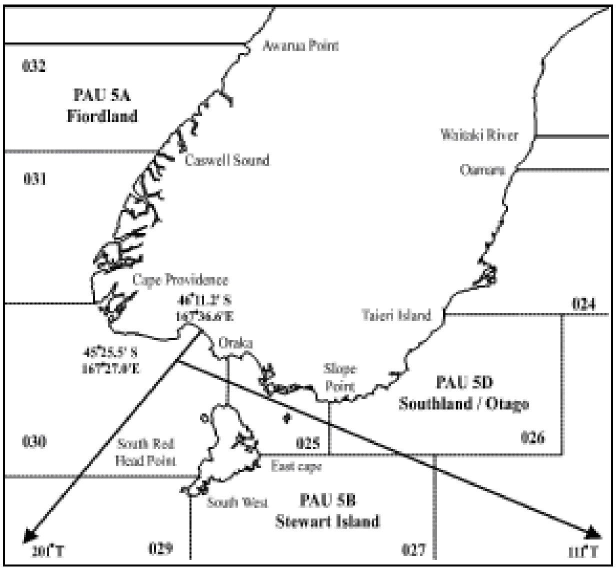
PAUA (PAU 5D) - Southland / Otago

(*Haliotis iris*)
Paua



1. FISHERY SUMMARY

Prior to 1995, PAU 5D was part of the PAU 5 QMA, which was introduced to the QMS in 1986 with a TACC of 445 t. As a result of appeals to the Quota Appeal Authority, the TACC increased to 492 t by the 1991-92 fishing year; PAU 5 was then the largest QMA by number of quota holders and TACC. Concerns about the status of the PAU 5 stock led to a voluntary 10% reduction in the TACC in 1994-95. On 1 October 1995, PAU 5 was divided into three QMAs (PAU 5A, PAU 5B, and PAU 5D; see figure above) and the TACC was divided equally among them; the PAU 5D quota was set at 148.98 t.

On 1 October 2002 a TAC of 159 t was set for PAU 5D, comprising a TACC of 114 t, customary and recreational allowances of 3 t and 22 t respectively and an allowance of 20 t for other mortality. The TAC and TACC have been changed since then but customary, recreational and other mortality allowances have remained unchanged (Table 1).

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 5 and PAU 5D since introduction to the QMS.

Year	TAC	Customary	Recreational	Other mortality	TACC
1986 - 1991*	-	-	-	-	445
1991 - 1994*	-	-	-	-	492
1994 - 1995*	-	-	-	-	442.8
1995 -2002	-	-	-	-	148.98
2002 - 2003	159	3	22	20	114
2003- present	134	6	6	-	89

*PAU 5 TACC figures

1.1 Commercial fishery

The fishing year runs from 1 October to 30 September. On 1 October 2001 it became mandatory to report catch and effort using fine-scale reporting areas developed by the New Zealand Paua Management Company for their voluntary logbook program (Figure 1). These reporting areas were subsequently adopted on MFish PCELRs. On 1 October 2010 the commercial fishery voluntarily adopted two different minimum harvest sizes of 128 mm and 130 mm specific to statistical areas

H38-H43 and H1 to H37 respectively. The minimum legal size of 125 mm remains in statistical areas H44 to H47. The commercial fishery have also voluntarily closed 4 specific areas within PAU 5D to commercial harvesting.

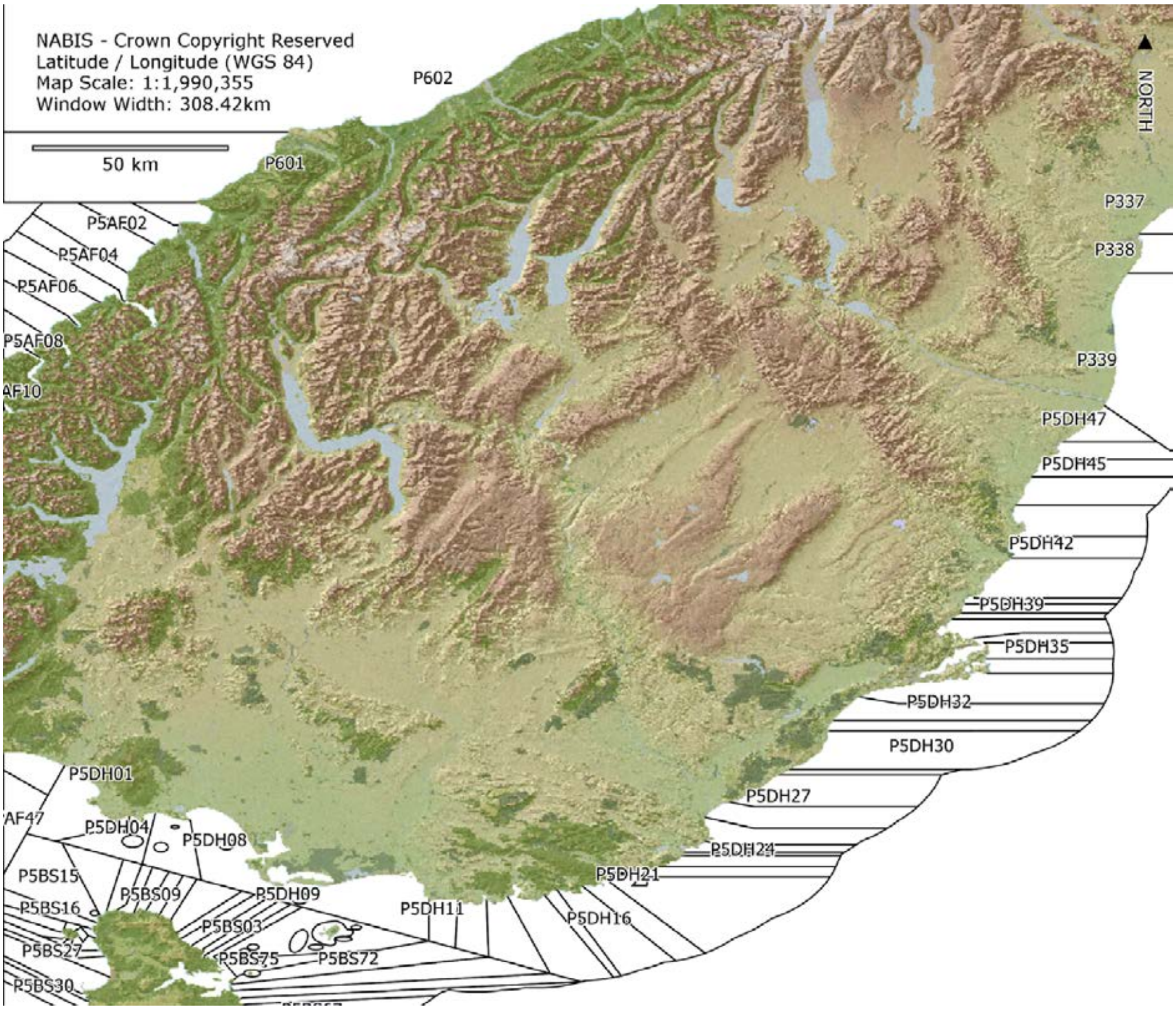


Figure 1: Map of fine scale statistical reporting areas for PAU 5D

Landings for PAU 5D are shown in Table 2. Landings for PAU 5 are reported in the introductory PAU Working Group Report.

Table 2: TACC and reported landings (t) of paua in PAU 5D from 1995-96 to 2010-11. Data were estimated from CELR and QMR returns.

Year	Landings	TACC
1995-96	167.42	148.98
1996-97	146.6	148.98
1997-98	146.99	148.98
1998-99	148.78	148.98
1999-00	147.66	148.98
2000-01	149.00	148.98
2001-02	148.74	148.98
2002-03	111.69	114.00
2003-04	88.02	89.00
2004-05	88.82	89.00
2005-06	88.93	89.00
2006-07	88.97	89.00
2007-08	88.98	89.00
2008-09	88.77	89.00
2009-10	89.45	89.00
2010-11	88.70	89.00

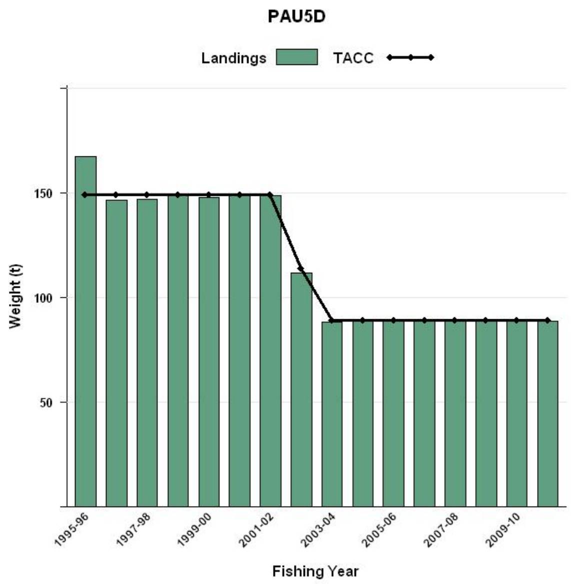


Figure 2: Historical landings and TACC for PAU5D from 1995-96 to 2010-11. For historical PAU5 landings prior to 1995-96 refer to the PAU introduction chapter, Figure 1 and Table 1.

1.2 Recreational fisheries
For the purpose of the stock assessment model, the SFWG agreed to assume that the 1974 recreational catch was 2 t increasing linearly 10 t by 2005. For further information on recreational fisheries refer to the introductory PAU Working Group Report.

1.3 Customary fisheries
For the purpose of the stock assessment model, the SFWG agreed to assume that the customary catch has been constant at 2 t for PAU 5D. For further information on customary fisheries refer to the introductory PAU Working Group Report.

1.4 Illegal catch
Illegal catch was estimated by the Ministry of Fisheries to be 20 t. For the purpose of the stock assessment model, the SFWG agreed to assume that illegal catches have been constant at 10 t for PAU 5D. For further information on illegal catch refer to the introductory PAU Working Group Report.

1.5 Other sources of mortality
For further information on other sources of mortality refer to the introductory PAU Working Group Report

2. BIOLOGY

For further information on paua biology refer to the introductory PAU Working Group Report. A summary of biological parameters used in the PAU 5D assessment is presented in Table 3.

3. STOCKS AND AREAS

For further information on stocks and areas refer to the introductory PAU Working Group Report.

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

Fishstock		Estimate	Source
1. Natural mortality (*M*)			
		0.114 (0.095-0.140)	Median (5-95% range) of posterior estimated by the model (run 053)
2. Weight = a(length)^b (Weight in g, length in mm shell length)			
All	a	b	
	2.99 x 10 $^{-5}$	3.303	Schiel & Breen (1991)
3. Size at maturity (shell length)			
		50% maturity at 80 mm (78-81)	Median (5-95% range) of posterior estimated by the model
		95% maturity at 93mm (89-98)	Median (5-95% range) of posterior estimated by the model
4. Estimated annual increments (both sexes combined)			
	at 75 mm	at 120 mm	Median (5-95% range) of posteriors estimated by the model
	19.6 (18.8-20.8)	8.2 (7.9-8.7)	

4. STOCK ASSESSMENT

4.1 Estimates of fishery parameters and abundance

CPUE is available from two series of data: the CELR until 2001 and the subsequent PCELR series from 2002 onwards. The first series has coarse area and effort information: three statistical areas and diver effort by day; the second series has 47 small reporting areas and effort is recorded as diver hours, and the divers are also identified in the second series. The second series can be treated as a separate series by using an extra parameter for catchability. For the 2006 PAU 5D assessment, the SFWG agreed to standardise CPUE as a single series. The working group also suggested not using FSU data in future assessments, omitting the CPUE indices before 1989 in the stock assessment

Standardised CPUE was updated for the combined CELR and PCELR series (1990-2008), with the PCELR data collapsed to the CELR format (Fu 2010). A separate CPUE series were also developed using only the finer-scale PCELR data (2002-08).

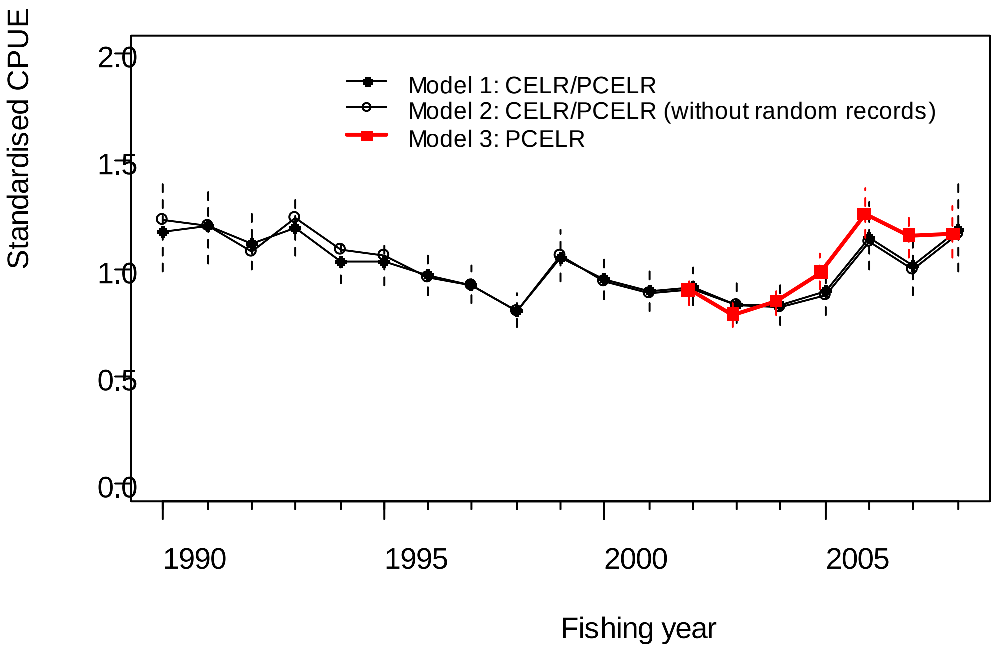


Figure 3: Standardised CPUE indices for PAU 5D: Model 1 and 2 are for the combined CELR and PCELR series (Model 2 has excluded CELR records which were randomly allocated to PAU 5F); Model 3 are for the fine-scale PCELR series. Vertical bars indicate the 95% confidence interval of the standardised indices for model 1 and 3.

CPUE in PAU 5D declined through the early 2000s (except for an increase in 1999), followed by a steady increase until 2006. Excluding records which were assigned to PAU 5D through a randomisation procedure made little difference to this CPUE series (Figure 3). The CPUE based on the fine-scale PCELR data also showed a generally increasing trend though 2006, and have remained relatively flat until 2008.

In some circumstances commercial CPUE may not be proportional to abundance because it is possible to maintain catch rates of paua despite a declining biomass. This occurs because paua tend to aggregate and divers move among areas to maximise their catch rates. Apparent stability in CPUE should therefore be interpreted with caution.

4.2 Biomass Estimates

The model used for the 2006 assessment of PAU 5D (Breen & Kim 2007) was the same model used for the 2005 assessment of PAU 7 (Breen & Kim 2005). The model was published by Breen *et al*. (2003). The PAU 5D assessment was considered inconclusive by the Shellfish Working Group. The Working Group considered the results to be equivocal. The Working Group noted that the results were equivocal and that the future direction of recruited biomass was uncertain because of the range of possible results that were dependent on modelling decisions. It was not known if the catch or the TACC levels would allow the stocks to move towards a size that would support the maximum sustainable yield.

4.3 Estimation of Maximum Constant Yield (*MCY*)

No estimate of *MCY* has been made for PAU 5D.

4.4 Estimation of Current Annual Yield (*CAY*)

No estimate of *CAY* has been made for PAU 5D.

4.5 Other yield estimates and stock assessment results

Only the current catch was used in projections.

4.6 Other factors

The assessment results had more uncertainty than that reflected in the posterior distributions. Most uncertainty was associated with the RDLF data set, and much uncertainty also stems from the choice of growth model.

Another source of uncertainty is the data. The commercial catch before 1974 is unknown and, although we think the effect is minor, major differences may exist between the catches we assume and what was actually taken. In addition, non-commercial catch estimates are poorly determined and could be substantially different from what was assumed, although generally non-commercial catches appear to be relatively small compared with commercial catch. The estimate of illegal catch in particular is uncertain.

Tag-recapture data may not reflect fully the average growth and range of growth in this population. Similarly, length frequency data collected from the commercial catch may not represent the commercial catch with high precision. The research diver survey data comprise five surveys, with large changes in the index that the model has trouble fitting. Length frequencies from these surveys are the source of much uncertainty in the model fitting.

In 2009 and 2010 several reviews were conducted by Cordue (2009) and Haist (2010) to asses: 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 outcome of both reviews suggests that outputs from paua stock assessments, that used the RDS data as input into the model, should be treated with caution. For a summary of the conclusions from the reviews refer to the PAU intro Working Group Report.

The model treats the whole of the assessed area of PAU 5D as if it were a single stock with homogeneous biology, habitat and fishing pressures. The model assumes homogeneity in recruitment and natural mortality, and that growth has the same mean and variance. However it is known that paua in some areas have stunted growth, and others are fast-growing.

Heterogeneity in growth can be a problem for this kind of model (Punt 2003). Variation in growth is addressed to some extent by having a stochastic growth transition matrix based on increments observed in several different places; similarly the length frequency data are integrated across samples from many places.

The effect is likely to make model results optimistic. For instance, if some local stocks are fished very hard and others not fished, recruitment failure can result because of the depletion of spawners, as because spawners must breed close to each other and the dispersal of larvae is unknown and may be limited. Recruitment failure is a common observation in overseas abalone fisheries, so local processes may decrease recruitment, an effect that the current model cannot account for.

The assumption made by the model that CPUE is an index of abundance is questionable. Literature on abalone suggests that CPUE is difficult to use in abalone stock assessments because of serial depletion. This can happen when fishers can deplete unfished or lightly fished beds and maintain their catch rates, thus CPUE stays high while the biomass is actually decreasing. In this assessment, the degree of hyperstability appeared reasonably well determined.

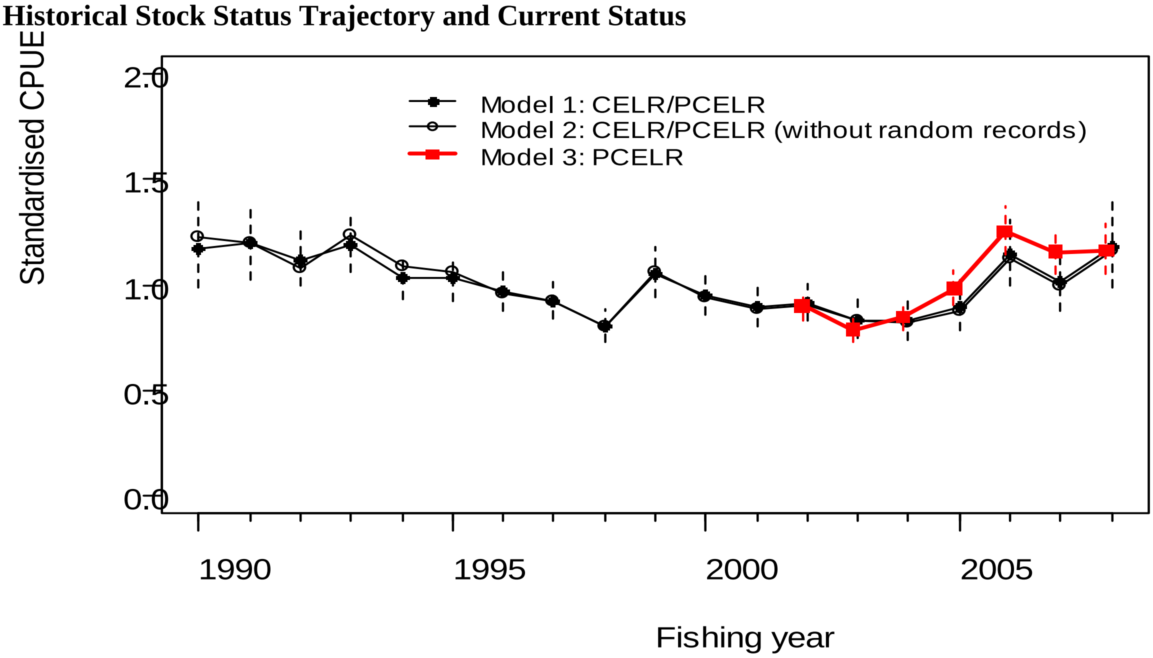
Another source of uncertainty is that fishing may cause spatial contraction of populations (Shepherd & Partington 1995), or that some populations become relatively unproductive after initial fishing (Gorfine & Dixon 2000). If this happens, the model will overestimate productivity in the population as a whole. Past recruitments estimated by the model might instead have been the result of serial depletion.

5. STATUS OF THE STOCK

Stock Structure Assumptions
A genetic discontinuity between North Island and South Island paua populations was found approximately around the area of Cook Strait (Will & Gemmell 2008).

- **PAU 5D - *Haliotis iris***

Stock Status	
Year of Most Recent Assessment	2009
Assessment Runs Presented	The 2006 assessment has not been presented because it was considered inconclusive by the Shellfish Working Group.
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)
Status in relation to Target	Unknown
Status in relation to Limits	Soft Limit: Unknown Hard Limit: Unknown

Historical Stock Status Trajectory and Current Status

Standardised CPUE indices for PAU 5D: Model 1 and 2 are for the combined CELR and PCELR series (Model 2 has excluded CELR records which were randomly allocated to PAU 5F); Model 3 are for the fine-scale PCELR series. Vertical bars indicate the 95% confidence interval of the standardised indices for model 1 and 3.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	-
Recent Trend in Fishing Mortality or Proxy	-
Other Abundance Indices	Standardised CPUE generally declined until the early 2000s, followed by a steady increase until 2006 and has remained relatively flat until 2008.
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	The Working Group at the time (2007) noted that the stock assessment results were equivocal and that the future direction of recruited biomass was uncertain because of the range of possible results that were dependent on modelling decisions.
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Unknown Hard Limit: Unknown

Assessment Methodology		
Assessment Type	Attempted Full quantitative stock assessment	
Assessment Method	Length base Bayesian model	
Main data inputs	CPUE, RSDI, CSLF, RDLF, tag recapture data, maturity at length data	
Period of Assessment	Latest assessment: 2009	Next assessment: 2013
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	Potential bias in RDSI CPUE as a reliable index of abundance Data are not completely accurate Model is homogeneous	

	Model assumptions may be violated Assessment applies only to areas open to commercial fishing

Qualifying Comments
-

Fishery Interactions
-

6. FOR FURTHER INFORMATION

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