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The Impact of Pre-European Māori Fishermen on the New Zealand Snapper, *Pagrus auratus*, in the Vicinity of Rotokura, Tasman Bay

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ABSTRACT

An archaeological site known as Rotokura in Tasman Bay produced abundant fish remains, among which snapper, *Pagrus auratus*, figure prominently. There is significant stratigraphy at the site, enabling fishing behaviour over about 600 years to be documented. Measurements were made on 824 snapper bones and regression formulae used to estimate live fork length and ungutted weight of the original catch. Size-frequency distributions are reconstructed and compared with modern-day catch data from research trawls in Tasman Bay in depths ranging from 17 to 165 m.

No significant difference was detected between the ancient and modern catches when all results were pooled together. However, a significant increase through time was found in the size of snapper in the archaeological site, from a mean weight of 3.5 ± 0.1 kg in the earliest deposit to 4.2 ± 0.1 kg in the latest layer. Several hypotheses which might explain such a change are suggested, including seasonal occupation effects, natural environmental changes, and localised depletion. Deciding between different options is difficult. One explanation might be that the occupants first harvested the shallow waters of Cable Bay close at hand and, as these became depleted, turned their attention to a more distant fishing ground which had larger fish. Tasman Bay is close to the southernmost distribution of snapper in New Zealand and is well known for anomalous age recruitment and patchy distribution by size, both from one area to another and through time. The observed change over archaeological time may therefore reflect such an episode.

Keywords: NEW ZEALAND, ARCHAEOLOGY, ARCHAEOZOOLOGY, FISHING, OVER-FISHING, SNAPPER, *PAGRUS AURATUS*, ENVIRONMENTAL IMPACT.

INTRODUCTION

The Rotokura site (O27/1, formerly S14/1) is situated on the western side of a small bay called Cable Bay near Pepin Island in Tasman Bay (Figs 1, 2). An excavation there in 1964 by D. Millar recovered a wide range of faunal material and quantities of bone fishhooks (Millar 1966; Challis 1991: 125). The fish bone was identified and reported by Butts (1977).

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Snapper, *Pagrus auratus*, was by far the most abundant fish present (Leach and Boocock 1993: 300). Since there is significant stratigraphy in the site, these bones offer the opportunity to examine change in the size of fish caught through time. The purpose of this paper is to describe the results of such an examination.

Previous studies of archaeological fauna in New Zealand have documented a reduction in mean size of shellfish and crayfish through time (Leach and Anderson 1979a). Although there has been strong anecdotal evidence of finds of large fish bones in New Zealand sites, this has not been adequately documented; moreover, at present, there is no documented case of any trend in mean size over time, which might indicate the impact of human predation on fish stocks in the inshore environment. Part of the problem concerns the lack of significant stratigraphy in many coastal middens in New Zealand. In this respect Rotokura offers a particularly valuable opportunity.

Millar distinguished six stratigraphic units during the excavation (Fig. 3), which are broadly grouped, according to artefacts and presence of moa bones, into 'Archaic' and 'Classic'. The change from one to another occurs within the main Layer 2 deposit, and it was therefore necessary to distinguish between an upper and lower component, Layer 2A and Layer 2B. One radiocarbon date has been obtained for the site as follows:

Lab Number	Conventional ^{14}C Age	Provenance	$\delta^{13}C$
NZ1105	625 ± 71	Square O/63 Layer 4, Charcoal	-25.0 assumed

METHODS OF ANALYSIS

The method by which snapper bones are measured and then reconstructed into size-frequency curves representing original live fish catches is described in detail by Leach and Boocock (1995). Only a brief description is necessary here. All the snapper bones were separated from the remainder of the faunal collection, keeping track of all bag information for each specimen. Wherever possible a measurement was taken on each snapper bone, and these were written on labels on the individual bags using a coding system. For example: RP1-47.52 means that measurement 1 on the Right Premaxilla is 47.52 mm. This information was then entered into a computer file, with measurements grouped into the appropriate stratigraphic provenance. A series of regression coefficients permit live fork length and live ungutted weight to be estimated from these bone dimensions, and this was done for all measurements according to provenance. As is usual for any excavation, some material was of uncertain provenance; for example, some material was bagged as Layer 2, not distinguishing between the upper and lower components. Similarly, material found on the boundary between Layers 2 and 3 was labelled as 2.3, and is here designated as Layer 2/3, indicating a location on the boundary between these two layers. Millar believes that this material is derived from layer 2, although it will be early in this context (Millar 1993: pers. comm.). Similarly, a designation of Layer 3/4 can be interpreted as deriving from layer 4 but in the upper part, on the boundary with the non-cultural deposit of Layer 3.

Thus, the bagged material can be split into four reasonable sized samples from earliest to latest times in the history of the site: Layer 4 (198 measurements), Layer 3/4 (118 measurements), Layer 2/3 (28 measurements), and Layer 2 (475 measurements). It is therefore possible to use these four samples to examine changes through time. One other way of looking for change through time is to group the bagged material into that associated

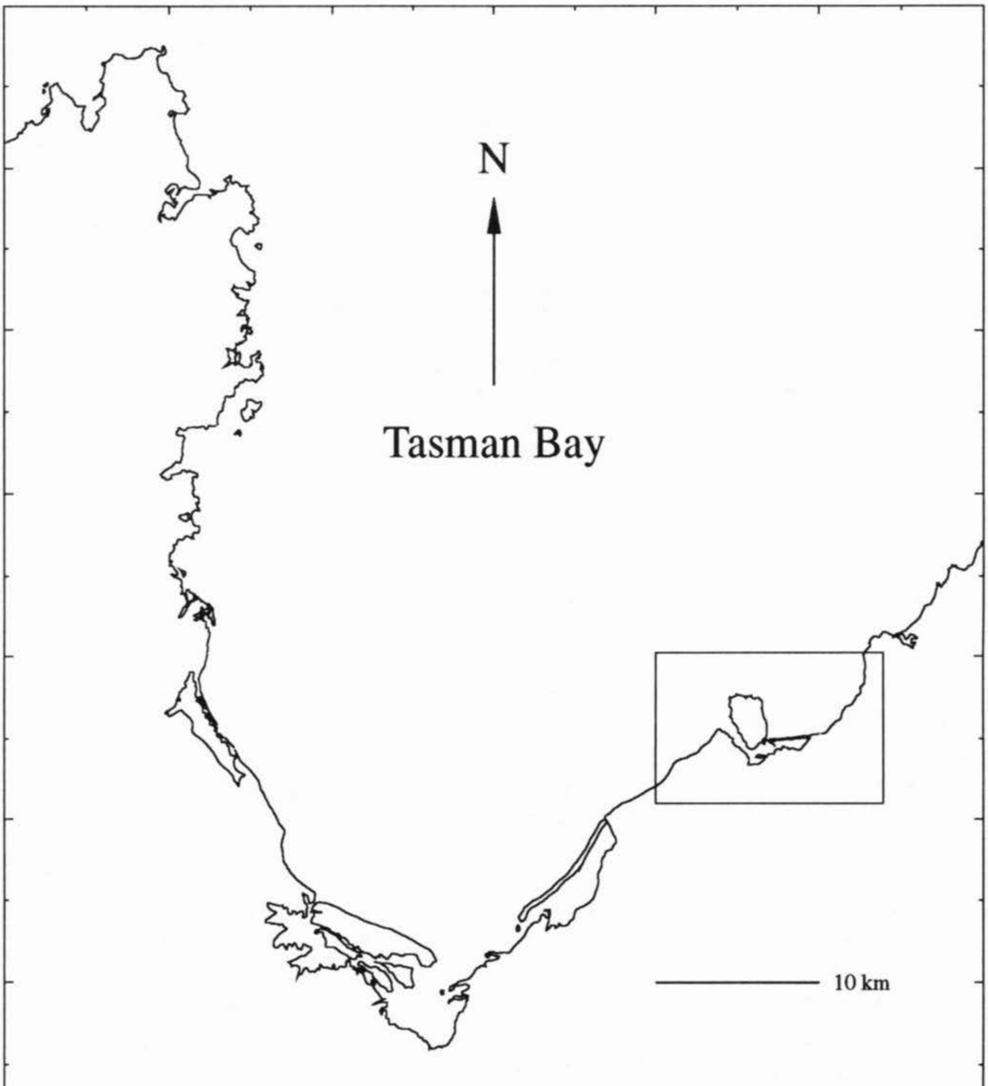

Figure 1: Map of Tasman Bay showing the general location of the Rotokura site, which is in the small boxed area (enlarged in Fig. 2).

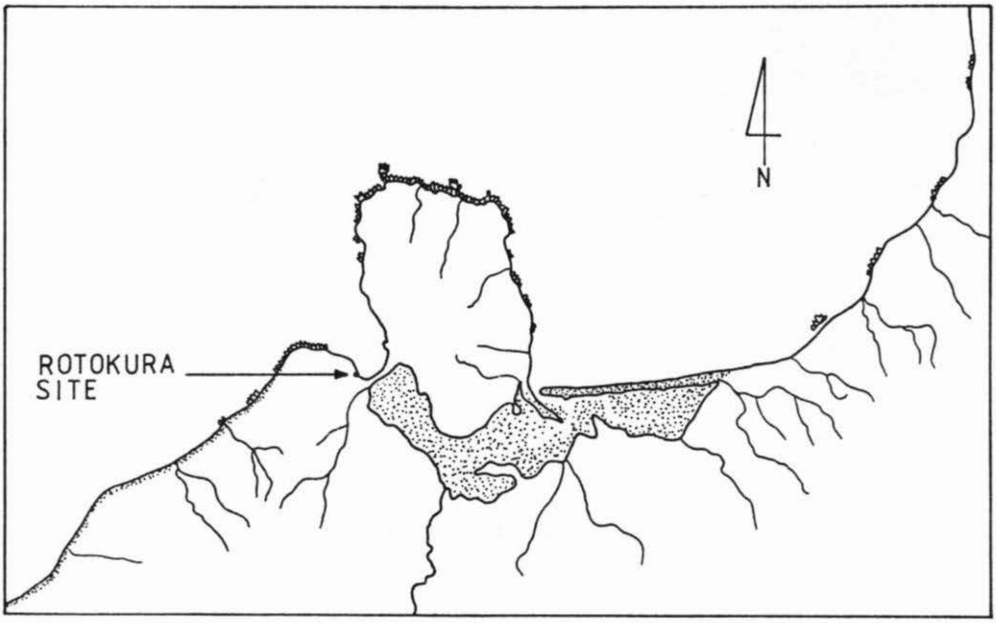

Figure 2: Cable Bay and Rotokura.

with Classic Māori artefacts and that associated with moa bone and Archaic artefacts. The layer designations for these are Layer 2A for Classic Māori, and for Archaic we can list Layer 4, Layer 3/4 (meaning the upper part of Layer 4), and Layer 2/3 (meaning the lowest part of Layer 2). Unfortunately, no fish bones were bagged solely as Layer 2B.

The full list of data files of bone measurements is given below, showing those which were added together for purposes of examining any change through time.

Filename	Grouped by Period	Provenances
LAYER2.DAT		Layers 2, 2A, 2A/2B
LAYER2&3.DAT		Layer 2/3
LAYER3&4.DAT		Layer 3/4
LAYER4.DAT		Layer 4
CLASSIC.DAT	Classic Artefacts	Layer 2A
MIXED.DAT		Layers ?, 2, 2A/2B
ARCHAIC.DAT	Archaic Artefacts	Layers 2/3, 3/4, 4

These data files were used to estimate original fish sizes, and then to calculate dispersion statistics and size-frequency histograms.

A special problem arises in arriving at a size-frequency distribution of fish catches from archaeological remains. The first step in this process is to estimate the live fish fork length and ungutted weight from individual bone measurements. The technique involved here is well understood and does not involve any serious problems. In the case of the snapper, the regression formulae have been thoroughly well established with large samples of modern bones (Leach and Boocock 1995). The next step, however, is somewhat more problematical.

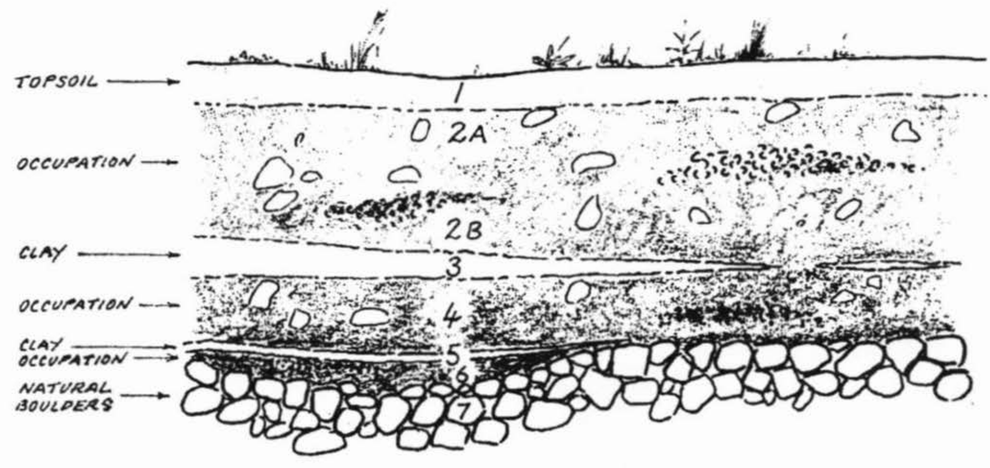

Figure 3: Stratigraphy of the Rotokura site. Layer 1 is a post-occupational deposit. Layer 2 is divided into an upper level A, which contains Classic Māori features; and a lower level B, containing Archaic features. Layer 3 is a clay deposit. Layer 4 has early Archaic features. Layer 5 is clay with some ash. Layer 6 contains Archaic material. There are natural beach boulders at the base of the site (courtesy of Don Millar).

For the Rotokura site, estimates of live fish size and weight can be established for 824 bones. The MNI (Minimum Number of Individuals) at this site is only 235 fish (Leach and Boocock 1993: 300). There are several ways in which a size-frequency distribution of the original catch could be worked out. Should it be based on 235 measurements or 824 ? It is interesting that this issue has received only scant attention by scholars involved in archaeozoological studies. Informal discussion with a number of colleagues who carry out research on fish remains revealed strong intuitive support for the second of these two options, notably to measure everything possible and work out catch statistics accordingly. In our view, taphonomic effects, which can lead to differential survival by anatomy or species, are unlikely to affect the size range differently from one species to another or from one part of the anatomy to another. For example, in cases where large bones are preferentially broken, such a pattern should be similar for similar sized species. Moreover, if large bones of one part of the anatomy, for example the maxilla, were preferentially broken compared with smaller parts of the anatomy, such as the quadrate, such a pattern would probably apply across the range of species.

Whatever approach is adopted there could be hidden snags, particularly when sample sizes are small. It should be noted that the option of measuring only the bones which gave the largest MNI (235 fish in this case) would not yield 235 measurements. The MNI figures are based on the identification not only of whole bones which can be measured, but also of non-matching bone fragments, many of which cannot be measured.

This issue has been the subject of formal theoretical analysis by Leach and Boocock (n.d.: Appendix 1) using a computer simulation model. This involved taking a large sample of bones from a fish catch where the size-frequency diagram and associated dispersion statistics were known, and carrying out recursive simulated breakage of bones so they could not be measured. It was concluded that estimating the size-frequency diagram on the basis of all

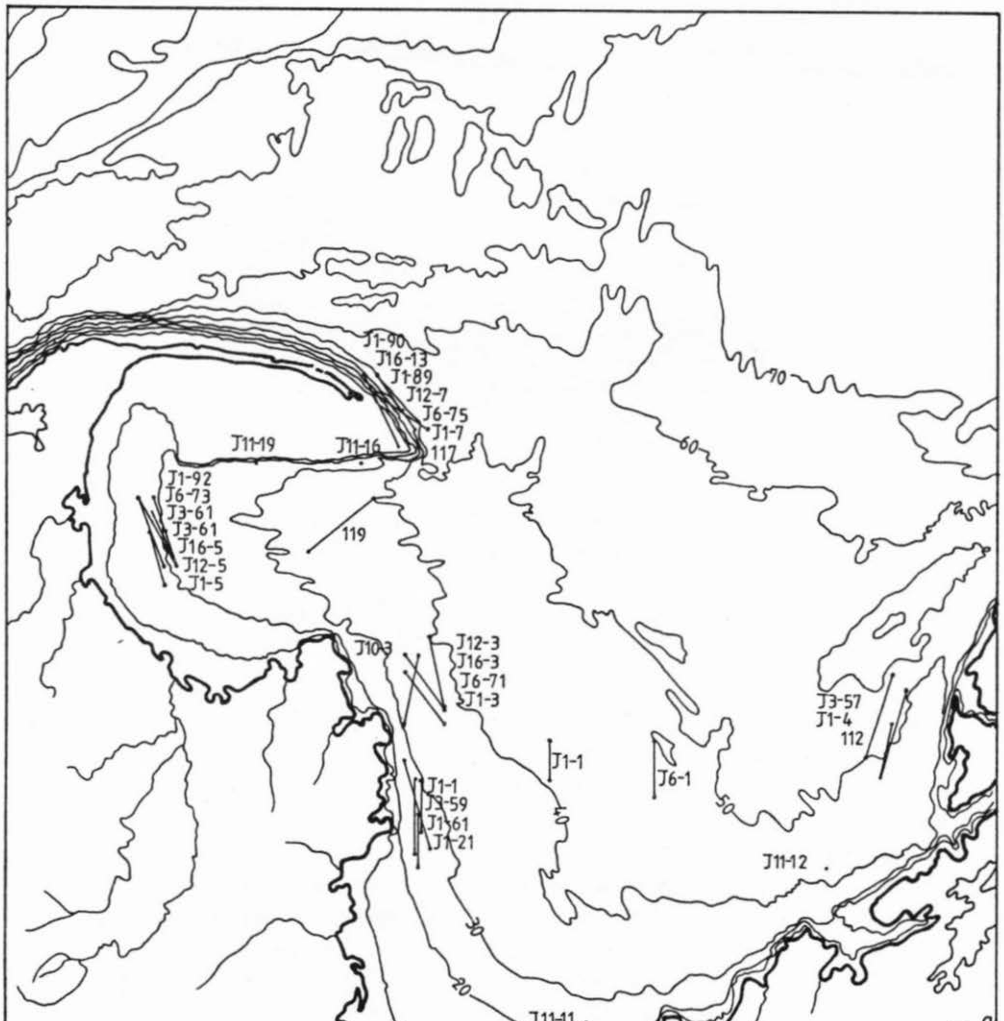

Figure 4: Benthic map of Tasman Bay showing the location of research trawls yielding snapper catch data in depths less than 50 m.

possible measurements did not produce bias. This approach was therefore adopted in this present study.

It is necessary to have something to compare these pre-European catches with, and for this purpose we used data from research trawling in Tasman Bay carried out by MAF-Fisheries

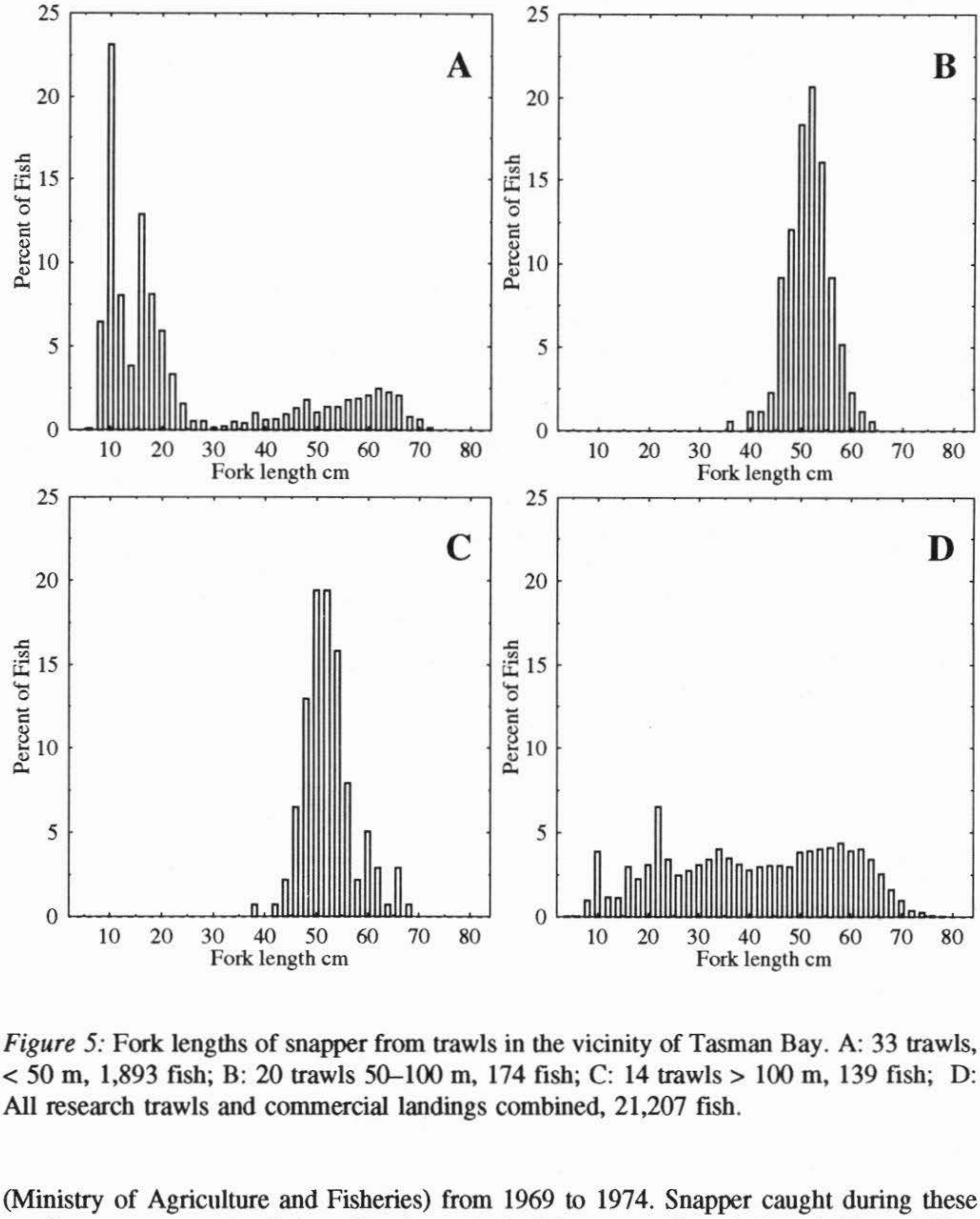

Figure 5: Fork lengths of snapper from trawls in the vicinity of Tasman Bay. A: 33 trawls, < 50 m, 1,893 fish; B: 20 trawls 50–100 m, 174 fish; C: 14 trawls > 100 m, 139 fish; D: All research trawls and commercial landings combined, 21,207 fish.

(Ministry of Agriculture and Fisheries) from 1969 to 1974. Snapper caught during these trawls were measured and since they were obtained from a number of places in Tasman Bay and at different seasons, they provide an excellent source of comparative information.

COMPARATIVE SNAPPER CATCH DATA FROM MODERN TRAWLS

Although there are considerable statistical data relating to commercial catches of snapper, including data from hand-lining, none has associated depth data; indeed the catches are bound to have come from a wide range of depths from many locations. The data from MAF research trawls, on the other hand, all had precise locations and depth. These were therefore chosen as the main group of data with which to compare the archaeological catches.

There were 67 trawls, amounting to 2,206 fish, which fitted these criteria, each with records of fork length. These data were grouped into three categories according to the depth of trawls as follows:

Shallow	<50 m depth	33 trawls	1893 fish
Medium	>50 <100 m depth	20 trawls	174 fish
Deep	>100 m depth	14 trawls	139 fish

In addition, the fork length data from all catches, including commercial ones, amounting to 21,207 fish, were pooled for the whole of the Tasman Bay area.

The waters in Tasman Bay are fairly shallow, and pre-European Māori living at Rotokura would have to travel a minimum of 24 km to reach waters 50 m deep. This is evident from the benthic contours in Figure 4. Although some catches may have been made in deeper waters, it is very likely that the bulk were taken in less than 50 m. The location of the research trawls in this depth range is shown on Figure 4. It will be noticed that two of these trawls, J9-1 and J11-11, were made very close to Rotokura in depths ranging from 15 to 22 m in July and October 1974. The first trawl yielded 92 snapper, all of which were less than 12 cm fork length. The second yielded 65 snapper, of which one had a fork length of 71 cm; the remainder were less than 12 cm. These are juvenile fish, and the fact that they are present in two different months in this same area suggests a spawning ground in this vicinity. A better known spawning ground is off Separation Point in western Tasman Bay, which has seen a number of research trawls.

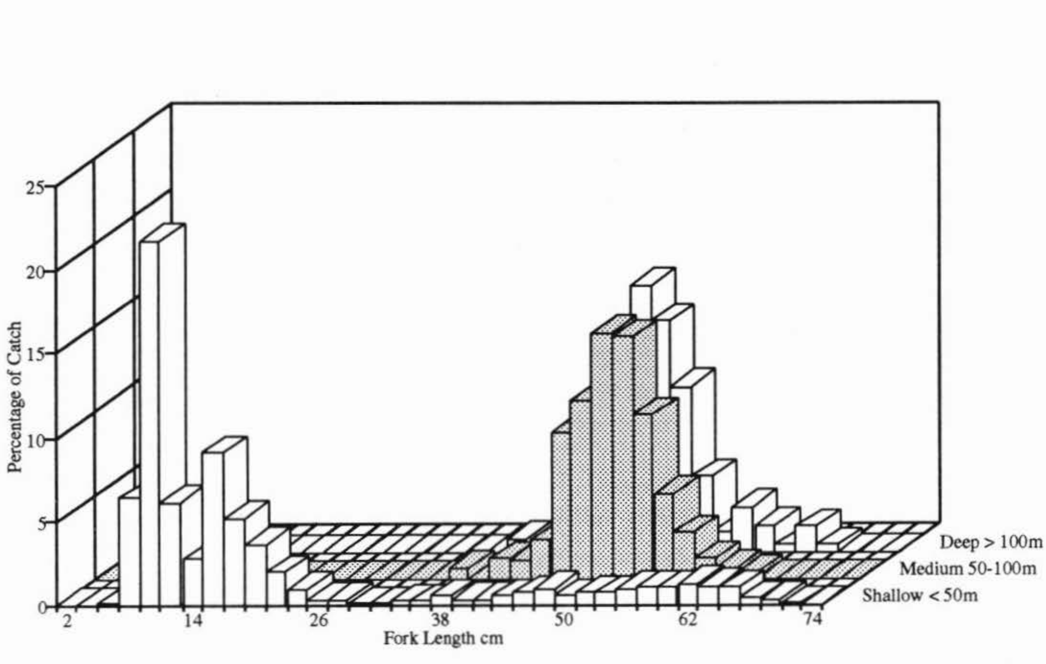

Figure 6: Comparison of fork lengths of snapper from trawls in the vicinity of Tasman Bay in three depth ranges.

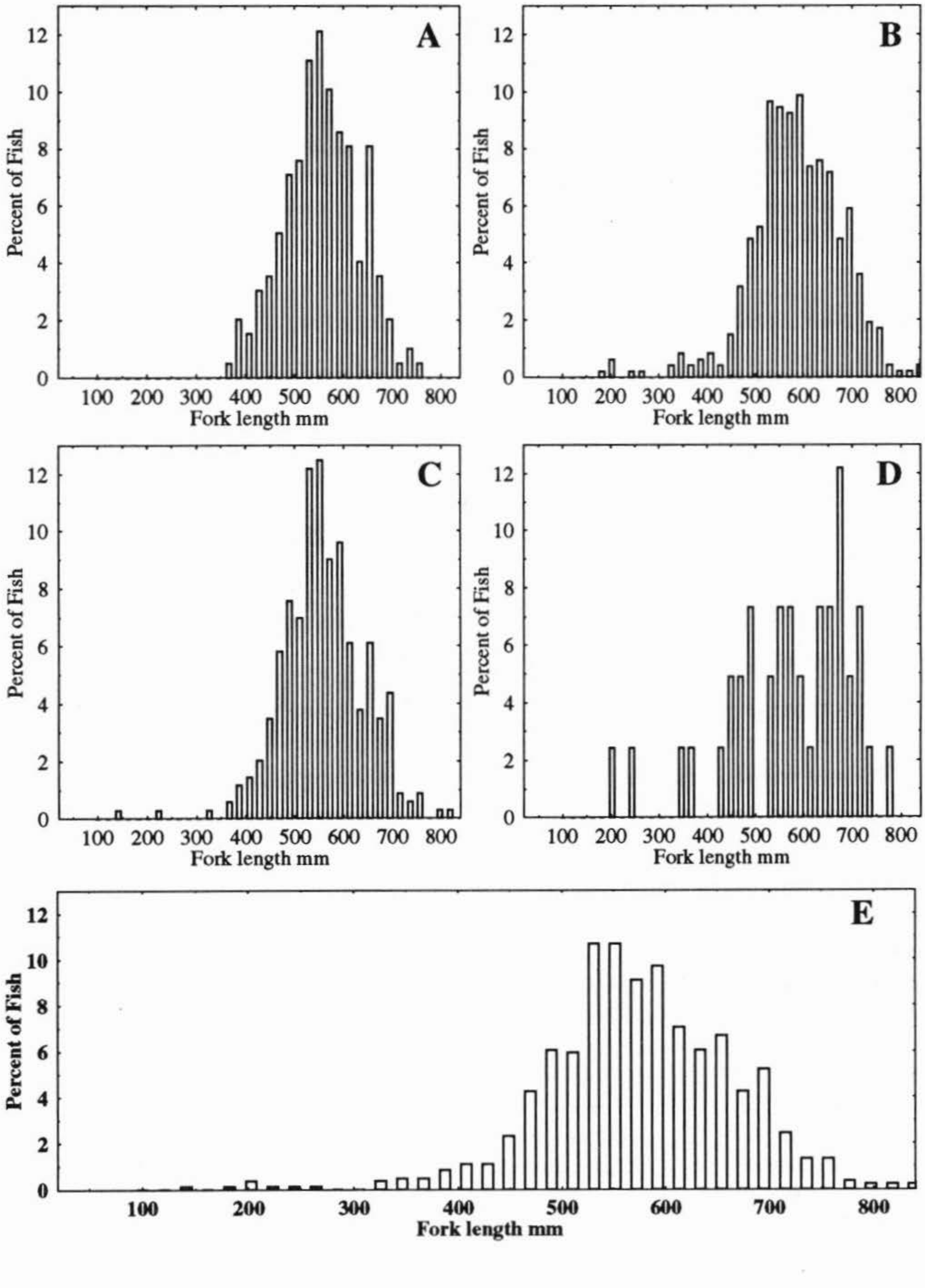

Figure 7: Size-frequency curves of the fork length of snapper catches at different periods at Rotokura. A: Layer 4, mean 557 mm, N=198; B: Layer 2, mean 587 mm, N=475; C: Archaic period, mean 558 mm, N=344; D: Classic period, mean 571 mm, N=41; E: All stratigraphic layers combined, mean 575 mm, N=824.

A series of size-frequency histograms are presented in Figures 5 and 6, broken down according to these different depth ranges. These clearly show the dominance of larger fish in waters over 50 m, and the abundance of juveniles in depths less than this. The central tendencies of the deeper two distributions are 51 and 52 cm, while the shallow water specimens are bimodal with peaks centred on about 12 cm and 55 cm. Statistics for these three distributions are given in Table 1. Figure 5D presents the distribution of fork lengths of all snapper for which figures are available for both commercial landings and research trawls, amounting to over 21,000 fish. This provides an overview of what snapper are available in these waters.

TABLE 1
MODERN SNAPPER TRAWL CATCH STATISTICS FOR TASMAN BAY REGION

Shallow = <50 m
Medium = >50 <100 m
Deep = >100 m

	Fork Length cm										
Depth	**N**	**Min**	**Max**	**Mean**	**SE**	**σ**	**SE**	**g1**	**W1**	**g2**	**W2**
Shallow	1893	6	71	24	0.4	19	0.3	1.2	19.3	2.8	1.5
Medium	174	36	64	51	0.3	4	0.2	-0.1	2.1	3.8	2.2
Deep	139	38	68	52	0.4	5	0.3	0.7	4.1	4.0	2.6

ARCHAEOLOGICAL SNAPPER CATCH DATA FROM ROTOKURA SITE

Measurements were able to be taken on 824 snapper bones, representing an excellent sample with which to reconstruct the original fish catch represented. This was done for each of the archaeological provenances. These data were then combined together into two cultural periods and finally for the whole site. The dispersion statistics and fork length size frequency distributions are presented in Table 2 and Figure 7.

When all measurements are combined, the mean fork length distribution (Fig. 7E) is uni-modal with a mean of 57.5 cm. The largest fish had a fork length of 87 cm and is estimated to have weighed 12.64 kg. The catch distribution is dominated by larger fish than those in other archaeological sites in New Zealand which have been subjected to similar analyses[3].

Fork length distributions are also given for the early (Layer 4) and most recent (Layer 2) horizons (Figs 7A, 7B), and also for the two units clearly associated with artefacts of Archaic types (Layers 2/3, 3/4 and 4) and Classic Māori (Layer 2A). These are illustrated in Figures 7D and 7C respectively. All these curves are strongly uni-modal, and show almost no juvenile fish (< 25 cm). In fact, almost all fish are above 40 cm fork length. It might be noted that the earliest layer in this site (Layer 6) did not produce measurable snapper bones.

[3]We have recently studied several large snapper collections from other archaeological sites in New Zealand, including those from the sites at Houhora, Galatea Bay, and Twilight Beach in the northern North Island. This research is not yet published.

TABLE 2
PRE-EUROPEAN SNAPPER CATCH STATISTICS FOR ROTOKURA

				Fork Length mm							
Provenance	**N**	**Min**	**Max**	**Mean**	**SE**	**σ**	**SE**	**g1**	**W1**	**g2**	**W2**
Layer 2	475	188	870	587	4.5	98	3.2	-0.5	6.4	5.0	9.2
Layer 2/3	28	408	703	587	14.2	75	10.0	-0.4	1.5	2.6	0.3
Layer 3/4	118	138	813	552	9.0	98	6.3	-0.5	3.1	6.1	7.3
Layer 4	198	362	746	557	5.4	77	3.8	-0.1	1.5	2.8	0.6
Classic	41	209	782	571	20.2	129	14.2	-0.9	2.7	3.6	1.1
Archaic	344	138	813	558	4.6	85	3.2	-0.3	4.4	4.9	7.5
Mixed	439	188	870	589	4.5	94	3.2	-0.4	5.2	5.0	9.0
All Data	824	138	870	575	3.3	94	2.3	-0.4	7.2	4.9	11.1
				Ungutted Weight g							
Provenance	**N**	**Min**	**Max**	**Mean**	**SE**	**σ**	**SE**	**g1**	**W1**	**g2**	**W2**
Layer 2	475	133	12639	4228	89.3	1946	63.1	1.0	9.1	5.2	9.9
Layer 2/3	28	1325	6698	4100	274.0	1450	193.7	0.1	0.7	2.1	0.9
Layer 3/4	118	52	10324	3554	164.0	1782	116.0	1.3	5.2	5.2	5.2
Layer 4	198	929	8003	3537	99.8	1404	70.5	0.6	4.6	3.2	0.8
Classic	41	181	9215	4107	339.3	2172	239.9	0.1	1.0	2.3	0.9
Archaic	344	52	10324	3588	83.6	1550	59.1	0.9	7.4	4.4	5.4
Mixed	439	133	12639	4249	92.2	1932	65.2	1.1	9.2	5.5	10.9
All Data	824	52	12639	3966	63.5	1822	44.9	1.1	12.3	5.3	13.6

A visual comparison between the early and late distribution curves suggests a change through time, but the significance of this is unclear in a size-frequency histogram. When the mean values for each assemblage are plotted out for the four main stratigraphic units (Figs 8A, 8B) and for the two cultural periods (Figs 8C, 8D), the changes are much clearer. The student's t values for Layer 4 to Layer 2 are 4.2 (for fork length) and 5.2 (for live weight) with 671 degrees of freedom. These values are highly significant ($p > 99.9\%$).

DISCUSSION AND CONCLUSIONS

The main purpose of this research was to examine the possibility that the pre-European Māori who lived at Rotokura had a significant impact on the marine resources in their vicinity, and in particular on snapper. It has been well documented from other parts of New Zealand that the mean size of species gathered in the inter-tidal area significantly decreases over archaeological time as a result of sustained exploitation (Anderson 1973; Leach and Anderson 1979a). This has been carefully studied in the case of early inhabitants of Palliser Bay, who initially had access to very rich marine resources, which were materially depleted over centuries. The marine organisms for which this has been well documented are a number of shellfish species and crayfish, *Jasus edwardsii*. However, such a decrease has not been adequately documented for any fish species in New Zealand. Shawcross, in his study of snapper remains from two archaeological sites at Galatea Bay and Houhora, suggested that there might be signs of decreasing fish size, but had inadequate sample sizes for different periods with which to document this, and did not press the point (Shawcross 1972:

611). He argued more strongly that there was a significant change in snapper size from pre-European to modern times (ibid.).

The snapper remains from the Rotokura site are numerous enough and distributed over a sufficient period of time to permit both these issues to be examined fairly thoroughly, at least for this part of New Zealand.

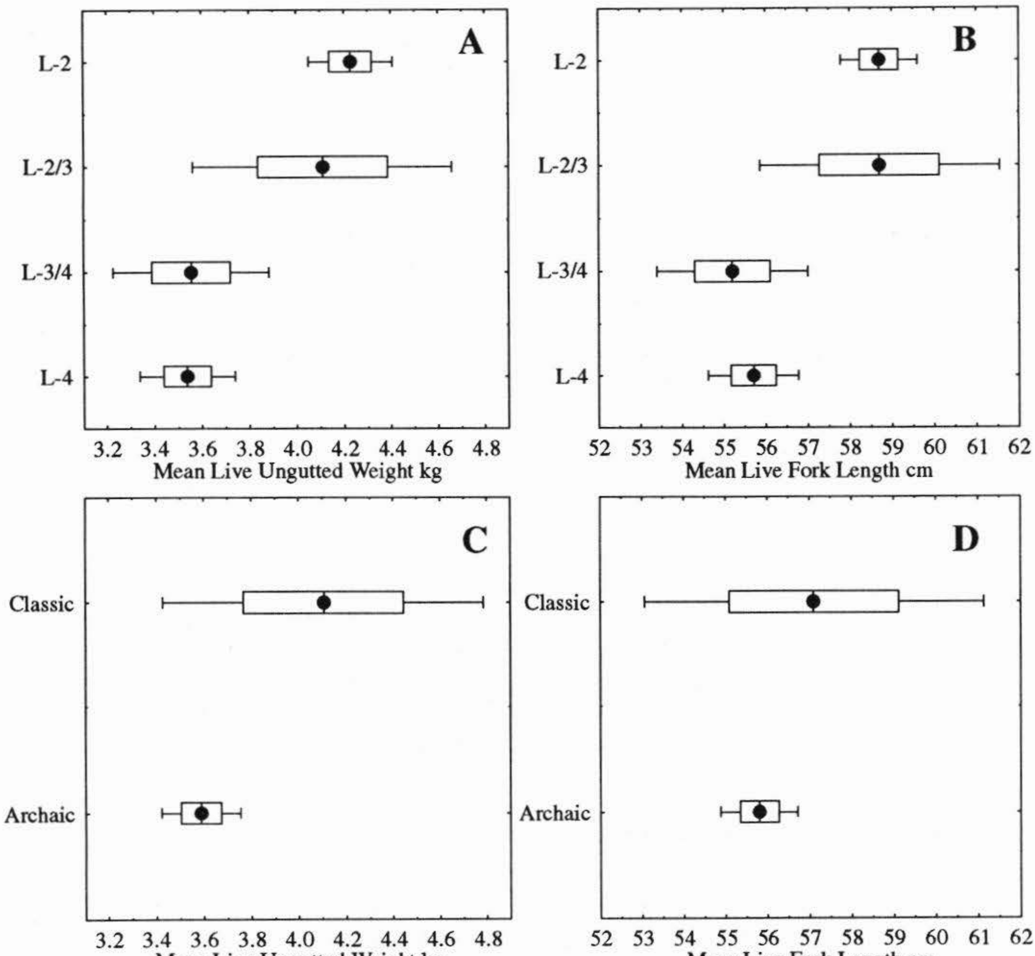

Figure 8: Changes through time in mean fork length and ungutted weight of snapper at Rotokura. The error bars indicate the 68% and 95% confidence limits for mean size (standard errors). As explained in the text, the designation Layer 2/3 indicates an early context in Layer 2; while Layer 3/4 indicates a late context in Layer 4. A and B show the changes in weight and fork length using the original stratigraphic later designations, while C and D present the same data for horizons closely associated with Archaic and Classic Māori artetacts. Unfortunately, the small sample size for the Classic assemblage prohibits a clear trend from being recognised. The graphs for the stratigraphic layers show an increase in mean fish size over time.

The first issue to be addressed is whether the fish in the modern environment are significantly smaller than the archaeological remains, reflecting a long history of intensive fishing, including that of the era of post-European contact. It could not be expected that pre-European Māori could have had a substantial impact on the resources of Tasman Bay as a whole. The fishing technology involved and the food requirements of a relatively small population would not materially affect such a large biomass. Any impact at this gross level is bound to have been post-European contact in character. Whether there is or is not a gross change, such as has been observed for the Hauraki Gulf by Shawcross, can best be examined by comparing two fork length size frequency distributions for the Rotokura sites as a whole (Fig. 7E) and the combined modern catch figures (Fig. 5D). The overall mean size for the site is 57.5 cm fork length. Although this may seem large by most standards for modern New Zealand, it is not out of character for Tasman Bay. Fig. 5D illustrates the complexity of the modern Tasman Bay fishing ground with a very broad range of snapper sizes from juvenile through to a strong peak at about 60 cm fork length. Figure 5, which illustrates modern fish catches at different depths, shows strongly uni-modal distributions for catches in both medium (>50 <100 m) and deep waters (>100 m), peaking at 50 cm. The shallow water catches (< 50 m, Figs 5A, 6), on the other hand, are more complex, and present a bi-modal distribution. Although the combined size-frequency curve is greatly dominated by juveniles, this reflects special research effort on known spawning areas. The second peak in the distribution is much broader, ranging up to 60 cm.

The modern snapper catches are therefore not dissimilar to those represented in the archaeological site, and this presents a strong contrast with snapper grounds further north in New Zealand.

Unfortunately, it is not possible to state where the Rotokura people were obtaining most of their snapper. One might think that a common sense approach to this question would be to use an 'efficiency hypothesis', that they caught snapper as close to their settlement as was possible to obtain them, and this would be Cable Bay. However, non-commercial fishing is not always driven by questions of efficiency, and there is ample ethnographic evidence of Polynesian fishermen, almost always men, wandering far from the easy catches close to home with a complex patchwork of objectives in mind—including the search for unusual species, or large specimens of more common ones, and a desire for adventure and opportunities which are not associated with the home patch. Whether the efficiency model applies in any instance also depends on whether people are short of food. Common sense in this mine-field is to use the efficiency model when all else fails. There have been two research trawls quite close to Cable Bay, and it was mentioned above that these produced almost entirely juvenile fish. Whether this is typical of the general vicinity for months other than July and October when these trawls were made is uncertain. Cable Bay itself is fairly small, and intensive fishing in this one bay for any length of time is bound to have depleted stocks. It is more likely that the Rotokura people caught the bulk of their snapper from canoes some distance from Pepin Island. The 50 m depth contour is 24 km from Rotokura, and it seems unlikely that people would regularly travel this far for daily food.

The second main issue is whether the fishing activities of these people depleted the resource they were harvesting. Judging from the statistics given in Table 2 and the changes illustrated in Figure 8, the answer appears to be negative. However, we have to be careful in interpreting this change towards larger fish on average in the upper part of the site than earlier. A change of this kind has been observed for *Haliotis iris* shellfish at Black Rocks in Palliser Bay (Leach and Anderson 1979a: 161). The reason in that case was a hiatus in occupation, lasting about 2–300 years. The evidence for this was compelling from several lines of research, including afforestation between the two settlement periods (Wallace 1979: 228). No such argument can be advanced in the case of the Rotokura site; on the contrary, the change from Archaic to Classic Māori takes place within one stratigraphic unit, notably Layer 2. This is clearly indicated in Figure 3.

There are a number of interpretations which could be offered for the observed change from large snapper to even larger ones over time. One concerns the possibility of occupation at different seasons. A careful study of the seasonal dimension of occupation at the site concluded year-round habitation in the later phases and all seasons except winter for the earliest period (Butts 1977). Finding direct evidence for winter occupation is notoriously difficult in New Zealand, and Butts persuasively argues that the site was not at any time a specialised seasonal camp, but one with a high degree of permanence throughout the occupation sequence. The idea that changes in snapper size are somehow related to different seasons of occupation therefore does not receive much support.

It seems unlikely that there would have been a naturally induced change in the character of resources available to the Māori over the period involved, but it can be noted that fishing conditions themselves may have varied through the sequence of habitation. Although detailed information on the chronology of occupation at Rotokura is lacking, the latest part of the sequence was probably close to the period known as the Little Ice Age from A.D. 1620 to 1830, when sea conditions were rougher than today (Leach and Leach 1979: 231). Offshore canoe fishing would have been more difficult in these conditions, compared with the period from A.D. 1000 to 1600, characterised by more settled weather. This could be used to argue that in rougher weather people were more restricted to fishing in waters closer to the shore. This has been documented for Palliser Bay (Leach and Anderson 1979b: 13), using evidence from labrid fishes. It is difficult to see how this scenario could result in larger fish being caught in this period.

This suggested climatic factor does not exhaust the possibilities of a natural explanation for the observed change. Tasman Bay is close to the southern limit of the distribution of snapper in New Zealand, and is well known amongst fishermen and fisheries scientists as having an unusual population. For example, snapper tend to be rather larger in these waters than further north. Another anomaly, which may be particularly important in this present discussion, is that the recruitment of year classes is highly irregular. This may be partly related to the generally cooler waters than further north. There is a tendency for a patchy distribution of different sized snapper in Tasman Bay, and over periods of 50 years or more the population can get older and older with very little recruitment of younger individuals. This is especially likely if such a period coincides with slightly cooler conditions than normally prevail. As this older, larger population dies out, it will be replaced by a considerably smaller population. In such a way, it is easy to see that Tasman Bay can have dramatic shifts in mean fish size over significant archaeological time (L. Paul 1995: pers.comm.). Such a phenomenon does not apply further north in New Zealand.

Another possible explanation is that the earlier people at Rotokura focused their fishing activities close at hand, perhaps within Cable Bay itself, and in a restricted area like this the resource may not be sustainable. If this is so, the later fishermen may have been obliged to venture further afield for good catches, possibly returning with somewhat larger fish on average than could be taken from waters close inshore. Such a suggestion could only be tentatively offered, and it is difficult to know how one might go about finding supporting evidence for this. It is well known that older individuals of snapper can become solitary in their habits and take up residence in quite shallow waters; this being the case, the first occupants of a place like Cable Bay would be able to catch large specimens for a time. We might therefore expect to find a decline in mean size over time in an archaeological site in such a locality rather than the reverse. On the other hand, the first occupation deposits may not have been excavated at Cable Bay, and the earliest horizon in the Rotokura site could represent a slightly later period. It is certainly unusual to find indications of an increase in size of fish over time in an archaeological site. As mentioned above, the earliest sample of snapper bones is from Layer 4, and this is not the earliest archaeological horizon. The stratigraphy has two further layers beneath this. However, these did not produce measurable bones of snapper, and it is not known whether they are significantly older than Layer 4.

Finally, it should be noted that moa and sea mammals are present in the early part of the Rotokura site, but absent from the later levels. It is possible that as these more substantial items of food became less accessible, fishing became a more significant economic activity, and fishing grounds with larger individuals were sought after more actively.

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