ORANGE ROUGHY CHALLENGER PLATEAU (ORH 7A)

1. FISHERY SUMMARY

1.1 Commercial fisheries

Historically, the fishery mainly occurred in the south-western 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. Total catches peaked at 10 000–12 000 t annually from 1986–87 to 1988–89 (Table 1). Total catch and ORH 7A catch were less than 2100 t annually from 1990–91 until the closure in 2000–01 (Table 1, Figure 1), when the TACC for this stock was reduced to 1 t.

Recent surveys have shown an increase in biomass in the area. On 1 October 2010 the TACC was increased from 1 t to 500 t, with a 25 t allowance for other mortality, raising the TAC to a total of 525 t.

Table 1: Reported catches (t) and TACs (t) from 1980–81 to 2012–13. QMS data from 1986-present.

Fishing year	Inside EEZ	Outside EEZ	Total catch	TACC
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	-
1984–85†	5 043	74	5 117	-
1985–86†	7 711	42	7 753	-
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
2009–10	+	+	< 0.1#	1
2010–11	+	+	476	500
2011–12	+	+	511	500
2012–13	+	+	513	500

†FSU data
*This is a minimum value, because of unreported catches by foreign vessels fishing outside the EEZ.
+Unknown distribution of catch between inside and outside the EEZ
Catches taken during winter trawl and acoustic surveys were approximately 200 t each year.

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.

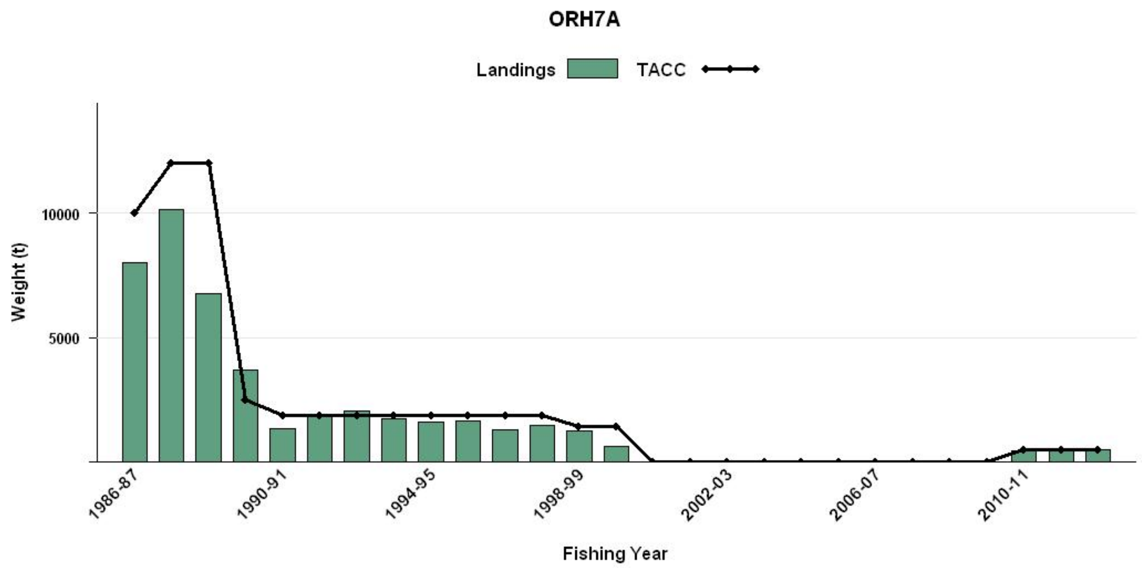


Figure 1: Historical reported landings and TACC for ORH 7A. Note that this figure does not show data prior to entry into the QMS.

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 Introduction section.

3. STOCKS AND AREAS

There is no new information on orange roughy stock structure beyond that presented in previous assessment documents.

Orange roughy on the southwest Challenger Plateau (Area 7A, including Westpac Bank) 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

A model-based Bayesian stock assessment was carried out for this stock in 2014. It was the first model-based assessment since 2005 (MFish 2006) when a Bayesian model was used to update the 2000 assessment (Annala et al 2000, Field & Francis 2001). From 2010 to 2013, assessments were conducted using an ad hoc approach which combined the virgin biomass estimate from the 2000 assessment and current biomass estimates from annual combined acoustic and trawl surveys (see Clark et al 2006, NIWA & FRS 2009, Doonan et al 2010, Hampton et al 2012, Hampton et al 2013, Cordue 2010, 2012, 2013).

The 2014 assessment for this stock was one of four orange roughy assessments carried out in 2014 which all used similar methods (see Orange Roughy Introduction). An age-structured population model was fitted to combined acoustic and trawl-survey estimates of spawning biomass, two trawl-survey time series of spawning biomass, and three trawl-survey age frequencies.

4.1 Model structure

The model was single-sex and age-structured (1-100 years with a plus group), with maturity estimated separately (i.e., fish were classified by age and as mature or immature). Two time steps were used: a full year of natural mortality followed by an instantaneous spawning season and fishery on the spawning fish. The fishery selectivity was uniform across ages (for spawning fish) and 100% of mature fish were assumed to spawn each year.

The catch history was constructed from the total catches in Table 1 and the over-run percentages in Section 1.5. Natural mortality was assumed to be fixed at 0.045 and the stock-recruitment relationship was assumed to follow a Beverton-Holt function with steepness of 0.75. The remaining fixed biological parameters are given in the Orange Roughy Introduction.

4.2 Input data and statistical assumptions

There were three main data sources for observations fitted in the assessment: spawning biomass estimates from combined acoustic and trawl surveys (2006, 2009–2013); an early trawl survey time series of relative spawning biomass (1987–1989); and three age frequencies from the trawl surveys (1987, 2006, and 2009).

4.2.1 Research surveys

Trawl surveys of orange roughy on the Challenger Plateau were conducted regularly 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 the 1989 and 1990 survey estimates much lower at approximately 10 000 t. From these early trawl surveys a “comparable area” time series, defined by Clark & Tracey (1994) and covering the period 1987–89, was selected for use in the assessment to provide some information on the early rate of spawning biomass decline (Table 2).

In 2005, a new series of combined trawl and acoustic surveys was begun 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 (with an enlarged survey area) and was then conducted annually from 2009–2013 (Clark et al 2006, NIWA & FRS 2009, Doonan et al 2010, Hampton et al 2012, Hampton et al 2013). It was apparent from the later surveys that the 2005 survey did not cover an appropriate area as the spawning biomass distribution had shifted somewhat in the intervening years. The surveys from 2006 onwards appear to have covered the bulk of the spawning biomass. The data from these surveys have been analysed to produce three types of indices used in this assessment: combined acoustic and trawl survey spawning biomass; acoustic estimates of spawning plumes; trawl survey indices of spawning biomass.

Combined acoustic and trawl survey indices

The method of Cordue (2010, 2012) was used to produce combined acoustic and trawl survey indices for 2010 and 2013 (Table 2). This method used an estimate of orange roughy trawl vulnerability to allow the trawl survey estimates to be combined with the acoustic estimates (trawl estimates are essentially scaled down by a vulnerability distribution with a mean of 1.66). The method accounts for observation error and potential bias in orange roughy target strength by combining priors and “error distributions” centred on the observations (Cordue 2010, 2012). Strata 9-11 were excluded from the estimates as they covered hills and/or very rough terrain (i.e., were not included because orange roughy are probably not equally vulnerable to the trawl gear on the hills and on the flat).

The 2010 and 2013 surveys were used in this way for different reasons. In 2010, the survey specifically excluded spawning plumes from the trawl survey strata and the plumes were surveyed acoustically. In other years, plumes were not explicitly excluded from the trawl survey area and a number of random trawl stations did obtain very high catch rates in the vicinity of plumes. The 2010 design was specifically aimed at combining the acoustic and trawl survey estimates.

The 2013 survey had three trawl stations with very high catch rates in two strata which were near where spawning plumes were surveyed. As a consequence, the trawl survey index had a very high CV of 51%. It seemed preferable to replace the trawl estimates from the two "plume" strata with the corresponding acoustic estimates and combine them with the remaining trawl estimates (following Cordue 2012) which gave a combined index with a lower CV of 35% (Table 2).

The estimates were used as relative biomass with a lognormal informed prior on the *q*. The total survey area was assumed to cover 90% of the spawning biomass and the three excluded strata (9-11) were estimated to account for 15% of the surveyed biomass (from years in which they were surveyed). The mean of the informed prior was therefore 0.9 × 0.85 = 0.77. The CV was chosen so that the CVs for the prior and the observation were equal in 2010 and the combined CV from observation error and the prior were equal to 0.3 (2010) and 0.35 (2013) (the CVs of the distribution-estimates of spawning biomass). This gave a prior CV of 0.21.

Acoustic estimate for two plumes in 2009

Two spawning plumes were acoustically surveyed on 4–5 July 2009. The main plume was covered by two snapshots and had a much higher average biomass than was seen in a comparable survey conducted during the previous few days (28 June–2 July): 16 800 t compared to 6700 t. A second plume was also surveyed with a single snapshot (6300 t) and the combined estimate was 23 100 t (Table 2). This unusual event led to the conclusion that "most" of the 2009 spawning biomass was present in the two surveyed plumes.

This was modelled by treating the acoustic estimate as relative biomass and estimating the proportionality constant (*q*) with an informed prior. The acoustic *q* prior described in the Orange Roughy Introduction was used: a mean of 0.8 (i.e., "most" = 80%) and a CV of 19%.

Trawl survey indices

The spawning biomass estimates from the *Thomas Harrison* trawl surveys in 2006, 2009–2012 (Table 2) were used as relative biomass with an informed prior. They excluded the rough terrain strata 9-11 and the mean of the informed prior was: 0.9 × 0.85 × 1.66 = 1.27 (allowing for total-survey availability (0.9), exclusion of strata 9-11 (0.85) and trawl vulnerability – mean of estimated vulnerability distribution = 1.66). Given the problematic nature of these trawl surveys (fish pluming and moving within the area), a process error CV of 20% was added to the estimated CVs (Table 2).

Table 2: Biomass indices used in the stock assessment. The model CV is the observation error used in the base model. A 20% process error CV has been added to the sample CV for the trawl indices. The CV for the combined acoustics and trawl estimates has been split between the informed *q*-prior (CV = 21%) and the observation error in the model.

Series	Year	Biomass index (t)	CV (%)	Model CV (%)
Amaltal Explorer	1987	75 040	26	33
	1988	28 954	27	34
	1989	11 062	11	23
Thomas Harrison	2006	13 987	27	34
	2009	34 864	24	31
	2011	18 425	26	33
	2012	22 451	18	27
	2013	18 993	51	55
Acoustics & trawl	2010	14 766	30	21
	2013	13 637	35	28
Two plumes	2009	23 095	25	25

Age frequencies

Age frequencies were available from three of the trawl surveys for use in the assessment. A previous analysis produced age frequencies for the 1987 *Amaltal Explorer* survey and the 2009 *Thomas Harrison* survey (Doonan et al 2013), although that study was based on a relatively small number of otoliths, it showed that the 2009 age frequency had much younger fish than the 1987 age frequency. For the stock assessment, the existing age frequencies were augmented with an increased number of otoliths (for a total of about 300 for each survey) and a new age frequency (from about 300 otoliths) was produced for the 2006 *Thomas Harrison* survey.

The age frequencies were assumed to be multinomial and were assigned effective sample sizes of 300/5 = 60 (with the sample size reflecting the number of trawl stations rather than the number of otoliths).

4.3 Model runs and results

In the base model, natural mortality (*M*) was fixed at 0.045. There were numerous MPD sensitivity runs but three main sensitivities are presented in this report: estimate *M*; and the LowM-Highq and HighM-Lowq runs (see the Orange Roughy Introduction section for specifications).

In the base model the main parameters estimated were: virgin biomass (B_0), the maturity ogive, and year class strengths (YCS) from 1925 to 1985 (with the Haist parameterisation and "nearly uniform" priors on the free parameters). There were also the proportionality constants (*q*) for the two trawl survey time series, the combined acoustic and trawl estimates (2010, 2013) and the two-plumes estimate in 2009.

4.3.1 Model diagnostics

The model provided good MPD fits to the biomass indices although the 2009 trawl index had a large positive residual (Figure 2, top right). The large positive residual in 2009 was balanced by negative residuals in the other years. In a sensitivity run, taken through to MCMC, the 2009 index was removed. This had no effect on the stock status estimates for the MPD or MCMC runs but it did provide an improved fit to the other biomass indices (the 2009 index is not influential in terms of important derived estimates but does affect the residual pattern). The MCMC normalised residuals for the biomass indices show a similar pattern to the MPD fit, but the only large residuals are for the *Amaltal Explorer* time series (Figure 3). The magnitude of the *Amaltal Explorer* residuals could be reduced by adding more process error, but this would not affect any of the important assessment estimates (the same results are obtained if the *Amaltal* time series is removed altogether).

The MPD fit to the age frequencies was very good (Figure 4).

The biomass indices with the informed priors are free to "move" somewhat as they are relative. The MPD estimated *q*s were not very different from the mean of the informed priors (Figure 5, blue dots). The same is not true for the MCMC runs, as the *Thomas Harrison q* and the combined acoustics and trawl *q* have both moved to the left appreciably (Figure 5, right-hand plots). Although they have moved, the posteriors are still well within the distribution of the priors, leaving the estimated *q*s credible.

Numerous MPD sensitivity runs were performed. These showed that the main drivers of the estimated stock status were natural mortality (*M*) and the means of the informed *q* priors (lower *M* and higher mean *q* give lower stock status; higher *M* and lower mean *q* give higher stock status). The base model was robust to changes in the relative weights of the different data sets. Large changes in estimated 2014 stock status only occurred when deterministic recruitment was assumed (49% B_0 compared to 32% B_0 for the base) or when recent biomass indices were halved or doubled (respectively 18% B_0 and 50% B_0).

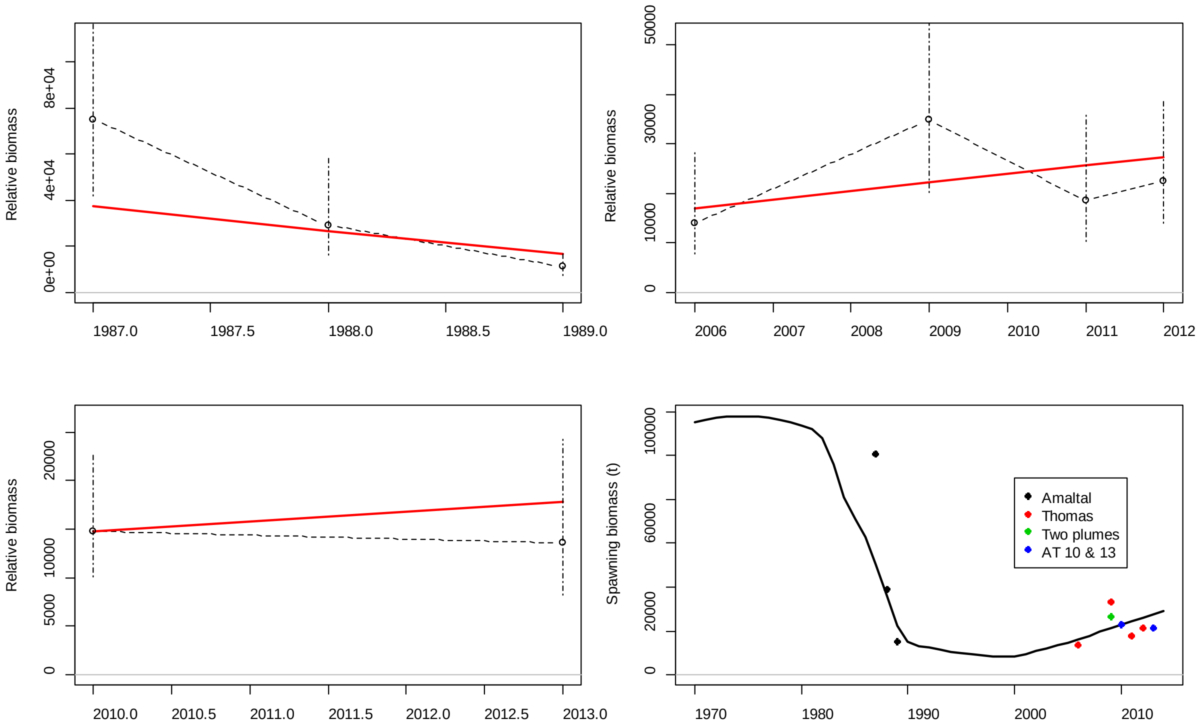


Figure 2: MPD fit to biomass indices: top left: *Amaltal Explorer*; top right: *Thomas Harrison*; bottom left: combined acoustics and trawl; bottom right: indices scaled to spawning biomass (using MPD estimated *q*s). Vertical lines are 95% CIs (model CVs).

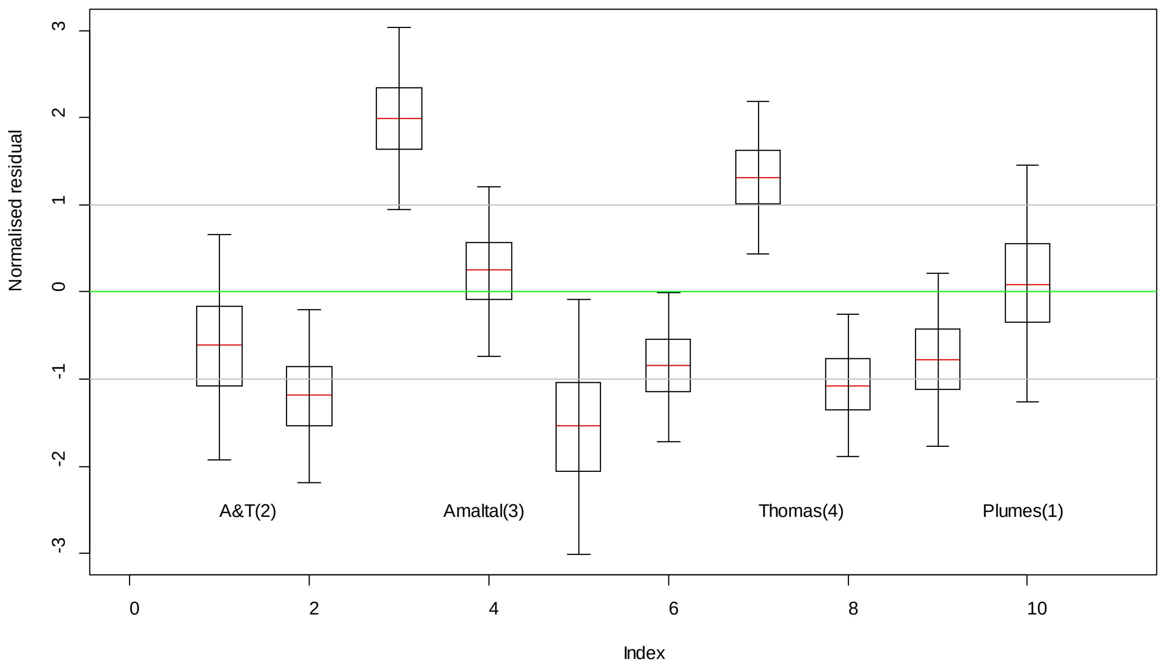


Figure 3: MCMC base: normalised residuals for the biomass indices. The box covers 50% of the distribution for each index and the whiskers extend to 95% of the distribution. "A&T" denotes combined acoustics and trawl (2010, 2013); "Amaltal" the *Amaltal Explorer* series; "Thomas" the *Thomas Harrison* series; and "Plumes" the two-plumes estimate from 2009.

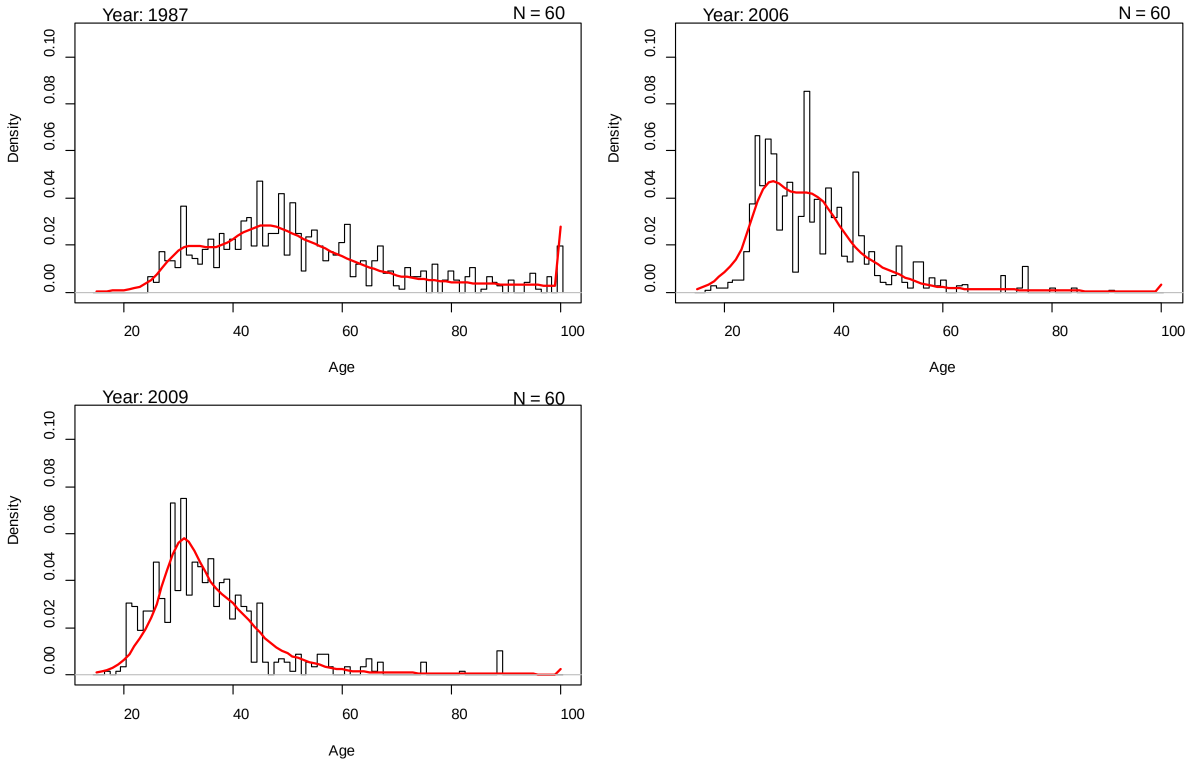


Figure 4: MPD fit to spawning-season trawl-survey age frequencies for the 1987, 2006 and 2009 surveys (N = 60 is the assumed effective sample size). Observations are square-topped black lines; model predictions are the smooth red lines.

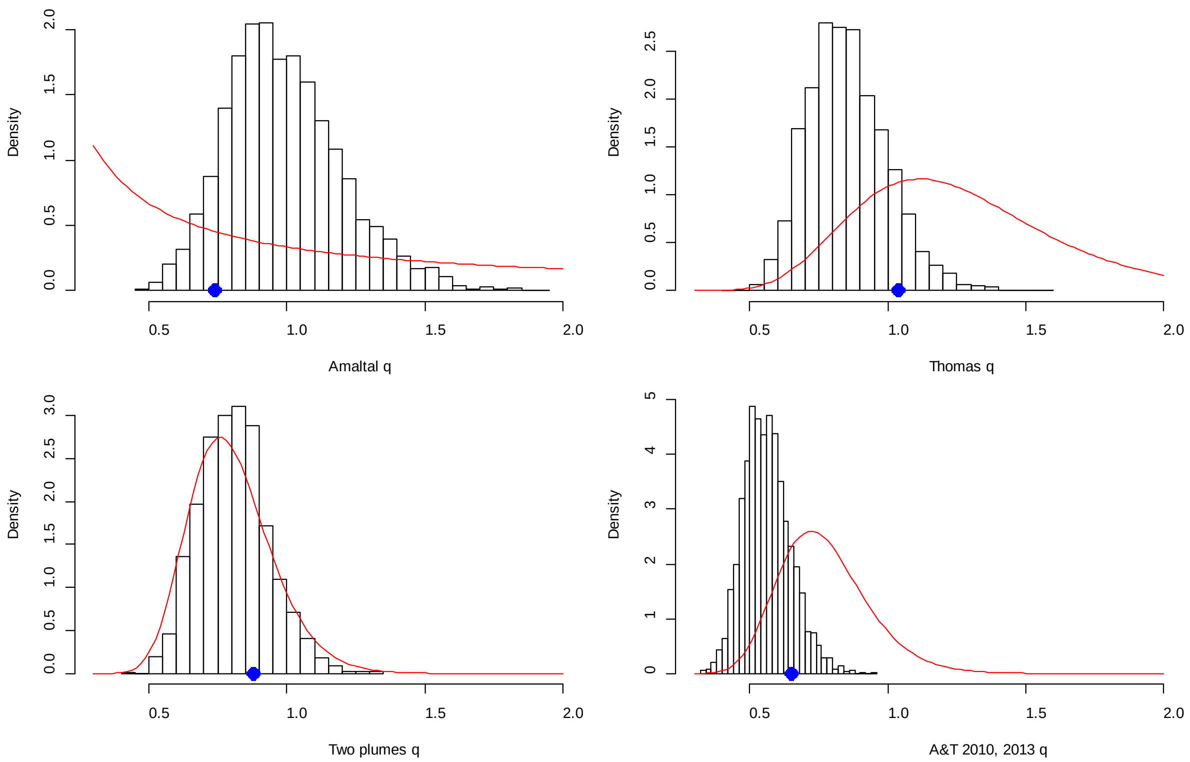


Figure 5: Base model MCMC diagnostics: prior and posterior distributions for the biomass time series *q*s (prior in red, posterior black histograms; the blue dot is the MPD estimate. "Amaltal q" denotes the *Amaltal Explorer* series; "Thomas q" the *Thomas Harrison* series; "Two plumes q" the two-plumes estimate from 2009; and "A&T 2010, 2013 q" denotes combined acoustics and trawl for those years).

MCMC results

For the base model, and the sensitivity runs, MCMC convergence diagnostics were excellent. Virgin biomass (B_0) was estimated to be about 90 000 t for all runs (Table 3). Current stock status was similar for the base and the estimate-*M* run (Table 3). The slightly lower stock status when *M* was estimated reflects the lower estimate of *M* (0.039 rather than 0.045). For the two runs, where *M* and the mean of the informed *q* priors were shifted either up or down by 20%, median current stock status was estimated within the biomass target range of 30–40% B_0 for the *LowM-Highq* run but well above the range for the *HighM-Lowq* run (Table 3).

Table 3: MCMC estimates of virgin biomass (B_0) and stock status (B_{2014} as %B_0) for the base model and three sensitivity runs.

	M	B_0 (000 t)	95% CI	B_{2014} (%B_0)	95% CI
Base	0.045	88	82-96	42	35-49
Estimate M	0.039	92	84-100	38	30-47
LowM-Highq	0.036	90	85-97	33	27-40
HighM-Lowq	0.054	88	81-97	51	44-59

The estimated YCS show little variation across cohorts but exhibit a long-term trend (Figure 6). The most recent 10 years (1976–1985) of estimates (those resampled for short-term projections) are about average.

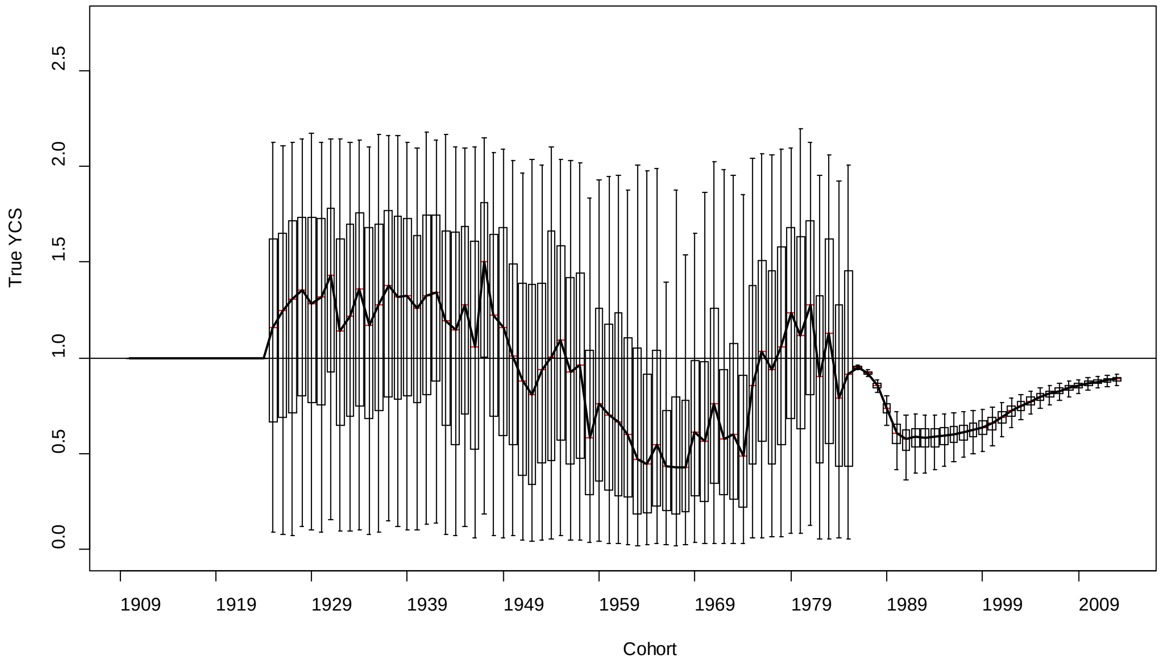


Figure 6: Base, MCMC estimated "true" YCS (R_y/R_0). The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution.

The stock status trajectory showed a steep decline to about 10% B_0 in 1990, reflecting the large removals during the initial fish-down phase of this fishery (Figure 7). From 1990 stock status remained at about 10% B_0 until a strong upturn in 2000 (Figure 7). Rebuilding has taken only 14 years to reach the top of the 30-40% biomass target range because the fishery was closed in 2001 and reopened in 2011, with relatively limited catches since then (see Table 1).

For the base model, the stock is now considered to be fully rebuilt according to the Harvest Strategy Standard (at least a 70% probability that the lower end of the management target range of 30–40% B_0 has been achieved).

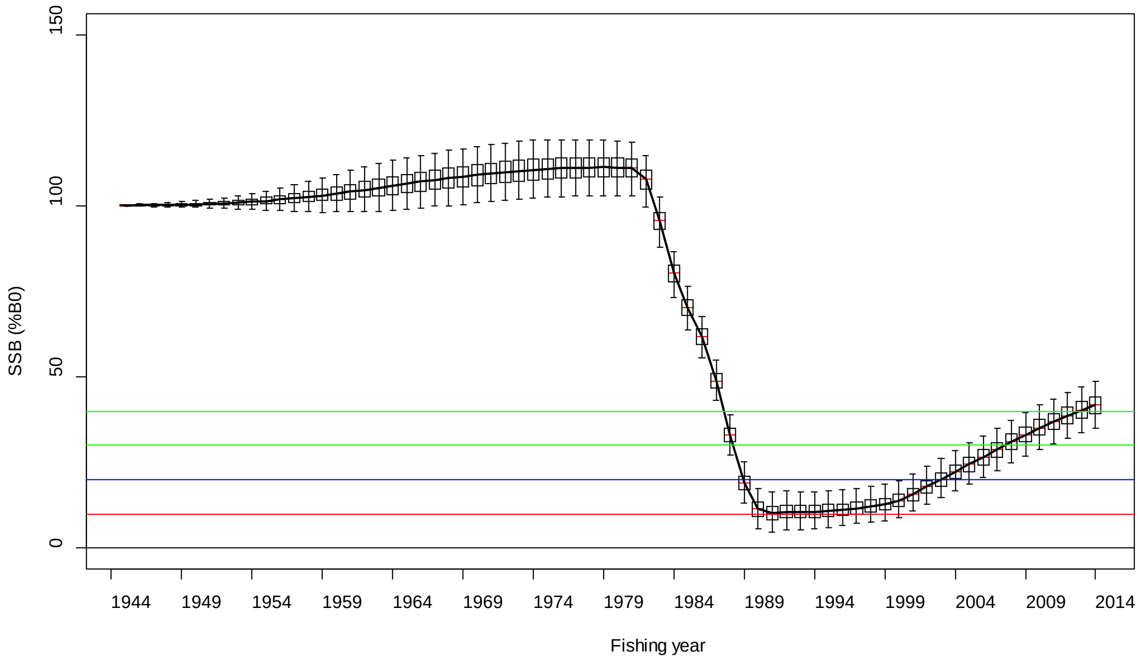


Figure 7: Base, MCMC estimated spawning-stock biomass trajectory. The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution. The hard limit 10% B_0 (red), soft limit 20% B_0 (blue), and biomass target range 30–40% B_0 (green) are marked by horizontal lines.

Fishing intensity was estimated in each year for each MCMC sample to produce a posterior distribution for fishing intensity by year. Fishing intensity is represented in term of the median exploitation rate and the Equilibrium Stock Depletion (ESD). For the latter, a fishing intensity of $U_{x\%B0}$ means that fishing (forever) at that intensity will cause the SSB to reach deterministic equilibrium at x% B_0 (e.g., fishing at $U_{30\%B0}$ drives the SSB to a deterministic equilibrium of 30% B_0). Fishing intensity in these units is plotted as 100–ESD so that fishing intensity ranges from 0 ($U_{100\%B0}$) up to 100 ($U_{0\%B0}$).

Estimated fishing intensity was within or above the target range ($U_{30\%B0}$–$U_{40\%B0}$) up until the closure of the fishery in 2001. Since then, it has been well below the target range (Figure 8).

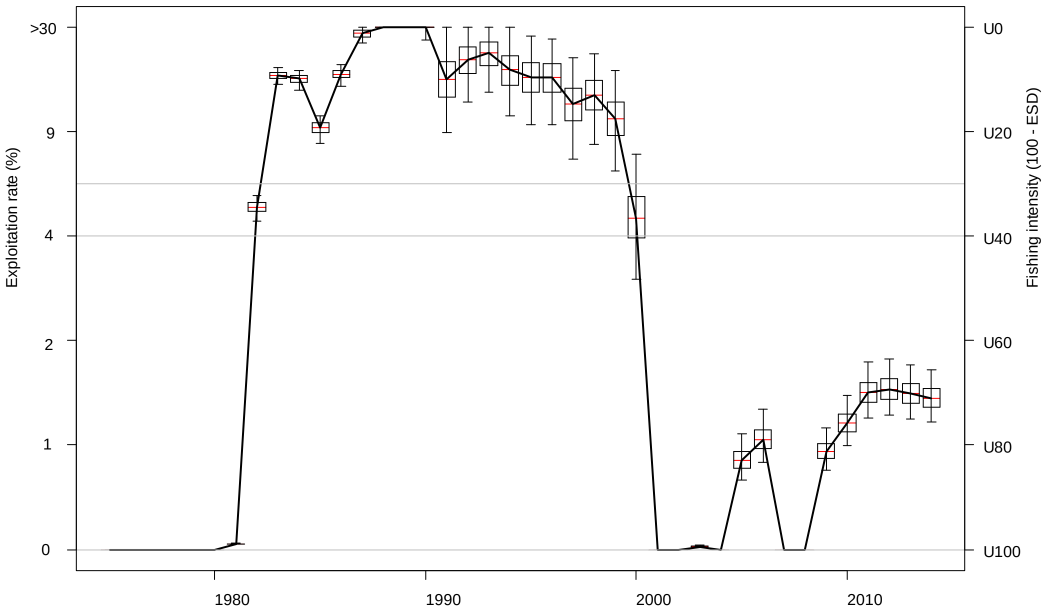


Figure 8: Base, MCMC estimated fishing-intensity trajectory. The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution. The fishing-intensity range associated with the biomass target of 30-40% B_0 is marked by horizontal lines.

Biological reference points, management targets and yield

MCMC estimates of deterministic B_{MSY} and associated values were produced for the base model. The yield at 35% B_0 (the mid-point of the target range) was also estimated. There is little variation in the reference points and associated values across the MCMC samples (Table 4).

There are several reasons why deterministic B_{MSY} is not a suitable target for use in fisheries management. First, it assumes a harvest strategy that is unrealistic in that it involves perfect knowledge (current biomass must be known exactly in order to calculate the target catch) and annual changes in TACC (which are unlikely to happen in New Zealand and not desirable for most stakeholders). Second, it assumes perfect knowledge of the stock-recruit relationship, which is often poorly known. Third, it would be very difficult with such a low biomass target to avoid the biomass occasionally falling below 20% B_0, the default soft limit according to the Harvest Strategy Standard.

Table 4: Base, MCMC estimates of deterministic equilibrium SSB and long-term yield (% B_0 and tonnes) for U_{MSY} and $U_{35\%B0}$. The equilibrium SSB at U_{MSY} is deterministic B_{MSY} and the yield is deterministic MSY.

Fishing intensity		SSB (%B_0)	Yield (%B_0)	Yield (t)
U_{MSY}	Median	24.5	2.1	1853
	95% CI	22.9-24.9	2.1-2.1	1728–2009
$U_{35\%B0}$	Median	35.0	2.0	1764
	95% CI	35.0-35.0	2.0-2.0	1645–1912

The estimate of long–term yield associated with $U_{35\%B0}$ for the 2014-15 fishing year is 2128 t (95% CI 1673–2694 t).

Projections

Five-year projections were conducted (with resampling from the last 10 estimated YCS, 1976–1985) for two different constant catch assumptions: 500 t (the current TACC); and 2100 t (the current estimated yield at $U_{35\%B0}$). In each case a 5% catch over-run was assumed. Projections were done for the base model and for the *LowM-Highq* sensitivity model (as a “worst case” scenario).

At the current TACC (500 t), SSB is predicted to increase steadily over the next five years for both models (Figure 9). At the catch associated with $U_{35\%B0}$ (2100 t), SSB is predicted to decrease slightly for both models (Figure 9). For both models and both constant catch scenarios the estimated probability of SSB going below either the soft limit (20% B_0) or hard limit (10% B_0) is zero. For the *LowM-Highq* model there is a small probability (1.5% and 3% respectively) of the SSB falling below 20% B_0 in 2018 or 2019 under a 2100 t catch (Figure 9).

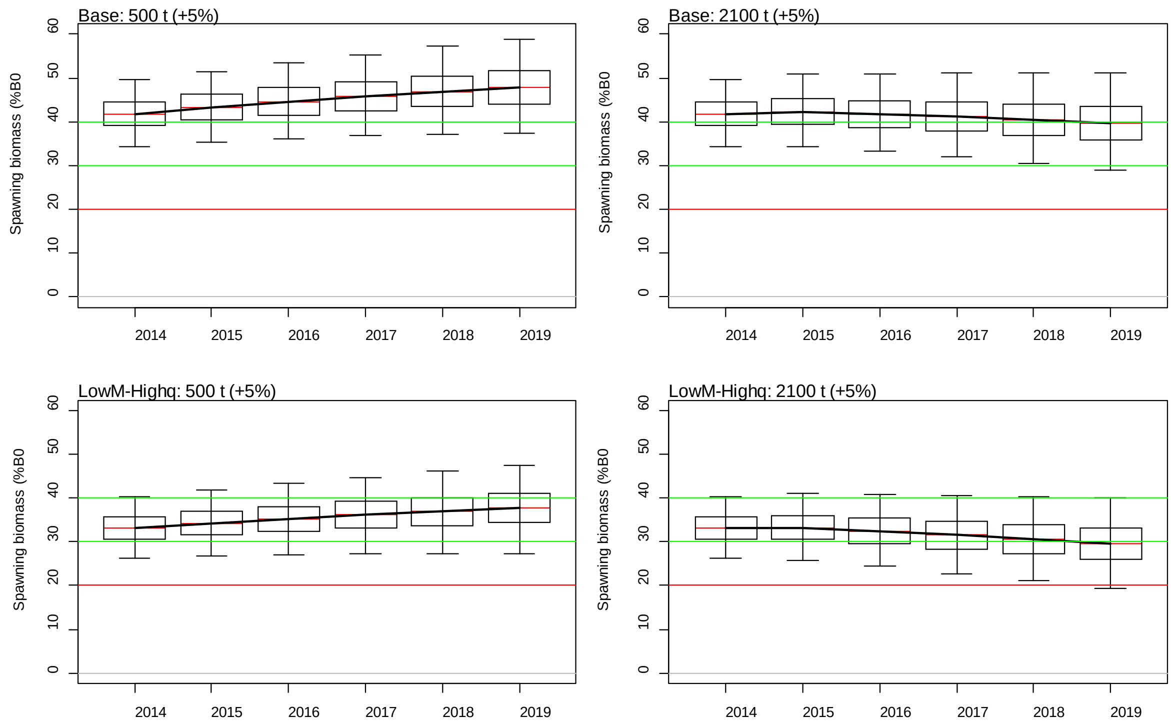


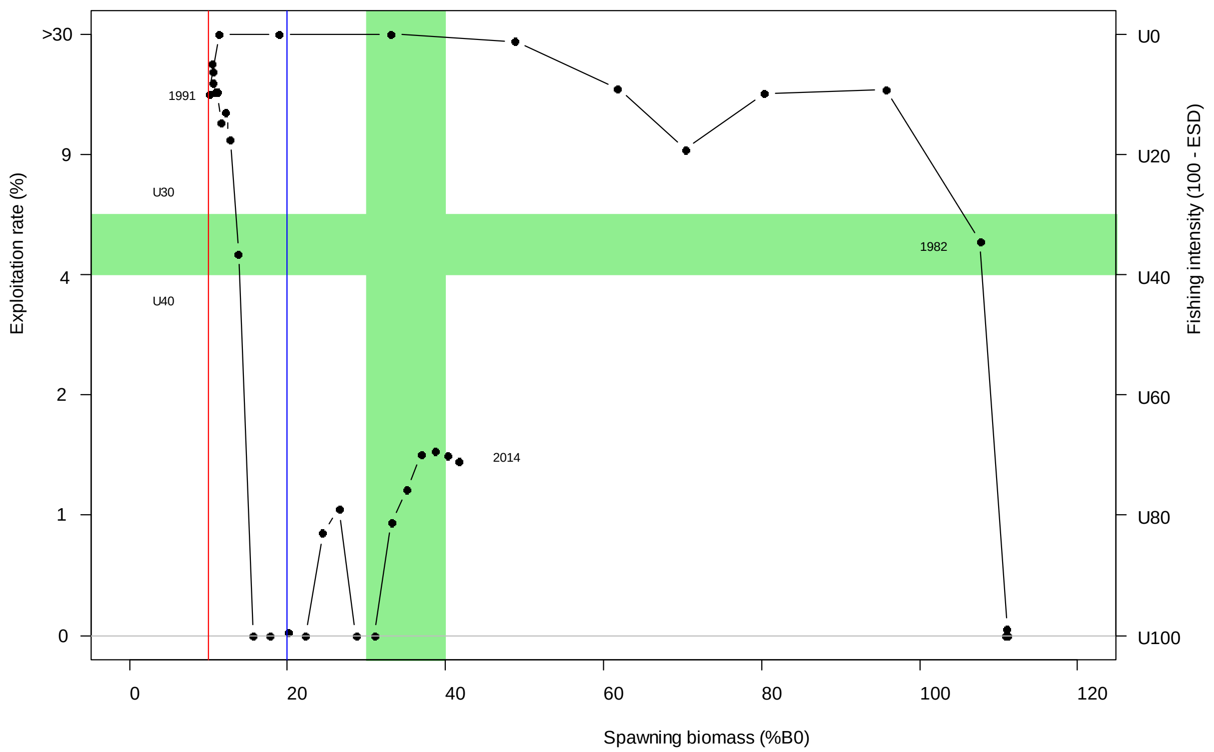
Figure 9: Base, MCMC projections. The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution. The projections are for the model and annual catch indicated (a 5% catch over-run was included in each year). The target biomass range(30–40% B_0) is indicated by horizontal green lines, the hard limit (10% $B_{0)}$ by a red line and the soft limit (20% $B_{0)}$ by a blue line.

5. STATUS OF THE STOCK

Orange roughy on the southwest Challenger Plateau (Area 7A, including Westpac Bank) are regarded as a single separate stock.

Stock Status	
Year of Most Recent Assessment	2014
Assessment Runs Presented	Base model only
Reference Points	Management Target: Biomass range 30–40% B_0 Soft Limit: 20% B_0 Hard Limit: 10% B_0 Overfishing threshold: Fishing intensity range $U_{30\%B0}$–$U_{40\%B0}$
Status in relation to Target	B_{2014} was estimated to be 42% B_0 Very Likely (> 90%) to be at or above the lower end of the management target range and About as Likely as Not (40–60%) to be at or above the upper end of the management target range
Status in relation to Limits	B_{2014} is Very Unlikely (< 10%) to be below the Soft Limit B_{2014} is Exceptionally Unlikely (< 1%) to be below the Hard Limit
Status in relation to Overfishing	Fishing intensity in 2014 was estimated at $U_{71\%B0}$ Overfishing is Very Unlikely (< 10%) to be occurring

Historical Stock Status Trajectory and Current Status



Historical trajectory of spawning biomass (%B_0), median exploitation rate (%) and fishing intensity (100-ESD) (base model, medians of the marginal posteriors). The biomass target range of 30-40% B_0 and the corresponding exploitation rate (fishing intensity) range are marked in green. The soft limit (20% B_0) is marked in blue and the hard limit (10% B_0) in red. Note that the Y-axis is non-linear.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The spawning biomass is estimated to have been steadily increasing since just before the fishery closure in 2000–2001. According to the Harvest Strategy Standard, the stock is now considered to be fully rebuilt (at least a 70% probability that the lower end of the management target range of 30–40% B_0 has been achieved).
Recent Trend in Fishing Intensity or Proxy	The fishery was closed in 2000-01 and re-opened in 2010-11, with fisheries surveys conducted since 2005. Fishing intensity has been low and fairly constant since 2010-11.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Biomass is expected to increase at the current TACC (500 t) or decrease slightly over the next 5 years at annual catches of up to 2100 t.
Probability of Current Catch or TACC causing Biomass to remain below, or to decline below, Limits	Soft Limit: Very Unlikely (< 10%) Hard Limit: Exceptionally Unlikely (< 1%)
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Very Unlikely (< 10%)

Assessment Methodology and Evaluation	
Assessment Type	Level 1 - Full quantitative stock assessment

Assessment Method	Age-structured CASAL model with Bayesian estimation of posterior distributions	
Assessment Dates	Latest assessment: 2014	Next assessment: Unknown
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	-Combined acoustic and trawl survey estimates of spawning biomass (2010, 2013)	1 – High Quality
	-Acoustic survey estimate of spawning biomass from two plumes in 2009	1 – High Quality
	-Two trawl survey time series: 1987-1989 and 2006, 2009-2012	1 – High Quality
	-Age frequencies from the trawl surveys in 1987, 2006, and 2009	1 – High Quality
Data not used (rank)	-CPUE	3 – Low Quality: unlikely to be indexing stock-wide abundance
	-Acoustic surveys of hills (hull-mounted transducers)	2 – Medium or Mixed Quality: species identification and dead zone problems
	-Early trawl surveys with different vessels covering different areas	2 – Medium or Mixed Quality: not a consistent time series
Changes to Model Structure and Assumptions	-The previous model-based assessment was in 2005. Recent assessments have been based on an ad hoc method. -The current assessment is fully quantitative and based on spawning biomass rather than transition-zone mature biomass. -Age data were included to enable estimation of year class strengths rather than assuming deterministic recruitment. - A more stringent data quality threshold was imposed on data inputs (e.g. CPUE indices were not used).	
Major Sources of Uncertainty	-The proportion of the stock that is indexed by the combined acoustic and trawl survey. -Patterns in year class strengths are based on only 3 years of age composition data.	

Qualifying Comments
- Estimates of stock biomass are sensitive to the means of the *q* priors. In addition, when higher CVs were used for the informed acoustic *q* priors, the median estimates of biomass and stock status were slightly higher and the confidence intervals were wider with a much higher upper bound.

Fishery Interactions
Historically, the main bycatch species were deepwater dogfish, spiky oreos and ribaldo. Since the fishery re-opened with a low level of catch and effort and fishing during the spawning season, bycatch levels have been relatively low at about 4%. The bycatch of low productivity species includes deepwater sharks, deepsea skates and corals. With limited fishing effort, there have been no observed incidental captures of protected species other than corals since 2002–03.

6. FOR FURTHER INFORMATION

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