ORANGE ROUGHY WEST COAST SOUTH ISLAND (ORH 7B)

1. FISHERY SUMMARY

1.1 Commercial fisheries

The orange roughy west coast South Island Fishstock was introduced into the Quota Management System with a TACC of 1558 t on 1 October 1986. The TACC was increased to 1708 t for the fishing year 1988–89. Landings ranged from 1139 t to 1763 t in the mid-1980s and early 1990s, before decreasing rapidly to just 290 t by 1994–95. The TACC was lowered to 430 t in 1995 and 110 t in 2001, before being reduced to just 1 t in 2007. Landings averaged just 0.68 t during the fishing years 2008–09 to 2018–19.

The fishery was initially centred on an area near the Cook Canyon in Statistical Areas 033, 034 and 705. Up until 1996–97 approximately 80% of the catch was taken in winter (June–July) when fish form aggregations for spawning. From 1997–98 onwards about 50% of the catch was taken in winter. Reported domestic landings and TACCs are shown in Table 1, while the historical landings and TACC for ORH 7B are depicted in Figure 1.

Table 1: Reported landings (t) of orange roughy and TACCs (t) for ORH 7B from 1983–84 to present. QMS data from 1986–present. Catches (t) taken under special permits during winter research surveys after 2013–14 are also noted.

Fishing year	Reported landings	TACC	Research catch
1983–84*	2	-	
1984–85*	282	-	
1985–86*	1 763	1 558	
1986–87*	1 446	1 558	
1987–88	1 413	1 558	
1988–89	1 750	1 708	
1989–90	1 711	1 708	
1990–91	1 683	1 708	
1991–92	1 604	1 708	
1992–93	1 139	1 708	
1993–94	701	1 708	
1994–95	290	1 708	
1995–96	446	430	
1996–97	425	430	
1997–98	330	430	
1998–99	405	430	
1999–00	284	430	
2000–01	161	430	
2001–02	95	110	
2002–03	90	110	
2003–04	119	110	
2004–05	106	110	
2005–06	77	110	
2006–07	125	110	
2007–08	5.95	1	
2008–09	1.44	1	
2009–10	0.04	1	
2010–11	0.14	1	
2011–12	0.06	1	
2012–13	0.25	1	
2013–14	0.62	1	
2014–15	1.67	1	21.7
2015–16	0.27	1	19.2
2016–17	0.58	1	11.0
2017–18	1.42	1	-
2018–19	1.00	1	57.0
2019–20	0.32	1	56.6
2020–21	0.54	1	-

*FSU data.

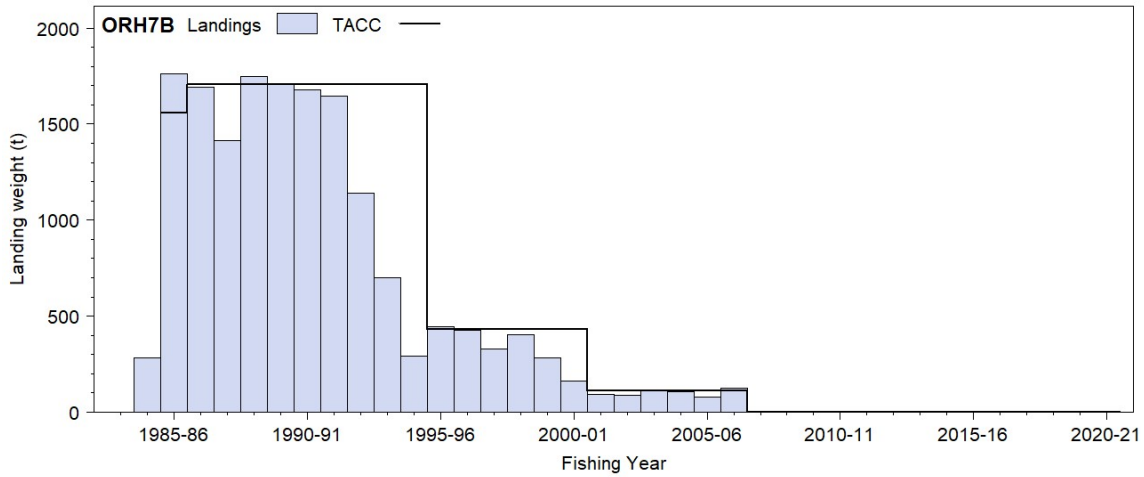

Figure 1: Reported commercial landings and TACC for ORH 7B (Challenger South).

1.2 Recreational fisheries

There is no known recreational fishery 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

There is no quantitative information available on other sources of mortality in this fishery.

2. STOCKS AND AREAS

There is no new information which would alter the stock boundaries given in previous assessment documents.

Orange roughy in this fishery are thought to be a single stock. Genetic studies have shown that samples of Cook Canyon orange roughy are significantly different from Challenger Plateau and Puysegur Bank samples (Smith et al 1996). Moreover, the size structure and parasite composition differ from fish on the Challenger Plateau (Lester et al 1988). Spawning occurs at a similar time to fish on the Challenger Plateau and the Puysegur Bank.

3. STOCK ASSESSMENT

The previous assessment for this stock was carried out in 2004 and is summarised in the 2006 Plenary Report. Virgin biomass (B_0) was estimated to be approximately 12 000 t with 2004 stock status at 17% B_0 (95% confidence interval 14–23%) when CPUE was assumed to be directly proportional to abundance (McKenzie 2005).

An updated assessment was attempted in 2007 with the addition of catch data up to 2005–06 and new standardised CPUE indices (McKenzie 2008). The Working Group rejected the assessment because of the poor fit to the CPUE data. The results were similar to those from the 2004 assessment; namely a slow rebuild up to 2006, which was not supported by the CPUE data.

A preliminary stock assessment was carried out in 2020 and some results from that assessment are reported here. Results from this assessment were inconclusive.

Results from the 2007 CPUE analysis and the previous assessments are retained below as they are relevant to the decision to effectively close the fishery from 1 October 2007. The use of CPUE analysis for an orange roughy fishery, to provide indices of biomass for use in stock assessment, has not been considered appropriate for more than a decade. Also, the previous assessments assume deterministic recruitment which is also inappropriate for orange roughy stock assessments (Cordue 2014)

3.1 The 2007 analysis of catch and effort data

Commercial catch and effort data are available from 1985. In 2007, these data were examined using both an unstandardised and a standardised analysis. Unstandardised catch rates declined substantially over the course of the fishery but showed no clear trend in the latter years of the fishery to 2005–06 (Table 2).

The standardised CPUE analysis was divided into two series to address reporting form changes: (i) using TCEPR data from 1985–86 through to 1996–97, and (ii) using CELR data from 1990–91 through to 2005–06. In addition, in order to increase vessel linkage across years, it was decided to use all months of data not just that from the winter fishery (June–July) as had been done for previous standardisations.

The standardised analysis for the TCEPR data used catch per tow in a linear regression model. Indices from this model (Table 3, Figure 2) show a steep decline after the first two years, followed by a more gradual decline and a slight increase in catch rates in 1995–96 and 1996–97.

Table 2: Summary of groomed data from TCEPR and CELR forms.

Fishing year	Number of vessel days	Number of tows	Total estimated catch (t)	Mean daily catch rate (t/tow)	Mean daily catch rate (t/h)
1985–86	138	357	1 544	4.5	2.9
1986–87	132	405	1 250	4.0	2.7
1987–88	132	420	1 250	3.4	2.3
1988–89	133	368	827	2.5	1.6
1989–90	123	356	1 282	4.5	5.6
1990–91	208	632	1 657	2.8	3.3
1991–92	238	810	1 601	2.0	1.4
1992–93	258	784	1 128	1.5	2.3
1993–94	298	708	660	1.1	0.9
1994–95	162	361	320	0.9	1.6
1995–96	66	150	275	2.2	1.7
1996–97	90	182	244	1.3	7.5
1997–98	96	228	170	0.7	0.3
1998–99	188	566	359	0.6	0.2
1999–00	213	647	259	0.4	0.1
2000–01	149	442	162	0.4	0.1
2001–02	117	282	76	0.3	0.1
2002–03	97	292	112	0.4	0.2
2003–04	90	252	118	0.4	0.2
2004–05	121	393	102	0.3	0.1
2005–06	87	257	73	0.3	0.2

Table 3: Standardised CPUE indices (relative year effect) based on TCEPR data with number of vessel tows from 1985–86 to 1996–97.

Year	CPUE index	CV	Number of tows	Year	CPUE index	CV	Number of tows
1985–86	1.99	0.20	153	1991–92	0.48	0.23	231
1986–87	2.13	0.23	150	1992–93	0.29	0.23	230
1987–88	1.11	0.26	212	1993–94	0.14	0.25	341
1988–89	0.58	0.22	310	1994–95	0.13	0.27	172
1989–90	0.61	0.22	236	1995–96	0.51	0.33	37
1990–91	0.76	0.23	238	1996–97	0.41	0.26	104

The standardised analysis for the CELR data used daily catch in a linear regression model. Indices from this model (Table 4, Figure 2) show a steep decline for the first four years, followed by an increase to a peak in 1995–96, and subsequent low catch rates after then.

Table 4: Standardised CPUE indices (relative year effect) based on CELR data with number of days from 1990–91 to 2005–06.

Year	CPUE index	CV	Number of days	Year	CPUE index	CV	Number of days
1990–1991	2.17	0.27	110	1999–2000	0.34	0.27	131
1991–1992	1.11	0.27	108	2000–2001	0.34	0.28	88
1992–1993	0.74	0.27	126	2001–2002	0.33	0.28	73
1993–1994	0.28	0.28	81	2002–2003	0.61	0.26	67
1994–1995	0.53	0.30	46	2003–2004	0.59	0.25	75
1995–1996	1.16	0.33	29	2004–2005	0.35	0.24	114
1996–1997	0.53	0.38	19	2005–2006	0.36	0.26	80
1997–1998	0.36	0.30	52				
1998–1999	0.39	0.28	112				

3.2 Stock assessment estimates in 2004

Based on previous stock assessments using CPUE data the TACC was cut back severely from about 1700 t in 1994–95 to 110 t in 2000–01. By the late 1990s the stock was believed to be well below B_{MSY} where it continued until at least 2004 (17% B_0 in the 2004 assessment, Figure 3). Despite the large reduction in annual removals from the stock after 2001–02, catch rates did not increase over the subsequent 5 years.

An updated assessment was attempted in 2007 with the addition of catch data up to 2005–06 and new standardised CPUE indices (Figure 2) based on TCEPR data (1986 to 1997) and a separate CELR series (1991 to 2006). These data were incorporated in a Bayesian stock assessment with deterministic recruitment to estimate stock size. The Working Group rejected the assessment because of the poor fit to the recent CPUE data. The model was insensitive to the recent CPUE data and predicted a rebuild (driven by the recruitment assumptions) that was not supported by any observations in the fishery.

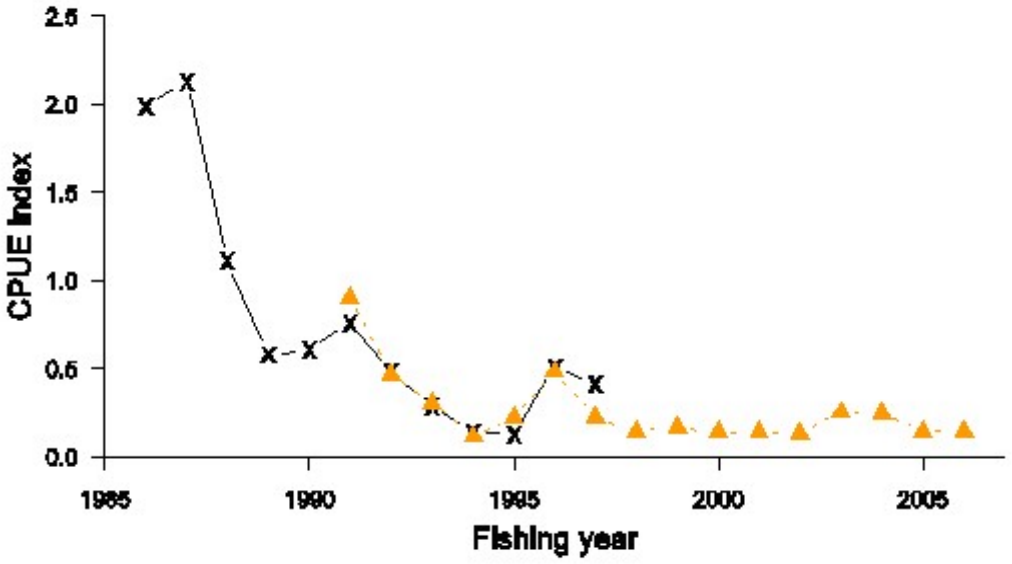

Figure 2: The CPUE indices based on: (i) TCEPR data (solid line and crosses) covering 1985–86 to 1996–97, and (ii) CELR data (triangles and dashed line) covering 1990–91 to 2005–06. The CELR index has been scaled so that it has the same mean value as the TCEPR index in the years that they overlap.

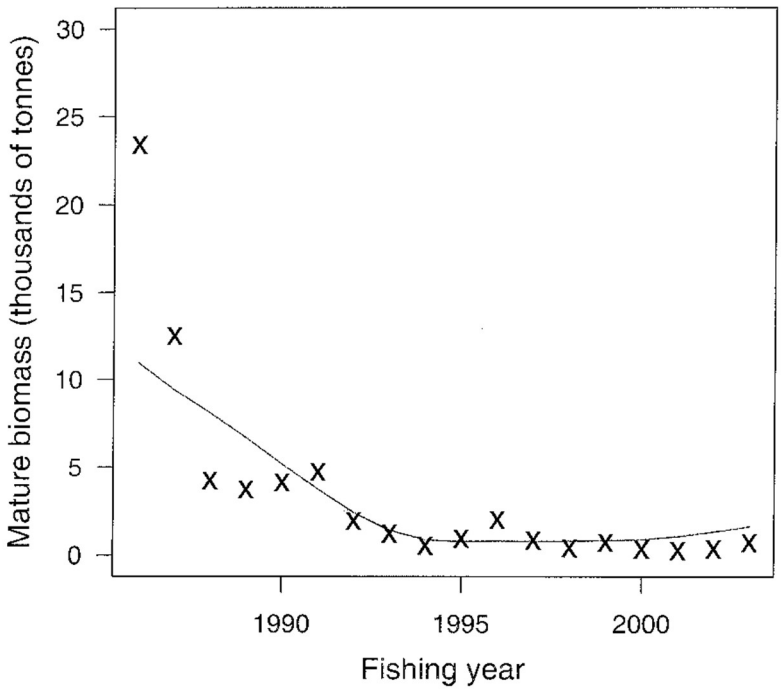

Figure 3: Biomass trajectory derived from Maximum Posterior Density (MPD) estimate of the model parameters (2004 stock assessment). The biomass trajectory is shown by the solid line; crosses denote the CPUE index scaled to biomass.

3.3 Survey biomass estimates

There were three random trawl surveys on the WCSI: two used the FV *Arrow* (October 1983, and in late July-early August 1986); and another by the RV *Tangaroa* in October 1991 (Tracey et al 1990, Armstrong & Tracey 1987, Clark 1991). All three used different stratification, but they broadly covered the same total area. Estimates from these trawl surveys are not used for assessment.

Since 2015, surveys have been regularly conducted in Cook Canyon aimed at locating and acoustically surveying spawning orange roughy plumes. In 2015 an orange roughy plume was seen in Cook Canyon during a search by FV *Amaltal Explorer* but it was transitory and could not be acoustically surveyed (Ryan & Tilney 2016). Another attempt was made from FV *Cook Canyon* from 8 to 11 July 2016 (Doonan et al 2016). There were two parts to the work in 2016: a search for spawning aggregations (plumes); and a random trawl survey in the area around the Cook Canyon, where most of the historical catch was caught. One main spawning plume was found on two consecutive nights, but it dispersed during daylight hours which is its historical behaviour. The plume was mapped using the vessel's echosounder (a fishing rather than a scientific echosounder), so it was not possible to perform acoustic integration and, hence, no acoustic abundance estimate was calculated. One short tow on the main plume produced about 18 t of spawning orange roughy with little bycatch. Most orange roughy catches in the random trawl survey (22 tows) were small (median 19 kg) with a wide size range (15 to 40 cm, mode at 22 cm), but there was one larger survey catch (600 kg) near the plume location which was composed of mainly spent (post-spawning) fish.

A successful acoustic survey was conducted on FV *Amaltal Explorer* in 2017 using a CSIRO acoustic-optical towed system (AOS) (Ryan & Tilney 2017). Three snapshots of a single spawning plume in Cook Canyon gave an average estimate of 824 t (Table 5). The timing of the snapshots was not ideal as they appeared to be late relative to the spawning cycle with 40–50% of sampled fish having spent gonads (Ryan & Tilney 2017). In 2019, on FV *Amaltal Mariner* a plume at the same location as in 2017 was surveyed with a hull mounted system (Ryan & Tilney 2019). The snapshots spanned the main spawning season and there was no trend in the estimates with the increasing percentage of spent fish, which reached 45–65% on 10–11 July (Table 6). The average estimate in 2019 of 877 t was very similar to that in 2017 (Table 6).

Table 5: Biomass estimates from CSIRO's AOS system (38 kHz) during the 2017 acoustic survey. For each snapshot the date, number of transects, the biomass estimate, and the CV are given. It is also noted that for each snapshot orange roughy marks were seen on more than two transects (indicating that a genuine spawning plume was surveyed).

Snapshot	Date	Transects	Biomass (t)	CV (%)	Transects with marks
1	4 July 17	5	627	53	> 2
2	5 July 17	7	930	32	> 2
3	6 July 17	7	915	50	> 2
Average			824	26	

Table 6: Biomass estimates from the *FV Amaltal Mariner* 38 kHz hull-mounted system during the 2019 acoustic survey. For each snapshot the date, number of transects, the biomass estimate, and the CV are given. The number of transects on which orange roughy marks were seen is also given (1 transect indicates a poor-quality snapshot; 2 transects may be adequate but more than 2 indicates that a genuine spawning plume was surveyed).

Snapshot	Date	Transects	Biomass (t)	CV (%)	Transects with marks
1	26 June 19	6	318	48	2
2	26 June 19	6	1393	35	2
3	3 July 19	9	927	21	> 2
4	4 July 19	9	746	31	> 2
5	9 July 19	6	511	64	1
6	9 July 19	5	473	38	2
7	10 July 19	10	958	33	> 2
8	16 July 19	4	198	58	1
Average (2 or >2)			803	14	
Average (>2)			877	17	

3.4 Age frequency data

Orange roughy otoliths have routinely been collected during research surveys of Cook Canyon but they have only been aged for the 2019 acoustic survey. There are some otoliths from early trawl surveys in 1983 and 1986 but the first survey "took place before the spawning distribution was well known" and the second survey was "carried out after spawning was finished" (O'Driscoll 2001). For the 2015 acoustic survey there are 360 otoliths available for Cook Canyon but there was probably only 1 trawl in the spawning plume (which caught 18 t of orange roughy) (Ryan & Tilney 2016). In 2016, there are 476 otoliths available, but 299 of these were from a single trawl catch of 18 t on the plume (Doonan et al. 2016). The otoliths collected in the 2017 acoustic survey are also likely to be unrepresentative of the spawning population that year as they were collected late in the spawning cycle and are heavily skewed towards females (452 female, 150 male) (Ryan & Tilney 2017). The age frequencies that could be created from these various collections of otoliths are likely not to be representative of the surveyed spawning fish population.

The 2019 age frequency was constructed using the method of Doonan et al (2013) from 500 otoliths collected over 6 trawls that targeted the plume. The trawls took place from 26 June to 16 July and caught from 2.5–18 t of orange roughy (Ryan & Tilney 2019). Males and females were almost equally represented and the age frequency across the 6 stations was similar. The scaled age frequency shows a large plus group at 100 years (Figure 4). The Working Group accepted that this sample was likely to be representative of the spawning plume.

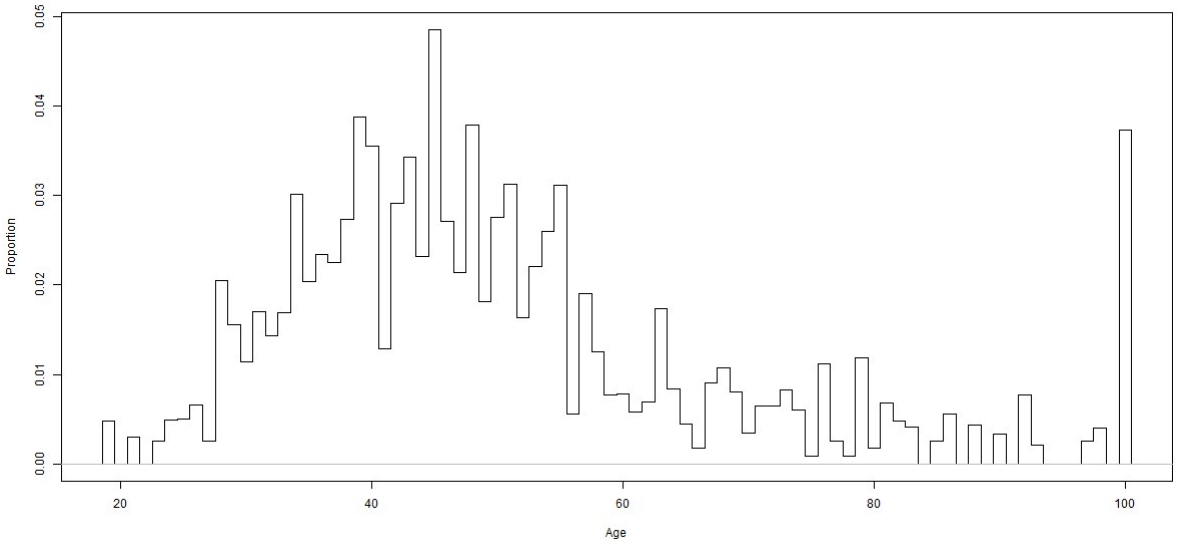

Figure 4: The proportion of orange roughy at age for the scaled age frequency from trawls targeting the spawning plume in the 2019 acoustic survey. There is a plus-group at 100 years.

3.5 The 2020 stock assessment

A preliminary stock assessment was performed in 2020 fitting to the acoustic biomass estimates in 2017 and 2019 and the 2019 age frequency. A single stock, single sex, single area, age-structured model was implemented in CASAL. There were three main model runs which used Bayesian estimation to estimate marginal posterior distributions for virgin biomass (B_0) and current stock status (SS_{2020}). Two of the models were constructed as "worst case" scenarios in an attempt to determine the lowest possible stock status consistent with the data and model assumptions. The other model used the standard approach for orange roughy stock assessments (e.g., Cordue 2014). The estimates of B_0 were consistent with previous estimates of virgin biomass. These estimates are driven by the total removals from the fishery.

The estimates of current biomass and stock status varied widely across the three preliminary models. The standard model adequately fitted the data. However, a low estimate of the acoustic q implied that the acoustic surveys had missed one or more spawning plumes. The other two models had lower stock status but were unable to fit the acoustic estimates and predicted much more spawning biomass in those years than had been observed (even allowing for the scaling effect of an acoustic q of about 0.6). Therefore, all three of the models implied that the acoustic surveys may have missed one or more spawning plumes.

It should be noted that since the ORH 7A stock has rebuilt spawning plumes have developed in areas where they were not previously seen (e.g., Cordue 2019). Also, for the ESCR orange roughy stock, there is an "old plume" which has been found in the same location for many years and a "new plume" which developed in a different location and consists of younger fish (Doonan et al 2017). The Working Group was unwilling to accept an assessment where current stock status depends on the existence of spawning biomass that has not been observed. The main alternative to an additional unobserved spawning plume is that there has been little recruitment to the spawning population since the closure of the fishery.

3.6 Future research considerations

The preliminary stock assessment results highlight the discrepancy between the expected increase in spawning stock biomass due to a lack of fishing and the observed acoustic survey spawning biomass estimates. Either there are spawning fish that have not been found or there has been an extended period of very low recruitment to the spawning population.

The next survey of Cook Canyon should include more time for searching than has been allocated previously in order to:

- Obtain multiple snapshot estimates of the Cook Canyon spawning plume,
- Perform targeted trawling on the spawning plume to obtain a representative age frequency,

- Search for additional spawning plumes in new areas near but outside Cook Canyon (in orange roughy depths but not necessarily associated with a feature or previous fishing for orange roughy).

4. STATUS OF THE STOCK

Stock Structure Assumptions
The ORH 7B stock has been treated as a single spawning stock located around the Cook Canyon area. It is assessed and managed separately from other stocks and is assumed to be non-mixing with orange roughy stocks outside of the Cook Canyon area.

Stock Status	
Year of Most Recent Assessment	2020 (preliminary)
Assessment Runs Presented	N/A
Reference Points	Target: 30–50% B_0 Soft Limit: 20% B_0 Hard Limit: 10% B_0 Overfishing threshold: -
Status in relation to Target	Unknown
Status in relation to Limits	Unknown

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Unknown, but biomass is likely to have increased since the closure of the fishery in 2007.
Recent Trend in Fishing Mortality or Proxy	Fishing mortality has been very low, limited to research catches, as the fishery has been closed since October 2007.
Other Abundance Indices	Acoustic surveys carried out in 2017 and 2019 showed no change in abundance
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Unknown but likely to be increasing at current catch levels
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unknown Hard Limit: Unknown

Assessment Methodology and Evaluation		
Assessment Type	N/A	
Assessment Method	N/A	
Assessment Dates	Latest assessment: 2020 (preliminary)	Next assessment: 2021
Overall assessment quality rank	N/A	
Main data inputs (rank)	- Catch history - Acoustic biomass 2017, 2019 - Survey age frequency 2019	1 – High Quality 1 – High Quality 1 – High Quality
Data not used (rank)	- CPUE Trawl surveys 1983, 1986, 1991, 2016	3 – Low Quality: not considered to be an index of abundance 3 – Low Quality: not considered to be an index of abundance
Changes to Model Structure and Assumptions	N/A	

Major Sources of Uncertainty	- The predicted spawning population, based on the estimated virgin biomass, catch history, and the expected increase with the lack of fishing since 2008, has not been detected by recent acoustic surveys

Qualifying Comments
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Fishery Interactions
Historically, the main bycatch species were oreos and deepwater dogfish. Other bycatch species recorded include deepwater sharks, deepsea skates and corals. The fishery is currently closed.

5. FOR FURTHER INFORMATION

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