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 landings peaked at 10 000–12 000 t annually from 1986–87 to 1988–89 (Table 1). Total landings and ORH 7A landings 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.

Surveys since 2005 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. This was to allow research surveys to be conducted using commercial fishing vessels. The TACC was further increased to 1600 t following a stock assessment in 2014, and to 2058 t following a stock assessment in 2019. Total landings since 2014–15 closely followed the TACCs, and then were on average 89% of the TACC during 2019–20 to 2022–23.

Table 1: Reported landings (t) and TACCs (t) from 1980–81 to present. QMS data from 1986-present. The last two columns are for research surveys on commercial vessels and give the research catch that was not recorded against ACE (WP = Westpac Bank).

Fishing year	EEZ	Outside	Total landings	TACC	EEZ extra	WP extra
1980–81†	1	32	33	-	0	0
1981–82†	3 539	709	4 248	-	0	0
1982–83†	4 535	7 304	11 839	-	0	0
1983–84†	6 332	3 195	9 527	-	0	0
1984–85†	5 043	74	5 117	-	0	0
1985–86†	7 711	42	7 753	-	0	0
1986–87†	10 555	937	11 492	10 000	0	0
1987–88	10 086	2 095	12 181	12 000	0	0
1988–89	6 791	3 450	10 241	12 000	0	0
1989–90	3 709	600	*4 309	2 500	0	0
1990–91	1 340	17	1 357	1 900	0	0
1991–92	1 894	17	1 911	1 900	0	0
1992–93	1 412	675	2 087	1 900	0	0
1993–94	1 594	138	1 732	1 900	0	0
1994–95	1 554	82	1 636	1 900	0	0
1995–96	1 206	463	1 669	1 900	0	0
1996–97	1 055	253	1 308	1 900	0	0
1997–98	+	+	1 502	1 900	0	0
1998–99	+	+	1 249	1 425	0	0
1999–00	+	+	629	1 425	0	0
2000–01	+	+	0.2	1	0	0
2001–02	+	+	0.1	1	0	0
2002–03	+	+	4	1	0	0
2003–04	+	+	< 0.1	1	0	0
2004–05	+	+	< 1	1	141	17
2005–06	+	+	< 1	1	196	22
2006–07	+	+	< 0.1	1	0	0
2007–08	+	+	< 0.1	1	0	0
2008–09	+	+	0.12	1	218	22
2009–10	+	+	< 0.1	1	339	5
2010–11	476	0	476	500	0	5
2011–12	504	7	511	500	0	0
2012–13	513	0	513	500	259	4
2013–14	484	13	497	500	0	50
2014–15	1 594	0	1 594	1 600	0	0
2015–16	1 248	320	1 568	1 600	0	0
2016–17	1 595	28	1 623	1 600	0	0
2017–18	1 026	575	1 601	1 600	126	53
2018–19	+	+	1 589	1 600	0	0
2019–20	+	+	1 897	2 058	0	0
2020–21	+	+	2 074	2 058	0	0
2021–22	+	+	2 193	2 058	0	0
2022–23	+	+	1 771	2 058	0	0

†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

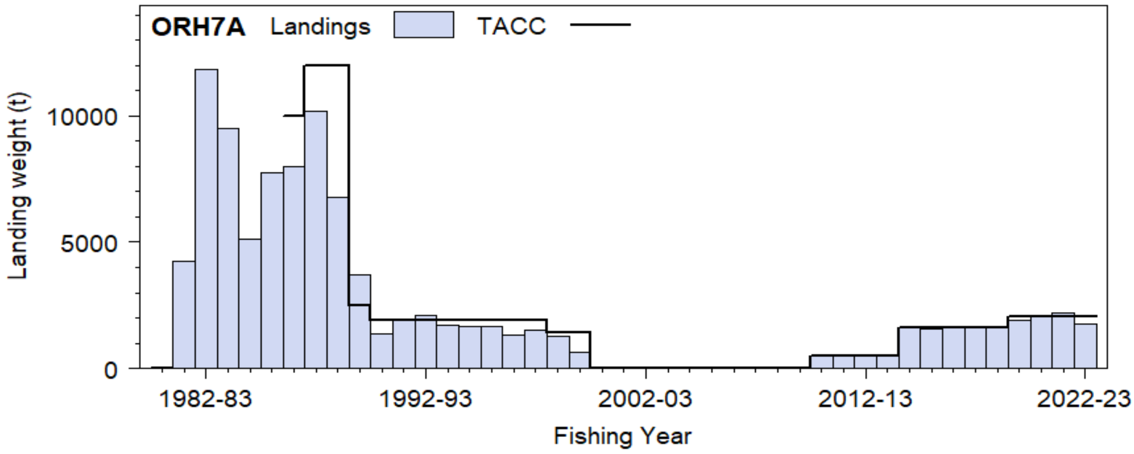


Figure 1: Reported commercial landings and TACC for ORH 7A.

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 which is likely to be negligible.

1.5 Other sources of mortality
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%. These estimates are used in the current stock assessment.

2. BIOLOGY

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

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 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 2024 (Dunn in prep), following similar assessments conducted in 2014 and 2019 (Cordue 2014a, Cordue 2019).

4.1 Model structure

The model was single-sex and age-structured (1–100 years with a plus group), with maturity in the partition (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. One fishery was modelled, including fishing within the EEZ and on Westpac Bank (which is outside of the EEZ). The fishery selectivity was estimated and assumed equal to maturity. 100% of mature fish were assumed to spawn each year.

The catch history was constructed from the catches in Table 1 and the over-run percentages in Section 1.5. The catch for 2023–24 was assumed equal to 2022–23. Natural mortality rate was estimated, and the stock-recruitment relationship was a Beverton-Holt function with steepness of 0.75. The remaining fixed biological parameters for growth are given in the Introduction – Orange Roughy chapter.

4.2 Input data and statistical assumptions

The main data sources for observations fitted in the assessment were spawning biomass estimates from acoustic and trawl research surveys (2005, 2006, 2009–2014, 2018) and acoustic survey only (2023); four age frequencies from the trawl surveys (1987, 2006, 2009, and 2018); and two age frequencies from Volcano (an Underwater Topographical Feature (UTF) on the Westpac Bank) (2014 and 2018).

Catch history

The catch history used in the stock assessment, including catch over-runs, is shown in Table 2.

Table 2: Orange roughy ORH 7A stock assessment catch history (t) including over-runs (see Section 1.5). * 2023–24 assumed to be the same as 2022–23.

Fishing year	Catch (t)	Fishing year	Catch (t)	Fishing year	Catch (t)	Fishing year	Catch (t)
1980–81	43	1991–92	2 102	2002–03	5	2013–14	574
1981–82	5 523	1992–93	2 296	2003–04	0	2014–15	1 674
1982–83	15 391	1993–94	1 819	2004–05	166	2015–16	1 646
1983–84	12 386	1994–95	1 718	2005–06	229	2016–17	1 704
1984–85	6 652	1995–96	1 752	2006–07	0	2017–18	1 869
1985–86	10 179	1996–97	1 374	2007–08	0	2018–19	1 670
1986–87	14 940	1997–98	1 577	2008–09	252	2019–20	1 990
1987–88	15 836	1998–99	1 311	2009–10	361	2020–21	2 178
1988–89	12 801	1999–2000	660	2010–11	505	2021–22	2 301
1989–90	5 171	2000–01	0	2011–12	536	2022–23	1 860
1991–91	1 561	2001–02	0	2012–13	815	2023–24*	1 860

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. Although a "comparable area" time series, as defined by Clark & Tracey (1994) and covering the period 1987–89, was selected for use in the 2019 assessment, these data were rejected for the 2024 assessment. This was because the decline in the biomass estimates over 1987–89 was far too large to be attributed to catches alone, and the Working Group has previously concluded the series did not reflect true stock abundance.

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 2013, Hampton et al 2014) with another survey in 2018. 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. Also, in 2014 an acoustic survey of Volcano was conducted using an Acoustic Optical System (AOS) (Ryan et al 2015) in addition to a hull-mounted transducer. The data from all of the surveys since 2005 have been analysed to produce separate acoustic and trawl survey indices of spawning biomass. In 2023, only an acoustic survey was completed. Since the 2019 assessment the acoustic data and trawl data have been used separately (Cordue 2019).

Acoustic survey indices

The acoustic biomass estimates from 2005 to 2018 have been reviewed and a number of adjustments were required to ensure that the time series of estimates were consistent (Cordue 2019). Estimates from the hull-mounted transducer were adjusted as necessary so that they all used the latest length to target strength relationship, the Doonan et al (2003) absorption coefficient, and a combined motion and bubble layer correction (1.33) borrowed from work done on the Chatham Rise (Cordue 2010b, Doonan et al 2012). The estimates from the AOS (2014 and 2018) were adjusted to use the Doonan et al (2003) absorption coefficient. In 2005, 2011, and 2013, the motion corrections applied to the snapshots were not documented and a factor of 1.06 (the mean for snapshots in 2006 and 2009) was used in the adjustment calculations. In those years the acoustic indices were assigned an additional 20% of error to account for the approximate adjustment.

The acoustic indices were used in one of two ways:

(1) Aoustic estimates of spawning aggregations on Volcano and in the West and East of the flats within the EEZ were used as three time series each providing an index of SSB (Table 3). This assumption followed the 2019 assessment, and assumed that the three spawning aggregations were independent, the proportion of the total SSB in each area was constant over time, and each area shared the same recruitment and exploitation pattern. This assumption has been given the label "3Series". The acoustic estimates included in this series followed the estimates used by Cordue (2019) with the addition of the 2023 estimate for Volcano. Estimates were excluded where biomass was substantially lower than adjacent years and the Working Group concluded the survey had missed the aggregation (Volcano 2009, 2011, East 2011) and where the timing of the survey in relation to peak spawning was uncertain (Volcano 2010, 2018).

(2) Acoustic estimates of spawning aggregations on Volcano and in the West and East of the flats were summed, providing a total SSB for each year when all three areas were surveyed (Table 3). This assumption is the same as used for assessments of the Chatham Rise and Mid-East Coast orange roughy stocks, and allows for movement of SSB between aggregations. Movement of aggregations from west to east was noted in Challenger acoustic surveys in 2012 and 2018, and variable allocation of spawning biomass betwen spawning areas has been assumed in the East & South Chatham Rise assessment.

Table 3: Acoustic biomass estimates of spawning aggregations surveyed on Volcano, and the West and the East within the EEZ, and the total for all three areas. The CV is the observation error CV with an additional 20% of error in the years when the vessel motion correction was unknown (2005, 2011, and 2013). –, no survey conducted; a, included in All6 but not 3Series.

	West		East		Volcano		Total	
Year	Biomass (t)	CV (%)	Biomass (t)	CV (%)	Biomass (t)	CV (%)	Biomass (t)	Model CV (%)
2005	4 210	53	–	–	2 682	39	–	–
2006	4 383	59	–	–	6 329	39	–	–
2009	13 555	22	8 471	61	671	21	22 697	26
2010	8 114	14	1 707	34	1 132	24	10 953	12
2011	13 340	33	136	56	171	44	13 647	32
2013	10 183	22	5 365	26	4 559	34	20 107	15
2014	–	–	–	–	3 954	29	–	–
2018	9 966	9	0	NA	3 834	16	13 800	8
2023	0	NA	0	NA	8 132	17	8 132	17

Two alternatives for assumption 2 were used:

The first included acoustic biomass estimates that were accepted and biological samples showed the survey timing was likely to be around peak spawning. This included surveys of all areas in 2009 and 2013, and was given the label "All2". The 2009 estimate for Volcano was rejected from previous assessments (which used assumption 1) because it was a relatively low estimate compared to previous years. Assuming the potential for movement of SSB between locations meant the 2009 Volcano estimate was included here.

The second added biomass estimates from four years to All2 from surveys where acoustic biomass was measured but it was uncertain that timing was around peak spawning (surveys of Volcano 2010, East & Volcano 2011; Volcano in 2018 and 2023), or where aggregations could not be located and surveyed despite search efforts (surveys of East in 2018; East & West in 2023). This included surveys in 2009, 2010, 2011, 2013, 2018, and 2023, and was given the label "All6".

An acoustic survey of the East and West strata was also conducted in 2012 but rejected because substantial uncertainty in species mix made the biomass estimates unreliable (Hampton et al 2014). The acoustic survey in 2014 only surveyed the Volcano before moving to ORH 1.

Informed lognormal priors on the proportionality constants (*q*) were used for the acoustic time series. For 3Series, the means of the priors for each area were derived from the 2013 SSB proportions across aggregations, and the assumption that all three aggregations combined represented "most" of the spawning biomass (80%; Cordue 2014a). Splitting this prior into three components gave priors for the West, East, and Volcano *q*s respectively of LN(0.41, 30%), LN(0.22, 30%), and LN(0.18, 30%), based on the biomass split between areas from the 2013 survey. For the ALL2 and ALL6 runs, there was a single acoustic biomass *q* with prior LN(0.80, 30%) based on acoustic biomass estimates from the early 2000s on the north east Chatham Rise.

Process error was added to the acoustic series to balance MCMC implied residuals. The process errors added were in 3Series Volcano 0.2 and East 0.35 (none for West); in All6 0.15; no process error was added in All2 runs.

Trawl survey indices

The spawning biomass estimates from the *Thomas Harrison* trawl surveys excluding the rough terrain strata 9–11 (Table 4) were used as relative biomass with an uninformed *q* prior.

Table 4: Biomass indices from trawl surveys used in the stock assessment. The CV is the observation error CV with an additional 20% of process error (Cordue 2019).

Vessel	Year	Biomass (t)	Model CV (%)
Thomas Harrison	2006	13 987	34
	2009	34 864	31
	2011	18 425	33
	2012	22 451	27
	2013	18 993	55
	2018	48 038	55

Age frequencies

Age frequencies were available from four 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 2014 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. For the 2019 assessment the age data from the 2018 survey were used to produce an age frequency for the EEZ (750 otoliths) and Volcano (150 otoliths). An age frequency was also produced from the 2014 survey of Volcano (470 otoliths) (Doonan et al 2015). The sample of otoliths collected during the 2023 survey was considered unlikely to be representative of the stock (they almost all came from a single catch) and has not been aged.

The age frequencies were assumed to be multinomial and were assigned effective sample sizes of 10, except for the 2018 age frequency from Volcano which was reduced to 5 to reflect that it may not have been representative of the aggregation. No statistical reweighting was attempted because of the short time series. These effective sample sizes were substantially lower than used in 2019 (60, 30 for Volcano in 2018) to give greater weight to the acoustic biomass estimates.

There are no age frequencies from the commercial fishery.

4.3 Model runs and results

The main parameters estimated were: virgin biomass (B_0), the logistic maturity (=selectivity) ogive, and the natural mortality rate (*M*). The prior on *M* was informed from empirical *M* estimators and was very broad: LN(0.078, 120%). Proportionality constants (q) were also estimated for the trawl survey and the three (3Series) or one (All2, All6) acoustic survey time series. Year class strength (YCS) was assumed to be constant (deterministic).

YCSs were estimated in the 2019 assessment, for the years 1925 to 1995 (71 paramaters), but in the 2024 assessment, sensitivity runs showed almost identical model fits and estimates of stock size, status, and uncertainty could be achieved by estimating a single parameter (M), providing a more parsimonious solution that reduced the potential for model over-parameterisation. When only YCS were estimated (with M fixed at the default value of 0.045) a correction to productivity was achieved by a strong historical trend in YCS from high to low. When M and YCS were estimated together, M was estimated to be lower and the YCS trend was almost flat. The estimates of M were influenced by the acoustic series estimates and q priors as well as by the age data, meaning the M was varying to fit the apparent productivity driven by the q prior rather than providing the most accurate fit to species longevity. The q prior and the age data imply different M values.

Other sensitivity runs were conducted assuming different M priors, dropping the 2023 acoustic estimate, including the *Amaltal Explorer* trawl series, excluding Volcano age data, or all age data (and fixing selectivity), changing the effective sample sizes assumed for the age data, and removing acoustic q priors. The fits to the data were generally similar and were not able to distinguish between the alternative hypotheses. The All6 runs were found to be most sensitive, and some incurred a catch penalty indicating that the biomass estimates were close to the minimum level able to satisfy the catch history (B_{min}) when the estimated acoustic q was closest to the mean of the q prior.

The model fits to the acoustic indices were acceptable, with the greater changes in the 3Series acoustic time series proving more difficult to fit with constant qs and selectivity, leading to a higher process error required to fit this data (Figure 2). The fits to the trawl series were good, although the high CV for 2013 and 2018 means that the trend was not very informative (Figure 3).

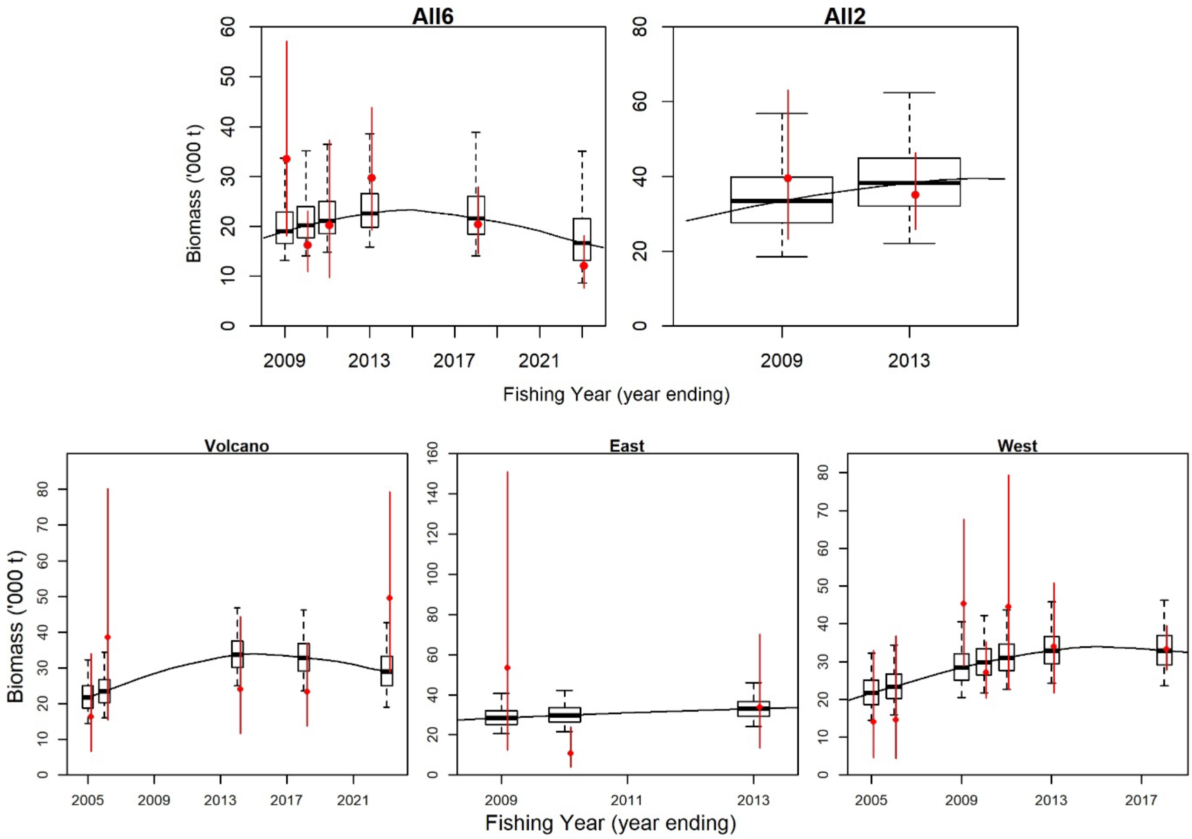


Figure 2: MCMC implied fits to the acoustic indices of the All6 and All2 runs (top panels) and Volcano, East, and West areas of the 3Series run (bottom panel). Each box covers the middle 50% of the distribution and the whiskers extend to 95% CIs. The solid black indicates the median fitted SSB. The observations are plotted as red points with red lines indicating 95% CIs (with a small offset by year to make them more visible).

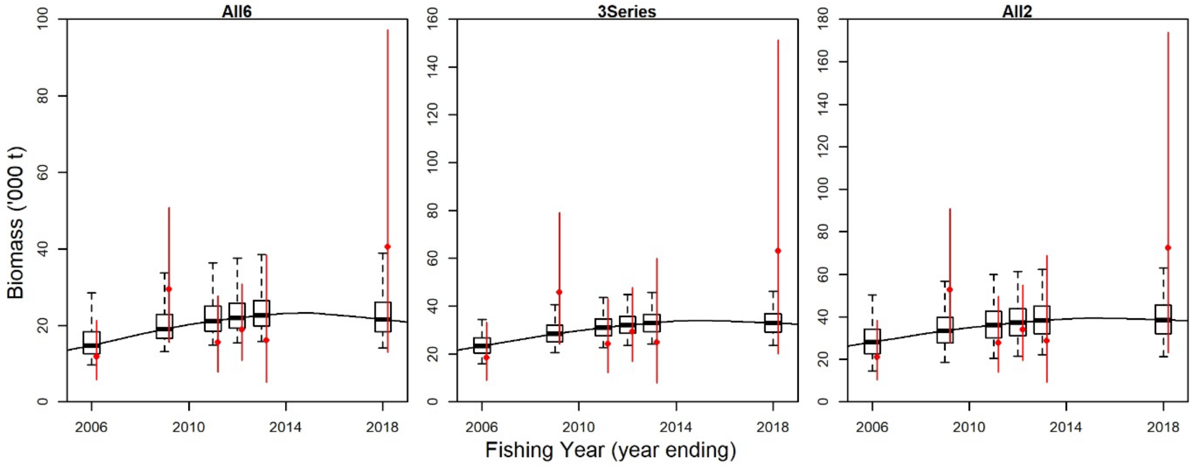


Figure 3: MCMC implied fits to the *Thomas Harrison* trawl survey series for the All6, 3Series, All2 runs. Each box covers the middle 50% of the distribution and the whiskers extend to 95% CIs. The solid black indicates the median fitted SSB. The observations are plotted as red points with red lines indicating 95% CIs (with a small offset by year to make them more visible).

The posterior distributions of the acoustic *q*s, which had informed priors, were estimated to be lower than the prior (All2 and All6), or close to or lower than the prior (3Series) (Figure 4). The persistent move to lower *q*s shows that the model estimated SSB was greater than prior expectations across all model runs.

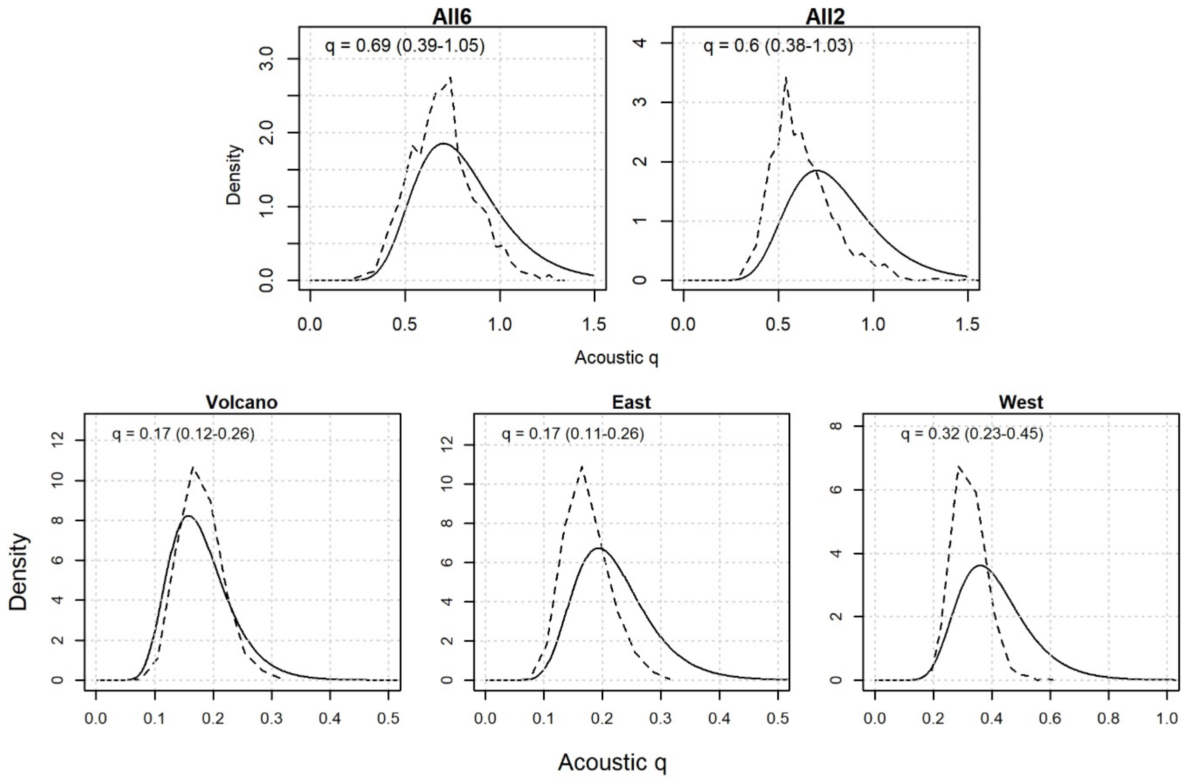


Figure 4: MCMC Prior distributions (solid lines) and marginal posterior distributions (dashed lines) for the All6 and All2 acoustic *q*s (top panels) and the Volcano, East, and West acoustic *q*s in the 3Series run (bottom panels). Inset values are the median and 95% credible intervals of the *q* estimates.

Natural mortality rate was estimated to be lower than the orange roughy default (0.045 yr^{-1}) in all model runs (Figure 5). Estimated *M* was lowest for the All6 run (0.024), where the estimated SSB was lowest and the acoustic *q* was closest to the prior (Figure 4); *M* was similar for the All2 and 3Series runs (0.033 and 0.031 respectively). In this context, estimated '*M*' is not directly comparable to natural mortality but includes other undefined factors and is a general descriptor of productivity.

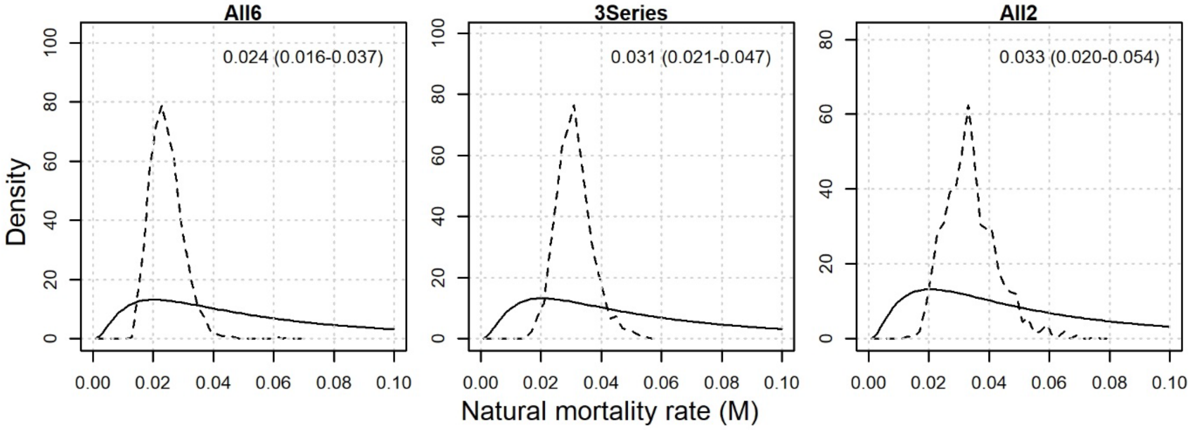


Figure 5: MCMC Prior distributions (solid lines) and marginal posterior distributions (dashed lines) for natural mortality rate in the All6, All2, and 3Series runs. Inset values are the median and 95% credible intervals of the *M* estimates.

The selectivity was assumed equal to maturity, and A_{50} in all runs was close to 34 years. The variability between age frequencies, in particular for Volcano, meant that they could not all be fitted well with the single logistic selectivity (Figure 6). The age sample for Volcano 2018, for example, included a much greater proportion of older fish than 2014. The misfit to the plus group in EEZ 1987 is also apparent, and occured because of a low *M* estimate, but the residual is no worse than for several individual cohorts at ages 30–40 in other samples. The fits to the age data were very similar across all model runs.

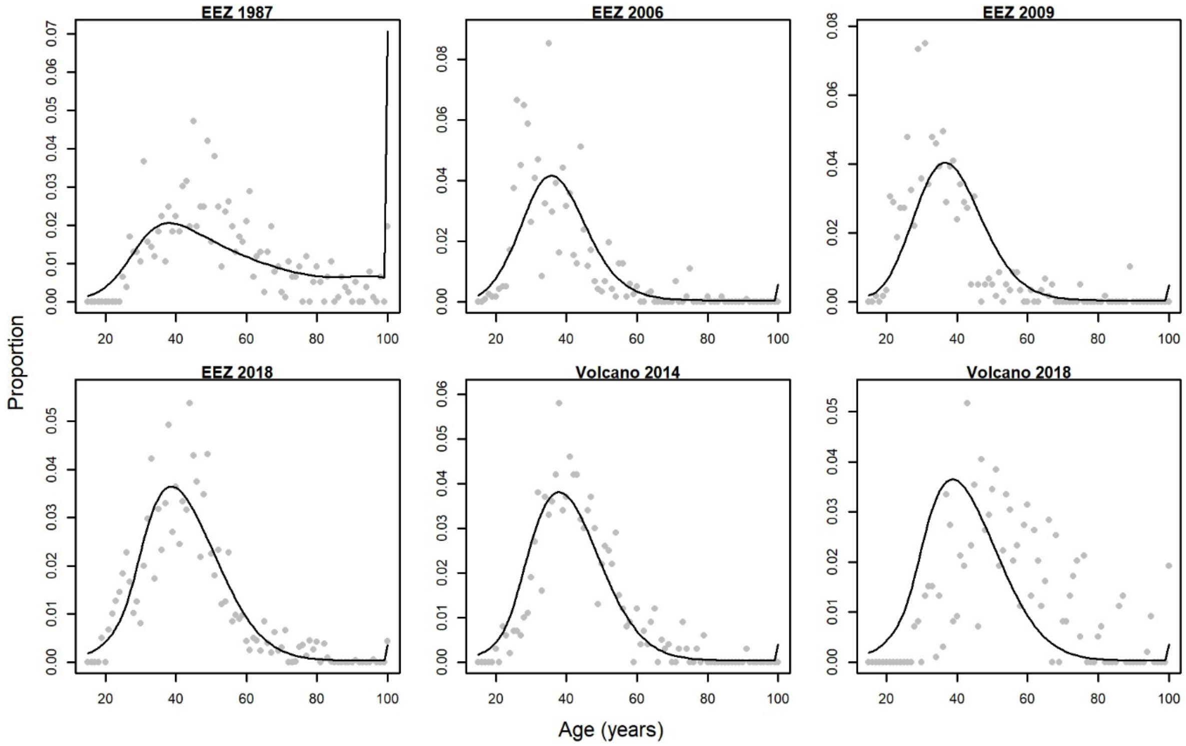


Figure 6: MPD fits (solid lines) to age frequencies (grey points) for the EEZ and Volcano for the All2 run.

Biomass estimates

The All2 run was chosen as a base model. The All6 run estimates were at or close to B_{min}, and relatively sensitive to model assumptions. The 3Series run was analogous to the 2019 assessment, but the independence of the three acoustic series indexing SSB was considered less plausible than the total acoustic estimates used in the All2 and All6 runs. The lack of recent data in the All2 run was reflected in relatively high uncertainty in current stock status (Table 5).

Virgin biomass (B_0) was estimated to be just under 100 000 t for all runs (Table 5). The main difference between runs was the productivity (M) estimates, which led to different current SSB size and status. For the base (All2) and 3Series runs, current stock status was estimated to be close to the lower bound of the target biomass range of 30–50% B_0. For the All6 run, with a lower M, current stock status was lower and between the hard (10% B_0) and soft (20% B_0) limits.

Table 5: MCMC estimates of estimated natural mortality rate (M), virgin biomass (B_0), stock status (B_{2024} as %B_0), and probability of being above the upper (50% B_0) and lower (30% B_0) limit of the target range and below the soft (20% B_0) and hard limit (10% B_0), for the base (All2) model, All6, and 3Series sensitivity runs.

	M	B_0 (000 t)	B_{2024} (%B_0)	p(> 50%B₀)	p(> 30%B₀)	p(< 20%B₀)	p(< 10%B₀)
Base (All2)	0.033 (0.020–0.054)	99.4 (87.6–117.2)	35 (16–57)	0.09	0.66	0.07	0
All6	0.024 (0.016–0.037)	98.5 (91.3–110.3)	16 (8–35)	0.00	0.06	0.71	0.12
3Series	0.031 (0.020–0.045)	97.5 (89.3–110.5)	29 (18–44)	0.09	0.44	0.05	0

In the base case, the stock status trajectory shows a steep decline to 11% B_0 in 1991, reflecting the large removals during the initial fish-down phase of this stock (Figure 7). From 1990, the All2 stock status remains low and slowly rebuilds until an upturn from about 2000. Biomass is estimated to have peaked in 2015 in all model runs, within the target range (All2 and 3Series runs) or just above the soft limit (All6 run), before the increased catches (enabled by a TACC increase), combined with a reduction in recruitment, caused a levelling out and then decline of the biomass trajectory after 2015 (Figure 7). The reduction in recruitment is a consequence of reduced SSB from the late 1980s, lagged by the estimated age of selectivity and maturity (A_{50}) of about 34 years, finally entering the fishery. The model predicts that recruitment will start to increase after about 2034 (2000 + 34).

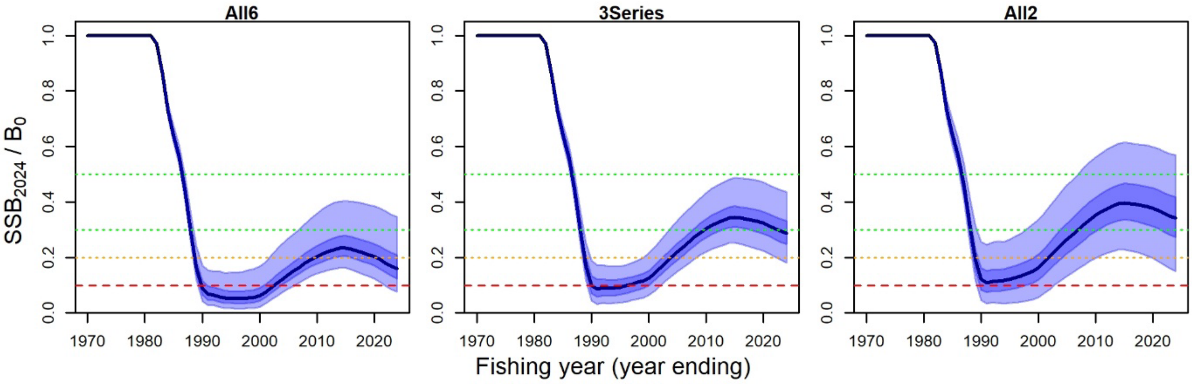


Figure 7: MCMC estimated spawning-stock status (SSB_{2024}/B_0) trajectory. The solid line shows the median, the darker shaded areas covers 50% of the distribution, and the lighter shaded areas 95% of the distribution. The hard limit 10% B_0 (dashed red), soft limit 20% B_0 (dotted orange), and biomass target range 30–50% B_0 (green) are marked by horizontal lines.

Estimated exploitation rate (catch/SSB) was generally well above the target range ($U_{30\%B0}$–$U_{50\%B0}$) during the fishing down period (1982–1989), above the target range (1990–1993), returning to the target range (1994–1999). Subsequently, it was well below the target range up until 2014, and from 2015 until 2024 it has remained in the lower half of the target range (Figure 8).

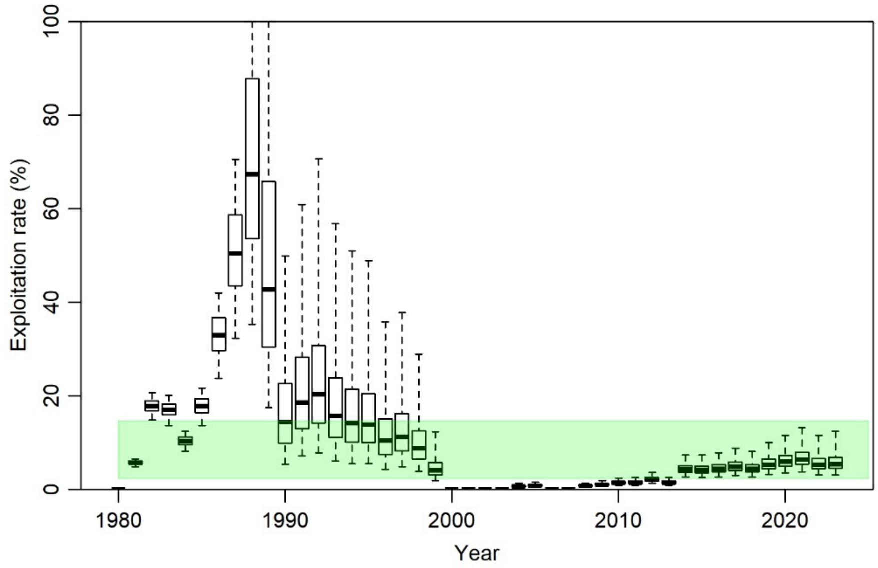


Figure 8: Base (All2) run, MCMC estimated exploitation rate trajectory. The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution. The fishing-intensity range associated with the biomass target of 30–50% *B₀* is marked bythe green shaded area.

Projections

Five-year projections were conducted for a constant catch equal to the current TACC (2058 t), 0.8×TACC, and 0.7×TACC. A 5% catch over-run was assumed. At all future constant catch levels, the SSB is predicted to decrease slowly over the next five years (Table 6), with the base (All2) remaining within the target biomass range and with at most a 19% probability of being below the soft limit, and with at most a 2% probability of being below the hard limit, during the next five years (Figure 9).

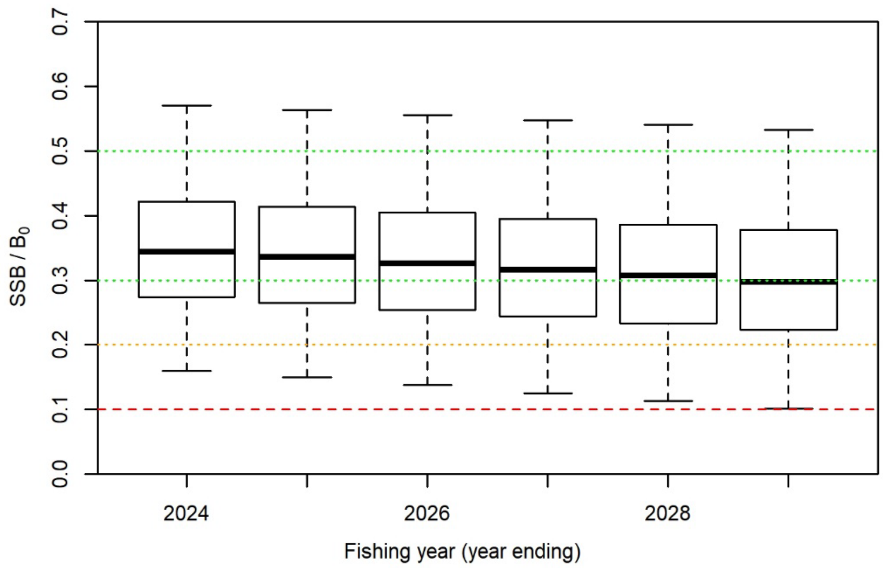


Figure 9: Base (All2) run, future projections of SSB with catch equal to the TACC. The box in each year covers 50% of the distribution and the whiskers extend to 95% of the distribution. The hard limit 10% B_0 (dashed red), soft limit 20% B_0 (dotted orange), and biomass target range 30–50% B_0 (green) are marked by horizontal lines.

The TACC reduction required for the predicted SSB in 2028–29 to be the same as 2023–24 was 0.43×TACC for the base (All2) run, 0.30×TACC for the All6 run, and 0.46×TACC for the 3Series run.

Table 6: MCMC estimates of stock status (*B_{2024}* as %*B_0*) for the base model (All2) and two sensitivity runs (All 6 and 3Series) with constant future catches (TACC, 0.8xTACC and 0.7xTACC), and the probability of the stock being above the upper and lower bound of the target range, below the soft limit (20% B_0) and hard limit (10% B_0).

SSB/B_0	2023–24	2024–25	2025–26	2026–27	2027–28	2028–29
All2						
TACC	35 (16–57)	34 (15–56)	33 (14–56)	32 (13–55)	31 (11–54)	30 (10–53)
0.8×TACC	35 (16–57)	34 (15–57)	33 (14–56)	33 (14–56)	32 (13–55)	32 (12–55)
0.7×TACC	35 (16–57)	34 (15–57)	34 (15–56)	33 (14–56)	33 (14–56)	33 (13–56)
All6						
TACC	16 (8–35)	15 (6–34)	14 (5–33)	12 (3–32)	11 (2–31)	10 (1–30)
0.8×TACC	16 (8–35)	15 (6–34)	14 (6–34)	14 (5–33)	13 (4–33)	12 (3–32)
0.7×TACC	16 (8–35)	15 (7–35)	15 (6–34)	14 (5–34)	14 (4–33)	13 (3–33)
3Series						
TACC	29 (18–44)	28 (17–43)	27 (16–42)	26 (15–41)	25 (14–40)	24 (13–39)
0.8×TACC	29 (18–44)	28 (18–43)	28 (17–43)	27 (16–42)	27 (15–42)	26 (14–41)
0.7×TACC	29 (18–44)	29 (18–43)	28 (17–43)	28 (17–43)	27 (16–42)	27 (15–42)

p(SSB > 0.5)	2023–24	2024–25	2025–26	2026–27	2027–28	2028–29
All2						
TACC	0.09	0.08	0.07	0.06	0.05	0.05
0.8×TACC	0.09	0.08	0.08	0.07	0.06	0.05
0.7×TACC	0.09	0.08	0.08	0.08	0.07	0.07
All6						
TACC	0	0	0	0	0	0
0.8×TACC	0	0	0	0	0	0
0.7×TACC	0	0	0	0	0	0
3Series						
TACC	0	0	0	0	0	0
0.8×TACC	0	0	0	0	0	0
0.7×TACC	0	0	0	0	0	0

p(SSB > 0.3)	2023–24	2024–25	2025–26	2026–27	2027–28	2028–29
All2						
TACC	0.66	0.63	0.60	0.56	0.53	0.49
0.8×TACC	0.66	0.64	0.62	0.60	0.58	0.56
0.7×TACC	0.66	0.64	0.63	0.62	0.60	0.59
All6						
TACC	0.06	0.05	0.05	0.04	0.03	0.03
0.8×TACC	0.06	0.06	0.05	0.05	0.04	0.04
0.7×TACC	0.06	0.06	0.05	0.05	0.05	0.04
3Series						
TACC	0.44	0.39	0.33	0.28	0.24	0.20
0.8×TACC	0.44	0.41	0.37	0.34	0.31	0.28
0.7×TACC	0.44	0.41	0.39	0.36	0.34	0.32

p(SSB < 0.2)	2023–24	2024–25	2025–26	2026–27	2027–28	2028–29
All2						
TACC	0.07	0.09	0.11	0.14	0.16	0.19
0.8×TACC	0.07	0.08	0.1	0.11	0.13	0.14
0.7×TACC	0.07	0.08	0.09	0.10	0.11	0.12
All6						
TACC	0.71	0.75	0.79	0.82	0.85	0.87
0.8×TACC	0.71	0.75	0.77	0.79	0.81	0.83
0.7×TACC	0.71	0.74	0.76	0.78	0.79	0.81
3Series						
TACC	0.05	0.08	0.12	0.16	0.21	0.27
0.8×TACC	0.05	0.07	0.10	0.12	0.15	0.17
0.7×TACC	0.05	0.07	0.09	0.10	0.12	0.14

p(SSB < 0.1)	2023–24	2024–25	2025–26	2026–27	2027–28	2028–29
All2						
TACC	0	0	0.01	0.01	0.02	0.02
0.8×TACC	0	0	0.01	0.01	0.01	0.01
0.7×TACC	0	0	0	0.01	0.01	0.01
All6						
TACC	0.12	0.18	0.27	0.35	0.43	0.50
0.8×TACC	0.12	0.17	0.23	0.28	0.33	0.39
0.7×TACC	0.12	0.17	0.21	0.25	0.29	0.33
3Series						
TACC	0	0	0	0	0	0.01
0.8×TACC	0	0	0	0	0	0
0.7×TACC	0	0	0	0	0	0

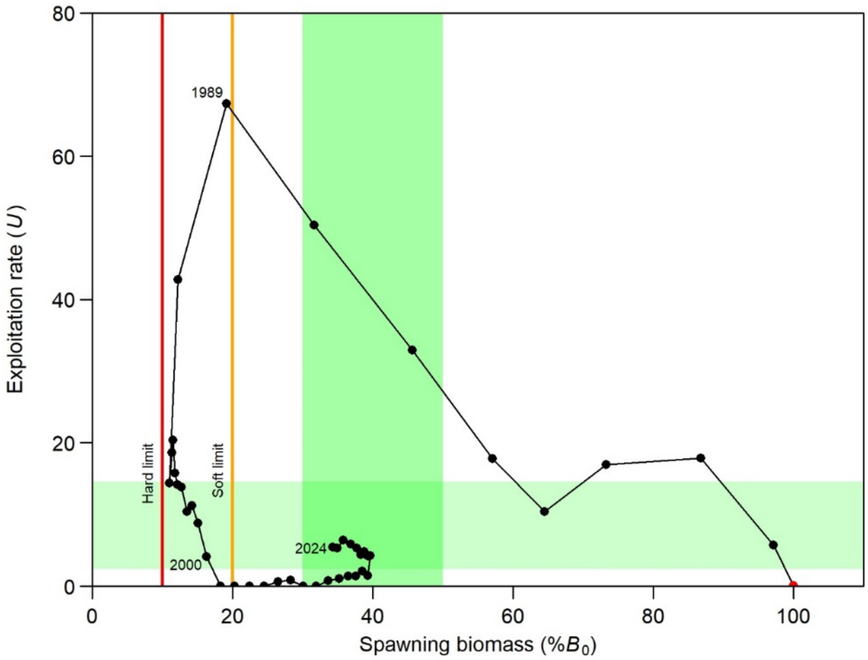
5. FUTURE RESEARCH CONSIDERATIONS

- Revise the acoustic survey design and implementation to maximise probability that abundance estimates are obtained for all three aggregations ('East', 'West' and Volcano) in the same year.
- Review data available on the timing of aggregations and revisit survey selection criteria.
- Reconsider the otolith sampling approach from acoustic surveys to maximise probability that adequate otoliths are obtained from each aggregation and that these are obtained from multiple tows to support the stock assessment.
- Review current arrangements for sampling commercial catches for age to ensure that adequate samples are being obtained from both spawning and non-spawning fisheries to support the development of useable age frequencies (this could be through sampling by observers and/or industry).
- Review and update the acoustic *q* prior, in particular the assumption that 80% of the SSB is present in the three surveyed areas.
- Review and update the natural mortality rate (*M*) prior.
- Run alternative models with either a strong *M* prior or a strong acoustic prior.
- Reexamine trends in CPUE and its utility in stock assessments, specifically exploring the potential of separate standardised indices for fishing on the flat and fishing on features.
- Explore error assumptions in assessment models when fitting survey data when abundance is low.

6. STATUS OF THE STOCKS

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

Stock Status		
Year of Most Recent Assessment	2024	
Catch in most recent year of assessment	Year: 2022−23	Catch: 1 860 t
Assessment Runs Presented	All2 Base model	
Reference Points	Management Target: Biomass range 30–50% B_0 Soft Limit: 20% B_0 Hard Limit: 10% B_0 Overfishing threshold: Fishing intensity range $U_{30\%B0}$–$U_{50\%B0}$	
Status in relation to Target	B_{2024} was estimated to be 35% B_0 As Likely As Not (40–60%) to be at or above the lower end of the management target range and Very Unlikely (< 10%) to be at or above the upper end of the management target range	
Status in relation to Limits	B_{2024} is Unlikely (< 40%) to be below the Soft Limit B_{2024} is Very Unlikely (< 10%) to be below the Hard Limit	
Status in relation to Overfishing	Fishing intensity in 2023–24 was estimated to be within the fishing intensity range. Overfishing is Unlikely (< 40%) to be occurring.	



Historical trajectory of spawning biomass (%*B₀*) and fishing intensity (exploitation rate) for the base (All2) model (medians of the marginal posteriors). The biomass target range of 30–50% *B₀* and the corresponding exploitation rate target range are shaded in green. The soft limit (20% *B₀*) is marked in orange and the hard limit (10% *B₀*) in red.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Median spawning biomass was estimated to have recovered from a low level in the early 2000s to about the mid point of the management range by 2014–2015, and to have slowly declined since then, but remained in the target range.
Recent Trend in Fishing Intensity or Proxy	Fishing intensity has been increasing slowly within the target range since 2014–15.
Other Abundance Indices	An acoustic survey between 4 and 13 July 2023 did not detect any aggregated orange roughy on the Challenger Flats.
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Biomass is expected to slowly decrease at the current TACC (2058 t) over the next 5 years.
Probability of Current Catch or TACC causing Biomass to remain below, or to decline below, Limits	At TACC: Soft Limit: Unlikely (< 40%) within the next five years Hard Limit: Very Unlikely (< 10%) within the next five years
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unlikely (< 40%) within the next five years

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 Plenary publication year: 2024	Next assessment: 2029
Overall assessment quality rank	1 – High Quality	

Main data inputs (rank)	- Acoustic survey indices for West, East, and Volcano aggregations (2009, 2013) - One trawl survey time series: 2006, 2009–2012 - Age frequencies from the trawl surveys in 1987, 2006, 2009, and 2018 - Age frequencies from Volcano in 2014 and 2018	1 – High Quality 1 – High Quality 2 – Medium or Mixed Quality: inconsistent between years 2 – Medium or Mixed Quality: inconsistent between years
Data not used (rank)	- Commercial CPUE - Acoustic surveys of UTFs other than Volcano - Other acoustic survey estimates (2005, 2006, 2010, 2011, 2014, 2018, 2023) - Early trawl surveys with different vessels covering different areas	3 – Low Quality: unlikely to be indexing stock-wide abundance 2 – Medium or Mixed Quality: species identification and dead zone problems 2 – Medium or Mixed Quality: not surveys of a spawning aggregation or timing uncertain – some used in sensitivities 2 – Medium or Mixed Quality: not a consistent time series, or potentially biased
Changes to Model Structure and Assumptions	- Acoustic SSB estimates for the three areas (Volcano, West, and East) were summed and used as a single index, rather than each assumed to provide an independent index of SSB. - One fishery was modelled instead of two. - Recruitment deviates were fixed and *M* estimated, rather than recruitment estimated and *M* fixed. - A prior based on empirical estimates was used for *M*. - The statistical weights (effective sample sizes) of the age data were reduced. - The *Amaltal Explorer* trawl survey series was excluded. - The informed *q* prior on the *Thomas Harrison* trawl survey was set to uniform.	
Major Sources of Uncertainty	- The proportion of the stock that is indexed by the acoustic and trawl surveys - Recent stock productivity, as estimated using *M* and/or year class strength, and the assumed stock recruitment relationships effect on projected status - Selection criteria for acoustic surveys	

Qualifying Comments
-There are no abundance indices in the base case since 2013. Recent acoustic surveys in 2018 and 2023 which have suggested lower abundance were not included in the base case.

Fishery Interactions
Since the fishery re-opened with a low level of catch and effort, bycatch levels have been relatively low at about 4 to 5%, with spiky oreo being 1.4% of the average catch for 2008–09 to 2013–14. The bycatch of low productivity species over this period includes a number of deepwater shark and coral species. There were four observed incidental captures of seabirds and no observed incidental captures of marine mammals between 2002–03 and 2020–21. Orange roughy are caught using bottom trawl gear. Bottom trawling interacts with benthic habitats.

7. FOR FURTHER INFORMATION

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