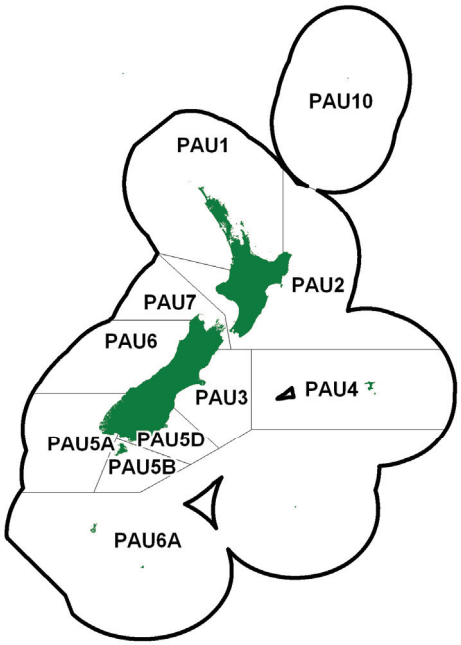
PAUA (PAU)

(*Haliotis iris, Haliotis australis*)
Paua



1. INTRODUCTION

Specific Working Group reports are given separately for PAU 2, PAU 3, PAU 4, PAU 5A, PAU 5B, PAU 5D and PAU 7. The TACC for PAU 1, PAU 6 and PAU 10 is 1.93t, 1.0t and 1.0t respectively and commercial landings for PAU 10 since 1983 have been 0.0t.

1.1 Commercial fisheries

Paua inhabit shallow waters (generally less than 6 m) off the coastline of New Zealand. The commercial fishery for paua dates from the mid-1940s, when shell was marketed and the meat generally discarded. Both meat and shell were sold from the late 1950s. Since the 1986–87 fishing season, the fishery has been managed with an individual transferable quota system and a total allowable commercial catch (TACC) for each of eight Quota Management Areas. Total reported landings of paua and TACCs are shown in Table 1while Figure 2 shows the historical landings and TACC for the main PAU stocks. Historically, two systems of spatial statistical areas have been used for reporting commercial catches of paua. Up until the 2002 fishing year, the general statistical areas were used. From 2002 onwards, a more finely scaled system of paua specific statistical areas were put in place throughout each QMA.

Fishers gather paua by hand while free diving (use of underwater breathing apparatus is not permitted). Most of the catch is from the Wairarapa coast southwards: the major fishing areas are in the South Island, Marlborough (PAU 7), Stewart Island (PAU 5) and the Chatham Islands (PAU 4). Virtually the entire commercial fishery is for the black-footed paua, *Haliotis iris*, with a minimum legal size for harvesting of 125 mm shell length. The yellow-footed paua, *H. australis* is less abundant than *H. iris* and is caught only in small quantities; it has a minimum legal size of 80 mm. Catch statistics include both *H. iris* and *H. australis*.

Table 1: TACCs and reported landings (t) of paua by Fishstock from 1983–84 to 2008–09.

	PAU 1		PAU 2		PAU 3		PAU 4		PAU 5	
Fishstock	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983–84*	1	–	110	–	114	–	409	–	550	–
1984–85*	0	–	154	–	92	–	278	–	353	–
1985–86*	0	–	92	–	51	–	221	–	228	–
1986–87*	0.01	1	96.2	100	54.02	57	267.37	261	418.9	445
1987–88*	0.98	1	122.11	111.33	62.99	60.49	279.57	269.08	465	448.98
1988–89*	0.05	1.93	121.5	120.12	57.55	66.48	284.73	270.69	427.97	449.64
1989–90	0.28	1.93	127.28	121.19	73.46	69.43	287.38	287.25	459.46	459.48
1990–91	0.16	1.93	125.82	121.19	90.68	77.24	253.61	287.25	528.16	484.94
1991–92	0.27	1.93	116.66	121.19	90.25	91.5	281.59	287.25	486.76	492.06
1992–93	1.37	1.93	119.13	121.19	94.52	91.5	266.38	287.25	440.15	442.85
1993–94	1.05	1.93	125.22	121.19	85.09	91.5	297.76	287.25	440.39	442.85
1994–95	0.26	1.93	113.28	121.19	93.26	91.5	282.1	287.25	436.13	442.85
1995–96	0.99	1.93	119.75	121.19	92.89	91.62	220.17	326.54	N/A	N/A
1996–97	1.28	1.93	118.86	121.19	89.65	91.62	251.71	326.54	N/A	N/A
1997–98	1.28	1.93	122.41	121.19	93.88	91.62	301.69	326.54	N/A	N/A
1998–99	1.13	1.93	115.22	121.19	92.54	91.62	281.76	326.54	N/A	N/A
1999–00	0.69	1.93	122.48	121.19	90.3	91.62	321.56	326.54	N/A	N/A
2000–01	1	1.93	122.92	121.19	93.19	91.62	326.89	326.54	N/A	N/A
2001–02	0.32	1.93	116.87	121.19	89.66	91.62	321.64	326.54	N/A	N/A
2002–03	0	1.93	121.19	121.19	90.92	91.62	325.62	326.54	N/A	N/A
2003–04	0.05	1.93	121.06	121.19	91.58	91.62	32.5.85	326.54	N/A	N/A
2004–05	0.27	1.93	121.19	121.19	91.43	91.62	319.24	326.54	N/A	N/A
2005–06	0.45	1.93	121.14	121.19	91.6	91.62	322.53	326.54	N/A	N/A
2006–07	0.76	1.93	121.20	121.19	91.61	91.62	322.76	326.54	N/A	N/A
2007–08	1.14	1.93	121.06	121.19	91.67	91.62	323.98	326.54	N/A	N/A
2008–09	0.47	1.93	121.18	121.19	90.84	91.62	324.18	326.52	N/A	N/A

Fishstock	PAU 6		PAU 7		PAU 10		Total	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983–84*	0.00	–	306.00	–	0.00	–	1409.00	–
1984–85*	3.00	–	1.08	–	0.00	–	881.08	–
1985–86*	0.00	–	145.92	–	0.00	–	737.92	–
1986–87*	0.00	1.00	242.18	250.00	0.00	1.00	1 078.68	1 261.00
1987–88*	0.00	1.00	244.94	250.00	0.00	1.00	1 175.59	1 269.08
1988–89*	0.00	1.00	246.03	250.00	0.00	1.00	1 137.83	1 270.69
1989–90	0.00	1.00	267.05	263.53	0.00	1.00	1 214.91	1 287.25
1990–91	0.23	1.00	273.25	266.24	0.00	1.00	1 271.91	1 287.25
1991–92	0.00	1.00	268.31	266.17	0.00	1.00	1 243.84	1 287.25
1992–93	0.88	1.00	264.80	266.17	0.00	1.00	1 187.23	1 238.04
1993–94	0.10	1.00	255.47	266.17	0.00	1.00	1 205.08	1 238.04
1994–95	18.21H	1.00	247.11	266.17	0.00	1.00	1 190.35	1 238.04
1995–96	28.62H	1.00	268.74	267.48	0.00	1.00	1 160.95	1 253.72
1996–97	0.11	1.00	267.59	267.48	0.00	1.00	1 159.43	1 257.69
1997–98	0.00	1.00	266.66	267.48	0.00	1.00	1 225.20	1 256.36
1998–99	0.00	1.00	265.05	267.48	0.00	1.00	1 200.02	1 256.36
1999–00	1.04	1.00	264.64	267.48	0.00	1.00	1 210.71	1 252.70
2000–01	0.00	1.00	215.92	267.48	0.00	1.00	1 145.69	1 220.91
2001–02	0.00	1.00	187.15	240.73	0.00	1.00	1 102.87	1 194.16
2002–03	0.00	1.00	187.22	187.24	0.00	1.00	1 075.26	1 083.50
2003–04	0.00	1.00	159.55	187.24	0.00	1.00	1 025.12	1 083.50
2004–05	0.00	1.00	166.94	187.24	0.00	1.00	1 026.81	1 058.50
2005–06	0.00	1.00	183.86	187.24	0.00	1.00	1 045.69	1 058.50
2006–07	1.00	1.00	176.05	187.24	0.00	1.00	994.71	1 058.50
2007–08	1.00	1.00	186.85	187.24	0.00	1.00	1 010.02	1 058.50
2008–09	1.00	1.00	186.85	187.24	0.00	1.00	1 008.11	1 058.50

* FSU data, H experimental landings.

Fishstock	PAU 5A		PAU 5B		PAU 5D	
	Landings	TACC	Landings	TACC	Landings	TACC
1995–96	139.53	148.98	143.66	147.66	146.60	147.66
1996–97	141.91	148.98	142.30	147.66	146.02	147.66
1997–98	145.22	148.98	145.34	148.98	148.72	147.66
1998–99	147.36	148.98	148.26	148.98	148.70	147.66
1999–00	143.91	148.98	118.19	143.98	147.90	148.98
2000–01	147.70	148.98	89.26	112.19	148.81	148.98
2001–02	148.54	148.98	89.96	112.19	148.74	148.98
2002–03	148.76	148.98	89.86	90.00	111.69	114.00
2003–04	149.10	148.98	90.00	90.00	88.02	89.00
2004–05	148.95	148.98	89.97	90.00	88.82	89.90
2005–06	148.92	148.98	90.47	90.00	88.93	89.00
2006–07	104.03	148.98	89.16	90.00	88.97	89.00
2007–08	105.13	148.98	90.21	90.00	88.98	89.00
2008–09	104.82	148.98	90.00	90.00	88.77	89.00

Note, PAU 5 was subdivided into PAU 5A, 5B and 5D on 1 October 1995 and reported landings for these Fishstocks are given separately from 1995-96.

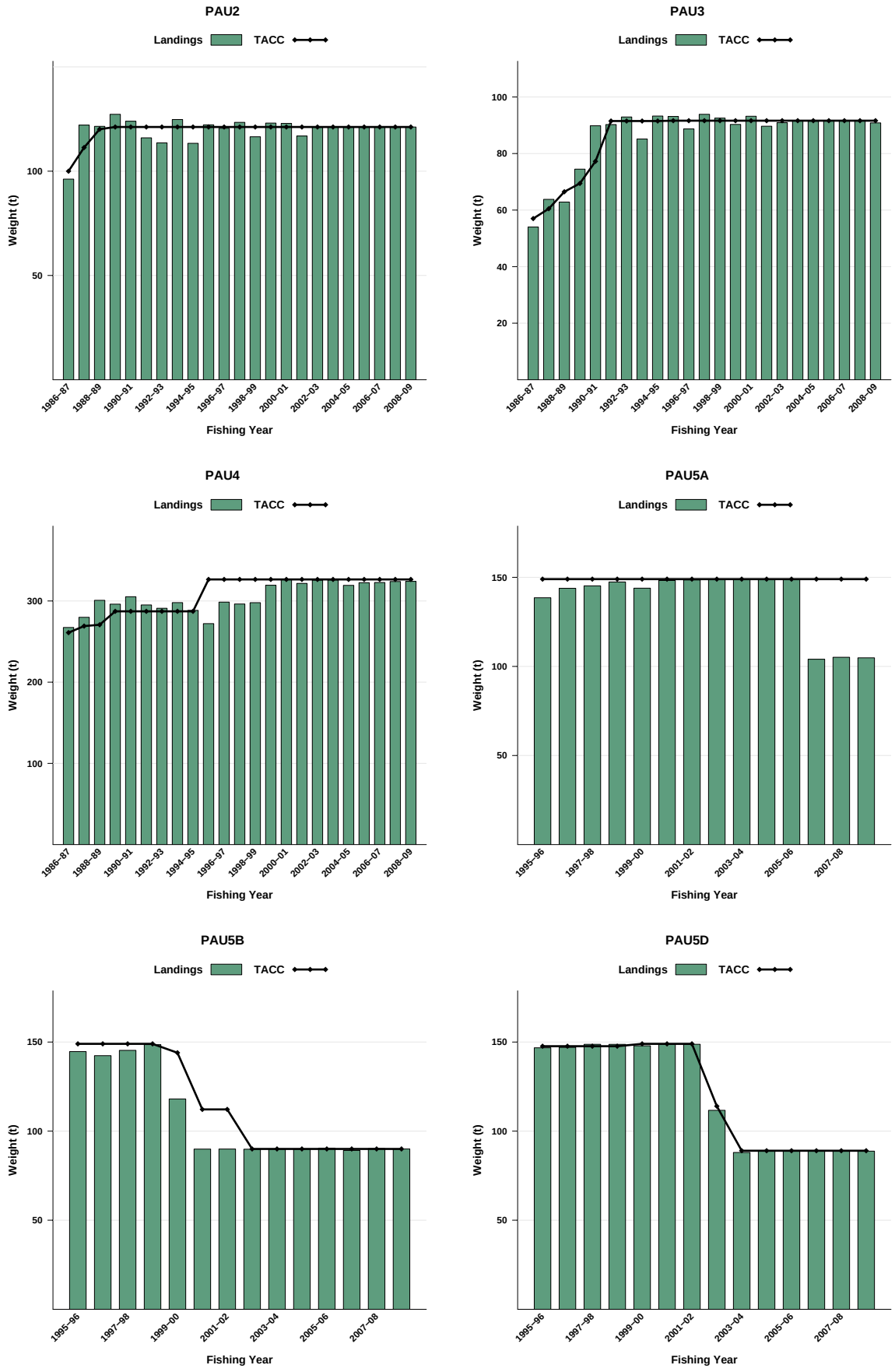


Figure 1: Historical landings and TACC for the eight main PAU stocks. From top left: PAU2 (Central), PAU3 (South East Kaikoura Coast), PAU4 (South East Chatham Rise), PAU5A (Fiordland), PAU5B (Stewart Island), PAU5D (Southland and Otago). [Continued on next page]…

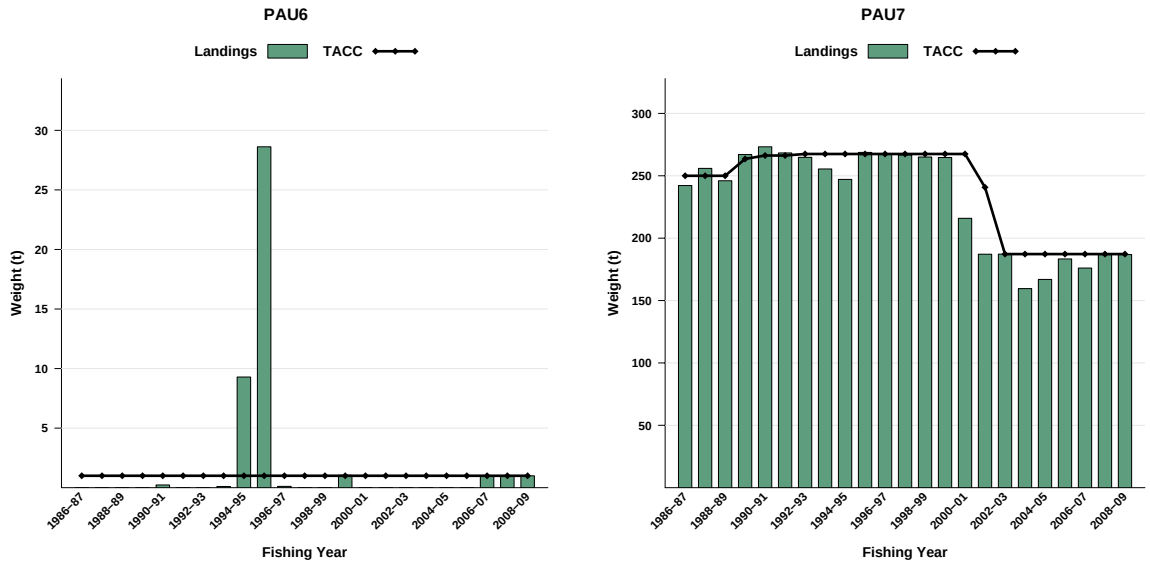


Figure 2: Continued: Historical landings and TACC for the eight main PAU stocks. From left: PAU6 (Challenger Westland), and PAU7 (Challenger Nelson Marlborough). Note that these figures do not show data prior to entry into the QMS.

1.2 Recreational fisheries

There is a large recreational fishery for paua. Estimated catches from telephone and diary surveys of recreational fishers (Teirney *et al*. 1997, Bradford 1998, Boyd & Reilly 2004, Boyd *et al.* 2004) are shown in Table 2. In 1996–97 sufficient diary data were available for an estimate in PAU 5D only (Bradford 1998, NIWA unpublished data). The Marine Recreational Fisheries Technical Working Group (RFTWG) has reviewed the harvest estimates from the national surveys. Due to a methodological error in the methodology, the harvest estimates for 1991–92 to 1993–94 and 1996–97 are not considered to be reliable. The harvest estimates for the 1999–2000 and 2000–01 surveys may be very inaccurate and some implausibly high. This may be due to a number of factors including the accuracy of the mean weight used to derive total harvest weight from the estimated numbers of paua caught by diarists, and the small number of diarists harvesting the stock in some areas. However relative comparisons can be made between stocks within the surveys.

Table 2: Estimated annual harvest of paua (t) by recreational fishers*.

Fishstock	PAU 1	PAU 2	PAU 3	PAU 5	PAU 5D	PAU 6	PAU 7
1991–92	–	–	35–60	50–80	–	–	–
1992–93	–	37–89	–	–	–	0–1	2–7
1993–94	29–32	–	–	–	–	–	–
1995–96	10–20	45–65	–	20–35	–	–	–
1996–97	–	–	–	N/A	22.5	–	–
1999–00	40–78	224–606	26–46	36–70	26–50	2–14	8–23
2000–01	16–37	152–248	31–61	70–121	43–79	0–3	4–11

*1991–1995 Regional telephone/diary estimates, 1995/6, 1999/00 and 2000/01 National Maine Recreational Fishing Surveys.

1.3 Customary non-commercial fisheries

There is an important customary use of paua by Maori for food, and the shells have been used extensively for decorations and fishing devices. Limited data is available for reported customary landings in PAU 3 however no information is available for current levels of customary non-commercial take for any other paua QMA. Kaitiaki are now in place in many areas and estimates of customary non-commercial harvest can be expected in the near future.

1.4 Illegal catch

Current levels of illegal harvests are not known. In the past, annual estimates of illegal harvest for some Fishstocks have been provided by MFish compliance based on seizures. In the current paua stock assessments, nominal illegal catches are used.

1.5 Other sources of mortality

Paua may die from wounds caused by removal, desiccation or osmotic and temperature stress at the surface. Sub-legal paua may be subject to handling mortality by the fishery if they are removed from the substrate to be measured. Further mortality may result indirectly from being returned to unsuitable habitat or being lost to predators or bacterial infection. Gerring (2003) observed paua (from PAU 7) with a range of wounds in the laboratory and found that only a deep cut in the foot caused significant mortality (40% over 70 days). In the field this injury reduced the ability of paua to right themselves and clamp securely onto the reef, and attracted predators. The tool generally used by divers in PAU 7 is a custom made stainless steel knife with a rounded tip and no sharp edges. This design makes cutting the paua very unlikely (although abrasions and shell damage may occur). Gerring (2003) estimated that in PAU 7, 37% of paua removed from the reef by commercial divers were undersize and were returned to the reef. His estimate of incidental mortality associated with fishing in PAU 7 was 0.3% of the landed catch. Incidental fishing mortality may be higher in areas where other types of tools and fishing practices are used. Mortality may increase if paua are kept out of the water for a prolonged period or returned onto sand. To-date, the stock assessments developed for paua have assumed that there is no mortality associated with capture of undersize animals.

2. BIOLOGY

Paua are herbivores which can form large aggregations on reefs in shallow subtidal coastal habitats. Movement is over a sufficiently small spatial scale that the species may be considered sedentary. Paua are broadcast spawners and spawning is thought to be annual. Habitat related factors are an important source of variation in the post-settlement survival of paua. Growth, morphometrics, and recruitment can vary over short distances and may be influenced by factors such as wave exposure, habitat structure, availability of food and population density. A summary of generic estimates for biological parameters for paua are presented in Table 3. Parameters specific to a particular area are reported the separate Working Group reports.

Table 3: Estimates of biological parameters for paua (H. *iris*).

	Estimate		Source
1. Natural mortality (*M*)			
All	0.02–0.25		Sainsbury (1982)
2. Weight = a (length)^{b} (weight in kg, shell length in mm)			
	a = 2.99E^{-08}	b = 3.303	Schiel & Breen (1991)

3. STOCKS AND AREAS

The present Fishstock boundaries may not represent discrete paua stocks.

4. ENVIRONMENTAL EFFECTS OF FISHING

This section is new for the May 2010 Plenary and has been considered by the Aquatic Environment Working Group (AEWG). It includes only a summary of the incidental bycatch of marine mammals and seabirds in this fishery and does not consider other potential environmental effects. A more detailed assessment of environmental effects across all fisheries will be available in the Ministry's Aquatic Environment Plenary that is under development.

4.1 Role in the ecosystem

Not discussed by the AEWG.

4.2 Incidental catch (fish and invertebrates)

Not discussed by the AEWG.

4.3 Incidental catch (seabirds and mammals)

Paua are taken exclusively by free diving and it is highly unlikely that seabirds or marine mammals are taken.

4.4 Benthic interactions

Not discussed by the AEWG.

4.5 Other considerations

Not discussed by the AEWG.

5. STOCK ASSESSMENT

The dates of the most recent survey or stock assessment for each QMA are listed in Table 3.

QMA	Type of survey or assessment	Date	Comments
PAU 1	No surveys or assessments have been undertaken		
PAU 2	Relative abundance estimate using standardised CPUE index based on commercial catch	2007	Standardised CPUE increased between 1992 and 2000 and has remained fairly stable up to 2007.
PAU 3	Relative abundance estimate using standardised CPUE index based on commercial catch	2007	Standardised CPUE decreased between 1990 and 1992 and has since remained fairly stable up to 2007.
PAU 4	Quantitative assessment using a Bayesian length based model	2004	In February 2010 the SFWG agreed that due to the lack of adequate data as input into the Bayesian length-based model, a stock assessment for PAU 4 using this model was not appropriate.
PAU 5A	Quantitative assessment using a Bayesian length based model	2006	In 2006 the Shellfish Working Group could not agree on the applicability of the assessment projections to the whole of the PAU 5A stock**.**
PAU 5B	Quantitative assessment using a Bayesian length based model	2007	Spawning biomass was more likely to increase than decrease under levels of total catch and was likely to remain below S_{AV} for the next three years. Recruited biomass showed a tendency to decrease and remain below B_{AV}. For recruited biomass, however, it could not be concluded strongly that current biomass was less than the B_{AV} reference level.
PAU 5D	Quantitative assessment using a Bayesian length based model	2006	The stock assessment results were equivocal. In 2006 the Working Group noted the future direction of recruited biomass was uncertain because of the range of possible results that were dependent on modelling decisions.
PAU 6	Biomass estimate	1996	This fishery has a TACC of 1.0t
PAU 7	Quantitative assessment using a Bayesian length based model	2008	The assessment showed a depleted stock however results suggested that the stock was likely to increase over the upcoming three years. Potential problems with the model are likely to cause model results to be optimistic.
PAU 10	No surveys or assessments have been undertaken		

5.1 Estimates of fishery parameters and abundance

5.1.1 CPUE

In 2008 standardised CPUE indices were constructed to assess relative abundance in PAU 2 and PAU 3. In QMAs where quantitative stock assessments have been undertaken, standardised CPUE is also

used as input data for the Bayesian length-based stock assessment model. There is however a large amount of literature on abalone which suggests CPUE may not be proportional to abundance as it is possible to maintain high catch rates despite a falling biomass. This occurs because paua tend to aggregate and divers move among areas to maximise their catch rates. Therefore, any apparent stability in CPUE should be interpreted with caution.

5.1.2 Research Diver Surveys

In PAU 4, 5A, 5B, 5D and 7 the relative abundance of paua has also been estimated from independent research diver surveys (RDS). In PAU 7, seven surveys have been completed over a number of years but only two surveys have been conducted in PAU 4. In 2009 and 2010 several reviews were conducted (Cordue P.L. (2009) and Haist V.(in press)) to assess; i) the reliability of the research diver survey index as a proxy for abundance; and ii) if the RDS data when used in the paua stock assessment models, results in model outputs that do not adequately reflect the status of the stocks. The reviews concluded that:

- Due to inappropriate survey design the RDS data appear to be of very limited use for constructing relative abundance indices
- There was clear non-linearity in the RDS index, the form of which is unclear and could be potentially complex.
- CVs of RDS index "year' effects are likely to be underestimated, especially at low densities
- Different abundance trends among strata reduces the reliability of RDS indices, and the CVs are likely not to be informative about this
- It is unlikely the assessment model can determine the true non-linearity of the RDS index-abundance relationship because of the high variability in the RDS indices
- The non-linearity observed in the RDS indices is likely to be more extreme at low densities, so the RDSI is likely to mask trends when it is most critical to observe them.
- Existing RDS data is likely to be most useful at the research stratum level.

5.2 Biomass estimates

Biomass was estimated for PAU 6 in 1996 (McShane et al 1996). However the survey area was only from Kahurangi Point to the Heaphy River.

Biomass has been estimated, as part of the stock assessments, for PAU 4, 5A, 5B, 5D and 7 (refer Table 3).

5.3 Estimation of Maximum Constant Yield (MCY)

The only estimate of MCY is for PAU 6 (McShane et al 1996). This QMA has a TACC of 1.0t

MCY has not been estimated for any other fishstocks.

5.4 Estimation of Current Annual Yield (CAY)

The only estimate of CAY available is for the area from Kahurangi Point to the Heaphy River in PAU 6 (McShane et al 1996).

CAY was not estimated for any other fishstocks.

6. STATUS OF THE STOCKS

The status of paua stocks PAU 2, PAU 3, PAU 4, PAU 5A, PAU 5B, PAU 5D and PAU 7 are given in the relevant Working Group reports.

TACCs and reported landings for the 2008–09 fishing year for all PAU stocks are summarised in Table 4.

Table 4: Summary of TACCs (t) and reported landings (t) for 2008-09 fishing year for all PAU stocks.

Fishstock		FMA	2008–09 Actual TACC	2008–09 Reported Landings
PAU 1	Auckland (East) (West)	1,9	1.93	0.47
PAU 2	Central (East) (West)	2,8	121.19	121.18
PAU 3	South-East	3	91.62	90.84
PAU 4	Chatham	4	326.54	324.18
PAU 5A	Southland	5	148.98	104.82
PAU 5B	Southland	5	90	90.00
PAU 5D	Southland	5	89	88.78
PAU 6	Westland	6	1	1.00
PAU 7	Nelson/Marlborough	7	187.24	186.85
PAU 10	Kermadec	10	1	0
Total			1 058.5	1 008.12

7. FOR FURTHER INFORMATION

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