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THE AUPOURI SAND DUNES ARCHAEOLOGICAL STUDY: AN INTERIM REPORT

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The narrow finger of land at the northernmost extremity of the North Island of New Zealand (Fig. 1) is usually referred to as the Aupouri Peninsula, after the tribe Te Aupouri, who still own a substantial proportion of it. It might be more accurate to call it the Aupouri tombolo, since the vast bulk of the peninsula, nearly 100 km long, is made up of late Pleistocene and Holocene dune sand linking what were once small islands of much older volcanic and sedimentary rocks of Miocene and earlier age. Most of the sands which compose this huge spit are therefore less than 100,000 years old, whereas the older islands of hard rock date back many millions of years (Kear and Hay, 1961; Hay, 1981). From an archaeological viewpoint, the importance of the older rocks is that they provide the only source on the peninsula of hard stone for industrial and domestic purposes, since no such material occurs naturally on the sand areas.

Geomorphology. The western half of the peninsula is composed of unstable sand dunes, covering an area of over 300 km^2 and rising to 120 m above sea level. These dunes have been moving slowly eastwards, obscuring and re-exposing archaeological sites as they progress, and now stretch inland for up to 6 km from the west coast. They are the latest in a sequence of at least four phases of dunes, spanning the last 50,000 years, described by Hicks (1975) and Hay (1981). The significance of the sand dunes for archaeological purposes lies in the soils which have formed on them. The two earliest series of dunes have formed hard, infertile, strongly leached and podzolised soils with little natural fertility, whereas the third series, named "Aupouri Parabolic III" dunes by Hicks, have formed much lighter soils which may have been well suited to Polynesian gardening. The Parabolic III dunes, referred to in this paper as "Pinaki" dunes from their characteristic soil type, are those which immediately preceded the current mobile dunes, (called the "Aupouri Transverse Dunes" by Hicks).

Pinaki dunes are of late Holocene age (Cox, 1977:26), almost certainly less than 5,000 years old. They result from the phase of sand movement immediately preceding human occupation and it is assumed that when man arrived in the Far North these Pinaki dunes were largely stabilised by vegetation, with definable lightly-weathered soils formed under scrub and light bush. Hicks (1977: 53) suggests that widespread burning and bush clearance by the early Maori would have denuded vegetation and initiated breakdown of the stable dunes, leading to the rapid formation of the present mobile transverse dune system.

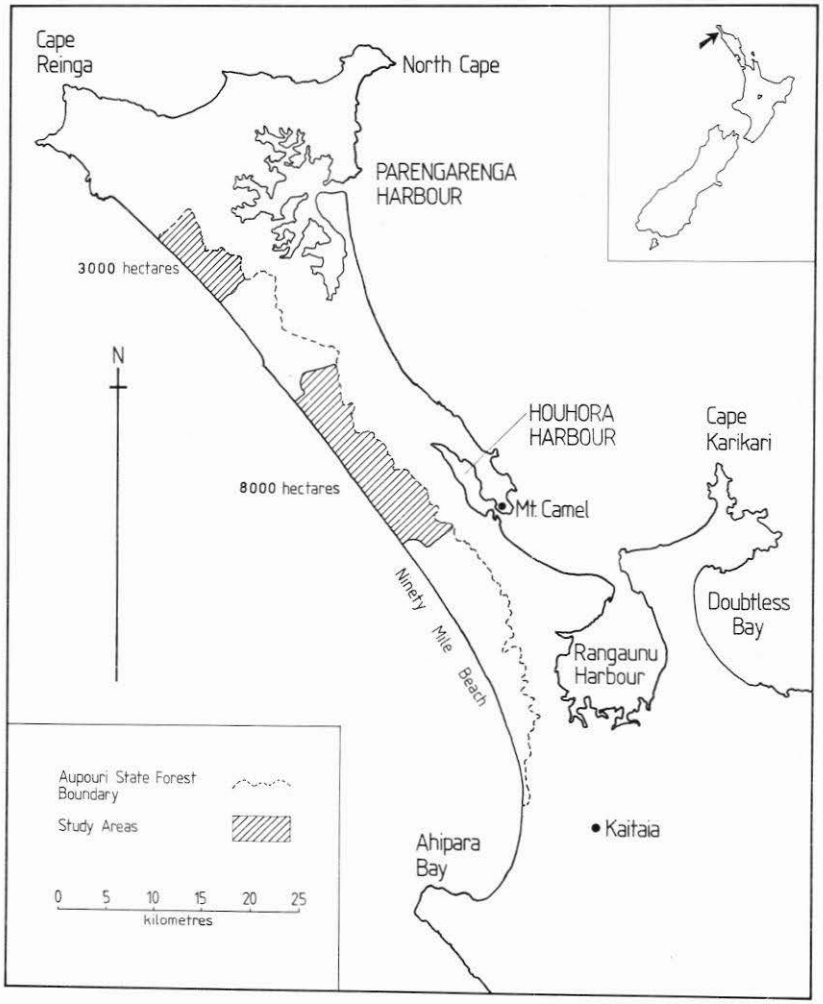


FIGURE 1. The Aupouri tombolo, showing Aupouri State Forest and extent of the study areas.

The suggestion that Pinaki soil formation more or less ceased on man's arrival is supported by the fact that, with one or two possible exceptions, no archaeological sites investigated in the present study were overlain by Pinaki or older soils, but only by recent windblown unweathered sand. In at least one case however, on site N6/438, shell midden has been found underlying a very lightly weathered sand which could be taken to imply some degree of soil formation, and hence a considerable time lapse, since occupation of the site.

Soils and horticulture. In marked contrast to the older leached and podzolised soils, Pinaki soils, being light, friable, well-drained and moderately fertile, would appear to be well suited to kumara cultivation. It is also possible that the swamp soils known as Ruakaka peaty sandy loams (Sutherland et al, 1980), although very wet unless drained, could have been used for the cultivation of taro. This suggestion was first put forward by Mitcalfe (ms.), based on the existence in the Motutangi Swamp (not far from the study area) of extensive, apparently pre-European, networks of shallow ditches covering many acres. These ditch systems are at present under study by Ian Barber of Auckland University. Similar systems are known elsewhere on the Aupouri tombolo and appear in each case to occur in an area where the advancing eastern face of the stable Pinaki dunes abuts a mosaic of Ruakaka and older soils (see Sutherland et al, 1980).

The fact that the ground surface on all such sites examined by the writer has been dry and well above the water table may argue against the hypothesis of wetland taro cultivation. It must be admitted that recent drainage for pastoral farming has probably lowered the water table drastically, but at the present time it appears that the plots formed by the ditch systems are as suitable for the cultivation of kumara as of taro. Leaving aside uncertainties as to what crops were actually grown, the fact remains that in several parts of the Aupouri tombolo a mosaic of Pinaki and Ruakaka soils, overlying and abutting older soils, occurs in conjunction with apparent pre-European agricultural systems. Such systems point toward intensive cultivation, most likely of root crops. An apparent correlation between the distribution of known pa sites and the Pinaki-Ruakaka soil complexes further supports the suggestion that these particular soils were highly significant for prehistoric horticulture.

Background to the Aupouri study

Aupouri State Forest comprises most of the recently-mobile sand dunes on the western side of the Aupouri peninsula. The "forest" occupies an area of about 300 km^2 and was established

by the New Zealand Forest Service in 1962, in an attempt (which has been outstandingly successful) to stabilise the active sand dunes by planting them in marram grass, lupin and pine trees (see Coster, 1980a). Between 1962 and 1976, when the Forest Service began intensive archaeological surveys of the remaining raw sand areas, about half of the sand dunes had been stabilised. Stabilisation with marram grass of the remaining sand is expected to be completed by 1986.

Over the last seven years, the Forest Service has carried out annual archaeological site surveys in order to record sites and allow their protection where feasible. When completed, these surveys will have covered a total area of about 110 km^2 (see Fig. 1), containing nearly 400 archaeological sites. The site surveys have covered less than half the total area of the forest, and it is reasonably certain that many unrecorded sites lie buried beneath the sand. It may therefore be assumed that well over 1000 sites were originally present on the Ninety Mile Beach dunes.

In 1980 the Forest Service, realising that afforestation would destroy or obscure a large proportion of the sites, and hence of the prehistory of the Aupouri peninsula, approved a programme of investigation to gather detailed data on the chronology, environment and economics of Maori occupation in the area. This programme, known as the "Aupouri Sand Dunes Archaeological Study" has occupied a total period of over 2½ years and was to be completed by June 1983. Field work for the project began in February 1981 and was substantially complete by July 1982.

Planning for the study was undertaken in consultation with Jim McKinlay (Senior Archaeology, New Zealand Historic Places Trust) and Roger Green (University of Auckland). The programme was financed largely by the Forest Service, with contributions from the Trust and the Skinner Fund of the Royal Society of New Zealand. Supervision was provided jointly by the Trust, the Forest Service and the University's Department of Anthropology. The study itself was undertaken by the writer, with the assistance of student volunteers and workers employed under the Department of Labour's Project Employment Programme and Student Community Service Programme. Laboratory facilities were provided by the Anthropology Department.

The investigations were authorised by Historic Places Trust permits 1981/12, 1981/54 and 1983/5. The Trust has issued authorities to the Forest Service to modify by afforestation virtually all sites in the inland part of the study area, on the condition that any outstanding sites may be protected and that all reasonable attempts will be made to avoid damage to sites in the coastal strip, within 300 m of high water mark.

As might be expected, the aims which were set out in the original statement of objectives and strategy for the project (Coster, 1980b) were over-ambitious. For example, it was originally intended to investigate up to 50 separate sites, but in fact only about 25 had been looked at in any detail by the end of the study, although at least 70 others had been sampled or probed with a spade. It was also hoped initially that a number of ancillary projects aimed at providing background information on geomorphology, palaeoenvironment and soils could be undertaken by scientists not directly connected with the project. None of these has borne fruit except for a study of landsnails, aimed at the reconstruction of prehistoric vegetation, undertaken by Rod Wallace of Waikato University.

Given that the original planning for the study was slightly unrealistic, some aspects of it have had to be scaled down considerably for lack of time and expertise. Nonetheless the three major aims originally formulated for the study have remained its primary focus. These aims, described in more detail below, were (1) to determine the nature of the prehistoric environment, (2) to establish a sequence of absolute and relative dates for the sites investigated, and (3) to examine the range of activities pursued by the prehistoric Maori within the study area.

Methods of investigation

The major characteristic of eroding sand dune sites is that archaeological features and objects which even in pastureland are usually hidden from the archaeologist's view are exposed or partly exposed on the surface of the ground by wind erosion. Large scale areal excavations are in effect provided free of charge by nature, with the disadvantage that stratigraphic and, to a lesser extent, spatial control is largely lost. In practise, however, excavation and examination of exposed sections reveals that very few of the Aupouri dune sites show evidence of stratigraphically distinct occupations, so it could well be that even large scale conventional excavation methods would fail to tie a site together stratigraphically. The problem remains that adjacent but chronologically separate occupations in one area may not be distinguishable and could be taken to represent one large site rather than a number of small ones. With this proviso in mind it was generally assumed that within any restricted area the archaeological evidence represented a single short-term occupation rather than two or more occupations extending over a longer period of time. Radiocarbon dating may establish whether or not this assumption is justified.

Having literally thrown stratigraphic control to the winds, one of the major methodological considerations was to establish

some sort of spatial control over the sites. In the field, it quickly became obvious that at any one time only part of any site is visible on the surface, but over the course of time, as the wind moves sand back and forth, a greater proportion of the site becomes visible. The Aupouri study was therefore planned with the requirement that it should be possible to re-visit a number of sites at short notice over a period of a year or more, as wind and weather dictated, in order to study newly-exposed portions of each site. This was achieved by living within a few miles of the survey area, at Houhora, over most of 1981 and 1982. By having a permanent base it was possible to combine 2-3 days per week of fieldwork with documentation and analysis of data as the work proceeded. The resources of a large government department like the Forest Service made it possible to use a four wheel drive vehicle throughout most of the fieldwork period and to provide sufficient equipment so that the vehicle could be used as a mobile archaeological survey and excavation unit. It was thus feasible to carry out virtually any operation, from plane table mapping to excavation, on the spot, as required, and if necessary with no prior warning. Given this general logistical background, the strategies adopted were as follows.

Site recording. Initially, sites were located in the field, allotted N.Z.A.A. Site Recording Scheme numbers as they were recorded, and a spade-probe used where appropriate to ascertain depth and extent of deposits, stratigraphy and nature of the substrate. The advantages of, in affect, site surveying with a spade are considerable, and a single spade cut into an exposed midden can supply a great deal of information, with little damage to the site itself and a minimal outlay of time and effort. The simultaneous recording of sites, partial investigation and allocation of site numbers, while perhaps justifiable only under extraordinary circumstances (which the Aupouri situation certainly presented) saved a great deal of time and effort. Indeed, having spent a number of days in the field with bulldozers close behind, the writer finds it difficult to imagine any other way of working in the circumstances. Obviously the procedure must involve close co-operation with the Historic Places Trust and with the local Association Filekeeper, and presupposes that site data can be processed and reported on a more-or-less continuous basis.

Mapping. Following recording, selected sites and features were marked with permanent relocatable, sequentially-numbered wooden pegs. They were then mapped in detail to show features such as ovens, middens, artefact concentrations and loose surface scatters of stone and shell. The use of permanent pegs enabled new information to be added to the plan, either by plane tabling, triangu-

lation, or tape and compass mapping, as the site was revisited and more features became exposed. This was a time-consuming process and only five or six sites (one of them 7.5 ha in extent) were mapped in this way. In the event, it transpired that very few new features (apart from small artefacts) needed to be added after the initial mapping of the site. For example, on one large site (N6/439) only 16 new features had come to light within 18 months of the first 200 features of the site being plotted.

A second approach to mapping was adopted in the case of three large coastal midden complexes which covered areas of up to 11 ha each. Here, low level vertical aerial photography, at altitudes of 2000-3000 feet, was flown by the Forest Service and the resulting photographs, with a resolution of as little as 20 cm, were enlarged to scales of 1:500 or 1:1000. By this means, still using numbered pegs to provide ground control, it was possible to plot detailed maps directly from the aerial photographs in about a fifth of the time which would have been necessary to map the sites by plane table survey.

Sampling. After site recording and mapping, some 55 individual middens and other features from 25 separate sites, were sectioned and sampled to elucidate their structure and provide material for midden analysis, dating, landsnail analysis and soil comparisons. In a few cases larger stream-cut sections through middens were trimmed back. Their greater extent (up to 40 m) was particularly useful in aiding interpretation. In all cases, the stratigraphy and features exposed in sections were drawn and photographed (Plates 2,3). In a few cases, small (0.5-1.5 m^2) test squares were excavated to examine particular features of interest or to look at the fine structure of midden deposits. The amount of time involved in excavating even a small area, however, strictly limited their use.

All surface artefacts found were collected for future analysis. Individual artefacts and concentrations of flakes were either mapped directly onto site plans or collected within a superimposed grid, with individual squares ranging from 1 to 10 metres. In this way, well over 4000 m^2 of artefact concentrations were intensively surface-collected. For large, particularly dense concentrations of flake material, a portable aluminium-framed collapsible grid, specially designed for surface-collecting, was used to save time. This grid was also used for accurate mapping of small areas where features such as postholes were exposed on the surface (Plate 4).

Midden analysis. During the course of fieldwork, 118 samples of shell midden were collected from 21 individual sites. Samples were usually between 3 and 5 litres in volume, with a total dry weight of 500 kg. They were partly analysed during 1982 and 1983, with the aim of consistently breaking down each midden into its physical components. This was done by initial dry sieving and sorting, followed by flotation and wet sieving of the finer fraction. Shell, sand, stone, bone, charcoal and other organic components were thus separated out, so that their respective proportions could be expressed as a percentage, either by volume or weight. Comparison of bar graphs which show the proportion of different components (see Fig. 2) then provides a means of assessing the range of variation between middens and of accurately sorting them into specific types which may represent different activities.

The use of standardised methods to analyse midden material has the advantage of enabling accurate comparison of midden samples collected at different times or from different areas. It is not suggested that any one sample is necessarily representative of a particular midden, but a number of samples as large as that collected should be sufficient to indicate the range of variation which occurs, both within single middens and over the study area as a whole.

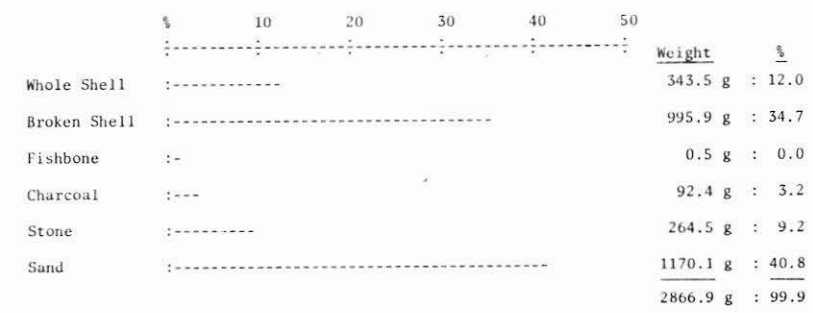


FIGURE 2. Example of computer-generated histogram expressing percentage composition of midden sample.

Summary. The main feature of the Aupouri study was its wide ranging nature, examining by one means or another all visible surface evidence over an area of thousands of hectares, coupled with the detailed mapping and investigation of a selected sample including both unusual and representative sites. The emphasis of the study was descriptive, in an attempt to provide a general account of the archaeology of a unique piece of New Zealand which will soon be largely inaccessible to archaeologists. In no sense (even that of determining the true distribution of sites) can it be regarded as a complete piece of work, the time for its execution having been too short. It is unfortunate therefore that it will not be possible for other archaeologists to undertake more detailed investigations, except in the case of those coastal middens which are to be protected from afforestation.

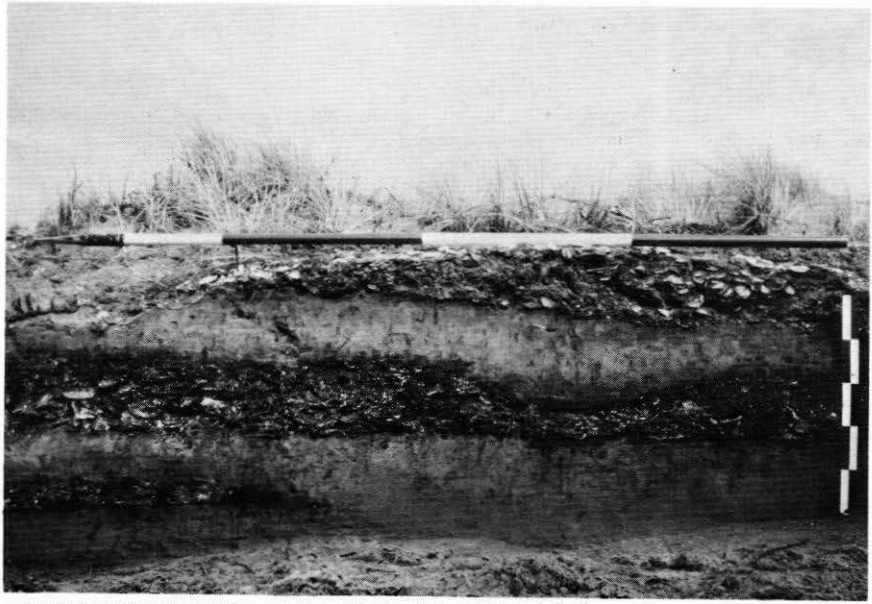
Results

Palaeoenvironment. The first major aim of the study was to determine the nature of the environment over the last 2000 years from the study of sand dune geomorphology, soils, landsnail samples from middens, identification of surface wood from the dunes, identification of archaeological charcoals and from accounts of early travellers in the area. The assumption underlying this aim is that in prehistoric times the land was clothed with vegetation to a much greater extent than it is now and that sites which are now surrounded by sand dunes were originally established in fernland, scrub or bush.

Geomorphological studies such as that of Hicks (1975) emphasise the relative instability of the Aupouri tombolo over the last 100,000 years. More than once, the land appears to have undergone a change from dense kauri forest to shifting sand or scrub, and then back to forest. Accounts by early nineteenth century travellers (including Dieffenbach, 1843; Jolliffe, n.d.; Jones, n.d.; Kinder in Evens, 1981; Mathew, n.d.) appear to agree in depicting a barren landscape of Leptospermum scrub, swamp and extensive sand dunes, almost entirely devoid of bush or even scattered trees. From about 1860 onwards, when the first European settlers arrived (Evans, 1981:52; Sale, 1981:65), the Far North was even further denuded of vegetation. Gumdiggers and graziers descended on the land with their matchboxes, clearing and burning, with the result that by the 1940s nearly half the tombolo was unstable windblown sand.

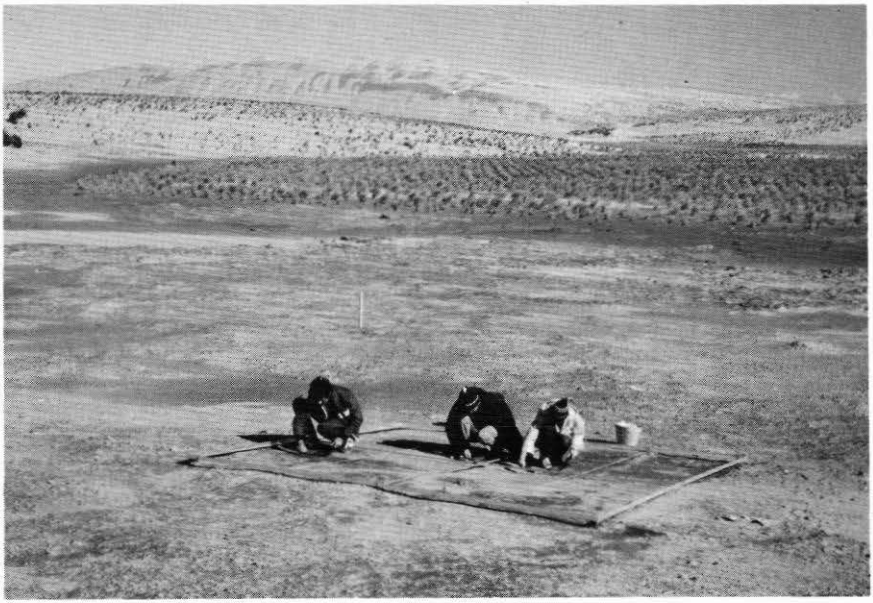
The prehistoric picture may have been a little brighter. Pinaki soils, the eroded remnants of which underly many archaeological sites, may be taken as an indication of forest cover in the period immediately preceding human occupation. Identific-

AUPOURI PROJECT Plate 1. Middens behind Ninety Mile Beach.



AUPOURI PROJECT Plate 2. Stratified midden (N3 & 4/151).

AUPOURI PROJECT Plate 3. Half-sectioned midden showing remnant shell cap.



AUPOURI PROJECT Plate 4. Surface collecting and mapping with portable 4 x 4m grid (N6/440).

ation of surface wood remnants and archaeological charcoals shows that broadleaf trees such as puriri and pohutukawa were readily available to the Maori, while even podocarps such as matai, monoao and tanekaha occurred in some areas (L. Donaldson, R.T. Wallace, pers. comm.).

Preliminary results of the analysis of landsnails extracted from 24 midden samples indicate vegetation types ranging from associations of coastal scrub and wiwi (Leptocarpus similis), to a light, closed canopy, coastal broadleaf forest growing on the dunes in the prehistoric period (R.T. Wallace, pers. comm.). The finding of a few specimens of in situ sub fossil Placostylus ambagiosus (flax snail) is a further indication of the presence of coastal broadleaf forest in the not too distant past (A. Penniket, pers. comm.).

The above results are all the more interesting when it is considered that at the present time the vast majority of the study area comprises a virtual desert of windblown sand and mobile dunes, with little vegetation present apart from coastal sandbinders. The only surviving remnant of the former coastal forest comprises a few small patches of scrub and broadleaf shrubs dominated by isolated pohutukawa, puriri and karaka trees.

Dating. The second aim of the study was to establish a sequence of relative and absolute ages of sites and to relate this to their distribution. Radiocarbon dating will provide the basis for a chronological sequence. It was hoped also to use conchiolin dating as a means of providing relative dates for a greater number of sites than can be dated by the radiocarbon method, but no work has yet been undertaken on this aspect. In the course of the study, 75 samples of marine shell, charcoal and wood were collected for dating purposes. Fourteen of these have been submitted to the Institute of Nuclear Sciences for radiocarbon dating, but results have not yet been received.

No data on the chronology of the Aupouri dune sites are therefore available at present, but it seems likely that Maori occupation spanned a broad period of prehistory. Early occupation may be indicated by the numerous Archaic artefacts which have been collected from the dunes over the years, but none of these is from an intact deposit and only a few can be tied down to particular sites. Nor have any middens which are demonstrably Archaic in character been found on the west coast dunes, and it may be that all early sites have eroded away or been buried by sand. It is equally possible that the Archaic artefacts simply represent visits to the west coast by people living to the east and north, where early sites are known to be present, notably the

Houhora site excavated by Shawcross and Roe (Roe, 1968) and the Twilight Beach midden (N1&2/976), recently excavated by Michael Taylor and Russell Foster of the University of Auckland (see Taylor, n.d.).

Prehistoric activities. The study's third aim was to examine the range of activities pursued by the prehistoric Maori who occupied the sites. This is being determined by study of site distribution, site layout, detailed analysis of midden samples and examination of the extensive surface collections of artefactual material. Numerous artefacts, including over 7500 flakes of stone, chert and obsidian, have been collected from the dunes, and these will provide a major source of information on prehistoric activities.

For the present, it can be said that the most immediately noticeable aspect of the distribution of the 350 or so sites recorded on the dunes is that the majority of them fall into two groups. A dense belt of coastal sites (Plate 1) lies within 200-300 m of the foredune, while a more diffuse scatter lies between one and five kilometres inland. The coastal sites typically contain large deposits of burnt crushed shell and little else, while the inland sites include more varied midden contents, ovens, occasional structures and numerous artefacts.

A number of activities can be shown to have taken place on the inland sites. Flakes of chert and obsidian are presumed to indicate a variety of cutting and scraping activities associated with day-to-day household tasks as well as light manufacturing. Grinding stones and large numbers of polished stone chips imply that adzes were reworked and sharpened on the sites, while one site (N3&4/224) gave clear evidence of the manufacture of a stone lure shank, to judge from the stone flake cutters and sandstone grinders found with it. There is evidence also that red ochre was used and prepared on the inland sites, and this could be associated with the wood-carving which is inferred from the presence of small nephrite chisels found on several sites. Tree-felling and woodworking, in early times at least, is implied by the numerous large archaic adzes found on the dunes. The Classic Duff 2B adze also occurs frequently, and probably indicates digging activities as well as woodworking, to judge from the use-wear striations on some of them.

The presence of at least one substantial house and of ovens and small middens which had been used more than once is indicative of some semi-permanent settlement. There is also evidence of foraging over considerable distances, perhaps including fernroot gathering if this can be inferred from the presence of a single wooden pounder. Certainly, frequent visits to the west coast

are implied by the quantities of toheroa and tuatua shells (Paphies spp.) in middens, while harbour and rocky shore shellfish in some cases indicate visits to the east coast as well (see Fig. 3).

Relatively little evidence was found of hunting and fishing. Fishbone occurred in fewer than a third of the middens examined and then only in very small quantities (less than one percent of total midden constituents). Of the artefacts normally associated with fishing, only a few isolated lureshanks and stone sinkers have been found. Very little bird bone has been found in middens and dog bone is also rare, although whale bone is not uncommon. The major fish species identified was snapper (Chrysophrys auratus), but barracouta (Thyrsites atun) occurred in at least one site (R. Nichol, pers. comm.).

It is not easy to explain the absence of evidence for fishing in particular, It cannot of course be assumed that midden

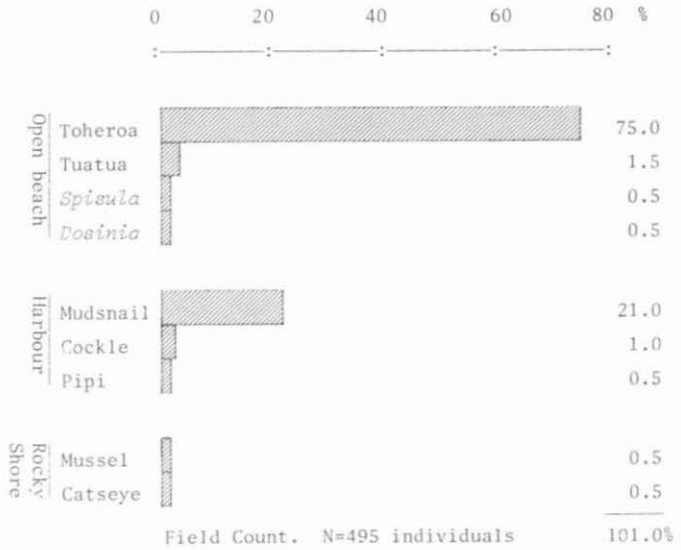


FIGURE 3. Example of species composition of an inland midden, showing exploitation of harbour (east coast) and rocky shore environments, as well as west coast beaches (N6/439, feature df.).

contents directly reflect food consumption, but even so the quantities of fishbone recovered, especially on the coastal sites are strikingly small. It may be that the west coast surf was generally too rough for conventional fishing methods, or it is possible that the local economy was heavily biased towards shellfish as a food resource, but neither of these explanations is at first sight very convincing. Certainly, it is unlikely that there was ever any lack of fish in Northland waters during prehistory.

There is a puzzling absence of direct evidence for horticulture on the inland sites especially since many or most of them are underlain by Pinaki soils which, as discussed earlier, appear to be suitable for kumara growing. In spite of this apparent horticultural potential, no large rectangular pits of the type usually associated with kumara cultivation have been found on the dune sites, although they are known to occur on some pa on the Aupouri tombolo. Pits have also been recorded in large numbers in the Cape Reinga - North Cape area by Davidson (1975). It can be stated with reasonable confidence that the absence of pits on the dune sites is real and not merely due to deficiencies in observation. It seems therefore to be important for the future to establish the potential for prehistoric horticulture in the Aupouri area, and also to explain the apparent absence of horticultural evidence on the dune sites.

To summarise, there is no reason to think that any of the inland sites were major settlements, indeed many were probably mere rest spots or casual camping places, but there is evidence on many of them for a wide range of domestic activities. With the notable exceptions of hunting, gardening and crop storage, these activities range from food-gathering and preparation to house construction and the manufacture of small artefacts.

The coastal sites are a complete contrast. They contain little evidence of being settlements like some of the inland sites, and appear to have fulfilled a different function. Many of the coastal middens are small and, as with some of the inland sites, may represent only casual camps (perhaps even overnight stops by people travelling along Ninety Mile Beach) but some are very extensive, with large quantities of shell midden present. It was estimated, by measuring the area and depth of intact shell deposits, that one 4 ha coastal midden complex (N3&4/116) originally contained something like 100 m^3 of shell (or about 20 large truckloads), with a dry weight of around 80 tonnes. The presence of such large quantities of shell, with up to 95% of it burnt and crushed, together with an absence of artefacts and structures, leads to the conclusion that the coastal middens represent a set of activities quite distinct from those carried out on the inland

sites. It is suggested (as does Butts (1982:273, 275) in regard to middens on the Manawatu coast) that, far from being long term living sites, the big coastal middens are mainly industrial waste from large scale manufacturing processes devoted to the production of dried shellfish for storage.

Conclusion - the wider context

People have lived on the Aupouri tombolo for at least 700 years (the Houhora site is dated to the 13th century (Davidson, 1982:18)). During this time, they have had as dramatic an effect on the landscape as anywhere in the country, reducing the vegetation by the time of European arrival to a uniform vista of scrub and swamp, broken only by sand dunes encroaching from either coast.

The lifestyle appears to have included a pattern of wide-ranging, and possibly seasonal, exploitation of the available resources, concentrating on the inexhaustible shellfish beds of the open west coast. More permanent settlement, where it existed, was concentrated around arable land and the varied resources of the east coast harbours and rocky shores.

Although a long distance from the rest of the country, the Maori of the Far North were not as isolated as might be supposed. Evidence of consistent contact, either direct or indirect, with other parts of the country is provided by the stone materials found on the sand dune sites. Adzes and fragments of Tahanga (Coromandel) basalt and Nelson metasomatised argillite occur frequently, while nephrite is also found, especially as small chisels and pendants. More than half the flake material collected is obsidian, the nearest source of which is at Kaeo, 65 km away. Trace element (XRF) analysis of a sample of 308 obsidian flakes from 31 sites shows however, that 53 % of them come from Mayor Island, nearly 400 km away by sea, while only 36% come from the Kaeo source (McCallum et al, 1980).

Rather than concentrating on a few isolated sites, the Aupouri study has aimed at placing a large number of sites in the context of their archaeological landscape. As more of the data from the study is analysed, it can be integrated with the results of other work such as that of Barber, Davidson, Taylor, Shawcross and Roe already referred to. It should then be possible, to build up a reasonably detailed picture of the prehistory of the Far North.

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THERMODYNAMICS OF EXPERIMENTAL SMALL UMU

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The preference for cooking foodstuffs in the ground with heated stones is of considerable antiquity in New Zealand, and the practice was probably brought here by the earliest voyagers from East Polynesia. The first ethnographic accounts of Polynesian ovens in New Zealand are from the journals of Captains Cook and Furneaux, concerning their respective visits to Queen Charlotte Sound in 1769 and 1773. Cook's surgeon Dr Anderson records the cooking of prepared fernroot in a "great hole dug for that purpose" (Reed and Reed, 1951:250).

As a consequence of the need for further information about the workings of small ovens (larger ones are considered a separate field of inquiry), a series of experimental ovens were constructed (Gillies, 1979). To prevent the experiment from becoming too unwieldy only three types of rock known to occur in small prehistoric umu were chosen. These were basalt, schist and greywacke; selected in two standardised sizes ('large' and 'small'), and used in small ovens of standardised dimensions.

The following problems were considered relevant to the thermodynamics of small ovens.

1. What is the 'life expectancy' of the three different stone types and their two sizes, i.e. how many times could a particular type and size be re-used before significant fracturing might render the stones unusable?
2. What is the qualitative cooking performance of the ovens for such foodstuffs as octopus, kumara (Ipomoea batatas), taro (Colocasia sp.), fish, beef and mutton?
3. Of the two standardised sizes of ovenstone chosen for the experiment, which is the optimum size?

Methods and materials

A site with alluvial soil by the Leith Valley Stream in Dunedin was chosen. Ovens were dug into a single homogeneous soil. These each had a top diameter of 1 m, tapering to a bottom diameter of 0.5 m, and with a depth of 0.5 m. These dimensions were considered representative of the variety of small umu found throughout prehistoric New Zealand (expecially Murihiku). The ovens were freshly dug into grass-covered soil eight hours before each firing. Thermocouples were placed in each oven and they were then covered with roofing iron to afford some protection from the elements. The following morning a fire was kindled in the two fresh ovens, and the recording of internal temperature commenced.