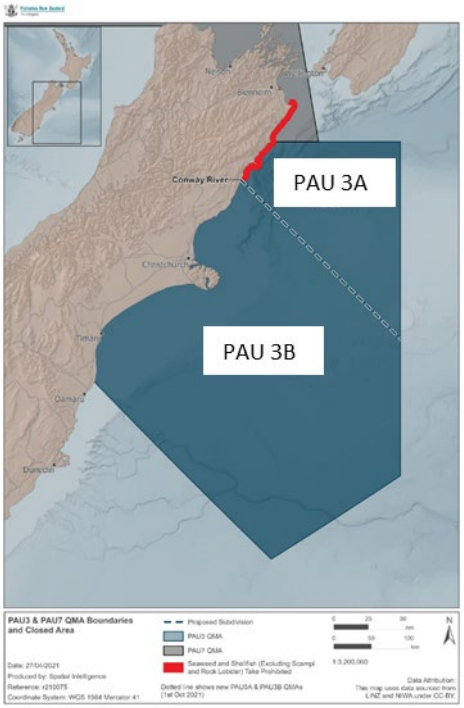
PĀUA (PAU 3B) - Canterbury

(*Haliotis iris*)
Pāua



1. FISHERY SUMMARY

Prior to October 2021, PAU 3B was part of the PAU 3 QMA, which was introduced into the QMS on 1 October 1986 with a TACC of 57 t and later increased to 91.62 t in 1995 as a result of appeals to the Quota Appeal Authority (Table 1).

The coastline between the Clarence River and Conway River was closed to commercial and recreational pāua fishing to protect the surviving pāua populations and associated habitats (see coastline in red in figure above) due to a significant loss of pāua habitat resulting from coastal uplift following the 2016 Kaikōura earthquakes. In addition, the TACC was lowered to 45.8 t, and a TAC was set at 79.3 t with a customary allowance of 15 t, a recreational allowance of 8.5 t, and other sources of mortality were at 10 t (Table 1). The closure of the Kaikōura coastline to fishing caused fishing effort to move onto the remaining open Canterbury coastline, which was unaffected by the earthquake, south of statistical area P310 (now PAU 3B).

On 1 October 2021, the PAU 3 QMA was subdivided into two smaller QMAs—PAU 3A (Kaikōura) and PAU 3B (Canterbury)— in response to the changed nature of the fishery (see figure above). At that time, a new TAC, TACC, and allowances were set to reflect the QMA subdivision, pre-earthquake catch levels, and the need to adopt a precautionary approach to enable the PAU 3A fishery rebuild to continue while providing for utilisation opportunities.

Table 1: Total allowable catches (TAC, t) allowances for customary fishing, recreational fishing, and other sources of mortality (t) and Total Allowable Commercial Catches (TACC, t) declared for PAU 3 and PAU 3B since introduction to the QMS.

Year	TAC	Customary	Recreational	Other mortality	TACC
1986–1995*	–	–	–	–	57.0
1995–2017*	–	–	–	–	91.62
2017–2021*	79.3	15	8.5	10	45.8
2021–present	80	15	9	10	46

*PAU 3 figures

1.1 Commercial fisheries

The fishing year runs from 1 October to 30 September. Commercial fishers gather pāua by hand while freediving.

On 1 October 2001 it became mandatory to report catch and effort on Pāua Catch Effort Landing Returns (PCELRs) using fine-scale reporting areas that had been developed by the New Zealand Pāua Management Company for their voluntary logbook programme. Figure 1 shows these fine scale statistical reporting areas with a focus on PAU 3B which became effective on 1 October 2021 and which corresponds to the fine-scale reporting statistical areas 311 to 339.

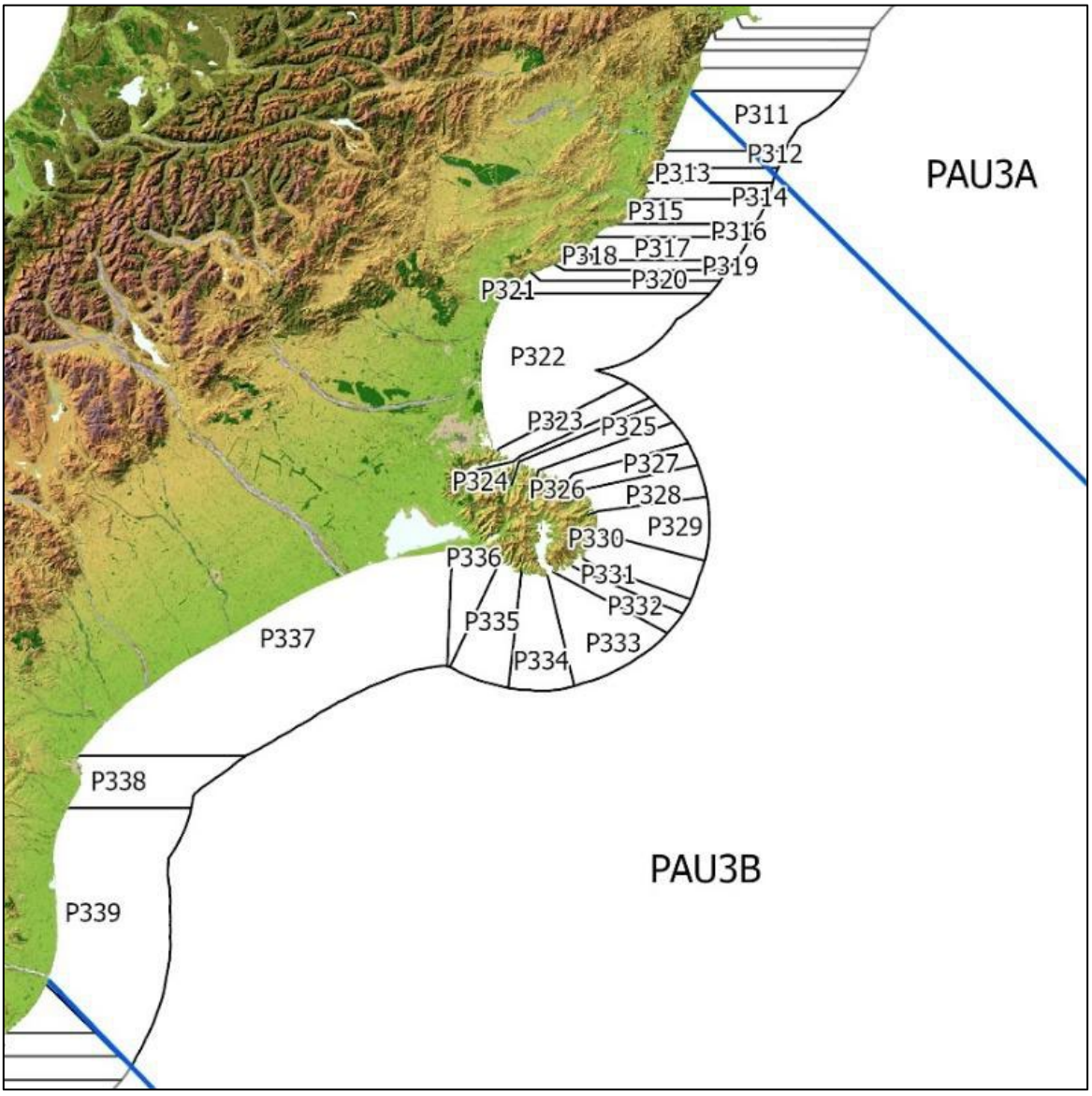


Figure 1: Map of fine scale statistical reporting areas for PAU 3.

Reported landings for PAU 3 are shown in Figure 2 and Table 2 between 1983–84 and 2020–21. Landings in PAU 3 have closely followed the TACC since the fishing year 1991–92. The commercial sector accounts for most of the harvest in the previous PAU 3 fishery.

Prior to the 2016 earthquakes, commercial catches predominantly came from the Kaikōura coastline (now PAU 3A) and Motunau/Banks Peninsula. Annual commercial catches were generally evenly distributed between these two fishing areas with about 45 tonnes (50% of the 91.6 tonne TACC) being caught in each area.

Since 2001, a redistribution of fishing effort within PAU 3 has been undertaken by the industry as a response to fears that the more accessible northern part of the fishery was being overfished. A voluntary subdivision was agreed by PāuaMAC3 which divided PAU 3 into four management zones.

A voluntary harvest cap was placed on each management zone and this cap was reviewed annually. Minimum harvest sizes (MHS) were also agreed each year for each zone in addition to the legislated minimum legal size (MLS). These management initiatives were officially in place until 2020–21.

Following the 2016 earthquakes, the coastline from Clarence Point in the north to the Conway River in the south was closed to all commercial (and recreational) fishing. This caused all commercial catches to be taken entirely from the open unaffected Canterbury areas, mainly the southern side of Banks Peninsula.

Table 2 also shows the reconstructed estimated catch equivalent to PAU 3B from the estimated PAU 3 catch between 2001–02 and 2020–21 and the reported landings for PAU 3B since 2021–22. The reported PAU 3B landings in 2021–22 totalled 46.56 t, with a TACC (t) of 46 t.

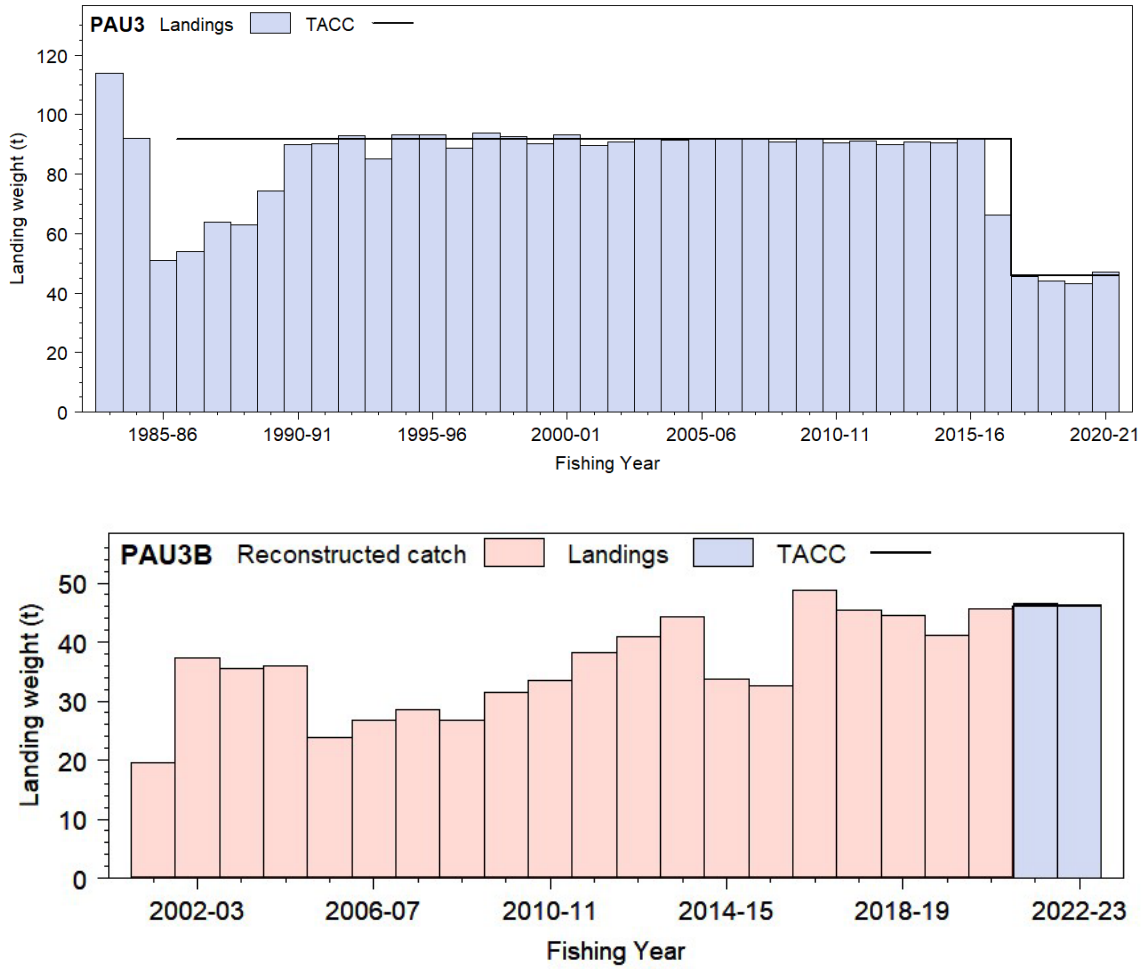


Figure 2: Reported commercial landings and TACC for PAU 3 (top) from 1983–84 to 2020–21 (last year before the QMA subdivision) and PAU 3B (bottom). The PAU 3B reconstructed landings between 2001-02 and 2020–21 correspond to the PAU 3 estimated catch for statistical areas 311 to 339 which correspond to PAU 3B QMA created in 2021–22.

In 2021, the Minister for Ocean and Fisheries approved a Fisheries Plan for the PAU fishery under s11A of the Fisheries Act 1996 to better manage commercial harvest activity across the wider fishery. This Plan prescribes using an 'adaptive rebuild' approach in response to the Kaikōura earthquakes using a number of tools including catch spreading arrangements, harvest control rules, larger minimum harvest size, and fine scale catch reporting and monitoring. The Plan includes new voluntary management areas (Table 3).

Table 2: TACC and reported landings (t) of pāua in PAU 3 between 1983–84 and 2020–21 and in PAU 3B from 2021–22. The PAU 3B reconstructed landings between 2001-02 and 2020-21 correspond to the PAU 3 estimated catch for statistical areas 311 to 339 which correspond to PAU 3B QMA created in 2021–22.

	PAU 3		PAU 3B		
Year	Landings	TACC	Reconstructed estimated catch	Landings	TACC
1983–84*	114.00	–	–	–	–
1984–85*	92.00	–	–	–	–
1985–86*	51.00	–	–	–	–
1986–87*	54.02	57.00	–	–	–
1987–88*	62.99	60.49	–	–	–
1988–89*	57.55	66.48	–	–	–
1989–90	73.46	69.43	–	–	–
1990–91	90.68	77.24	–	–	–
1991–92	90.25	91.50	–	–	–
1992–93	94.52	91.50	–	–	–
1993–94	85.09	91.50	–	–	–
1994–95	93.26	91.50	–	–	–
1995–96	92.89	91.62	–	–	–
1996–97	89.65	91.62	–	–	–
1997–98	93.88	91.62	–	–	–
1998–99	92.54	91.62	–	–	–
1999–00	90.30	91.62	–	–	–
2000–01	93.19	91.62	–	–	–
2001–02	89.66	91.62	19.67	–	–
2002–03	90.92	91.62	37.29	–	–
2003–04	91.58	91.62	35.47	–	–
2004–05	91.43	91.62	36.01	–	–
2005–06	91.60	91.62	23.80	–	–
2006–07	91.61	91.62	26.72	–	–
2007–08	91.67	91.62	28.50	–	–
2008–09	90.84	91.62	26.73	–	–
2009–10	91.61	91.62	31.50	–	–
2010–11	90.40	91.62	33.59	–	–
2011–12	91.14	91.62	38.15	–	–
2012–13	90.01	91.62	40.99	–	–
2013–14	90.85	91.62	44.19	–	–
2014–15	90.44	91.62	33.73	–	–
2015–16	91.73	91.62	32.66	–	–
2016–17	66.29	91.62	48.76	–	–
2017–18	45.59	45.80	45.49	–	–
2018–19	44.05	45.80	44.46	–	–
2019–20	43.09	45.80	41.20	–	–
2020–21	47.10	45.80	45.54	–	–
2021–22	–	–	–	46.56	46.00
2022–23				46.02	46.00

* FSU data.

Table 3: Summary of the management zones within PAU 3B as initiated by PāuaMAC3.

Management zone (since 2021)	Area	Statistical area zone
3B1	Conway River to Motunau Island	P311–P317
3B2	Motunau Island	P318
3B3	Motunau Island to Hickory Bay	P319–P329
3B4	Hickory Bay to Te Oka Bay	P330–P335
3B5	Te Oka Bay to Waitaki River	P336-P339

1.2 Recreational fisheries

For further information on recreational fisheries refer to the Introduction – Pāua chapter. The 'National Panel Survey of Marine Recreational Fishers 2022–23: Harvest Estimates' estimated that the recreational harvest for PAU 3B was 2.4 t with a CV of 33% (Heinemann & Gray, in prep). Previous National Panel Survey estimates from the PAU 3B area are 6.7 t (CV 56%) and 8.8 t (CV 36%) in 2011–12 and 2017–18 (Wynne-Jones et al 2014; 2019).

1.3 Customary fisheries

Pāua is a taonga species and as such there is an important customary use of pāua by Maori for food, and the shells have been used extensively for decorations and fishing devices.

For information on customary catch regulations and reporting refer to the Introduction – Pāua chapter.

Estimates of customary catch for PAU 3 until 2020–21 are shown in Table 4. These numbers are likely to be an underestimate of customary harvest because only the catch approved and harvested in numbers are reported in the table. In addition, many tangata whenua also harvest pāua under their recreational allowance and these are not included in records of customary catch.

Landings before 2010–11 do not include the area between the Hurunui River and the South Shore (just north of Banks Peninsula), because tangata tiaki were not appointed there until November 2009.

Estimates of customary take before the 2016 earthquakes ranged from about 7 to 13 tonnes. Customary take then initially declined given the immediate loss of significant pāua abundance along the Kaikōura coastline, but increased in 2019–20 in response to feeding the local communities during the Covid-19 event. Information is not available at the PAU 3B level up to 2020–21 and customary estimates since 2021–22 for PAU 3B are shown in Table 5.

Table 4: Fisheries New Zealand records of customary harvest of pāua (approved and reported in numbers) in PAU 3 between 2000–01 and 2020–21. Landings data before 2010–11 exclude the area between the Hurunui River and Pegasus Bay. – no data.

	Numbers			Numbers	
Fishing year	Approved	Harvested	Fishing year	Approved	Harvested
2000–01	300	230	2011–12	5 675	4 242
2001–02	6 239	4 832	2012–13	15 036	12 874
2002–03	3 422	2 449	2013–14	10 259	7 566
2003–04	–	–	2014–15	8 761	7 035
2004–05	–	–	2015–16	14 801	11 808
2005–06	1 580	1 220	2016–17	11 374	9 217
2006–07	5 274	4 561	2017–18	2 708	1 725
2007–08	7 515	5 790	2018–19	480	278
2008–09	10 848	8 232	2019–20	30 288	21 527
2009–10	8 490	6 467	2020–21	11 462	8 609
2010–11	8 360	7 449			

Table 5: Fisheries New Zealand records of customary harvest of pāua (approved and reported in numbers) in PAU 3B since 2021–22. – no data.

Fishing	Numbers	
year	Approved	Harvested
2021–22	6 041	4 013
2022–23	2 160	1 086

1.4 Illegal catch

For further information on illegal catch refer to the Introduction – Pāua chapter.

Within the 2021 stock assessment process (no accepted assessment was produced), the SFWG agreed to assume that illegal catches rose linearly from 1 t in 1974 to 10 t in 1990 and remained at 10 t between 1990 and 2000. A subsequent decline in illegal fishing from 10 t in 2000 to 2 t by 2010 was assumed due to perceived advances in fisheries enforcement.

1.5 Other sources of mortality

For further information on other sources of mortality refer to the Introduction – Pāua chapter.

On 16 November 2016 a 7.8 magnitude earthquake hit the upper east coast of the South Island, causing extensive uplift of about 110 km of coastline by as much as 6 m in some areas. This resulted in the widespread mortality of marine organisms, changes to the structure of intertidal and subtidal rocky reefs, and significant alterations to the structure of nearshore reef communities (Alestra et al 2019).

The whole northern part of the PAU 3 fishery (Pāua Statistical Areas P301 to P310, now PAU 3A) was impacted to varying degrees by the earthquake; however, the area now included within PAU 3B was largely unaffected. The earthquake caused the direct mortality of a large number of juvenile and adult pāua that became exposed to the terrestrial environment with no means of being able to return to the water. More indirect mortality is also expected from the earthquake due to an immediate loss of pre-earthquake pāua habitat that now lies above the new post-earthquake high tide mark.

2. BIOLOGY

For further information on pāua biology refer to the Introduction – Pāua chapter. A summary of published estimates of biological parameters for PAU 3 is presented in Table 6. Note, that these values are from the most recent stock assessment covering the whole of PAU 3 and may therefore not be appropriate for PAU 3B. No area-specific, representative biological data are available for PAU 3B.

Table 6: Estimates of biological parameters (*H. iris*) in PAU 3.

	Estimate	Source
1. Natural mortality (*M*)		
	0.135 (0.120–0.153)	Median (5–95% range) of posterior distribution for the base case model
2. Weight = a(length)^b (Weight in g, length in mm shell length)		
All	a = 2.99 x 10 $^{-5}$, b = 3.303	Schiel & Breen (1991)
3. Size at maturity (shell length)		
	50% maturity at 82 mm (80–84)	Median (5–95% range) of posterior distribution for the base case model
	95% maturity at 102 mm (96–108)	Median (5–95% range) of posterior distribution for the base case model

3. STOCKS AND AREAS

For further information on stocks and areas refer to the Introduction – Pāua chapter.

4. STOCK ASSESSMENT

A stock assessment for the PAU 3B area was attempted in 2021–22, based on estimates of historical catches, CPUE trends, and commercial length frequency data. CPUE trends were found to be stable despite steady increases in catch over the past decades. For this reason, all stock assessment models that were attempted estimated an exceedingly high biomass that was judged to be implausible by the Fisheries New Zealand Shellfish Working Group. In the absence of an acceptable assessment model, the Shellfish Working Group explored comparative analyses of absolute CPUE in PAU 3B in comparison with areas of assessed stock status. These analyses were used to gain a qualitative understanding of current biomass level and exploitation rate in the fishery.

4.1 Relative abundance estimates from standardised CPUE analyses

PCELR and ERS data from 2002 to 2021 were used to derive a standardised, fishery-dependent index of abundance, initially for use within a stock assessment model, and subsequently to estimate median current absolute CPUE. Data prior to 2002 (CELR, FSU reporting) were not used in the assessment process; as for other recent assessments, changes to the composition of the fleet and gear during the 1990s, combined with inconsistent reporting, mean that the trends in CPUE from CELR data are questionable and likely hyper-stable to an unknown degree in most PAU QMAs.

CPUE standardisation was carried out using Bayesian Generalised Linear Mixed Models (GLMM) which partitioned variation among fixed (research strata) and random variables. CPUE was defined as the log of daily catch. Variables in the model were fishing year, estimated fishing effort, client number, research stratum, diver ID (PCELR). Previous standardisation models for PCELR data routinely used small scale statistical areas as a standardising variable. For the present assessment, this variable was not available with sufficient precision for recent (ERS) data, where it is inferred from position data, and was therefore omitted. Nevertheless, follow-up work on the quality of ERS data for pāua CPUE suggested limited effects of spatial reporting and the inclusion, or not, of statistical areas in the standardisation made little difference to resulting indices before 2021 (Neubauer & Kim 2023).

Standardised CPUE in all areas suggested increases in recent years, after nearly two decades of stable CPUE (Figure 3), with the most notable increase in zone B2 - Motunau Island and highly variable trends

in raw CPUE in other areas. While other zones (B3, B4) also showed increases in raw CPUE in 2020 and 2021, these increases were largely compensated by the standardisation model. Median absolute CPUE (> 50 kg/h) was found to be substantially higher than in all assessed PAU QMAs (< 50 kg/h), suggesting that current PAU densities in PAU 3B are high relative to other QMAs. The latter may be linked to relatively low catches across the PAU 3B area prior to the 2016 Kaikōura earthquake, when most of the commercial catch was located in areas P301–P310, which now make up the PAU 3A QMA.

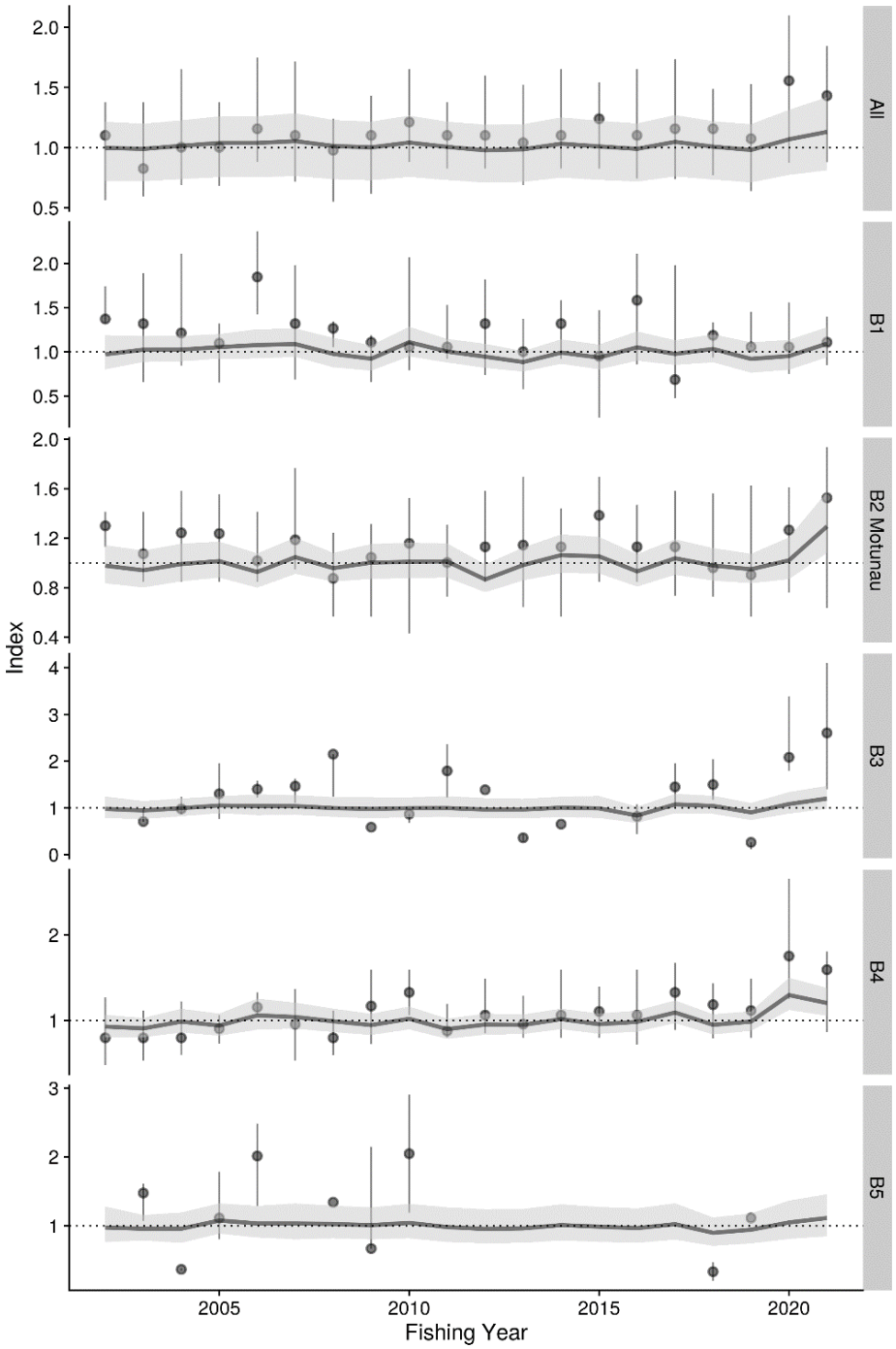


Figure 3: Raw CPUE (points are median with inter-quartile interval indicated by vertical intervals) and standardised CPUE index (line) with 95% confidence interval (shaded ribbon) by industry management zone (B1–B5) and overall (All). Shading of points indicates the relative amount of data available for standardisation.

4.2 Operating model and testing management procedures

With the establishment of PAU 3B, there has been increased interest in understanding the stock status of the area and in developing management measures that can maintain the fishery at target levels. Between 2020 and 2022, a project aimed to develop models to understand stock status and to test potential management procedures in PAU 3B.

The project compiled catch, catch-per-unit-effort (CPUE), and length frequency information to inform models for stock in PAU 3B. Catch and CPUE information is only known with some certainty since the early 2000s and the establishment of fine-scale pāua statistical areas, which allow partitioning of PAU 3 catches and catch and effort data into PAU 3A and PAU 3B components. Assumptions about spatial catch splits needed to be made to reconstruct catches prior to 2002. Nevertheless, early catches were likely relatively low because the area was less targeted by commercial fisheries than the northern area of PAU 3. The CPUE has remained relatively constant throughout the 2000s, with a small increase in recent years (see section 4.1).

An initial attempt to fit stock assessment models was unsuccessful based on the flat or increasing CPUE, which occurred in the context of increasing catch over time. In the absence of a robust stock assessment model, the use of CPUE (kg/h) relative to CPUE in other areas was explored as an indirect measure of potential stock status or exploitation rate. This approach suggested a relatively low exploitation rate and high stock status.

To test potential harvest control rules, we used empirical estimates of stock status to condition operating models using depletion-based stock reduction analysis. The operating models produced a range of outcomes depending on productivity assumptions and conditioning constraints and were used to test the suitability of control rules to maintain target catch rates.

4.3 Other factors

Another source of uncertainty are the catch data. The commercial catch is known with accuracy since 1985 but is probably not well estimated before that. Furthermore, the recent split of PAU 3 into PAU 3A and PAU 3B following the Kaikōura earthquake and subsequent fishery closure did not match the early (CELR) reporting areas, leading to substantial uncertainties about catch prior to 2002, when PCELR and fine-scale reporting was introduced. In addition, non-commercial catch estimates are poorly determined. Therefore, better information on the scale and trend in recreational catch needs to be collated for more accurate assessment of the stock status.

5. STATUS OF THE STOCKS

- **PAU 3B - Canterbury**

Stock Status		
Most Recent Assessment Plenary Publication Year	2022, not successful given conflicting signals in catch and CPUE trends	
Catch in most recent year of assessment	Year: 2020–21	Catch: 46 t
Assessment Runs Presented	-	
Reference Points	Target: 40% B_0 (Default as per HSS) Soft Limit: 20% B_0 (Default as per HSS) Hard Limit: 10% B_0 (Default as per HSS) Overfishing threshold: $U_{40\%B0}$	
Status in relation to Target	Unknown, but likely relatively high given that CPUE levels are well above most other mainland QMAs	
Status in relation to Limits	Unknown	
Status in relation to Overfishing	Unknown	

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	CPUE has been stable or increasing in all management zones, despite increasing catches.
Recent Trend in Fishing Intensity or Proxy	Steady increase in catch over the past decades, but high and stable CPUE suggests low overall exploitation rates.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Unknown
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

Assessment Methodology and Evaluation		
Assessment Type	None accepted	
Assessment Method	N/A	
Assessment Dates	Latest assessment Plenary publication year: 2021	Next: unknown
Overall assessment quality (rank)	N/A	
Main data inputs (rank)	- Catch history	1 – High Quality for commercial catch 2 – Medium or Mixed Quality for recreational catch, which is not believed to be fully representative over the history of the fishery
	- CPUE indices early series	2 – Medium or Mixed Quality: not believed to proportional to abundance
	- CPUE indices later series (since 2002)	1 – High Quality
	- Commercial sampling length frequencies	1 – High Quality
	- Tag recapture data (to estimate growth)	2 – Medium or Mixed Quality: no area specific data, inferred from meta-analysis of New Zealand-wide data
	- Maturity at length data	1 – Medium or Mixed Quality: no area specific data, inferred from meta-analysis of New Zealand-wide data
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	No accepted stock assessment model	
Major Sources of Uncertainty	- Catch levels and trends uncertain prior to 2002 - CPUE may not be a reliable index of abundance at low exploitation rates - Very little growth data available and growth not well known	

Qualifying Comments:
-

Fishery Interactions
-

6. FOR FURTHER INFORMATION

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