ORANGE ROUGHY CHALLENGER PLATEAU (ORH 7A)

1. FISHERY SUMMARY

1.1 Commercial fisheries

From the 2000–01 fishing year the TACC for this stock was reduced to 1 t. Previously the fishery occurred in the southwestern region of the Challenger Plateau, both inside and outside the EEZ. Fish were caught throughout the year, with most effort in winter when the orange roughy form aggregations for spawning. Domestic vessels caught most of the quota. Reported commercial catches and TACs from 1980–81 to 2008–09 are shown in Table 1 while Figure 1 shows the historical landings and TACC values for ORH 7A.

Table 1: Reported catches (t) and TACs (t) from 1980–81 to 2008–09. QMS data from 1986–present.

Fishing year	Inside EEZ	Outside EEZ	Total catch	TAC
1980–81†	1	32	33	–
1981–82†	3 539	709	4 248	–
1982–83†	4 535	7 304	11 839	–
1983–84†	6 332	3 195	9 527	4 950
1984–85†	5 043	74	5 117	4 950
1985–86†	7 711	42	7 753	6 190
1986–87†	10 555	937	11 492	10 000
1987–88	10 086	2 095	12 181	12 000
1988–89	6 791	3 450	10 241	12 000
1989–90	3 709	600	*4 309	*2 500
1990–91	1 340	17	1 357	1 900
1991–92	1 894	17	1 911	1 900
1992–93	1 412	675	2 087	1 900
1993–94	1 594	138	1 732	1 900
1994–95	1 554	82	1 636	1 900
1995–96	1 206	463	1 669	1 900
1996–97	1 055	253	1 308	1 900
1997–98	+	+	1 502	1 900
1998–99	+	+	1 249	1 425
1999–00	+	+	629	1 425
2000–01	+	+	0.2	1
2001–02	+	+	0.1	1
2002–03	+	+	4	1
2003–04	+	+	< 0.1	1
2004–05	+	+	< 1#	1
2005–06	+	+	< 1#	1
2006–07	+	+	< 0.1	1
2007–08	+	+	< 0.1	1
2008–09	+	+	0.12#	1

†FSU data.
*This is a minimum value, because of unreported catches by foreign vessels fishing outside the EEZ.
+Unknown distribution of catch.
Catches taken during winter trawl surveys were 158 t in 2005, 218 t in 2006, and 240 t in 2009

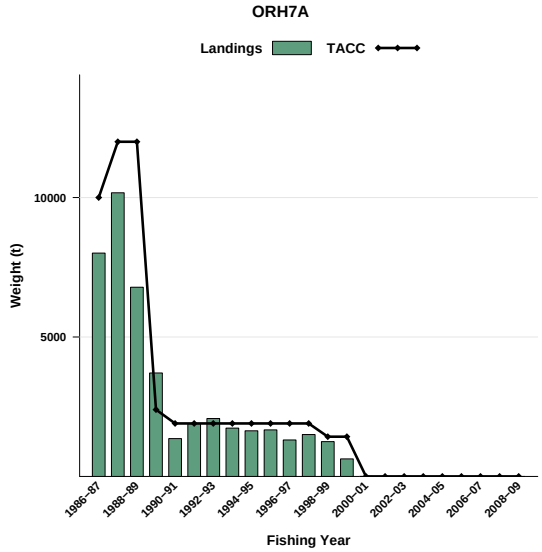


Figure 1: Historical landings and TACC for ORH 7A. Note that this figure does not show data prior to entry into the QMS.

1.2 Recreational fisheries

There is no known recreational fishing for orange roughy in this area.

1.3 Customary non-commercial fisheries

There is no known customary non-commercial fishing for orange roughy in this area.

1.4 Illegal catch

There is no quantitative information available on illegal catch.

1.5 Other sources of mortality

In previous stock assessments, catch overruns from various sources (including lost and/or discarded fish, use of nominal tray weights and low conversion factors) have been estimated as: 1980–81 to 1987–88, 30%; 1988–89, 25%; 1989–90, 20%; 1990–91, 15%; 1991–92 to 1992–93, 10%; 1993–94 onwards, 5%.

2. BIOLOGY

Biological parameters used in this assessment are presented in the Biology section at the beginning of the Orange Roughy section.

3. STOCKS AND AREAS

There are no new data which would alter the stock boundaries given in previous assessment documents.

Orange roughy on the Challenger Plateau are regarded as a single separate stock. Size structure, parasite composition, flesh mercury levels, allozyme frequency and mitochondrial DNA studies show differences to other major fisheries. Spawning occurs at a similar time to fish on the Chatham Rise, Puysegur Bank, Ritchie Banks, Cook Canyon and Lord Howe Rise.

4. STOCK ASSESSMENT

An assessment was carried out for this stock in 2000 (Annala *et al*. 2000, Field & Francis 2001) and is reported here. It was similar to the 1998 assessment (Annala *et al*. 1998, Field 1999) in using standardised CPUE in a stock reduction analysis (Francis 1990), but differs from that assessment in allowing stochastic recruitment (i.e., it uses the enhanced stock reduction method of Francis *et al*. 1992; *see* Appendix of Francis *et al*. 1995 for details).

In 2005 the working group considered a revised assessment, although there was little new data available for the stock since 2000. The primary reason for the re-assessment was to determine whether a Bayesian modelling framework, similar to that used for other orange roughy stock assessments, would give a substantially different result. A new standardised CPUE series was calculated with the additional fishing year 1999–00, shown in Table 2 alongside the CPUE series used in the 2000 assessment. The trawl survey biomass indices and length frequencies from 1987 to 1990 were included in the 2005 analysis, along with observer length frequencies from the 1987–88 and 1988–89 fishing years. Results from the 2005 assessment are summarised qualitatively in section 4.4, but no new quantitative estimates are presented here.

In 2010, the results of the 2009 trawl and acoustic survey of the Challenger Plateau (NIWA & FRS, 2009) were used to estimate mature biomass. Two types of estimates were produced: a “minimum” estimate which only used the acoustic estimates from plumes seen on the flat; and total estimates which used trawl and acoustic data from the whole survey area (Cordue, 2010). The “total estimates” used an estimate of orange roughy trawl vulnerability which, as it is based on very limited data, may be unreliable. The methods and results are summarised in section 4.5.

4.1 Estimates of fishery parameters and abundance

Catch-per-unit-effort

In the 2000 assessment, commercial catch and effort data were examined from 1983 using both an unstandardised and standardised analysis. CPUE indices from both methods are given in Table 2. Unstandardised mean catch per tow during winter months declined rapidly until the late 1980s, and has continued to decline since then, but at a slower rate. The standardised analysis used catch per nautical mile for tows in all months and all areas in a linear regression model. Indices from this model show a similar trend to unstandardised catch rates except that the initial decline was more extreme. This reflects increasing tow length and shifts to new areas within the fishery, which could not be incorporated in the unstandardised analysis. For this reason, the Working Group decided not to use unstandardised results in the stock assessment.

Table 2: CPUE indices from unstandardised data (mean catch [t/trawl] in the June-September period, all N.Z. vessels combined), and from standardised data (all months included) from 1982–83 to 1999–2000. A new standardised CPUE index was added to the table in 2005.

Fishing year	2000 Unstandardised index	2000 Standardised index	2005 Standardised index
1982–83	15.8	1.00	1.00
1983–84	15.3	1.30	1.038
1984–85	13.5	0.37	0.712
1985–86	10.8	0.59	0.652
1986–87	9.4	0.28	0.418
1987–88	5.3	0.084	0.212
1988–89	3.5	0.062	0.11
1989–90	5.8	0.089	0.071
1990–91	3.9	0.038	0.088
1991–92	4.3	0.038	0.139
1992–93	2.7	0.026	0.112
1993–94	3.2	0.025	0.086
1994–95	3.8	0.027	0.066
1995–96	3.7	0.024	0.058
1996–97	1.8	0.012	0.043
1997–98	1.6	0.021	0.032
1998–99	0.9	0.017	0.02
1999–00	—	—	0.033

Research surveys

Trawl surveys of orange roughy on the Challenger Plateau were regularly conducted from 1983 to 1990. However, a variety of vessels and survey strata were used which makes comparisons problematic (Dunn *et al*., 2010). Wingtip biomass estimates in 1983-1986 ranged from 100,000-185,000 t but in 1989 and 1990 the estimates were approximately 10,000 t.

In 2005, a new series of combined trawl and acoustic surveys began using the *FV Thomas Harrison* with a survey area comparable to that used from 1987-1990 (Clark *et al*., 2005). The survey was repeated in 2006 and 2009 (Clark *et al*., 2006; NIWA & FRS, 2009). In 2005 and 2006, the trawl survey indices were of the order of 20,000 t, but in 2009 the trawl-survey index was 52,000 t (NIWA & FRS, 2009).

The large increase in spawning biomass from 2005 and 2006 to 2009 was confirmed by the acoustic survey results (NIWA & FRS, 2009). Few signs of spawning were seen in 2005 or 2006, but in 2009 there were two separate plumes surveyed in the flat strata (Table 3). The plume in stratum 22 contained more biomass on 4-5 July compared to the earlier period of 27 June-2 July (Table 3; snapshots 1-4, mean = 6692 t, CV = 27%; and snapshots 5-6, mean = 16,791 t, CV = 26%). Strong acoustic marks were also seen on some hills but the species composition of these marks is not known (NIWA & FRS, 2009).

Table 3: Acoustic biomass estimates of orange roughy from the 2009 acoustic survey of the Challenger Plateau (NIWA & FRS, 2009; Hampton, 2010).

Stratum	Snapshot	Date	Biomass (t)	CV (%)
22	1	27-28 June	7447	67
22	2	28 June	8968	26
22	3	1 July	4518	90
22	4	2 July	5836	36
22	5	4 July	18024	37
22	6	5 July	15557	37
24	1	5 July	6304	61

In the 2009 trawl survey, the two strata which contained plumes provided the highest biomass estimates (strata 22 & 24plume – see Table 4), contributing 44% of the post-stratified index (the total in Table 4). However, there was also a large estimated biomass within stratum 23 where no plumes were seen (Table 4). The remaining strata each contained relatively small estimates but collectively made up 23% of the post-stratified index.

Table 4: Trawl survey estimates of orange roughy biomass from the 2009 trawl survey of the Challenger Plateau (NIWA & FRS, 2009; Cordue, 2010). Stratum 24 was post-stratified by Cordue (2010) because of the plume in the north-east corner (original estimate = 17,454 t, CV = 55%).

Stratum	Biomass (t) (length ≥ 27 cm)	CV (%)
9	1407	53
1	124	31
3	265	86
4	216	73
10	1735	62
11	3787	66
21	982	50
22	10211	49
23	15336	51
24plume	9883	34
24	1650	57
25	378	40
Total	45,974	22

4.2 Outcome of the 2000 assessment

In the 2000 assessment, stochastic stock reduction analyses were carried out using relative abundance indices from the standardised CPUE analysis (Table 2), which were assumed to be normally distributed with a CV of 0.3. The catches used in the model were the "Total catch" given in Table 1, adjusted by the estimated overrun (*see* Section 1.5). The model treats sexes separately, and has natural mortality occurring prior to fishing mortality (the Challenger fishery occurs largely in June and July, near the end of the fishing year).

In terms of virgin biomass, the 2000 estimate of 91000 t (Table 5) is similar to the range estimated (95000–99000 t) in the 1998 assessment. However, in terms of current biomass the assessments are very different: 3% B_0 in 2000, compared to 15–19% B_0 in 1998. This difference is because the stochastic model fits the CPUE data reasonably well, whereas the deterministic model does not (Figure 2).

Table 5: Estimates of mid-year biomass (t), with upper and lower bounds for 95% confidence intervals. B_{2000} is the mid-year biomass in 1999–00; B_{MSY} is calculated as 30% B_0, which is the mean biomass under a CAY policy (evaluated following Francis 1992).

			B_{2000}	
	B_0(t)	B_{MSY}(t)	(t)	(%B_0)
Estimate	91 000	27 000	2 500	3
Lower bound	60 000	18 000	1 300	1
Upper bound	130 000	39 000	5 400	6

4.3 Estimation of yields

Estimates of MCY, CAY and MAY were calculated in 2000 using the method of Francis (1992). Long-term yields ($MCY_{long\text{-}term}$ and MAY) are similar to catches near the end of the 1990's, but short-term yields ($MCY_{2000–01}$ and CAY) are very much smaller (Table 6).

Table 6: Yield estimates (t, corrected for an assumed overrun of 5%), with upper and lower bounds for 95% confidence intervals.

	$MCY_{2000–01}$	$MCY_{long\text{-}term}$	CAY	MAY
Estimate	170	1 200	220	1 600
Lower bound	50	800	90	1 100
Upper bound	500	1 700	520	2 300

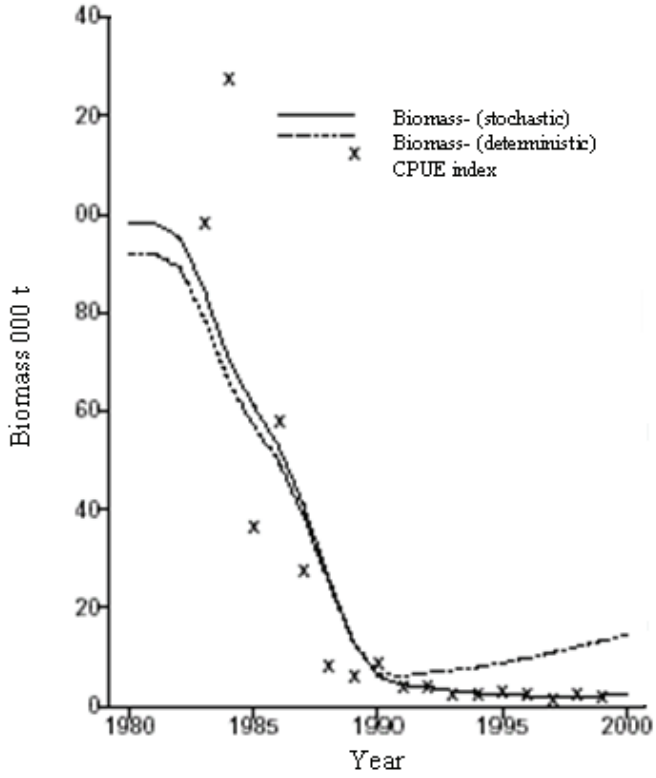


Figure 2: Biomass trajectories estimated in the 2000 assessment (solid line) and also using the deterministic model of the 1998 assessment (broken line).

4.4 Outcome of the 2005 assessment

The ORH 7A assessment in 2005 with the new CPUE series proved inconclusive. The stochastic stock reduction model fit was not persuasive because fitting nearly 80 parameters to 19 CPUE data points is questionable. Relatively small changes in the CPUE were accommodated through large perturbations in the recruitment residuals, indicating that the model was over fitted. Adding the survey and observer data did not change the model predictions, but the model was not able to fit the data convincingly, even under the assumption of stochastic recruitment. It is not known if this outcome is due to unreliable data or to model mis-specification. The estimation of a hyperdepletion parameter helped to fit the early part of the 2005 CPUE series but not the latter part.

It was concluded that stock status in 2000 when the fishery was closed was likely to have been poor, although the actual stock size is uncertain. Predictions of the amount of rebuilding that had taken place since the closure of the fishery were uncertain.

4.5 2010 stock assessment

The status of the stock was assessed in 2010 by using the virgin biomass estimate from the 2000 assessment (91 000 t) and estimating the 2009 mature biomass (Cordue 2010). A "minimum" estimate of mature biomass was obtained from the acoustic estimates of the plumes seen on the flat on 4-5 July and the assumption that only 90% of the mature biomass spawned in 2009 (see Dunn et al. 2010 for a

discussion of proportion spawning for orange roughy stocks). The estimation procedure took account of potential bias in orange roughy target strength and incorporated observation error (Cordue 2010).

Additional estimates of 2009 mature biomass were made by estimating the trawl-survey vulnerability of orange roughy based on 2009 survey information. Vulnerability was estimated using trawl and acoustic data from the two strata in which plumes were surveyed (Table 3). In both strata the trawl estimate of stratum biomass was about 1.5 times larger than the acoustic estimate of plume biomass (note, in stratum 22, the mean of the first four snapshots was used; see Tables 3 and 4). If it is assumed that most of the stratum biomass is in the plume, then this suggests that vulnerability is approximately 1.5 – and trawl survey estimates should be scaled down by this factor (see Cordue 2010 for the details, including additional assumptions, and the method used to incorporate observation error and other sources of uncertainty).

The estimates are presented as probability distributions and are given below for three models: Aco5-6 (acoustics only for plumes on the flat, using the mean of snapshots 5 and 6 in stratum 22); AllTrawl (applying the estimated vulnerability to the trawl survey over all strata); TrawlAco1-4 (acoustics for plumes on the flat, using the mean of snapshots 1-4 in stratum 22, plus the vulnerability-adjusted trawl estimates for the other strata). Two of the distributions were restricted in their range: AllTrawl and TrawlAco1-4 were required to be less than the assumed B_0 = 91,000 t; and AllTrawl was required to be greater than the 0.1th percentile of Aco5-6 (which was 8617 t).

The two total estimates have medians for 2009 mature-biomass of approximately 32,000 t, but with a high level of uncertainty (Table 6, Figure 3). The minimum estimate (Aco5-6) has a lower median but its 10th percentile is similar to the total-estimate from AllTrawl (at about 15 000 t – see Table 7). All these biomass estimates are known to be biased negatively, although the level of bias for any of these estimates is not known.

Table 7: Summary statistics for 2009 mature-biomass distribution-estimates.

Model	Median B_{2009} (t)	10th percentile (t)	25th percentile (t)	Mean (t)	CV (%)
TrawlAco1-4	31,900	19,500	24,500	34,500	40
AllTrawl	32,900	16,100	22,600	36,300	49
Aco5-6	22,700	14,600	17,800	25,300	43

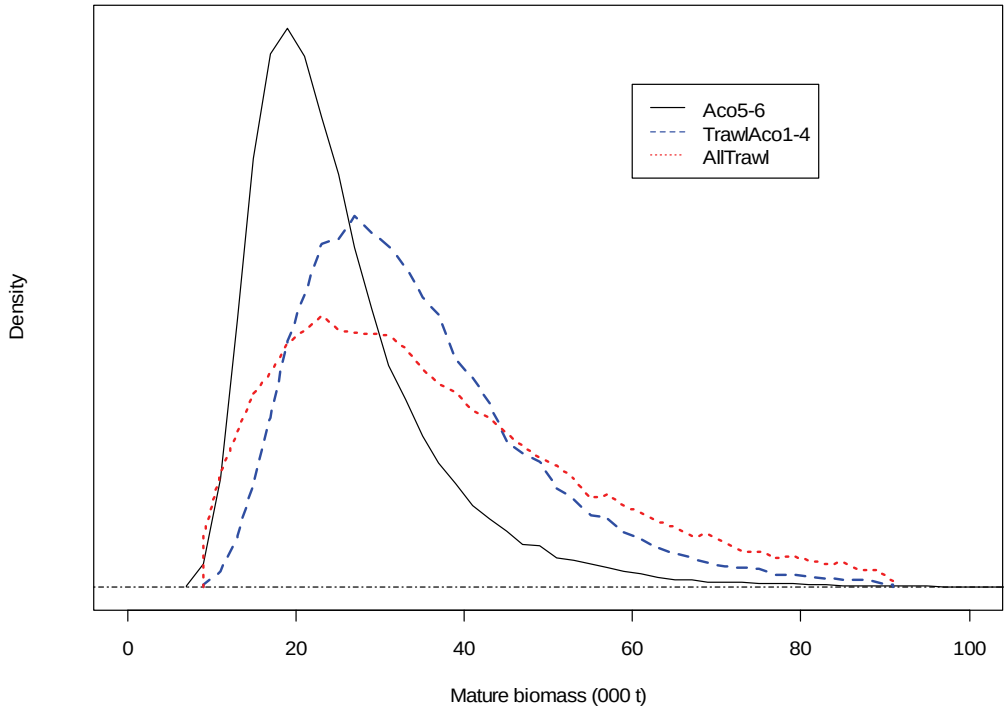


Figure 3: Estimated 2009 mature biomass for the minimum-biomass model (Aco5-6) and the two total-biomass models (TrawlAco1-4, AllTrawl).

All three models suggest that the biomass was greater than 10% B_0 in 2009 and show a high probability that it was above 20% B_0 (Table 8). The median estimates of the two total-biomass models are above the target of 30% B_0 but the minimum estimate is below the target (Table 8, Figure 4).

Table 8: Summary statistics for 2009 stock-status distribution-estimates assuming B_0 = 91 000 t (the point estimate from the 2000 assessment).

Model	Median B_{2009} (%B_0)	P(B_{09}>10%B_0)	P(B_{09}>20%B_0)	P(B_{09}>30%B_0)
TrawlAco1-4	35	1.00	0.93	0.65
AllTrawl	36	1.00	0.86	0.63
Aco5-6	25	1.00	0.73	0.32

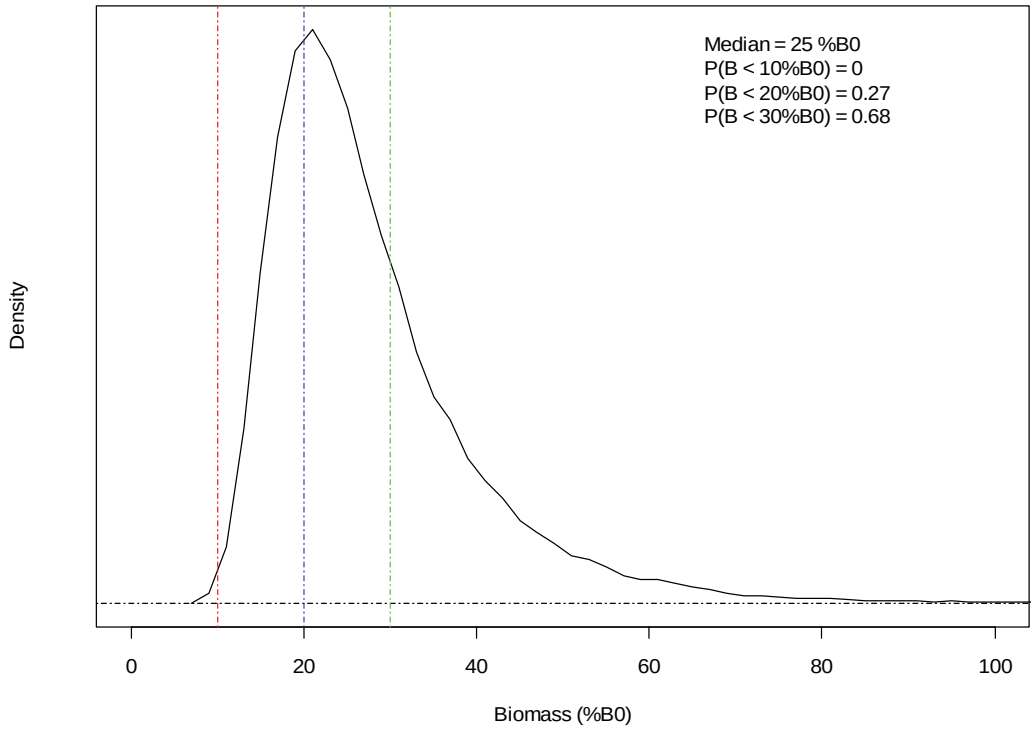


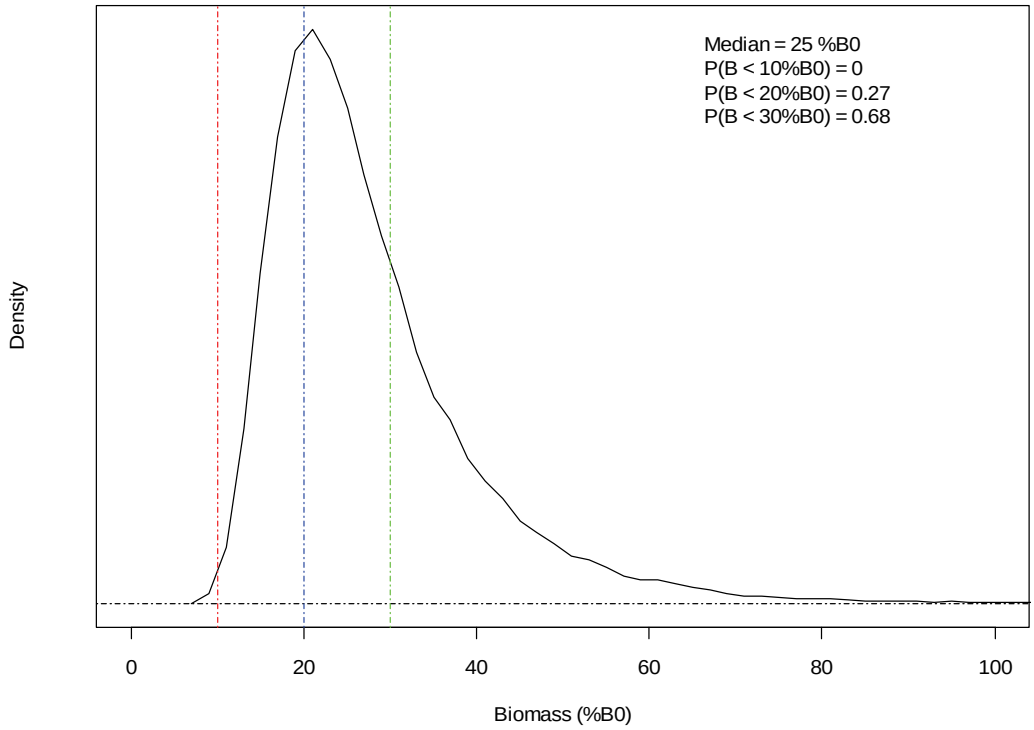
Figure 4: Estimated "minimum" stock status for the acoustics only model (Aco5-6). The hard and soft limits at 10% B_0 and 20% B_0 are shown as vertical lines together with the target at 30% B_0.

5. STATUS OF THE STOCK

For this stock, B_{MSY} is interpreted as the mean biomass under a CAY policy (B_{MAY}), which is estimated to be 30% B_0.

Stock Status	
Year of Most Recent Assessment	2010
Assessment Runs Presented	A minimum biomass based on using acoustic survey results as an estimate of absolute biomass.
Reference Points	Target: 30% B_0 Soft Limit: 20% B_0 Hard Limit: 10% B_0
Status in relation to Target	The minimum biomass estimate of 23,000 t is Unlikely (< 40%) to be at or above the target
Status in relation to Limits	The minimum biomass estimate is Unlikely (< 40%) to be below the Soft Limit and Very Unlikely (< 10%) to be below the Hard Limit

Historical Stock Status Trajectory and Current Status



Estimated "minimum" stock status for the acoustics only model (Aco5-6). The hard and soft limits at 10% B_0 and 20% B_0 are shown as vertical lines together with the target at 30% B_0

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass declined steeply through the 1980s and did not appear to have increased by 2000 when the fishery was closed. Survey results from 2009 suggest that biomass has increased since the closure.
Recent Trend in Fishing Mortality or Proxy	The fishery has been closed since 2000 but annual catches up to 240 t associated with research surveys have occurred in 2005, 2006 and 2009.
Other Abundance Indices	Recent acoustic surveys have found spawning plumes in the survey area. A minimum estimate of biomass based on the acoustic results was 23 000 t.
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	The stock has probably been increasing since the fishery closure in 2000.
Probability of Current Catch or TACC causing decline below Limits	The fishery is currently closed.

Assessment Methodology		
Assessment Type	Type 2 – Partial quantitative stock assessment	
Assessment Method	Acoustic survey	
Main data inputs	Minimum biomass estimate winter 2009.	
Period of Assessment	Latest assessment: 2010	Next assessment: 2011
Changes to Model Structure and Assumptions		
Major Sources of Uncertainty	- Target strength - Only fish in the spawning plumes have been included in the minimum biomass estimate.	

Qualifying Comments
The fishery has been closed since 1 October 2000. An acoustic survey in 2009 found spawning plumes of orange roughy and trawl and acoustic estimates in 2009 were much higher than in 2005 and 2006.

Fishery Interactions
Historically, the main bycatch species were deepwater dogfish, spiky oreos and ribaldo. Bycatch species of concern included deepwater sharks, deepsea skates, seabirds and corals. The fishery is currently closed.

6. FOR FURTHER INFORMATION

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