997–98	2	1	–	–
1998–99	–	–	12	19
1999–00	30	6	–	3
2000–01	4	–	1	1

Relative abundance estimates from CPUE analyses

The standardised CPUE analyses used a two part model which separately analysed the tows which caught smooth oreo using a log-linear regression (referred to as the positive catch regression) and a binomial part which used a Generalised Linear Model with a logit link for the proportion of successful tows (referred to as the zero catch regression). The binomial part used all the tows, but considered only whether or not the species was caught and not the amount caught. The yearly indices from the two parts of the analysis (positive catch index and zero catch index) were multiplied together to give a combined index. The pre-GPS data covered the years from 1983–84 to 1987–88 and the post-GPS data covered 1992–93 to 2000–01.

The pre-GPS and post-GPS indices and jackknife CV results are in Tables 3 and 4. The pre-GPS combined indices showed a steep decline over time. The post-GPS indices were more variable but overall showed a slight decline.

Table 3: Smooth oreo pre-GPS combined index estimates by year, and jackknife CV estimates from analysis of all tows in the study area that targeted smooth oreo, black oreo, or unspecified oreo.

	Combined index	Jackknife CV (%)
1983–84	1.75	22
1984–85	1.65	29
1985–86	1.19	33
1986–87	0.48	23
1987–88	0.61	27

Table 4: Smooth oreo post-GPS combined index estimates by year, and jackknife CV estimates from analysis of all tows in the study area that targeted smooth oreo, black oreo, or unspecified oreo.

	Combined index	Jackknife CV (%)
1992–93	1.27	39
1993–94	1.09	78
1995–96	1.62	103
1996–97	0.52	84
1997–98	1.14	27
1998–99	0.9	17
1999–00	0.93	21
2000–01	0.89	38

4.2.2 Biomass estimates

Biomass estimates were made based on a Markov Chain Monte Carlo analysis which produced a total chain length of 500,000. The first 10,000 points were discarded (burn-in) and then every 100th point was retained. The final converged chain had a length of 4900 points.

Biomass estimates for the base case are given in Table 5. Biomass trajectories for the base case and the fit to the CPUE series are shown in Figure 2. These biomass estimates are uncertain because of the paucity of observer length frequency data, the uncertain quality of recent catch data resulting from area mis-reporting, and the lack of fishery-independent abundance estimates and the consequent reliance on commercial CPUE data for abundance indices. The estimates of biomass and depletion levels were also sensitive to which observer length frequency data sets were included in the model runs. Given the estimate of B_0 relative to the total catch taken during the history of this fishery, the estimate of B_0 is likely to be close to a minimum estimate of the unexploited biomass.

Table 5: Biomass estimates (t) for the base case.

(a) Mid-year biomass estimates

	Median	90% C.I.
Mature virgin	15 900	13 800–20 700
Mature 2001–02 mid-year	4 800	2 800–9 500
Mature 2001–02 mid-year (% B_0)	30	20–46
Vulnerable virgin	16 700	13 900–22 400
Vulnerable 2001–02 mid-year	5 300	2 800–10 800
Vulnerable 2001–02 mid-year (% B_0)	32	21–48

	Mean
B_{MCY}	†7 800
B_{MAY}	†4 300

† mid-year vulnerable biomass.

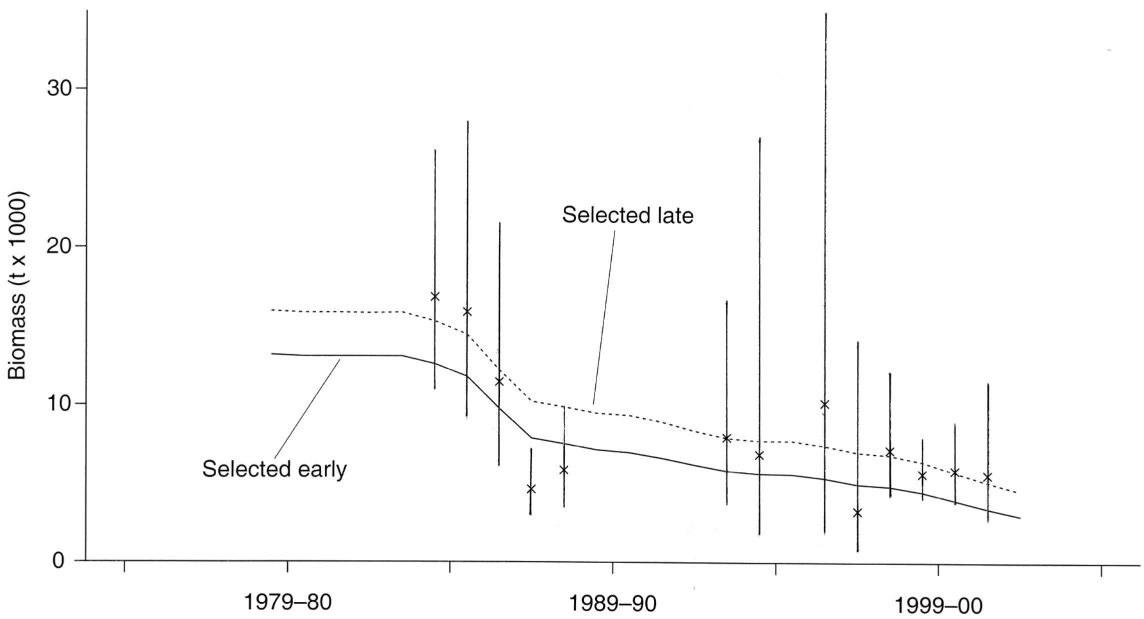

Figure 2: Predicted biomass trajectories for the base case. Selected biomass for the early (before 1989–90) and late (from 1989–90 on) fisheries. Also shown are the CPUE indices from the pre- and post-GPS analyses with 2 SE confidence interval indicated by the vertical lines.

4.2.3 Projections

The model was used to project stock status into the future using stochastic recruitment. The simulations used randomised year class strengths with an assumed lognormal distribution (mean = 1, σ_r = 0.65). Biomass projections for 5 years into the future were made under a range of constant catch regimes to determine the probability that the projected biomass would exceed the current biomass, the probability that the projected biomass would exceed 20%Bo, and the probability that the projected biomass would exceed B_{MSY} (estimated to be 26%Bo). Projections were made based on a random sub-sample of 500 values from the posterior distribution (Table 6).

Five year projections to estimate future mature and vulnerable biomass were subject to the same data problems as the biomass estimates. However, the Plenary concluded that catches at the level of the 2000–01 annual catch (1010 t) are probably not sustainable.

Table 6: Probability that biomass in 5 years ($B_{2006–07}$) is greater than the reference biomass (20% and 26%B_0) and the median biomass in 5 years as a %B_0 ($B_{MED2006–07}$) under different constant catch scenarios. The 2000–01 catch for smooth oreo in the Southland fishery was 1010 t.

Catch (t)	P($B_{2006–07}$ > 20%B_0)	P($B_{2006–07}$ > 26%B_0)	$B_{MED2006–07}$
1010	0.31	0.15	15
800	0.48	0.23	20
600	0.69	0.41	24
500	0.8	0.5	26
400	0.89	0.62	28
300	0.94	0.71	31
200	0.99	0.84	33

4.3 Pukaki Rise smooth oreo fishery (part of OEO 6)

This is the first assessment for this fishery (developed in 2006) and applies only to the assessment area as defined in Figure 3. This is the main smooth oreo fishery in OEO 6 with mean annual catches of about 1700 t from 1995–96 to 2004–05, taken mainly by New Zealand vessels. There was also a small early Soviet fishery (1980–81 to 1985–86) with mean annual catches of less than 100 t. There were no fishery-independent abundance estimates, so relative abundance estimates from a post-GPS standardised CPUE analysis and length frequency data collected by MFish (SOP) and Orange Roughy Management Company (ORMC) observers were considered. Biological parameter values estimated for Chatham Rise and Puysegur Bank smooth oreo were used in the assessment because there are no research data from Pukaki Rise.

The following assumptions were made in this analysis.

1. The CPUE analysis indexed the abundance of smooth oreo in the Pukaki Rise (OEO 6) assessment area.
2. The length frequency samples were representative of the population being fished.
3. The ranges used for the biological values covered their true values.
4. Recruitment was deterministic and followed a Beverton & Holt relationship with steepness of 0.75.
5. The population of smooth oreo in the assessment area was a discrete stock or production unit.
6. Catch overruns were 0% during the period of reported catch.
7. The catch histories were accurate.
8. The maximum exploitation rate (E_{MAX}) was 0.58.
9. The prior for stock size was bounded at an upper limit of 100 000 t.

Data inputs included catch history, relative abundance estimates from a standardised CPUE analysis, and length data from SOP and ORMC observers. The observational data were incorporated into an age-based Bayesian stock assessment (CASAL) with deterministic recruitment to estimate stock size. The stock was considered to reside in a single area, with a partition by sex. Age groups were 5–70 years, with a plus group of 70+ years.

The length-weight and length-at-age population parameters are from fish sampled on the Chatham Rise and Puysegur Bank fisheries (Table 1, Biology section). Fish sampled from the Puysegur Bank fishery are used for the natural mortality estimate (Table 1). The maturity ogive is from fish sampled on the Chatham Rise, and the age at which 50% are mature is between 18 and 19 years for males and between 25 and 26 years for females.

4.3.1 Estimates of fishery parameters and abundance

Catch history

A catch history was derived using declared catches of OEO from OEO 6 (Table 2 in the "Fishery summary" section of the Oreos report above) and tow-by-tow records of catch from the assessment area (Figure 3). The tow-by-tow data were used to estimate the species ratio (SSO/BOE) and therefore the SSO taken. It was assumed that the reported landings provided the best information on total catch quantity and that the tow-by-tow data provided the best information on the species and area breakdown of catch. There may be unreported catch from before records started, although this is thought to be small. Before the 1983–84 fishing year the species catch data were combined over years to get an average figure that was then applied in each of those early years. For the years from 1983–84 onwards, each year's calculation was made independently. The catch history used in the population model is given in Table 7.

Table 7: Catch history of smooth oreo from the Pukaki Rise fishery assessment area. Catches are rounded to the nearest 10 t.

Year	Catch	Year	Catch	Year	Catch	Year	Catch
1980–81	30	1988–89	0	1996–97	1 650	2004–05	1 370
1981–82	20	1989–90	0	1997–98	1 340		
1982–83	0	1990–91	10	1998–99	1 370		
1983–84	640	1991–92	0	1999–00	2 270		
1984–85	340	1992–93	70	2000–01	2 580		
1985–86	10	1993–94	0	2001–02	2 020		
1986–87	0	1994–95	130	2002–03	1 340		
1987–88	180	1995–96	1 360	2003–04	1 660		

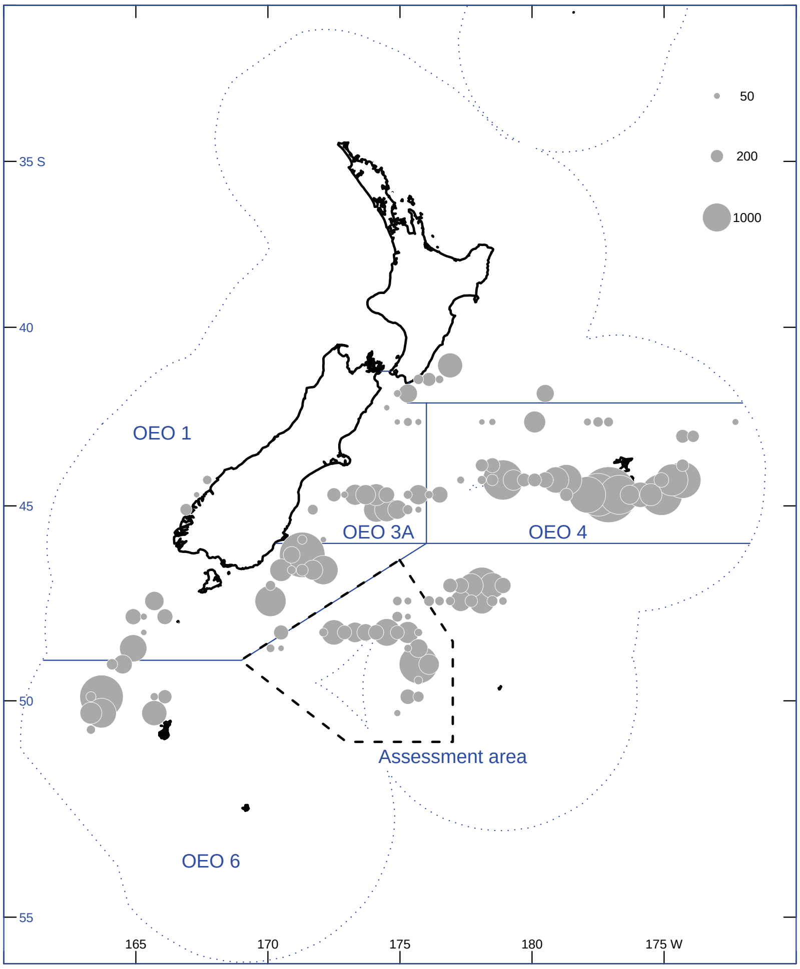

Figure 3: The Pukaki Rise fishery assessment area (polygon) abutting the north boundary of OEO 6. The circles are proportional to the mean of smooth oreo estimated catches (t) from the last 5 years (2000–01 to 2004–05) plotted by summing the catches over 0.4 x 0.4 degree grids. The dotted line is the EEZ.

Length data

Smooth oreo length frequency data collected by SOP and ORMC observers are available from the last eight years (Table 8). An in-depth analysis indicated that these data were reasonably representative of the fishery in terms of spatial, depth and temporal coverage in those years that had adequate data. The depths fished by the sampled fleet varied between years so the length data were stratified by depth resulting in shallow (less than 900 m), middle (900–990 m) and deep strata (greater than 990 m). The data from adjacent years were also grouped because some years had few samples. The resulting length frequencies are shown in Figure 4. There is a trend towards a flatter distribution over the last three grouped distributions (2000–01, 02, and 03–05).

Table 8: Summary of length frequency data for smooth oreo available for the assessment area. The table shows the number of tows sampled by year, the sample source, and the year group. –, no data.

	Year group	Number of tows sampled		
Year		ORMC	SOP	All
1997–98	98–99	–	15	15
1998–99	98–99	64	9	73
1999–00	00–01	5	36	41
2000–01	00–01	37	17	54
2001–02	2	42	22	64
2002–03	03–05	4	12	16
2003–04	03–05	–	19	19
2004–05	03–05	–	19	19
Totals		152	149	301

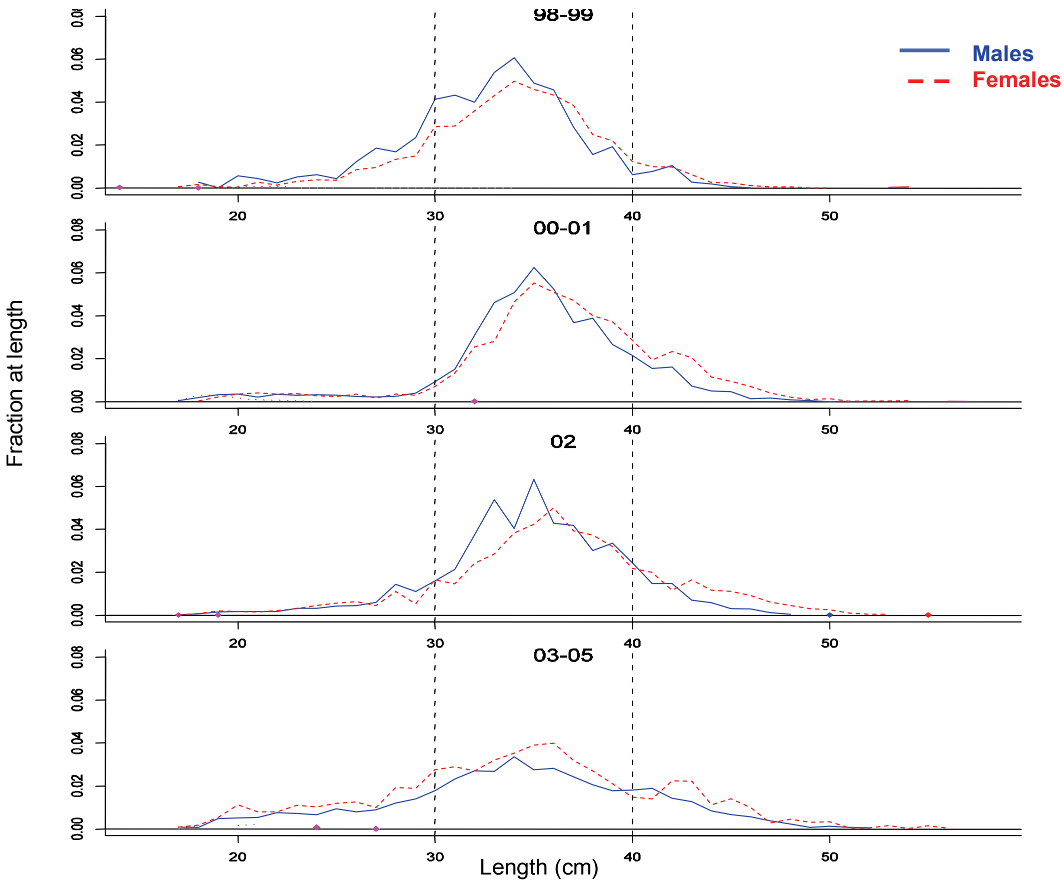

Figure 4: Length frequencies for Pukaki Rise smooth oreo, stratified by depth (see text), and grouped by years.

Relative abundance estimates from CPUE analyses

There was a small early Soviet fishery (1980–81 to 1985–86) with too few data for a standardised CPUE analysis. The New Zealand vessel fishery (1995–96 to 2004–05) was used to analyse standardised CPUE.

This new standardised CPUE analysis of Pukaki Rise smooth oreo used regression based methods similar to those in previous oreo CPUE analyses but because the fraction of zero tows were low

(Table 9) only a positive catch model was used. The annual CVs for the index were estimated using bootstrap methods. The data used are summarised in Table 9.

Table 9: Summary of data used as input to the standardised CPUE analysis for New Zealand vessels.

Year	No. of tows	No. of vessels	Estimated catch (t)	Mean t/tow	Zero catch tows (%)
1995–96	278	9	1 170	4.2	1
1996–97	402	10	1 490	3.7	1
1997–98	356	10	1 190	3.4	5
1998–99	377	12	1 230	3.3	7
1999–00	591	9	2 070	3.5	7
2000–01	651	9	2 310	3.5	8
2001–02	415	7	1 920	4.6	1
2002–03	533	9	1 240	2.3	5
2003–04	585	9	1 520	2.6	2
2004–05	712	12	1 300	1.8	5

The regression model chosen as the final run included vessel, time of year (day), depth, and axis-position (point on a line drawn through the fishery that follows the 1000 m contour around the Pukaki Rise), and excluded data from vessels that fished for less than three years. Target species was chosen as a predictor variable in initial runs but was excluded in the final run because it is believed that it is not accurately reported. The final run index declines (Table 10).

Table 10: Final run CPUE index estimates by year, and bootstrap CV estimates from analysis of all tows in the assessment area that caught smooth oreo.

Year	Standardised CPUE index	
	kg/tow	CV
1995–96	3 339	0.316
1996–97	2 266	0.417
1997–98	1 421	0.421
1998–99	1 143	0.243
1999–00	969	0.272
2000–01	1 260	0.319
2001–02	1 247	0.27
2002–03	804	0.451
2003–04	735	0.829
2004–05	243	0.768

4.3.2 Biomass estimates

In all model runs the length-frequency data were poorly fitted, even if selectivity was allowed to vary with depth. This may be due to the use of growth parameters that were derived from another area or to other modelling problems, and is an issue that should be further investigated in the future. In the meantime, the length frequency data were omitted from the stock assessment and the model was fitted to the CPUE data alone. The age at 50% selectivity (a_{50}) was assumed to be knife-edged at 19 yr, corresponding to a fish size of approximately 33 cm. For this model, the MPD estimate of virgin mature biomass (B_0) was 17 400 t, and the current mature biomass was 22% B_0 (Figure 5).

MCMC runs resulted in extremely skewed distributions of B_0 and $B_{CURRENT}$ with right hand tails extending to very high biomass levels. Based on comparisons with other smooth oreo stocks (e.g., OEO 4), and the observation that the standardised CPUE has declined rapidly even though catches have been relatively small, a modified prior which truncated B_0 at an upper limit of 100 000 t was adopted. This gave a median estimate of B_0 of 24 000 t (90% confidence intervals 16 000 - 78 000 t) and a median estimate of $B_{CURRENT}$ of 9800 t (2400 - 64 000 t). Because of the wide confidence intervals, the current status (%B_0) is highly uncertain with a median of 42% but 90% confidence intervals of 15 - 82% (Table 11 and Figure 6).

Table 11: Mid-year mature biomass estimate (median, with 90% confidence intervals in parentheses) for the model run with only CPUE data. $B_{CURRENT}$ is the mid-year mature biomass in 2006.

Run	B_0(t)	$B_{CURRENT}$(t)	$B_{CURRENT}$(% B_0)
Only CPUE	24 000 (16 000-78 000)	9 800 (2 400-64 000)	42 (15-82)

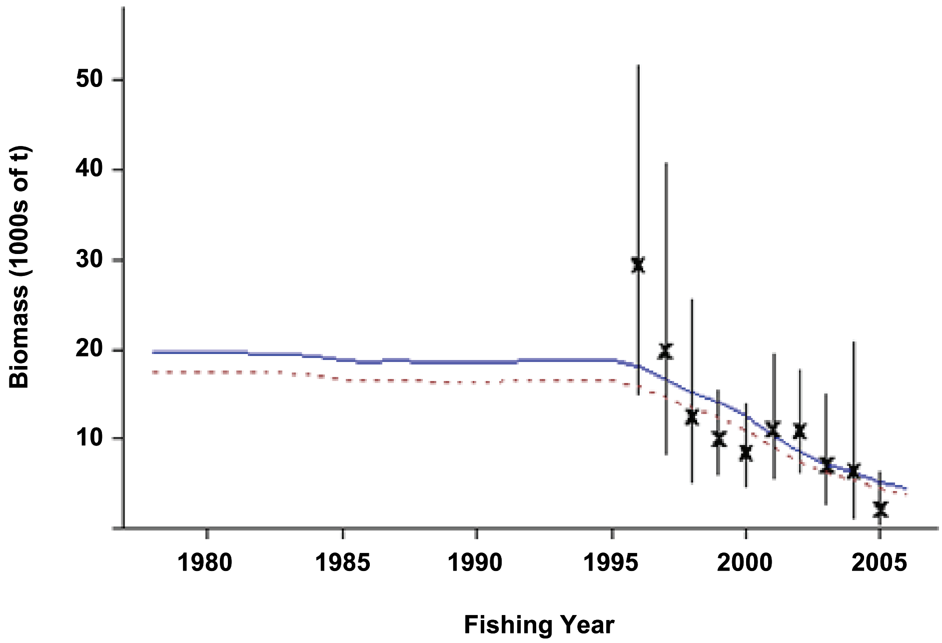

Figure 5: Model run based on CPUE data only, with a_{50} set at 19 yr. The crosses show the CPUE data (vertical lines are the 95% confidence intervals for the indices) and their fits to the vulnerable biomass trajectory (solid line). The dashed line shows the mature biomass trajectory. Fits and trajectories are from MPD estimates.

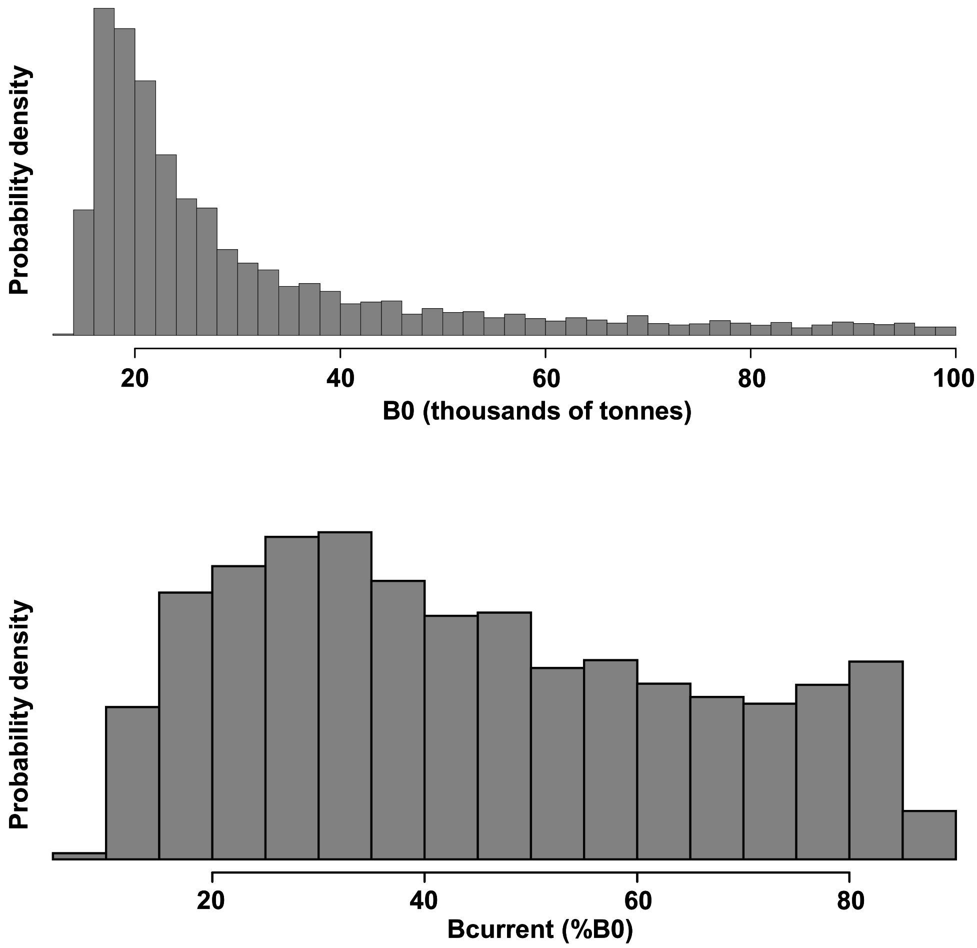

Figure 6: Posterior densities for mature biomass estimates (virgin biomass, and current biomass as a percentage of virgin biomass).

4.3.3 Yield estimates

Estimates of the Maximum Average Yield (MAY) were based on calculations performed for the Southland smooth oreo stock, which has similar life history characteristics (e.g., assumed natural mortality and steepness, and length-age and weight-age relationships) (Coburn *et al*. 2003). For Southland, the MAY was estimated to be 2.3% of the median mature virgin biomass. Applying this value to the estimates of B_0 in Table 11 gives a median estimate of MAY for Pukaki smooth oreo of 550 t, with 90% confidence intervals 370-1800 t.

4.3.4 Projections

No projections were made because of the uncertainty in this assessment.

4,4 Bounty Plateau smooth oreo fishery (part of OEO 6)

The first assessment for this fishery was developed in 2008 and applies only to the study area as defined in Figure 7. There were no fishery-independent abundance estimates, so relative abundance estimates from a post-GPS standardised CPUE analysis and length frequency data collected by MFish (SOP) and Orange Roughy Management Company (ORMC) observers were considered. Biological parameter values estimated for Chatham Rise and Puysegur Bank smooth oreo were used in the assessment because there are no research data from Bounty Plateau.

The following assumptions were made in this analysis.

1. The CPUE analysis indexed the abundance of smooth oreo in the Bounty Plateau (OEO 6) assessment area.
2. The length frequency samples were representative of the population being fished.
3. The biological parameters values used (from other assessment areas) are close to the true values.
4. Recruitment was deterministic and followed a Beverton & Holt relationship with steepness of 0.75.
5. The population of smooth oreo in the assessment area was a discrete stock or production unit.
6. Catch overruns were 0% during the period of reported catch.
7. The catch histories were accurate.
8. The maximum exploitation rate (E_{MAX}) was 0.58.

Data inputs included catch history, relative abundance estimates from a standardised CPUE analysis, and length data from SOP and ORMC observers. The observational data were incorporated into an age-based Bayesian stock assessment (CASAL) with deterministic recruitment to estimate stock size. The stock was considered to reside in a single area, with a partition by sex. Age groups were 1–70 years, with a plus group of 70+ years.

The length-weight and length-at-age population parameters are from fish sampled on the Chatham Rise and Puysegur Bank fisheries (Table 1, Biology section). The natural mortality estimate is based on fish sampled from the Puysegur Bank fishery. The maturity ogive is from fish sampled on the Chatham Rise, and the age at which 50% are mature is between 18 and 19 years for males and between 25 and 26 years for females.

4.4.1 Estimates of fishery parameters and abundance

Catch history

A catch history was derived using declared catches of oreos from OEO 6 (Table 2 in the "Fishery summary" section of the Oreos report above) and tow-by-tow records of catch from the assessment area (Figure 7). The tow-by-tow data were used to estimate the species ratio (SSO/BOE) and therefore the SSO taken. The catch history used in the population model is given in Table 12.

Table 12: Catch history (t) of smooth oreo from the Bounty Plateau fishery assessment area. Catches are rounded to the nearest 10 t.

Year	Catch	Year	Catch
1983–84	620	1996–97	610
1984–85	0	1997–98	650
1985–86	0	1998–99	1 200
1986–87	0	1999–00	870
1987–88	10	2000–01	550
1988–89	0	2001–02	980
1989–90	0	2002–03	1 530
1990–91	20	2003–04	1 420
1991–92	0	2004–05	2 190
1992–93	110	2005–06	1 790
1993–94	490	2006–07	670
1994–95	1 450	2007–08	670
1995–96	900		

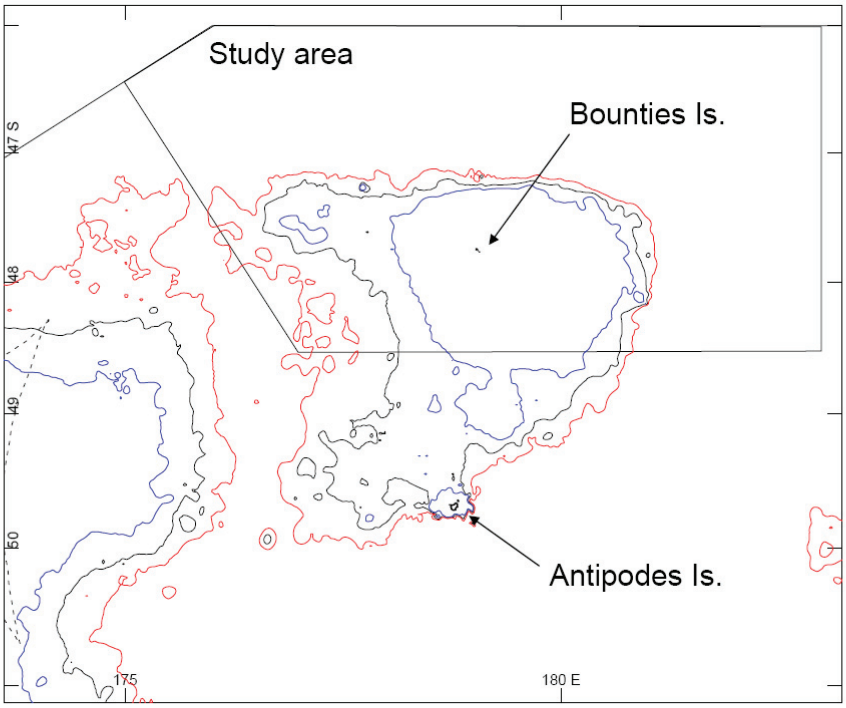

Figure 7: The Bounty Plateau fishery assessment study area.

Length data

Smooth oreo length frequency data collected by SOP and ORMC observers are available from the last twenty eight years. An in-depth analysis indicated that these data were reasonably representative of the fishery in terms of spatial, depth and temporal coverage in those years that had adequate data. Length frequencies were based on tows from the core area (a subset of the study area where about 80% of the catch is take). The data from adjacent years were grouped because some years had few samples (Table 13). The resulting length frequencies are shown in Figure 8. In the final model runs the 1994–95 year of the length frequency series was omitted as it contained very few samples.

Table 13: Core length analysis Year group, year applied and the number of length frequencies. Smooth oreo sample catch weight, fishery catch and sample catch as percentage of the fishery.

Year group	Year applied	No. of lfs	Catch sampled (t)	Fishery catch (t)	% fishery sampled
1991–92 to 1995–96	1994-95	7	88	1505	6
1998–99 to 1999–2000	1998-99	30	246	1121	22
2000–2001 to 2002–03	2001-02	25	398	2261	18
2003–04 to 2004–05	2004-05	29	261	2280	11
2005–06	2005-06	32	379	1121	34
2006–07 to 2007–08	2006-07	17	168	494	34

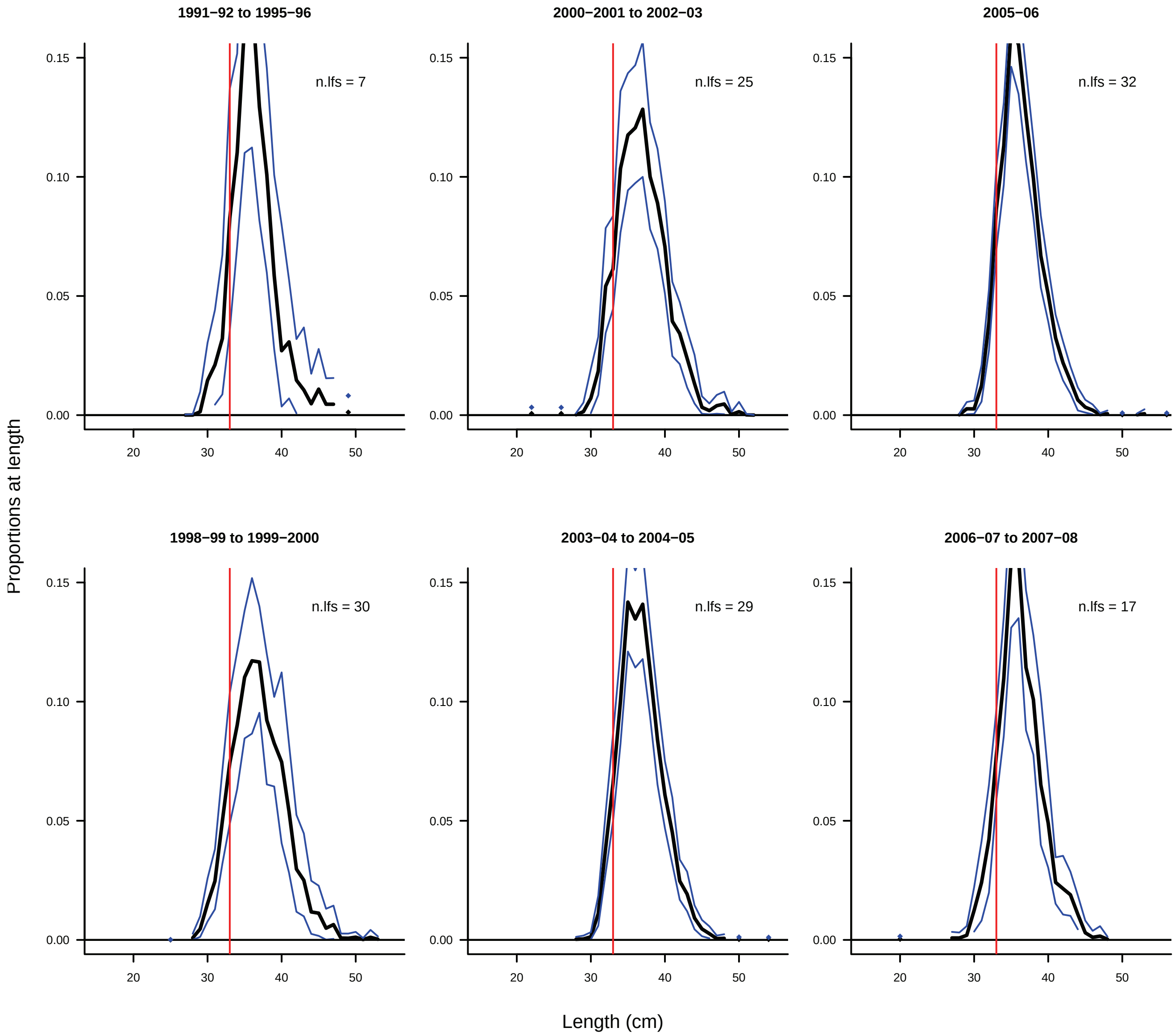

Figure 8: Length frequency distribution plots for core data only (thick lines) with 95% confidence interval (thin lines)

Relative abundance estimates from CPUE analyses

The small early Soviet fishery had too few data for a standardised CPUE analysis. The standardised CPUE analysis was from the the New Zealand vessel fishery and only included those vessels that had fished at least three years. Just a single vessel puts in significant continuous effort from 1995–2007, with the rest of the vessels effort confined to mainly either 1995–2000 (early) or 2001–2007 (late). Because of this, in addition to the single standardised CPUE covering the entire time period, two separate standardised CPUE indices were calculated covering the early and late periods.The final indices are shown in Tables 14 and 15.

Table 14: Early and late period CPUE combined index estimates by year, and bootstrap c.v. estimates.

Early period	Kg/tow	C.v	Late period	Kg/tow	C.v
1995–96	3551	0.423	2000–01	850	0.487
1996–97	3322	0.496	2001–02	2976	0.274
1997–98	2306	0.980	2002–03	1489	0.243
1998–99	781	0.391	2003–04	1727	0.260
1999–2000	1536	0.306	2004–05	1604	0.227
			2005–06	1386	0.310
			2006–07	966	0.232

Table 15: Single period CPUE combined index estimates by year, and bootstrap c.v. estimates.

Year	Kg/tow	C.v
1995–96	7472	0.286
1996–97	4453	0.735
1997–98	3366	1.264
1998–99	1444	0.406
1999–2000	2835	0.286
2000–01	2817	0.436
2001–02	632	0.680
2002–03	1973	0.663
2003–04	1296	0.615
2004–05	1284	0.445
2005–06	1289	0.563
2006–07	1056	1.200

4.4.2 Biomass estimates

In all preliminary model runs the length-frequency data series were not well fitted to, and gave a strong but contrasting biomass signal relative to the CPUE indices. Therefore, for final model runs, the length frequency data was down-weighted by using just the 1999 length frequency.

The basecase model used early and late period CPUE indices, and the 1999 length frequency data, and current mature biomass was estimated to be 33% of a virgin biomass of 17 400 t (Figure 9).

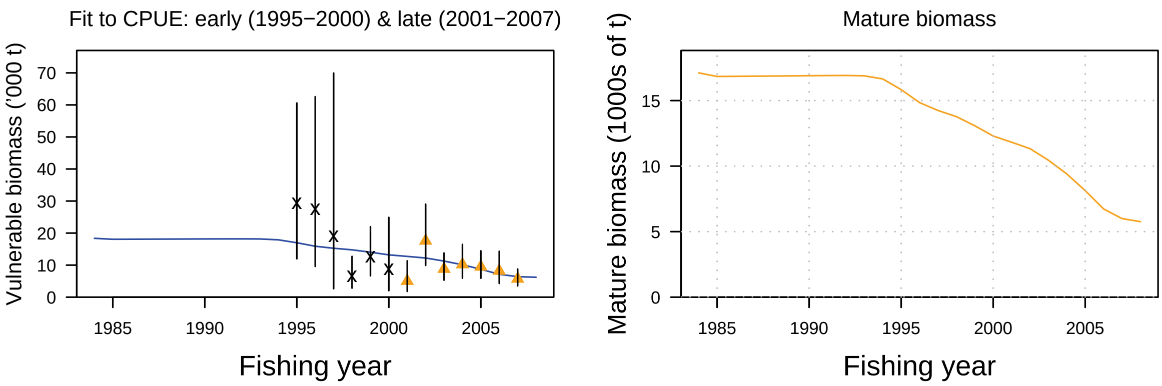

Figure 9: Model run showing the MPD fit to the CPUE data (vertical lines are the 95% confidence intervals for the indices) and the trajectory of mature biomass.

Two sensitivity model runs were carried out with the 1999 length frequency data dropped from the model, but retaining the fishery selectivity estimated using the length data. The first used the early and late period CPUE indices and current biomass was estimated to be 39% of a virgin biomass of 19 300 t. In the second, the single CPUE series covering the same period was used and current biomass was estimated to be 17% of a virgin biomass of 13 900 t. No MCMC runs were carried out with the basecase model as the sensitivity run showed that the assessment was quite different if the CPUE analysis was not split into two series.

Biomass estimates are uncertain because of the reliance on commercial CPUE data, the use of biological parameter estimates from other oreo stocks, and because of contrasting biomass signals from using either a single or split CPUE indices.

4.4.3 Projections

No projections were made because of the uncertainty in the assessment.

4.5 Pukaki Rise black oreo stock (part of OEO 6)

This 2009 assessment is the first for this stock applying to the area defined in Figure 10. In 2009, this is the largest black oreo fishery in the New Zealand EEZ with mean (1994–95 to 2007–08) annual catches of 1800 t, but with over 3000 t taken in the last two years, mainly by New Zealand vessels. There was an early Soviet fishery (1980–81 to 1984–85) with mean annual catches of about 1700 t. Fishery-independent abundance estimates were not available, so a series of relative abundance indices, based on an analysis of post-GPS standardised CPUE, have been developed. Length frequency data collected by MFish (SOP) and Orange Roughy Management Company (ORMC) observers were included in the model. The assessment used biological parameter values estimated for Chatham Rise and Puysegur Bank black oreo because no biological data from Pukaki Rise are available.

The following assumptions were made in this assessment.

1. The CPUE is an index of abundance of black oreo in the Pukaki Rise (OEO 6) assessment area.
2. The length frequency samples were representative of the population being fished.
3. The ranges used for the biological values covered their true values.
4. Recruitment was deterministic and followed a Beverton & Holt relationship with steepness of 0.75.
5. The population of black oreo in the assessment area was a discrete stock or production unit.
6. The catch histories were accurate with no assumed overruns.
7. The maximum exploitation rate (E_{MAX}) was 0.80.
8. The prior for stock size was bounded at an upper limit of 150 000 t.

Data inputs included catch history, relative abundance estimates from a standardised CPUE analysis, and length data from SOP and ORMC observers. The observational data were incorporated into an age-based Bayesian stock assessment (CASAL) with deterministic recruitment to estimate stock size. Life history parameters are from Table 1 of the Biology section at the beginning of the Oreo report.

4.5.1 Estimates of fishery parameters and abundance

Catch history

A catch history for black oreo was derived (Table 16) using declared catches of OEO from OEO 6 (Table 2 in the "Fishery summary" section of the Oreos report above) and tow-by-tow records of catch from the assessment area (Figure 10). The catch history used in the population model is given in Table 16.

Table 16: Catch history (t) of black oreo from the Pukaki Rise fishery assessment area.

Year	Catch	Year	Catch	Year	Catch
1978–79	17	1988–89	0	1998–99	1 181
1979–80	5	1989–90	0	1999–00	1 061
1980–81	283	1990–91	15	2000–01	1 158
1981–82	4 180	1991–92	27	2001–02	988
1982–83	1 084	1992–93	27	2002–03	1 701
1983–84	1 150	1993–94	10	2003–04	1 530
1984–85	1 704	1994–95	242	2004–05	1 588
1985–86	46	1995–96	1 352	2005–06	2 811
1986–87	0	1996–97	2 413	2006–07	3 434
1987–88	0	1997–98	2 244	2007–08	3 346

Length data

Black oreo length frequency data collected by SOP and ORMC observers are available from the last twelve years (Table 17). An analysis indicated that there was a trend in fish size across years (with smaller mean lengths in more recent years) and with depth (deeper fish being larger). The length data were considered reasonably representative of the fishery in terms of spatial, depth and temporal coverage for those years that had adequate data. The length data were stratified into two depth bins: shallow (less than 900 m), and deep strata (greater than 900 m). Length data from adjacent years were grouped because of the low number of samples in some years (Figure 11). There is no trend in mean length over the first six year-groups, but fish sizes appear to be generally smaller in the later year-groups with the mode of the distributions shifting to the left in the plots for 2005–6, 2006–7, and 2007–8

Table 17: Summary of length frequency data for black oreo available from the assessment area. The table shows the number of tows sampled by year, the sample source, and the year group.

		Number of tows sampled		
Year	Year group	SOP	ORMC	All
1996–97	97–98	7	0	7
1997–98	97–98	25	0	25
1998–99	99–00	7	44	51
1999–00	99–00	6	0	6
2000–01	01–02	8	18	26
2001–02	01–02	2	8	10
2002–03	03–05	7	2	9
2003–04	03–05	18	0	18
2004–05	03–05	21	0	21
2005–06	06	21	42	63
2006–07	07	154	11	165
2007–08	08	31	9	40
Total		307	134	441

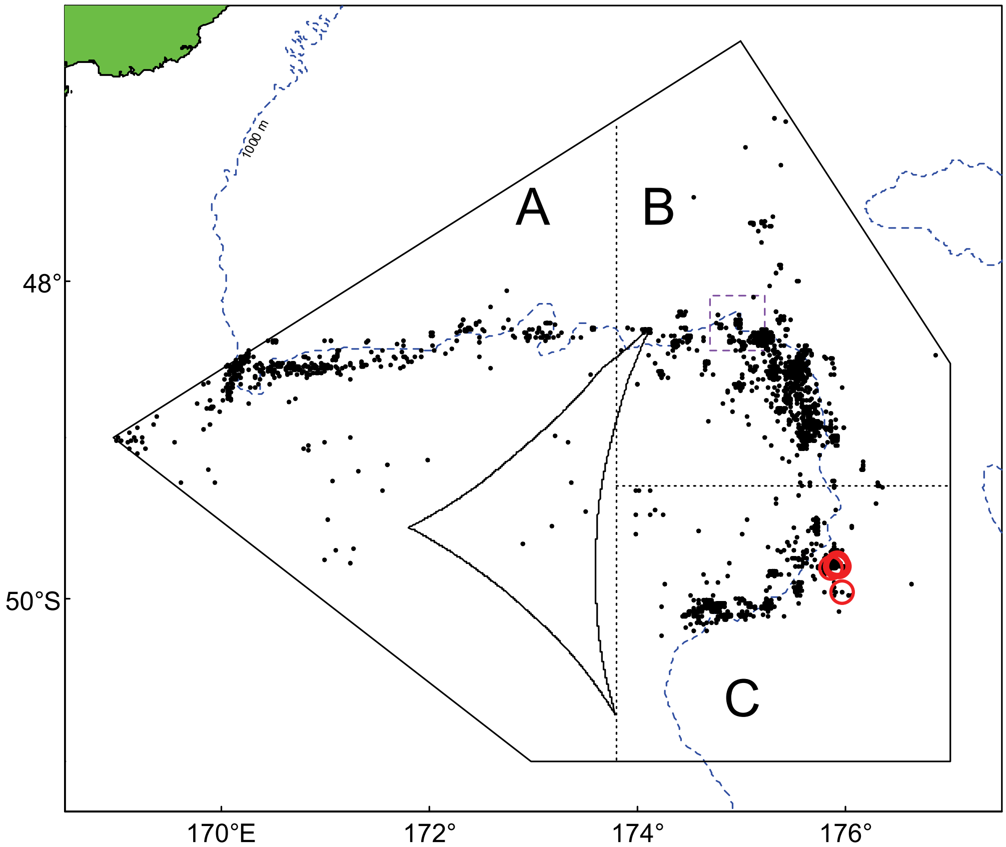

Figure 10: The Pukaki Rise fishery black oreo assessment area (polygon) abutting the boundary of OEO 6/OEO 1 in the north-west. The dots show tows positions where black oreo catch was reported from 1980–81 to 2007–08. A, B, and C are the three areas defined in the standardised CPUE analysis.

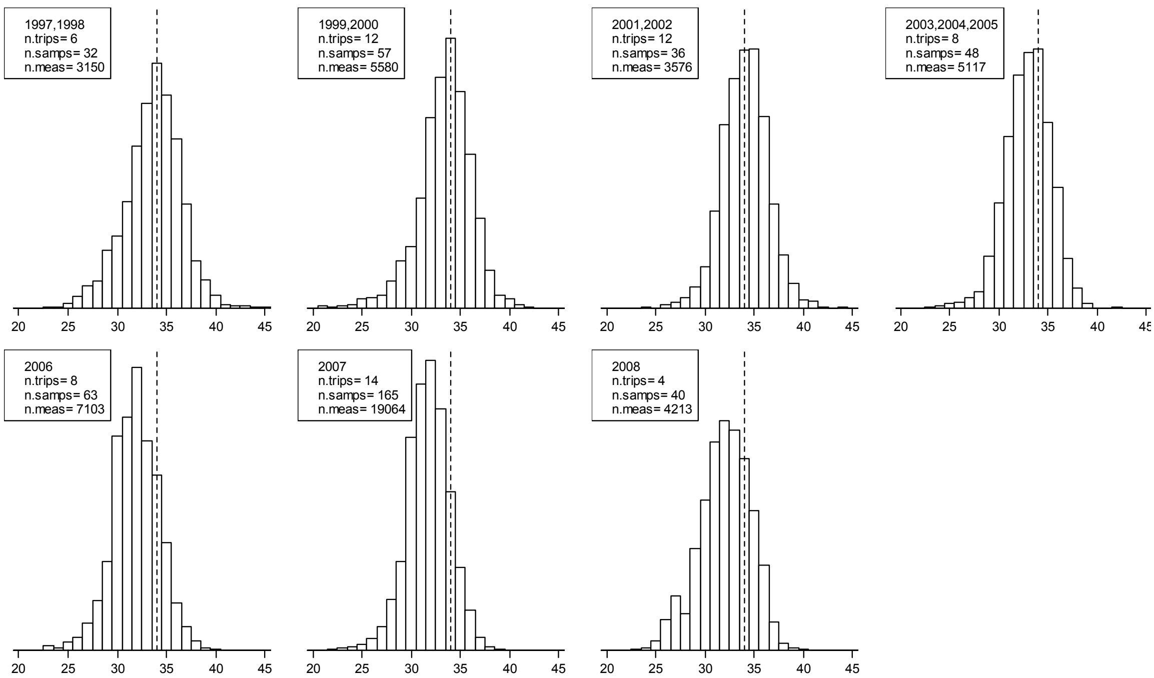

Figure 11: Observer length frequencies for Pukaki Rise black oreo, stratified by depth (see text), and grouped by years (in the legends 1997=1996–97 etc.). The vertical dashed lines indicate the approximate overall mean length as an aid to comparing the distributions.

Relative abundance estimates from CPUE analyses

The fishery taking Pukaki Rise black oreo divides into two distinct periods: a pre-GPS period 1980–81 to 1984–85 when much of the catch was taken by Soviet and Korean vessels, and a post-GPS period, 1995–96 to 2007–08 when most of the catch was taken by New Zealand vessels. The intervening period was characterised by low catches and the introduction of GPS technology in the fleet. Standardisation of CPUE for the pre-GPS period was attempted but rejected due to poor linkage of vessels across years and the shifting of fishing effort between areas.

The standardised CPUE analysis of Pukaki Rise black oreo was therefore based on the post-GPS period and used regression based methods similar to those in previous oreo CPUE analyses but, because the fraction of zero tows was low, only a positive catch model was used. The annual c.v.s for the index series used in the assessment model were derived from the regression model standard errors. The analysis was restricted to data from vessels fishing in the eastern areas (B and C in Figure 10) with a minimum of 20 successful tows for black oreo in at least three years . Tows orginating from a set of ten features identified (by the catch history) as mainly orange roughy or smooth oreo features and which targeted these two species were not used. The selected explanatory variables in this model were depth, tow duration, and area, and the resultant indices showed a decline over the period. The number of tows and CPUE indices are summarised in Table 18.

Table 18: Summary of data used as input to the standardised core target CPUE analysis, CPUE index values and c.v.s by year as used in the assessment model.

Year	No. of tows	CPUE index	c.v.	Year	No. of tows	CPUE index	c.v.
1995–96	63	1.91	0.11	2002–03	303	1.13	0.14
1996–97	55	1.50	0.15	2003–04	324	1.17	0.13
1997–98	187	1.58	0.11	2004–05	294	0.89	0.17
1998–99	221	1.35	0.12	2005–06	465	1.05	0.14
1999–00	242	0.94	0.17	2006–07	618	0.90	0.15
2000–01	189	1.21	0.14	2007–08	747	0.78	0.18
2001–02	167	1.17	0.15				

4.5.2 Biomass estimates

The base case (NoLF) employed a two-step approach, estimating the fishery selectivities from the observer length data during the first phase followed by a second estimation phase where the selectivities were fixed at the MPD values from the first phase and estimating the biomass-related parameters solely on the basis of the CPUE relative biomass indices. The WG chose a basecase with M fixed at its best estimate (0.044). Other cases investigated the sensitivity of the model to alternative fixed values for M, representing the range of plausible values for this parameter (0.029 and 0.066) and the influence of the length frequency data (M fixed at 0.044). The three NoLF MCMC runs used a prior on B_0 which limited this parameter to a maximum of 150 000 t, based on estimates of B_0 from other oreo fisheries. In the basecase, the current status ($\%B_0$) is highly uncertain with a median of 44% and 95% confidence intervals of 19–80% (Table 19, Figure 12).

Table 19: Mid-year mature biomass estimates (medians) and 95% confidence intervals for the basecase model run. $B_{CURRENT}$ is the mid-year mature biomass in 2009, *V*=vulnerable biomass.

	NoLF, M=0.044		
Biomass estimates	Median	5% CI	95% CI
B_0	40 900	26 900	116 000
$B_{CURRENT}$	18 000	5 060	92 400
$B_{CURRENT}$ ($\%B_0$)	44	19	80
V_0	39 700	26 200	113 000
$V_{CURRENT}$	18 600	6 110	90 600
$V_{CURRENT}$ ($\%V_0$)	47	23	81

4.5.3 Yield estimates

No yield estimates were made.

4.5.4 Projections

Projections were made using the basecase model, assuming deterministic recruitment and the current catch (3346 t) for the next five years (Figure 12). The estimated probability of the biomass being less than 20% B_0 went from 0.06 in 2008–09 to 0.47 in 2013–14.

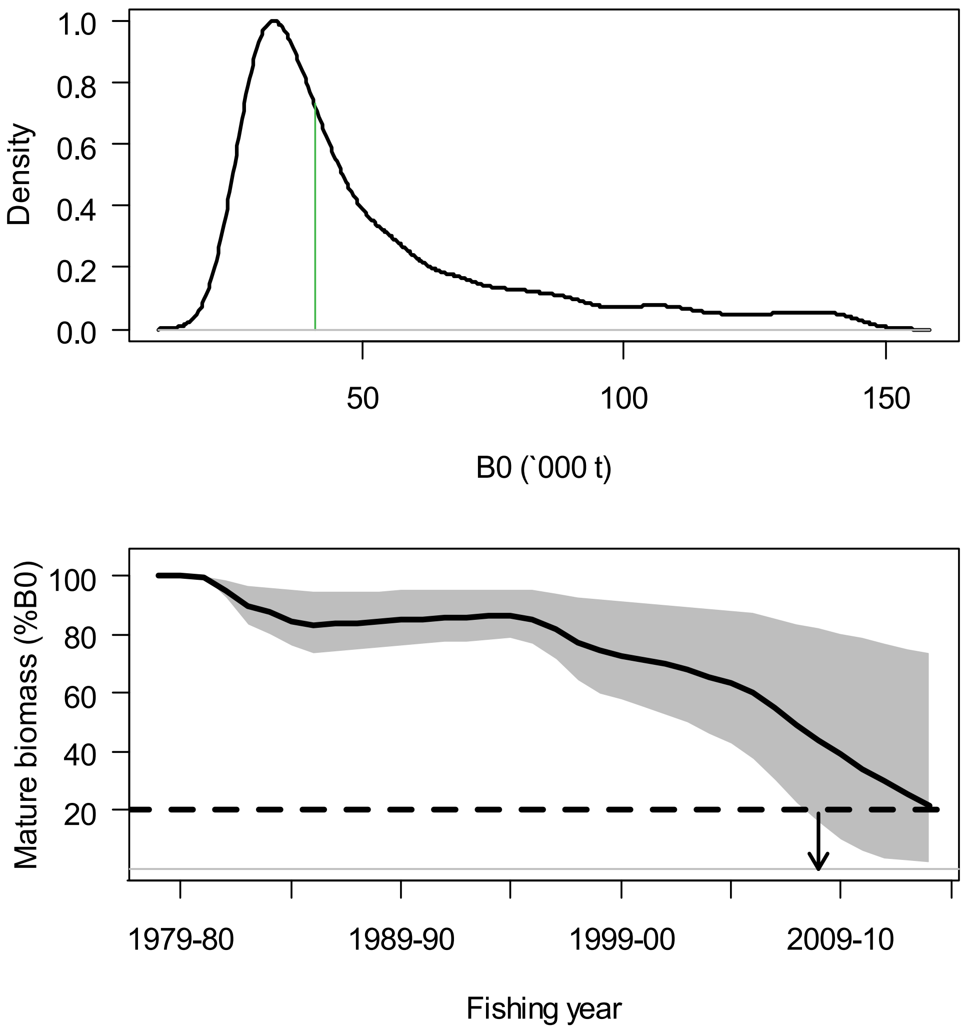

Figure 12: Biomass estimates (B_0) and fishery projections of mature biomass (as $\%B_0$) for the next five fishing years (to 2013–14) for the basecase,. A prior on B_0 limited it to a maximum of 150 000 t. Catch levels were assumed constant at the current level (3346 t).

4.6 Other oreo fisheries in OEO 1 and OEO 6

4.6.1 Estimates of fishery parameters and abundance

Relative abundance estimates from trawl surveys

Two comparable trawl surveys were carried out in the Puysegur area of OEO 1 (TAN9208 and TAN9409). The 1994 oreo abundance estimates are markedly lower than the 1992 values (Table 20).

Table 20: OEO 1. Research survey abundance estimates (t) for oreos from the Puysegur and Snares areas. N is the number of stations. Estimates for smooth oreo were made based on a recruited length of 34 cm TL. Estimates for black oreo were made using knife-edge recruitment set at 27 cm TL.

Smooth oreo					
Puysegur area (strata 0110–0502)					
	Mean biomass	Lower bound	Upper bound	CV (%)	N
1992	1 397	736	2 058	23	82
1994	529	86	972	41	87
Snares area (strata 0801–0802)					
	Mean biomass	Lower bound	Upper bound	CV (%)	N
1992	2 433	0	5 316	59	8
1994	118	0	246	54	7
Black oreo					
Puysegur area (strata 0110–0502)					
	Mean biomass	Lower bound	Upper bound	CV (%)	N
1992	2 009	915	3 103	27	82
1994	618	0	1 247	50	87
Snares area (strata 0801–0802)					
	Mean biomass	Lower bound	Upper bound	CV (%)	N
1992	3 983	0	8 211	53	8
1994	1 564	0	3 566	64	7

4.6.2 Biomass estimates

Estimates of virgin and current biomass are not yet available.

4.6.3 Estimation of Maximum Constant Yield (MCY)

MCY cannot be estimated because of the lack of current biomass estimates for the other stocks.

4.6.4 Estimation of Current Annual Yield (CAY)

CAY cannot be estimated because of the lack of current biomass estimates for the other stocks.

4.6.5 Other factors

Recent catch data from this fishery may be of poor quality because of area misreporting.

5. STATUS OF THE STOCKS

New assessment results are reported in 2009 for Pukaki Rise black oreo. A preliminary assessment from 2008 is reported for Bounty Plateau smooth oreo (only MPD results).

Southland smooth oreo stock (OEO 1/OEO 3A)

Current and virgin biomass for smooth oreo, in Southland (OEO 1/OEO 3A), were estimated in 2004. These biomass estimates are uncertain because of the scarcity of observer length frequency data, the poor quality of recent catch data resulting from area mis-reporting, and the lack of fishery-independent abundance estimates and the consequent reliance on commercial CPUE data for abundance indices. Therefore, quantitative biomass estimates are not reported here and are not considered suitable as a basis for providing management advice. But the analysis suggested that the mature virgin biomass was probably small, less than 21 000 t, and that the stock was unlikely to be able to support a large fishery.

Five year projections to estimate future mature and vulnerable biomass were subject to the same data problems as the biomass estimates. However, the Plenary concluded that catches at the level of the 2000–01 annual catch (1010 t) are probably not sustainable.

Pukaki Rise smooth oreo stock (part of OEO 6)
Current and virgin biomass for smooth oreo, on Pukaki Rise (part of OEO 6), were estimated for the first time in 2006. These biomass estimates are uncertain because of the lack of fishery-independent abundance estimates and the consequent reliance on commercial CPUE data, and because of the lack of biological parameter estimates specific to smooth oreo in this assessment area.

Model results suggest that mature virgin biomass is about 24 000 t with wide 90% confidence intervals (16 000 - 78 000 t). The Plenary noted that large stock sizes were unlikely, particularly because standardised CPUE has declined rapidly under catch levels that have been small relative to other smooth oreo fisheries. Smooth oreo life history parameters suggest a median long-term yield (MAY estimate) of about 550 t, which is lower than the current catch of 1300 t.

The estimated confidence intervals around virgin biomass were so wide that it is not possible to make a definitive statement about stock status. However, based on CPUE trends and the catch history, the Plenary agreed that current annual catch levels are unlikely to be maintained in the future.

No projections were made because of the uncertain biomass estimates.

Bounty Plateau smooth oreo stock (part of OEO 6)
Current and virgin biomass on Bounty Plateau (part of OEO 6) were estimated for the first time in 2008. Biomass estimates are uncertain because of the reliance on commercial CPUE data, biological parameter estimates are from oreo stocks, and because of contrasting biomass signals from using either a single or split CPUE indices.

The basecase model used the early and late period CPUE indices, and just the 1999 length frequency data, and current mature biomass was estimated to be 33% of a virgin biomass of 17 400 t (MPD estimate only). No MCMC runs or projections were made because of the uncertain biomass estimates.

Pukaki Rise black oreo stock (part of OEO 6)
An initial assessment was made for this stock in 2009. These biomass estimates are uncertain because of the lack of fishery-independent abundance estimates and the consequent reliance on commercial CPUE data, and because of the lack of biological parameter estimates specific to black oreo in this assessment area.

The basecase results suggest that mature virgin biomass was between 27 000 t and 117 000 t. The stock is currently estimated to be at 44% B_0 but with high uncertainty (19-80% B_0). Projections suggest that mature biomass is as likely as not to fall below 20% B_0 within the next five years if catches are maintained at the 2007-08 level.

OEO 1 black oreo and smooth oreo
The TACC was increased from 5033 t to 6044 t in 1992–93 under the adaptive management programme but reverted to 5033 t in 1998–99. It is not known if recent catch levels or the current TACC are sustainable or will allow the stock to move towards a size that will support the maximum sustainable yield. From 1 October 2007 the TACC was reduced to 2500 t.

OEO 1: Summary of yield estimates (t) and estimated catch (t) for the most recent fishing year. Estimated catch was scaled to the reported oreo landings for each fishstock using the reported estimated catch of black or smooth oreo from Tables 2 and 3 of the Fishery Summary section at the beginning of the Oreos report. Reported landings and TACCs for both oreo species combined are in Table 2 of the Fishery Summary section at the beginning of the Oreos report. –, not available.

Species	CAY	Long-term MCY	2007–08 estimated catch
Black oreo	–	–	429
Smooth oreo	–	–	407

OEO 6: Summary of yield estimates (t) and estimated catch (t) for the most recent fishing year. Estimated catch was scaled to the reported oreo landings for each fishstock using the reported estimated catch of black or smooth oreo from Tables 2 and 3 of the Fishery Summary section at the beginning of the Oreos report. Reported landings and TACCs for both oreo species combined are in Table 2 of the Fishery Summary section at the beginning of the Oreos report. –, not available.

Species	CAY	Long-term MCY	2007–08 estimated catch
Black oreo	–	–	3022
Smooth oreo	–	–	2182

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6. FOR FURTHER INFORMATION

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