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Determination of length at maturity of paua around the Taranaki coast

New Zealand Fisheries Assessment Report 2016/23

Reyn Naylor
Pete Notman
Dan Fu

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Ministry for Primary Industries
PO Box 2526
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EXECUTIVE SUMMARY

Naylor, R.; Notman, P.; Fu, D. (2016). Determination of length at maturity of paua around the Taranaki coast.

***New Zealand Fisheries Assessment Report 2016/23.* 14 p.**

Length at maturity of paua (*Haliotis iris*) was estimated from four sites around the Taranaki coast in 1998 and in 2015–16. Lengths at maturity are low compared with most commercial paua fishery areas. The length distributions at the sites were similar between sampling times. The length distribution, the shape of the larger shells, and the relatively low lengths at maturity indicate that paua at the Taranaki sites don't grow as large as other paua populations around New Zealand.

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1. INTRODUCTION

Minimum size limits (minimum legal size, MLS) are used as a management tool to ensure that spawning success and subsequent recruitment into the paua (*Haliotis iris*) fishery is maintained at a level that can sustain the fishery. Initially, it was thought that a MLS of 125mm throughout all of New Zealand would allow this. However, previous research undertaken around the Taranaki region (Naylor & Andrew 2000) found that all paua sampled there were shorter than the MLS, and so did not contribute to the legal fishery. The estimated growth parameters and length frequency distributions suggest that few, if any, paua reached the MLS. This work (Naylor & Andrew 2000) found that the length at maturity and maximum length of paua in this region was lower than in other parts of New Zealand.

Based on the work done by Naylor & Andrew (2000), the MLS for the recreational paua fishery in the Taranaki region was reduced from 125 mm to 85 mm on a trial basis. The reduced MLS has been in place since 1 October 2009 and this was the first time that a MLS different from 125 mm has been applied within New Zealand's paua fisheries. At that time it was also recommended that research should be undertaken in the future to reassess the length at maturity in this region.

The current report analyses up-to-date length at maturity data for paua in the Taranaki region to determine if the new MLS of 85 mm for recreational paua fishers is still appropriate.

2. METHODS

Size-at-maturity was determined for four sites around the Taranaki coast. The locations and dates of sampling are shown in Table 1. Sites were at Puketapu, Opunake, Cape Egmont, and New Plymouth (Figure 1). The sites are the same as those sampled in 1998 (Naylor & Andrew 2000). At each site sampled, about 100 paua between 40 mm and 100 mm shell length were collected and assigned to 5 mm sizes classes. As far as possible, these paua were evenly spread over the available size range. Sexual maturation was determined by visual inspection of the testis or ovary. Abalone in each size class were scored as: 0, immature (no visible signs of gametes); 1/2, just mature (some gametes visible but gut tissue visible through the gonad); and 1, mature (no gut tissue visible through the gonad). For estimating size-at-maturity, gonads scored as 'just mature' were considered immature because they are unlikely to make a significant contribution to gamete production (Poore 1973; Sainsbury 1982; Wilson & Schiel 1995; Naylor et al. 2006). Ogives of maturity-at-length were determined by fitting these data to the logistic equation:

$$p = \frac{e^{a+bl}}{l + e^{a+bl}}$$

where p is the proportion mature, l is shell length (in 2 mm bins where the mid-point is taken as the length), and a and b are parameters of the logistic function.

Paua were collected under NIWA's Special Permit (542). NIWA contacted the Ministry's local compliance office in New Plymouth at least 24 hours before any sampling trip took place and provided them with details of departure and return, the location of sampling, the number and names of personnel, and the nature of the sampling work being undertaken. An iwi representative (Sam Tamarapa) was also contacted before the commencement of each field trip.

A search for historic data on paua size from around the Taranaki coast revealed a 1946 Marine Department memorandum (Kaberry 1946). This short report gave the lengths of paua sampled at Arawhata Beach, which is 5 km north of Opunake (Appendix 1).

Table 1. Sampling dates and locations of sites sampled around the Taranaki coast.

Site	Sampling dates	Latitude	Longitude
New Plymouth	23/01/1998 14/03/2016	-39.05423	174.060929
Cape Egmont	25/01/1998 4/03/2016	-39.247746	173.770332
Opunake	26/01/1998 18/02/2015	-39.456014	173.848053
Puketapu	18/11/1998 14/03/2016	-39.519278	173.913995

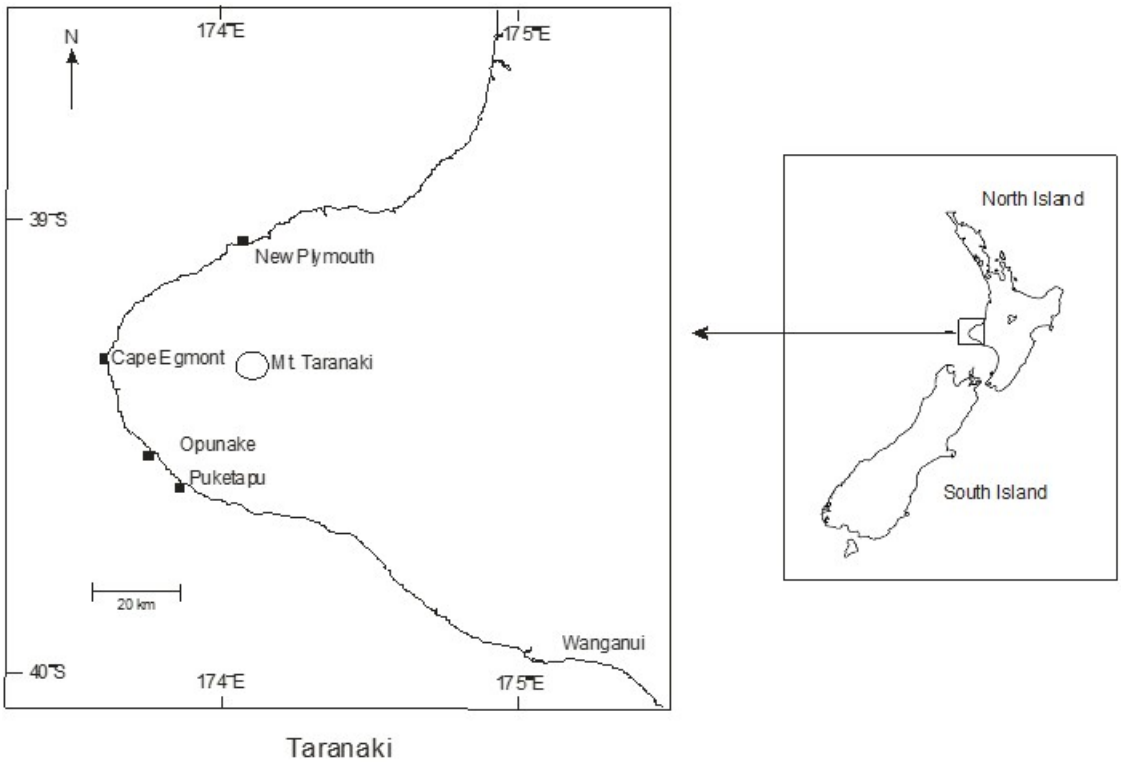

Figure 1: Location of sampling sites around the Taranaki coastline.

RESULTS

Length-at-maturity ogives and lengths at 50% and 95% maturity from sites in 1998, and 2015 and 2016 are shown in Figure 2. The lengths below which all paua were immature and the lengths above which all paua were mature are shown in Table 2.

At Opunake, the estimated length at 50% maturity (L_{50}) was slightly higher (by about 4 mm) in 2015 than it was in 1998 (Figure 2). The length at 95% maturity (L_{95}) was about 9 mm higher in 2015 than it was in 1998 (Figure 2). The length below which all paua were immature at Opunake was similar between 1998 and 2015 and the length above which all paua were mature was 6 mm greater in 2015 than in 1998 (Table 2).

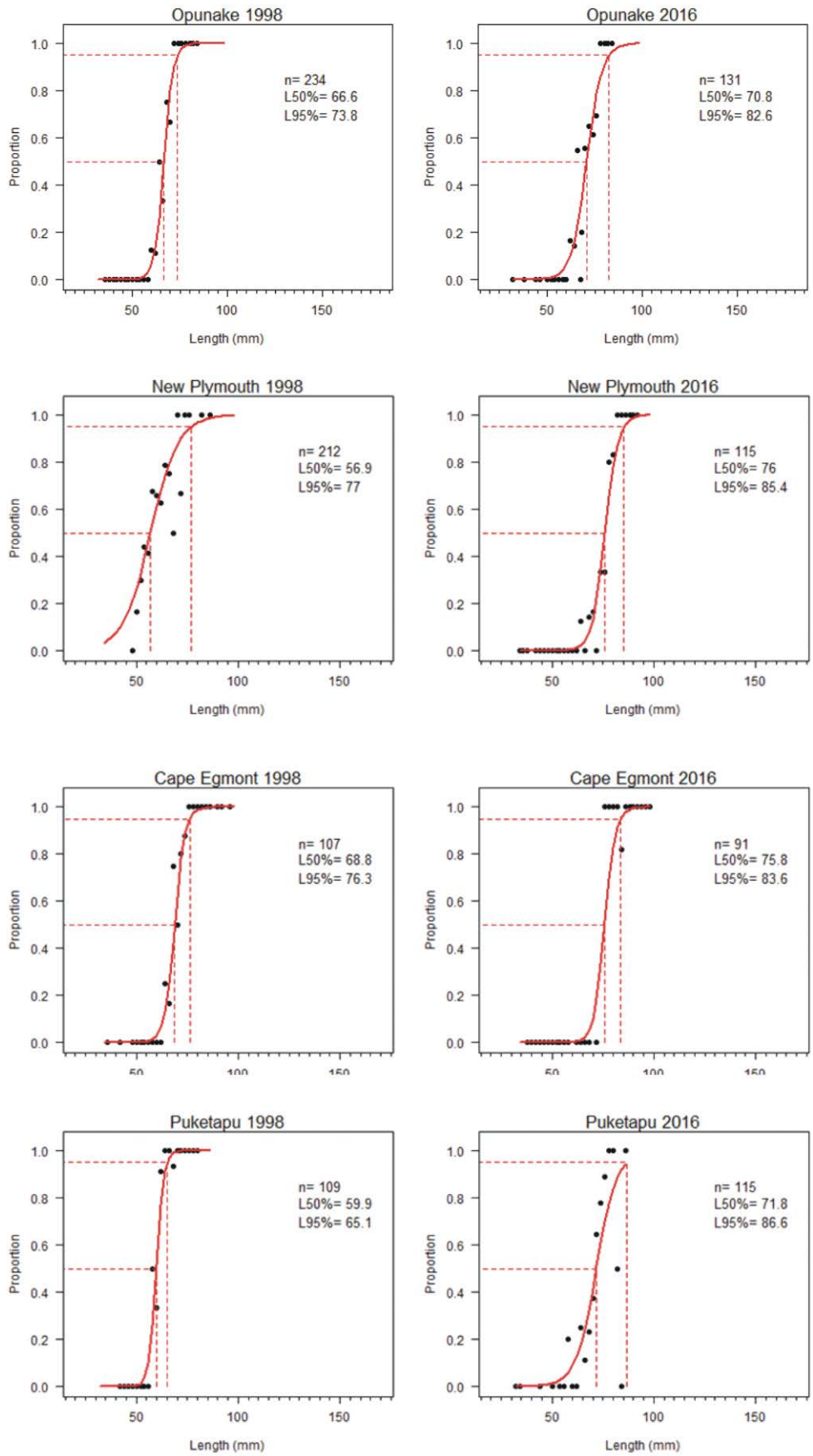

Figure 2: Length-at-maturity ogives and length at 50% maturity and 95% maturity for sites sampled around the Taranaki coast in 1998, and in 2015 and 2016.

At New Plymouth, estimated L_{50} was about 19 mm larger in 2016 than it was in 1998 (Figure 2). Estimated L_{95} was about 8 mm higher in 2016 than it was in 1998 (Figure 2). The length below which all paua were immature at New Plymouth and the length above which all paua were mature were both larger by more than 10 mm in 2016 than they were in 1998 (Table 2).

At Cape Egmont, estimated L_{50} and L_{95} were about 7 mm larger in 2016 than they were in 1998 (Figure 2). The lengths below which all paua were immature at Cape Egmont and above which all paua were mature were larger by 14 mm and 10 mm respectively in 2016 than in 1998 (Table 2).

At Puketapu, estimated L_{50} and L_{95} were about 12 mm and 20 mm larger respectively in 2016 than in 1998 (Figure 2). The lengths below which all paua were immature at Puketapu were similar in the two sampled years but the length above which all paua were mature was larger by 17 mm in 2016 than in 1998 (Table 2). The transition between immature and mature was not well described by the data in 2016 at this site.

Table 2. Lengths (mm) below which all paua sampled were immature and lengths (mm) above which all paua sampled were mature, and sample size, by site and year of sampling.

Site	Year	Length below which all paua immature (mm)	Length above which all paua mature (mm)	Sample size
Opunake	1998	61	71	117
Opunake	2015	62	77	131
New Plymouth	1998	52	72	212
New Plymouth	2016	65	84	115
Cape Egmont	1998	64	74	107
Cape Egmont	2016	78	84	91
Puketapu	1998	57	68	109
Puketapu	2016	59	85	115

The length frequency distributions from sites sampled in 1998 and in 2015 and 2016 are shown in Figure 3. Sample sizes are much larger in 1998 as paua were being collected for tag recapture to estimate growth. In 2016, samples were being collected for the determination of length at maturity. Given the relatively small sample sizes in 2015 and 2016, any differences in the size structure between sites over time should be interpreted cautiously.

At Opunake, the maximum paua size in the distribution is smaller in 2015 than in 1998, with the 2015 sample truncated at about the current recreational minimum legal size of 85 mm. There are also relatively fewer paua larger than 80 mm in 2015 and the mean and median lengths are about 8 mm lower than those in 1998 (Figure 3).

At New Plymouth, the maximum, mean, and median lengths of paua are similar between the 1998 and 2016 sample collections (Figure 3).

At Cape Egmont, the maximum size (about 100 mm) is similar between 1998 and 2016. The larger mean and median sizes in 2016 are due to relatively few paua smaller than about 40 mm and between about 55 and 79 mm being collected in the 2016 sample (Figure 3).

At Puketapu, the maximum size (about 90 mm) is similar between 1998 and 2016. The larger mean and median sizes in 2016 are due to relatively fewer paua smaller than about 55 mm being collected in the 2016 sample (Figure 3).

The length frequency distribution from the small sample of paua collected from Arawhata Beach in 1946 is shown in Figure 4, and indicates that at that time relatively more paua larger than 100 mm were present than at the other sites sampled in 1998 and in 2015–16. About a quarter of the paua in

the 1946 sample were larger than those recorded at Opunake in the later years, but the sample size is small, and the environmental similarity between the two sites is unknown. The 1946 memorandum (Kaberry 1946) and the associated map are appended to this report (Appendix 1).

The shape of most of the larger shells (above about 60 mm) indicated that paua at all the Taranaki sites were stunted. In these shells, the anterior growing edge slopes steeply down, such that shell growth results in increased shell height as much as increased shell length. In areas of fast growth and large maximum size, the slope at the anterior edge of the shell is relatively flat (pers. obs.). This difference in shell shape between a 90 mm shell collected from Puketapu in 2016 and an 88 mm shell grown in Wellington is shown in Figure 5.

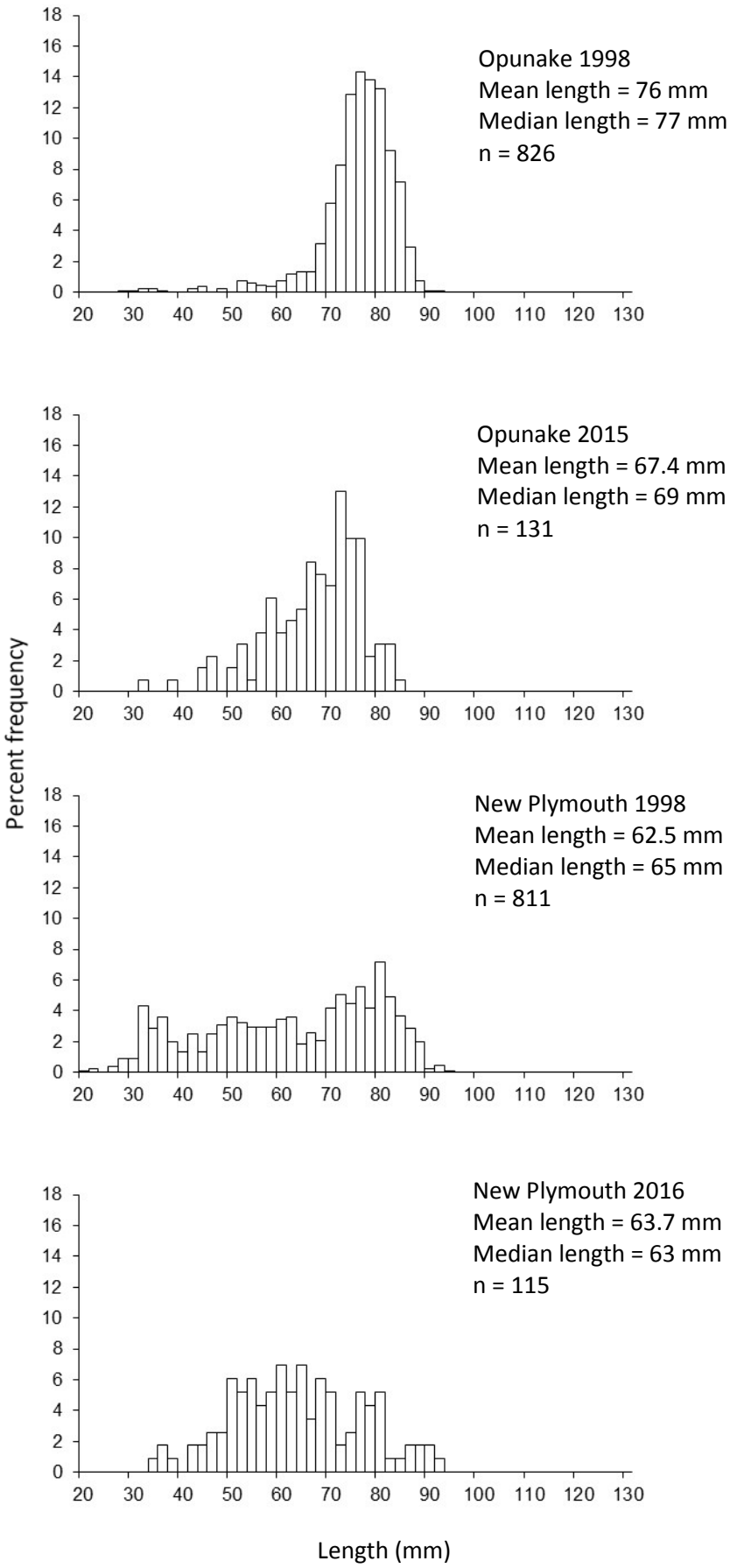

Figure 3: Length frequency distributions of paua sampled from sites around the Taranaki coast.

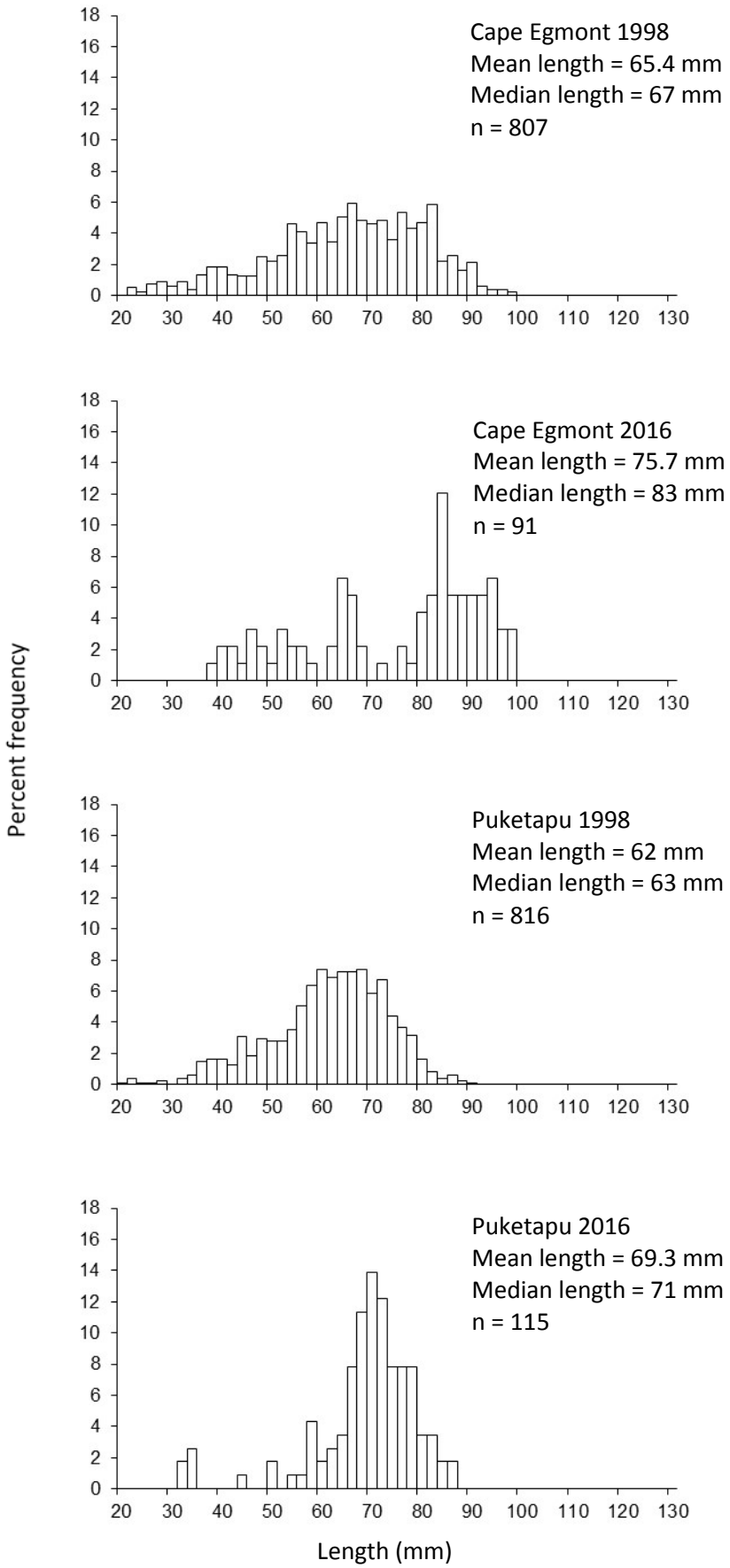

Figure 3 cont'd: Length frequency distributions of paua sampled from sites around the Taranaki coast.

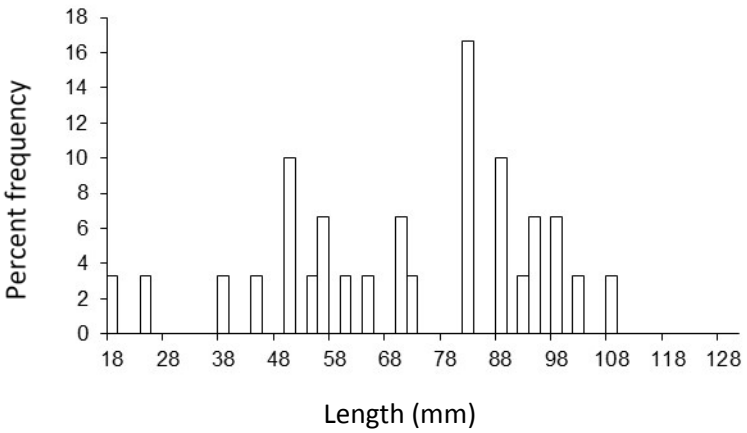

Figure 4: Length frequency distributions of paua sampled from Arawhata Beach in 1946. Sample size = 30.

Figure 5: Photograph of stunted shell from Puketapu (left, 90 mm) and fast growing shell from Wellington (right, 88 mm). *Photo: Dave Allen, NIWA.*

3. DISCUSSION

Lengths at maturity increased at some sites between 1998 and 2016, although these changes may be artefacts of the samples collected. The lengths at maturity indicate that the populations in this region have smaller maximum length compared to most areas that are commonly fished. L_{50} is typically around 90 mm in most paua fisheries (e.g. Fu et al. 2014a, b, and 2015, for PAU 3, 5B, and 5A respectively).

Apart from the site at Opunake, which is very accessible and adjacent to the township, maximum sampled lengths were similar between sampling years, and no paua larger than 100 mm were found at any site at any time. At Opunake, the length distribution of paua appears to be truncated at about the minimum legal recreational harvest size of 85 mm, possibly due to increased fishing pressure associated with a lower minimum legal size.

An unpublished 1946 Marine Department report gives a length frequency distribution for Arawhata Beach, which is 5 km north of Opunake. Some of the paua in this sample are markedly larger than those at Opunake in both subsequently sampled years, but the 1946 sample size is small, and the similarity between the two sites is unknown.

Abundance estimates were not made during the 1998 surveys, so no base-line data exist to compare abundance over time.

4. ACKNOWLEDGMENTS

We thank Roberta D'Archino and Owen Anderson for help with the collection of samples and Peter Horn for reviewing a draft of this report. This work was funded under MPI Project PAU 2013-03.

5. REFERENCES

Fu, D.; McKenzie, A; Naylor, R. (2014a). Summary of input data for the 2013 PAU 3 stock assessment. *New Zealand Fisheries Assessment Report 2014/42*. 45 p.

Fu, D.; McKenzie, A; Naylor, R. (2014b). Summary of input data for the 2013 PAU 5B stock assessment. *New Zealand Fisheries Assessment Report 2014/43*. 61 p.

Fu, D.; McKenzie, A; Naylor, R. (2015). Summary of input data for the 2014 PAU 5A stock assessment. *New Zealand Fisheries Assessment Report 2015/68*. 88 p.

Kaberry, A.C. (1946). Paua stocks – Taranaki. Memorandum for the Chief Inspector of Fisheries. Marine Department Wellington. 3 p. (Unpublished report added as an Appendix to this document.)

Naylor, J.R.; Andrew, N.L. (2000). Determination of growth, size composition, and fecundity of paua at Taranaki and Banks Peninsula. *New Zealand Fisheries Assessment Report 2000/51*. 25 p.

Naylor, J.R.; Andrew, N.L.; Kim, S.W. (2006). Demographic variation in the New Zealand abalone *Haliotis iris*. *Marine and Freshwater Research 57*: 215–224.

Poore, G.C.B. (1973). Ecology of New Zealand abalones, *Haliotis* species (Mollusca: Gastropoda). 4. Reproduction. *New Zealand Journal of Marine and Freshwater Research 7*: 67–84.

Sainsbury, K.J. (1982). Population dynamics and fishery management of the paua, *Haliotis iris*. Population structure, growth, reproduction and mortality. *New Zealand Journal of Marine and Freshwater Research 16*: 147–161.

Wilson, N.H.F.; Schiel, D.R. (1995). Reproduction in two species of abalone (*Haliotis iris* and *H. australis*) in southern New Zealand. *Marine and Freshwater Research 46*: 629–637.

APPENDIX 1

NEW ZEALAND.

IN YOUR REPLY PLEASE

QUOTE THIS REFERENCE.

MARINE DEPARTMENT.
P.O. Box 3014,
WELLINGTON.

Memorandum for:-

12th April, 1946.

The Chief Inspector of Fisheries.

PAUA STOCKS - Taranaki.

As instructed particular attention was given to that area of coast between Opunaki and Waitara. This area of coast consists of masses of large boulders extending far out into the beating surf. The paua beds are almost continuous along this piece of coastline with their shoreward margin at low tide level. At this level the paua are to be found only on the under surfaces of the boulders although it was reported that on very favourable tides in calm weather when more of the beds were uncovered some paua were to be found on the exposed surfaces of the rocks.

The Maori population in the Taranaki is considerable, the Maoris there being strict followers of the teaching of Te Whiti and Tohu and resent particularly any move of the Pakeha to use their natural foods. The Maoris in the district since there is no other fish supply available make considerable use of the paua and the sea eggs and do at times send supplies inland.

Again for the same reason namely, that there are no supplies of fish along this part of the coast the Pakehas also make regular use of paua meat in place of fish.

The Maoris do not care for even these pakehas to touch the paua because while the Maori always replaces the stone after removing the paua the pakeha leaves the stone turned over. This according to the Maori drives the paua away.

During the course of the survey I heard several stories of the ample supplies of paua, but on questioning I found in each case that what was thought of as plentiful was a kitful or possibly a sugar bag full, and that only on suitable tide and weather.

Unfortunately adverse weather and poor tides made impossible collection of any quantity of paua, a total of thirty being gathered in the entire survey. I was forced to base my observations as to size and quality of shell on samples collected by others previously and have selected the largest of their shells to compare with those to be had on the Wellington coast.

Apart from size the shells were thin and useless for commercial use other than grinding as grit for fowls.

Access to the beaches was mostly across paddocks and by path down the cliff face, except from Cape Egmont and Oakura - here too the bouldery nature of the coast made movement along the beach slow and difficult.

Collection and transport of paua in this area, when considered in conjunction with the remarks set out above indicate that first supplies for canning would be out of the question entirely, and secondly that to operate in this area would be to remove the only available sea food for both Maori and Pakeha along the South Taranaki coast.

continuation). 12/4/46.

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MEASUREMENTS of SAMPLES.

1. Arawhata Beach - 30 paua collected by two people in 1 hour.

Number.	Short Diameter by Long Diameter in inches.
1	$\frac{7}{8}$ x $\frac{3}{4}$
1	$\frac{3}{4}$ x 1
1	1 x $1\frac{1}{2}$
1	$1\frac{1}{8}$ x $1\frac{3}{4}$
3	$1\frac{1}{8}$ x $2\frac{1}{8}$ - $1\frac{3}{8}$ x 2 - $1\frac{3}{8}$ x 2.
4	$1\frac{1}{2}$ x 2 - $1\frac{1}{2}$ x $2\frac{3}{8}$ - $1\frac{1}{2}$ x $2\frac{1}{4}$ - $1\frac{1}{2}$ x $2\frac{1}{4}$
1	$1\frac{3}{4}$ x $2\frac{1}{2}$
3	2 x $2\frac{3}{4}$ - 2 x $2\frac{3}{4}$ - 2 x $2\frac{7}{8}$
6	$2\frac{1}{4}$ x $3\frac{1}{4}$ - $2\frac{1}{4}$ x $3\frac{1}{4}$ - $2\frac{1}{4}$ x $3\frac{1}{4}$ - $2\frac{1}{4}$ x $3\frac{1}{4}$ - $2\frac{1}{4}$ x $3\frac{1}{2}$ - $2\frac{1}{4}$ x $3\frac{1}{4}$
4	$2\frac{1}{2}$ x $3\frac{5}{8}$ - $2\frac{1}{2}$ x $3\frac{1}{8}$ - $2\frac{1}{2}$ x $3\frac{1}{2}$ - $2\frac{1}{2}$ x $3\frac{5}{8}$
4	$2\frac{3}{4}$ x $3\frac{3}{4}$ - $2\frac{3}{4}$ x 4 - $2\frac{3}{4}$ x $3\frac{1}{8}$ - $2\frac{3}{4}$ x $3\frac{3}{4}$
1	$3\frac{1}{8}$ x $4\frac{1}{4}$
30 Total.	

2. Oakura Beach - shell selected from collection of Maori shells.

$2\frac{3}{8}$ x $3\frac{3}{8}$
$2\frac{1}{2}$ x $3\frac{3}{8}$
$2\frac{5}{8}$ x $3\frac{1}{8}$

3. New Plymouth - shell selected from collection of Maori shells.

$2\frac{1}{4}$ x $3\frac{1}{4}$ - $2\frac{1}{4}$ x $3\frac{1}{4}$
$2\frac{1}{2}$ x $3\frac{1}{2}$ - $2\frac{1}{2}$ x $3\frac{1}{2}$
$2\frac{3}{8}$ x $3\frac{1}{2}$
$2\frac{1}{8}$ x 4
$3\frac{1}{4}$ x $4\frac{1}{4}$

4. Paora Beach, Puniho - few paua reported - none collected.

5. Cape Egmont (North side) - paua reported but 1 hour's work - nil collection.

The map attached sets out the distribution of the paua beds along the Taranaki Coast.

In conclusion the stocks of paua on the Taranaki Coast would be of little value for commercial exploitation for the following reasons:

(1) Supplies in quantity can be gathered only when most suitable tides coincide with calm weather.

(2) Handling of quantities of paua in sacks or boxes on such a rough coastline, and transporting them up cliffs then by dray or cart to motor services or rail heads would be too costly.

(3) The individual shell fish are small, being about ½ to ⅓ of the size of those on the Wellington coast line.

(4) Mostly they are to be found under boulders which have to be moved to collect the paua thus making the collection slow.

(5) The shell is small and thin and would have no commercial value.

(6) Labour for collecting is not available.

(7) The Maori people there resent deeply any interference with the paua and insist on all boulders being replaced after being disturbed.

continuation)

12/4/46.

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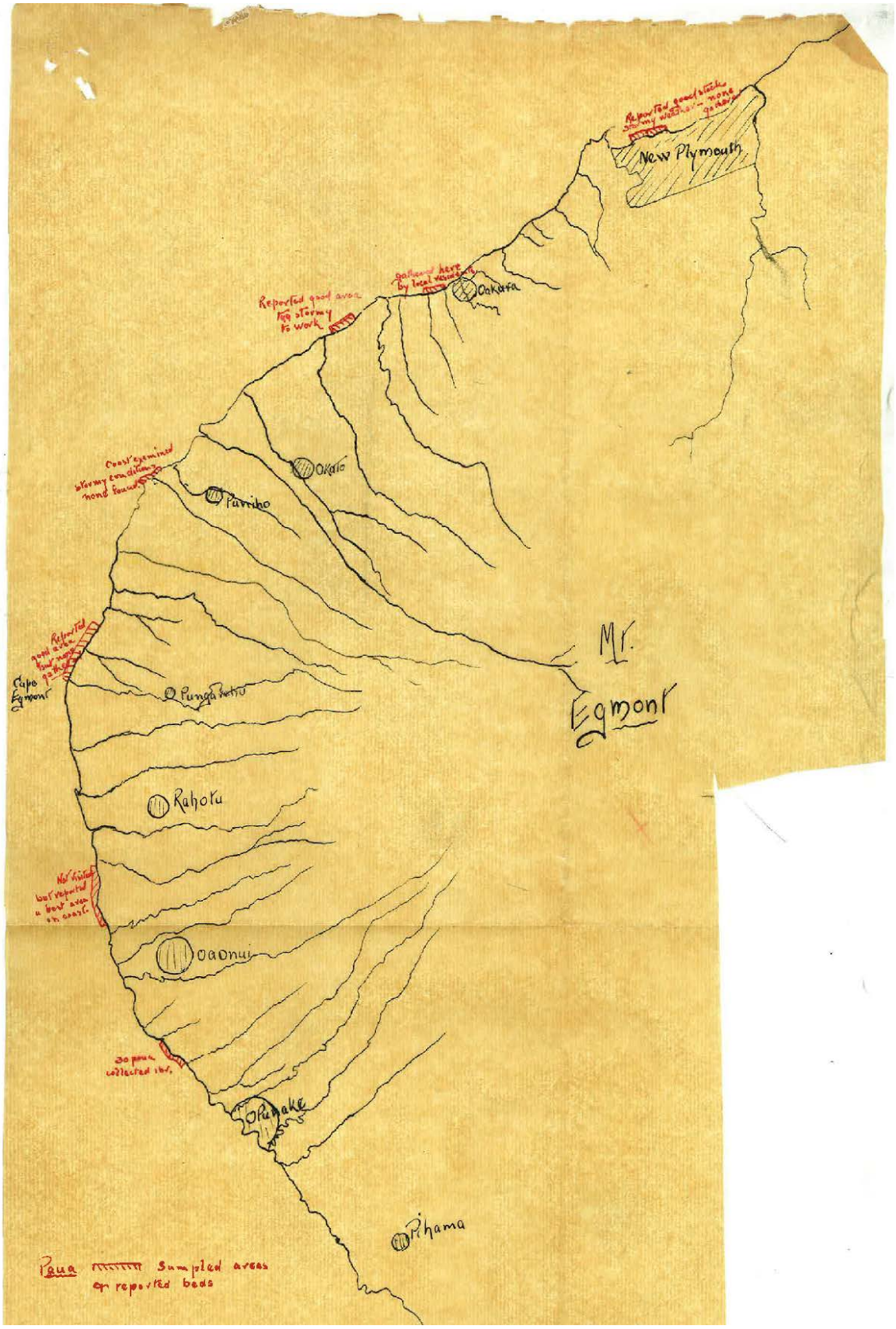
(8) It would be unjust to remove from this area the only available sea food which is at present made use of by both Maori and pakeha.

The photographs attached of the coastline will serve to illustrate these points.

A.G. Kaberry.

District Inspector of Fisheries.


New Plymouth
Oakura
Reported good area for stormy to work
Okato
Parihoa
Cape Egmont
Punga Nui
Mt. Egmont
Rahotu
Oaonui
Opunake
Pihama
Sampled areas or reported beds