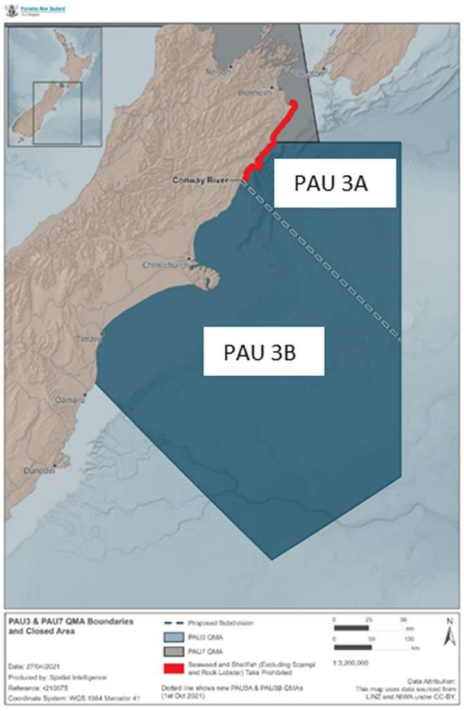
PĀUA (PAU 3A) – Kaikōura

(*Haliotis iris*)
Pāua



1. FISHERY SUMMARY

Prior to October 2021, PAU 3A was part of the PAU 3 QMA. The PAU 3 fishery 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 for PAU 3 was lowered to 45.8 t, and the 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 unaffected open Canterbury coastline (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 fishery to 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 3A 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	40.5	7.5	5	5	23.0

*PAU 3 figures

1.1 Commercial fisheries

The fishing year runs from 1 October to 30 September.

Commercial fishers in PAU 3A gather pāua by hand while freediving. 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 northern part of the QMA, now PAU 3A, between the northern end of Pegasus Bay and the Clarence River, and from the southern side of 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.

Reported landings for PAU 3 are shown in Figure 1 and Table 2 between 1983–84 and 2020–21. Landings in PAU 3 closely followed the TACC between the fishing year 1991–92 and the 2016 earthquake closure. 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. The reported landings in 2020–21 totalled 47.10 t, with a TACC of 45.8t, all of which came from areas unaffected by the earthquake, which remained opened to commercial fishing. These areas now make up the PAU 3B QMA.

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 2). The PAU 3A QMA effective since 1 October 2021 corresponds to the fine scale reporting statistical areas 301 to 310.

Table 2 shows the reconstructed estimated catch equivalent to PAU 3A from the estimated PAU 3 catch between 2001–02 and 2020–21. Table 2 also shows the reported landings for PAU 3A since 2021–22, noting the fishing season for 2021–22 was only 3 months (1 December 2021 to 28 February 2022).

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.

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 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).

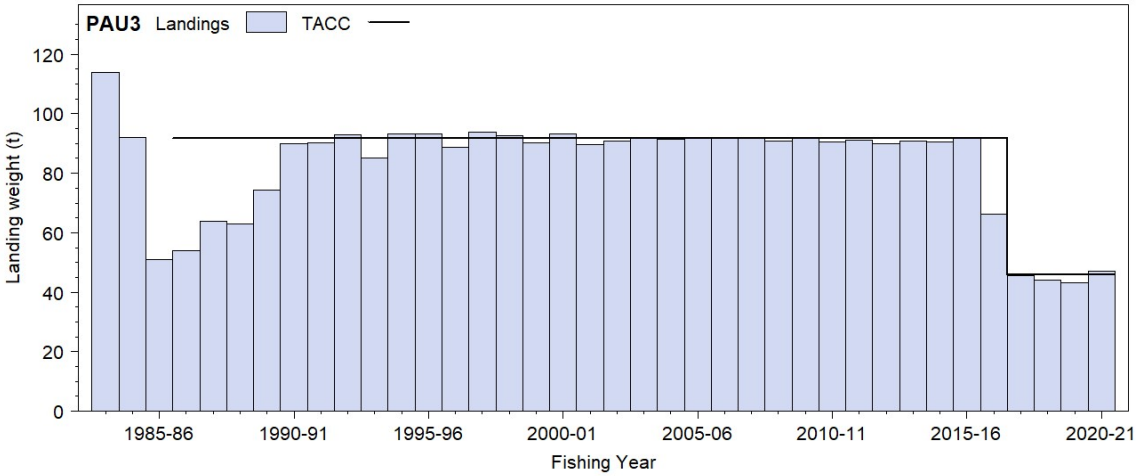


Figure 1: Reported commercial landings and TACC for PAU 3 from 1983–84 to 2020–21 (last year before the QMA subdivision).

Table 2: TACC and reported landings (t) of pāua in PAU 3 between 1983–84 and 2020–21 and in PAU 3A from 2021–22. * FSU data. † the 2021–22 season was 1 December 2021 to 28 February 2022. The PAU 3A reconstructed landings between 2001–02 and 2020–21 correspond to the PAU 3 estimated catch for statistical areas 301 to 310 which correspond to PAU 3A QMA created in 2021–22.

	PAU 3		PAU 3A		
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	71.36		
2002–03	90.92	91.62	52.47		
2003–04	91.58	91.62	54.64		
2004–05	91.43	91.62	52.50		
2005–06	91.60	91.62	66.66		
2006–07	91.61	91.62	63.27		
2007–08	91.67	91.62	60.34		
2008–09	90.84	91.62	62.38		
2009–10	91.61	91.62	59.01		
2010–11	90.40	91.62	56.93		
2011–12	91.14	91.62	52.78		
2012–13	90.01	91.62	48.54		
2013-14	90.85	91.62	46.03		
2014–15	90.44	91.62	55.08		
2015–16	91.73	91.62	56.90		
2016–17	66.29	91.62	17.03		
2017–18	45.59	45.80	0		
2018–19	44.05	45.80	0		
2019–20	43.09	45.80	0		
2020–21	47.10	45.80	0		
2021–22†				20.74	23.00

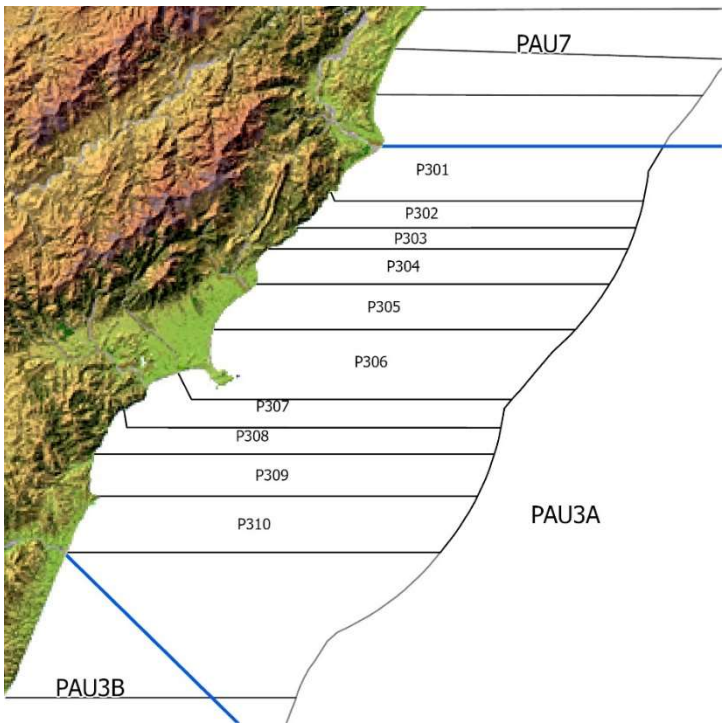


Figure 2: Map of fine scale statistical reporting areas for PAU 3.

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

Management zone (since 2021)	Area	Statistical area zone
3A1	Paparoa	P301–P302
3A2	Rakautara	P303–P304
3A3	Omihi	P307–P308
3A4	Oaro	P309–P310

1.2 Recreational fisheries

For further information on recreational fisheries refer to the Introduction – Pāua chapter. The 'National Panel Survey of Marine Recreational Fishers 2017–18: Harvest Estimates' estimated that the recreational harvest for PAU 3 was 8.8 t with a CV of 35% (Wynne-Jones et al 2019). For the 2013 stock assessment, the Shellfish Working Group (SFWG) agreed to assume that the recreational catch rose linearly from 5 t in 1974 to 17 t in 2013.

Following initial high levels of mortality related to the earthquake, local pāua abundance recovered significantly, and the pāua fishery was re-opened on 1 December 2021, until 1 March 2022. The significant local interest in the fishery and high numbers of easily accessible pāua were considered likely to lead to a very active recreational fishery, once reopened. Therefore, a recreational harvest estimation survey (Holdsworth 2021) using a roving access design was implemented over the December to March fishing period. Preliminary recreational harvest estimates are anticipated by the end of May 2022.

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 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 Kaikoura 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 3A level up to 2020–21.

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

Fishing year	Numbers		Fishing year	Numbers	
	Approved	Harvested		Approved	Harvested
2000–01	300	230	2012–13	15 036	12 874
2001–02	6 239	4 832	2013–14	10 259	7 566
2002–03	3 422	2 449	2014–15	8 761	7 035
2003–04	–	–	2015–16	14 801	11 808
2004–05	–	–	2016–17	11 374	9 217
2005–06	1 580	1 220	2017–18	2 708	1 725
2006–07	5 274	4 561	2018–19	480	278
2007–08	7 515	5 790	2019–20	30 288	21 527
2008–09	10 848	8 232	2020–21	4 960	3 242
2009–10	8 490	6 467			
2010–11	8 360	7 449			
2011–12	5 675	4 242			

1.4 Illegal catch

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

For the purpose of the 2013 stock assessment, the SFWG agreed to assume that illegal catches rose linearly from 5 t in 1974 to 15 t in 2000 and remained at 15 t between 2001 and 2013.

1.5 Other sources of mortality

The Working Group agreed that handling mortality would not be included in the model.

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 4 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). Ongoing monitoring of these nearshore reef communities has revealed signs of recovery in the low intertidal zones, whereas sub-tidally there has been little recovery in areas that were de-vegetated and previously abundant algal stands appear to have become sparser and more fragmented (Alestra et al 2020).

The whole northern part of the PAU 3 fishery (Pāua Statistical Areas P301 to P310, now PAU 3A, Figure 3) was impacted to varying degrees by the earthquake. 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.

Although the impacts of the seabed uplift on pāua populations around Kaikōura will only become clear in the longer term, work was undertaken to evaluate the area utilised by the pāua fishery that is now above the post-earthquake low tide mark (Neubauer 2017). The results suggested that the seabed uplift led to a loss of up to 50% of the pre-earthquake fished area in the pāua statistical areas P301 to P310. In area 301, the habitat loss was 7 ha, which corresponds to 52% of the fished area. However, this area has contributed relatively little to the commercial catch. In area 302, which has contributed a larger proportion of the PAU 3 commercial catch, the area lost was 43 ha, which corresponds to 43% of the fished area. In other affected areas, the area lost was generally less than 10%. Across PAU 3 statistical areas, a total of 21% of the fished area (24% of catch weight as recorded on PCELR forms), was impacted by uplift (Figure 3).

The immediate loss of area to the fishery, assumed to be good habitat for pāua, is only part of the impact that the seabed uplift associated with the Kaikōura earthquake will have on pāua populations. Juvenile pāua recruit in shallow water, and so the loss of juvenile habitat will have been higher than the loss of adult habitat. This will impact on the number of juvenile pāua growing into the fishery over the coming years. Recent surveys have indicated large scale recovery of pāua populations in the affected areas (McCowan & Neubauer 2021, 2022).

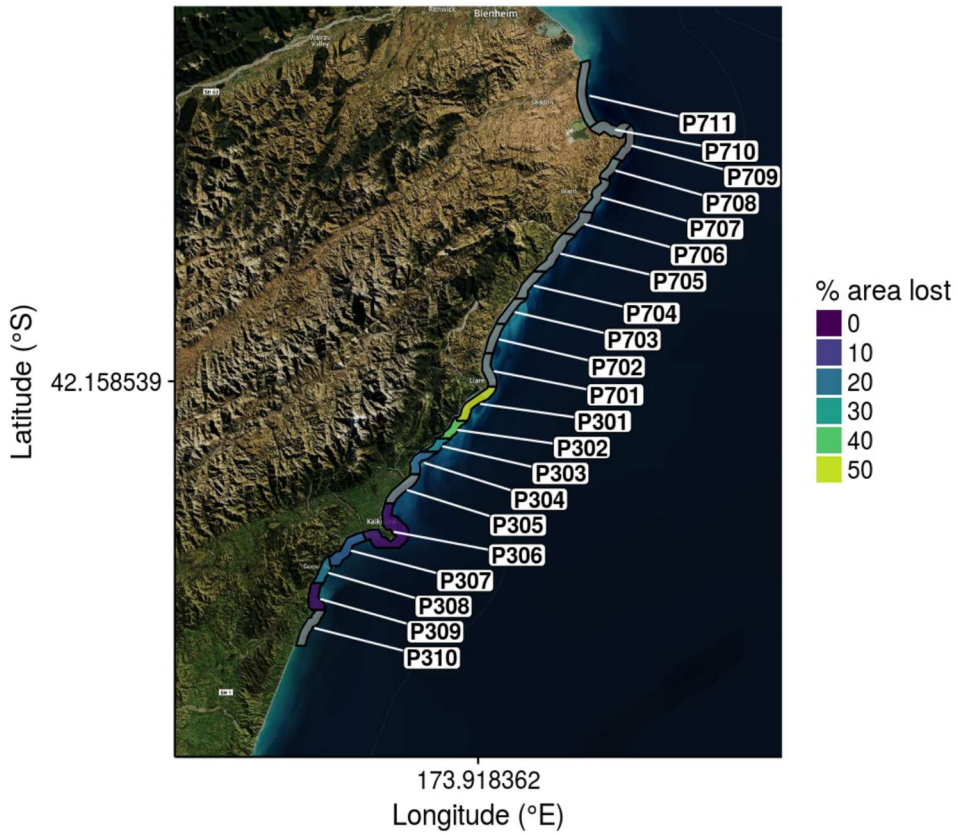


Figure 3: Percent fished area above the post-earthquake low tide mark for statistical areas within the Kaikōura earthquake fishery closure zone. Grey indicates that no post-earthquake elevation data were available.

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 5. 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 3A. No area-specific, representative biological data are available for PAU 3A.

Table 5: 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	b	
	2.99×10^{-5}	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

The last assessment for PAU 3 was conducted in 2014; however, given the potential effects of the earthquake, it is unclear how representative estimates from this assessment are for the current PAU 3A stock. Details of the PAU 3 stock assessment are given by Fu (2014).

Since the PAU 3A area has been closed to fishing, no stock assessment has been conducted. The fishery reopened in 2021–22 and several years of landing data will be necessary before a stock assessment can be attempted.

4.1 Biomass survey and monitoring

Following the 2016 Kaikōura earthquake, a biomass survey was implemented to estimate and monitor pāua abundance and recruitment in the earthquake-affected area, to inform management decisions relating to the re-opening of the pāua fishery (McCowan & Neubauer 2018, 2022). To estimate abundance, novel methodologies using GPS dive loggers and underwater electronic callipers were developed. Thirty-five sites were initially surveyed to obtain baseline estimates of site- and fishery-level abundance and length-frequency.

Pāua were mostly found in aggregations, preferentially in shallow water. This was not just the case for small pāua but also for large individuals (i.e., over 120 mm), although smaller individuals (under 100 mm) showed a strongly decreasing trend with depth. Initially estimated pāua density was 0.028 pāua per square metre (geometric mean; 95% confidence interval (CI) [0.009; 0.08]) across the earthquake-affected fishery closure. Scaling density estimates to total biomass or abundance was difficult due to the lack of robust estimates of habitat area for pāua. In the absence of a defensible solution, only density was calculated. After the first two years, the project has been extended for another three years until mid-2023.

As of March 2022, four further rounds of surveys of the 35 initially surveyed sites have been undertaken to monitor pāua abundance and recruitment trends.

Initially an assessment was made of the appropriateness of using the number of measurements per unit effort (MPUE) as a proxy for pāua density to overcome issues with missing data from GPS dive units (originally used to delimit area to estimate density) and to enable the use of significantly larger data sets of measurements and counts of pāua at each site. The measurements per unit effort, as well as biomass per unit of survey effort (BPUE, number of measurements multiplied by the length frequency distribution of measured pāua), correlated well (R^2=0.86) with density. Therefore, MPUE and BPUE were used as indices of changes in pāua density.

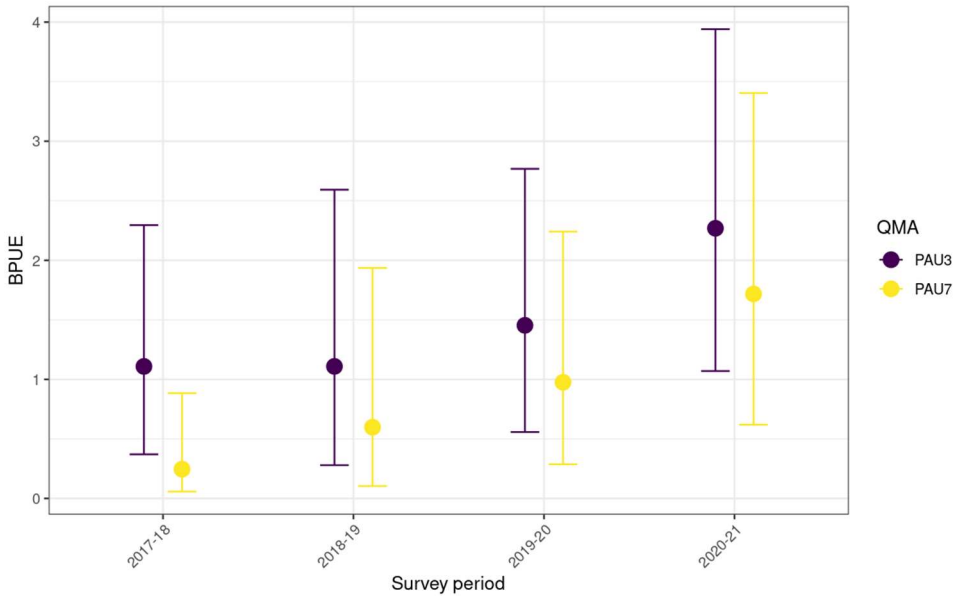


Figure 4: Marginal trend (relative to a geometric mean of 1) in biomass per unit effort (BPUE) across survey years for QMAs PAU 3 and PAU 7 from the BPUE model after accounting for confounding variables.

An overall increase in pāua abundance was observed at a QMA-wide level in both QMAs over the four survey periods (Figure 4). Increased abundance was generally more pronounced in PAU 7 than in PAU 3. In PAU 3, abundance trended slightly downwards in the second survey period, which was likely due to the consistently poor survey conditions during the period, as well as a potential bias towards sampling sites with lower rates of increase due to weather conditions. There was high variability in abundance trends across sites. This variability was in part related to variability in the amount of uplift at each site, because sites with a larger increase in abundance were those with less uplift (Figure 5). Variability in abundance trends across sites could also be linked to habitat related factors and pre-earthquake abundance. Comparison of length frequency profiles across the four survey periods showed reasonably stable profiles in larger size classes (125–160 mm, Figure 6), with an increase in the number of individuals in the 80–100 mm size range in both QMAs, which is likely to be indicative of post-earthquake recruitment. Recruitment signals were variable between sites due to differences in available recruitment habitat and variability in uplift.

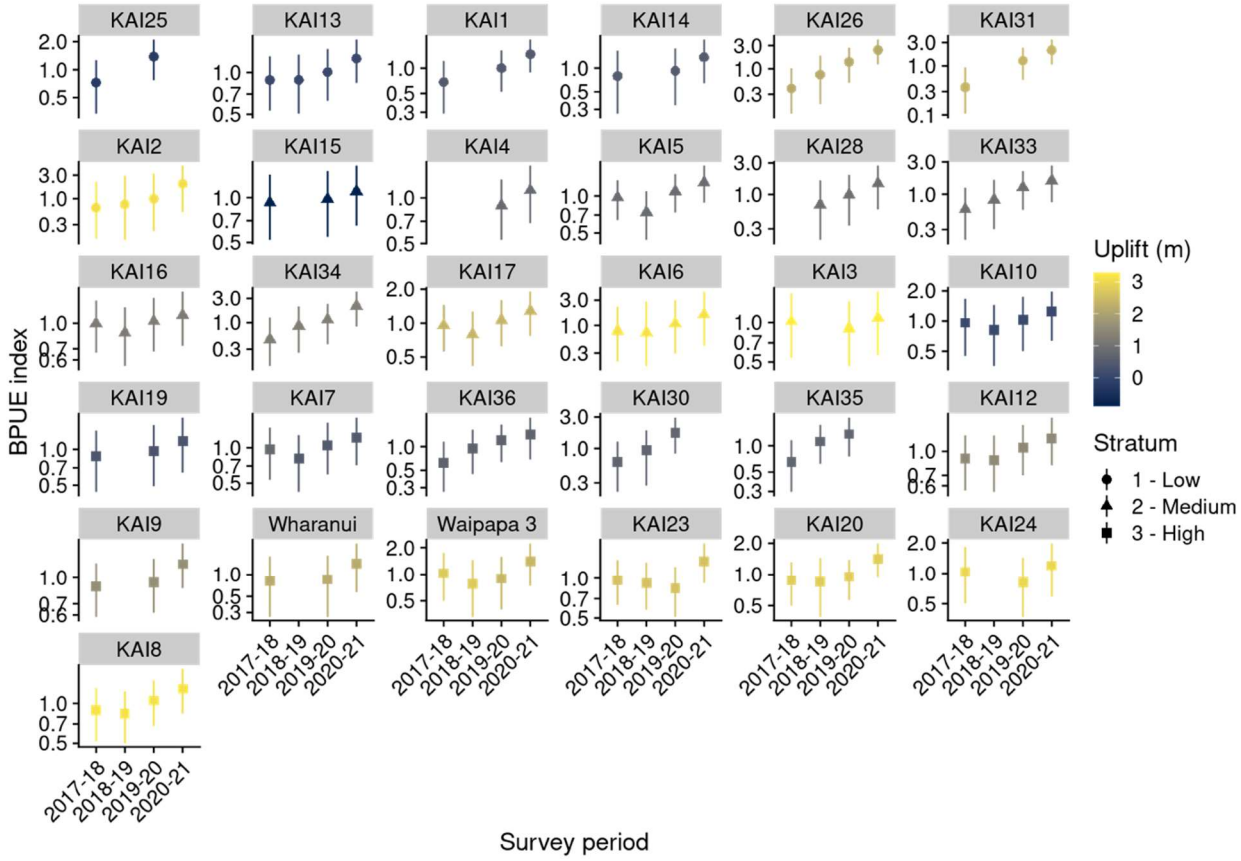


Figure 5: Marginal trend (relative to a geometric mean of 1 at each site) in biomass per unit effort (BPUE) across survey years for QMAs PAU 3 and PAU 7 from the BPUE model after accounting for confounding variables.

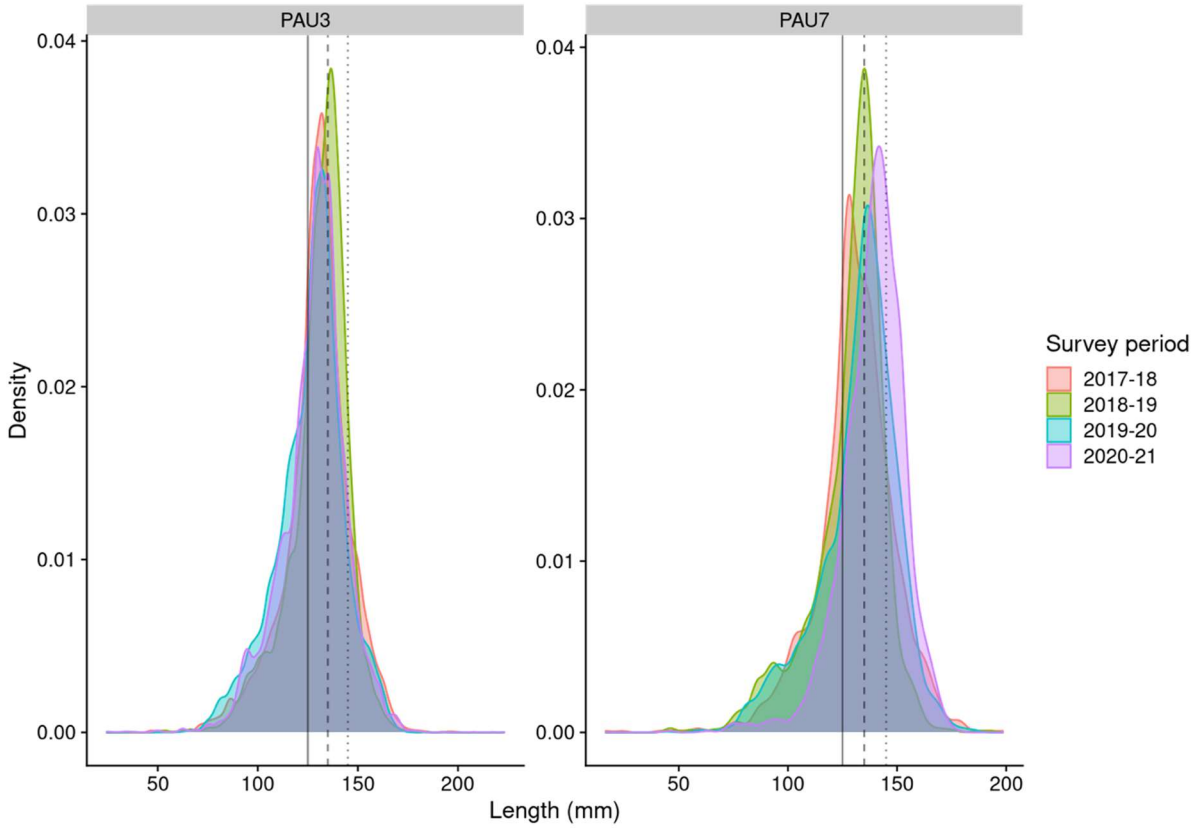


Figure 6: Length-frequency profiles (as relative densities) for all pāua measured over four survey periods in PAU 3 and PAU 7. Vertical lines show the legal size of 125 mm (MLS; solid line), 135 mm (dashed line), and 145 mm (dotted line).

5. STATUS OF THE STOCK

- **PAU 3A - *Haliotis iris***

Stock Status	
Year of Most Recent Assessment	The most recent assessment for PAU 3, conducted in 2014, is thought to be of limited use for the PAU 3A area since the 2016 Kaikoura earthquake
Assessment Runs Presented	N/A
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 CPUE levels are well above most other mainland QMAs, and a substantial biomass rebuild is evident in surveys post-earthquake
Status in relation to Limits	Unknown
Status in relation to Overfishing	Unknown

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Recent trends in the survey index provide evidence of a substantial recovery of biomass since the 2016 earthquake.
Recent Trend in Fishing Intensity or Proxy	Unknown
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Survey length frequencies showed both post-earthquake recruitment and increase in mean length.

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	N/A	
Assessment Method	N/A	
Assessment Dates	Latest:	Next: unknown
Overall assessment quality (rank)	-	
Main data inputs (rank)	-	
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	

Qualifying Comments:
The last assessment was conducted in 2014; however, given the potential effects of the earthquake, it is unclear how representative estimates from this assessment are for the current pāua stock.

Fishery Interactions
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6. FOR FURTHER INFORMATION

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