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Recent evolution of the Mangawhai Spit dunefield

N. J. Enright* and M. J. Anderson*

Development of the Mangawhai Spit dunefield since about 800 years B.P. is reconstructed on the basis of palaeo-environmental evidence. A buried soil with abundant charcoal beneath the present high dune suggests the former existence of forest on a low hill. Radiocarbon ages of charcoal samples are consistent with destruction of this coastal vegetation around 800 years B.P. Sites containing Kaharoa ash, assumed age *c.* 650-670 years B.P., usually overlie undifferentiated dune sands, indicating that dunefield development had already begun at that time. A number of middens (shell refuse heaps) dated to *c.* 400 years B.P. are now found on isolated sandy pedestals near the coast. At the time of their origin it is assumed that there must have been a foredune closer to the sea than the nearest one now is. Net east to west movement of sands has resulted in a large deflation surface near the coast, and the development of a 50 m high dune burying the former low coastal hill and associated soil.

Keywords: charcoal, dunefield, Kaharoa ash, midden, palaeosol, radiocarbon age

INTRODUCTION

The use of biological and geomorphic evidence in the reconstruction of past environments and climates is well established in New Zealand. However, such evidence may also be important in both supporting, and extending, archaeological findings concerning the age and impact of pre-European human activities on the New Zealand landscape (Sutton, 1987; McGlone, 1983a). McGlone (1983a) has reviewed the palynological evidence of Maori impact on forests and coasts in general. He noted a marked increase in the frequency of fire, and decline in area of forest cover, during the period 800-600 years B.P. Although such findings are not directly associated with archaeological sites, it is generally assumed that these sudden changes are indicators of the presence of people.

Coastal middens (shell refuse heaps) provide one source of direct evidence of human activity. They are dateable by the radiocarbon method, and contain biological remains which indicate the availability and variety of faunal food resources within the local area. Taylor (1984), Millener (1981), Jones (1984) and J. Coster (unpublished) reported on the species composition and age of middens associated with unvegetated coastal dune systems in northern New Zealand. The oldest middens contain bones of forest birds, often including species now extinct in that area, while most middens dated to < 500 years B.P. contain only shells and fish bones. This suggests the progressive loss of forest near the coast, and may also date the beginning of development of large dunefields. However, there are no clear accounts of the evolution of such dune systems, or whether or not coastal land-use is implicated in their development.

This paper examines the evidence of environmental changes, over the last 800-900 years, for a small area of coastline at Mangawhai, Northland (Fig. 1). The site is now occupied by unvegetated dunes (up to 52 m high) and deflation surfaces that form a sandy spit at the mouth of the Mangawhai estuary. There are several middens along both the ocean and estuary foreshores. In addition, several other sources of palaeo-environmental information, including palaeosols, tephra and charcoal are present. Together, these data allow a reconstruction of the evolution of the unvegetated dunefield.

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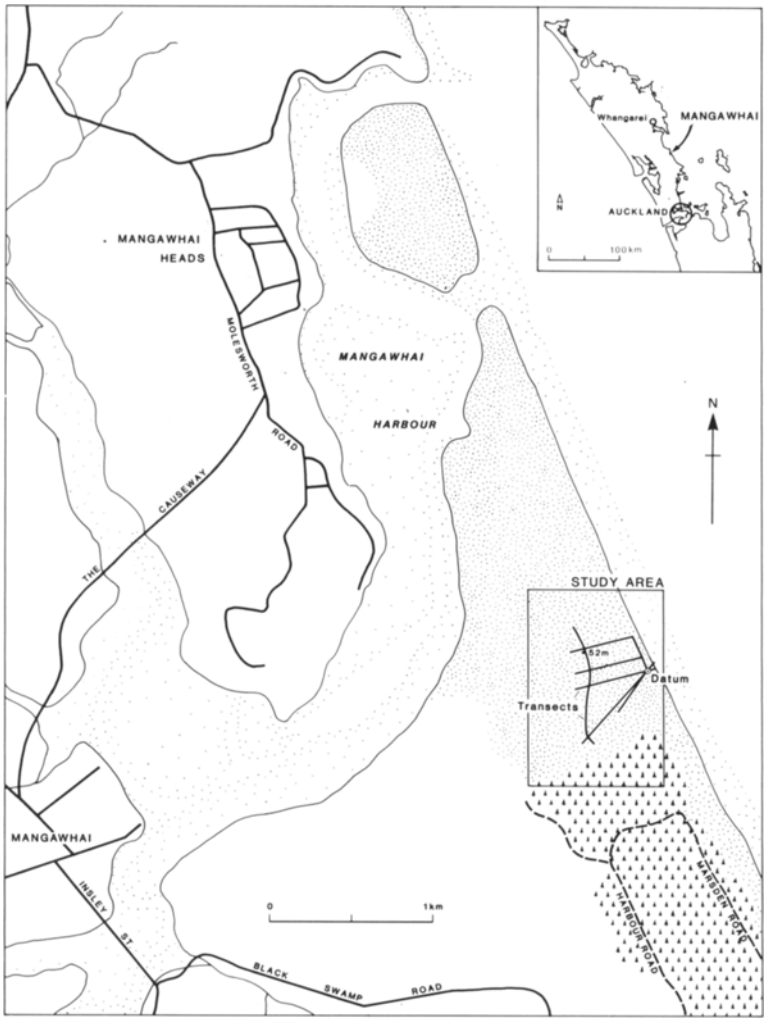

Fig. 1—Location of the Mangawhai Spit and dunefield, showing the study area and survey transect lines.

METHODS

Features of palaeo-environmental interest were mapped from aerial photographs. Abney Level surveys along transects from a fixed datum (number 2941) established in 1978 by the Auckland Regional Water Board (Fig. 1) allowed construction of a contour map of the study area, including spot heights of important features.

Bulk samples were collected from two middens. Shell species were identified by comparison with a reference collection, and fish bones were identified by R. Nicholl (Anthropology Department, University of Auckland). Specimens of the cockle, *Chione stutchburyi*, from each midden were submitted for radiocarbon dating to the Institute of Nuclear Sciences, Wellington, Radiocarbon ages are reported with respect to the New Zealand shell standard, and based on the Libby half-life (5568y).

Charcoal fragments were collected from the surface of a buried soil (palaeosol), and from one of the coastal middens. Species identities were determined by R. Wallace (Anthropology Department, University of Auckland). Three charcoal samples from the palaeosol were submitted for radiocarbon dating as described above. The reported ages are

based on the Libby half-life and with no corrections made for secular or other effects. The charcoal samples used were selected to represent the outermost growth rings on the largest locatable stem remains.

Three samples of wood from a small clump of partially buried *in situ* stumps located on the eastern slopes of the main dune were collected for species identification, and one was submitted for radiocarbon dating (Fig. 2).

Samples of volcanic ash from five sites were sent for identification to the Geology Department, Victoria University, Wellington.

Grain size and colour of sand and soil samples were described for a variety of locations including beach, dune crest, palaeosol, above and below volcanic ash (tephra) and below middens.

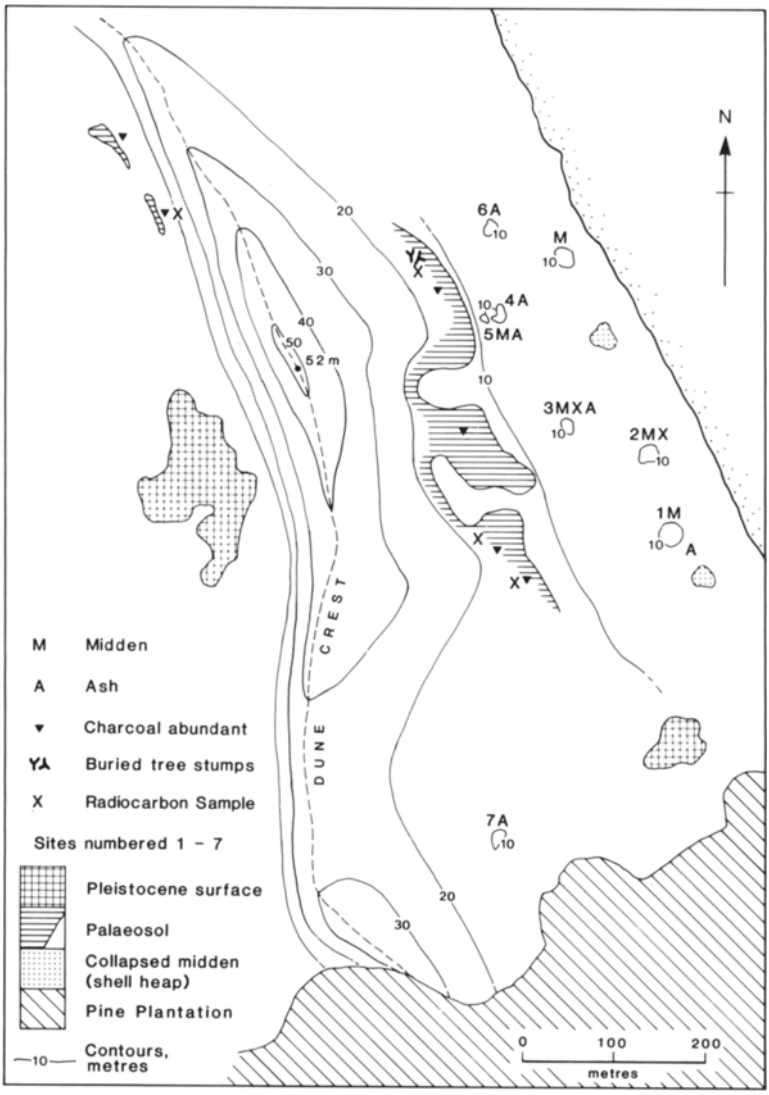

Fig. 2 — Location and type of palaeo-environment indicators within the field area. The collection sites for radiocarbon samples are also shown. Note: ash refers to Kaharoa ash only; Kawakawa ash (?) is found in association with the Pleistocene surface in the southeast of the field area.

Nomenclature of plant species follows Allan (1961), except for *Kunzea ericoides* A.Rich. which follows Thompson (1983).

RESULTS

The locations of palaeo-environmental features are shown in Fig. 2. An old surface is present in the deflation basin to the west of the high dune, and near the coast at the southern edge of the field area at an elevation of about 6 m. It is also exposed, or covered by only a thin veneer of sand, at several points in the deflated area to the east of the high dune. This surface, probably the B horizon of a truncated palaeosol, is compacted but sandy, bright brown in colour (Munsell Soil Colour code: 7.5YR 5/8) and with mean grain size of 2.1 phi. Several reworked ash samples directly overlying the surface were tentatively identified as Kawakawa ash (*c.* 20,000 years B.P.) from their hypersthene and hornblende mineralogy. This implies that the profile was already truncated before the ashfall.

A younger palaeosol is exposed on the eastern slopes of the high dune at elevations of 15 to 20 m, but is visible only after prolonged, or strong, easterly winds (Fig. 2). This palaeosol is partially covered by a compacted layer of reworked sand and ash up to 5 cm in thickness. Winds from the west lead to burial of this surface by mobile sands from near the dune crest. Sands of the beach and dunefield are light grey (5Y 8/2) to pale yellow (5Y 8/3) in colour, while mean grain size varies little from 1.9-2.1 phi (medium to fine sand), becoming finer as distance inland from the beach increases (Anderson, 1984). Beneath the ash, and a thin (<5 cm), darkened A horizon containing much charcoal, the palaeosol consists of unconsolidated bright yellowish brown (2.5Y 7/6) to yellow (2.5Y 8/6) sands with mean grain size of 2.1 phi. This description is similar to that for Marsden series soils found in patches nearby, which are described as weakly weathered and weakly leached sands of the coastal complex (Cox *et al.*, 1983). The palaeosol is analagous to the Pinaki series described by Cox (1977) and Millener (1981) and is assumed to have developed within the last 6000 years.

Charcoal samples from the A horizon of the palaeosol returned radiocarbon ages ranging from 860 ± 60 years B.P. (NZ7480) to 1005 ± 35 years B.P. (NZ6592) (Table 1). The proximity of these dates, and the continuous distribution of charcoal throughout the palaeosol A horizon, suggests that a single fire event is responsible for all three samples. Dates based on charcoal are problematical since the carbon dated may have been laid down in the growing tree many years before the date of the fire. Clearly, the most recent date must be closer to the true age, but even this may overestimate the true age by a number of years. One of the dated fragments was identified as *Podocarpus totara* (totara), while charcoal samples later identified from the same sites showed totara charcoal was abundant, and *Hoheria* sp. (lacebark), *Nestegis* sp. (maire), *Alectryon excelsus* (titoki), and *Podocarpus spicatus* (matai) were all present. We assume a possible inbuilt age of no more than 200 years for the charcoal samples and therefore suggest that the fire dates to about 800 years B.P.

Table 1 — Radiocarbon dates for samples from the Mangawhai Spit study area. $T^{1/2} = {}^{14}C$ half-life. NZ = Radiocarbon Laboratory, Institute of Nuclear Sciences, D.S.I.R. Wellington.

Site	Fossil Record No.	Sample No.	Libby age ($T^{½}$ old 5568y)	Material dated
Western deflation hollow	R08/f014	NZ6592	1005 ± 35	charcoal
Palaeosol A horizon eastern slope	R08/f013	NZ6591	929 ± 34	charcoal
Palaeosol A horizon eastern slope	R08/f016	NZ7480	860 ± 60	charcoal (*P. totara*)
High dune eastern slope	R08/f015	NZ7481	<250	wood (*K. ericoides*)
Midden site 2	R08/f011	NZ6593	403 ± 29	shell
Midden site 3	R08/f012	NZ6609	418 ± 34	shell

Volcanic ash samples were identified as Kaharoa ash on the basis of abundant biotite in the ferromagnesian assemblage. The ages of Kaharoa ash sampled from a number of sites elsewhere in the North Island are estimated as 890 ± 80 years B.P. (NZ10C), 850 ± 54 years B.P. (NZ872A) and 656 ± 55 years B.P. (NZ1765C) (Pullar *et al.*, 1977); 656 ± 57 years B.P. (NZ4804) (McGlone, 1983a); and 667 ± 57 years B.P. (NZ4991) (McGlone, 1983b). The cluster of dates in the 650-670 years B.P. range are now accepted by most workers as being close to the true date of the Kaharoa event. At Mangawhai the ash is present in abundance at six locations, and in traces elsewhere (Fig. 2). Ash thickness of up to 39 cm were recorded. Sands similar in colour and grain size to existing dune sands were present below the ash in four of the six sites, and indicate ash-fall on unvegetated (or sparsely vegetated) dune sands. At the other two sites ash was overlying a podsolized sand at one, and a yellow sand at the other. Presence of reworked ash over the burned A horizon of the palaeosol indicates that ashfall postdates the fire. Stratigraphies of all major sites containing ash, middens, or palaeosol are illustrated in Fig. 3.

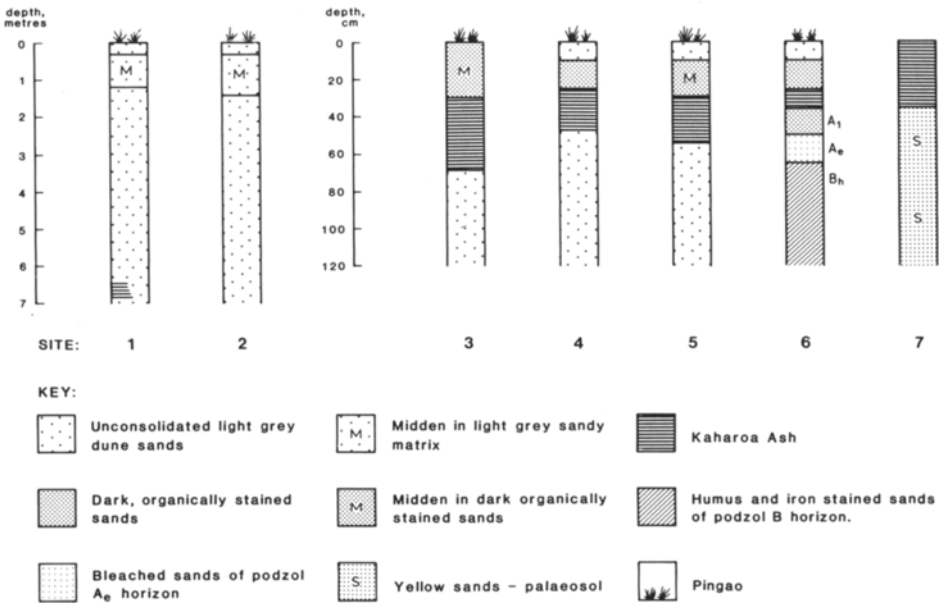

Fig. 3 — Stratigraphies of field sites containing palaeo-environmental indicators such as Kaharoa ash, middens, and palaeosols. Site numbers refer to sites described in the text and located in Fig. 2.

According to Pearce (1975) there are 16 middens on the Mangawhai spit. Five of these lie along the eastern shore within the field area described here. There are two sequences of middens, one close to the coast on sand pedestals up to 13 m in height, and another parallel to, but inland from, the first. In the inner sites, shell refuse overlies ash which has been exposed through deflation of the surrounding area. All five middens support a sparse cover of pingao (*Desmoschoenus spiralis*).

A bulk sample from the centre of one of the coastal middens (Fig. 3, site 2) contained remains of a variety of shell and fish species, including snapper (*Chrysophrys auratus*), jack mackerel (*Trachurus novaezelandiae*), blue mackerel (*Scomber japonicus*), cockles (*Chione stutchburyi*), tuatua (*Paphies subtriangulata*) pipi (*Paphies australis*) and speckled whelk (*Cominella adspersa*). The shell layer was located within a grey sandy matrix 1.15 m thick and overlying 6 m of unconsolidated dune sands. A layer of ash was exposed at about 6 m on the oceanward side of a nearby midden and dune remnant (site 1). Cockles from site 2 gave a radiocarbon age of 403 ± 29 years B.P. (NZ6593). Radiocarbon age of cockles from one of the inner row of middens was 418 ± 34 years B.P. (NZ6609) (Fig. 3, site 3). Shells were concentrated in a thin layer (35 cm) of dark, organically-stained sand overlying

Kaharoa ash. Cockles dominated the fauna of both middens; however, the inner middens contained no fish bones.

Charcoal fragments from the coastal midden (site 2) were mostly from *Metrosideros excelsa* (pohutukawa) twigs. Other species included *Agathis australis* (kauri), *Lophomyrtus bullata* (ramarama), *Leptospermum scoparium* (manuka) and *Pseudopanax arboreus* (five-finger).

A small group of *in situ* stumps was located at about 17 m altitude on the eastern slopes of the high dune. Individuals ranged from 2 to 10 cm in diameter and the trunks branched within one metre of the dune surface. Excavation of several stumps indicated the development of major lateral roots in dune sand close to, but above, the yellow sands of the palaeosol and a total stem height of 1.5 to 2.5 m. Three wood samples were all identified as *Kunzea ericoides* (kanuka) suggesting a patch of young, regenerating bush. A radiocarbon age of <250 years B.P. (NZ7481) was obtained for one of these samples.

DISCUSSION

The nature and age of the palaeo-environmental indicators available for the Mangawhai site allows tentative reconstruction of the topography, and to a lesser extent the vegetation, at several points in time over the last 800 years. This proposed sequence of changes is shown in Fig. 4.

Before an extensive fire some 800 years B.P., mixed forest, including totara, kanuka, titoki, lacebark and maire, grew on yellow sandy soils, probably of the Marsden series (Cox *et al.*, 1983), on a coastal hill about 20 m in height and 300 m from the sea. Subsequent evidence provided by the location of Kaharoa ash remnants implies the existence of at least two sets of coastal dunes to the east (sea side) of this hill (Fig. 4). This implies a coastline extending some 20 m oceanward of its present position. Destruction of coastal vegetation by the fire initiated a phase of instability. There is little evidence of revegetation in the field area after this time.

Deposits of Kaharoa ash are characterised by their unusual thickness (up to 39 cm) and patchy distribution. Puller *et al.* (1977), and Osborne (1983), recorded ash thickness of only 2-3 cm at Bream Bay some 40 km north of Mangawhai. It seems certain, therefore, that this ash was rapidly redeposited into depressions, such as dune swales, and lost completely from more exposed sites. Thin lenses of sand within the ash layer, and the concave-upwards stratigraphy of these deposits, supports this contention. Evidence of rapid redeposition in swales, and the position of the ash above unconsolidated grey sands in most sites to the east (sea side) of the high dune at Mangawhai (Fig. 3) suggests that areas within about 200 m of the shore were largely bare of vegetation at that time. Ash is found at approximately the same level (10 m) in association with four remnant features (including the two inner middens, sites 3 and 5), and at a lower level (6 m) under one of the coastal middens (site 1). If these two levels represent swales of a coastal dune system, then a row of dunes must have existed on the oceanward side of each of these swales (Fig. 4).

It is unclear how much time separated the fire event from the subsequent Kaharoa ashfall. The close stratigraphic association between the burned palaeosol A horizon and Kaharoa ash may indicate ashfall soon after the fire. However, ash overlying the palaeosol is patchy in distribution, has been reworked and contains much sand. Until further dates on the age of the Kaharoa ashfall are available we tentatively accept an age of 650-670 years B.P. for purposes of our reconstruction.

Between the time of Kaharoa ashfall and midden development (*c.* 650-400 years B.P.) there were several substantial changes in topography. The dark, organically-stained sands over ash at sites 3, 4 and 6 probably developed as a result of poor drainage in swales lined with a deep ash layer. Subsequent erosional retreat of the coastline led to burial of ash in the swale behind the foredune. At the same time a deflation surface was developing between the retreating foredune and the coastal hill, which was now receiving sand from the deflating surface and increasing in height. Areas of deep, consolidated ash afforded resistance to wind erosion, and these former swales became small mesa-like remnants, decreasing in area but increasing in height above the deflation surface as time progressed. Osborne (1983) described a similar pattern of Kaharoa ash exposure near

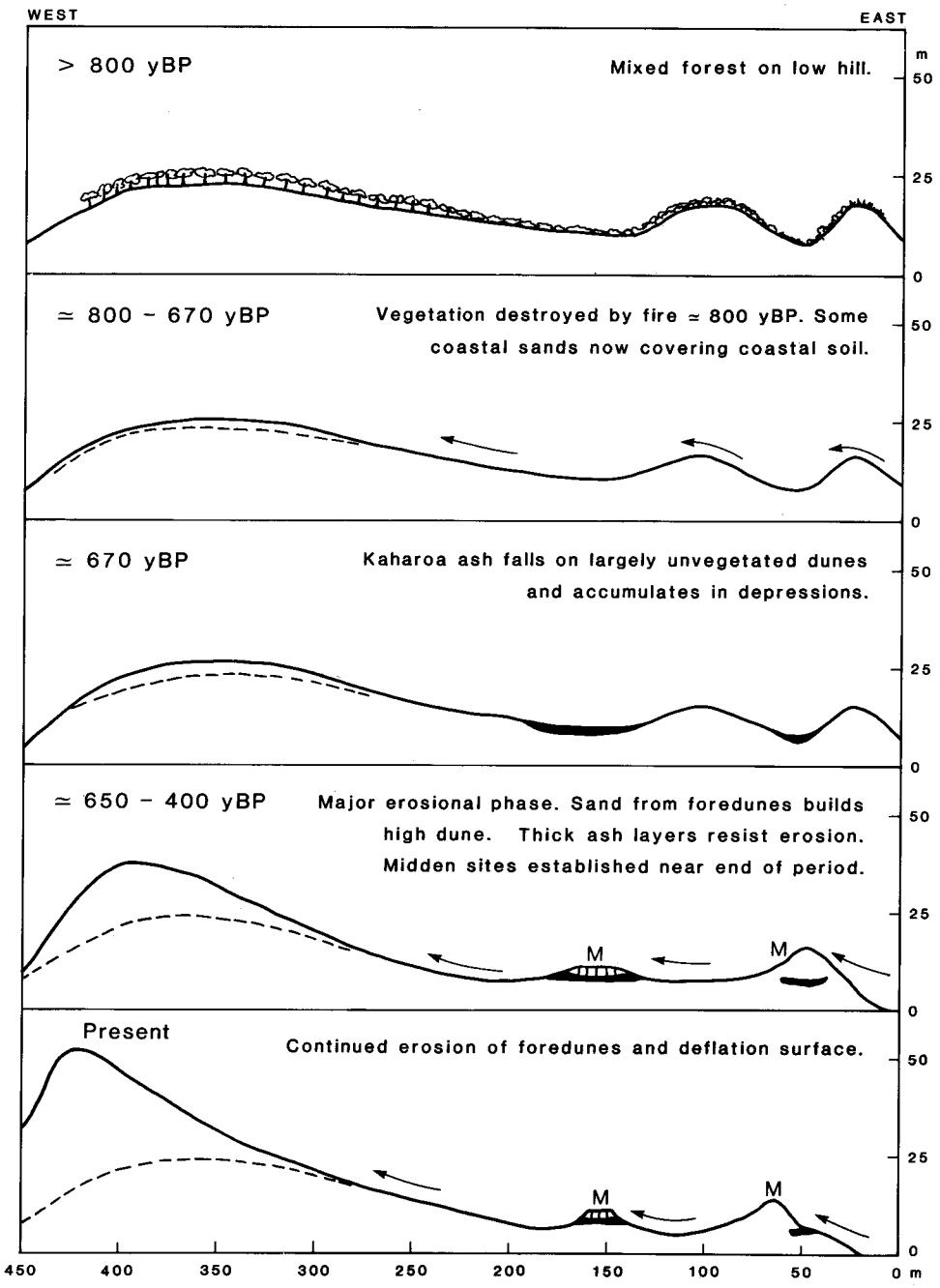

Fig. 4—Suggested model of dunefield evolution at Mangawhai since about 800 years B.P. Kaharoa ash is indicated by dark shading, middens by the letter M, organically-stained sands by vertical bars, and location of the palaeosol by a broken line.

the beach at Marsden Point, and considered that the ash probably fell on to a relatively stable coastal dune and swale system, but that there has been a subsequent retreat of the coastline.

Middens are now situated on isolated upstanding features surrounded by a deflation surface. However, we assume that a continuous foredune must have existed at the time of shell deposition about 400 years B.P. Middens were probably located on the landward (western) slopes of the foredunes (sites 1 and 2), and on top of the mesa-like remnants of former swales (sites 3 and 5). These sites would have been well-drained, and yet sheltered from onshore winds. Charcoal fragments from coastal midden site 2 were predominantly of pohutukawa, a coastal species often found growing on undifferentiated sands. This might imply the presence of at least patches of pohutukawa forest nearby. The charcoal samples from the buried soil and midden sites had no species in common, however, both contained forest species. Wood for fires may have been carried some distance, and driftwood was probably also used, so that no firm conclusions concerning the nature of the vegetation can be drawn from these spot samples.

Between 400 years B.P. and the present, nearly the whole of the foredune system was lost. Only remnants of this feature remain where the shell heaps described above (sites 1 and 2) have provided some resistance to wind erosion. Several low shell mounds may indicate erosional loss of other coastal middens. The deflation surface has now reached the old, Pleistocene surface in a number of places and there is little available sand left. The original coastal hill is now covered with up to 30 m of sand that came from the coastal dune and deflation area.

The "modern" (<250 years B.P.) date for kanuka stem material from the *in situ* stumps on the eastern slope of the high dune indicates the existence of a small patch of living, woody vegetation on the dune long after the initial phase of destabilization. Burial of this vegetation implies continued erosion of sand from the deflation surface and growth in height of the high dune.

The evidence for coastal change presented here indicates that coastal devegetation and erosion was already initiated by fire prior to the Kaharoa ashfall, and certainly before the deposition of shell heaps by the Maori about 400 years B.P. Osborne (1983) dated a major phase of coastal erosion at Bream Bay to the period 1000-500 years B.P. Pain (1979) described coastal instability near Kawhia dating to 660 years B.P. (WK31), while Pullar and Selby (1971) noted development of blowout dunes in the Bay of Plenty after Kaharoa ashfall. However, erosion of the coastal zone at Mangawhai has continued from 400 years B.P. to the present. Loss of a continuous foredune dates to this period and may account for burial of the small kanuka remnant within the last few hundreds of years. Anderson (1984) has presented evidence of a continued net east to west movement of sand at this site over the last 30 years.

One cannot suggest any direct association between human occupation and destabilization in this area. Nevertheless, the fire event at about 800 years B.P. could have been lit by people, and does appear to date the start of dunefield development. Natural factors such as depletion of onshore sediment supply and increased storminess (Grant, 1985) favoured erosion at that time. Continued coastal erosion over the last 400 years is within the known period of human occupation and could be attributed to human activities within the coastal zone. The absence of Archaic sites from the area, in common with much of the east coast of Northland (Davidson, 1982), may be real, or may be a result of erosional loss of sites older than about 500 years B.P.

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REFERENCES

Allan, H. H., 1961. *Flora of New Zealand, Vol. 1.* Government Printer. Wellington.

Anderson, M. J., 1984. *Evolution, morphology and dynamics of the Mangawhai high dune system.* Unpublished M.A. Thesis, University of Auckland.

Coster, J., 1987. Dates from the dunes: A sequence for the Aupouri Peninsula, Northland, New Zealand. (unpubl. manuscript)

Cox, J. E., 1977. *In* Neall, V. E. (Ed.): *Soil Groups of New Zealand. Part 2: Yellow-brown sands.* N.Z. Society of Soil Science, Wellington.

——— Taylor, N. H., Sutherland, C. F., and Wright, A. C. S., 1983. Northland peninsula soil legends. N.Z. Soil Bureau. D.S.I.R. Lower Hutt.

Davidson, J., 1982. Northland. *In* Prickett, N. (Ed.): *The First Thousand Years: Regional Perspectives in New Zealand Prehistory*, pp. 11-27. N.Z. Archaeological Association, Monograph 13. Dunmore Press, Palmerston North.

Grant, P. J., 1985. Major periods of erosion and alluvial sedimentation in New Zealand during the late Holocene. *Journal of the Royal Society of N.Z.* 15: 67-121.

Jones, K. L., 1984. Dune soils and polynesian gardening near Hokianga north head, North Island, New Zealand. *World Archaeology* 16: 75-88.

McGlone, M. S., 1983a. Polynesian deforestation of New Zealand: a preliminary synthesis. *Archaeology in Oceania* 18: 11-25.

——— 1983b. Holocene pollen diagrams, Lake Rotorua, North Island, New Zealand. *Journal of the Royal Society of N.Z.* 13: 53-65.

Millener, P. R., 1981. *The Quaternary avifauna of the North Island of New Zealand.* Unpublished PhD Thesis, University of Auckland.

Osborne, N. M., 1983. *Holocene coastal depositional landforms: Bream Bay, Northland.* Unpublished M.A. thesis, University of Auckland.

Pain, C. F., 1979. Radiocarbon ages from dune sands near Aotea and Kawhia Harbours, North Island, New Zealand. *N.Z. Journal of Geology and Geophysics* 22: 291-292.

Pearce, P., 1975. *Archaeological site survey report: Te Arai Point to Poutawa Stream.* N.Z. Historic Places Trust, Wellington.

Pullar, W. A., and Selby, M. J., 1971. Coastal progradation of Rangitikai Plains, New Zealand. *N.Z. Journal of Science* 14: 419-434.

——— Kohn, B. P., and Cox, J. E., 1977. Air-fall Kaharoa ash and Taupo Pumice and sea-rafted Loisels Pumice, Taupo Pumice in northern and eastern parts of the North Island, New Zealand. *N.Z. Journal of Geology and Geophysics* 20: 697-717.

Sutton, D. G., 1987. A paradigmatic shift in polynesian prehistory: implications for New Zealand. *N.Z. Journal of Archaeology* 9: 135-155.

Taylor, M. A., 1984. *Bone refuse from Twilight Beach.* Unpublished M.A. Thesis, University of Auckland.

Thompson, J., 1983. Redefinitions and nomenclatural changes within the Leptospermum suballiance of Myrtaceae. *Telopea* 2: 379-383.

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