FS329

Remember further submissions close at 5pm, Monday 4th September

Proposed Far North District Plan further submission form

Form 6: Further submission in support of, or in opposition to, submission(s) on the notified Proposed Far North District Plan

Clause 8 of Schedule 1, Resource Management Act 1991

To: Far North District Council

This is a further submission in support of or in opposition to submission(s) on the Proposed Far North District Plan.

1. Further submitter details *(mandatory information)*	
Full name of individual/organisation making further submission:	Jeffrey Edward Archer
Contact person ***(if different from above):***	
Email address:	haelo@icloud.com
Postal address:	76 Blackbridge Road, Haruru **Postcode** 0293
Preferred method of contact:	☑ **Email** ☐ **Post**
Phone contact:	**Daytime:** **Mobile:** 0275228101

2. Eligibility to make a further submission *(for information on this section go to RMA Schedule 1, clause 8)*

I am:

☐ **A person representing a relevant aspect of the public interest. In this case, also specify below the grounds for saying that you come within this category; or**

☑ **A person who has an interest in the proposal greater than the interest that the general public has. In this case, also specify below the grounds for saying that you come within this category; or**

☐ **the local authority**

My reasons for selecting the category ticked above are:

This proposal directly affects our health, our livelihood, the archaeological and historic value of the region, disrupts the delicate balance and quality of a critical watershed, reduces the size and quality of the significant natural environment (SNA) putting more pressure on an already diminished and soon-to-be extinct guild of local vulnerable species, and puts more pressure on an already congested and damaged roadway, posing a safety hazard for pedestrians, cyclists, and motorists, also leading to increased maintenance costs for the local authorities, burdening taxpayers and diverting funds from more pressing community needs. Not to mention the significant impact it has on our community's serene environment and peaceful ambiance that would be irreversibly compromised, causing a decline in property values and impacts on livelihood (eco-tourism, AirBnB horse-riding, etc.) making the area less attractive for residents and potential investors alike. We encourage the exploration of alternative economic development strategies that prioritize sustainability, the well-being of residents, and the preservation of our environment. By investing in industries that align with these values, we can ensure a brighter and more promising future for our community

For example: Any person representing a relevant aspect of the public interest would likely include public interest environmental groups

Any person that has an interest in the proposed policy statement or plan greater than the interest that the general public has is likely to include owners of land and users of resources directly affected by plan provisions. It is also likely to include iwi and hapu where their interests are directly affected.

3. Request to be heard at hearing

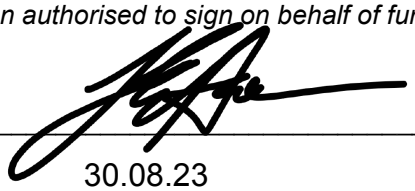
☑ **Yes, I wish to be heard at the hearing in support of my further submission; or**

☐ **No, I do not wish to be heard at the hearing in support of my further submission**

If others make a similar submission, I will consider presenting a joint case with them at the hearing

☑ **Yes** ☐ **No**

Signature of further submitter:
(or person authorised to sign on behalf of further submitter)



Date: 30.08.23

(*A signature is not required if you are making your further submission by electronic means)*

Important information:

1. A copy of your further submission must be served on the original submitter within five working days after it is served on Far North District Council.
2. The Far North District Council must receive this further submission before the closing date and time for further submissions (5pm Monday, 4 September 2023)
3. Please note that further submissions, including your name and contact details are treated as public documents and will be made available on council's website. Your further submission will only be used for the purpose of the District Plan review.
4. Submitters who indicate they wish to speak at the hearing will be emailed a copy of the planning officers report (please ensure you include an email address on this further submission form). If you don't have an email address, it will be posted.

Please note that your further submission (or part of your submission) may be struck out if the authority is satisfied that at least one of the following applies to the further submission (or part of the submission):

- it is frivolous or vexatious:
- it discloses no reasonable or relevant case:
- it would be an abuse of the hearing process to allow the further submission (or the part) to be taken further:
- it contains offensive language:
- it is supported only by material that purports to be independent expert evidence but has been prepared by a person who is not independent or who does not have sufficient specialised knowledge or skill to give expert advice on the matter.

Send your further submission to:

Post to: Proposed Far North District Plan
Planning and Policy, Far North District Council
Private Bag 752
KAIKOHE 0400

Email to: pdp@fndc.govt.nz

Or you can also deliver this further submission form to any Far North District Council service centre or library (check the Council website for opening hours).

Please refer to pdp.fndc.govt.nz for further information and updates.

Please note that original documents will not be returned. Please retain copies for your file.

The specific submission(s) on the Proposed Far North District Plan that this further submission relates to:						
Name of original submitter	Address of original submitter	Original submitter number	Original submission point number	Support or oppose	Reasons for supporting or opposing	I seek that the whole (or part [describe part]) of the submission be allowed (or disallowed) *Give precise details*
Example *John Smith*	*Example* *60 Kerikeri Road* *Kerikeri 0230*	*Example* *600*	*Example* *600.001*	*Example* *Support*	*Example* *I support because I believe …..*	*Example* *I seek that the whole of the submission point be allowed*
Ventia Ltd Steven Sanson	PO Box 318, Paihia 0247	S424	S424.001	OPPOSE	See Attached - section S424.001	I seek that the whole of the submission be disallowed based on significant negative effect to the affected region in terms of archeological, environmental and socio-economic impacts as described in the attached document. FS329.001
Ventia Ltd Steven Sanson	PO Box 318, Paihia 0247	S424	S424.002	OPPOSE	See Attached - section S424.002	I seek that the whole of the submission be disallowed based on significant negative effect to the affected region in terms of archeological, environmental and socio-economic impacts as described in the attached document. FS329.002
Ventia Ltd Steven Sanson	PO Box 318, Paihia 0247	S424	S424.003	OPPOSE	See Attached - section S424.003	I seek that the whole of the submission be disallowed based on significant negative effect to the affected region in terms of archeological, environmental and socio-economic impacts as described in the attached document. FS329.003

Use additional sheets if necessary

The specific submission(s) on the Proposed Far North District Plan that this further submission relates to:						
Name of original submitter	Address of original submitter	Original submitter number	Original submission point number	Support or oppose	Reasons for supporting or opposing	I seek that the whole (or part [describe part]) of the submission be allowed (or disallowed) *Give precise details*

Use additional sheets if necessary

Attachments related to Further Submissions in relation to: Submissions S424.001, S424.002 & S424.003 for RT NA 97B/387.

Subject: Strong Opposition to Proposal for Quarry Expansion
Reference: RT NA 97B/387
Submissions S424.001, S424.002 & S424.003

To Whom it May Concern,

I am writing to express my deep concern and opposition to the proposed expansion of the Puketona quarry operation in our community in reference to submissions S424.001, S424.002 & S424.003 of RT NA 97B/387. While I understand the economic benefits that such an expansion may bring, I firmly believe that the negative impact on our environment, quality of life, local ecosystem, archaeological significance, watershed function, vulnerable species, and neighbourhood, far outweigh any potential gains.

Archaeological Significance:

Our community takes pride in its rich cultural heritage, and the potential destruction of any artifacts, historical sites, or indigenous remains would be a tremendous loss. These resources are not only a connection to our past but also an educational asset for future generations.

The area under consideration for quarry expansion holds significant historical, archaeological, and cultural value to both Māori and non-Māori cultures.

This relatively unstudied field of stone mounds and associated remains (Furey, L. 2006 – see appendix) in this Lot are considered an important Māori heritage site with significant cultural importance, and are part of larger archaic horticultural system in the region belonging to the archaeological site complex 'NZAA Site Record No. PO5/756' subject to protections by the NZ Historic Places Trust under Section 17 of the Act (Ref: HP 11036/11013-014). It contains mountain Pa, garden mounds, terraces, heaps and stone alignments, trenches, ditches and wetland modifications relating to kumara and taro cultivation dating to pre-European times and possibly back to the 12th Century and the arrival of Polynesian settlers and introduction of the first crops in New Zealand. Due to the relatively unstudied nature of this site, there is a significant possibility that it contains undiscovered Taonga or recognised Māori culture remains.

Watershed Function:

The quarry expansion will disrupt the delicate balance of our local watershed. The quarry's excavation will interfere with the current swamp and stream systems in this Lot and runoff will lead to erosion, sedimentation, and contamination of our water bodies. This will harm aquatic ecosystems, disrupt natural water flow patterns, and increase the risk of flooding downstream. The proposed footprint of the site impinges upon the delicate and untouched waterway, marshland and mature native forest and will no doubt have a significant affect on the survival of local swamp species, such as kiwi, pukeko, weka, morepork, hawks, frogs, eels, stick insects, geckos, aquatic plants, etc.

Images of watershed area included in the Proposal for expansion of the quarry

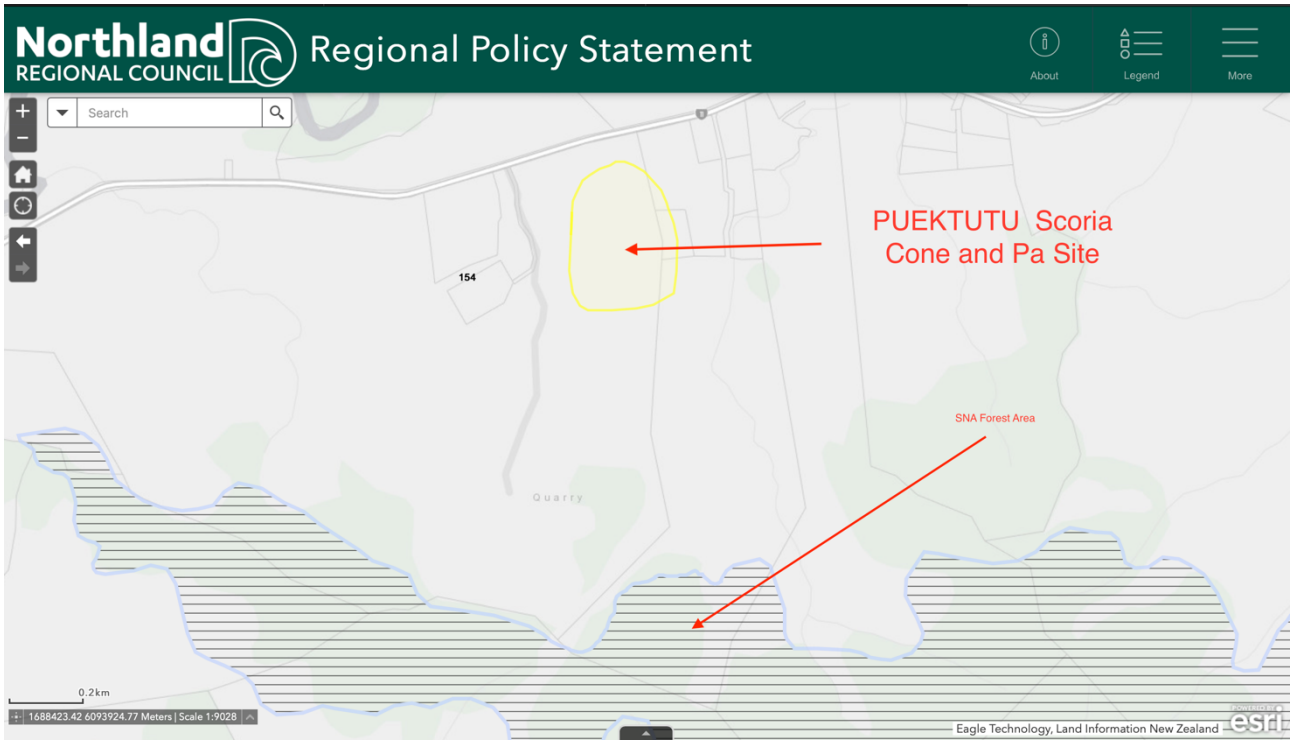
We must prioritise the protection of our water and forest resources for the well-being of both our environment and our community.

Loss of Vulnerable Species:

Our region's unique ecosystem supports a variety of plant and animal species, some of which are endangered or vulnerable. The proposed expansion area provides crucial habitat for these species - especially the northern brown kiwi, native gecko and a number of plant species which have been raised in this area with the effort and stewardship of the local community and numerous NGOs such as Bay Bush Action and the Forest & Bird Society.

The proposal seeks subsume a large portion of forest that is an important component of the Puketona Forest chain and is protected by the Significant Natural Areas (SNA) Act.

Below: SNA Area in relation to the proposed quarry expansion area.



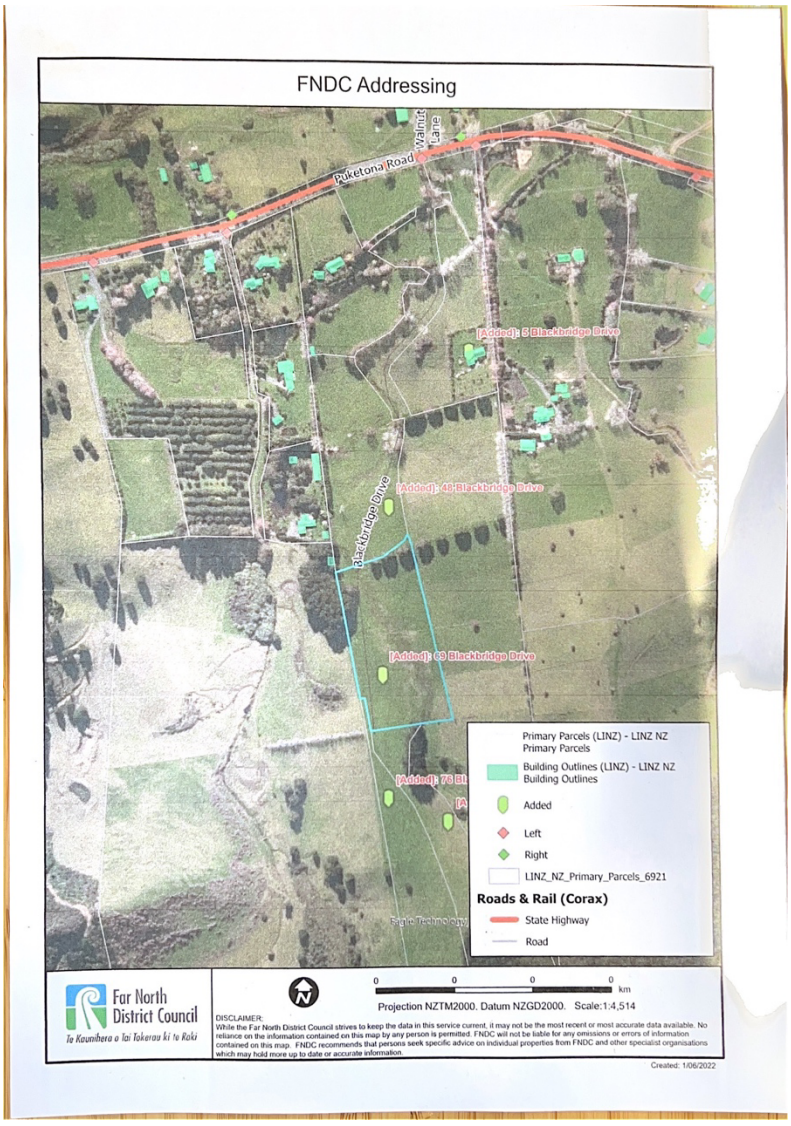
This forest contains some rich and untouched primary temperate rainforest with some of the largest specimens of totara, rimu and tree fern in the entire region and a struggling population of northern brown kiwi. The disturbance caused by quarry activities could push these species further toward extinction, negatively impacting the overall biodiversity of our environment.

Below: Photos showing the portion of SNA forest and Watershed proposed to be subsumed in expansion.

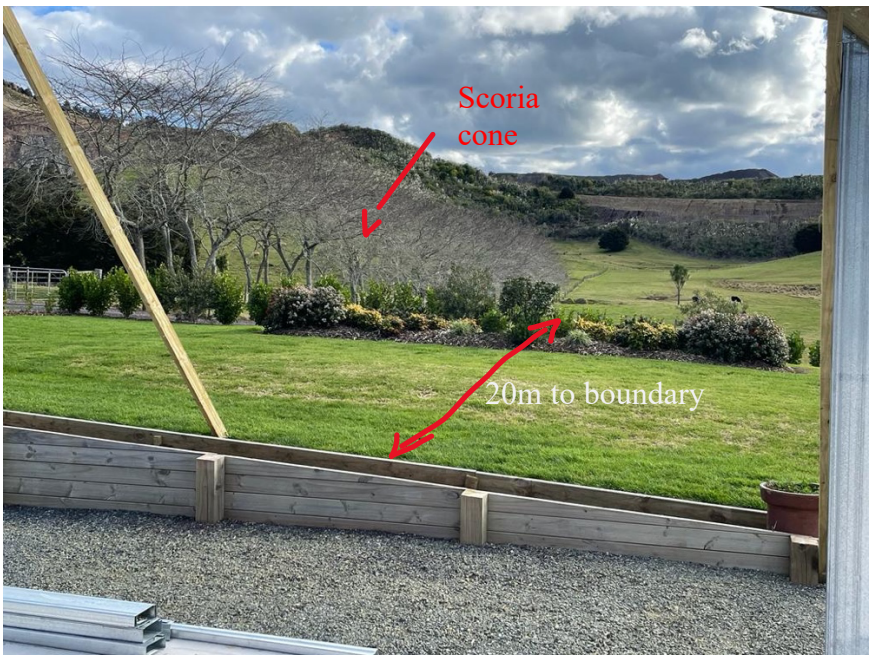
Environmental and Social Impact:

There is a significant community living directly adjacent and in close proximity to the proposed expansion site - people who have settled in the area with the understanding and assurance that expansion of the quarry activities would not occur in the proposed direction.

The below shows all the properties affected by the proposed plan for expansion of the quarry. The yellow 'Added' symbols in the document indicate the location of new properties which have largely been occupied since this document was issued in 2022.



There are a number of private properties immediately adjacent to the Lot in the proposed expansion plan and in many cases, windows of the buildings are no more than a few metres from the boundary of potential quarry and auxiliary activities.



View from one property showing proximity of lounge window to proposed quarry location.

View from another property showing proximity and view of proposed quarry expansion.

View from another property showing proximity and view of proposed quarry expansion.

The expansion of the quarry would likely result in increased noise levels, heavy traffic congestion, and dust pollution in the surrounding areas. Our community's serene environment and peaceful ambiance would be irreversibly compromised, causing a decline in property values and making the area less attractive for residents and potential investors alike.

Moreover, the environmental repercussions of this expansion cannot be ignored. The disturbance to the natural landscape and habitats could threaten the local flora and fauna, potentially leading to the extinction of some species.

As a majority of the significant number of inhabitants of this community derive their potable water from rainfall collection, the release of harmful particulates and pollutants into the air and water contaminate our natural resources, affecting not only our health but also the health of future generations.

Furthermore, the increased transportation of materials to and from the quarry would strain our already congested and damaged roadway, posing a safety hazard for pedestrians, cyclists, and motorists. This could also lead to increased maintenance costs for the local authorities, burdening taxpayers and diverting funds from more pressing community needs.

In light of these concerns, I urge you not to approve the proposal for quarry expansion. Instead, I encourage the exploration of alternative economic development strategies that prioritize sustainability, the well-being of residents, and the preservation of our environment. By investing in industries that align with these values, we can ensure a brighter and more promising future for our community.

Thank you for considering my perspective and taking into account the best interests of our community and its long-term prosperity.

Maori gardening

An archaeological perspective

Louise Furey

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Wellington, New Zealand

Cover: Pa, stone row enclosures and puke (garden mounds) at Waikekeno, Wairarapa.
Photo: Kevin L. Jones, DOC.

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CONTENTS

Abstract 5

1. Introduction 6

2. Maori cultigens 10

2.1 Kumara 10
2.2 Taro 13
2.3 Yam 14
2.4 Gourd 14
2.5 Ti pore 15
2.6 Aute 16

3. Gardening techniques 17

3.1 Garden location 17
3.2 Garden size 17
3.3 Fallowing 18
3.4 Garden preparation 18
3.5 Soil additives 19

4. Limitations to growth of Maori cultigens 20

5. Archaeological evidence of Maori gardening 23

5.1 Stone structures 24
5.1.1 Stone walls and rows 24
5.1.2 Stone alignments 31
5.1.3 Stone heaps 31
5.1.4 Stone mounds 31
5.1.5 Stone facing 34
5.2 Ditches and trenches 34
5.2.1 Steep-slope trenches 36
5.2.2 Trenches on gentle slopes 38
5.2.3 Trench boundary divisions 39
5.2.4 Wetland ditches 40
5.3 Borrow pits 44
5.4 Garden soils 46
5.5 Garden terraces 52

6. Gardening evidence by region 53

6.1 Northland 53
6.2 Auckland 58
6.3 Waikato 61
6.4 Bay of Plenty 65
6.5 East Coast/Hawke's Bay 68
6.6 Tongariro/Taupo 72
6.7 Wanganui 73
6.8 Wellington 76
6.9 Nelson/Marlborough 80
6.10 Canterbury 83
6.11 Other southern regions 86

7. Case studies 86

7.1 Panau, Banks Peninsula 87
7.2 Clarence River, Marlborough 90
7.3 Okoropunga, Wairarapa 96
7.4 Pukaroro, Wairarapa 99
7.5 Cape Runaway–Potikirua Point, East Coast 103
7.6 Rangihoua–Marsden Cross, Bay of Islands 109

8. Maori gardening in the 19th century 111

9. Factors affecting site survival 115

10. Conclusions 117

11. Acknowledgements 123

12. References 123

Appendix 1

Maori garden sites investigated 132

Appendix 2

Radiocarbon dates of Maori garden sites 134

Maori gardening

An archaeological perspective

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A B S T R A C T

Polynesian settlers to New Zealand brought with them tropical cultigens, but the temperate climate imposed restrictions on where crops could be grown. The adaptations Maori gardeners made to the landscape in order to grow their vegetables can be seen archaeologically. The types of evidence are described, drawing on specific archaeological sites and archaeological investigations. Regional variation is also discussed. Kumara (*Ipomoea batatas*), in particular, was an important source of carbohydrate, but equally importantly it played a major role in discharging social obligations and exchange transactions with other groups. New vegetables and plants were introduced by Europeans. These were embraced into the Maori gardening system, and the traditional crops were either dropped or replaced with superior varieties. These new introductions were also taken up into the Maori cultural system of gifting and exchange, and sales of vegetables formed the basis of the Maori commercial economy in the first half of the 19th century.

Keywords: archaeology, cultigen, kumara, kumara storage pits, taro, yam, Maori, Maori gardening, Maori horticulture, New Zealand

Furey, L. 2006: Maori gardening: an archaeological perspective. Department of Conservation, Wellington. 137 p.

1. Introduction

The Polynesian ancestors of Maori, when they settled in Aotearoa New Zealand, brought with them long-established traditions and techniques for growing staple food crops. Within the New Zealand landscape, there is ample and varied evidence of the continuation of those gardening practices, and of the changes and adaptations that were made over time to accommodate local circumstances and environmental conditions. This report describes the nature and location of that garden evidence at a broad regional level. The discussion about different types of Maori garden sites draws on archaeological excavations and research.

Field evidence of Maori gardening, and the growing conditions necessary for each cultigen, is summarised here at a very general level. Other publications provide a more extensive examination of this diverse subject (e.g. Best 1976; Leach, H.M. 1976, 1979b, 1984). Since the late 1960s, there have been archaeological investigations of Maori garden sites at a range of localities, with an intensification of interest in the mid-1970s to late 1980s (Barber 2004). The results of these studies are selectively reported here, the aim being to demonstrate the extent of understanding of field evidence and soil horizons. For some sites, there may be a variety of explanations or opinion as to what the evidence represents. In particular, stone rows and adjacent garden plots in the Wairarapa have attracted divergent views (see section 5.1.1).

Archaeological investigation of garden sites has provided details about their variability and, most importantly, an indication of their age. Maori garden sites that have been investigated are listed in Appendix 1, and the main places that are mentioned in the text are shown on Fig. 1. Major excavations on garden sites have taken place in Palliser Bay, where nine sites were investigated, and in Auckland, where, over a period of 15 years, remnants of several stone field garden systems around the volcanic cones have been excavated in advance of site destruction. Salvage archaeology, carried out prior to site modification, has also provided information about gardening in coastal and inland Bay of Plenty, often in areas where evidence was not visible on the surface. We now know that the tephra (volcanic ash) layers of this area were a productive growing medium. The relationship between borrow pits and modified soils has been investigated in the Waikato Basin, Aotea and Wanganui areas, where Maori gardeners sought to improve surface soils by adding coarser material, such as sand and gravel, excavated from under the surface soils (see section 5.4).

Archaeological research on Maori garden soils followed on from earlier soil survey studies; in particular, research on the modified soils in the Waikato and Tasman Bay areas has provided primary sources for archaeological discussion of Maori gardening practices. Experiments have been carried out by archaeologists and others, to test in a rigorous way the yields of kumara (sweet potato, *Ipomoea batatas*) obtained from different garden situations, replicating practices believed to have been used by Maori, or examining the effect of moisture and heat retention in an attempt to explain archaeological stone features.

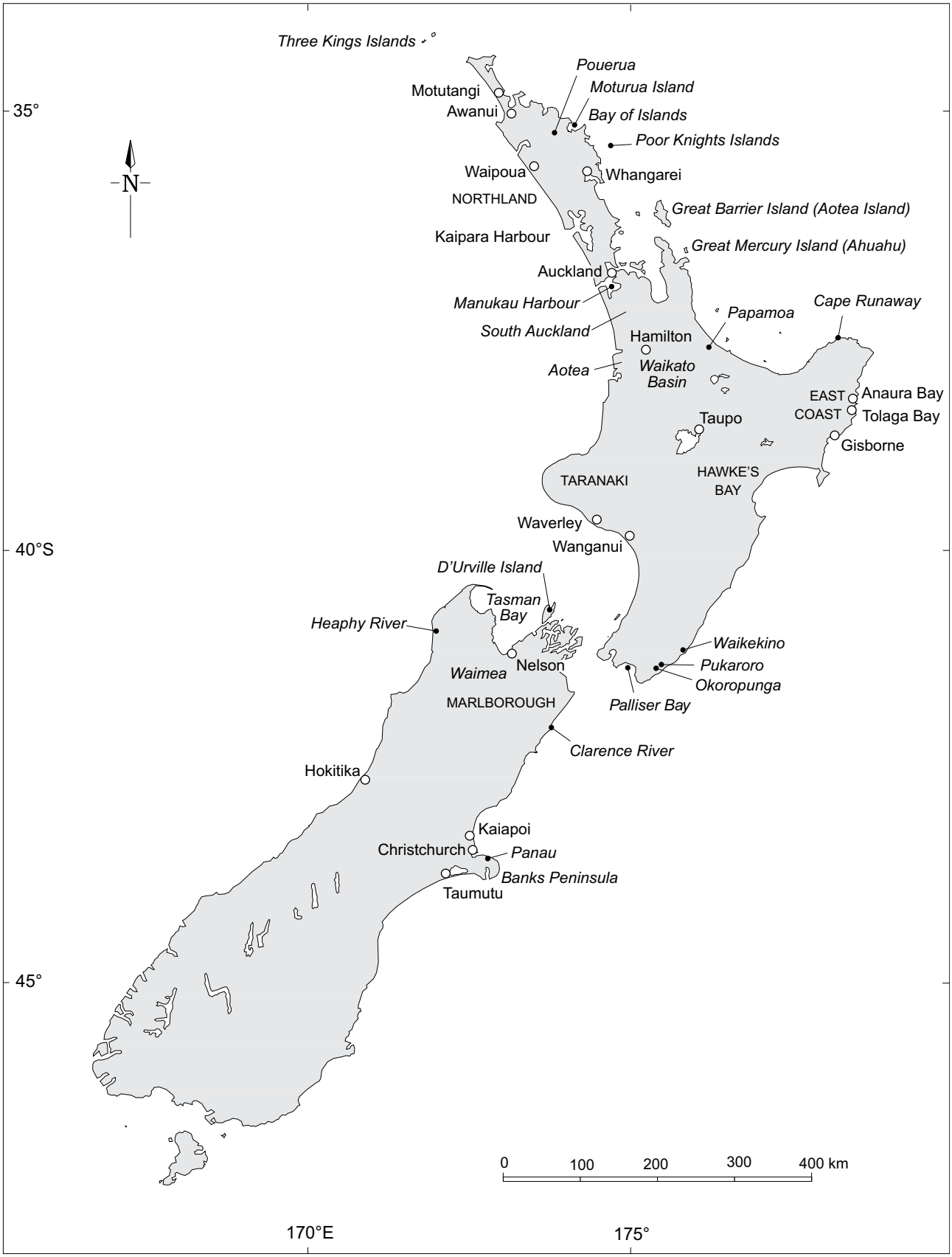


Figure 1. Main Maori garden areas and places mentioned in the text. *Map: C. Edkins, DOC.*

Information in this report on the locations and types of garden sites is derived from the New Zealand Archaeological Association's (NZAA) Site Record File. This file contains over 50 000 records on places of Maori occupation. An electronic index of the paper records on sites is known as CINZAS (Central Index of New Zealand Archaeological Sites) and has basic information on site number, grid reference, site type, site condition, local territorial authority and land classification. Site types also have abbreviated codes. From CINZAS, a list of sites in which garden-related field remains featured prominently was produced. This was followed up by consulting the NZAA Site Record File where the paper records are held, to obtain more detailed descriptions of sites.

There are limitations to using this records-based approach to arrive at a regional and national distribution of Maori garden evidence. First, absence of recorded sites in a particular locality does not necessarily mean that no garden sites exist; the distribution of sites may well indicate only where sites have been observed and recorded. Similarly, even though an area may have been walked over and examined for surface remains, the invisibility of archaeological evidence may be due to other factors, such as vegetation cover at the time of the survey, the ability of the recorder to recognise particular site types, and the extent of land-use change.

In addition, the NZAA Site Record File is, to some extent, a historical document, as the site-description records have been submitted over the last 45 years. Many of the records are now more than 30 years old, and the vast majority of sites have not been revisited since they were first recorded. Therefore, the list of sites reflects what was there rather than what might still exist. An upgrade project to relocate sites is in progress, initiated and administered by the NZAA, but it has not yet been carried out in the regions with the greatest amount of gardening evidence. It was not within the scope of this project to determine whether individual recorded sites have survived. However, the status of many sites is known at a broad level. For instance, the garden sites of the volcanic soils of the Auckland Isthmus have been largely destroyed or severely modified in the last 30 years (Clough & Plowman 1996).

Locating garden sites in the site file has been dependent on individual sites being assigned a suitable garden-related category or code in CINZAS. For instance, where the garden evidence has been considered peripheral or secondary to the main site description during coding for CINZAS, it will not be possible to extract that site from the list of sites. This is most apparent in Auckland, where stone field gardens surrounding the cone pa have not been identified separately. In this case, personal knowledge of the landscape enabled the problem to be identified, and anomalies in the records to be rectified. In other areas, browsing through all the site files for selected map sheets allowed any additional sites with garden evidence to be picked up. A further example of the problems associated with identifying garden sites from the site files is Matakana Island in the Bay of Plenty, where gardening soils were noted in reports and in site records but were not included in the CINZAS coding. Overall, this deficiency in the records would account for less than 1% of the more than 1400 recorded sites with garden evidence in the NZAA site file. It should also be noted that the particular coding assigned to individual sites is exclusive, even when several categories of site type are represented in the description. Therefore, the number of recorded sites in each category is indicative only.

A significant limitation to identifying the distribution of Maori gardening in the landscape is the lack of visible field evidence. Large areas were able to be gardened without the addition of stone or trench boundaries, stone clearance or soil modifications. The vast majority of Maori gardens will therefore be invisible—it is generally only the specialised or unusual methods of cultivation field evidence that are detected in field remains. Determining the extent of Maori gardening at a broad level is best derived from wider evidence, including the distribution of kumara storage pits. Examination of pre-1840 vegetation patterns (e.g. Beever 1981) may also be relevant when identifying where forest was cleared or modified.

The number of sites recorded per topographic map sheet, or per Department of Conservation (DOC) conservancy as an indicator of broad geographic regions, mainly reflects recording activity, which is variable. There is no consistent approach to the recording and identification of garden sites. Thus, the 32 sites representing garden evidence at Ambury Park near the Manukau Harbour in South Auckland carry no more weight or significance than the one site for the Wiri Mt/McLaughlin's Mt stone field gardens, which also has a number of individual features.

Although there is a large amount of garden evidence, the extent to which cultivated crops provided a staple food has been questioned (Shawcross 1967; Leach 2000). Seasonal crop failures and political unrest contributed to fluctuations in the supply of kumara. Energy expended in gardening was possibly as much about social needs, hospitality, obligations and aspirations as it was about nutrition and survival. Compared with tropical Polynesia, even the northern North Island was marginal for gardening, as the population could not be sustained on garden produce alone. Instead, there was a mixed economy, based on gardening, gathering and fishing; the relative importance of each of these changed with distance south. Gardening provided essential carbohydrates when there was little other wild food (except for bracken fern *Pteridium aquilinum* var. *esculentum*) that could provide it in quantity.

Cultivated food was not a consistent dietary staple (even in the most suitable regions), but it was nonetheless very important in the cultural sense. The ceremonies, rituals and strict rules associated with kumara gardening, and to a lesser extent gourd (hue, *Lagenaria siceraria*), are well reported in Best (1976). The lack of information about rules governing the growing of taro (*Colocasia esculenta*) does not necessarily imply that taro was grown without attention to ritual and ceremony. Gardening practices in the pre-European period may have differed from those carried out in the 19th century, when taro was not an important crop.

2. Maori cultigens

Only six imported cultigens were grown at the time of European arrival—kumara, taro, yam (uwhi, *Dioscorea* spp.) and gourd, with ti pore (*Cordyline fruticosa*) also grown in some areas. Aute (paper mulberry, *Broussonetia papyrifera*) was grown specifically for use as a textile. These six cultigens represent a very restricted range of crops compared with what was grown in tropical Polynesia, where a total of eight root crops and 11 tree crops were available, although not all were grown on each island group and the number cultivated tended to diminish away from the high islands of Eastern Polynesia (Leach 1976: 148). In addition to the root crops that survived in New Zealand until European contact, other crops may have been introduced but failed to grow or reproduce. Crops such as arrowroot, banana, breadfruit, coconut, kape or giant taro, smaller yams, sugar cane and turmeric may have been unable to survive the local conditions encountered. The major difference between temperate New Zealand and tropical Polynesia is New Zealand's seasonal temperature range, which influences whether or not root crops are able to mature. This seasonal range becomes more pronounced with increasing latitude. Detailed information on the growing requirements of each cultigen is presented in Leach (1976, 1984).

The successful introduction of Polynesian root crops to New Zealand not only required skills in plant husbandry, but also modification of the garden environment to improve conditions for plant growth and maturation. These modifications included the addition of gravel and sand to soil, mulching, fences and windbreaks, and possibly stone rows, to provide shelter for the growing plants, heaped soil and stone for warmer ground temperatures, and mechanisms for storage of kumara tubers once harvested. Over time, there may have been some selection for varieties that were more tolerant of cooler growing conditions or that were faster maturing.

2.1 KUMARA

Kumara (sweet potato, *Ipomoea batatas*) was the most extensively grown Maori cultigen in New Zealand, although it was of minor importance in most of tropical Polynesia. Only on Rapa Nui (Easter Island) did kumara attain a similar importance as a principal food crop. It was absent entirely from some islands, notably in the southern Cooks (with the exception of Mangaia), until it was introduced by Europeans in the 19th century (Green 2005). Kumara may have attained primary crop status over yam or taro due to its greater tolerance of drier or cooler conditions, or because it was faster maturing, an essential factor in the seasonal, temperate climate of New Zealand. Kumara was most likely introduced into East Polynesia by the end of the first millennium, with convincing arguments being put forward now for Polynesians voyaging to northern Peru or Ecuador and returning with tubers (Green 2005). It was being grown on islands likely to be the homeland of the New Zealand Maori and therefore was brought here at the time of settlement, or soon after. In contrast, kumara was a later introduction on both Rapa Nui and Hawaii, which were settled prior to kumara reaching

Polynesia; it was well-suited to the dry growing conditions on Rapa Nui and the leeward side of the Hawaiian islands (Green 2005).

Of all the cultigens, kumara is tolerant of the widest range of conditions. Some of the growing characteristics and requirements identified by Leach (1984) and others are summarised below. Kumara is a member of the Convulvolaceae family, and the earliest varieties grown in New Zealand were erect and bushy. In tropical Polynesia, sweet potato is treated as a perennial, with stem cuttings planted and tubers harvested year-round. In temperate New Zealand, kumara is grown as an annual, with sprouted tubers planted in spring and tubers lifted in autumn. Temperature is a critical factor in tuber propagation and plant growth. Experiments have shown that plants do not survive in soil temperatures < 12°C, and at 15°C they will survive but not grow. A temperature range of between 15°C and 35°C is the optimum for the assimilation of nutrients and rapid growth (Worrall 1993: 4). Because kumara is sensitive to cold, small increases or decreases in temperature are important. Plants achieve full canopy within 6 weeks of sprouting and tuber formation commences 2–8 weeks after planting; yield increases occur in the last 4–5 weeks before harvest (Worrall 1993: 47). The crop takes 5 months to mature. Plants are frost tender, but frosts late in the growing season will not unduly affect the tubers, provided they are mature enough and can be lifted soon after the event. However, frosting does affect germination of the tubers in the following spring (Leach 1976: 150). Similarly, low soil temperatures and excessive moisture while the tubers are forming can lead to tuber rot. Kumara can be grown as far south as Banks Peninsula in coastal areas, but at this latitude the yield is usually low and, depending on conditions, the crop may be unsuccessful in some years (Law 1969: 238; Yen 1961, 1990).

The best soil type for kumara is considered to be a light and porous sandy or gravelly loam. Free-draining soil heats up faster early in the growing season and retains heat for a longer period. Certainly, in more marginal areas from the lower North Island south, success or failure of the crop may have been dependent on having lighter, more porous soils. However, granular loams and clays, and yellow-brown earths predominate over a significant proportion of the North Island, and some of these soils were also extensively gardened (Welch 2000). Soil type may not have been such an important consideration if the range of maximum-minimum temperatures encountered during the growing season was narrow, as in the far north of the North Island.

Several methods were used for planting kumara. Captain James Cook observed kumara grown in rows, on mounds, in a quincunx (offset spacing) pattern. A feature noted by many Europeans was the neatness and weed-free state of Maori gardens, but this may have been easier to achieve in the absence of introduced European weeds, which aggressively colonise open ground today. A high level of maintenance was required during the growing season to remove caterpillars, which ate the leaves, to keep the ground around the plants tilled and heaped up, and to trim dead leaves (Best 1976).

During the growing season, small immature tubers were removed, scraped, and dried in the sun. These dried kumara were called kao, and were considered a sweet delicacy when cooked, mashed, and eaten at feasts (Best 1976: 138–139). The mature main crop was carefully dug in autumn, sorted to remove damaged tubers, and stored in kete in storehouses (including the semi-subterranean store

pits found archaeologically) or in above-ground structures such as pataka or whata (ibid).

The exact number of varieties of kumara originally brought to New Zealand by Maori ancestors is unknown. Colenso (1880: 34–35) named 32 varieties from Northland and another 16 from the Hawke's Bay and East Coast areas. These ranged from white-skinned with white flesh through to purple-skinned with purple flesh. Although kumara do not set seed in New Zealand, mutation of buds can lead to new varieties, which might explain the large number reported by Colenso. Elsdon Best recorded over 100 names from different districts, but the original introductions may have only numbered about a dozen (Leach 1984: 103). Different varieties were known for specific characteristics, such as sweetness, flavour, the production of large tubers, or high yield. Only three of these varieties now survive, but experimental work may show that some varieties were more suited to particular conditions or to marginal climates. DNA analysis of the remaining traditional varieties—Hutihuti, Rekamaroa and Taputini—has confirmed that they have lineages separate from the kumara cultivars grown in New Zealand today (Harvey et al. 1997). Rekamaroa and Hutihuti are closely related, and distinctly different from Taputini.

Kumara continued to be grown after the introduction of European crops, but by the early 1800s Maori kumara was being replaced with the European-introduced varieties, which produced larger tubers and were considered sweeter (Coleman 1972: 5; Best 1976: 114).

Kumara tubers have only been recovered archaeologically from two sites: Waioneke on the Kaipara Harbour (Leach, H.M. 1979b: 241), and NZAA site number P05/288, known as Haratua's Pa, at Pouerua in Northland (Leahy & Nevin 1993; Yen & Head 1993). In each case, the kumara were carbonised, or burnt, and excavated from storage pits. Tubers from P05/288 were identified as being from the varietal types Rekamaroa and Hutihuti/Taputini (Yen & Head 1993: 58).

Kumara plants do not flower or set seed in temperate New Zealand. However, microscopic examination of soils shows some promise for identifying phytoliths (silica deposits) from leaves (Horrocks et al. 2000) or the starch grains found in tubers (Horrocks et al. 2004), which may enable confirmation of the types of crops that were grown in specific localities. The technique may also establish whether some identified modified soils were gardens. However, caution is needed in the identification of kumara phytoliths, as New Zealand tree species such as rewarewa (*Knightia excelsa*) and beech (*Nothofagus* spp.) produce phytoliths of similar appearance, and rewarewa in particular is frequently present in vegetation patterns after forest disturbance (Horrocks et al. 2000).

Experimental gardening with traditional kumara at Robin Hood Bay in coastal Marlborough and at Whatarangi in Palliser Bay have demonstrated that harvest results can be mixed, with some plants producing well and others having very few, or no, tubers (Harris et al. 2000: 308; Burtenshaw et al. 2003). Harvests in successive years, with different climatic conditions during the growing seasons, also produced variable results. In the 1999–2000 growing season at Robin Hood Bay, a 5 m × 5 m plot containing 65 plants yielded 29.4 kg, or the equivalent of 11.8 tonnes/ha. The following year the yield was the equivalent of 7.6 tonnes/ha (Burtenshaw et al. 2003: 178).

2.2 TARO

Taro (*Colocasia esculenta*) was grown primarily for the starchy tuber, although the leaves could also be eaten after cooking. In tropical Polynesia, there is both wetland cultivation, based around the use of ditches, ponds and irrigation, and dryland cultivation of taro. Early European observers noted only the latter in New Zealand. Colenso (1880: 36–37) named ten varieties from Northland, some of which were only eaten on particular occasions, and another nine varieties from Hawke's Bay and the East Coast, where some of the known Northland varieties were also grown. Like kumara, these varieties could be distinguished by size, sweetness and colour.

Taro has higher moisture requirements than kumara and, in the wild, often grows on the banks of streams or in swampy areas. Colenso (1880: 8) reported that the best soils were light yet deep, or alluvial, and on the banks of streams or adjacent to the coast, and sometimes at the foot of high cliffs, presumably because soil conditions there were damper. The growing season is 6–7 months long. While taro will grow in cooler temperatures, corms are small or fail to develop. Historically, taro is known as far south as Hokitika and the Heaphy River mouth on the west coast of the South Island, but Leach (1984: 105) suggests that this may have been a European-introduced variety with a greater tolerance of cooler conditions. Joseph Banks observed taro growing at Anaura Bay on the East Coast in 1769 (Beaglehole 1962: 417), but there are no early accounts from further south.

Microfossil analysis of soil samples at Triangle Flat in Golden Bay indicates that taro was grown there (Horrocks 2004). There may have been a number of favourable microclimates in the north of the South Island that were taken advantage of for taro, but the full extent of the growing range is not yet documented.

According to Colenso (1880: 9), taro was not grown on mounds but on a carefully levelled surface, and was surrounded by a fence or screen to provide shelter from the wind. At Anaura Bay, Monkhouse described taro planted in 'circular concaves', similar to the description by Colenso for gourd cultivation. Colenso also referred to hue and taro being grown together in plantations (Best 1976: 134).

Mature taro could be left in the ground or lifted and stored in the open (Colenso 1880: 15), presumably without deterioration, unlike kumara, which required a very narrow range of temperature and humidity conditions to survive storage in either semi-subterranean store pits, rua, or pataka.

Taro can be found in the northern half of the North Island as cultivated or wild plants. Although plants produce pollen, seed production has not been observed in New Zealand (Matthews 1985: 270). While not strictly speaking archaeological sites, the locations where taro has been recorded growing nonetheless provide valuable information on the distribution and hardiness of the crop. There are three taro variants in New Zealand: RR, GR and GP, distinguished by variations in the colour of the petiole and the shape of the leaf blade (Matthews 1985). The most common variant is RR, accounting for 75% of the records made by Matthews (1985) during his survey of taro distribution in New Zealand. The RR variant is now believed to be a historical introduction of Chinese origin (Matthews 2002). GR and GP are most common in Northland. Anecdotal evidence suggests

that these two variants were grown primarily for pig food in historic and recent times and, because of their limited distribution, they are believed to be post-European introductions. The variants growing in New Zealand have chromosome number 2n = 42. The poor representation of plants with 28 chromosomes, which are widespread throughout Polynesia and Asia, cannot be explained at present (Matthews 2002).

2.3 YAM

Little is known of yam (uwhi, *Dioscorea* spp.) cultivation, as the potato (*Solanum toberosum*) soon replaced it in 19th-century Maori gardens, due to its high yields and tolerance to a wide range of conditions (Leach 1984). Like kumara, yams were grown for their starchy tubers. The rapid replacement of the traditionally grown yam suggests that it may have been difficult to grow, low yielding and a marginal crop, even in the warmest parts of the country. The diminished importance of yam in New Zealand mirrors the situation in other East Polynesian islands; this contrasts with the situation further west, where yam played an important role both as food and in the ritual cycle of ancestral Polynesians (Leach 2005: 64).

Yams require a longer growing season than kumara (several months more than kumara's 5 months to maturity), and over-wintering in the ground may have been necessary (Leach 1984: 60). However, like kumara, the successful varieties grown in New Zealand may have been more adaptable to cooler conditions and faster maturing than modern tropical varieties grown experimentally in New Zealand. The tubers can be successfully preserved for 3–4 months, provided there is little variation in temperature during storage (Leach 1984).

Yams were grown in similar conditions to kumara and were planted on small earthen mounds or puke. The plant had a twining habit, different from the creeping structure of kumara. Yams were observed growing in Tolaga Bay and Anaura Bay in 1769, and also in the Bay of Islands (Beaglehole 1962: 444).

Starch grains and xylem cells from yam roots and underground stems have recently been found in microscopically examined soil samples from Motutangi in the Far North (Horrocks & Barber 2005). This is the first archaeological indication of yam (specifically *Dioscorea alata*) being grown here.

2.4 GOURD

This cucurbit (hue, *Lagenaria siceraria*) was grown primarily for the large fruits, which, when mature, were used as containers to store water, oils and food. Small immature fruits were eaten during the summer, before the kumara were harvested. A relatively long growing season of 6–7 months is required for the fruit to enlarge and mature. Like other crops, gourd is temperature sensitive and grows most favourably when the mean temperature is above 17°C. Gourd requires a damp rich soil, and it was often grown near taro plantations. In late October 1769, Monkhouse saw gourd vines in flower growing over houses in Anaura Bay (Salmond 1991: 164). This seems very early in the season for gourd to be growing, and training the vines over the houses may have been a particular technique for encouraging plant growth and the early maturation of fruit.

Captain Cook described gourd plants growing in small hollows at Tolaga Bay (Best 1976: 29); Colenso (1880: 9) referred to these features as 'convex bowl-shaped pits'.

Gourd remains have been found in archaeological excavations at Kauri Point Swamp and Kohika in the Bay of Plenty, Te Miro in the Waikato, and Waitore in Taranaki (Cassels 1979; Edson 1979; Irwin 2004; Maingay 1984). Gourd fragments have also been recovered from Whakamoenga Cave and Waihora in the Taupo area (Leahy 1976; Hosking & Leahy 1982), indicating that gourd remains are capable of surviving in both wet anaerobic and dry conditions. Gourd pollen has been found in soil samples from a stone mound at Pouerua, inland Bay of Islands (Horrocks et al. 2000), and in coprolites at Harataonga, Great Barrier (Aotea) Island (Horrocks et al. 2002), demonstrating the potential for microfossil studies to assist with the archaeological interpretation of garden features.

2.5 TI PORE

Ti pore (*Cordyline fruticosa*) occurs throughout Asia and the Pacific, and was part of the suite of plants carried into Polynesia by Polynesian ancestors. It also occurs on Raoul Island in the Kermadec Group where, in a tropical environment and in the absence of grazing animals, it has continued to thrive (Simpson 2000). It has not been so fortunate in New Zealand, where it was reduced to a few plants by the beginning of the 20th century (Walsh 1900) and is now very rare in the wild, being confined to Northland. *Cordyline fruticosa* differs from native New Zealand *Cordyline* species in having a shrub-like habit with broad leaves on thin clumping stems. The thick rhizome was used as food. *Cordyline fruticosa* was previously identified in the literature as *C. terminalis*.

The pre-European distribution of ti pore in New Zealand is unknown, but Walsh (1900), after reviewing Northland distributions, concluded that it was a tropical plant suited only to favourable parts of Northland. Ti plants were observed in gardens in the Bay of Islands in 1772 (Crozet, reported in Salmond 1991: 412).

Ti para was also cultivated in New Zealand (Colenso 1880: 16). This is now identified as a cultivar of *Cordyline australis*, the native cabbage tree (Simpson 2000: 144), that was developed by continually selecting plants that suckered. According to Colenso, ti para was grown extensively in the Waikato, Wanganui and Hawke's Bay, as well as further north. Ti para was not cultivated in the South Island, but the name was adopted there for *C. australis*. The tap root of *C. australis* was an important source of carbohydrate after it had received lengthy steaming in a distinctive type of earth oven, known as an umu-ti (Fankhauser 1990; Simpson 2000: 144).

Both ti pore and ti para were reproduced by replanting the stalk with a small portion of root attached, or by planting small side shoots (Best 1976: 257). Ti pore did not produce flowers, and could therefore only be reproduced by vegetative methods. Ti plants do not produce phytoliths, so it will be difficult to determine from microscopic analysis of soils where ti pore was cultivated (Horrocks 2004).

Like the yam, ti pore disappeared from Maori gardens soon after Europeans introduced new plants and sweet alternatives to eating ti root.

2.6 AUTE

Aute (paper mulberry, *Broussonetia papyrifera*) is a fast-growing shrub or small tree widely grown throughout Polynesia, and is used to manufacture tapa cloth by beating and felting strips of bark together. The plant has male and female flowers on separate plants, but it was probably reproduced vegetatively in New Zealand (Matthews 1996). It is unlikely that this tropical plant was ever able to be cultivated in sufficient numbers in New Zealand to produce large quantities of cloth. Dependence on aute for clothing was not necessary, since other fibre-producing plants, particularly flax (harakeke, *Phormium* spp.), were present in abundance. At the time of European contact, use of aute cloth was confined to small pieces that were rolled up and inserted through a perforation in the ear lobe.

In 1769, aute plants were growing wild in Anaura Bay and Tolaga Bay (Monkhouse, quoted in Salmond 1991: 168, 172), but it is not clear from the descriptions whether plants were plentiful or only a few were observed. A few cultivated plants were also seen in the Bay of Islands. Distinctive square-sectioned wooden beaters, which were used to make tapa from the bark, have been found as far south as Taranaki (Neich 1996). This may indicate the southern tolerance of paper mulberry. Aute became extinct in New Zealand after 1844 (Colenso 1880).

Pollen and phytoliths of aute have recently been found in a swamp core at Rangihoua in the Bay of Islands (Horrocks 2004). This discovery reinforces the potential of microscopic studies to contribute to our understanding of the distribution of individual cultigens in Maori gardening.

3. Gardening techniques

Unfortunately, there are few first-hand accounts of Maori methods of gardening and preparing soils. Elsdon Best (1976) is acknowledged as the most authoritative source, but his work is derived from observations made by individuals such as Cook, Banks, Colenso, Wade, Cheeseman, Nicholas and various Maori informants, principally from the East Coast and Waikato areas. It is unclear whether he observed any of the reported gardening techniques himself. Nonetheless, there is a wealth of information present in his book on Maori agriculture about the growing requirements of the various crops. However, there is less specific information about topics of interest to archaeologists, e.g. stone rows, or the reasons why other materials were added to soils. There are also contradictions in some of the reported information, which are explained as differences in custom and practice in different parts of the country (Best 1976: 278).

The available information can be summarised under several headings. These relate to the preferred locations of gardens, the length of time a garden plot was used before fertility declined and the soil was left to recover, how gardens were made ready and specific preparations for kumara, the size of individual garden plots, and comments on soil additives.

3.1 GARDEN LOCATION

Sloping land was preferred for kumara because flat land was too damp (Best 1976: 158, 163). In addition, the garden should have a northerly aspect or face the sun (Best 1976: 163). Archdeacon Walsh (1902: 13–14) stated that 'almost any soil will do for the kumara, so long as the situation is dry and the plants are not exposed to the cold southerly winds, or to the spring and autumn frosts…advantage was taken of well drained sheltered spots on higher ground for the early plantings'.

Colenso (1880) reported that hue was often sown in and near taro plantations, as both species had similar soil requirements. Kumara, however, appears to have been planted in separate gardens. This segregation is in keeping with the observance of ritual associated with the planting and harvesting of kumara (Best 1976).

3.2 GARDEN SIZE

The early European accounts are generally in agreement on the size of gardens. Joseph Banks reported that gardens in Anaura Bay ranged from 1–2 acres to 8–10 acres. In the Bay of Islands, a garden of 40–50 acres was seen planted around a village on Moturua Island (Salmond 1991: 164, 230). Smaller gardens were seen in various locations, but the size was not recorded, except at Mercury Bay, where there was a half acre planted in kumara (Salmond 1991: 205). In 1769 in the Bay of Islands, the French explorers noted plantations 12–20 ft^2 near fishing villages

(Ollivier & Hingley 1987: 33); however, these are unlikely to have been the main gardens. There was little change in garden size over the next half century. Gardens in the Bay of Islands in 1814–15 were of a similar size to those recorded earlier (Shawcross 1967: 334).

3.3 FALLOWING

There is little information on the amount of time gardens were left fallow, and also on how long gardens were used. Both of these would be dependent on variables such as natural fertility of the soil, soil type, climatic conditions and previous vegetation. Richard Taylor reported that soils could be cropped for 3 years then fallowed (Best 1976: 143). The length of time depended on the type of vegetation: if bracken fern was present, the ground was fallowed for 7–14 years before reuse, but if scrub or light bush was present, the interval was variable and depended on how long it took for the vegetation to grow up. Maori Land Court records for the Waihou area in Hauraki suggest that gardens could be cropped for 2–3 years, or possibly up to 6 years, before the soil was rested (Phillips 2000: 58). The fallow period in the Tamaki area may have been between 10 and 20 years, following 3 years of cropping (Sullivan 1985: 485). Jones (1989: 62), following a different methodology, attempted to calculate the amount of hillslope that was in garden in Anaura Bay during Cook's visit in 1769. Based on a total usable space of 240 ha, he estimated that the amount of land in use compared with the amount lying fallow was in the range of 1:5 or 1:6 in any one season.

3.4 GARDEN PREPARATION

Following the burning of vegetation, the ash was spread around, and loose branches and stones were cleared to the outer corners of the garden (Best 1976). Prior to planting kumara, the ground was loosened at regular intervals then formed up into puke: '… when the ground was cleared, it was not turned over as with us; the earth was loosened and formed into puke or little mounds at certain intervals, but the space of earth between such mounds was not turned up or loosened, it was simply cleared from weeds and rubbish' (Best 1976: 157). However, if bracken fern was present, the ground was fully dug over to remove the roots. It is not clear, however, whether the same puke were reused in following years, or whether the ground was smoothed out and new puke dug. This comment is particularly significant when considering what might be observed in an exposed soil profile. If ground was only used once, soil might show a pattern of disturbed and undisturbed soil horizons in close proximity.

Puke for kumara are described by Archdeacon Walsh as 9 inches (23 cm) high, and 20–24 inches (50 cm) in diameter, with the bases about 4 inches (10 cm) apart (Best 1976: 149, 155). The mounds were set out in rows, in a quincunx pattern, which Best describes in detail. Yams were planted in a similar fashion.

The concave circular bowls in which taro were grown on the East Coast were about 24 inches (60 cm) in diameter and 8 inches (20 cm) deep, and between 18 and 36 inches (45–90 cm) apart. The holes were filled with gravel, three or four taro tubers were planted, and gravel was drawn back around the tubers and firmed (Best 1976: 236). Also on the East Coast near Te Kawakawa, Colenso described a taro plantation planted in quincunx layout, with sand laid on the ground between the tubers. Fences of manuka (*Leptospermum scoparium*) intersected the plantation to act as wind breaks (Best 1976).

Best (1976: 173) also mentions mounded ridges of soil called tuaka kumara, which were used to form raised beds for kumara growing on damp soil. These may be similar to hummocky surface features that are still visible on some archaeological sites.

Fences were commonly observed around the gardens. These may have been windbreaks, and/or barriers to keep ground-dwelling birds and animals out. Rats (*Rattus* spp.) are frequently mentioned as possible garden marauders, probably because snares were seen on the ground around the gardens in Anaura Bay, but weka (woodhen, *Galliralus australis*) are also a possibility. The fences were constructed of closely spaced reeds and were about 20 inches high (Monkhouse, in Salmond 1991: 164). Best (1976: 39) lists a number of terms for fences around gardens. Later, after European animals arrived, gardens had more sturdy fences around them to keep out pigs (*Sus scrofa*).

3.5 SOIL ADDITIVES

There are many Maori names recorded for different types of soils including clay, alluvial soil, gravel soil, fertile dark soil, sandy soil, and a stiff brown soil, which was fertile but needed breaking up and to have sand or gravel added (Best 1976: 42–43). Best, quoting other observers, makes several references to the addition of gravel to soils. Archdeacon Walsh (1902) indicated that while a light, porous soil was preferred, soils could be improved by adding a layer of sand from the river-bed or, in the Waikato area, sand from the river terraces. Sand or gravel, when added to clay soil, kept it porous and able to take up water (Best 1976: 132–133). Colenso (1880: 138) reported that adding gravel was an annual activity.

A description of gardening reported in Best (1976: 163–172) by an informant of Ngati Kahungunu contributes further information. Heavy loam soils were improved by gravel, but they were not favoured because of the amount of work involved. Lighter, rich soils were preferable for kumara, and small amounts of gravel could be used to put under the leaves to protect them from mud and dampness; grass was used if no gravel was available. Gravel was poured between the puke, then scooped up and added to the soil in the mound before the kumara was planted. This warmed the soil and allowed air in.

These accounts suggest that there were multiple reasons why sand or gravel was added to soils; archaeologists should, therefore, beware of simplistic, universal interpretations of the evidence.

4. Limitations to growth of Maori cultigens

As outlined above in the requirements for individual cultigens, mean temperature and length of growing season are the main limitations to the regional distribution of Maori gardening. The ability to store the tubers in appropriate conditions is also a consideration. Historic observations suggest that only kumara could be grown in the South Island and southern North Island, and while taro was more cold-tolerant than yam, neither could be grown south of Poverty Bay or Hawke's Bay.

There are two critical periods in the growing of kumara: spring and early summer for the sprouting of tubers and for plant growth, and late summer and early autumn, when tuber formation and thickening occurs (I. Lawlor, Auckland Regional Council, pers. comm.). The higher the minimum soil temperatures, the better the growth and yields. Low soil temperatures in late summer and early autumn also affect the viability of tubers, inhibiting germination the following year (Law 1969: 240). Experimental growing of Maori kumara varieties near Christchurch has shown that plant growth and crop yields varied from year to year according to the weather conditions, suggesting that kumara was at the southern limit of its tolerance (Law 1969; Yen 1990; Horn 1993).

New Zealand's climate in the early centuries of Maori settlement is largely unknown. The postulated Little Ice Age, with cooler temperature conditions, which has been used to explain the abandonment of gardening on the Palliser Bay coast in the 15th century, has been based on climatic influences affecting Europe (Leach, H.M. & Leach, B.F. 1979). The severity of the effect of the cold period on New Zealand is, as yet, unknown. However, recent work on the dendrochronology of silver pine (*Lagarostrobos colensoi*) from Oroko Swamp near Hokitika indicates two periods of above-average warmth in the 12th and 13th centuries alternating with periods of below-average temperatures (Cook et al. 2002). This coincides with the Medieval Warm Period experienced in the northern hemisphere. The timing of these warm periods may have been particularly important for the development of horticulture in New Zealand, although the range of temperature change is likely to have been only 2–3°C at most. The same study indicates a sharp reduction in temperature after AD1500, followed by a long period of warming but with temperatures still below the average (Cook et al. 2002). Climatic reconstruction tied to precise chronology over the last 1000 years using dendrochronology, speleotherms and vegetation reconstruction is the subject of ongoing research. Temperature is likely to be only one factor affecting the viability of Maori horticulture—excessive rainfall, or the frequent incidence of cyclonic events, and prolonged dry conditions are also likely to have had significant effects.

Using present-day temperature and frost-occurrence statistics as a basis for determining the viability of Maori horticulture in the past can provide a useful guide, but can also be misleading. Suitable microclimate conditions, related to aspect and shelter from prevailing winds, will exist locally, but are not detected in generalised climate statistics. In addition, bush cover was formerly more widespread and gardens would frequently have been enclosed by bush. The

shelter provided by the bush may have encouraged higher temperatures and protected against frost and wind, thus making gardening more viable. However, in the case of Palliser Bay, general environmental degradation caused by forest clearance in association with climatic change have been put forward as factors affecting the on-going viability of gardening on the coastal platform after the 15th century (Leach, H.M. & Leach, B.F. 1979) although, more recently, this interpretation has been challenged and environmental catastrophe following earthquakes and tsunami have been proposed as reasons why the Palliser Bay area was abandoned (Goff & McFadgen 2001).

In keeping with the tropical and sub-tropical origins of the Maori cultigens, the evidence for gardening is most extensive in the upper half of the North Island. Evidence is mostly confined to coastal areas, where the severity and number of frosts is limited. Table 1, which shows the number of recorded archaeological sites with evidence of gardening by each DOC conservancy, should be treated as indicative only, as it is subject to limitations of site recording and how site features were identified. However, it does quite correctly show that there is considerably more evidence of Maori gardening in the North Island than the South Island, and that evidence increases progressively towards the north.

Storage pits and archaeological garden sites indicate that gardening was viable at the northern end of the South Island and in favourable locations on the eastern coast as far south as Banks Peninsula. Radiocarbon dates indicate that the gardens on the Marlborough coast were in use from the early period of settlement through to the European period (Challis 1991: 104).

TABLE 1. NUMBER OF RECORDED MAORI GARDEN SITES BY DEPARTMENT OF CONSERVATION (DOC) CONSERVANCY.
Information collated from New Zealand Archaeological Association site records.

CONSERVANCY	STONE ROWS	STONE STRUCTURES	STONE MOUNDS/HEAPS	MODIFIED SOIL	TRENCHES/ DITCHES	BORROW PITS	TARO	HISTORIC CULTIVATIONS	TOTAL	STONE-FACED TERRACES*
Northland	59	18	173	18	118	–	87	40	513	40
Auckland	87	28	76	23	32	–	30	28	304	14
Waikato	32	5	15	22	18	40	40	13	185	2
Bay of Plenty	3	–	1	29	4	1	2	15	55	6
East Coast/Hawke's Bay	15	2	–	19	16	2	2	9	65	1
Tongariro/Taupo	4	1	–	7	–	1	–	2	15	–
Wanganui	–	–	5	4	1	64	1	3	78	–
Wellington	79	1	2	9	–	–	–	3	94	–
Nelson/Marlborough	24	1	1	39	–	6	–	–	71	–
Canterbury	7	–	–	5	1	4	–	–	17	–
West Coast	–	–	1	–	–	–	–	–	1	–
Otago	–	–	1	1	–	–	–	–	2	–
Southland	–	–	–	–	–	–	–	–	–	–
Total	310	56	275	176	190	118	162	113	1400	63

* Stone-faced terraces are included to show that they have a limited distribution coinciding with the area of greatest horticultural activity. They may, however, have functions other than gardening.

There are 17 garden sites reported from Canterbury. A series of borrow pits in the vicinity of Woodend and Tuahiwi, near Kaiapoi, suggest extensive gardening (Walton 1985a; Trotter & McCulloch 2001). The Banks Peninsula evidence is variable and generally untested archaeologically. Stone rows and earthen rows are present at Panau and several other northern and eastern bays, and indications of modified soils in association with raised-rim pits and borrow pits are present at Okuora Farm near Birdlings Flat (Gordon et al. 2004). There is a possible modified soil and borrow pits at Taumutu, from where there are also traditional accounts of kumara growing, and agricultural implements have been recovered (Trotter & McCulloch 1999a). However, these are marginal climes, with the southern limit for kumara growing being at or about latitude 43°S. Thus, suitable warm, frost-free and sheltered coastal microclimates would have been used for successful gardening, and it is unlikely that gardening was widespread. Clearly identified storage pits are rare south of Kaikoura (Law 1969: 229), and only a few of the pit features identified on Banks Peninsula are likely to be storage pits (C. Jacomb, New Zealand Historic Places Trust, pers. comm.). In the absence of storage pits, the question of how the crop was stored at this southern extreme of cold tolerance is an important one. Yen (1961, 1990) argued that appropriate pit storage was the key to the success of kumara in New Zealand, as without storage over the winter in suitable conditions (i.e. a narrow temperature range), the crop would not be healthy or viable for planting the following spring.

Evidence of gardening is also present in Nelson/Marlborough, although the density of sites diminishes with increasing latitude (Challis 1991). Soils modified by the addition of gravel have been recorded in the Nelson-Waimea plains area, and stone rows, together with modified soils, are present in the Marlborough Sounds and eastern Marlborough coast, and into North Canterbury. This distribution of direct horticultural evidence is mirrored by the distribution of storage pits, but to what extent this combined evidence is a reflection of site survey coverage is unknown, as large areas (e.g. of the Marlborough Sounds) have not been inspected for sites.

Historically, Captain Cook, on the many visits he made to the Marlborough Sounds during his three voyages, did not report on gardening or evidence of recent gardening, but members of D'Urville's exploring party noted that potato and kumara were being grown on the western side of Tasman Bay in 1827 (Law 1969: 236).

Microclimates and good soils will have been factors dictating where crops were able to be grown, especially in more marginal areas. The possibility that the islands in the northern North Island were particularly desirable, with warmer, frost-free climates, was raised by Edson (1973), who further suggested that kumara could be grown all year round in these locations. Although no climatic data is available to support or refute this claim, it is unlikely that even on these islands the average minimum soil temperature (day and night) is sufficiently high throughout the winter months to encourage tuber growth and maturity. Yen (1969) also dismissed the possibility of two kumara crops a year based on the current climate, but argued that an average temperature of 1–2°C higher in the initial adaptive stage of kumara growing in New Zealand might have been sufficient to extend the growing season.

Predictive modelling of environmental data and archaeological site distribution demonstrates in an empirical way the relationship between certain site types and relevant variables. The implicit assumption of such work is that people chose where to live and carried out certain activities based on consideration of the local environment. Leathwick (2000) compared a range of climatic variables with known pit and pa distributions. There was a high correlation between the location of these sites and warm mean temperatures (14–15°C), high solar radiation, mild winters and dry summers. Soils with limestone, basaltic or andesitic parent materials also correlated well. Predicted rates of occurrence of pits and pa were then calculated. As expected, the highest predicted probability of pits and pa and, by inference, gardening were in the northern North Island. The probability dropped off markedly south of a line from Wanganui to Hawke's Bay. Although such a pattern was already apparent at a broad level from examining the distribution of sites, the model has potential for analysing the relationship between sites and the landscape at a regional level.

5. Archaeological evidence of Maori gardening

Several types of field remains have been interpreted as evidence of Maori gardening. Definitions are taken from the Site Recording Handbook (Walton 1999), with other descriptions added where appropriate. The main types of field evidence include:

- *Stone structures*, where surface stone has been used to construct rows, alignments, mounds and heaps
- *Ditches and channels*, both as shallow parallel lines on hill slopes and as regular series of interconnecting ditches or channels in swampy areas
- *Borrow pits*, where coarse sand or gravel has been removed for inclusion in nearby gardens
- *Garden soils* that have had other materials such as sand, gravel or shell added, or where the natural soil profile has been altered through mixing or artificial deepening
- Other stone structures, such as *stone-faced terraces*, which were often terraces specifically constructed as gardens to retain soil on steep slopes or where soils were thin
- *Taro* locations where wild remnant populations exist

In the following text, each of these site types will be described, outlining evidence from archaeological investigation and any regional variability. This detailed appraisal of each site type, including both representative and unusual features encountered nationally, enables a comprehensive picture to be developed, against which individual sites can be evaluated. This 'defining of the resource' is important in any assessment of site significance. Archaeological research plays a very important role at this level of site description, contributing to the characteristics that allow the site type to be defined in all its variations.

Stone and trench remains have led to an understanding of aspect, details such as plot size and pathways, and preferences for garden sites within local environments. However, it is generally only the unusual features associated with Maori gardening that can be detected in surface remains. In most areas in the North Island, gardening was carried out without the need to add materials to soils, or there was no stone to be cleared from the garden areas. Therefore, for the majority of garden sites, the evidence of gardening is elusive and difficult to identify, let alone interpret.

5.1 STONE STRUCTURES

Stone rows, mounds and alignments are the most visible evidence of gardening in a number of localised areas (Fig. 2). There has been considerable discussion about the purpose of these structures. Was the stone removed from the soil for clearance purposes, or for constructing boundaries and windbreaks, or did the structures themselves function as gardens? The debate is ongoing (McFadgen 1980b, 2003).

Stone structures are found on soils around volcanic cones, on old raised beach ridges, weathered fans, or alluvial terraces and river flats where weathered gravels are exposed on or near the surface. The main areas where stone has been recorded in association with gardening evidence are around the volcanic cones of the Taiamai Plains in the inland Bay of Islands; the central and South Auckland volcanic cone areas; Waipoua Valley; Three Kings, Cavalli, Poor Knights, Taranga, Great Barrier (Aotea), Hauturu/Little Barrier, Great Mercury (Ahuahu) and Moutohora Islands; the Cape Runaway area near East Cape; coastal Wairarapa, including Palliser Bay; D'Urville Island, the Marlborough Sounds and east coast Marlborough; and the north Canterbury coast and coastal Banks Peninsula. There are other sites where the main features are stone heaps and mounds. These generally occur on river flats in a number of areas, such as Hawke's Bay, the Coromandel coast, Auckland and Northland.

Archaeological literature from Eastern and Central Polynesia confirms the use of stone as boundaries between garden plots, and reinforces that such gardening practices, imported into New Zealand, have a long tradition amongst Polynesian horticulturalists (Leach 1976: 134–144).

5.1.1 Stone walls and rows

Walls are defined in New Zealand archaeological literature as 'solidly built, free-standing, and have more or less perpendicular parallel sides' (Walton 1999). Stone rows are described as elongated heaps of stone (ibid). Both features are interpreted as being garden remains, and the terms are often used loosely and interchangeably. An attempt was made in Auckland to differentiate various types of walls, e.g. edged stone and earth walls, and mounded earth and stone walls (Rickard et al. 1983), but this level of detail is often difficult to determine from visible remains. Some of these features do have curbing to confine stones, but they are more akin to rows than constructed, free-standing walls with prepared foundations, and for that reason the term 'row' is used here in preference to 'wall'. These features are most likely to have defined boundaries around plots,

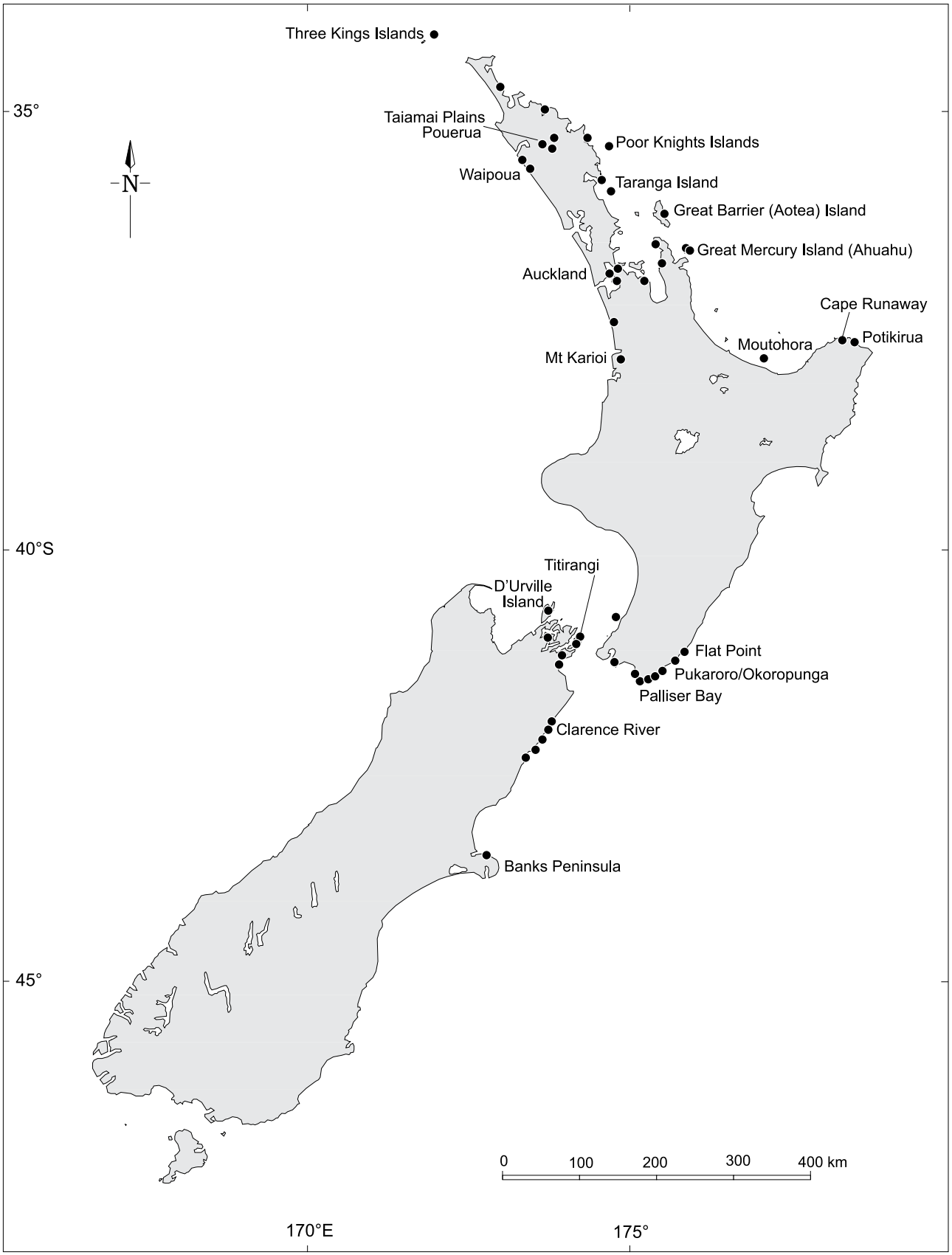


Figure 2. Distribution of recorded archaeological sites containing stone rows, stone mounds, heaps and stone alignments. Each locality represents one or more sites. *Map: C. Edkins, DOC.*

but they also represent the clearance of unwanted stone from gardens, and were possibly also used as wind shelters. These linear stone features (Fig. 3) are present on gravel fans, coastal terraces and platforms, riverine flats, and volcanic soils. They have been investigated in geographically diverse locations, from Clarence River on the northeast coast of the South Island to Pouerua in inland Bay of Islands, Northland.

There are some examples of isolated rows recorded in the NZAA site file, but stone rows are usually found as part of what is called a garden system or garden complex, consisting of multiple parallel stone rows, often covering a large area in association with stone alignments, stone heaps, mounds and occupation evidence, such as shell midden, ovens, terraces and pits. Modified soils or borrow pits may also be present, especially in the southern sites of Marlborough and in some sites in Palliser Bay and elsewhere in coastal Wairarapa. In the Auckland area and at Pouerua in the inland Bay of Islands, this combination of archaeological features can cover hundreds of hectares.

Stone rows and other evidence have been mapped at a number of sites in Palliser Bay (Leach, H.M. 1979a), the eastern Wairarapa coast at Okoropunga (McFadgen 1980b), Pukaroro Maori Reserve and Waikekino. In Marlborough, sites include those at D'Urville Island, Cattleyards Flat (Titirangi) in the Marlborough Sounds (Trotter 1977), Clarence River (Trotter & McCulloch 1979) and at several

Figure 3. Stone row at North Kawakawa, Palliser Bay (S28/79). These features are often low, grass covered, and more visible in low-angled light. *Photo: L. Furey.*

smaller garden sites on the Marlborough coast (Brailsford 1981). In Auckland, there has been extensive archaeological mapping of garden systems—primarily in the remnants of the Wiri-McLaughlin's volcanic field (Lawlor 1981b; Cramond et al. 1982; Veart et al. 1984; Veart 1986; Foster 1988), the East Tamaki stone field of Otara-Green Mount (Foster & Veart 1986; Albert 1987) and at Otuataua near Mangere (Foster & Veart 1985). However, the most comprehensively mapped volcanic garden system incorporates the majority of the volcanic area around Pouerua in Northland, including the pa and open-settlement (kainga) sites. This work provides a unique opportunity to investigate the social dimension of land subdivision hinted at from other volcanic areas in Auckland where only remnants of garden systems survive. The Pouerua map is as yet unpublished.

Stone rows generally appear in a regular pattern, in keeping with the orderliness of Maori gardens reported historically by the earliest European observers. They are parallel or roughly parallel, and may have rows at right angles, which define changes in slope or divisions into smaller plots. These remains of garden systems may be extensive. For example, some in Palliser Bay cover more than 9 ha. The parallel stone rows there are 2–3 m wide and between 400 mm and 600 mm high. The rows extend across the coastal platform from near the coast to the base of the hills. At the Black Rocks garden complex (S28/103) in Palliser Bay, rows are up to 212 m long. Sometimes, the main longitudinal rows are connected by transverse rows or cross-rows, dividing the land into plots, but the long rows were always oriented the same way, probably to allow all gardeners to have equal access to the range of conditions: 'Thus each rectangular strip in a group of apparently contemporary strips contains comparable soils, and no single land user could monopolise the deeper soils of the hollows, while another used only the dry stony ground of the beach ridge' (Leach, H.M. 1979a: 159–160). These boundaries were made up not only of rows, but also of alignments of stones (see section 5.1.2). In some cases, trenches have been found under, or next to, stone rows, or are visible on the surface. Natural topographic features, such as scarps, were also incorporated into the rows to form continuous garden plot boundaries. It is this kind of evidence that provides compelling proof that the stone rows were not merely the result of a convenient place to dispose of unwanted stones, but that they also had important functions in identifying and enclosing gardens.

On the Auckland volcanic fields of East Tamaki and the Wiri-McLaughlin field in South Auckland, the rows commenced not on the coast or older fans (as at Palliser Bay), but on the lower slopes of the volcanic cones. Rows at Wiri radiated out into the surrounding lava field, creating strips or wedges between 25 m and 60 m wide and between 80 m and 300 m long. These strips were sub-divided by rows at right angles to the main rows, forming plots of 250 m^2 or more (Sullivan 1974). While the general intention may have been one of straight lines, in reality the rows and alignments followed natural topographic features, incorporating natural rock scarps and outcrops into the line (Fig. 4). Where there were no impeding natural features, the tendency was to form rectangular plots (as at Palliser Bay). The boundaries became more irregular with increasing distance from the cone, reinforcing the suggestion that they originated from the very regular zone around the base of the cone itself (ibid). Green Mount in East Tamaki displays a similar pattern of rows radiating out from the cone, becoming more haphazard with distance from the cone. Veart (1986: 231) attributes this

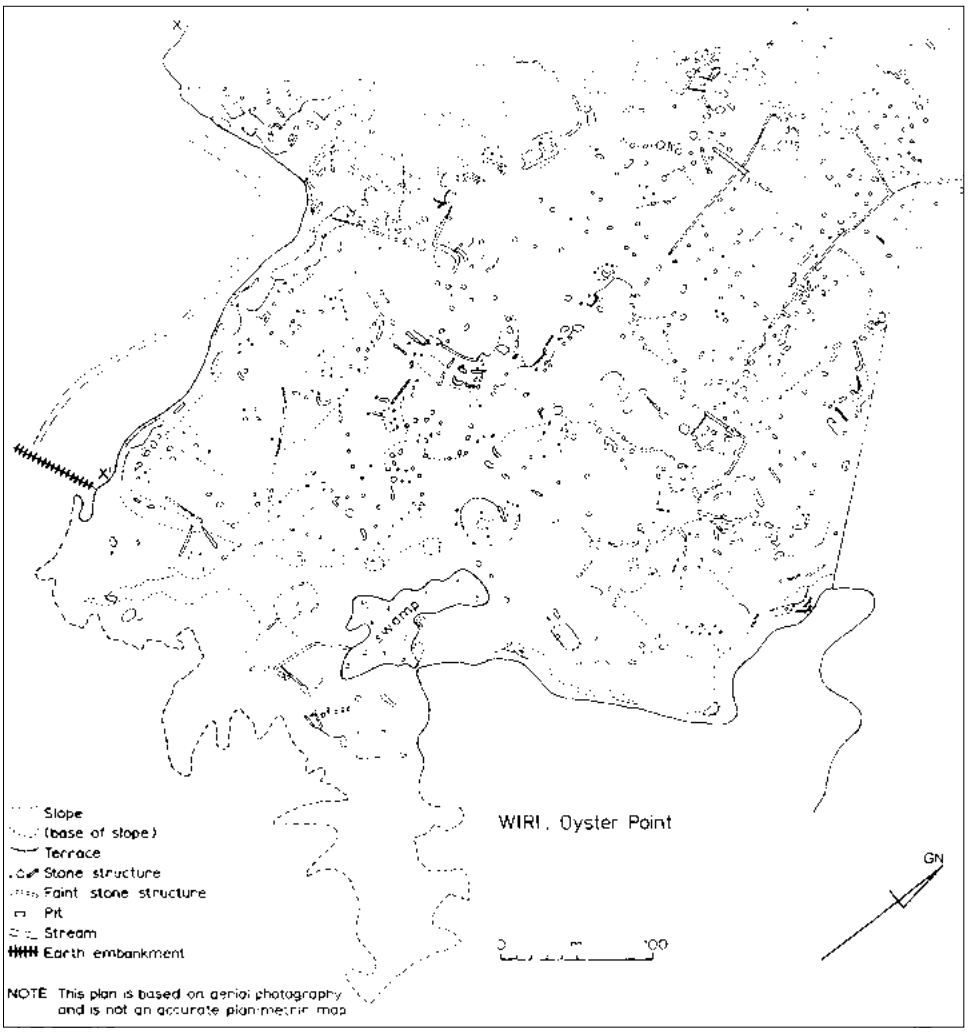


Figure 4. Part of the stonefield garden area at Oyster Point, Puhinui (R11/25), South Auckland, associated with the McLaughlan Mt/Matukureia Paa area. The Puhinui Creek, which flows into the Manukau Harbour, forms the boundary to the west and south. Archaeological excavations were carried out at this site by Ian Lawlor in 1981. *Anthropology Department, University of Auckland; mapping by A. Sullivan.*

to the unevenness of the terrain on the lava fields creating difficulties for Maori gardeners attempting to continue straight lines unimpeded by barriers. At both Wiri and Green Mount, aerial photographs show that there was an overall radiating division based on rows, but within these units there were longitudinal row divisions of parallel rather than divergent orientation. It is now difficult to resolve what the original shape of these land units may have been, since only remnants of the Auckland complexes exist.

Stone rows covering an area of 2.5 ha at Cattleyards Flat (P26/217) in the Marlborough Sounds give the impression of enclosures rather than strips of land, and right-angled rows may form the front edges of terraces or changes in slope (Trotter 1977; Brailsford 1981). These are unusual, and a similar configuration of rows has not been recorded elsewhere on the Marlborough coast. At Clarence River, the longitudinal rows, over c. 5 ha, are definitely parallel in orientation, with only a few rows sub-dividing the longitudinal space. Rows at three sites in Wairau Bay in Marlborough, including Robin Hood Bay and Rough Paddock, are also parallel (Brailsford 1981).

On the northern offshore islands, the stone row systems are smaller than at the mainland sites described above, and many have short rows that may also be interpreted as elongated heaps. Some larger garden complexes exist on islands such as Great Barrier (Aotea) and Great Mercury (Ahuahu).

The majority view of archaeologists, based on the evidence, is that the rows and other stone features were the result of the need to clear stones from the garden soils. However, Helen Leach (1979a) contends that stone rows and stone alignments were constructed primarily to define garden plots and land ownership, a view supported by the use of trenches and single stone alignments as boundaries. Natural boundaries were also used, where appropriate, for garden divisions, and stones were only gathered up where they hindered land use.

Since the rows are in a regular pattern, enclosing land in rectangular plots, it has long been assumed that the soils inside the rectangles or between the rows were gardened. Stone heaps enclosed within the rows were the result of stone clearance. McFadgen (1980b, 2003) suggests an alternative interpretation for stone rows, based on his research at Okoropunga in eastern Wairarapa. He argues that the stones used in row construction were taken from borrow pits on the crest of beach ridges rather than from the area between the rows. An excavated section through a row showed that the soil profile within the feature was thicker and darker than the surrounding ground, leading to speculation that the rows themselves were gardens rather than the intervening space. A second line of argument—that the soils between the rows had not been modified by the addition of gravel and sand, were not uneven like nearby modified soils, and did not have thickened topsoil depth—was used to support the view that the space between the rows had not been cultivated. However, given that rows tend to be regularly spaced, are oriented in a particular direction in relation to the sea and the hills, and, in some excavated examples, have earlier and less permanent trench boundaries underneath, are continuous with stone alignments and incorporate not only stones but charred wood and branches, twigs and occupation debris, strongly suggests that their primary function was that of delineating garden space, as appears to have been the case in garden systems in other regions. In addition, if the rows themselves were gardens, they should be more closely spaced to maximise the area of garden in production. The rows may, however, have served the secondary purpose of windbreaks and shelters for plants. Windbreaks were, from historic accounts, important features of Maori gardens. The notion of delicate wind-sensitive plants being grown on rows in the most exposed situation is counter to all known literature on Maori garden practices.

Most of the stone incorporated into rows was present on the surface or within the depth of the garden soil, but this is not always the case. For instance, the Black Rocks garden complex in Palliser Bay has rows on old fans and on sand-mantled, earthquake-uplifted beach ridges. Towards the lower end of the rows, some of the stones are beach cobbles derived from the beach rather than the fan (Leach, H.M. 1979a). At Okoropunga, the stone rows are on sand-mantled beach ridges where there is little or no stone present on the surface, yet beach cobbles have been dug out from beneath the surface to form the rows (McFadgen 1980b). These two examples strongly support the case that rows are not merely the result of clearing stones from the soil.

Few long profiles through gardens and across rows have been published or, indeed, investigated (Fig. 5). It is, therefore, difficult, in the absence of section drawings showing the depth of soil horizons, relative density of stone in different parts of the garden, and distribution of materials added to the soil, to dismiss one or other of the opposing interpretations. To progress the debate further, it would be useful to examine both stone rows and soil in the open space between rows for distinctive microfossils to indicate where crops were grown.

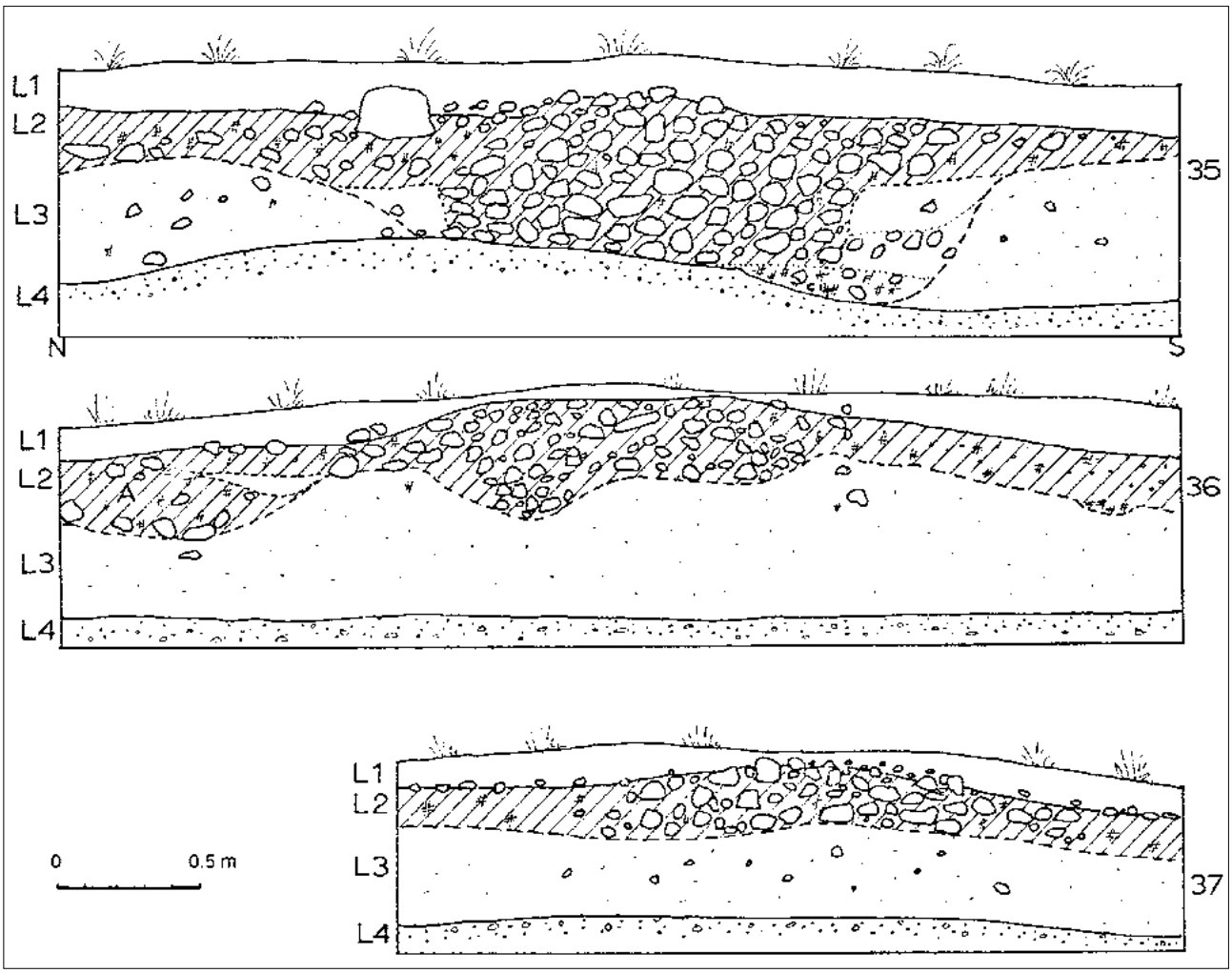


Figure 5. Sections through stone walls, North Kawakawa, Palliser Bay (S28/79). In the upper section a trench was dug into the natural 'C' horizon, filled in, and redug with straight sides into which the stone row was constructed. In the middle figure, the topsoil has been artificially deepened on either side of the row. The lower section shows the concentration of stones within the cultivated L2 soil. *After Leach, H.M. 1976: figs 35–37.*

Some rows in Palliser Bay may have been constructed as early as the mid-14th century. It is believed that environmental deterioration and cooler climatic conditions may have led to the abandonment of gardens on the coastal platform in Palliser Bay by the 15th century (Leach, H.M. & Leach, B.F. 1979; McFadgen 2003). This part of the Wairarapa coast is extremely exposed, receiving both north-west and southerly winds; thus, vegetation regrowth necessary to replenish the soil during the fallow period would have been slow and patchy. Rows at Clarence River have been dated to between the 15th and 17th centuries, while those at Cattleyards Flat at Titirangi, Marlborough Sounds, were constructed in the 16th to early 17th centuries (Challis 1991). Similarly, the dates from the Auckland volcanic fields indicate row building and garden division from the 15th century (Lawlor 1981b,c), but the majority of field evidence from the Wiri-McLaughlin's complexes is slightly later (Bulmer 1987). There is no direct evidence for when row construction began at Pouerua, but forest clearance, assumed to be related to agricultural development, began in the 15th century, and repeated occupation of the Pouerua cone and the smaller sites within the volcanic field suggests that gardening was an ongoing activity over several hundred years (Sutton et al. 2003).

Garden systems based on stone rows are highly visible and can be mapped and interpreted at a general level, but are only a variant of gardening. The use of stone was not a technique especially developed for marginal areas, although there may have been advantages derived from using stony soils, perhaps leading to higher yields and more reliable and consistent harvest results.

5.1.2 Stone alignments

Stone alignments are lines marked out on the ground by stones, generally not more than one course high. These are likely to be boundaries or plot delimiters in the same way that rows and trenches are. However, at the South Pararaki complex in Palliser Bay, an alignment ran parallel to a row and followed its orientation exactly, to the extent of turning a right-angled corner. Excavation revealed a posthole and paving in the space between the alignment and the row, and it was interpreted as marking out a footpath around the edge of the garden (Leach, H.M. 1979a: 148). A similar feature is described from the Cattleyards Flat site in the Marlborough Sounds (Brailsford 1981). After rows, alignments were the second most common feature of the garden systems at Palliser Bay, and feature prominently at the Washpool garden site. In several instances, single stone alignments were a continuation of stone rows. This was attributed to the absence of stone in silty soils compared with the more stony soils where rows were present (Leach, H.M. 1979a).

5.1.3 Stone heaps

Stone heaps are piles of stones of various sizes that may be faced with carefully placed larger stones. Walton (1999: 60) identified heaps associated with Maori gardens as having small stones, being regular in shape and having had some care taken in their construction. They contain no soil. In addition, the heaps are often located on waste ground. In contrast, heaps made during European land-clearance practices tend to comprise larger stones and be constructed in an irregular fashion.

5.1.4 Stone mounds

Stone mounds are interpreted as being more structured than heaps and often have soil incorporated into them. Mounds may have a stone curbing around the base and have smaller stones in the core. In the archaeological literature, the terms 'stone heaps' and 'stone mounds' have been used interchangeably, but work focusing specifically on these features during the 1980s' investigations of the garden systems of South Auckland has indicated that there are differences between them (Coates 1992). Mounds have a distinctive rock and soil core covered with, or surrounded by, small rocks (Fig. 6). Challis & Walton (1993) defined heaps at Pouerua as being structured piles using larger stones on the outside and smaller stones in the core. In contrast, mounds were defined as low piles with larger stones forming a perimeter and often containing a large quantity of earth. They suggested that heaps, which contain more stones, may represent the first attempt at stone clearance, and mounds may have been the result of a second level of clearance or may have functioned as gardens. A classification of mounds has been attempted based on plan, cross-section and composition (Rickard et al. 1983), but it is the internal composition that is important (Coates 1992), and this cannot always be ascertained from surface features. Mounds may also be fragmentary or dilapidated rows (Sullivan 1974).

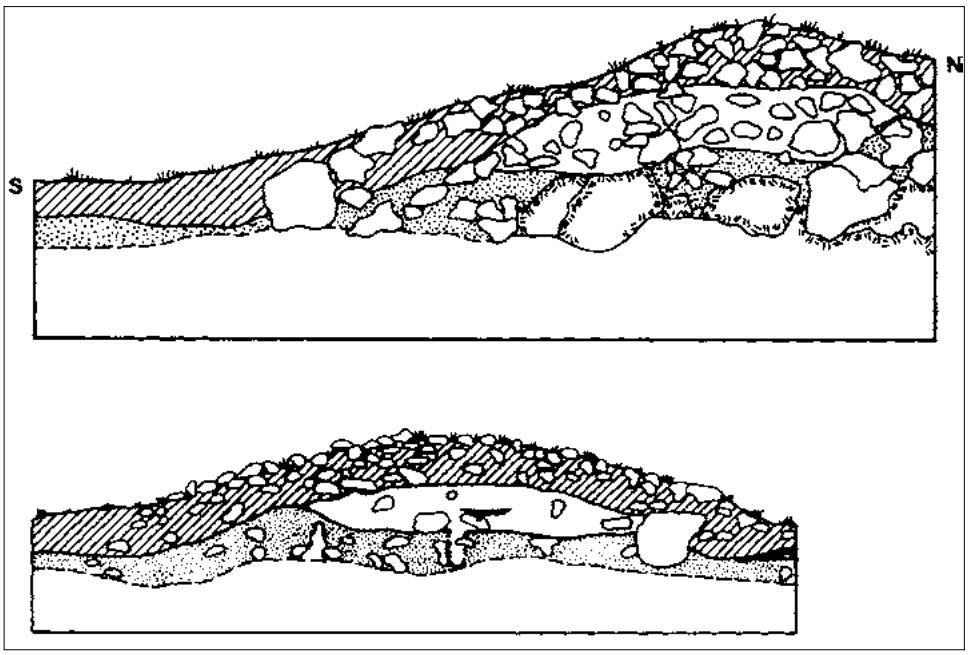


Figure 6. Cross-section through stone mounds, Wiri Railway site (R11/1188), Auckland. The upper mound, 937, had a capping of small stones over a dark reddish-brown friable soil resting on natural subsoil into which large rocks were embedded. The lower mound, 942, also had a rock capping. The dark layer inside the mound contained fragments of shell and charcoal which were not encountered in other mounds. There was also a posthole in the centre of the mound. *After Coates 1992.*

The distinction in terminology for mounds and heaps, and for walls and rows, may be unnecessary at the level of site recording, unless it is clear to the site recorder that a stone mound contains earth and has a structured form. It is important, however, to be explicit in how the individual terms are used.

Use of stone and earth mounds has not been part of the historically recorded Maori gardening practices in New Zealand. There are, however, several references from the inland Bay of Islands of garden areas being cleared of stones, which were then formed into heaps (Wilkes 1845: 372; Best 1976: 127). The earth and stone mounds are distinctly different from the low earthen mounds (called puke) associated with kumara.

The presence of single postholes in mounds at Wiri (Coates 1992) and in one mound in the Cross Site at Palliser Bay (Leach 1984: 42) lends credence, in at least some instances, to the interpretation of mounds as garden features and not just piles of stone. The posthole possibly represents a post or stake support for the gourd vine. The function of stone mounds was first suggested by Sullivan (1974), to account for the large numbers of structured mounds on flat land, where their appearance could not otherwise be accounted for. Without further elaboration, Sullivan interpreted these as gourd gardens, although there was acknowledgement that this explanation was not convincing.

Stone mounds are most commonly associated with stony soils on volcanic fields, and can be present in large numbers. In the garden systems of Auckland, very high densities of mounds have been recorded within small areas at Wiri Railway site (R11/1188) and at Harris Rd (R11/1301) in East Tamaki. It has been estimated that there may originally have been up to 10 000 stone mounds in the c. 280 ha of field remains at Wiri in South Auckland (Sullivan 1974: 128). Similarly, at Pouerua in the inland Bay of Islands, concentrations of mounds have been identified (Fig. 7). For example, clusters of mounds as close as 400 mm apart were recorded at P05/681. Heaps of larger stones were also recorded at this site. There was also a high density of mounds at the Washpool Cross Site in Palliser Bay, leading B.F. Leach (1979: 120) to comment that there was very little space between them.

Figure 7. Aerial photograph of part of the stonefield garden area around Pouerua Pa (P06/5), Northland, showing large numbers of stone mounds. *Photo: K. Jones, DOC.*

At the Wiri Railway site, 8 of the 14 mounds excavated had earthen cores of friable loam (Coates 1992). One of these mounds (measuring 2.5 m × 2.2 m × 0.4 m) was estimated to contain 640 L of soil and 800–900 rocks. Two of the excavated mounds had shell fragments incorporated into their earthen core, but there was no shell in the surrounding soil. No evidence was found of gardening between and around the mounds.

After experimental work relating to soil temperature, soil moisture and chemical analysis of the soil, Coates (1992) concluded that there were strong grounds for interpreting mounds with inner soil cores as deliberately constructed garden features within which crops were grown. Soil in the mounds was found to be consistently warmer than the surrounding flat land. However, when there was a substantial drop in air temperature, all soil temperatures, regardless of location, also dropped rapidly, perhaps limiting the perceived advantage of using these structures in more marginal areas where rapid temperature changes are more likely to occur (Coates 1992: 59).

There may have been good reasons for growing plants in elevated stone structures, especially in Marlborough, where the climate was marginal for gardening. Temperatures would have been higher within the mounds and cold air would have drained down and away from the plants, reducing the likelihood of frost damage (McFadgen 1980b). However, they are not a common feature in gardens in more climatically marginal areas. In Marlborough, mounds are only reported from the Cattleyards Flat and Robin Hood Bay sites, and they are not abundant in Wairarapa sites either. While there are concentrations of small stones at Clarence

River, the excavation of one revealed a heap containing no soil (Trotter 1977). The excavated mound at the Cross Site in the Makotukutuku Valley, Palliser Bay, had a high soil content amongst the rocks, which was interpreted as a growing medium that would have provided a deeper soil profile than the thin underlying soils (Leach, H.M. 1979b: 242).

As to which crops might have been grown in these soil-filled mounds, again only inferences are possible. Archaeologists in New Zealand have favoured gourd (Leach 1984). Use of high-resolution investigative techniques to look for pollen, phytoliths and starch grains in soil could potentially help answer this question. Traces of gourd pollen have been found in soil samples from a small mound at Pouerua, inland Bay of Islands, suggesting that gourd plants may have been grown on or near the mound (Horrocks et al. 2000). Kumara starch grains and xylem cells have also been detected in the same mound at Pouerua, and also at a mound at Puketona, the adjacent volcanic stone field to the east of Pouerua (Horrocks 2004). In each case, the mound was a similar form to that described above from Wiri, having an outside curbing of large stones and an inner core of earth. However, pine (*Pinus radiata*) pollen was also found at all levels within the Pouerua mound, which raises questions about the ease with which pollen grains can infiltrate and contaminate layers. However, the presence of pine pollen may also indicate that the mound was constructed in historic times. Further controlled work is necessary to understand why pollen from both pine and gourd, and kumara in traces, was present. The two most likely explanations are that either the soil profile was contaminated through infiltration, or older garden soils were redeposited in a more recent (historic) feature.

5.1.5 Stone facing

Stone facing may retain the front edge of artificial terraces. Such features are particularly common on islands, and are often associated with stone heaps. Terraces with stone facings may have been used for residential purposes, and some do have evidence of houses and midden; however, many are large, with rows, alignments or heaps placed on them, and are likely to have been used for gardens. No excavations have been carried out on these features on the islands. These sites are confined to the upper part of the North Island and northern offshore islands (Table 1).

5.2 DITCHES AND TRENCHES

Ditches and trenches occur in various situations and probably had more than one function, according to local and regional conditions. They can be divided into two broad types according to location and arrangement (Fig. 8). Although these features are referred to as ‘ditches’, ‘channels’, ‘drains’ and ‘trenches’ in the literature, the terminology does not imply a particular function. It is unlikely that the linear, parallel depressions on slopes were intended to conduit water to, or away from, garden areas. Instead, they probably functioned in a similar way to fences, or to parallel stone rows, and partitioned gardens into individual plots, although a drainage function cannot be ruled out. In contrast, the ditches in swamp areas of Northland may have channelled water away from gardens and controlled the flow of water from sources such as springs. For consistency, and

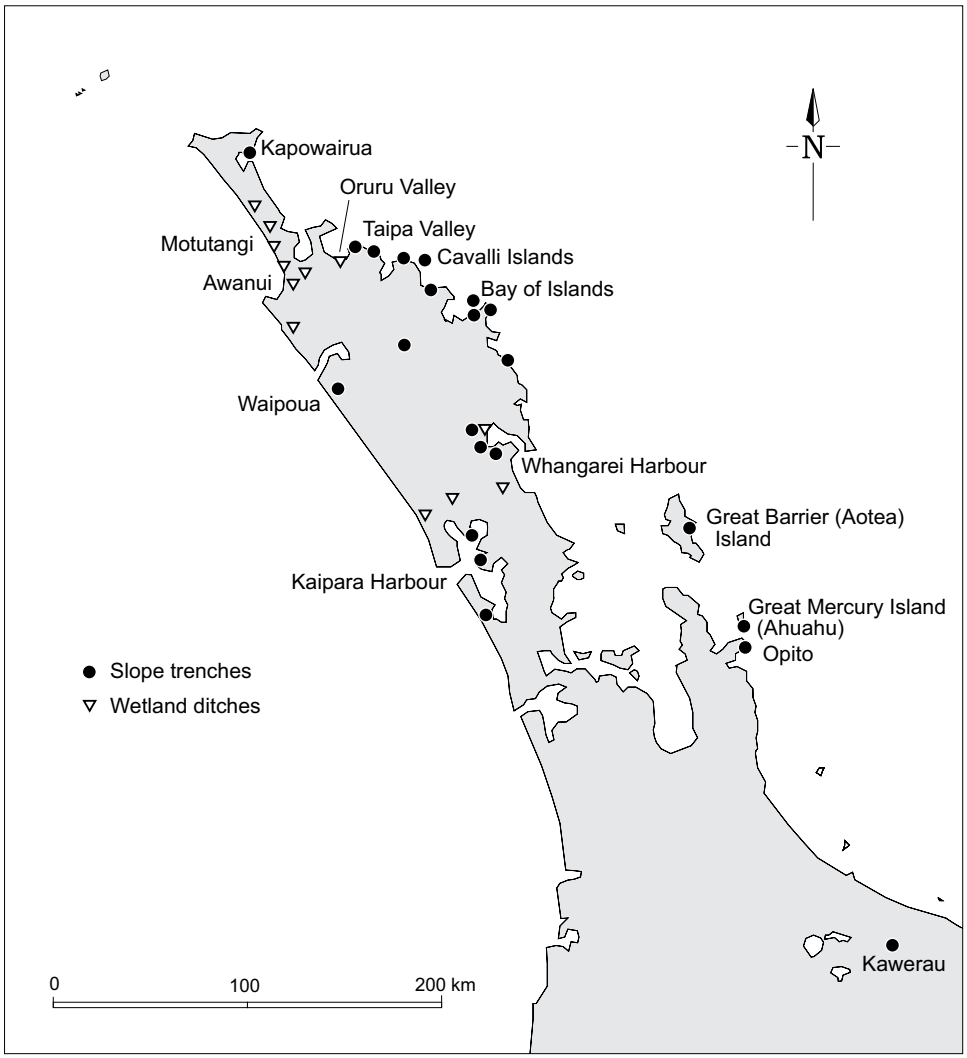


Figure 8. Distribution of recorded archaeological sites with slope trenches and ditches.
Map: C. Edkins, DOC.

in keeping with terminology used for boundary divisions in the Wairarapa, in the following discussion the term 'trench' is used in relation to those features present on slopes and on flat land. 'Ditch' is used in relation to those features in swamps and on poorly drained land.

Within the NZAA site records, there are references to large and wide ditches in swamps, which could have been canoe portages, or for trapping eels, fish and ducks (e.g. those at Bulls in the Manawatu, and at Wairau in Marlborough). Other smaller connecting ditch systems are most likely related to gardening, and comprise many interconnecting channels on wet or poorly drained land. They are confined to Northland (Barber 1982, 1989a,b, 2001).

Other evidence takes the form of shallow, parallel trenches on slopes. These are more widespread, although the majority of the recorded sites are also in Northland. They occur on slopes varying from gentle to steep, on terraces and flats at the base of slopes, and in river valleys. These features are generally considered to demarcate garden plots (Nicholls 1965). Although Peters (1975: 178) agreed with this interpretation, he suggested that in some cases they may also have channelled surface water away from the garden area, and he cautioned that '…each field system must be looked at and interpreted in relation to the pattern it forms and its physical location'. Peters queried whether the term ditch was appropriate, and suggested that the linear features at Moturua Island, Bay of

Islands, were the result of soil being scooped up to form a raised ridge. However, there is no evidence for this archaeologically. Cross-slope trenches linking to the main down-slope linear trenches also occur at some sites, but these are not common, and in some instances have been interpreted as relating to more recent (historic) gardening activities.

These ditch-and-trench features are often difficult to see and they may be severely under-represented in the records: because they are shallow (usually less than 500 mm deep) and narrow, they are vulnerable to erosion and infilling, and on flat land are destroyed by ploughing and intensive European land-use practices. Often they are only visible when seen from a distance in particular light conditions, and under close-cropped pasture grass. Walton (1982b) has queried whether the implied association of these features with Maori gardening may be misleading, as plough lines can leave similar evidence. Although this explanation has merit in highlighting that surface evidence may have other origins, especially when on gently rolling or flat ground, the majority of the recorded features of this type are on steep slopes or poorly drained ground that has never been ploughed. The fact that these linear features have a very narrow geographical distribution reinforces that they are largely Maori in origin. Ploughing lands are more likely to have made a significant negative contribution to the survival of the Maori horticultural evidence rather than added to the quantity of sites recorded.

Barber (1982, 1989b) used the term 'ditch' and identified several types in Northland. His classification system also recognised features made by gum diggers, plough lines and recent land drainage. Eel weirs, duck traps and canoe portages were also incorporated. Four classes of site associated with Maori horticulture, and separated by the steepness of the land, were recognised:

- Steep-slope ditches associated with gardening
- Ditches on gentle slopes associated with gardening
- Boundary divisions on dry and level ground
- Wetland ditches and canals associated with cultivation

Examples of each of these types are present in the site records. Barber (1982, 1989b) assumed that the first two categories were multi-functional, serving as garden plot boundaries and to channel water. The third category acted as boundary divisions only, and the fourth was for drainage or reticulation ditches only. The separation of the first two categories may be arbitrary and unnecessary, as there is considerable overlap in possible function, as will be seen from the following discussion.

5.2.1 Steep-slope trenches

Steep-slope trenches, which are generally parallel (Fig. 9) or occasionally converge, occur on slopes with a gradient of over 15°, and on clay and clay loam soils. Barber (1989b: 28, 30) suggested that gardening on hillslopes had certain advantages, including being elevated above cold air in valley bottoms and having better drainage. However, in coastal parts of Northland, where this site type predominantly occurs, air temperature is unlikely to have been a major consideration affecting the development of slope gardens. Barber also argued that these slope trenches may have been constructed to manage erosion, by channelling slope run-off in areas subject to heavy downpours. A similar view is held for evidence in the Oruru Valley, Northland (Johnson 1986).

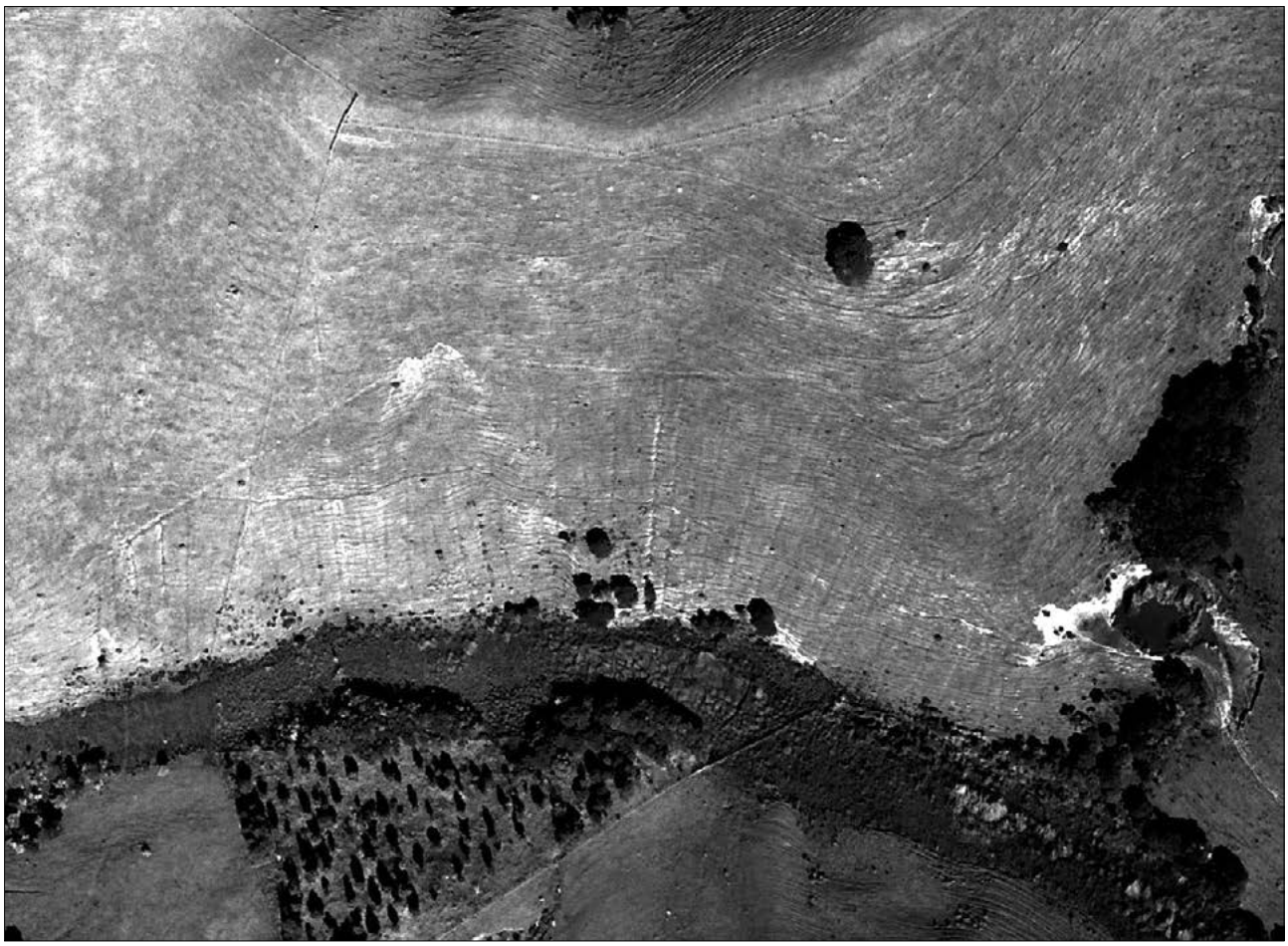


Figure 9. Aerial photograph of parallel slope trenches near Marsden Cross, Bay of Islands. *Photo: K. Jones, DOC.*

Well-known examples of slope trenches in Northland include those on steeper slopes at Tupou Bay on the east coast (Nicholls 1965; Jones 1994: 100–101), Marsden Cross and Rangihoua in the Bay of Islands (Spencer 1983; Jones 1994: 70), and Limestone Island in Whangarei Harbour (Q07/530).

Two systems of slope trenches have been investigated on Moturua Island. During excavations on Paeroa Pa in 1964–65, Groube (1966) uncovered trenches on the south-facing slope below the pa. This site (Q05/44) was in Hahangarua Bay. During further excavations at the same site in 1968, two modified soils containing shell and shingle from the beach were reported (Peters 1975). Trench-like features were cut into the later modified soil on an estimated 20° slope. The four trenches illustrated were 12 m, 9 m and 6–7 m apart. Two of them converged part way down the slope to form one trench. These features are not described in any detail and illustrated stratigraphic sections are not at a sufficiently large scale to establish whether the trenches were associated with the modified soil or post-dated it. If they post-date it, as suggested by Peters (1975), then they are unlikely to be horticultural in origin, as the modified soil was covered by modern topsoil rather than further garden-related deposits. Charcoal from the upper modified soil was radiocarbon dated to 510 ± 70 BP (ANU 543; Peters 1975), with a 95% probability that it was laid down before AD 1630. A similar result for the layer was obtained by Groube (1966; see Appendix 2). If the trenches were later than the soil, then the soil date gives a lower-end

range for indication of age. If contemporary, the soil and the ditches could have been in use any time from the late 13th century to the early 17th century. More recent investigations have been carried out in the adjacent Opunga Bay at site Q05/46 (Johnson 1997). This was the location of Peters' (1975: 176–177) other investigation on the 'flat area behind the beach', where a modified soil was revealed. Johnson estimated that the soil covered c. 0.7 ha, extending from the lower hillslope and across the beach flat. Nine parallel trenches were detected on the slope south-west of the beach flat. The widths of the features varied from 0.53 m to 0.90 m, and depths from 0.30 m to 0.78 m. Distances between trenches were generally 16–17 m, although two trenches were 9 m apart. One trench extended for about 40 m downslope. None appeared to continue onto the coastal flat at the base of the slope. An age estimate on pipi (*Paphies australis*) shell within the soil indicates that it was constructed in the 16th–17th centuries (Johnson 1997: 35). See Appendix 2 for radiocarbon results.

5.2.2 Trenches on gentle slopes

Trenches occurring on gently sloping or well-drained flat land are on clay loam, silt loam and alluvial soils. These trenches differ from those on steeper slopes in that they often have transverse trenches that break the land up into rectangular or square plots. At some sites, systems with connecting trenches may be adjacent to an area of parallel steep-slope trenches and, in fact, may be a continuation of these, as at Tupou Bay (Nicholls 1965). This suggests that the separation of trenches into two categories based on slope does not match the continuous relationship observed archaeologically. Other examples on flat ground include those in the Oruru Valley (Johnson 1986), Waipoua Valley on river terraces associated with stone heaps and stone-faced terraces (O06/169), Q05/119 on Urupukapuka Island, and many others in northern coastal areas (Barber 1982). Some of these sites are in association with peach and fig trees, or with ditch-and-bank enclosures (e.g. O04/284), indicating that they are historic in age.

Within this category, several different functions or overlapping functions are implied from the surface evidence. These include diversion of surface water away from gardens, and reticulation of water to flatter areas for specific crop requirements. This latter interpretation implies that taro (the only moisture-tolerant cultigen) was grown on the flat, and kumara on the slopes; however, this may be a simplistic explanation. Examples of water diversion include systems with cross-ditches on the upper slope.

Archdeacon Walsh (1902: 15) provides further explanation of the function of these shallow trenches: 'In the case of clay lands, especially those on the river-flats, drainage was necessary, and, where possible, surface channels were made before the winter rains set in, as a prolonged exposure to water not only retarded the spring operations, but had the effect of "souring" the soil and making the work of cultivation more difficult. On the old cultivations the cleaning-out of these drains was the first thing to be attended to as the planting-time approached'. He was referring to the growing of kumara, and reporting historic practices, but there is field evidence recorded, tentatively identified as historic, to which this function might apply.

Trenches on flat land generally have well-defined origins (or exits) at either stream banks or scarps above beaches, progressing upslope to finish at irregular

distances. This pattern was also observed with the stone rows at Palliser Bay, leading H.M. Leach (1979a: 155) to conclude that gardening started on the flat and extended for uneven distances up the slope in each strip.

5.2.3 Trench boundary divisions

Although water or erosion control may be one reason for the presence of trenches on some sloping sites, in other places on gentle slopes or flat land, such as on sandy loam flats behind beaches or on volcanic soils, drainage was not an issue. At Pouerua, there are examples of slope trenches joining longer trenches in valley floors, and parallel trenches up to 300 m long that cross knolls and ridges in the lava flow (Fig. 10). Short, transverse trenches occur in the space between the long trenches (Phillips 1980). Given the free-draining nature of the volcanic

Figure 10. Aerial photograph of shallow trenches as boundary divisions, Pouerua, Northland. Deep ash mantles the landscape on the eastern side of the volcanic cone. In the absence of stone, the trenches outline the garden plots. *Photo: Anthropology Department, University of Auckland.*

soils at Pouerua, and the fact that these trenches cross over knolls, they are unlikely to have had a drainage or water-channelling function. Rather, they can be interpreted as garden boundaries, perhaps doubling as footpaths around the edges of gardens.

Profiles through stone rows at North Pararaki in Palliser Bay revealed trenches underneath rows and may have been the initial boundary marker lines constructed prior to the more permanent stone rows (Leach, H.M. 1979a: 159). Parallel lines of trenches also occur at Pukaroro Maori Reserve and at Okoropunga on the Wairarapa coast; however, these are not like the Palliser Bay examples, which seem to be related to the rows themselves. At Panau on Banks Peninsula, a complex of parallel lines on a north-facing slope consists of low linear ridges in association with stone rows. Profiles through several of these indicated that they were not well-defined, and the features could be interpreted as being low earthen ridges or slight linear depressions (Jacomb 2000: 98). The southernmost recorded instance of the parallel down-slope raised linear ridge site is at Flea Bay on Banks Peninsula.

5.2.4 Wetland ditches

Wetland ditches in poorly drained or water-logged soils (Fig. 11) were first described in the 1920s, and were attributed to the drainage of swamps by Maori for horticulture (Wilson 1921, 1922). A similar system was described for the Kaipara Flats (Harding 1928). A large area of interconnecting ditches covering 125 ha has been recorded at Awanui near Kaitaia (Barber 1989a), and in the Oruru Valley (Johnson 1986). A similar system exists at Lake Tangonge, also near Kaitaia.

Barber (1983) mapped the large ditch complex (N03/638 and 639) at Motutangi near Houhora, which covered over 47 ha. Parallel lineal ditches and shorter cross-ditches enclose plots of land. The land is not flat, but the slope gradient is generally below 15°. The surviving part of N03/639 covers more than 7.7 ha, with a cumulative ditch length of over 6 km. Ditches were up to 500 mm deep and less than 500 mm in width. Soil excavated during ditch construction was heaped onto adjacent plots; this may be evidence of raised beds (Barber 1983), or may merely reflect the need to dispose of spoil efficiently and with the least effort. Radiocarbon dating of peat from above the bases of two ditches at Motutangi indicates that they were no longer in use by the mid-17th century at the latest (Barber 1989b: 39–40). Although drainage of water was the most likely function of the ditches, Barber (1983: 123) proposed that because the plots were concentrated in the wettest area of the swamp, the intention was also to redistribute water from natural springs through the ditch system and to irrigate the soil. After eliminating kumara, due to its intolerance of excessive moisture, and using traditional history from the area, Barber (1983) concluded that taro was the plant most likely to have been grown there. However, taro is not known to have been grown in wetland conditions in historic times and none of the early observers referred to the use of irrigated ditch systems. In New Zealand, taro was only ever observed growing in dryland situations throughout Northland and further south to Poverty Bay, although wetland taro cultivation was widely practised in Polynesia.

Figure 11. Parallel drainage channels on the valley floor, Northland. *Photo: J. Coster, NZ Forest Service records.*

Swamp ditch systems in the Oruru Valley, draining into Doubtless Bay and to the east of the Awanui River, are also extensive (Barber 2001). The field evidence at these locations has been interpreted as representing a hierarchy of ditches, with the land divided up into units and sub-units by ditches of different sizes and orientations (Johnson 1986: 156–157). Like Barber (2001), Johnson (1986) considers taro to have been the crop grown in these garden systems. Site O04/580, an extensive site at Waimutu Swamp, Taipa, was investigated by Johnson in 1990. No report is available.

Kumara, while preferring moist soil in early spring and late summer, does not like excessive moisture and is, therefore, less likely to have been grown in these gardens. Kumara will, however, produce tubers provided the water table is not less than 500 mm from the surface (Worrall 1993: 4). Soil temperatures need to be above 15°C (or 21°C in early spring) for root development to take place (Coleman 1972: 21). It is possibly only in Northland that this high a temperature could be achieved in moist soils during the early part of the growing season.

Microscopic analysis of sediments from the area between ditches at Motutangi indicate that taro, yam (specifically *D. alata*) and possibly also kumara are present. Starch grains of taro were also found in sediments from within a ditch (Horrocks & Barber 2005). While this reinforces Barber's view that taro was grown in the swamp systems, the possible presence of kumara provides another

dimension requiring further explanation. Colenso (1880) stated that kumara was always grown alone, and none of the historic accounts refer to mixed plantings of kumara with another crop.

There is potential for further research on soil temperature within ditch complexes in early spring to determine the viability of kumara (and yam) in seasonally wet soils. Kumara does well in fertile soils, and the Ruawai flats at the northern end of Kaipara Harbour, which were previously poorly drained peat soils, are one of the most important modern kumara-producing areas. Drainage, in this instance, is achieved by deep modern drains, quite unlike the shallow features found at Motutangi.

The majority of swamp drainage systems are concentrated in the Far North area (Fig. 8). In addition to those examples mentioned above, archaeological evidence has also been recorded at Houhora and Taumatawhana near Te Kao. Isolated examples of swamp drainage systems further south include those at Ruawai, Waipu, Parakai, Great Barrier (Aotea) Island and reputedly at Mercury Bay on the Coromandel Peninsula.

There are no known historic accounts of trenches on slopes and few references, all lacking any detail, for trenches on river flats. At Kapowairua, in the Far North, members of the French expedition in April 1772 described a disused cultivation on the river flat: '…every ten paces there are to be seen little canals for water to flow along. The grass grows very tall there, sure proof of the goodness of the soil' (Ollivier & Spencer 1985: 131). A similar account from a member of Cook's party, who noted that the river flats at Tolaga Bay had 'drainage ditches around the cultivations' (Salmond 1991: 175), suggests that the practice of draining water from the ground was more widespread than the archaeological records would indicate. A similar site was recorded near the Maraetaha River south of Gisborne, but like the Tolaga Bay example, it has not been confirmed in the field.

The descriptions of trenches are diverse, and their functions are likely to be equally so. Few trench features have been investigated and nearly all interpretation is based on surface evidence. There is an implication that an important function was to remove or channel water (e.g. Barber 1982, 2001; Jones 1994). However, this was obviously not the case at Pouerua, where the features can be interpreted as delineating land plots, perhaps having a dual role as footpaths through the gardens. Multiple functions have been suggested to account for the evidence at other sites. Excavations at Q05/46 at Opunga Bay on Moturua Island revealed what might have been a garden trench dug into natural deposits and buried by a modified soil. This trench is not apparent in section illustrations, although it was reported as being 540 mm deep (Peters 1975: 177). Its location suggests that it may be part of the site excavated by Johnson (1997: 42), but the stratigraphic interpretation provided by Peters (1975) does not support this. Johnson (1997) considered that the trenches had a dual function as plot boundaries and to channel water away during periods of heavy rainfall, supplementing the drainage function of the shell and gravel additives to the clay soil. Jones (1994: 66, 70) added to the debate by suggesting that the trenches were the taro beds and that the upper ends of the trenches were used to accumulate water for use by

plants grown at the lower end of the slope. He further suggested that using the trenches as taro beds allowed the area in between to be used as kumara gardens. There are several objections to this explanation, however. Taro can grow in dry conditions, a fact which is reinforced by the historic accounts of taro growing without access to water (Colenso 1880). Furthermore, the channelling of water downslope in heavy rainfalls would serve to scour out soil from around the taro tubers at the lower end of the slope and, even if taro was grown at the lower end of the trenches, the trenches seem unnecessarily lengthy for the purpose.

Trench and ditch features are concentrated in Northland, an area subject to year-round rainfall. This contrasts with other areas further south (e.g. East Coast and Hawke's Bay), which experience seasonal rainfall with a summer and autumn minimum. Historic accounts frequently referred to gardens being planted high on slopes. The majority of these were successful without resorting to the use of trenches either as garden dividers or for some other function related to soil moisture or rainfall. It is possible that the use of ditches was a local adaptation for a particular period in time. The sticky clay soils that commonly occur in Northland would have benefited from drainage or soil moisture depletion during the early part of the growing season. The trenches also may have served to provide better drainage and, therefore, drier and warmer soils throughout the growing season, but particularly in the spring.

Another type of garden site that does not obviously fit into Barber's classification system has been reported from Kawerau in the Bay of Plenty (Lawlor 1981a, 1983). Here, the sloping valleys between ridges and side spurs were used for gardening. Trenches up to 65 m in length were present at the head of valleys and the base of the hillside. They were cut into Kaharoa Ash, which was modified and deepened by the addition of further mixed ash deposits. The trenches were interpreted as being for the purpose of diverting surface water away from the gardens and controlling erosion.

As with much of the horticultural evidence, many arguments and counter-arguments can be put forward to explain the evidence, or lack of it. If the purpose of trenches was to modify the growing environment through either the removal or addition of water, then these sites should be encountered more widely on similar soil types and slope angles. If the intention was to delineate plot boundaries, then again the evidence should be extensive and certainly recorded further afield than Northland. There is a geographic pattern to the evidence, but insufficient information to make interpretations. Further investigation needs to be carried out into age, function, soils, climate and association with particular cultigens. There also needs to be consistency in the type of information collected, including the size and depth of trenches, and distance apart, to help elucidate their function.

5.3 BORROW PITS

These amorphous, and sometimes large, depressions found in geographically restricted localities are the result of sand or gravel being removed from the ground and added to nearby soils. More appropriately, these features could be called 'quarry pits' (Buist 1993), but the term 'borrow pit', adopted from an engineering term, is now entrenched in the literature. Borrow pits are found in the Hamilton Basin, at Aotea in the Waikato, in north and south Taranaki, Tasman Bay in the Nelson area, Clarence River on the east coast of Marlborough, and at Kaiapoi, Birdlings Flat and Taumutu in Canterbury (Fig. 12). Borrow pits are the visible indicator that modified soils are present in the area; the material extracted from the pits was rarely transported more than 100 m (Walton & Cassels 1992: 166).

In the Waikato Basin, borrow pits occur in scattered groupings within 1 km of both the Waikato and Waipa Rivers. Maori gardeners removed up to 800 mm of the more recently deposited volcanic ash and silty sediment on river terraces, in order to access the coarse gravelly sand layer derived from water-borne pumaceous material carried down from the volcanic plateau and deposited in large alluvial fans (Gumbley & Higham 1999a,b). Quarrying of this sand formed the distinctive, irregularly shaped depressions (Fig. 13). The location of borrow pits is inextricably linked to expanses of modified soil used as gardens. These features, in the Waikato at least, are closely associated with other forms of settlement evidence, such as pa and storage pits. They therefore contribute to the overall picture of focal points and the density of evidence in the archaeological landscape.

At Aotea, near the Waikato west coast, borrow pits are clustered along the old sand ridges and dunes, which have been overlain by more recent andesitic tephra. The extent of associated modified soils is c. 100 ha (Walton 1978: 27). The material extracted from the borrow pits was a fine sand, and more than 100 000 m^3 of sand was excavated from the total of 380 borrow pits around Manuaiti Pa at Aotea (Walton 1978: 31; see also Jones 1994: 118–119).

The distribution of borrow pits in Taranaki is variable, with the greatest concentration in south Taranaki, where old sand dunes and ridges underlie the more recent volcanic ash. In the 50 km of coastline between the Manawapou and Waitotara Rivers, there are more than 77 recorded borrow pits (Buist 1993).

In the northern South Island, gravels were quarried from under more recent silt and sandy loams. On the Marlborough east coast and in North Canterbury, the borrow pits are on gravel fans or recent river terraces. The preference was for smaller gravels. At Clarence River, large stones were sorted out and discarded on the edges of borrow pits (McFadgen 1980b). Similarly, at Motueka, small boulders present in natural soil profiles are absent from the modified gravel-added soils (Challis 1976: 252). The most extensive area (400 ha) of modified soil in the upper South Island is on the Tasman Bay lowland. Borrow pits are also numerous in this area—one at Waimea has been radiocarbon dated to the 15th–17th centuries (Challis 1991: 102).

In addition to gravels and sands being quarried to add to existing soils, stones were also quarried in the Wairarapa to construct surface features. At Okoropunga, borrow pits on beach ridge crests are thought to have been the source of stones used in the garden rows and mounds (McFadgen 2003).

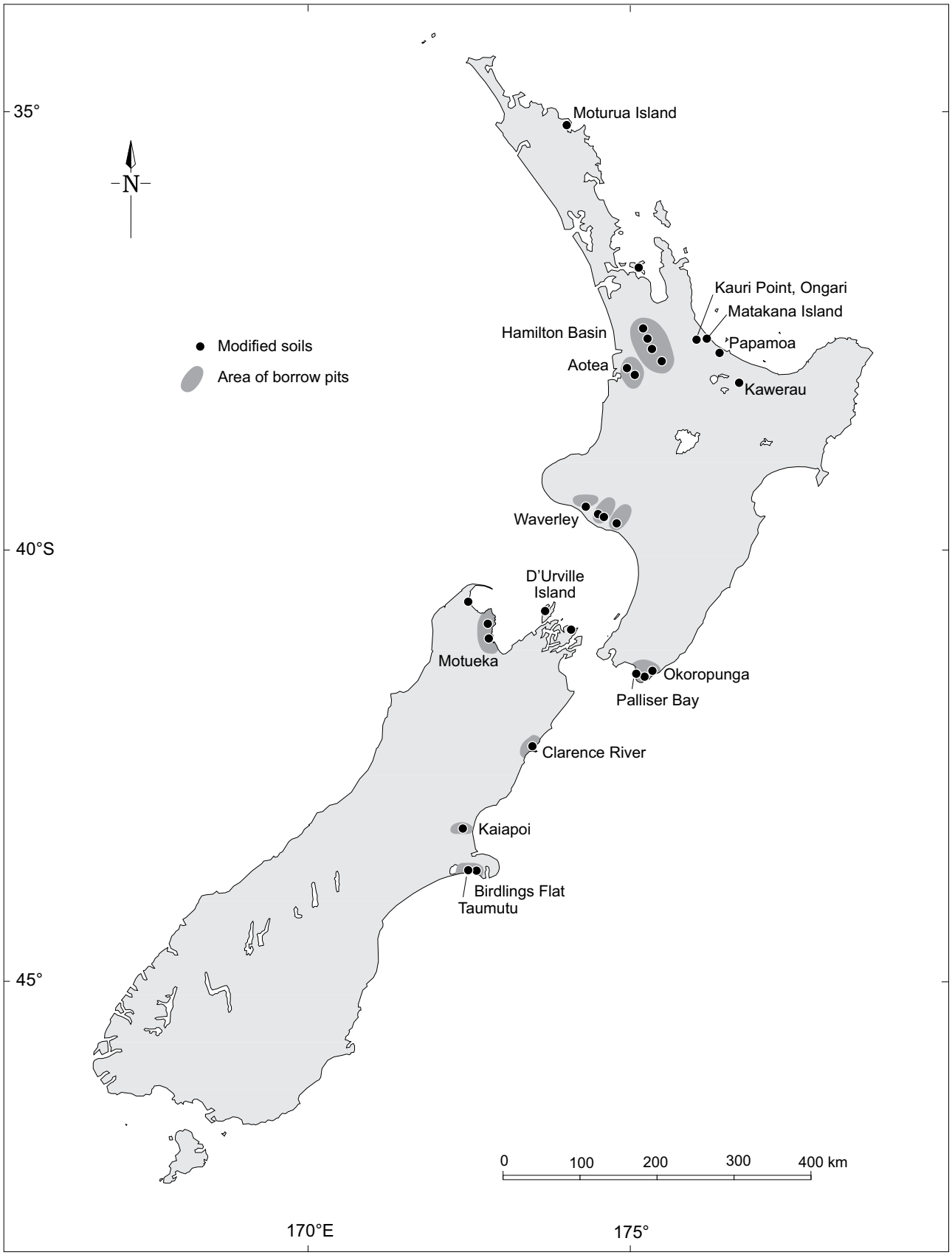


Figure 12. Distribution of recorded archaeological sites with modified soils and borrow pits. Coarse sand and small gravel was extracted from underlying deposits and added to soil prior to gardening. In other places, beach shell was added to the topsoil or tephra layers were displaced. *Map: C. Edkins, DOC.*

Figure 13. Borrow pits at Horotiu. Modified soils will be adjacent to the pits. *Photo: K. Jones, DOC.*

5.4 GARDEN SOILS

There are several types of evidence for garden soils, none of which are visible on the surface of the ground. The most common has sand or gravel added to the original topsoil. Other additives include shell and charcoal, although topsoil that has had shell added to it is rarely identified as deliberately enhanced garden soil. McFadgen (1980a) prefers the term 'plaggen soils' to describe soils with added material, but the terms 'made soils' or 'modified soils' are used more commonly. 'Modified soils' is used in this report. Evidence for garden soils where no additives are observed include alteration to the natural soil profile through mixing of the A and B horizons, artificial deepening of the A horizon, or an absence of well-defined tephra layers due to mixing. Generally, for soils without additives, few common profile characteristics are reported, resulting in very variable soil descriptions.

Sand and gravel was added to both clays and lighter loams; therefore, it was not necessarily added solely to improve drainage or soil texture, and nor was the technique used consistently within a region. Even in localities where extensive areas of modified soils have been identified, there are also garden soils without additives. Aotea and south Taranaki are two regions where borrow pits, modified soils and unmodified soils are present within a relatively small area (Walton & Cassels 1992).

The most extensive areas of modified soils are associated with the borrow pits described above. Modified soils are very rare in Northland, Auckland, Bay of Plenty, East Coast or Hawke's Bay. Soil scientists recognised altered soils in the Waikato and Nelson areas (Rigg & Bruce 1923; Grange et al. 1939) decades before archaeologists were interested in Maori gardening, and the soils in the Waikato Basin and the Tasman Bay area have been studied extensively and mapped (Chittenden et al. 1966; Bruce 1978, 1979).

It is estimated that there may have been up to 2000 ha of modified soils situated within 3 km of the Waikato River (Taylor 1958). Modified soils also occur in the adjacent Waipa River Valley. Further down the Waikato River, between Huntly and Rangiriri, gravelly sand that is incorporated into soil on river levees covers an estimated 90 ha (Law 1968). Modified soils are identified on soil maps as 'Tamahere gravelly sand' formed on Taupo, Horotiu or Waikato parent loams, depending on their location. There may have been a preference for soils on the Taupo terraces, as borrow pits are more common here than on the higher terraces (Gumbley & Higham 2000). The soils most frequently altered were the Horotiu yellow-brown loams, but the Te Kowhai silt loam has also been identified as a parent soil (Bruce 1978, 1979; Gumbley & Higham 1999a).

In Tasman Bay and along the Marlborough-Canterbury coast, there is a close correlation between modified soils and old gravel fans in river valleys or on coastal terraces. In the Motueka area of the northern South Island, the area of gravel-added soils may have been 115 ha (Challis 1978: 28). At Aotea and Taranaki, coarse sands derived from underlying dunes have been 'mined' and added to the tephra-derived topsoil (Walton 1983, 2000).

Reliable ethnographic accounts for adding sand and gravel are rare (Walton 1982a). Yate (1835: 156) explained that, in the Bay of Islands, sand or small gravel from river banks was added to clay soil to make it friable and suitable for kumara. In contrast, Colenso (1880: 9) described mulching of taro gardens on the East Coast in the early 1840s: '…I passed by several of the taro plantations… These plantations were large, in nice condition, and looked very neat, the plants being planted in true quincunx order, and the ground strewed with fine white sand'.

Archaeological confirmation of ethnographic descriptions is rare. Three examples are reported in the literature. An unusual set of individual planting features containing sand were uncovered at S14/201, Chartwell in the Waikato (Higham & Gumbley 2001; Gumbley et al. 2003). Clusters of circular features containing sand were exposed in plan view after the topsoil was removed (Fig. 14). These were interpreted as the bases of scooped-out depressions in the parent loam, which were then filled with sand heaped up to form mounds. However, the upper edges of the features, within the topsoil, had been scraped off by earth-moving machinery, so there is no actual evidence that the sand was mounded up above the original ground surface. Dated to the 16th century, these features were set out in a quincunx pattern, similar to that described by Banks and Monkhouse at Anaura Bay in 1769 (Leach 1984). The two clusters of these features covered 73 m^2 and 50 m^2 in an area of over 6 ha of modified soils, although only 1.2 ha was stripped of topsoil. Patches of sand exposed during topsoil stripping suggest that these features may have been more common, but that not all extended down into the sub-soil. Borrow pits and more widespread

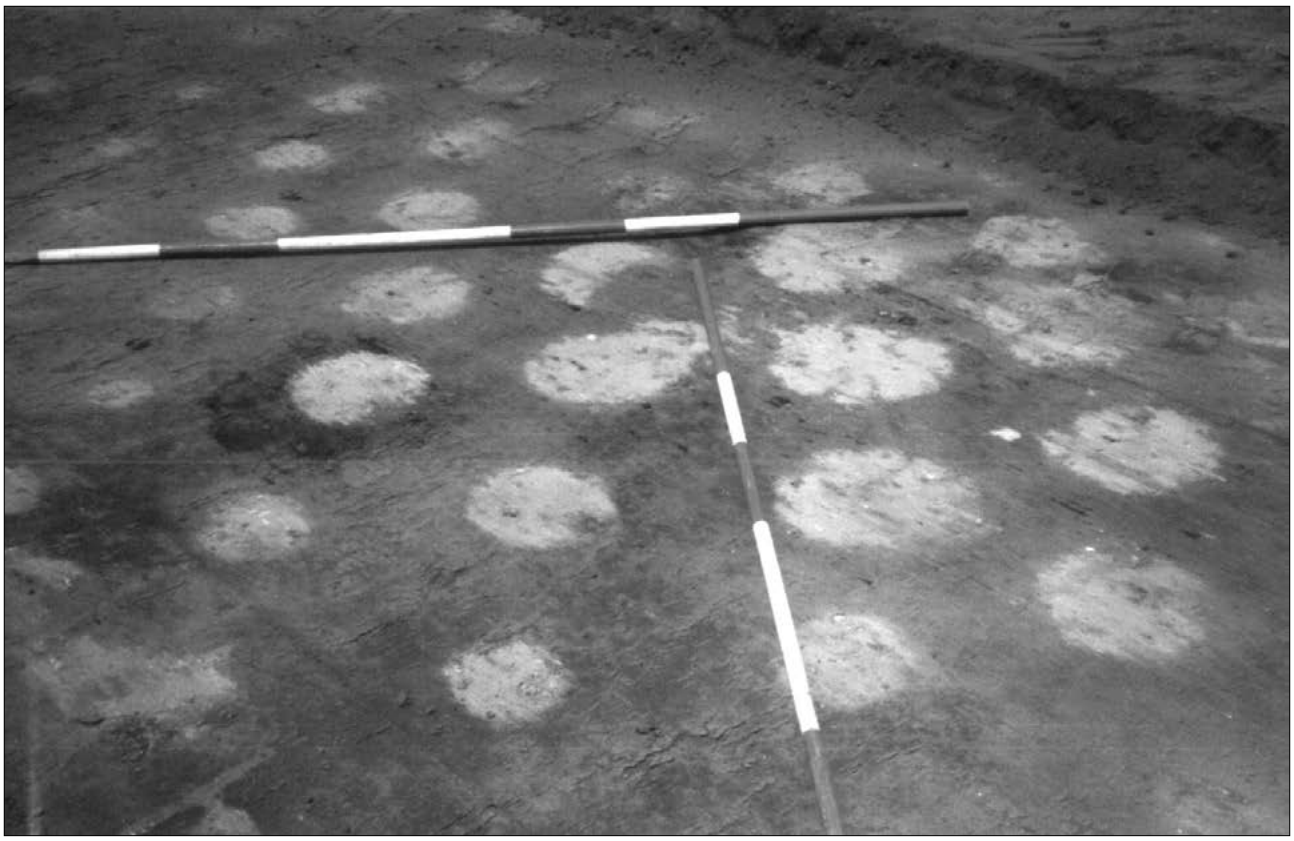


Figure 14. Circular features containing coarse sand, laid out in rows, at S14/201, Hamilton. *Photo: W. Gumbley, Hamilton.*

modified soils were found in association with these. The fact that these features survived suggests that the area was gardened only once, as subsequent digging would have destroyed the features. A variation of this type of evidence was found at Kirikiriroa Pa in Hamilton, where the features extended between 50 mm and 150 mm into the subsoil and were filled with a mix of organic material and shell (Simmons 2003). These features have been interpreted as kumara gardens, but taro cannot be ruled out. Small circular depressions up to 500 mm deep have been uncovered at Triangle Flat, Golden Bay (Barber 2004). Starch grains and xylem cells of taro were found in the fill of one depression, and kumara microfossils were found in the fill of another in a separate group of the features (Horrocks 2004: 328). However, whether similar features could be used interchangeably to grow different cultigens is not answered by the microfossil results, as other issues, such as transportation and the reuse of soil at another time, have not been addressed in a discussion of results.

The evidence from these sites also gives some credence to Best's (1976: 186) statement that the entire garden plot was not dug over when preparing the ground for planting. If this was the general rule, there should be more archaeological evidence for variability within soil profiles in areas identified as gardens. Site recorders have also used a hummocky surface appearance to signify the presence of mounded soil and gardens. At Waverley, sand mixed with loam was mounded, giving the surface an uneven appearance (Walton & Cassels 1992). However, reported instances of this field evidence are rare, not because the practice was carried out only occasionally, but because the mounded-up soil was dug over

during harvesting and replanting. More recent activities, such as post-garden ploughing, have also destroyed the surface evidence.

Under certain soil conditions, substantial benefits may have been derived from making soils more free-draining or soil temperatures warmer. It would be expected that in any circumstances the effect would have been sufficient to warrant the labour involved in digging, transporting and incorporating the sand or gravel into existing topsoil. Challis (1976) suggested that gravel-added soils warmed up faster than soils with no additives at the beginning of the growing season, providing the advantage of adding an extra week to the growing season. This may have been a significant benefit in the lower North Island and South Island, where conditions for kumara growing were more marginal, but is hardly applicable to northern regions. The practice may, in fact, have been used for different reasons in different areas, or may simply represent a garden technique of a particular period in time. An alternative explanation has been proposed based on observations made during practical experiments: the loose soil resulting from the addition of gravel may have reduced the potential for damage to tubers during harvesting (Horn 1993). This also warrants consideration. Further understanding of the role of adding gravel will be dependent on looking at the conditions in a local area rather than providing an explanation at a national level.

The benefits of adding gravels and sands to soils have been explored under experimental conditions (Horn 1993; Worrall 1993). Soil plots near Christchurch were mixed through with combinations of soil, gravel, sand and charcoal, and were tested for temperature variation. Surface mulches of each material were also tested (Worrall 1993). For mixed soils, night-time temperatures in all plots were similar, but the benefits of adding sand and gravel to soil became apparent during the day, when soil temperature reached a peak of 4°C higher than that of unmodified soil or soil with charcoal. Similar results were achieved when surface mulches were tested, with the exception that soil with charcoal on the surface was found to have a slower rate of temperature increase and did not achieve the maximum of the other surface treatments. A charcoal layer on the surface did, however, retain heat in the soil for a longer period overnight. An increase in soil temperature would be most beneficial in those first few weeks of growth, when canopy and root growth was being established. Once the canopy covered the soil, any temperature-related benefits would be reduced (Horn 1993).

Other experiments on the effect of adding varying proportions of additives to soil on plant growth had interesting results (Horn 1993). The premise being tested was that additives in any quantity would dilute the amount of nutrients present in the parent soil. Using Rekamaroa kumara, Horn (1993) found that a surface sand layer increased plant root growth. However, too much sand volume relative to parent soil affected plant growth, decreasing yields substantially: a mix of 50% sand was sufficient to reduce yield by 24%. In similar experiments conducted by Worrall (1993), plants grown in soils with a high proportion of additive also failed to thrive. However, these experiments concentrated on kumara growth. The tolerance of hue and taro has not been tested.

Calculations of the volume of material that was added to archaeologically investigated soils vary from 45% of total soil in the profile at Rocky Bay on Waiheke, where shell was incorporated (Law 1975), to 60% at Aotea, where tephra sand was added (Walton 1978: 30), and 47% and 67% at two sites in Hamilton, where

gravelly sand was the additive (Gumbley et al. 2003). However, at Aotea, this material may have been added over time and in successive crop cycles, so that the nutrient value may have been relatively low, especially if cropped for several years.

Since there is variability in the characteristics of modified soils, such as whether additives were mixed through the soil or a layer on top was mulched, there are no definitive conclusions to be drawn. Combinations of factors may also affect plant growth differently, so that an experiment conducted further north where temperatures were warmer for longer period during the growing season may produce different results from the same experiment at the climatically marginal southern limits of Maori horticulture.

Walton & Cassels (1992: 170) attempted to put modified soils in perspective by suggesting that they were but one method of gardening. Within the Waverley area, borrow pits and modified soils were restricted to areas where there was only a thin layer of ash overburden over the sand, but storage pits, which indicate horticultural activity that was carried out without the use of modified soils, are widespread throughout the area. Similarly, at Aotea there are soils with evidence of disturbance to the natural soil horizon but no additives, indicating that there is more than one way to grow a kumara. Large broad terraces without any occupation evidence are assumed to have had a horticultural function, but again have no additives present in the soil profile (Walton 1983: 91–92).

Shell, charcoal and fine pebbles have been identified through excavation, or in site records, as having been added to soils. Various coastal profiles showing fine gravel and sand added to a silt soil have been interpreted as garden soils (e.g. Law's (1975) description of the soil profile at Rocky Bay on Waiheke Island). Coastal deposits of water-rolled shell and beach pebbles, along with sand and charcoal, were added to agricultural soil on a coastal terrace at Moturua Island in the Bay of Islands (Johnson 1997). Modified soils (Q05/44 and 46) were also found on the slopes in two adjacent bays. Radiocarbon age estimates suggest that the slope garden Q05/46 dates to the 17th century (Johnson 1997). Age estimates for Q05/44 were obtained by both Groube (1966) and Peters (1975) for the lower of two modified soils that were separated by clay. Age estimates for the earlier soil were in agreement, suggesting a 15th century age, although the underlying gley soil layer, which contained charcoal, had widely varying and earlier dating results. This difference was put down to Groube dating old charcoal. Johnson (1997) argued that based on relative obsidian hydration dating of obsidian flakes from both this site and Q05/46, and radiocarbon dates from Q05/46, the upper modified soil is the same age as the lower, and that rather than being 15th century in age, is more likely to be 17th century. This reinterpretation of Groube's (1966) and Peters' (1975) lower garden soil has major implications for a soil that was previously interpreted as being associated with the 14th or 15th centuries, as this was some of the earliest direct evidence of gardening in the northern North Island.

Shell is also described in an agricultural soil that seals the Phase 1 pits at Kauri Point Pa (Ambrose n.d.). At nearby Ongari, the soil had small fragments of shell and charcoal incorporated. The source of this material was attributed to occupation debris (Shawcross 1966: 56). The extent to which the presence of shell midden, as a suitable medium for incorporation into the soil, may have influenced the location of gardens is unknown.

Gardening may also have occurred at the Sunde site on Motutapu Island. Nichol (1988: 368–373) described the addition of shell and water-rolled greywacke gravel from the beach to an area covering several hundred square metres on the banks of the stream. This was incorporated into the upper part of the latest tephra layer.

Soils in the Palliser Bay garden complexes are typically described as sandy loam topsoil with added charcoal and beach pebbles, and an absence of large stones. In several sites, the topsoil has been artificially deepened (Leach, H.M. 1979a: 139–140, 148, 151, 156). Excavation of the Washpool Garden Terrace revealed ash, charcoal and burnt rock mixed in with the underlying natural sand horizon to a depth of 400 mm (Leach, B.F. 1979: 112).

At Papamoa in the Bay of Plenty, soils on coastal dunes have been identified by the mixing of the Kaharoa bedded tephra layers and the underlying Taupo Ash with the original topsoil and charcoal. The soils were well mixed in some places, but were patchy in others, so that the individual components had retained their distinctive characteristics (Gumbley 1999). A similar mixed tephra and sand layer was adopted as evidence of gardening on Matakana Island (Marshall et al. 1994: 9, 40). In contrast, at Kawerau in the inland Bay of Plenty, garden soils were characteristically deeper in valley floors, due to Kaharoa Ash being stripped off slopes and added to the valley deposits. This action formed variously an artificially deep layer of Kaharoa Ash, or the individual tephra layers were well-mixed in a homogeneous deposit of sand and pumice (Lawlor 1981a, 1983).

Multiple excavations in the Auckland volcanic horticultural field systems have not provided in-depth descriptions of garden soils. Sullivan (1975b: 55, 65) defined a cultivation soil by the presence of well-integrated charcoal and sharply defined upper and lower boundaries, and by the absence of scoria. On the adjacent Puhinui field system near Wiri, garden soils were excavated in various places. Characteristically, these were loam soils that were rich in charcoal, scoria free and often artificially deep. Useful soil was possibly stripped off areas that were unsuitable due to underlying lava and added to garden areas (Lawlor 1981b: 91, 142).

Just as descriptions of soils vary enormously, so do the reported depths of the modified soil: 60–120 mm at Ongari (Shawcross 1966); 200–600 mm at Kawerau (Lawlor 1981a); 250–300 mm at Opunga Bay Moturua Island and 150–300 mm at the adjacent Hahangarua Bay (Johnson 1997); 250–300 mm at Makara near Wellington Harbour (McFadgen 1980a); 500 mm at Okorupunga (McFadgen 1980a,b); 300–500 mm at Clarence River (McFadgen 1980a,b); 400–500 mm at Aotea (Walton 1983); 200–250 mm at Waverley (Walton & Cassels 1992); 240–300 mm at Motueka (Challis 1976); 200–600 mm at Papamoa (Gumbley 1999); 200–600 mm at Matakana Island (Marshall et al. 1994); 40–230 mm at Horotiu (Gumbley & Higham 1999b); 100 mm at Wiri (Sullivan 1975b); 100–300 mm at Puhinui (Lawlor 1981b); and 200 mm at Black Rocks in Palliser Bay (Leach, H.M. 1979a). The greater depths of modified soils are from areas where large quantities of gravel or sand additives have been recognised.

Where soils have relatively little modification, it is extremely difficult to identify gardening because either there is no physical trace, or subsequent soil formation processes and later land modification have masked the characteristics of a garden

soil. Even in areas with strong indications of gardening, such as Pouerua, there is little in the soil profiles to independently suggest that gardening was carried out.

There has been a considerable amount of literature discussing the characteristics of a Maori garden soil, and it is debatable whether all of the reported examples are evidence of gardening. Early on in the study of soils on archaeological sites, Pullar & Vucetich (1960: 4) cautioned on extrapolating from a small area to arrive at an interpretation: 'To estimate the degree of disturbance the pedologist has to refer to the natural soils in the vicinity and, better still, possess knowledge of the soils of a region. No worthwhile opinion can be offered on a mere spot examination'. Archaeologists should heed this advice and consider that profile variation can also be attributed to vegetation, characteristics of the underlying subsoil and parent material, and worm action.

5.5 GARDEN TERRACES

Although not recognised in the horticultural literature as a site type in their own right, garden terraces are present in a number of geographic areas. Garden terraces appear to be large terraces constructed for the purpose of gardening and have soil profiles consistent with the mixing of natural A and B horizons. They are recorded from Kawerau (Lawlor 1984) and the Aotea Harbour area (Walton 1983). Large terraces at Weiti in North Auckland (Coates & Rickard 1985) and Whitireia Peninsula, Porirua (Walton 1986), are natural features that may have been modified for gardening. Some of the site descriptions from offshore islands, where stone facing has been used to support the front scarp of terraces, may also fit into this category.

At Aotea, there are a number of sites with a series of large terraces descending down a slope or with fixed parabolic cliff-top dunes. Test excavations at one site, N64/196, indicated that the terrace was constructed by building up soil behind a wooden front scarp (Walton 1978). There was no occupation debris on this terrace. Consequently, the features at Aotea were interpreted as horticultural because of their size and proximity to borrow pits. In some instances, borrow pits were dug into the front scarps of existing terraces (Walton 1978, 1983).

Similarly, at Whitireia Peninsula near Porirua, a series of terraces previously identified as gardens were, on excavation, shown to be partly or entirely natural (Walton 1986). However, at least one may have been modified for gardening by the addition of pebbles to what was already a pebbly soil (McFadgen 1980a).

Extensive areas of garden soils were identified at Kawerau. These were in semi-enclosed valleys and were associated with ditches around the base of the slopes. Lawlor (1984: 236) described '...a pattern of stepped gardens within a single valley...but for the most part gardens seemed to occupy the whole valley areas'.

Like other types of gardening evidence, these garden terraces are unlikely to be isolated examples. However, it is only by excavation, and the elimination of domestic use, that a garden interpretation can be placed on such features. Terraces may have been used as a way of controlling erosion and run-off, especially in light, fragile soil conditions, such as the tephra-based soils at Kawerau or the light sandy loams at Aotea.

6. Gardening evidence by region

In the following discussion of the regional distribution of gardening evidence, there are brief descriptions of the main gardening-related characteristics of each region, and where the main site concentrations and typical or atypical and well-known sites are situated. This is intended to be a broad overview only. For convenience, the regional divisions are by DOC conservancy boundary. More in-depth discussion of specific sites, using information obtained through archaeological techniques of mapping and excavation or radiocarbon dating, is addressed in the previous sections describing the different site types.

The distribution of evidence reflects where sites have been recorded or investigated rather than the actual distribution of garden evidence. Many garden-related sites have yet to be discovered, or have already been destroyed through alteration of the landscape. The broad location of storage pits is, at a regional level, a fairly accurate indicator of where gardening is likely to have taken place. However, the distribution of pits is subject to the same recording deficiencies as direct evidence of gardening.

The recorded information can be used to indicate favourable locations for gardening. A high density of storage pits or the association of certain soil types with horticultural evidence can be used to establish regional predictive models of the likelihood of horticultural field evidence being present in particular areas. A more formal exercise in predicting probabilities of occurrence of archaeological sites throughout New Zealand has been carried out (Leathwick 2000). In this study, factors such as soil parent material and distance to major water bodies were the most important contributors to determining the probability of occurrence of pits and pa, followed by mean annual temperature. The greatest likelihood of occurrence coincides with warm summer-dry situations, and limestone, granite, andesite or basalt parent materials (Leathwick 2000: 12).

6.1 NORTHLAND

The archaeological evidence for gardening is most varied in Northland, and includes stone rows, mounds, large complexes of garden rows and structures based on the use of stone in the inland Bay of Islands, slope trenches and garden boundaries, and the extensive ditch systems of Awanui, Oruru, Motutangi and Taumatawhana. Gardening evidence is concentrated around the coast, around inland areas where fertile volcanic soils are present and on the islands (Fig. 15). Storage pits are widespread, reflecting that much of Northland provided suitable conditions for growing crops (Fig. 16).

Most of the islands off the Northland coast are of volcanic origin. Soils on these sometimes very rocky islands are thin, yet they have extensive gardening evidence. Stone-faced terraces have been constructed to contain and retain the topsoil. In some instances, low rows divide some terraces into separate smaller units. Stone heaps are also present. Soil fertility may have been maintained through the incidental incorporation of petrel guano (Maori did not deliberately

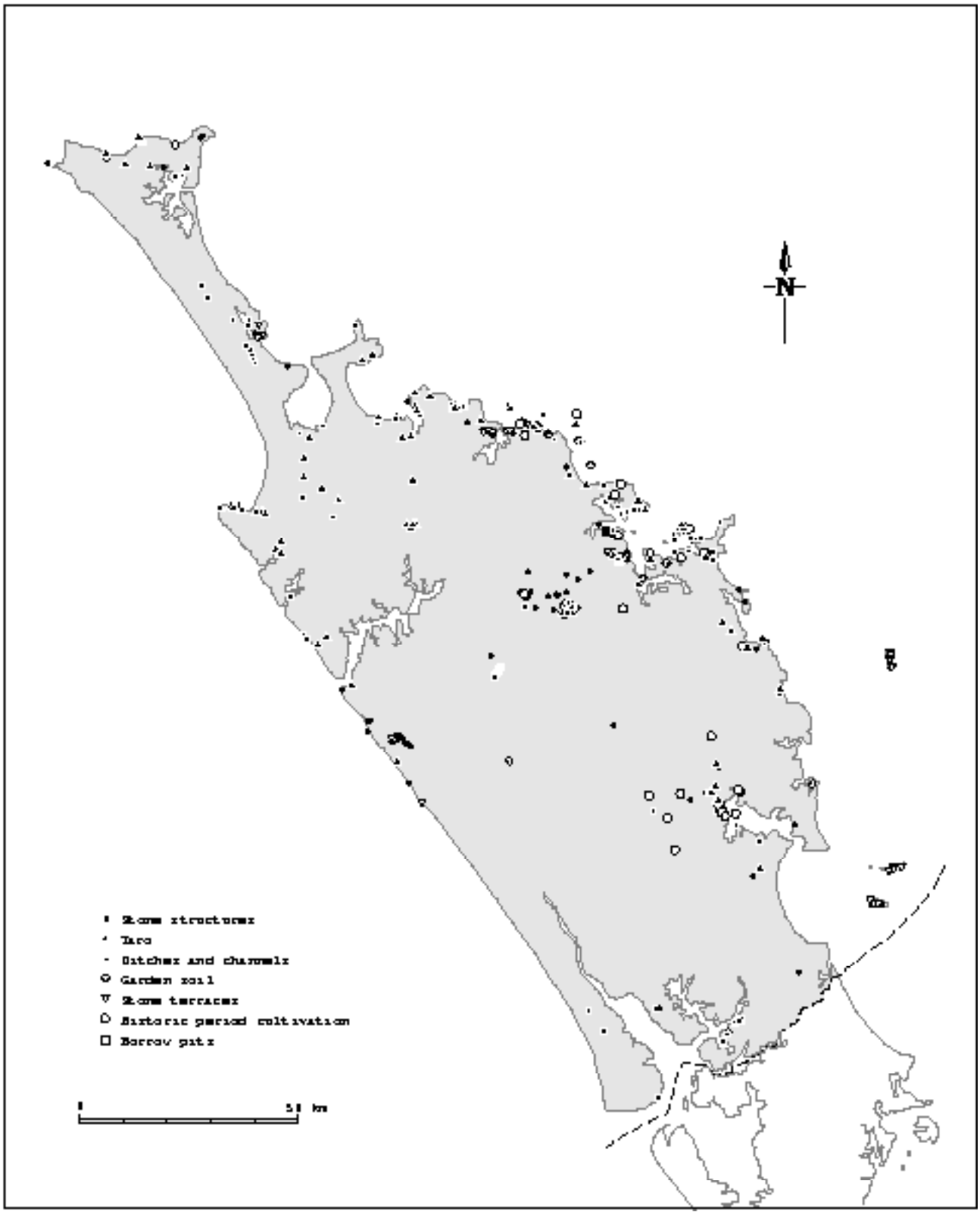


Figure 15. Distribution of recorded Maori horticulture-related archaeological sites, Northland Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

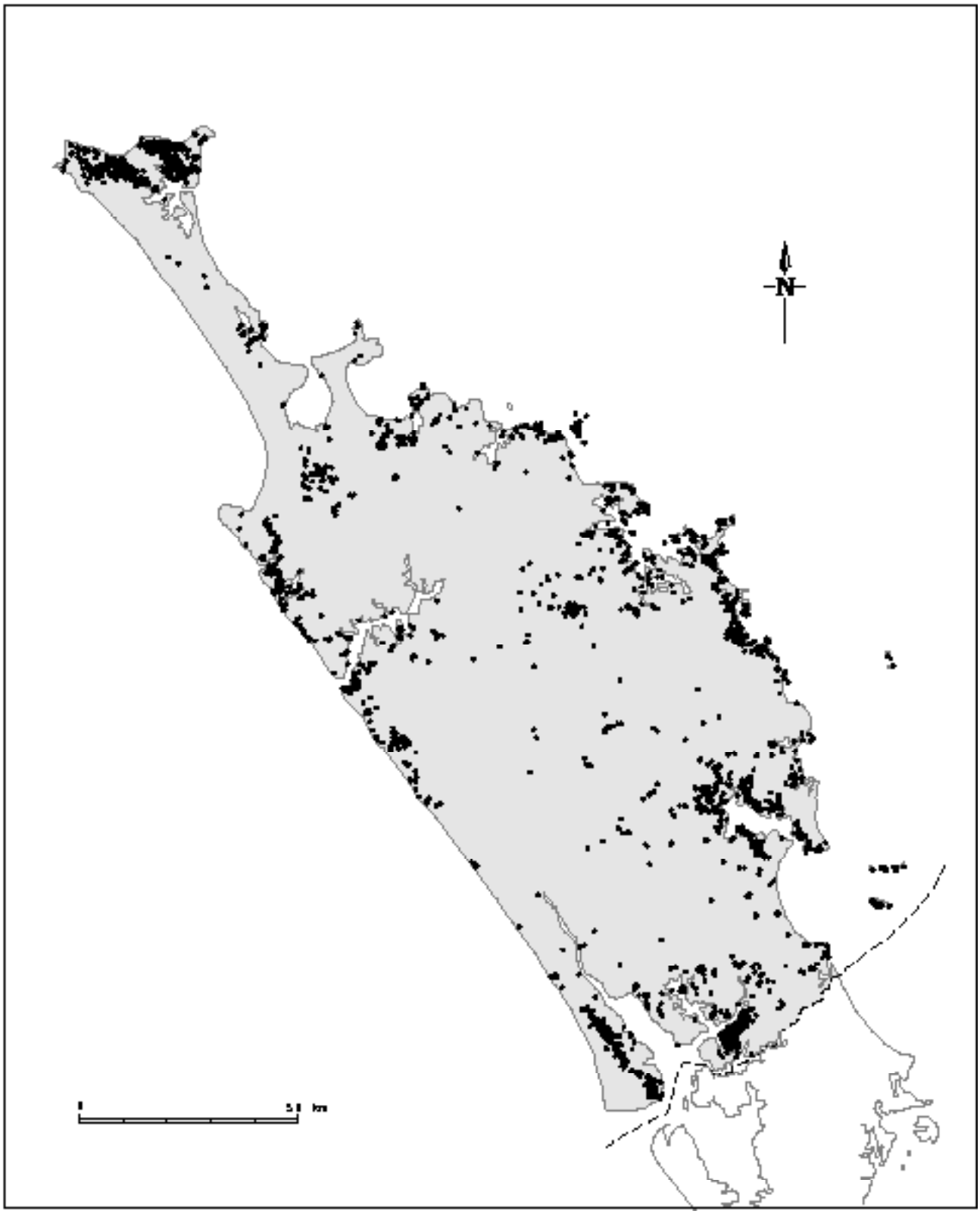


Figure 16. Distribution of recorded archaeological sites with kumara storage pits, Northland Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

enhance soil fertility by using animal waste). Ironically, petrel burrows are likely to have a major destructive effect on the survival of garden sites on the northern islands. Gardening evidence is a feature of all islands down the east coast of the upper North Island. Whether this is due to the survival of sites on land not subsequently altered, in combination with the presence of stone structures, or reflects a significant advantage of the island climates, as suggested by Edson (1973), can only be speculated on.

Major concentrations of stone structures are to be found in the inland Bay of Islands, where the volcanic cones of Ahuahu, Pouerua, Putahi, Maungaturoto and Puketona produced fertile red-brown volcanic loams ideal for gardening. Remnants of the Maori garden landscape are present around Ahuahu and Puketona, but they largely consist of isolated groups of stone mounds and heaps in a landscape damaged by farming and quarrying (Sutton 1982: 187). Pouerua is the only garden landscape in the inland Bay of Islands to have suffered little damage. Stone rows, heaps, mounds, alignments and enclosures are present on the stonier soils. Shallow boundary trenches, which extend for some distance over undulations in the landscape, together with shorter cross-trenches are present on soils with a greater depth of ash (Phillips 1980). The garden evidence covers an area of c. 550 ha around the volcanic cone, which is a terraced pa with defensive ditches on the rim. Many of the garden features and the associated settlements situated within the garden areas have been mapped. The survey carried out in 1982–83 was, at that time, an innovative exercise that aimed to produce an analysis of the garden systems (Sutton 1983). However, the site map has still not been produced in its final form. Some areas around the margin of the volcanic soils at Pouerua were not included in the intensive mapping exercise, but these have since been examined and their features recorded (Challis & Walton 1993). Differences in the density of recorded sites around Pouerua can be accounted for by different methods of recording. The Sutton-directed work was map-based rather than site record-based, so there are few site records for the garden-related stone evidence and few written descriptions, but relationships between features can be readily seen (part of the site map is reproduced in Sutton 1984: frontispiece). On the other hand, the later recording exercise on the outer margins of the volcanic soil zone by Challis & Walton (1993) was based on descriptions of concentrations of features and topographic changes, and resulted in 133 additional site records being added to the Northland site file. This latter approach, while adding significantly more detail about individual groups of features, lacks the integrated landscape view of the former, but the need to identify the extent of the cultural landscape prior to registration under the Historic Places Act dictated the different approach. Both approaches—mapping and site records—have merit, but an integration of both maps and written descriptions of features and groups of features would be the ideal.

Isolated garden areas based on the use of stone occur at Mt Camel, Kerikeri, around the coast of the Bay of Islands and on the coastline north to Whangaroa Harbour. These sites tend to be small in size and are on coastal platforms or hillslopes. Further south, remnants of stone rows and mounds are present at McLeod's Bay near Whangarei Heads, and at Maungatapere and Maungakaramea, west of Whangarei Harbour, where volcanic soils also occur (Nevin 1983).

Stone structures are present on terraces in a riverine valley system, and on clay loams, rather than volcanic-derived soils, in Waipoua Valley and other locations

between Waimamaku River and Waipoua. Although some imaginative theories have been put forward to explain the origin of these sites, they are undoubtedly of Maori construction. Stone heaps, without any obvious soil component, are the most commonly occurring feature, with a density of up to 172 heaps/ha (Papworth 1980: 5–6). Stone rows and stone-faced terraces form only a small percentage of the sites at Waipoua. Some shallow ditch features are also present.

The large complexes of parallel and intersecting ditches on flat, poorly drained soils, such as at Oruru, Awanui, Motutangi and Taumatawhana, are uncommon elsewhere in the country. Similar systems are reported from the Dargaville area and possibly at Waipu. The system at Motutangi covered 47 ha, and that at Awanui c. 125 ha, representing many kilometres of ditch length (Barber 1982, 1989a). The latter has been largely destroyed.

Shallow parallel trenches on slopes, which are different from the ditch complexes discussed above, are widely distributed through Northland. Well-known examples include those at Tupou Bay, Moturua Island, Pouerua, Limestone Island in Whangarei Harbour and Marsden Cross on the Purerua Peninsula. This site type is particularly difficult to detect—often only visible in certain low-angle light or under particular vegetation conditions—and may be more widespread than the current known distribution indicates. A survey of this site type in Tai Tokerau was conducted by Barber (1982). Similar sites are present on coastal Whangaroa, Cavalli Islands, coastal Bay of Islands, the south side of Whangarei Harbour and Kaipara. The rendzina soils present at Whangarei and Kaipara, which are based on limestone parent rock, are sticky clay soils high in nutrients (Gibbs 1980) and have abundant evidence of horticulture, including the site that covers 14 ha on Limestone Island.

There are no borrow pits in Northland and records of garden soils are rare: there are only 17 instances of soils incorporating shell, charcoal or water-rolled pebbles, including Moturua Island (Johnson 1997). Some recorded examples may not be modified garden soils.

Taro sites are plentiful in Northland. The distribution of taro is a reflection of where taro was grown historically (adjacent to settlements) and the extent of its tolerance to the local environmental conditions.

Although East Polynesian-type settlement sites are well known from Northland, there is no evidence for an association with horticulture. This is no doubt due to the ephemeral nature of the evidence or a sampling problem, rather than a lack of gardening by the first settlers. Reinterpretation of the garden soils on Moturua Island, which were excavated by Groube (1966) and Peters (1975), has raised some doubts about whether these slope gardens and trenches do actually represent early gardening. Forest clearance in the inland Bay of Islands at Pouerua, in an area of fertile volcanic soils, was underway in the first decades after AD 1400 (Sutton et al. 2003). It can, therefore, be said with some confidence that horticulture has been practised in the north of the North Island for more than 600 years.

Land administered by the Crown contains many Maori garden-related sites, but these are not representative of the full range of garden evidence in Northland. The sites tend to be small, possibly historic in the case of Ranfurly Scenic Reserve, and do not encompass the wetland systems or sites on volcanic soils on the mainland. The Waipoua sites are extensive, but they are not representative in either form or landscape type of gardening evidence in Northland.

6.2 AUCKLAND

There is a diverse range of environmental conditions and gardening sites in the wider Auckland region (Fig. 17). The evidence does, however, tend to be dominated by the gardens on the volcanic soils of the Tamaki Isthmus.

Islands such as Hauturu/Little Barrier, Rakitu (Arid) and Great Barrier (Aotea) have stonework reminiscent of that on other smaller islands in Northland and the Waikato/Coromandel regions; however, Great Barrier (Aotea) Island also has larger sites with stone row complexes and slope trenches on the eastern coast. Motutapu, Motuihe, Waiheke and Ponui Islands are generally free of surface stone, and although some modified soils have been recorded, the direct evidence of gardening is lacking. There are, however, many storage pits on these islands (Fig. 18). Browns Island (Motukorea), being volcanic, has stone rows, heaps and mounds on the basaltic lava fields surrounding the cone. The area involved is a relatively small 4 ha.

Figure 17. Distribution of recorded Maori horticulture-related archaeological sites, Auckland Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

A distinctive feature of Maori gardening in the Auckland region is the use of stone on the basaltic lava fields surrounding the volcanic cones to construct rows, alignments, mounds, heaps and stone-faced terraces within and around the gardens. Prior to urban development, there were 30 separate effusive cones in the Auckland region, and 18 explosive cones and craters (Searle 1981: 47), with an estimated 8000 ha of red and brown loam soils (Bulmer 1989: 692). The individual lava fields are separated by heavy clays of low to average fertility (Sullivan 1972). The explosion craters and tuff rings lack the characteristic lava sheet and rock-strewn landscape surrounding the volcanic cones, but have fertile, deep volcanic loam soils. Evidence of former gardening is not so apparent at these places, such as Onepoto and Tank Farm on the North Shore, St Heliers, Pukaki Lagoon, Papatoetoe Crater and Ash Hill (Sullivan 1972: 150).

The majority of the field systems around Auckland's volcanic cones have been destroyed by urban development over the last 150 years. Extensive stone row-based garden areas were formerly present at Maungakiekie/One Tree Hill, Maungarei/Mt Wellington and Maungawhau/Mt Eden. Smaller systems were

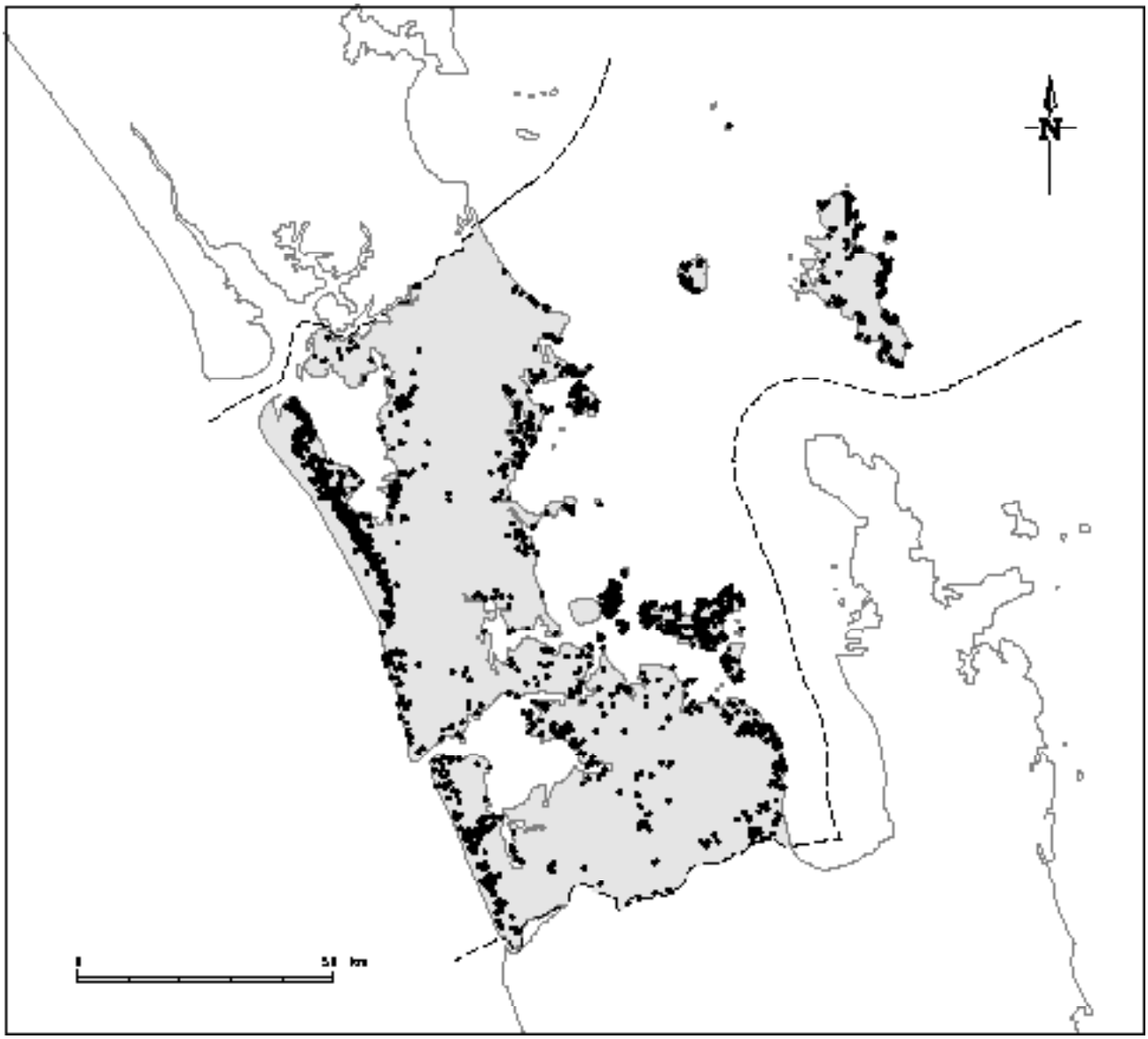


Figure 18. Distribution of recorded archaeological sites with kumara storage pits, Auckland Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

present around other cones (Sullivan 1972). The lava fields surrounding Green Mt-Otara were destroyed in the 1980s. Reasonably intact garden areas survive at Matukutururu/Wiri and the adjacent Matukutureia/McLaughlins, where there are 60 ha of stone features, and at Otuataua, where there are 100 ha of gardens. Small areas exist around some other cones, such as Puketutu, Mangere, Maungarei/Mt Wellington, Maungataketake/Ellett's Mt, Ohuirangi/Pigeon Mt, Crater Hill, and Motukorea/Brown's Island (Clough & Plowman 1996).

Volcanic areas and gardening evidence are also present to the south of the Auckland Isthmus. There is a small concentration of evidence at Ramarama near Bombay, where stone heaps and rows, and stone-faced terraces are present, and although there is no direct horticultural evidence in the form of stone structures present at Bald Hill on the Manukau lowland, the isolated pocket of basaltic tuff sandy loam coincides with a cluster of storage pit sites and pa (Walton 1985b). Isolated instances of the use of stone are to be found as far south as the Waikato River.

Stone heaps are a distinctive feature of the landscape at Orere and Tapapakanga on the Firth of Thames, but these have not been constructed into stone rows, mounds or other evidence. Instead, the evidence seems to suggest the unsystematic clearance of stones from soil on the valley flats rather than an attempt to impose on the landscape a structured garden boundary system based on stone.

Storage pit sites are numerous on Motutapu and Waiheke Islands, but gardening-related site records are few in number (Figs 17 and 18). Modified soils have been identified in a few places on Waiheke, and their presence suggests that there is likely to be more widespread evidence of gardening; however, this has not, so far, been identified. Similarly, on Motutapu Island, disturbance to ash lenses after the Rangitoto eruption has been interpreted as evidence of gardening at the Sunde site (Nichol 1988). Ash-based soils on Motutapu may have been one of the attractions of the island (Davidson 1987).

Areas with sandy loam soils on the west coast at Awhitu, and at South Kaipara and Muriwai have numerous storage pits (Fig. 18), yet little actual evidence of gardens. This demonstrates the difficulty of identifying garden areas from surface evidence alone.

As with the evidence from other regions, there is no tight chronological control over when gardening commenced in the Auckland region. Age estimates of the 12th–13th centuries from the lower slopes of Wiri (Sullivan 1975a) are likely to be too old, on the basis that unidentified charcoal (possibly heartwood from a large tree) was dated. Age estimates for the use of the adjacent Puhinui garden system are 15th century or later, although stream-side occupation may have been earlier (Lawlor 1981c). Other field systems in Auckland volcanic areas are not well dated.

Some gardening sites are on protected land under the administration of DOC, and territorial and regional local authorities. The Auckland Regional Council manages sites at Tapapakanga (stone heaps on riverine terraces) and Ambury Park (mounds, heaps and short sections of stone rows on volcanic soil). Auckland City Council has responsibility for Browns Island (mounds, heaps and stone rows), and Manukau City Council and DOC manage Otuataua (an extensive garden area with rows, heaps, mounds and enclosures; Foster & Veart 1985). A further reserve area is to be set up at Wiri (I. Lawlor, Auckland Regional Council, pers. comm.). DOC administers Motutapu Island.

6.3 WAIKATO

The Waikato Conservancy, DOC, incorporates diverse landscapes, including interior riverine valley systems, weathered dunes on the west coast, and the coastal Coromandel Peninsula area, which is similar to areas in Northland and Auckland. The range of gardening sites is also diverse, with those in the Waikato river valley being predominantly modified soils and borrow pits, and the islands off the Coromandel Peninsula having stonework (stone-faced terraces, heaps and rows), while on the adjacent mainland there are slope trenches, modified soils and taro sites (Fig. 19).

Gardening was an important activity on the islands off the eastern Coromandel coast. Stonework is reported from Korapuki, Red Mercury Island (Whakau), Double Island and the Aldermen Islands. Ohinau is known traditionally and historically to be a place where gardens were planted in early spring, but there are no recorded sites (Furey 2000). On Great Mercury Island (Ahuahu) there is a high proportion of garden sites (20 of a total of 99) with stone rows and mounds, and parallel slope trenches leading into swampy areas. The largest field system is reputed to cover up to 100 ha. The majority of garden areas are concentrated in the northern half of the island, which has a different underlying geology and more fertile soils than the southern half.

On the Coromandel Peninsula, stonework in the form of rows and heaps has been reported from Papa Aroha, Moehau, Port Charles, Tuateawa, Kennedy Bay, Whangapoua and Wharekaho. Slope trenches at Opito are reminiscent of those on Great Mercury Island (Ahuahu), a short distance offshore. None of the recorded sites on the peninsula are large.

Stonework is present at Te Toto on Mt Karioi (R14/261, 1259), south of Raglan, although the evidence there is a complex mix of constructed features and natural geological formations. The age of these features is also uncertain, with some having been constructed quite recently and for purposes not related to gardening. Stone lines, heaps and a dry-stone wall are, however, likely to be related to Maori gardening on the volcanic soils (Wilkes 1998). Stone rows and heaps are also present at Waikaretu (R13/120), south of Port Waikato, in a similar geological situation.

Within the King Country, numerous storage pits have been recorded (Fig. 20), but few garden soils (Fig. 19). The soils are stone-free, so there is no obvious evidence of gardening. Borrow pits are rare, even though this area is sandwiched between the Waikato and Taranaki, where they are distinctive features of the cultural landscape. The reported borrow pits at Te Maika and in the Marokopa Valley are on the crest of relict sand dunes, as in Aotea to the north. Gardens have been identified by low earthen ridges, and may be more numerous than the recorded distribution (late O. Wilkes, pers. comm.). Little is known of gardening evidence in the inland King Country from Te Awamutu south, although storage pit sites are present and soils are volcanic in origin.

In the Waikato basin, borrow pits are found near the Waikato and Waipa Rivers, and are either dug into the scarps between the river terrace levels or into the ridges on the terraces. The main concentration is between Hamilton and Ngaruawahia. A density of c. 10 borrow pits/ha has been recorded at Horotiu, where pits are up to 30 m in diameter and may be 4–5 m deep (Gumbley & Higham 2000).

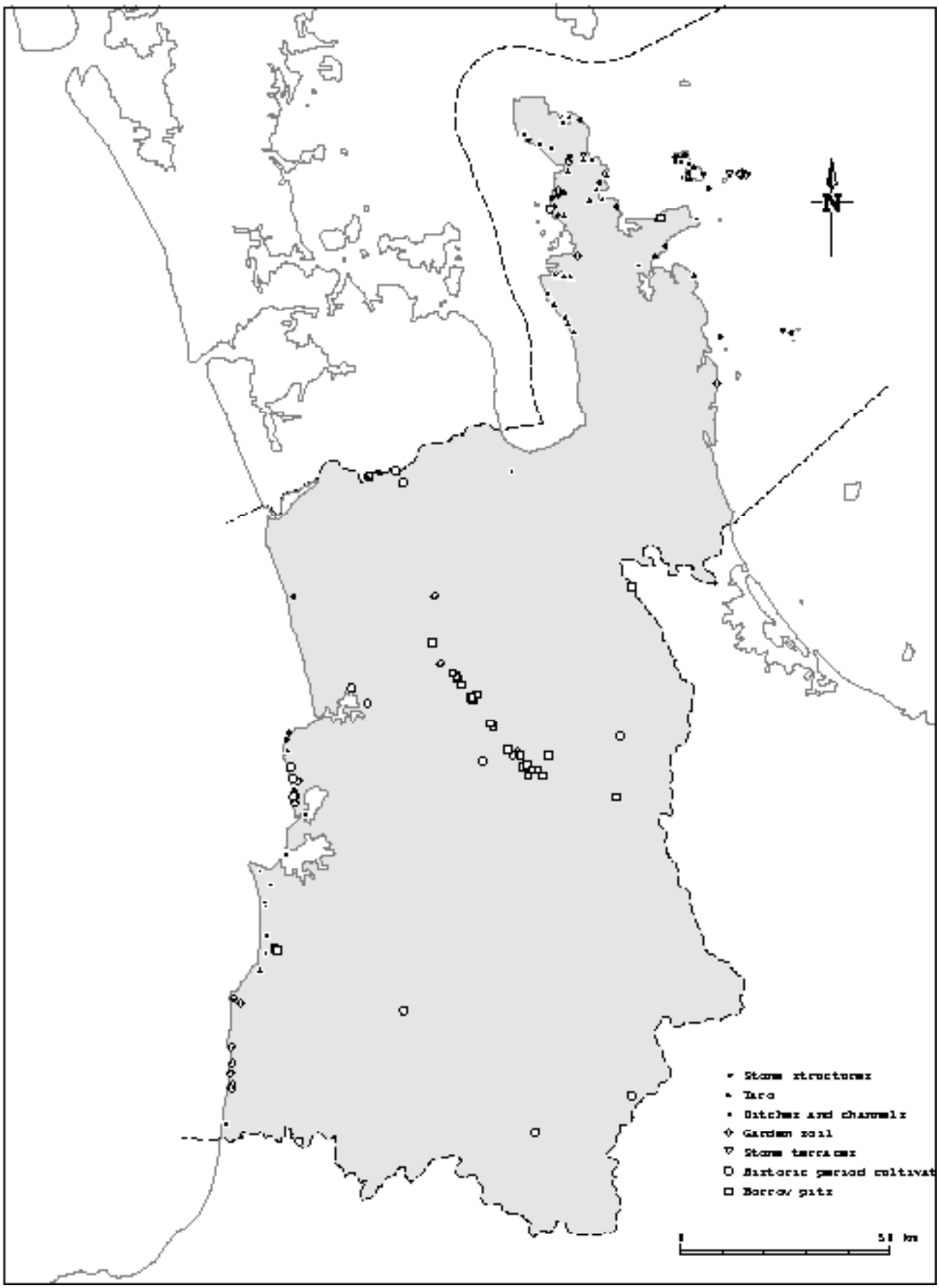


Figure 19. Distribution of recorded Maori horticulture-related archaeological sites, Waikato Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

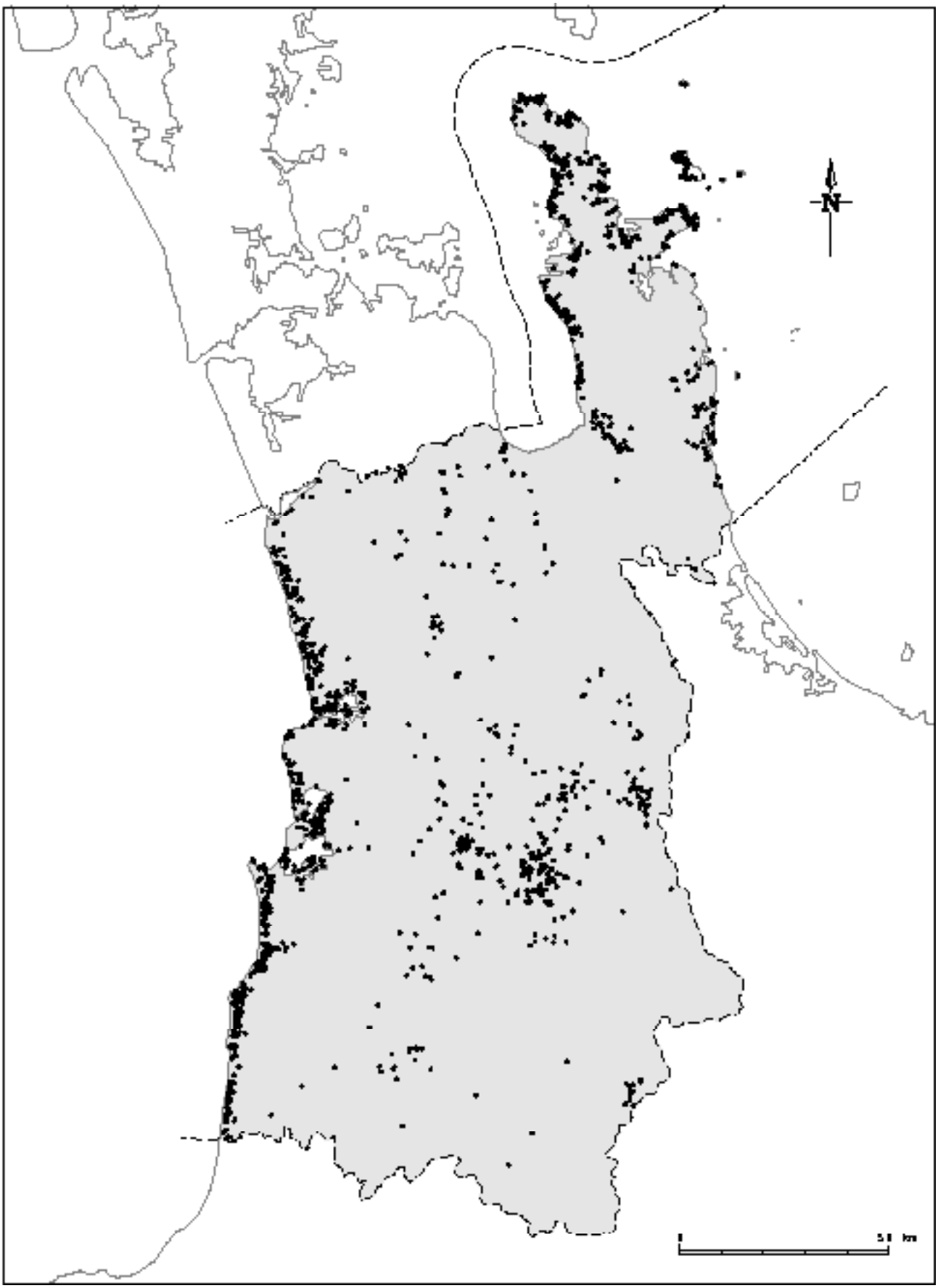


Figure 20. Distribution of recorded archaeological sites with kumara storage pits, Waikato Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

Borrow pits at Aotea near the west coast are distributed along the crest and sides of relict sand ridges. Again, the fine sand removed from the pits was incorporated into parent soils with a fine sand and silt composition (Walton 1983). Large terraces without occupation debris or features, which are therefore assumed to be gardens, indicate that there is more than one form of gardening evidence present in this area.

Maori gardening sites on protected land are confined to Korapuki, Double Island and the Aldermen Islands. These protected sites are not a representative sample of what is present on the Coromandel Peninsula, much less in the Waikato Conservancy region as a whole.

6.4 BAY OF PLENTY

In the Bay of Plenty region, the majority of the 55 sites where evidence of gardening has been recorded are modified garden soils (Fig. 21). Many of the records describe alteration to natural tephra layers or absence of layers, but some records of gardens soils are doubtful and from the descriptions could also be interpreted as occupation debris. Garden soils have been recorded on the Papamoa dune plain (Gumbley 1999; McFadgen & Walton n.d.). These have only become apparent on excavation, but are an important part of the settlement evidence on the coastal dunes and may be widespread through the eastern Bay of Plenty and elsewhere. Disturbed tephra layers, which were interpreted as garden soils, were also identified on Matakana Island (Marshall et al. 1994).

The remains of extensive garden systems have been identified in valley bottoms at Kawerau (Lawlor 1981a, 1983, 1984). The evidence consisted of modified soils and ditches or trenches utilising, and dug into, the Kaharoa Ash. All features have been blanketed by up to 500 mm of gravelly ash from the Tarawera eruption, masking what could be evidence of a widespread and extensive method of gardening in the inland valleys. Storage pits are abundant on spurs and ridges overlooking the valleys (Fig. 22).

Gardening evidence in river valleys such as those of the Rangitaiki and Whakatane Rivers is sparse, but storage pits are frequent on higher ground within the valleys (Fig. 22). The lack of direct evidence for gardening mirrors the situation in major river valleys on the East Coast, where suitable weathered alluvial soils could have been used for gardens without any modifications (Jones 1991).

Stone-faced terraces, assumed to be associated with gardening, are present on Mayor Island (Tuhua) and Moutohora Island. Stone rows and stone heaps are also present in several locations on Moutohora (Bain 1987). This evidence is similar to that present on islands from Northland through the Hauraki Gulf and eastern Coromandel.

With the exception of evidence around Kawerau, little is known of gardening in the inland Bay of Plenty. Traditional and historical accounts of cultivations around Lake Rotorua, and physical evidence of storage pits and rua, are described in some detail in Stafford (1994). A recorded site on Mokoia Island in Lake Rotorua has rock boundary markers outlining garden plots.

Horticultural sites on protected land are sparse. Only those sites on Moutohora Island qualify as having protected status.

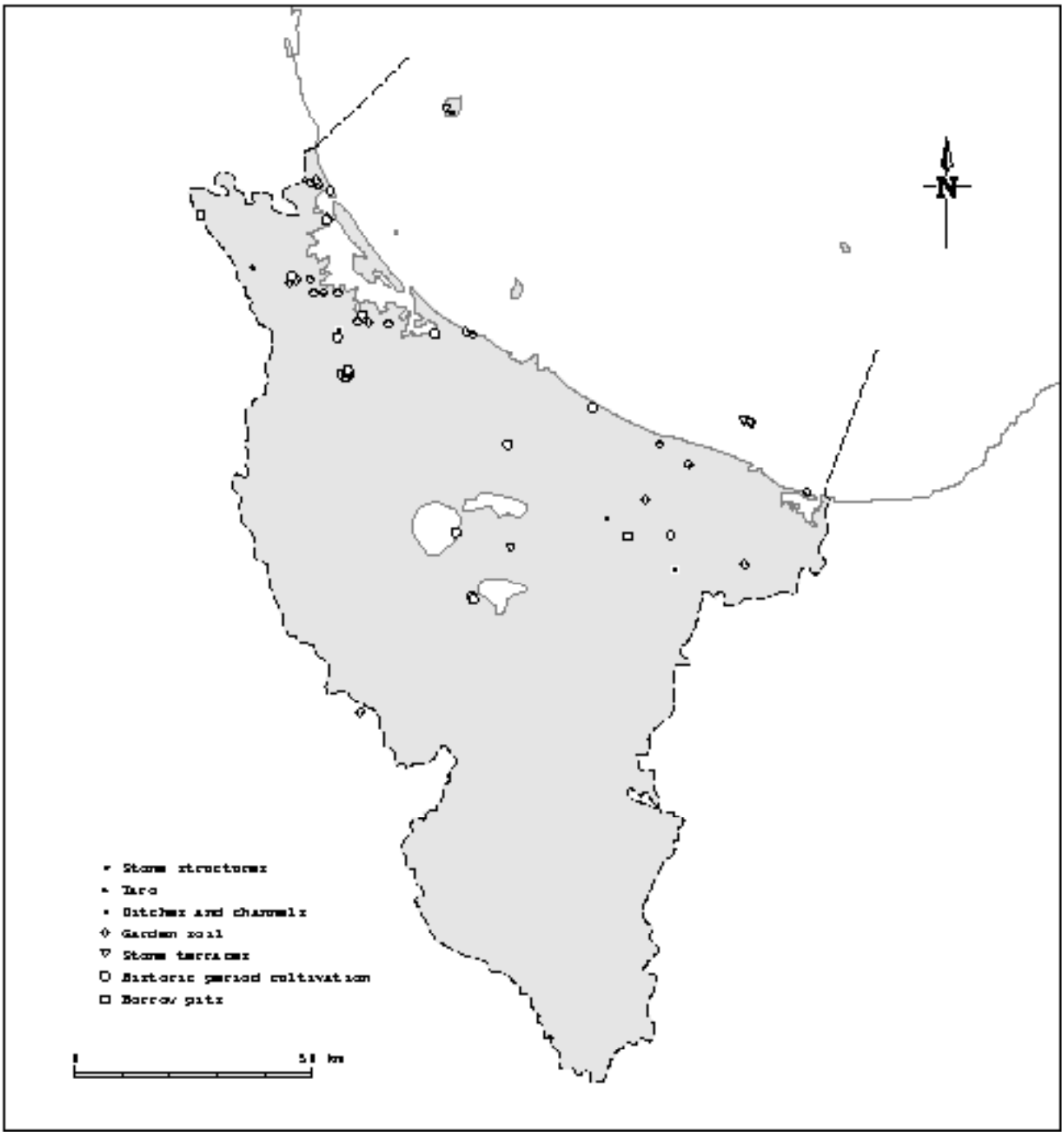


Figure 21. Distribution of recorded Maori horticulture-related archaeological sites, Bay of Plenty Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

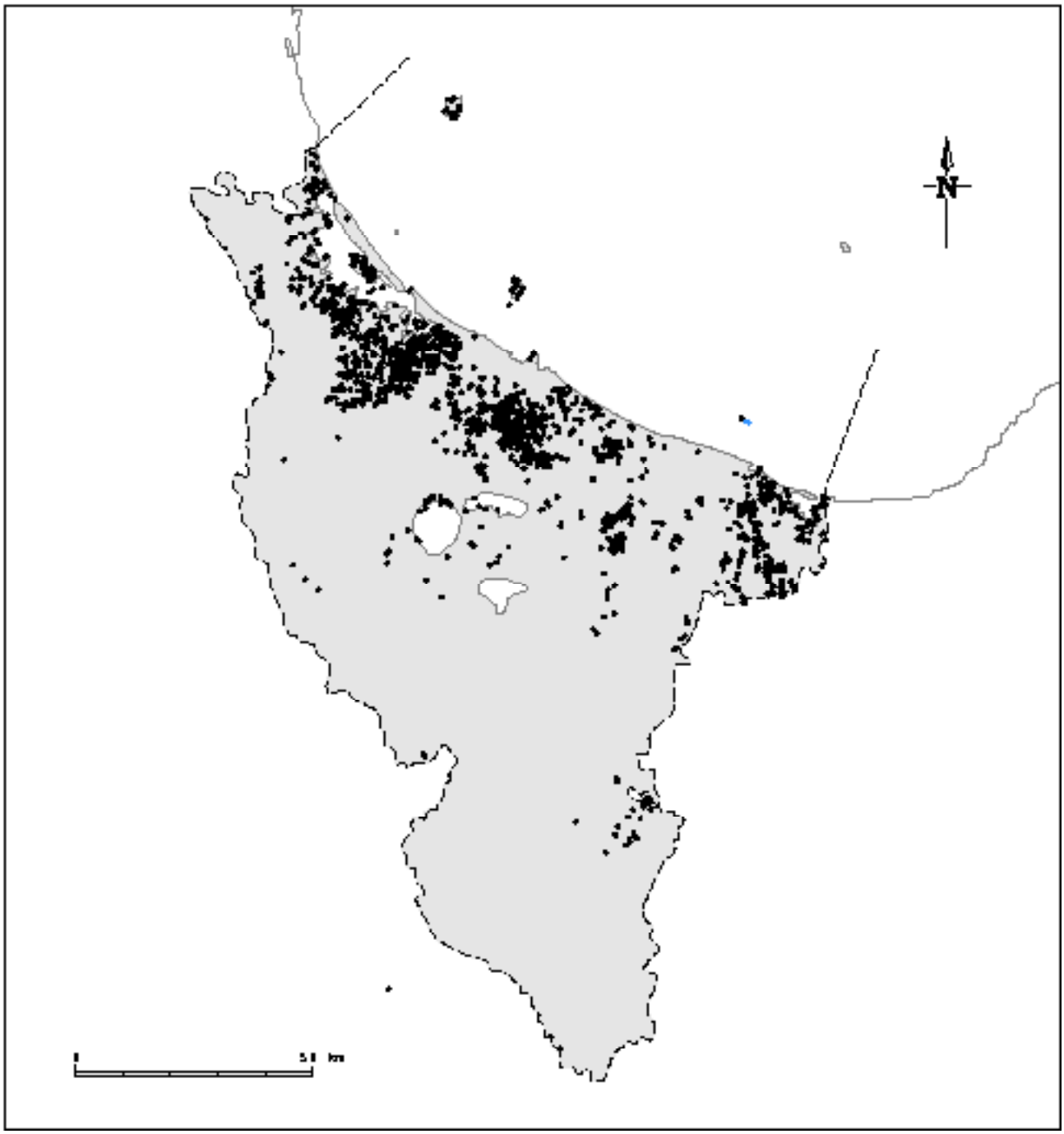


Figure 22. Distribution of recorded archaeological sites with kumara storage pits, Bay of Plenty Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

6.5 EAST COAST/HAWKE'S BAY

The East Coast/Hawke's Bay Conservancy area is large and diverse. Since there are significantly different topographic conditions and archaeological evidence for gardening, each area will be discussed separately.

Direct evidence of gardens is not common on the East Coast. A total of 46 sites have been recorded, including stone rows, modified soils, shallow ditches and one borrow pit (Fig. 23). Stone rows are present on the coastal platform near Cape Runaway, where a number of sites have been identified. However, storage pit sites are numerous on the East Coast (Fig. 24).

Gravels in topsoil have been recorded in several places, but Jones (1986) cautions against interpreting the presence of gravels in soils on alluvial flats as evidence of gardening where they might have a natural origin. In the Uawa and Waipaoa River Valleys, there is well-developed topsoil along the margins of the rivers at the base of the hills. In the absence of stone for making boundary rows, the evidence of horticulture is all but invisible. It is only the concentration of pa and storage pit sites in the vicinity that hints at widespread and intensive use of suitable soils for horticulture (Jones 1986, 1988).

The most extensive and well-preserved garden areas are those near Potikirua Point, between Cape Runaway and Lottin Point, where stony soils on the coastal strip allowed construction of numerous stone rows (Jones 1994). Fifteen stone row garden sites have been recorded on this north-facing area. These sites are discussed in more detail in section 7.5.

Stone rows, enclosures and stone heaps (Y14/126) are also present at Raukokore to the west of Cape Runaway, on the coastal terrace to the east, and are also known historically from Waihau Bay. South of Gisborne, there is a historic reference to stone rows at Bartlett's Flat (Mitcalfe 1970: 175).

Trench-like features or low banks with ground divided into rectangles were recorded at three sites to the east of Whanarua Bay (Leahy & Walsh 1982: 13) and were observed at Whangara (P. Bain, DOC, pers comm.)

In 1769, Captain Cook and Joseph Banks observed an extensive area under cultivation on the slopes above Anaura Bay (Salmond 1991). The descriptions of taro and gourd plants, and kumara plantations of different sizes and growth, show the potential of the area for growing most of the pre-European crops. No evidence of this former gardening activity is visible archaeologically (Jones 1989).

Botanical evidence may provide indirect evidence for Maori gardening. At Grey's Bush in the Waipaoa River Valley, a remnant of the forest that originally covered the valley is situated on the flood plain and borders a clay silt and sand fan. The mixed kahikatea (*Dacrycarpus dacrydioides*) and puriri (*Vitex lucens*) canopy of the bush is estimated to be c. 500 years old and represents a single-age stand (C. Ward, DOC, pers. comm.). The common age of the trees may provide evidence for the time of initial forest clearance and also for preferred gardening areas, with the bush (situated on Waiharere Soils of the flood plain) not being reburnt, while repeated burning and gardening prevented the natural sequence of regeneration on the adjacent clay loam derived from the alluvial fan.

As on the East Coast, storage pits are numerous in Hawke's Bay (Fig. 24), but gardens are difficult to detect (Fig. 23). This is a common problem in areas where loam soils suitable for gardening were also stone-free. A total of 19 horticultural sites are recorded in the NZAA site recording file, a serious deficiency in comparison with other site types.

Parallel trenches on north- and north-east-facing slopes have been recorded in a few locations, but the details are brief. Stone rows, similar to the descriptions of the trenches, have been observed near Waipukurau. Rows have also been observed near the base of Te Mata Peak in Havelock North. Records of modified soils have brief descriptions, and some are doubtful gardening sites. Instead, they are likely to be evidence of shell midden scattered around a former settlement nearby. In the Napier area, terraces of irregular size on north-facing slopes have been tentatively identified as garden terraces (Fox 1982).

No specific gardening sites are recorded on protected land, but it is likely that the Otatara-Hikurangi Pa complex near Napier, which is a reserve, has garden areas adjacent to the living sites.

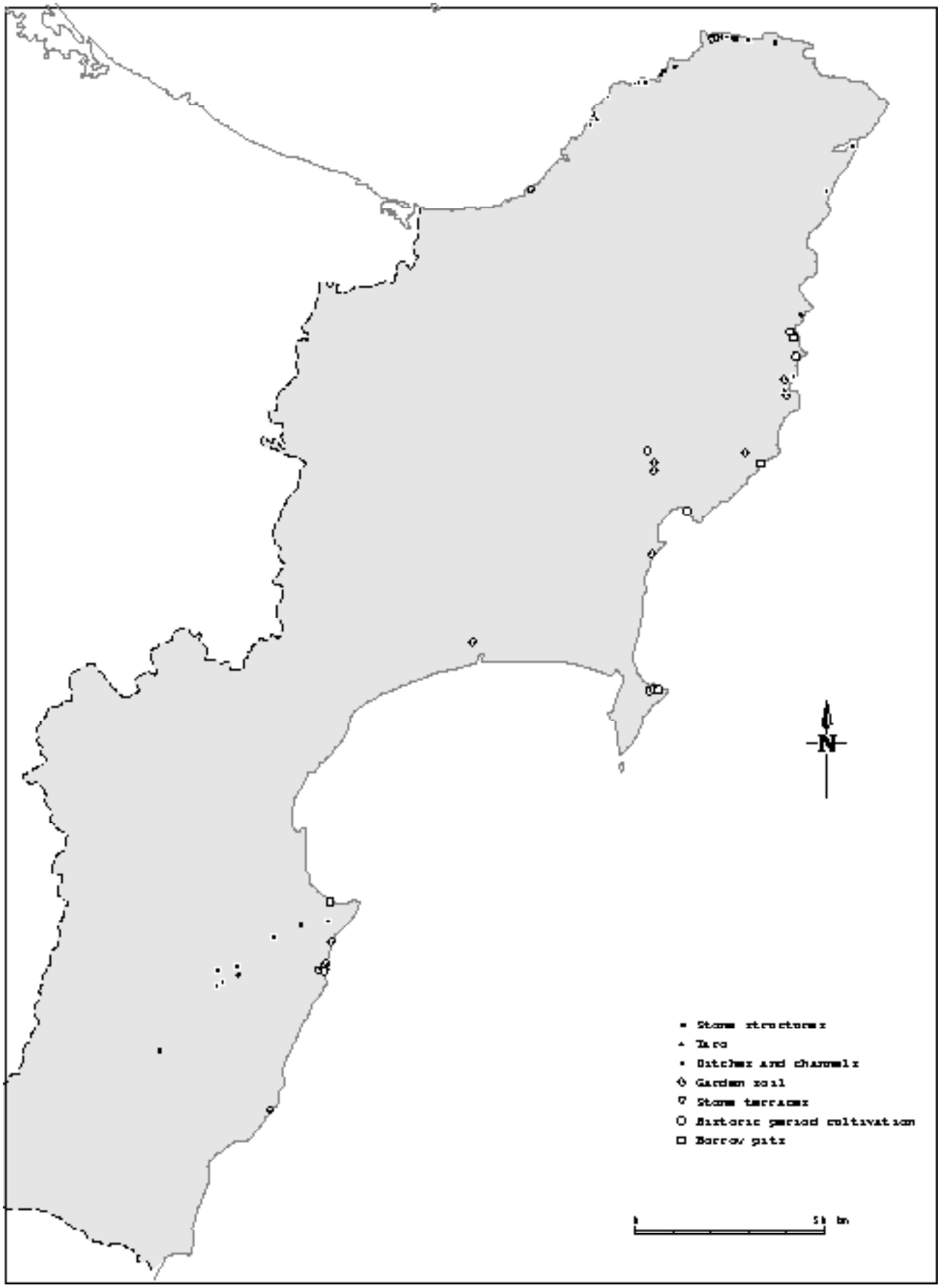


Figure 23. Distribution of recorded Maori horticulture-related archaeological sites, East Coast/Hawke's Bay Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

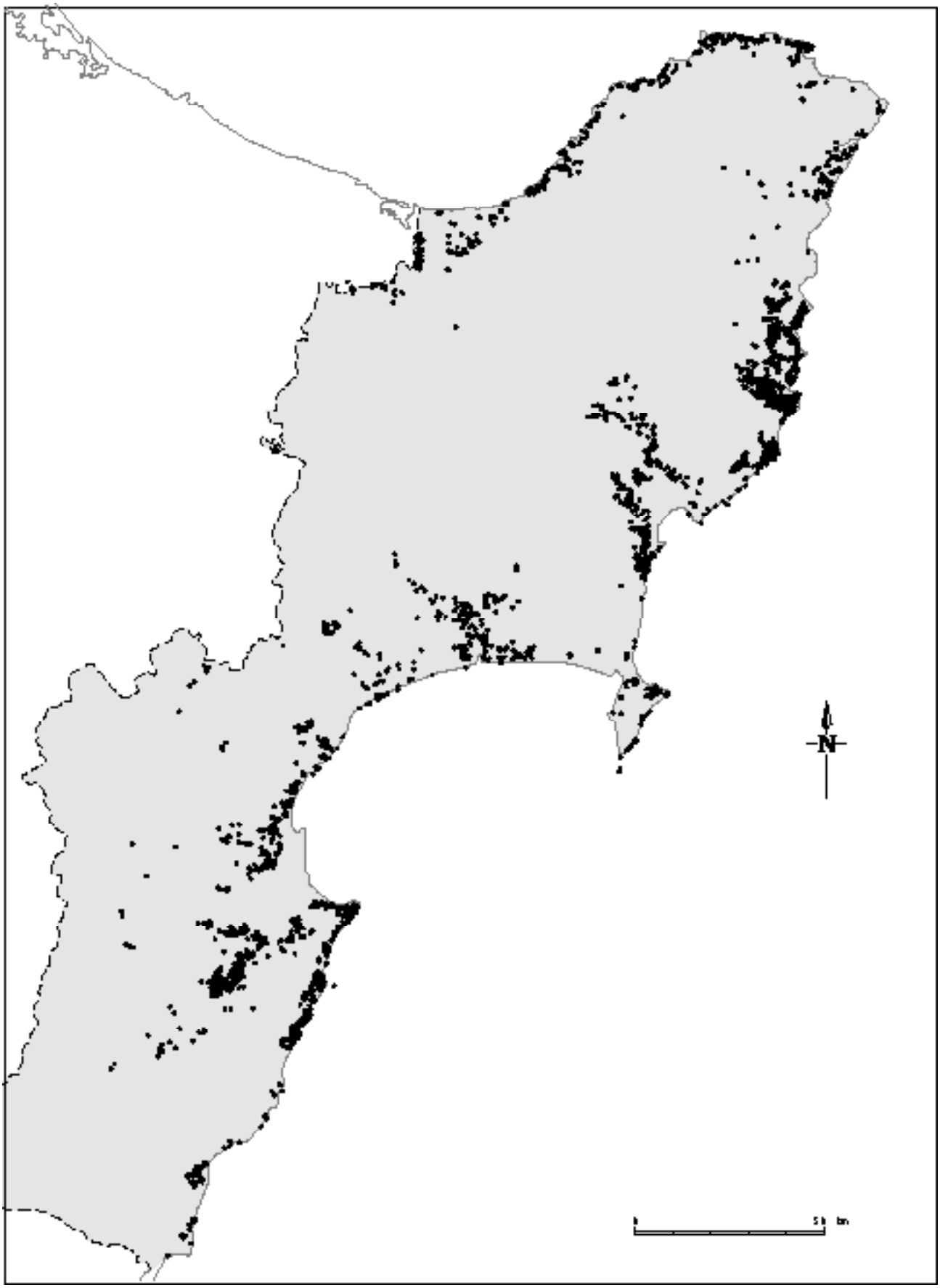


Figure 24. Distribution of recorded archaeological sites with kumara storage pits, East Coast/Hawke's Bay Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

6.6 TONGARIRO/TAUPO

Little is known of the range of gardening sites in the Taupo area. There are 14 gardening-related records in the NZAA site file (Fig. 25), but some of these are doubtful or their function has been incorrectly assigned to gardening. Stone rows and modified soils account for 10 of the 14 recorded sites. Storage pits are present (Fig. 26), indicating that gardening was able to be carried out here, just as it was in the Rotorua lakes district.

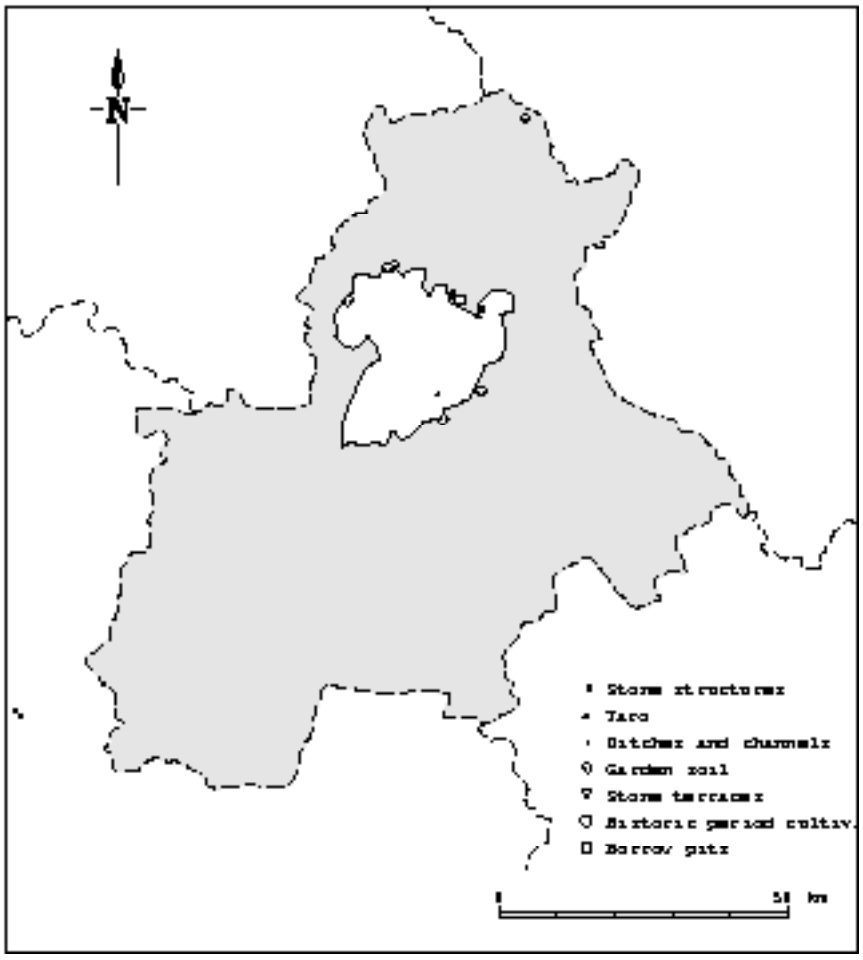


Figure 25. Distribution of recorded Maori horticulture-related archaeological sites, Tongariro/Taupo Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

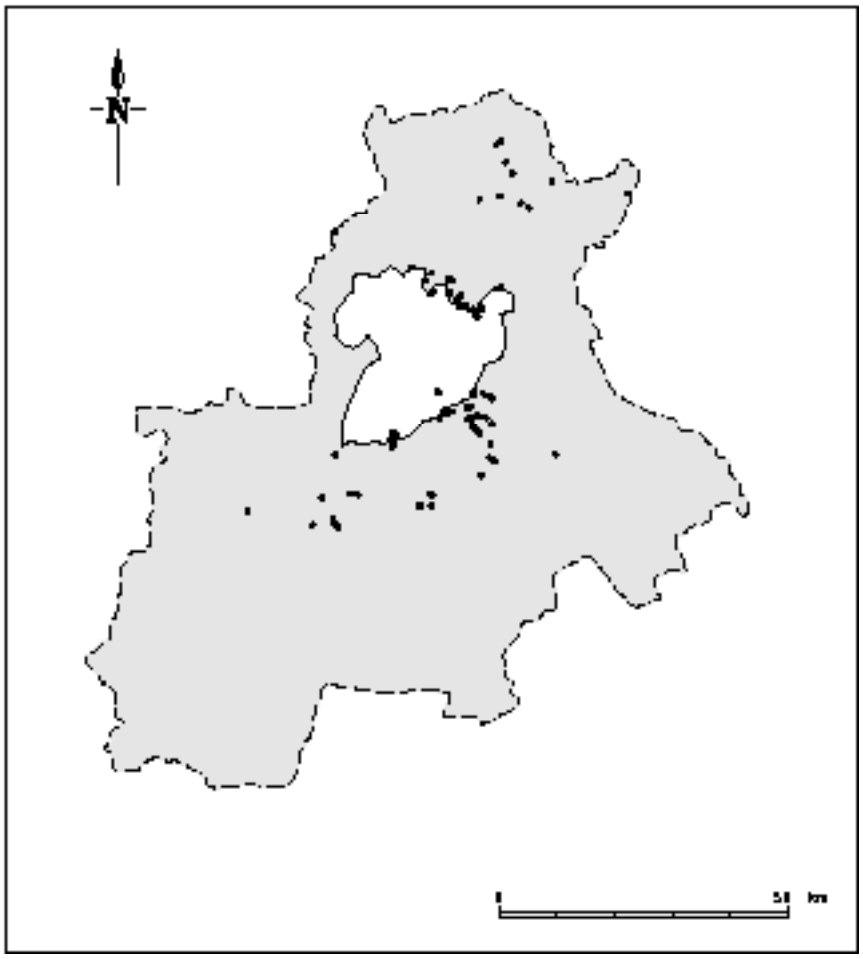


Figure 26. Distribution of recorded archaeological sites with kumara storage pits, Tongariro/Taupo Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

6.7 WANGANUI

The range of gardening sites is poorly represented in the Wanganui region. Borrow pits dominate the archaeological evidence of gardening, accounting for 82% of the 78 recorded sites (Fig. 27). By inference, records of modified sand-added soils should be present in equal numbers, but such sites are not well represented in the records. Only the better soils were modified by adding sand, but soils without additives also appear to have been used (Walton & Cassels 1992).

Borrow pits are most frequently found in south Taranaki, between the Manawapou River and the Waitotara River, where sand was taken from underlying dune ridges and added to tephra-derived loams on the surface (Walton 2000). They are relatively rare in north Taranaki. Buist (1993) considered that this anomaly was due to the absence of pronounced dunes in the north, so that the borrow pits were confined to river terraces where coarse river sand and pebbles were extracted.

Stone rows were noted in the Warea area in the 19th century, but these no longer exist (Walton 2000). They were probably removed by European farming activities.

The distribution of storage pits (Fig. 28) in undefended sites and pa mirrors the pattern for borrow pits. There are fewer undefended sites with associated pits in north Taranaki, but there is a large number of pa present. However, whether these pa sites contain large numbers of storage pits is not known.

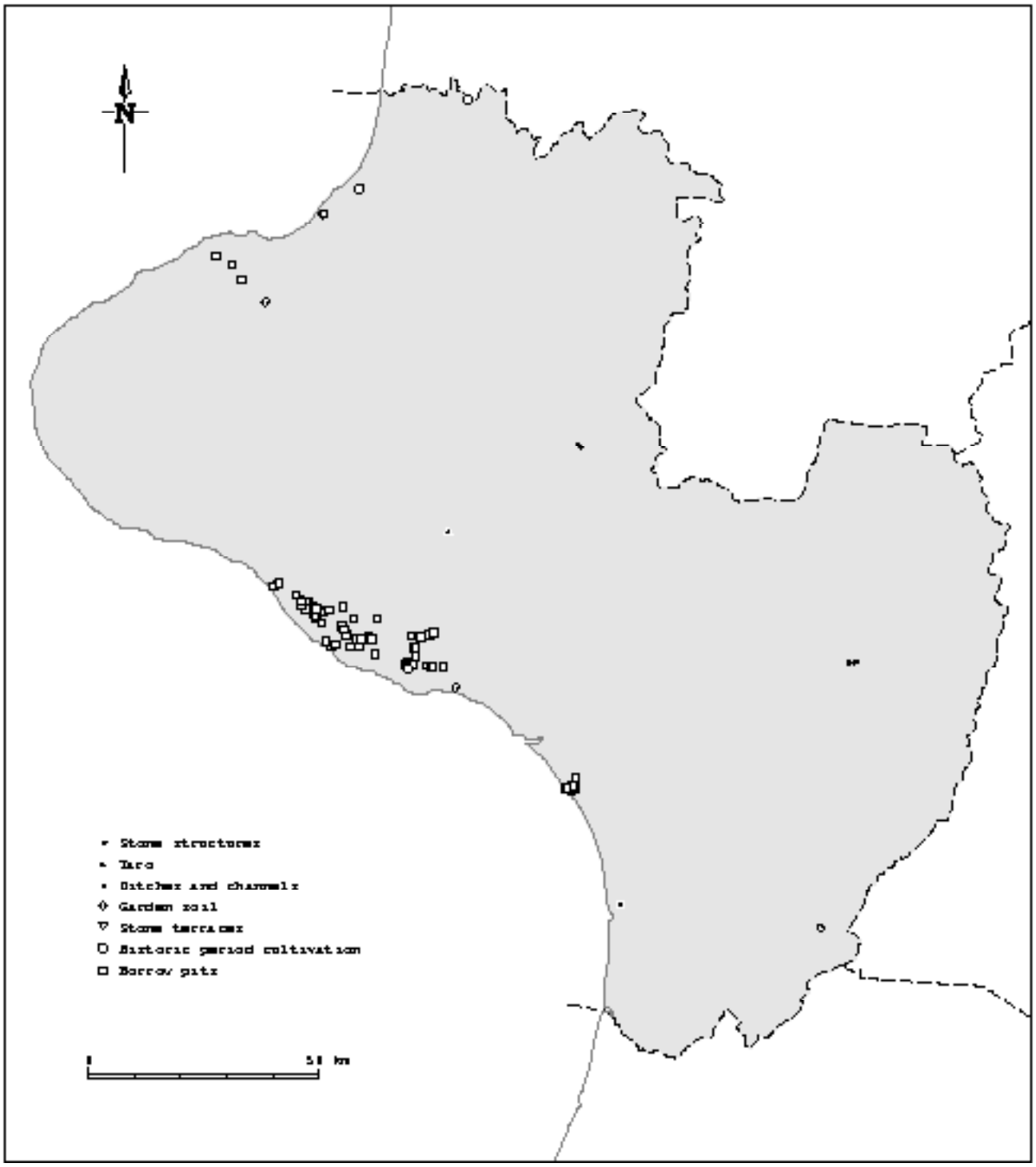


Figure 27. Distribution of recorded Maori horticulture-related archaeological sites, Wanganui Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

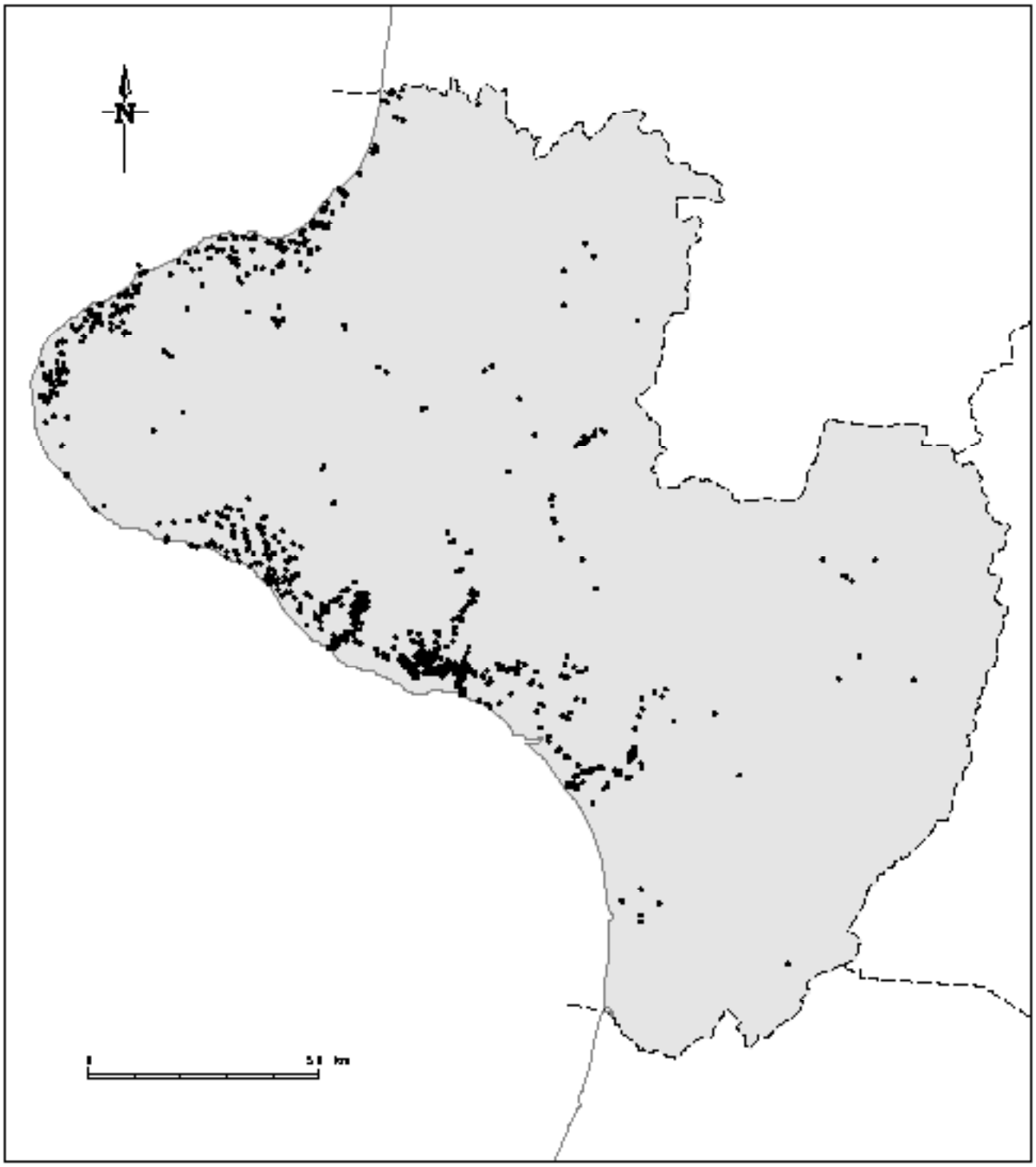


Figure 28. Distribution of recorded archaeological sites with kumara storage pits, Wanganui Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

6.8 WELLINGTON

The Wellington region has widely varying environmental conditions and is best addressed as several sub-regions, including the Horowhenua coast, the greater Wellington city area, and Palliser Bay and the coastline north through Wairarapa. With the exception of the Wairarapa area, the evidence for gardening in most of the Wellington region is sparse. A total of 94 gardening-related sites have been recorded, of which 82% are stone rows (Fig. 29). Of the few storage pit sites that are recorded, most are clustered around Porirua, although they are also present in the Wairarapa (Fig. 30).

The Horowhenua coastline has documented historic cultivation of kumara and taro (and European-introduced crops) but there is no archaeological evidence for this. However, gardening sites may still be present, buried under recent dunes. Wooden gardening tools have been recovered from some water-logged sites, indicating that gardening was carried out. Few storage pits have been recorded (McFadgen 1997).

Terraces, thought to have been constructed and used for gardening, are present at Whitireia Peninsula, Porirua. Excavations showed that natural terraces had been modified, and although the evidence did not conclusively indicate gardening, this is considered to be the most likely explanation (Walton 1992).

Stone rows and modified soils have been recorded on Kapiti Island, but may be historic. Similarly, rows have been noted at Fitzroy Bay on Wellington's south-east coast, but these may have a natural origin and be part of an old shoreline. However, in the same area, there are also rows on the coastal platform that run at right angles to the shoreline and are undoubtedly cultural in origin.

The most extensive evidence for gardening is from the Wairarapa coast. The coastal platform, with shingle fans and marine-deposited stones, gravel and sand, has stone rows and mounds at many locations. These are usually associated with stream mouths. The most concentrated evidence is on the section of coast from Cape Palliser to Lake Onoke, where the platform is continuous and wide. These sites are well known through the Wairarapa Archaeological Research Programme, in which there was an emphasis on horticultural sites (Leach, B.F. & Leach, H.M. 1979; Leach, H.M. 1979a).

Less well known is the area from Flat Point to Cape Palliser, where large and well-preserved stone row systems are also present. Several sites, such as Okoropunga and Tora, have been investigated (McFadgen 1980a, 2003). The coastal platform on this section of coastline is discontinuous and narrower than further south. There are no gardening sites on the coast north of Flat Point, as the coastal platform is absent or very narrow, and steep hills border the coast (McFadgen 2003). The stone rows of the Wairarapa are situated on old beach ridges that make up the coastal platform, or on old shingle fans that spill out of the hills behind. Suitable sheltered valleys are rare in this area of steeply dissected hills, but where the right conditions exist, gardening sites are present on the valley floor and lower slopes.

During the Wairarapa Archaeological Research Programme, 15 garden sites were mapped: 12 on the coastal platform (Leach, H.M. 1979a), two in the Makotukutuku Valley (Leach, B.F. 1979) and one in the Moikau Valley (Prickett 1979). Mapped sites vary in size from Waiwhero (7 ha), to Black Rocks (16 ha). This latter site is the largest garden complex in Palliser Bay (Leach, H.M. 1979a: 155). The evidence at these garden complexes consists primarily of stone rows oriented at right angles to the coast. At a few sites, the addition of cross-rows formed enclosures. In some instances, e.g. at Pararaki, cooking and domestic evidence have been recorded in association with the gardens. Only rarely were soils on the Palliser Bay coast modified by the addition of extra sands and gravels, but charcoal was well incorporated into the soil profile. Mounds are rare and present at only a few sites (e.g. Makotukutuku Valley and North Waiwhero). Stone paving, which has been interpreted as a footpath, has also been excavated. Three sites with modified soil, but without associated stone rows, were recorded in Palliser Bay.

Excavations were conducted at seven coastal garden complexes (Black Rocks, North Waiwhero, North Kawakawa, South Pararaki, Te Humenga, Washpool and Whatarangi) where stone rows, mounds and soils adjacent to gardens were investigated. Evidence of environmental degradation was apparent; in some instances, garden soils and stone rows were covered by silt and sand. In addition to the stone row garden systems of the coastal platform, there are also garden sites in the Makotukutuku Valley that are of different form and probably of later age. One such terrace was excavated at the Washpool Terrace Garden, and a deep modified loam soil was found (Leach, B.F. 1979). A stone mound at the Washpool Cross site was found to have been constructed over an earlier modified soil, and contained a posthole thought to have been for support of a gourd vine (ibid). Both of these sites were c. 2 km inland from the coast.

Excavations at Okoropunga revealed a soil modified by the addition of marine gravel and constructed over existing stone rows. In contrast to the sites in Palliser Bay, the soils at Okoropunga did not have significant amounts of charcoal present through the profile, and the presence of gravel-added soils and borrow pits distinguish them from other sites (McFadgen 1980b). It is also likely that gravel was added to soils at Pukaroro Maori Reserve, c. 1 km north of Okoropunga (K. Jones, DOC, pers. comm.).

The Palliser Bay sites are notable for being well-preserved examples of garden plots and Polynesian horticultural practices related to the period between the mid-14th century and the end of the 15th century. Many of these gardens appear to have been used only once, and there was no later modification to the original plot layout. The sites on the coastal platform were abandoned—H.M. Leach & B.F. Leach (1979) suggested that climatic and landscape deterioration was

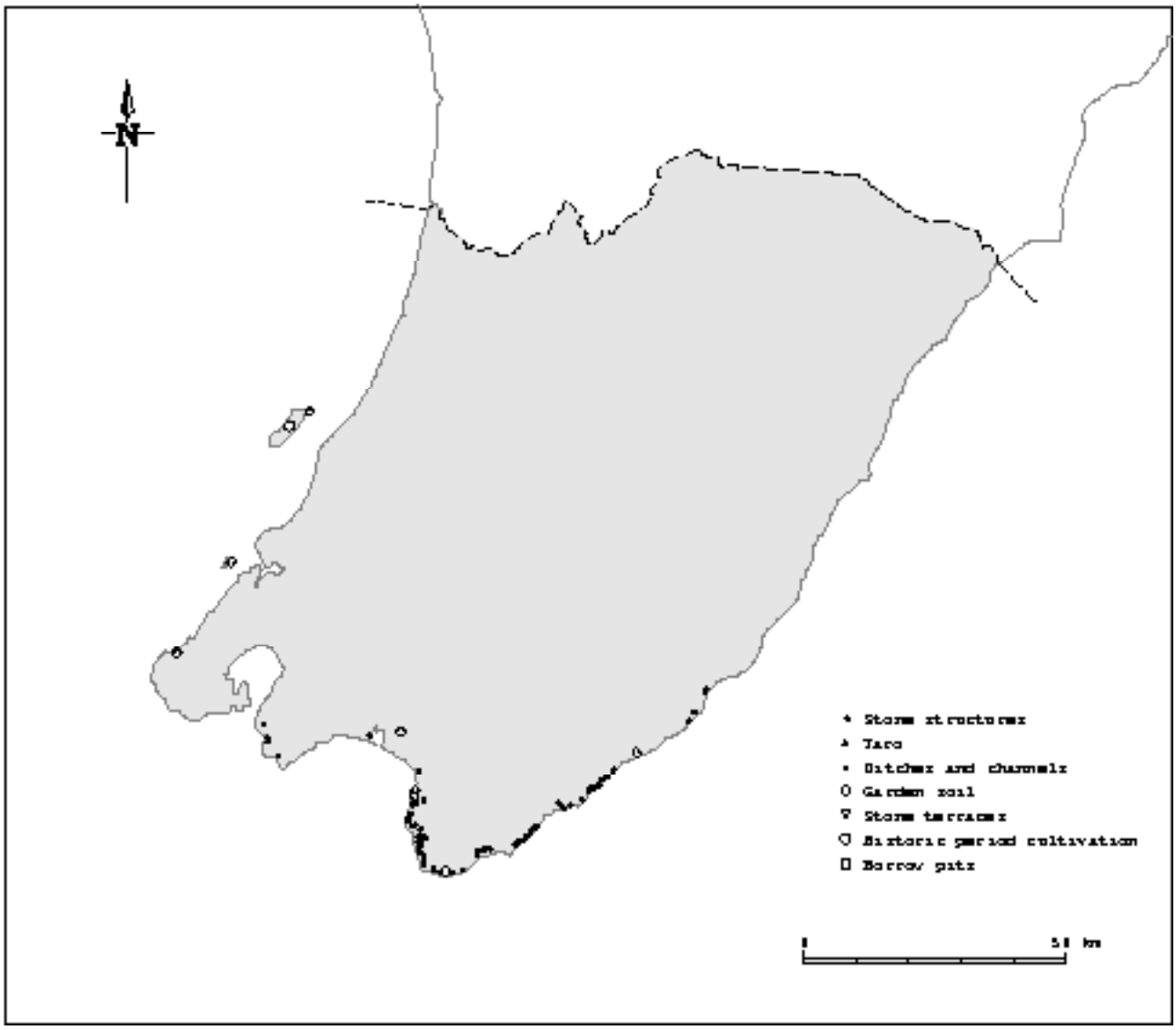


Figure 29. Distribution of recorded Maori horticulture-related archaeological sites, Wellington Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

responsible in what was always a marginal area for gardening. New research based on geomorphology suggests that landscape changes induced by seismic and tsunami events may have been a contributing factor to the abandonment of the coastal Wairarapa area (McFadgen 2003), but this has not been proven archaeologically. The sites are largely intact and many are well mapped. Terraces, middens and living structures exist within the gardens. These sites are, therefore, a relict archaeological landscape, primarily because they collectively capture an economy at a defined period in time. As such, their importance cannot be understated.

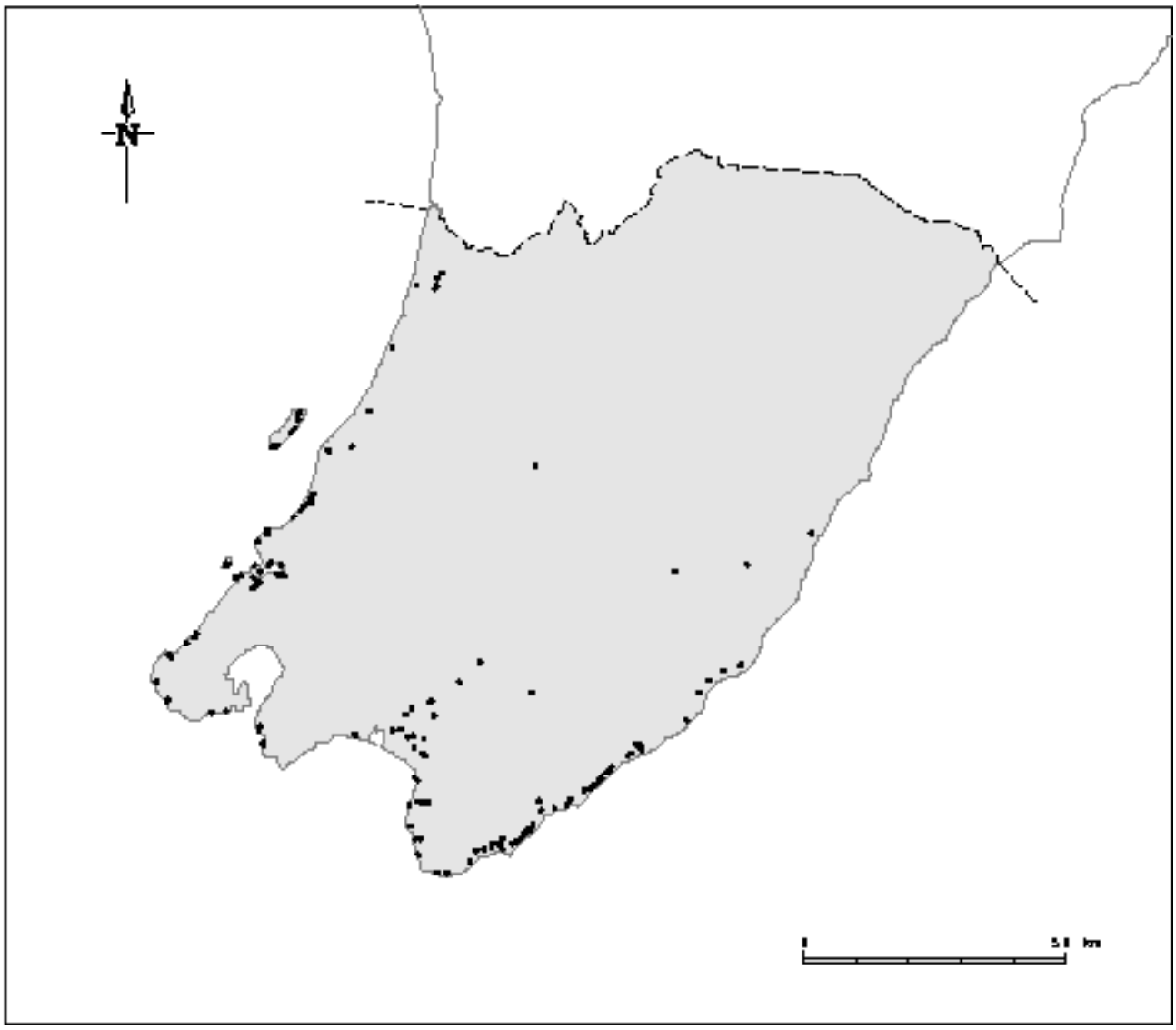


Figure 30. Distribution of recorded archaeological sites with kumara storage pits, Wellington Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

Although gardening was no longer carried out on the coastal platform of Palliser Bay, it continued to be practised in the wider area, but centred on small valleys and on the inland plains, rather than the coast. There are records of storage pits and accounts of historic gardening on the east side of the valley south of Carterton (McFadgen 2003). Storage pit complexes in the Wairarapa Valley tend to be associated with ditches, banks and scarp defences (Leach, H.M. 1979a).

None of the recorded garden sites are on protected land, although the Pukaroro site is a Maori Reserve.

6.9 NELSON/MARLBOROUGH

In total, 71 sites related to gardening are recorded in the Nelson/Marlborough region (Figs 31 and 32). Twenty-five of these are stone rows or rows, and 39 are modified soils. The evidence can be split geographically. The primary form of gardening evidence in the Nelson area is modified soils, but in the Marlborough Sounds, D'Urville Island and the east coast of Marlborough, stone rows are more

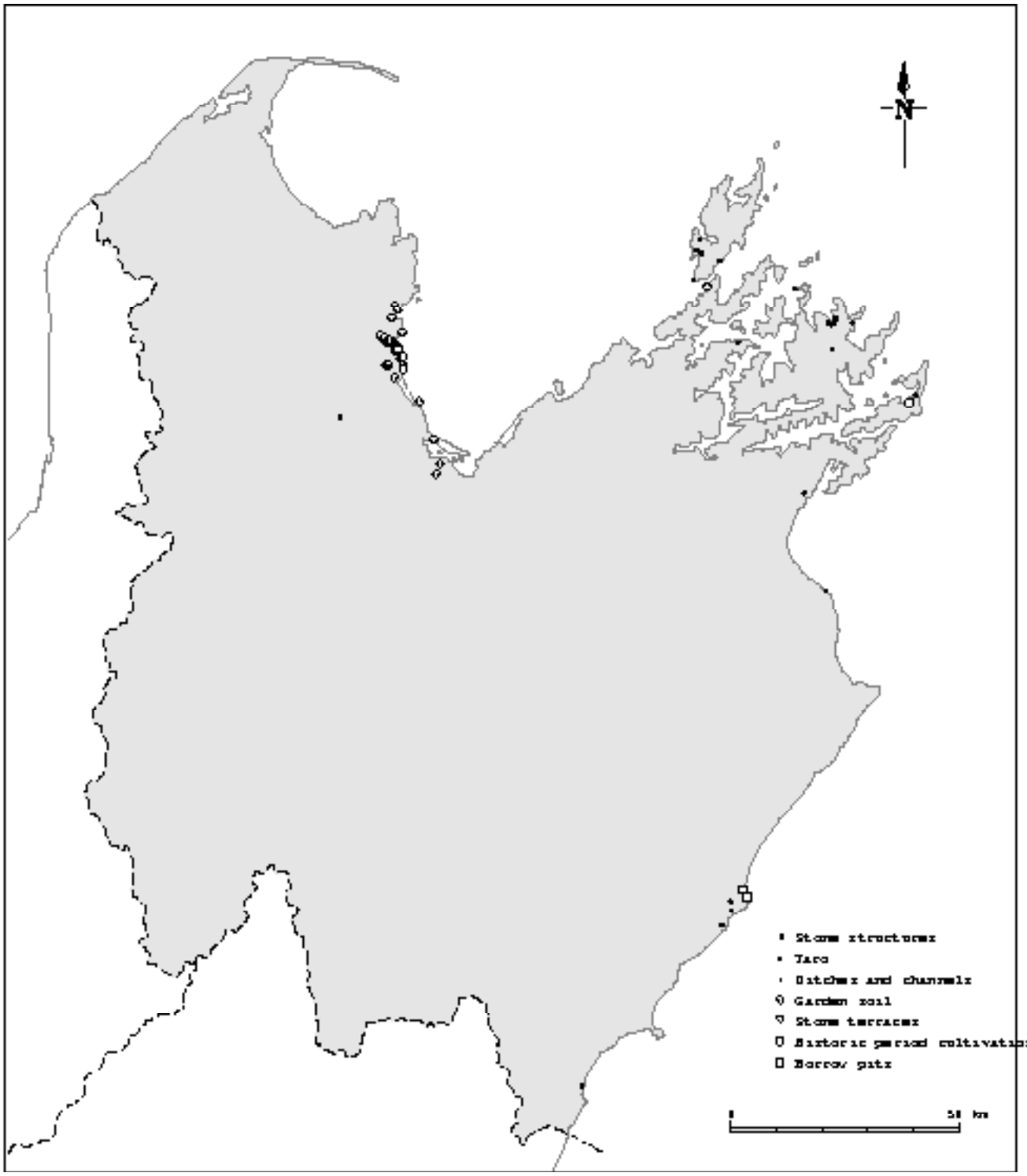


Figure 31. Distribution of recorded Maori horticulture-related archaeological sites, Nelson/Marlborough Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

common, although modified soils also occur. Borrow pits are rarely reported in the records: there are only four sites in the Nelson area and none in Marlborough. However, the level of recording does not reflect the incidence of borrow pits in relation to soils; instead, it is due to borrow pits being ploughed out, or the fact that most of the locations for the modified soils are taken from soil maps and have not been ground checked. Stone mounds are rare in this region.

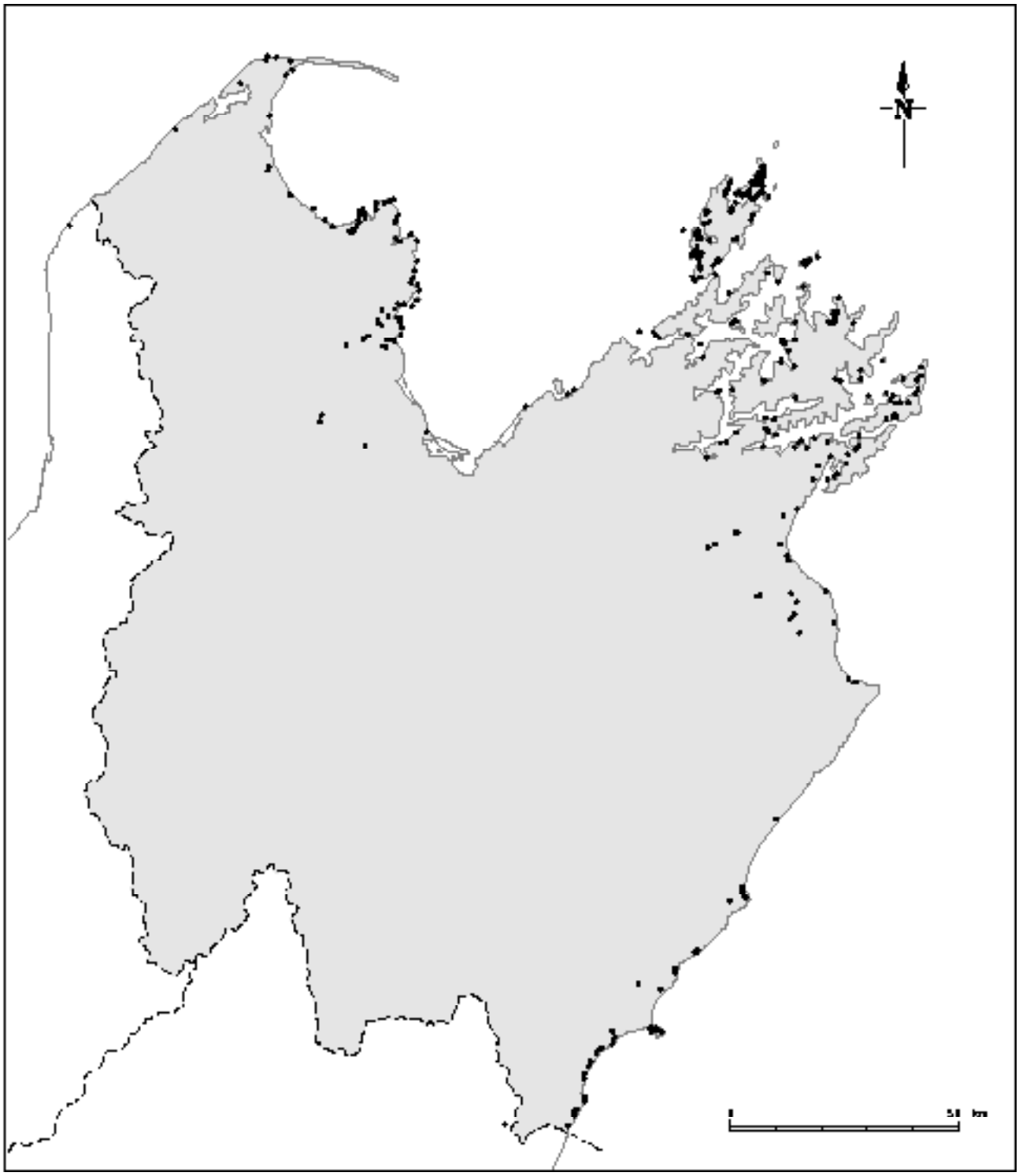


Figure 32. Distribution of recorded archaeological sites with kumara storage pits, Nelson/Marlborough Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

The majority of the recorded sites are in the Nelson area (including D'Urville Island), with fewer sites in Marlborough. Within the Nelson lowlands area, the principal horticultural site type is modified garden soil, where gravel and sand have been added to silt loam soils (Challis 1976). Several modified soils are recorded in this area, but it is obvious that further sites are yet to be located, or that gardening took place without the need to alter soil texture. Similarly, storage pit sites are distributed throughout Golden Bay, but direct evidence of gardening is under-represented. A detailed analysis of gardening sites in the Motueka area is presented in Challis (1978: 28–29). It is worth noting that some storage pits reported in the literature have been found to be sunken dwelling sites when excavated (Challis 1991: 105–106).

Stone rows on D'Urville Island are situated on old shingle fans at Manawakupakupa and Opotiki Bays. General occupation evidence, including storage pits, is present in addition to the rows. At Opotiki Bay, the rows run across the slope, while those at Manawakupakupa (which cover 2–3 ha) are oriented up and down the slope but are less ordered than those at Opotiki (Prickett & Prickett 1975: 123). Storage pits are present in large numbers in this area. In contrast, in the north-east part of the island in an area of rich soils, no surface evidence of gardens was seen in 1840. This demonstrates, yet again, the difficulty of assessing the horticultural potential of an area from the remaining field evidence of gardening. Modified soils were noted in association with the stone rows, and were also reported from Greville Harbour (Challis 1991: 102).

In Marlborough, the evidence is predominantly of stone rows. Well-known investigated sites include Titirangi and Woolshed Flat in the Marlborough Sounds and the complex of sites in the Clarence area on the east coast. The rows at Titirangi formed enclosures, which contrasts with the usual parallel lines more commonly reported elsewhere. Again, these sites are located on shingle fans adjacent to the coast. The Cattleyards Flat site has been described by Trotter (1977) as '…probably the most impressive garden site in the South Island, it comprises an extensive complex of stone and earth rows, mounds and middens'. Within the garden plots, the soil had been modified by the addition of pebbles.

The sites at Clarence River, on old raised coastal terraces, are present over a distance of c. 5 km and consist of stone rows, modified soils and borrow pits (McFadgen 1980a; Trotter & McCulloch 1999b). It has been estimated that P30/5 alone covered an area of 10 ha (Trotter & McCulloch 1979), but the site has been partially destroyed by ploughing. Earth rows, in addition to those of stone, have been recorded (see section 7.2).

Sites with storage pits are more numerous than garden sites (Fig. 32). Golden Bay and the Marlborough Sounds have concentrations of storage pits, but this may be an artefact of site surveying. Storage pits are in association with stone rows at Robin Hood Bay and at Seventeen Valley near Wairau (Brailsford 1981: 74, 77). Garden sites are expected to be present in larger numbers, but perhaps without the highly visible stone rows.

6.10 CANTERBURY

Within the Canterbury region there are only 17 recorded garden-related sites (Fig. 33), and four possible sites without NZAA site file numbers, as recorded in Challis (1992: 108). These include stone rows and borrow pits (Harrowfield 1969; Brailsford 1981; Walton 1985a; Trotter & McCulloch 1999a, 2001; Gordon et al. 2004). The evidence in north Canterbury is sparse and similar to that present on the Marlborough east coast. Borrow pits and modified soils are evident at Woodend and Tuahiwi near Kaiapoi, and possibly at Gore Bay (Walton 1985a; Challis 1992; Trotter & McCulloch 2001). The gravels accessed at the Woodend and Tuahiwi borrow pits were alluvial rather than from old beach ridges (C. Jacomb, Dunedin, pers. comm.).

The southernmost gardening evidence is adjacent to Lake Ellesmere. The bays of Banks Peninsula have warm, frost-free and sheltered coastal microclimates, which were favourable to gardening, but most of the garden sites are in the northern and eastern valleys, possibly because other factors, such as sea access and exposure to the south, placed limitations on settlements in south-facing bays. The gardening evidence is of earth and stone rows, of which the largest complex is at Panau, covering an area of c. 16 ha (Jacomb 2000). Stone rows have been reported from Menzies Bay, Stony Bay, Ducksfoot Bay, Goughs Bay and Paua Bay (Harrowfield 1969), and Island Bay, and most recently from Flea Bay, to the east of Akaroa Harbour. Shallow, parallel trenches are known from Paua Bay and Lavericks Bay. However, storage pits are rare on Banks Peninsula (Fig. 34) (Law 1969; C. Jacomb, Dunedin, pers. comm.). Modified soils are present at Okuora Farm near Birdlings Flat, near raised-rim storage pits and what appear to be borrow pits on the old beach ridges below. Possible kumara phytoliths have been identified in these soils (Gordon et al. 2004). Borrow pits have also been recorded at Taumutu near the western end of Kaitorete Spit at Lake Ellesmere (Trotter & McCulloch 1999a). These pits cover an extensive area, extending in two lines for c. 1 km along an old beach ridge, and modified soils have reputedly been found in the vicinity. If this site does indeed represent the southernmost extent of pre-European Maori kumara gardening in the South Island, then its size is quite remarkable. The number of borrow pits here is far in excess of the number found at Woodend, where there is a maximum of seven definite and nine possible borrow pits (Walton 1985a), and the 400 m × 20 m strip at Tuahiwi (Trotter & McCulloch 2001). The pits indicate that there must have been very extensive areas of modified soils and gardens right at the limit of tolerable growing conditions. Further work needs to be done at this site, particularly on descriptions of soil profiles, examination of soil samples for microfossils and mapping of borrow pits. It would also be useful to have a geomorphologist assess the site, and to evaluate other possible explanations for the origin of the pits.

None of the gardening sites in the Canterbury region are on protected lands (Challis 1992).

Figure 33. Distribution of recorded Maori horticulture-related archaeological sites, Canterbury Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

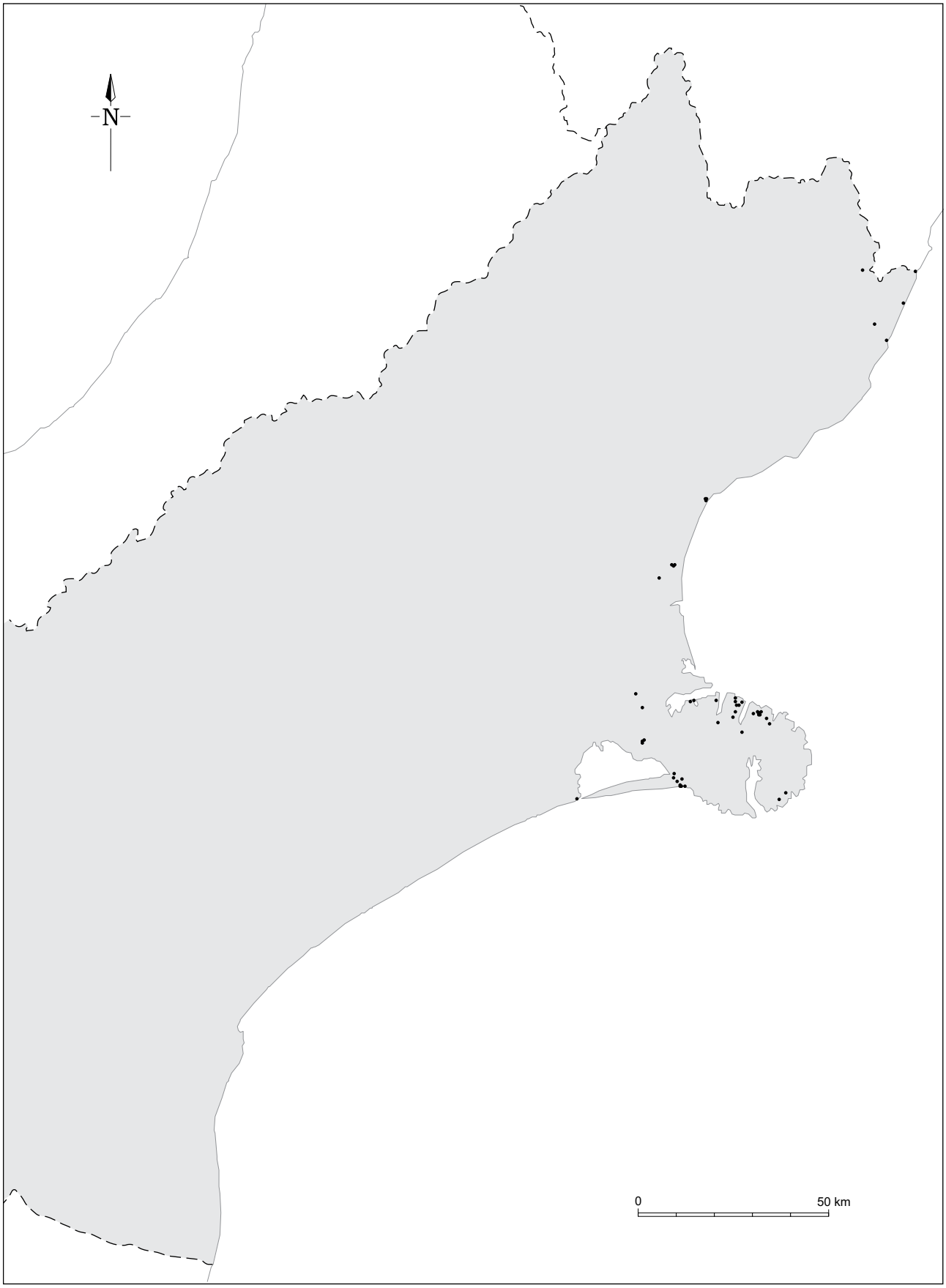


Figure 34. Distribution of recorded archaeological sites with kumara storage pits, Canterbury Conservancy region, Department of Conservation. *Map: C. Edkins, DOC.*

6.11 OTHER SOUTHERN REGIONS

There is one record of stone heaps at Okarito on the West Coast. This feature is more likely to be remnants of ovens rather than gardening evidence. Similarly, a stone pile in Otago, which has been recorded as being garden-related, is probably an oven, and deep sand containing shell at Aramoana is unlikely to be a pre-European Maori gardening site; instead, it probably represents a build-up of occupation-related deposits.

7. Case studies

This section provides several more detailed case studies that have been selected to cover both site type and region. It was not the intention to identify a few sites that stand out as being important or more significant than other sites. Choices were made to cover geographic distribution, site type and a range of archaeological interest. These sites are not isolated in the landscape, but form part of the wider cultural settlement pattern, and the intention was to discuss selected garden-related sites or groups of sites in the context of the local landscape. Where the sites, or group of sites, have been investigated archaeologically, this work is described.

Selections were carried out partly on the basis of information contained in site records, i.e. some sites were identified as being well preserved, having a range of information and being representative of the site type for that locality. Available archaeological investigation or surface study plus mapping also influenced the choice of site. Geographic spread from the far north to the very southern limits of horticulture was also considered. For instance, Panau was selected because it was well preserved and at the southern extreme of viable horticultural activity. Clarence River was also selected because it was of large extent, represents a range of material, including stone rows, borrow pits and modified soils, together with other occupation evidence, such as storage pits and terraces, and has been studied archaeologically. The sites of Okoropunga and Pukaroro were selected to complement the Palliser Bay sites in the discussion of horticulture in the Wairarapa region. The stone row systems at Cape Runaway were chosen because they are unique on this part of the coastline and have had little archaeological interest expressed in them and warrant more attention. The slope trenches at Rangihoua in the Bay of Islands were selected because they have been mapped in detail and are representative of this site type in Northland.

The case studies are only examples of their site type. Other sites or garden-related landscapes are no less significant. Not all sites of merit could be included—some places are already well known as outstanding landscapes; for example, the Pouerua garden area together with its associated kainga and pa, or the well-studied garden sites of Palliser Bay on the Wairarapa coast.

7.1 PANAU, BANKS PENINSULA

7.1.1 Location

North side of Banks Peninsula overlooking a small bay to the east of the entrance to Little Akaloa Bay, on north-west-facing slopes.

7.1.2 Condition

The garden site and Panau Pa (Fig. 35) are under a land management system of pastoral farming, predominantly being grazed by sheep. Recent fencing across and down the contours may affect the condition of the features in the long term, especially if sheep form tracks along fence lines, or smaller paddocks lead to intensification of stocking rates at particular times of the year. There is some slumping at the southern end of the site.

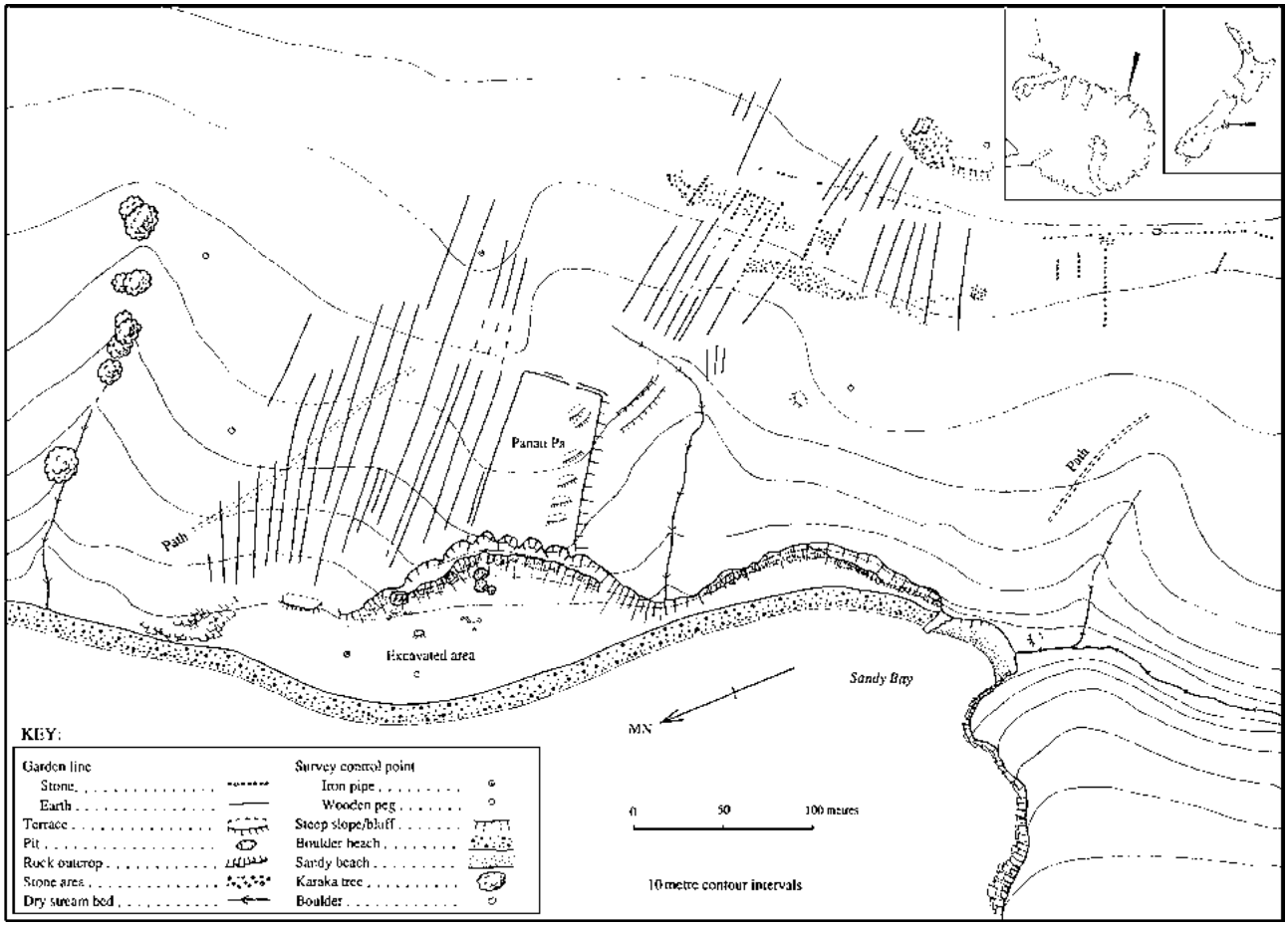


Figure 35. Plan of slope trenches (N36/74) at Panau, Banks Peninsula. The south-eastern group is partly constructed from stone. Panau Pa (N36/73) separates the two groups of lines. The Panau settlement is on the foreshore, identified as 'excavation area'. *After Jacomb 1995.*

7.1.3 Description

The gardens (N36/74) consist of parallel rows of either stone or earth (Figs 36 and 37). These are barely distinguishable, except in certain low-light conditions and on closely cropped grass. The stone has been used to form narrow alignments rather than rows composed of many stacked rocks. They fall naturally into two groups: one group at a higher contour to the south of Panau Pa (N36/73), and a lower group to the north of the pa, descending on steeper slopes to just above Panau village (N36/72). The southern group incorporates stone from the outcrop of basaltic stone near the top of the broad ridge, with stone and earthen rows descending across the contours from c. 70 m a.s.l. to the head of a gully. Use of stone is confined to the upper slope, close to the stone source (Fig. 36). The distance north-south is close to 300 m. The northern group, at a slightly different orientation, more closely matched to the 'ditch' of the pa, are composed of earth and extend for c. 150 m across the slope and the same distance down (Fig. 35).

Soils in the area are yellow-grey earths derived from loess and the underlying basalt. There is no known evidence of a modified soil associated with rows. The soil profile in an exposed section through a stone alignment was interpreted by Jacomb (2000) as being largely undisturbed. There was, however, a greater depth to the topsoil adjacent to the stone alignment. Jacomb (2000: 98) concluded that the crops must have been grown on or immediately adjacent to the stone

Figure 36. South-eastern set of slope trenches, Panau, with stone outcrops on the slope above. The two children are standing on trenches, which can be seen running under the fenceline. *Photo: L. Furey.*

Figure 37. A stone row that merges into an earthen line further downslope, Panau. *Photo: L. Furey.*

alignments rather than in the intervening space. This argument has also been put forward by McFadgen (1980b, 2003) for the Wairarapa sites. This type of gardening regime is unlikely for a number of reasons, which have been discussed in section 5.1 of this report. A common feature of descriptions of Maori gardens by early European visitors was the presence of fencing or windbreaks around the garden areas (Best 1976). It is possible that the deeper topsoil may be the result of organic matter accumulating against the stone row or, in the case of earthen linear features, material possibly accumulating against a fence, or soil being heaped up to give greater stability to the fence. These possible explanations should be testable archaeologically.

The age of the gardens at Panau is unknown. Radiocarbon dates for the Panau village suggest a lengthy period of settlement in the area from the 14th century (Jacomb 2000: 98). The types and styles in the artefact assemblage suggest that the main occupation was in the 17th–18th century. Traditional accounts associate the pa with Ngai Tahu in the early 19th century (Brailsford 1981: 162).

The gardening evidence at Panau is amongst some of the southernmost evidence of Maori gardening in the South Island. Several bays, particularly on the northern and eastern sides of Banks Peninsula, also have recorded gardening-related evidence, and a recently recorded site at Flea Bay to the east of Akaroa has surface evidence of raised lines (although it is not known whether these are stone-based or earthen) and gravel-added soils on steep west-facing slopes. Collectively, these features demonstrate that gardening was able to be carried out on Banks Peninsula. Panau differs from other sites in the vicinity, e.g. Flea Bay and Okuora Farm near Birdlings Flat, in that modified soils are apparently absent. Since the Panau evidence is undated, it might equally well be from the historic period and associated with the pa. If so, then potato may have been grown here.

7.2 CLARENCE RIVER, MARLBOROUGH

7.2.1 Location

Situated on the eastern Marlborough coast to the north of Clarence River. The sites are located mostly on a Holocene coastal platform abutting the lower slopes of an older Pleistocene terrace. Between the coastal platform and the sea are a series of parallel Holocene beach ridges.

7.2.2 Condition

All sites are under a land management system of pastoral farming, predominantly being grazed by sheep. Significant damage to the site has occurred over a number of years. Ploughing, construction of State Highway 1 and the rail trunk line, and bulldozing of farm tracks have separated the main concentration of sites closest to Clarence River.

7.2.3 Description

There is a concentration of gardening evidence on this part of the Marlborough coast. The stone rows on the coastal platform were originally recorded in 1966. Site record P30/5 described stone rows extending intermittently for some 3 miles to the north. Further site recording was carried out by Tony Fomison, who described pa and terraces, followed by Barry Brailsford, and Michael Trotter and Beverley McCulloch. Recent evaluation of all the sites and their locations has reduced Duff's estimate of distance to 3.5 km (Trotter & McCulloch 1999b).

The garden sites are concentrated between the ridge forming the north side of the Clarence River valley and Camp Stream to the north. Fourteen recorded sites, plus three unrecorded, are known (Fig. 38; Table 2). A relatively narrow coastal platform is present at the base of the hills, with Holocene coastal ridges

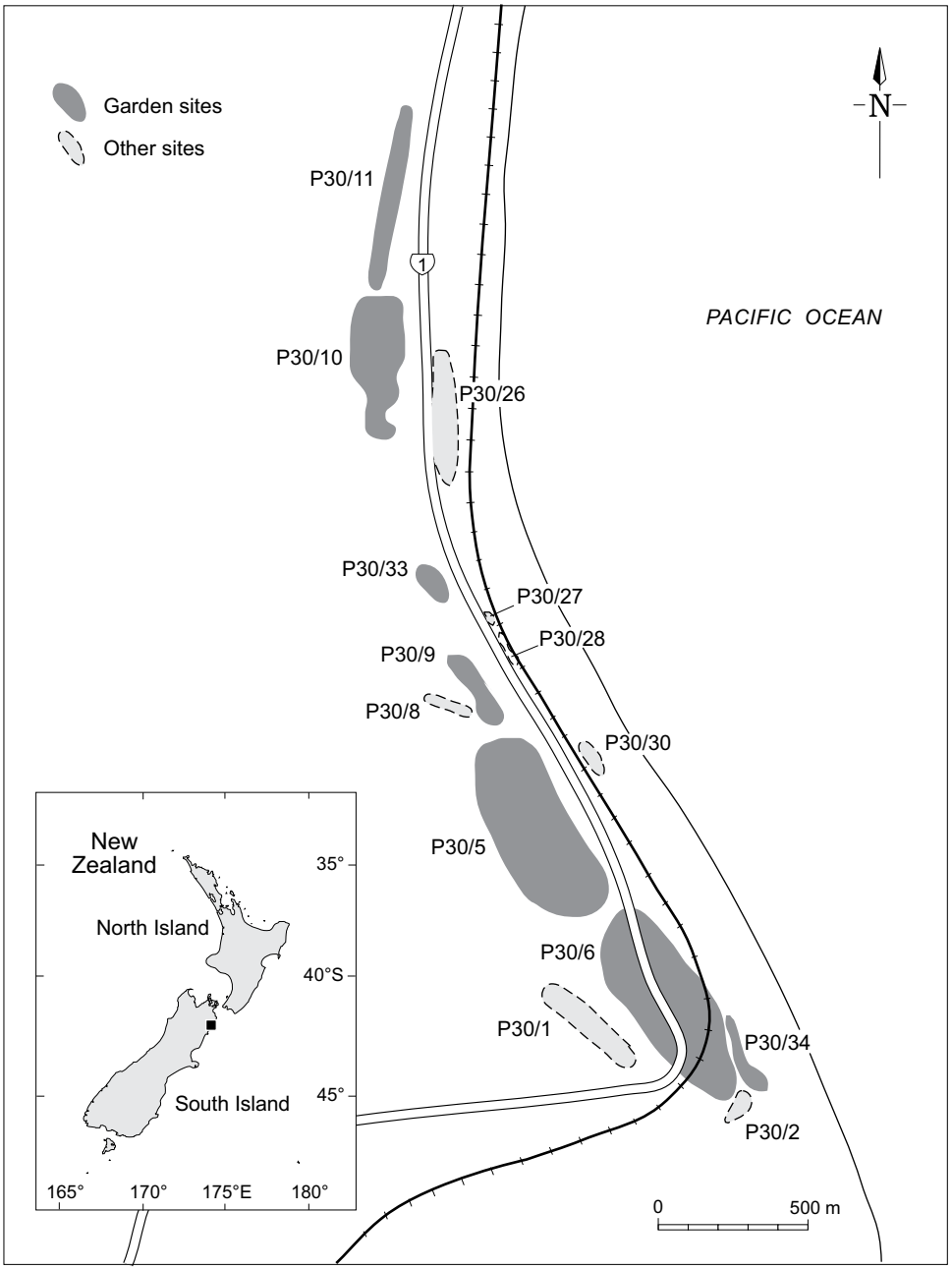


Figure 38. Garden sites in the vicinity of Clarence River, east coast Marlborough. The largest site is P30/5, where several small investigations were carried out. A plan of the stone rows on P30/5 is shown in Fig. 39. *Map: C. Edkins, DOC.*

extending to the sea. All but six of the sites are on the coastal platform, extending up onto the lower part of the slope behind. The remaining sites are on the coastal beach ridges or the river terrace close to the Clarence River. The site records are somewhat confusing (Trotter & McCulloch 1999b), and related evidence has, in at least one instance, been split into two site numbers (e.g. the source of the gravel for garden P30/6 is recorded as borrow pit P30/34).

Soils are identified as Omaka gravelly loams in the vicinity of P30/6 and P30/5 on the northern side of the mouth of the Clarence River, merging with Spring Creek heavy silt loam on the coastal platform further to the north. Shingle fans spill out of the hills and onto the coastal platform. The rows rarely extend onto the fans.

TABLE 2. RECORDED MAORI GARDEN-RELATED SITES ON THE NORTH SIDE OF THE CLARENCE RIVER MOUTH.

SITE NO.	SITE TYPE	DESCRIPTION
P30/5	Stone rows	Parallel stone rows on east-facing slope over a distance of 750 m, extending from slopes to beach ridges. Some short cross-rows between the east-west oriented long rows form enclosures. Rectangular pit-like depressions, shallow terraces, low stone mounds or heaps and, reportedly, shell midden are present at the northern end of the site where Trotter and McCulloch carried out investigations. The northern boundary of the site is defined by a stream, which intersects the coastal platform. A map made by Trotter & McCulloch (1979) shows the arrangement of stone rows. A very abrupt southern boundary to the rows suggests that the area at the base of the hill, between the end of the ridge and the state highway, may have been ploughed out some years ago—possibly when road or railway tracks were put through. The stone rows on the slopes are in good condition. Since the 1977 map was made, a fence has been erected along the 20-m contour (approx.), where the hill slope changes from steep to gentle. A farm track has been formed on the western side of this fence. There are now no stone or earthen rows present to the east of the fence, having apparently been ploughed out. This is seen clearly in Figs 39 and 40. The southern group of rows were c. 5–7 m apart. Two distinct cross-rows were observed—one had a shallow trench adjacent to the row on two sides.
P30/6, P30/34	Gravel-added soil; borrow pit	No surface features. Adjacent borrow pit P30/34 is unchanged from previous site description. ?Recently ploughed. Borrow pit P30/34 is unchanged from previous site description.
P30/2	Pits, ?pa	Storage pits on river terrace. Southern end, near farmhouse, has had track cut through it to access lower area of beach ridges. Exposed profile shows gravel-added soil over loess, as described by McFadgen (1980a).
P30/9	Pits/terraces	Closely spaced and regularly arranged storage pits on coastal platform. Terraces also present. One pit investigated by Trotter & McCulloch (1979). The site is illustrated in Brailsford (1981: 99, 101). A farm track, cut through the site since the late 1970s, has possibly damaged features at the rear of the platform.

7.2.4 Archaeological investigation

Only two sites have received more than cursory archaeological attention. Excavations were carried out at P30/5, the largest of the stone row systems, in 1977 (Trotter & McCulloch 1979). Sections were cut through three rows, but the location of only one investigated row is known (site record P30/9). The site, which was mapped from aerial photographs, extended down the slope from about the 40-m contour line to the beach ridges—a distance of c. 270 m (Figs 39 and 40). The site area was originally c. 10 ha, but by 1977 some of the features on land of lesser slope had been ploughed out. The rows were briefly described as being composed variously of large or small stones, or earth, depending on what was available nearby. On the lower, stone-free parts of the slope, earth or sand was formed up into linear ridges of similar appearance to the stone rows. No radiocarbon dates were obtained from the stone row excavations, but shell from the northern end of the site gave dates of 511 ± 30 BP (NZ4500) and 586 ± 28 BP (NZ4501). While acknowledging that there was no evidence for association between the gardens and the shell midden, Trotter & McCulloch (1979: 14) nonetheless considered that they were contemporary.

The same site was investigated twice by McFadgen (1980a; site record P30/5). A stone row (identified on Fig. 39) was sectioned. Above a dark brown natural layer, described variously as both silty sand and sandy loam, there was a modified soil containing sand and gravel (Layer 2; L2). In the published profile, the modified soil is described as 24 cm deep, but is also referred to as being 30–50 cm thick (McFadgen 1980a: 9, 18). McFadgen (1980a) considered that the area of modified soil exceeded 40 m^2, but did not discuss the source of the gravel. There was a distinct horizon between the modified soil containing sand and gravel and the natural sandy loam. The stone row was placed on top of the L2 modified soil and a brown sand, 40 cm deep, was built up around the row. No gravel was present in this layer. There was a concentration of charcoal on the surface of L2 (the modified soil) under the stone row, but very little was found within the layer. A radiocarbon date of 382 ± 59 BP (NZ3113) was obtained from charcoal under the row, giving a maximum age for row construction overlying the earlier modified soil. Subsequently, another excavation was conducted at P30/5 by McFadgen and Peter Adds (T. Walton, DOC, pers. comm.). There is no information available on this later work.

If the interpretation of formation of a modified soil followed by row construction and the build-up of another soil is correct, there must have been two phases of gardening at this site. From the described section, the initial activity involved adding gravel to the original soil on the slope, followed by a second period of gardening, where stones were formed into parallel rows and a second garden layer without gravels then built up. Presumably, the stones in the row were derived from the adjacent soil, but the underlying natural Layer 1 (L1) was a sandy loam with no stones, and Layer 2 (L2), the modified soil, consisted of gravelly loamy sand. However, the 1.8-m section through the row could hardly be called representative of the garden area as a whole. The boundaries between L1 (natural) and L2 (modified soil), and L2 and L3 (sand) were distinct, whereas the boundary between L3 and the topsoil was indistinct, suggesting that it was built up *in situ*. It was estimated that the L2 modified soil contained 15%–20% gravel additive, in which case the natural soil must have been mixed up with the gravels and sand. This would be unlikely to produce a distinct horizon. Another possibility, which was not considered by McFadgen (1980a), is that the L2 material had slipped downslope after vegetation removal or an event causing some instability, as the rounded gravels do occur naturally in the soil. In addition, the described soil profile has gravels reaching a maximum size of 3 cm, yet the illustrated profile shows large stones, of similar size or larger than those incorporated into the stone row. If McFadgen's modified soil is one gardening episode, followed by another with a different technique, this would be unique amongst investigated gardening sites. However, the question of whether Layer 2 is in fact a modified soil needs further investigation.

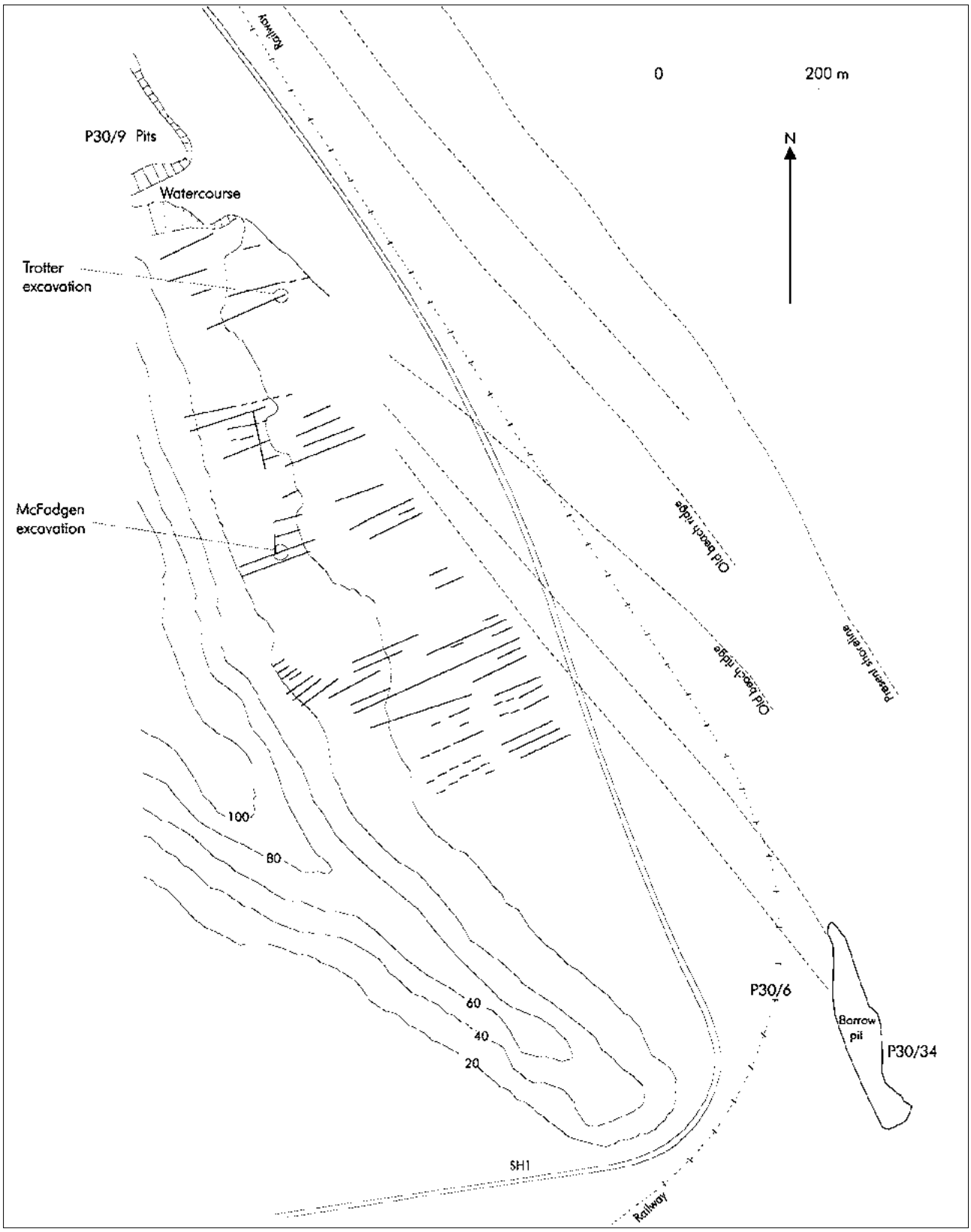


Figure 39. Plan of P30/5, Clarence River, showing parallel stone rows on the slope inland of the earliest beach ridge and the location of small excavations carried out by Trotter and McFadgen. The area of stone rows on the flat adjacent to the beach ridge has now been ploughed out (see Fig. 40 for comparison). *Based on plan in Trotter & McCulloch 1979.*

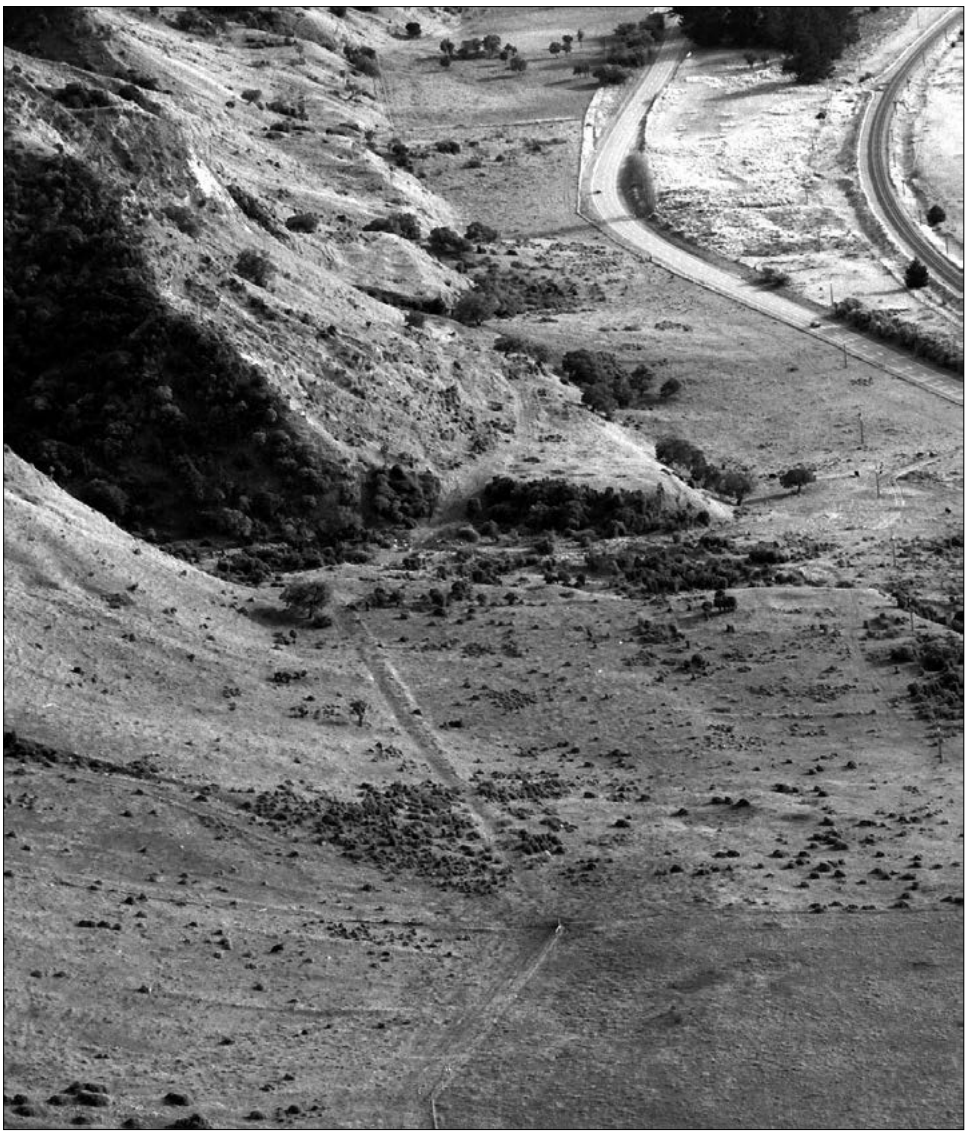


Figure 40. Aerial photograph showing stone rows on the slope, kumara pits on the coastal platform in the centre rear of the photo, and the ploughed out area, Clarence River.
Photo: K. Jones, DOC.

A second site (P30/6) investigated is situated on the river terrace abutting the Holocene beach ridges, and some 600 m south-east of P30/5 (McFadgen 1980a). Below the 4-m-high scarp between the river terrace and the westernmost beach ridge is an irregularly shaped borrow pit, 280 m long, 40 m wide and up to 3 m deep. Large stones are scattered around the edge of the pit. The river terrace has a silty loess, over which there is a slightly stony and gravelly coarse sandy loam to a depth of 260 mm. Like the previous site (P30/5), there was a distinct boundary between the modified soil and the underlying natural soil. The modified soil originally covered c. 4.5 ha. Gravel was carried no further than 160 m from the borrow pit (McFadgen 1980a: 11–12). An age estimate of 355 ± 41 BP (NZ3397) was obtained from a buried soil at the base of the borrow pit, giving a minimum age for the use of the pit.

Other borrow pits are known from the vicinity. With the exception of P30/5 and P30/6, the remaining sites are small and consist of a few short parallel rows.

7.3 OKOROPUNGA, WAIRARAPA

Several sites on the southern Wairarapa coast were either inspected by walking over, or noted while driving past. Gardens are concentrated on the narrow coastal platform backed by steep hills. The gardens are found on uplifted beach ridges or on old shingle fans spreading out from drainage systems. These sandy loam soils were stony yet free-draining.

A number of stone row sites on the Wairarapa coast are recorded, and several in Palliser Bay have been mapped and investigated. Less well known are the rows between Cape Palliser and Pahaoa. These include those at Tora, investigated by Mitcalfe (McFadgen 2003), Okoropunga (McFadgen 1980b), and the Pukaroro Maori Reserve. Further north are the garden sites at Waikekino and Flat Point. The sites are usually present at the rear of the coastal platforms and near streams, probably to take advantage of mature soils on the older ridges and on shingle fans.

7.3.1 Location

Okoropunga is on the south Wairarapa coast to the north of Te Awaiti, between the Oterei and Pahaoa Rivers. The rows are on the narrow coastal platform, and continue up the lower slopes of the steep hills behind (Fig. 41).

Figure 41. View to the south along the coastal platform at Okoropunga, Wairarapa coast. The stone rows (T28/47) are at the far end of the platform. *Photo: L. Furey.*

7.3.2 Condition

The surface features are in good condition, although they are not as distinctive or pronounced as they appear in the photograph in McFadgen (1980b). A deer enclosure, subdivided into a number of paddocks, is situated over the entire site. Although there is no evidence of pugging in gateways or around water troughs, or on tracks along fence lines, the high density of stock numbers may be having a detrimental impact on the site features and intervening ground.

7.3.3 Description

A large complex of rows, borrow pits and gravel-added soils are present on and across uplifted beach ridges on the coastal platform. The rows run across the beach ridges, but there are also rows at right angles (Figs 42 and 43). The site, known as T28/47, appears to be in two groups. The northernmost is situated on beach ridges C and D, while the southern group is on beach ridges E and F and continues to the foot of the hillslope, with some rows extending some distance up the slope. Each group is c. 4 ha in size, giving a total site size of 8 ha. The southern group is described as having parallel stone ridges 2–3 m wide and 0.2–1 m high (McFadgen 1980a: 7).

The uplifted beach ridges are composed of sand, gravel and boulders, which were deposited during storm events and then uplifted during earthquakes. After uplift, each ridge was covered with sand blowing inland; therefore, the soils formed on older ridges further inland have progressively less gravel and boulders and more sand. Present-day topsoil is a gravelly sandy loam. Gravel-added soils identified by McFadgen (1980a) cover 0.7 ha, and are adjacent to beach ridges E and F, and to borrow pits on the seaward edge of ridge E (Fig. 43).

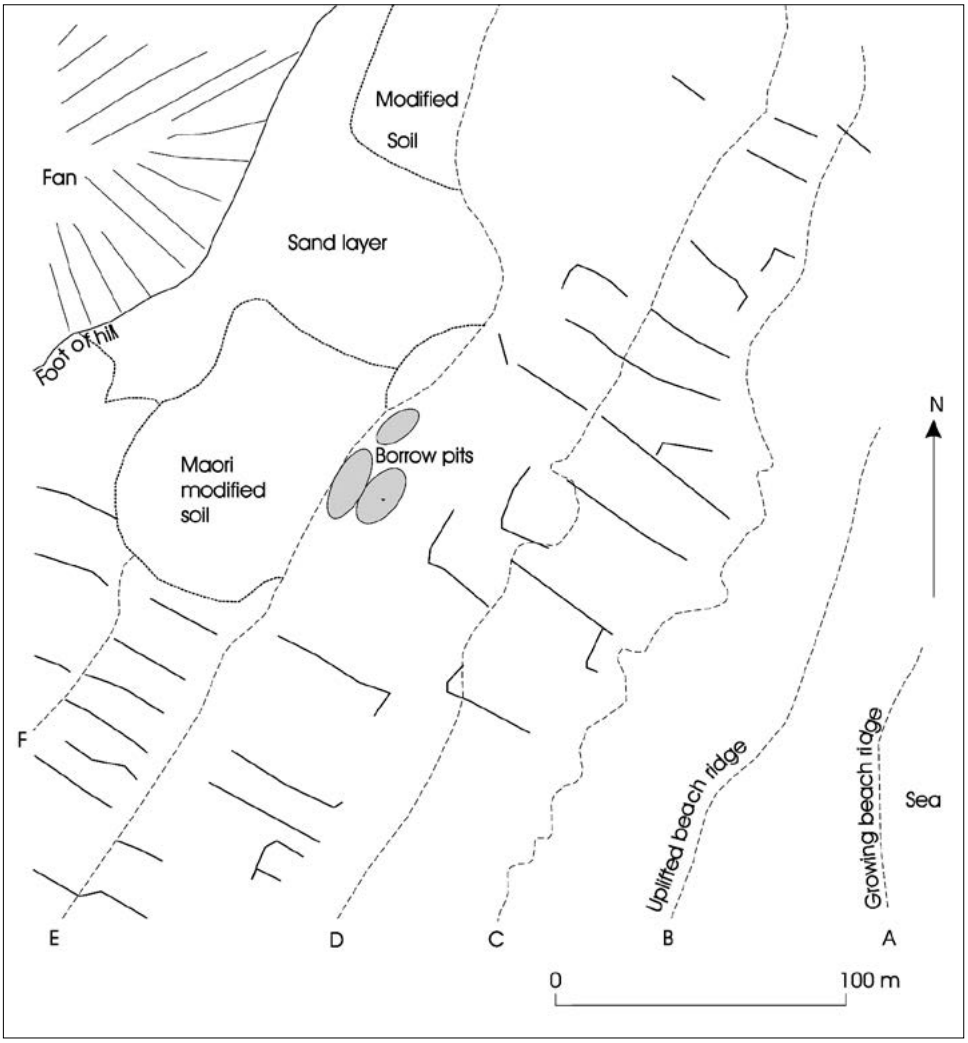
7.3.4 Archaeological Investigation

Okoropunga has been mapped by McFadgen (1980b), and a small excavation has been conducted across a stone row on beach ridge E towards the southern end of the site. The stones in the row were most likely derived from the borrow pit on the seaward side of beach ridge E (McFadgen 1980b: 192). The soil around, within and under the row was sandy, and it was inferred that the sandy topsoil was deliberately placed in the row, as any wind-blown material would be expected to be of smaller particle size. Charcoal from around the stones, and also from the soil under the stones, was radiocarbon dated. Results are shown in Appendix 2. These indicate that the gardens were in use in the mid- to late 15th century. Geomorphological evidence suggests that beach ridge C was uplifted in the late 15th century (McFadgen 2003: 35).

Soils between the rows were also investigated. McFadgen (1980b) concluded that the soils between the rows were not gardened. This interpretation was based on the absence of additional gravel in the topsoil between the rows and the fact that the soil was no thicker than a relatively recently formed topsoil on younger beach ridges, which had not been gardened, and that the ground surface was smooth. It was also based on the assumption that all garden soils were modified by additional gravel (McFadgen's plaggen soil). However, as experience elsewhere has demonstrated, this is not a valid assumption. There is considerable variability in the extent of modified soils within and between sites. It follows that if no additional gravel was added, then the soil would not

Figure 42. Aerial photograph of stone rows at Okoropunga. Note that the walls terminate at irregular intervals on the hillslope. *Photo: K. Jones, DOC.*

Figure 43. Plan of part of the garden system with stone rows, modified soils and borrow pits in relation to uplifted beach ridges, Okoropunga. *Based on plan in McFadgen 1980b.*



be artificially deepened, would not be a different colour, and the uneven surface contours noted on gravel-added soils would most likely be absent. McFadgen's conclusions are important to his wider explanations that the rows themselves were gardens and that the intervening spaces were uncultivated. More recently, some of the evidence at Okoropunga has been reinterpreted by McFadgen as possible tsunami damage and sand deposits left after the water rushed back out to sea (McFadgen 2003: 35). However, this is, as yet, unproven.

The modified, gravel-added soil was stratigraphically later than the stone row and extended across a row (McFadgen 1980a: 7). This indicates that more than one gardening technique was in use here through time.

The extent to which Okoropunga is typical of the garden complexes on the southern Wairarapa coast is unknown. There was no evidence in the Palliser Bay gardens for soils modified by the addition of gravel, and although there are modified soils at Okoropunga, they are not present over the entire site. While debate about the importance of these gardens, or the amount of modification (and therefore labour) put into gardening, is useful, the emphasis should be on defining variability within the region and the value of gardening, rather than focusing on issues such as whether gardens were formed on the stone rows or the intervening ground.

Okoropunga is a reasonably intact, large, well-presented garden site on the south Wairarapa coast.

7.4 PUKARORO, WAIRARAPA

7.4.1 Location

On the south Wairarapa coast, c. 1 km to the north of Okoropunga. Like other garden sites on the Wairarapa coast, it is situated on the coastal platform. The site is a Maori Reserve.

7.4.2 Condition

The site is in very good condition. The coastal platform is in pasture grass with no fences dividing the area into smaller paddocks. Sheep are grazed and numbers are kept low. A farm track is evident through part of the site and has damaged stone rows. There is coastal erosion occurring on the platform at the northern end of the main site, which has exposed an occupation layer of ovens and oven rake out.

7.4.3 Description

There are a number of garden and other occupation features present in the area. The main southern part of the reserve is identified as T28/42 and consists of stone rows and pits; this covers an area of c. 5 ha. There are five beach ridges, of which the inner three (C, D and E) have been uplifted. Rock stacks are also present. Rows are present over ridges C, D and E and there are regular depressions interpreted as gravel quarry pits present on beach ridge B (Figs 44 and 45). Unlike most of the Palliser Bay sites, the rows at this site are relatively short in

Figure 44. Aerial photograph Pukaroro, Wairarapa coast (T28/42), showing stone rows, possible borrow pits and house sites, and uplifted beach ridges. *Photo: K. Jones, DOC.*

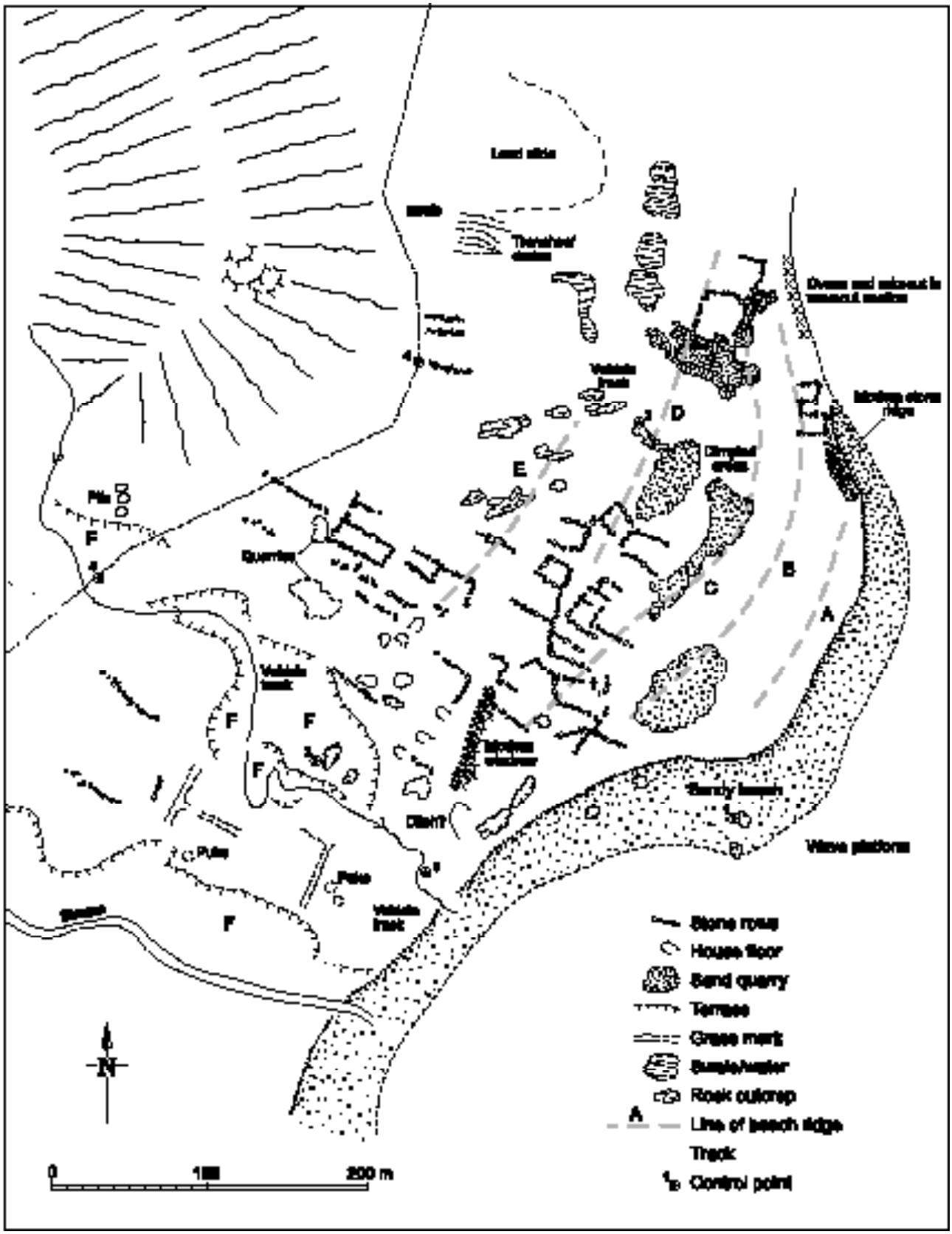


Figure 45. Plan of Pukaroro drawn from aerial photograph. *K. Jones, drawn by C. Edkins, DOC.*

length, and there are cross-rows forming semi-enclosures. House floors are also present at the southern end of the site. Isolated groups of rows, alignments and parallel trenches further along the platform to the north suggest a number of separate gardening events (Fig. 46).

Of interest at this site, and not found at other sites studied in the Wairarapa area, is the regular pattern of depressions on beach ridge B in the main part of the site seaward of the rows (Fig. 45). Another group of similar features is present c. 200 m further to the north of the northern margins of the site. These depressions, each c. 1 m in diameter and 300–400 mm deep, cover an area of 60 m × 30 m in a grid-like arrangement. One series of these depressions has a shallow trench leading into it. A wave-cut section through the platform shows a 100–150-mm-thick lens of small-sized gravel (mostly up to 5 mm diameter) c. 1 m below the surface. This may have been mined for adding to garden soils in the vicinity. No test excavations have been carried out to demonstrate a relationship between the borrow area and adjacent gardens. The small holes at this site contrast with the larger borrow pits present at Okoropunga. However, McFadgen (1980b) speculated that large stones were also being removed from the pits to aid row construction. This suggests a different underlying stratigraphy, possibly related to the position on the dune ridge where the material was being extracted.

Other sites in the vicinity include raised-rim storage pits on a river terrace immediately to the west of the site, and terraces (T28/50) on the crest of the

Figure 46. View north along the coastal platform, showing parallel trench features (centre right) to the north of the landslide shown in Fig. 45. *Photo: L. Furey.*

adjacent ridge. To the north of the landslide visible on Fig. 46 is a series of five parallel trenches crossing beach ridge C. More of the small, regular 'borrow pits' are adjacent. Other evidence of occupation and gardening is present along the platform to the north.

This is an impressive garden site. It is in very good condition and a variety of different types of evidence are present, including house sites and signs of occupation (which has not been recorded at Okoropunga). Together with the storage pits on the river terrace, this site suggests a self-contained settlement unit.

7.5 CAPE RUNAWAY–POTIKIRUA POINT, EAST COAST

7.5.1 Location

Situated at the northernmost part of East Cape to the east of Cape Runaway. A 400-m-high range of hills extends east-west from Cape Runaway to Matakaoa Point. The geology of these hills differs from that of the East Cape area, as they are derived from ancient undersea volcanics that have been thrust up and moved some distance by plate movement. Shingle fans are present at the mouths of some of the steep and rapidly eroding gullies. Some of these fans are still active. On the northern side of the range, the erosion-resistant rock forms steep hills, which drop to the rocky coastline. Although there is no marine terrace or distinct levelling-out of the land adjacent to the coast, there is a change in slope at c. 80–100 m a.s.l., with higher slopes being >30° and lower slopes <30°. These lower slopes form the coastal strip, which varies from 100 m to 230 m in width (Fig. 47). The change in slope angle coincides with a change in soil type. The soils are not derived from recent volcanic activity and cannot, therefore, be compared with the fertile volcanic soils of the Auckland and inland Bay of Islands regions. Soils in this area are silty grey loam, derived from fluvial deposits, tephra and loess; specifically, Tikirau Loam, which is identified as a fertile soil suitable for pastoral farming and agriculture. This soil is present to the west of Tahurua Point (encompassing the garden sites) and from Potikirua Point to Lottin Point. The land between the two locations is identified as having steepland soils with less agricultural potential.

7.5.2 Condition

All sites are under a land management system of pastoral farming; sheep are mainly grazed here, but some cattle are also grazed. Each site is in good condition, although slips have damaged or destroyed rows on three sites (Y14/18, 363 and 235). Continuing rock fall above the eastern end of Y14/18 is adding to the confusion of rock patterns at the upper end of the garden row area. Visibility of the sites is threatened by the spread of kikuyu (*Pennisetum clandestinum*) through the pasture grass. Although kikuyu might protect and preserve stone features if allowed to take over, it will hamper any attempts to observe, map and photograph the patterning of rows and associated terraces.

Figure 47. View of north-facing coastal slopes looking east towards Tahurua Point, East Cape. Y14/18 is in the centre of the photo. *Photo: L. Furey.*

7.5.3 Description

There is a concentration of garden rows on north-facing slopes over a distance of 7 km, from 1 km west of Tahurua Point to 2 km east of Potikirua Point (Table 3; Fig. 48). Two larger systems, Y14/18 in the west and Y14/234-5 near Potikirua Point, cover 18 ha and 28 ha respectively. Y14/223 also has rows over a large area. Twelve other smaller sites are recorded. The assignment of site record numbers has been somewhat arbitrary—one site number may cover several discontinuous groups of rows. There does, however, appear to be two areas without stone rows, the westernmost of which has no surface stone to be gathered into rows. The land immediately to the west of Potikirua Point was not visited; therefore, the lack of recorded sites cannot be discussed. To what extent the recorded presence/absence of surface evidence reflects the actual distribution of garden sites is unknown. In areas where no evidence has so far been recorded, gardening may have been carried out without the need to remove stones from the garden plots, or the soils and sub-surface hydrology may be slightly different, creating unfavourable gardening conditions. It is unlikely that the soil types are significantly different from those on surrounding land.

Pa, pits and terraces are present on the steep narrow ridge forming the top of the range (Fig. 48). Terrace sites also occur on the coastal strip and on the edges of deep narrow gullies, and several gardens have small terraces within the boundaries of the rows. Shell midden has not been recorded from this

TABLE 3. HORTICULTURAL SITES RECORDED FROM WEST OF TAHURUA POINT TO EAST OF POTIKIRUA POINT, CAPE RUNAWAY.

SITE NO.	SITE TYPE	DESCRIPTION
Y14/18	Stone rows	Large area of parallel stone rows down north-facing slope. Some cross-divisions.
Y14/223	Stone alignments	Series of stone alignments (rows?) running south-west down the ridge. Pits and terraces also present.
Y14/234	Terraces/stone lines	Stone lines running down slope below terraces.
Y14/235	Garden complex	Stone rows running down and across slope. Several transverse terraces up to 50 m long and 3–4 m wide (natural?). Continues for hundreds of metres along coast. Largest site of at least 38 rows, fanning out from upper to lower on old fan.
Y14/248	Terraces/stone row	One stone row on the edge of a group of terraces.
Y14/249	Stone rows	Stone rows and terraces. Rows are at different angles above and below terraces (natural?). High on slope.
Y14/254	Agricultural field system	Parallel lines appear to be made of earth, but probably have a stone base.
Y14/255	Terraces/stone alignments	Two well-defined terraces with stone alignments running down slope. Karaka (*Corynocarpus laevigatus*) grove.
Y14/331	Stone rows	Six or seven parallel stone rows from the edge of rocky bluff outcrop to where the coastal plateau slopes level out. Rows are c. 30 m long, 1–2 m wide at the base, with spaces 8–9 m between rows.
Y14/336	Terraces/pits	Stone rows form an enclosed area between two parallel ledge terraces (natural?). Height of rows 0.5–0.8 m. Terraces and pits also present.
Y14/341	Stone row	1–2 ha of coastal slopes with fan-like stone rows radiating down and out towards the coast.
Y14/361	Stone rows	Small area of rows on east-facing slope below Tahurua Point.
Y14/362	Stone rows	More than nine long rows, equally spaced, commencing where slope changes from steep to less steep. Small terraces within the row area.
Y14/363	Stone rows	Eight rows running down the slope. Erosion scarp intersected one row, which shows large boulders set into subsoil (?trench) and smaller stones heaped over and around. Total width of row 1.5–1.8 m.
Y14/364	Stone rows	Four long rows on north-facing slope. Large transverse terrace (natural?) at upper end. Rows very well defined. Post and wire sheep enclosure and paddock at the lower end.

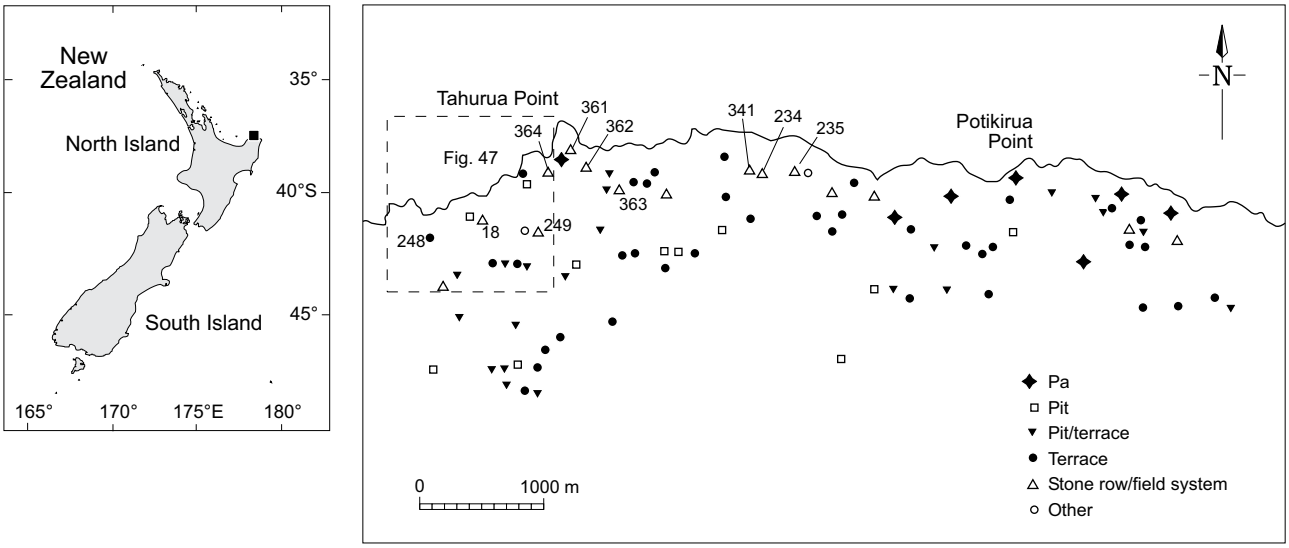


Figure 48. Distribution of recorded archaeological sites, Tahurua Point to Potikirua Point, East Cape. A high proportion of the sites are garden sites or kumara store pits. *Map: C. Edkins, DOC.*

area, although there are abundant seafood resources on the rocky shoreline. Leahy & Walsh (1982) attributed their absence to the fact that the shells of the most commonly occurring shellfish species—mussel (*Perna* sp.) and paua (*Haliotis iris*)—do not preserve well and thus disappear over time.

The Tahurua to Potikirua Point garden sites have not been described in detail or adequately mapped. Rows run down the slope or spread out on old erosion fans (Figs 49 and 50). There are few cross-rows subdividing the land into plots, and shallow mounds of stone, distinct from the rows, were only observed at one site. Only one small excavation has been carried out on Y14/364 (K. Jones, DOC, pers. comm.).

The size and concentration of the stone rows is unparalleled elsewhere on the East Coast. The rows start high on the slope, close to where the slope angle changes from steep to less steep. In general, the rows stop short of the coastal edge, although at Y14/235 a few rows do reach almost to the edge of the coastal platform (see Fig. 50).

Y14/235, the largest of the sites, has in excess of 38 stone rows. Although generally parallel, the rows are closer spaced at the upper end of the slope and spread out downslope, reflecting the shape of the fan on which they are constructed. Row lengths are variable and up to 200 m long. Some have a distinct curvature towards the lower end. Rows at this site are wider and higher than those found at other sites in the vicinity. Stones are a mix of sizes, but there is generally an absence of soil. A farm track intersects the site, and although some of the rows continue through this, others appear to commence below the track, or the alignment varies slightly between areas above and below the track. It is possible that the farm track has been constructed along a natural break in the hillslope (either a natural terrace or a slip scarp), similar to the large, long terraces visible on Y14/18 (Fig. 50). These long, broad terraces are described from several of the sites and may be the result of a natural widespread slump event. The rows are generally not continuous across these terraces, suggesting that they were used in a different way, or used to separate the upper and lower gardens. The ground in the central portion of Y14/235, below the farm track, was quite lumpy and irregular in appearance, suggesting an old slip or slump surface. It is not immediately clear whether row construction and gardening took place before the slump, but the movement of the underlying ground might account for the curvature of the rows and different alignment in this locality.

Drainage on the slope is variable. During a visit, water was percolating out of the ground where a shallow scarp was evident, and the adjacent ground was considerably wetter than elsewhere on the slope (pers. obs.). A stone row adjacent to this poorly drained area has a ditch or trench on its western side, which may possibly have functioned as a channel for water. This was the only example of this type of feature observed on the site.

Y14/18 has long rows and some cross-rows. The rows are narrower than and not as high as some on Y14/235. The situation is confused by more recent surface rock falls at the western end. There are also rocks that are too large to be moved, both on the surface and protruding from the surface. What appear to be long transverse terraces on the slope at different levels may be natural features relating to slipping or land movement. Although these level areas may have been used

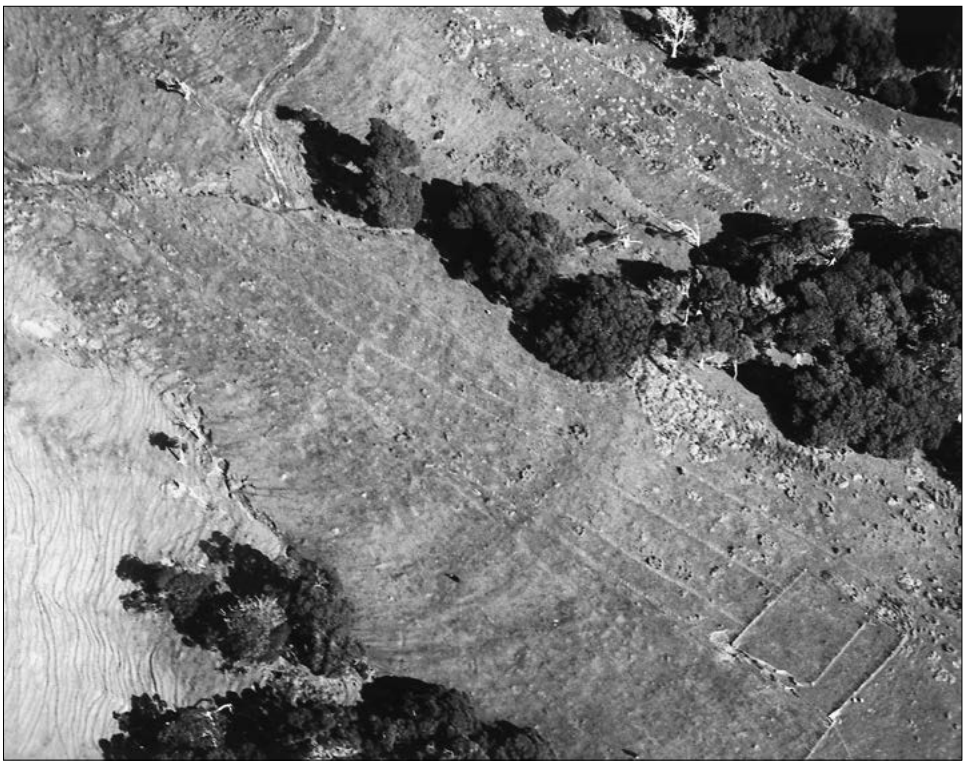


Figure 49. Eastern end of Y14/18 near Tahurua Point. Oblique aerial photograph. *Photo: K. Jones, DOC.*

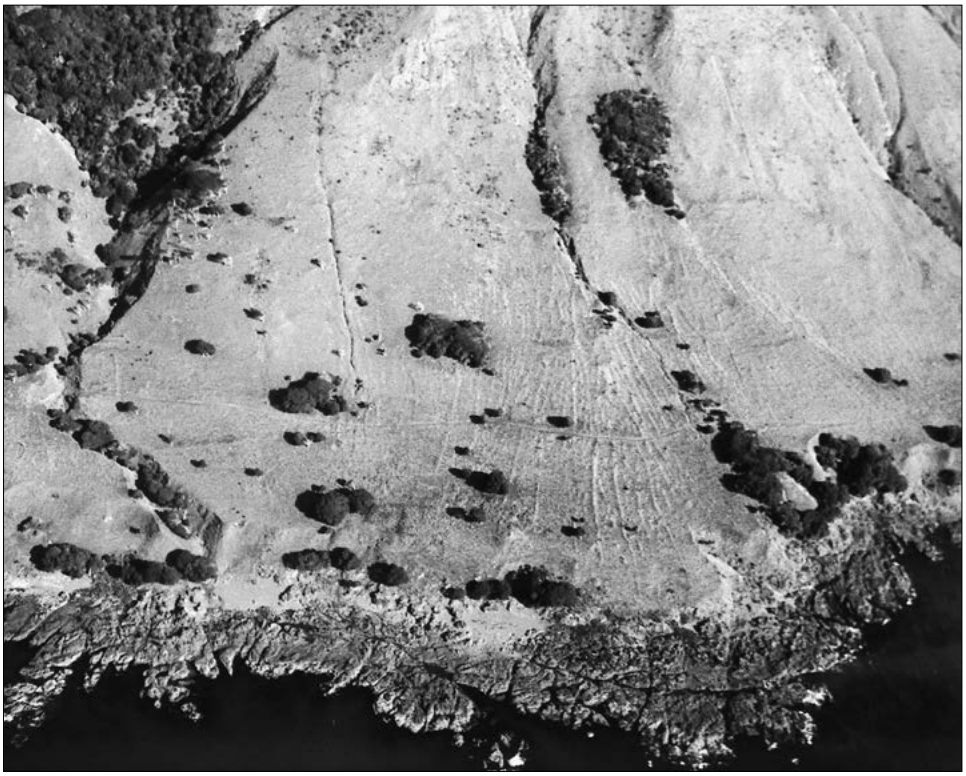


Figure 50. Oblique aerial photograph of stone rows (Y14/235) between Tahurua Point and Potikirua, East Cape. This is the largest site in the area containing stone rows running down the slope. *Photo: K. Jones, DOC.*

for gardening, it is unlikely that they were constructed on such a large scale. The rows, in most instances, pass over these features.

Collectively, the Cape Runaway to Lottin Point sites identify an area used intensively for gardening. It is likely that the entire eastern Bay of Plenty coastal terraces were highly desirable gardening areas and, in fact, may have been more favourable than the Cape Runaway sites, because it would not have been necessary to remove large quantities of stone. However, the considerable amount of labour that would have been invested in constructing the garden areas at Cape Runaway suggests that the effort was worthwhile. The large number of storage pits present on sites indicates that high yields of kumara could be obtained from the area.

The age of the gardening sites in this area is unknown. They have tentatively been interpreted as old and assigned to the early end of the New Zealand settlement sequence (Leahy & Walsh 1982). This interpretation was possibly based on radiocarbon dates from stone rows at Wairarapa, where the gardens are from the first few centuries after Polynesian settlement. However, dates from various garden sites in New Zealand suggest that similar features were being constructed and used throughout the prehistoric period of several hundred years. The fact that there are pa with storage pits in the immediate vicinity suggests that they may be contemporary with these and, therefore, are likely to be 16th century or younger in age.

This is undeniably an intact and significant Maori horticultural landscape under a low-impact farming regime, which is managed, in part, by an informed and supportive land owner. The isolation of the area has also contributed to its protection and preservation. However, very little is known of archeological features such as the pattern of rows and whether remodelling of gardens can be detected, the relationship of the gardens to soil and drainage, the crops grown and the time period involved. Until more is known about these sites, significance at a national level can only be assessed on the intact surface remains.

7.6 RANGIHOUA–MARSDEN CROSS, BAY OF ISLANDS

7.6.1 Location

Purerua Peninsula, northern Bay of Islands. Regularly spaced trenches are situated on a north-facing hillslope below Rangihoua Pa, on a south-facing slope at Te Oihi (Marsden Cross) (Q05/5), and on a south-facing slope further up the stream valley from Te Oihi (Q05/6). Both the Rangihoua slopes and Q05/6 are in pasture grass and are grazed by sheep. Q05/5 is a reserve, visited by small numbers of people. Soils are classed as Marua Clay Loam.

7.6.2 Condition

The Q05/5 trenches at Te Oihi are under kikuyu grass over 0.5 m high and are not visible. Those examples below Rangihoua have been eroded by water, and the trenches are irregular in width and depth. The trenches at Q05/6 appear to be in good condition.

7.6.3 Description

Q05/5 at Marsden Cross has been mapped in detail. Terraces constructed for the Mission Station in 1814 intersect some of the trenches (Spencer 1983: facing p. 94), and give a terminal date for their use. Although no longer visible, the trenches are parallel and 5–8 m apart. At the eastern end, they terminate at the scarp behind the beach; they probably also did so at the western end, but the spoil thrown over the front scarp during construction of the mission terraces has obscured any evidence. The uphill end of the trenches is obscured by manuka and light scrub.

Q05/6, on the south-facing slope, c. 100–150 m to the west of Marsden Cross, has equidistant parallel trenches over 200 m in length on the western side of a steep-sided, eroded gully (Fig. 9). The trenches terminate just above the swampy margins of Oihi Creek, while the eastern trenches end at the rear of a small stream flat beside the creek. Both groups start high on the slope, approximately where the slope angle changes from steep to less steep.

There are possibly three groups of trenches on the north-facing slope below Rangihoua Pa, only one of which is mapped in Spencer (1983: facing p. 80). Parallel lines on the north-facing slope show up on the aerial photograph in Jones (1993: 244) below the large terraces at the easternmost end of Rangihoua Pa. These showed up only as vague features on the surface in mid-winter. The westernmost group (Fig. 51) are of different appearance. They are situated in a shallow basin, which might be a natural drainage system. The trenches are irregular in width and are not parallel. Instead, they run down the slope, occasionally merging with an adjacent trench, so that in one example five trenches had merged into one by the lower end. These features terminated at the Oihi Stream. Although there is a road scarp that intersected the trenches, these were not visible in section, but the clay subsoil was very variable in colour and texture. The irregular width and depth of these features may be due to erosion, with water scouring out the sides and forming ponding in places. On one trench, another trench commenced at the point where the depth was considerably deeper and the base rose again on the downhill side. This evidence suggests that at least some of the trenches

Figure 51. Slope trenches on north-facing slope below Rangihoua Pa near Marsden Cross, Bay of Islands. *Photo: L. Furey.*

may be natural features resulting from water action, or have been extensively modified.

The trenches on the slopes of Rangihoua were not in use, or at least were not observed in use, during Augustus Earle's visit in 1827, although he did draw a garden higher up on the slopes below the terraces near the western end of the pa (Spencer 1983: facing p. 95). An earlier visitor, John Nicholas, described gardens in 1817: 'On the top of a hill…overlooking the harbour, was built the town of Rangehoo… Around this town (if it may be so called) were several plantations of potatoes, coomeras, and other vegetables, and the cultivation had such an appearance of neatness and regularity... Each plantation was carefully fenced in, and hanging down from the sides of steep hills' (Nicholas 1817, Vol. 1: 170).

These gardens were enclosed by '… paling, which was ingenious though simple, gave an effect to the enclosure that was peculiarly striking', and were observed at close quarters on ascent from the beach to the eastern end of the pa, and before reaching the main ditch (Nicholas 1817, Vol. 1: 174). No mention was made of trenches, but it does indicate that the north-facing slope below the pa was gardened.

These parallel trench boundary features are typical of those encountered throughout Northland. Other examples are recorded on the Purerua Peninsula, including at Te Puna. The branching trenches are unusual but not unique. They have been recorded at several other places, including Whangaroa, and the upper trenches at Tupou Bay would also possibly fit into this category.

8. Maori gardening in the 19th century

The 19th century saw a number of significant changes to Maori gardening practices. Most important were the introduction of new crops and the subsequent demise of some traditional varieties in favour of new imports. Other effects of European introductions included changes in Maori settlement patterns, changes in Maori economy and society, and the adoption of new technologies.

Captain Cook introduced new crops at various places in 1769. Salmond (1991: 151, 152, 182) records cabbage and turnip being given to Maori at Cape Kidnappers and Mahia, and potato at Uawa (Tolaga Bay) and also at Mercury Bay. It is unlikely that these were the only places Cook gave potatoes and other vegetables on the first voyage, but other exchanges have not been recorded. Also in 1769, de Surville gave peas, wheat and rice to a chief in Doubtless Bay (Leach 1983). On Cook's second voyage in 1773, he established gardens in five places in Queen Charlotte Sound, planting potato, cabbage, radish, onion, parsnips, carrots, leeks, parsley, mustard, broad beans, kidney beans, peas, turnips and wheat. Subsequent early introductions were by du Fresne, who planted a model garden containing wheat, maize, nuts and potatoes on Moturua Island in the Bay of Islands (Leach 1984: 98), and by Governor King, who introduced maize, wheat and peas to the far northern area in 1793. Maori had no experience in growing and using some of these crops, so the success of these early ventures may have been limited (Hargraves 1963). These introductions, and other unrecorded gifts of plants and seeds, changed Maori agriculture. Between April and June 1801, missionaries and crew on the *Royal Admiral* in Hauraki were able to obtain turnips and potatoes, and observed large plots of potatoes being grown beside the Waihou River (Furey 1996: 16). Potatoes were being grown for trade in the Bay of Islands in 1806 and wild cabbage was growing everywhere (Leach 1984: 99). By 1810, potatoes were growing as far south as Foveaux Strait, demonstrating the extent to which the new crop was impacting on Maori economies. Historic accounts suggest that these early introductions were treated in the same way as traditional crops and were subject to the same tapu restrictions and growing techniques (Leach 1984: 99). These practices may have continued for some time, until missionary influences brought about change through religious and horticultural instruction, and by example. Peaches and watermelons were introduced and adopted into the suite of traditional and non-traditional vegetables. In the 1820s in the Bay of Islands, watermelon was known as hue, perhaps a reference to the similarity of vine growth. Pumpkins and marrow were also adopted (Leach 1984: 106). Maori varieties of kumara soon lost favour to newly introduced varieties, which produced larger tubers, and new taro varieties, which may have been better suited to temperate conditions, were grown (Leach 1984: 105–106).

The area under cultivation increased in size to meet the demand for supplying ships with potatoes, and later the growing European-based commercial centres. For example, by the mid-19th century, Maori from the Hauraki area were supplying not only Auckland, but also the goldfields of New South Wales and Victoria

with wheat and potatoes. Ever-increasing areas of land were being planted and Maori were encouraged to plant crops as a means of establishing wealth (Monin 2001: 153). In 1853, more than 1300 canoe loads of produce, worth over £8000, arrived in the Waitemata Harbour from Hauraki (Monin 2001: 154). Waikato tribes were similarly productive, introducing their crops through the Manukau Harbour route. Ngati Porou of the East Coast were also growing crops for sale in the Auckland market, and in 1853 were gifted land at Kennedy Bay on the Coromandel Peninsula as a stopover for their schooners on the way to Auckland (Monin 2001: 208). This level of Maori horticultural endeavour, which was on a far larger scale than traditional gardening, required leadership, direction and a considerable amount of labour. In Hauraki at least, the produce was obtained without the use of European technologies of plough and horse, which were not introduced until the late 1850s. In addition to supplying Europeans, Maori were engaging in 'competitive hospitality', providing large quantities of food for feasts, which placed further pressure on garden land. Without the use of fertilisers and with such heavy cropping, the soil fertility was soon depleted. By 1860, the Hauraki agricultural economy was in decline, and much of the large-scale gardening had ceased by 1862 (Monin 2001: 158–161). This example serves to demonstrate not only the adaptiveness, but also the huge changes that Maori agriculture underwent in the first half of the 19th century.

A shift in the crops grown was also observed in Auckland. Marsden reported that in 1820, Ngati Paoa in Tamaki had kumara, potatoes, turnips and cabbage as their principal food (Elder 1932: 280), and by the time permanent European settlement was established in 1840, Maori were growing kumara, maize, taro, watermelon, pumpkin and potato (Stone 2001: 69).

Settlement pattern changes brought about by the introduction of European crops—particularly potato—are, as yet, not fully documented. Being hardier than kumara, potatoes could be grown throughout the year in warmer climates and extended the geographic range of Maori gardening from a few marginal sites in the northern South Island to throughout the South Island. Potatoes were a more reliable and palatable source of carbohydrate than bracken fern roots, and could tolerate a wider range of soil types and had higher yields (if only because more than one crop could be grown per year) than traditional kumara (Stone 2001: 69). Growing large areas of crops also necessitated a high labour input for land clearance and tending gardens, perhaps on a year-round basis. Bigger and more permanently occupied villages or landscapes may have resulted, but the environmental effects have not been well documented.

In the 19th century, forest was being cleared at a far greater rate than previously. Hargraves (1963: 110) associated this with the adoption of European tools for both land clearance and tilling the soil. This factor, together with a commercial trade, led to a tenfold increase in the area of land under cultivation in the Bay of Islands between 1814 and 1819. In the Waikato, missionaries observed that large areas of what had been primary forest 15 years previously was now planted with potatoes (Ballara 2003: 57).

In historic times, there was a change from community-oriented gardening to individual or family plots. At Thames, the following observation was made: 'Instead of living together in large numbers at their different settlements, and cultivating large areas of food in common, as they used to do, they now separate

into families or parties and go away into the hills to dig kauri-gum, where they remain for months' (AJHR[1] 1887: G-1:7–8). The result of this change in settlement pattern was a move to smaller subsistence gardens adjacent to individual houses or groups of houses. Explanations put forward for the demise of large-scale community gardens include the lack of demand for garden produce for the Australian goldfields, families travelling to other places to take part in activities such as gum digging, and a general population decline (Ballara 1998: 254–255).

Along with cereals, vegetables, fruit and other edible plants, animals such as pigs, chickens, cattle and horses were also taken up in the Maori economy. Pigs, in particular, entered the Maori economy in the 1820s for trade with Europeans, and Maori in Auckland grew potatoes and reared pigs for Auckland settlers (Stone 2001: 71). Cattle and horses were expensive and, therefore, not widely owned. The first horses were acquired by Hauraki people in the 1850s, and it is likely that cattle were also not farmed or owned prior to that time. Certainly, in Hauraki, the first European farms were not developed prior to 1840 (Monin 2001: 94–96), although missionaries in the Bay of Islands were practising animal husbandry from the time of their arrival.

Physical remains of gardens are difficult to trace, even when the location of gardens is known. No surface evidence remains of the Anaura Bay gardens sketched by the HMS Endeavour artist, Spöring, in 1769 (Jones 1989). The large acreages of the early decades of the 19th century in Hauraki and the East Coast are also now invisible. There are, however, small, shallow-ditched enclosures, described in site records from Northland, Coromandel, the Waikato and the East Coast, which are likely to be historic in age, although their direct association with Maori gardeners cannot be proven in the majority of cases. These features are undoubtedly present in other areas but have not been recorded. Site records describing these features are all similar. The enclosures are on flat land adjacent to the coast or a stream bank, and sometimes have peach or fig trees, or taro associated with them. Inside the ditch-and-banks are various features, including shallow ditches, scarps, and a possible potato clamp in one instance. Some well-defined examples (Q05/183–185) occur in Parekura Bay in the Bay of Islands (Fig. 52).

A distinctive 19th-century site type, found throughout the North and South Islands, and associated with both Maori and European gardening and farming practices, is the ditch-and-bank enclosure. Intact examples of these features have been reported, but they have been vulnerable to land-use changes over many decades and were undoubtedly more widespread previously. The intention of ditch-and-banks was to keep free-roaming farm animals out of the enclosed garden space. Ditch-and-bank fencing usually had a fence or hedge (often gorse (*Ulex europaeus*) or barberry (*Barberis* spp.) to deter penetration) along the top of the bank, and could either be linear or form an enclosure (Smart 1966). Earth was excavated from the ditch and used to make the bank. These features are more likely to be a European influence rather than associated with defensive ditches and banks. An historic photograph of an example at Wairoa near Mt Tarawera shows a garden within the enclosure, and an irregular ground surface within a similar enclosure at Pahaoa, Wairarapa, also suggests cultivated ground, leading Smart (1966) to interpret the ditch-and-bank as a barrier to keep

[1] Appendices to the Journals of the House of Representatives.

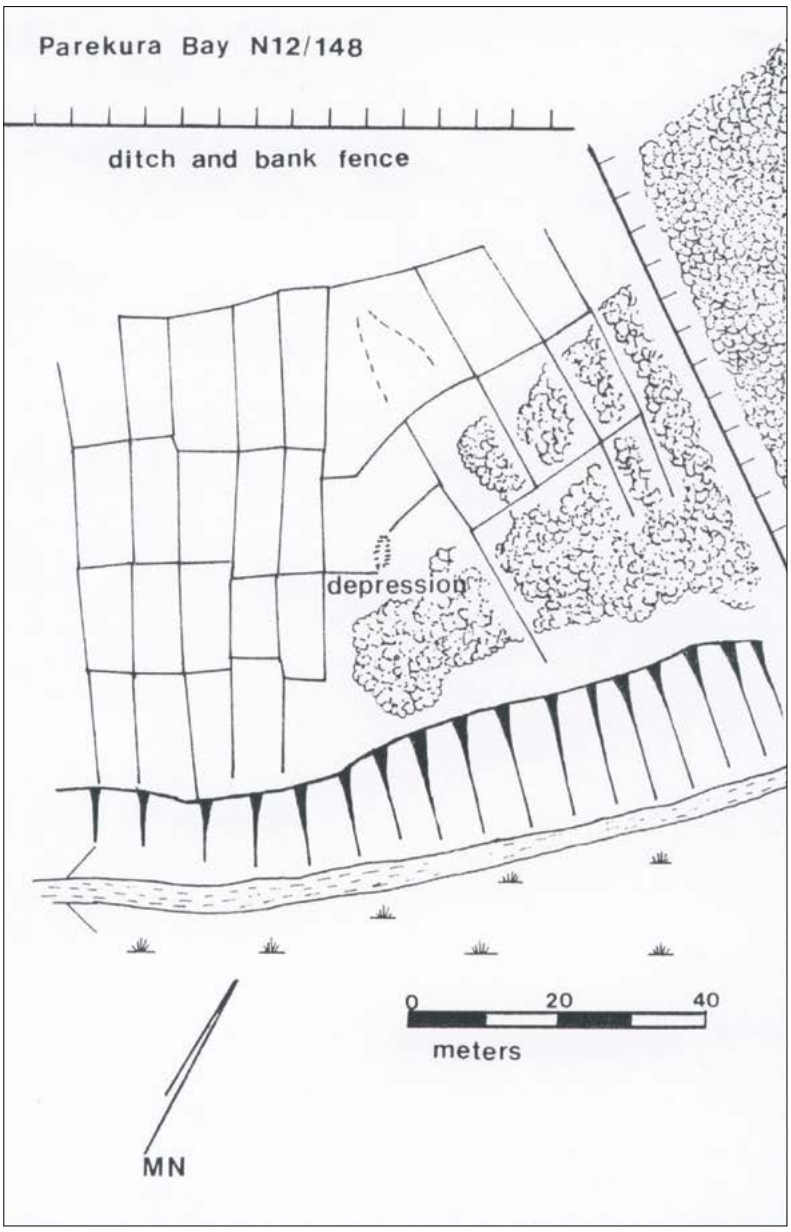


Figure 52. Ditch-and-bank feature, with garden plots identified by shallow channels, Parekura Bay, Northland. *After Barber 1989b.*

pigs out of gardens. Smaller examples, enclosing c. 0.25 acres, are also recorded, and are thought to have enclosed a house and garden.

Diamond (1966) contributed further information on these ditch-and-bank features, indicating that they were a European introduction used to delineate boundaries and to enclose paddocks, orchards, gardens and homesteads. The ditch may also have acted as a drain to remove surface water. When barbed wire became widely available as a fencing medium, ditch-and-bank features were no longer constructed.

Archaeological investigation of a ditch-and-bank feature near Waverley in south Taranaki revealed that it was an enclosure surrounded on three sides by a bank 2 m wide and 200 mm high (Cassels & Walton 1992). No ditch was present. Postholes were present along the top of the bank, and the conclusion was that the enclosure was used to contain stock. A mid-19th-century age is suggested by the authors. Without detailed historic records for an area, it is difficult to determine both the origin and function of these features.

9. Factors affecting site survival

Each site type is subject to different, and sometimes unique, factors affecting site survival. As has been mentioned several times in the course of this document, many of the archaeological features of garden sites are vague, ephemeral and susceptible to damage from a range of sources. There is little substantial information available to document stability or the rate of deterioration over time, as individual sites are not routinely revisited or evaluated for condition.

Garden sites, like all other evidence of Maori occupation on the landscape, are vulnerable to damage from a wide variety of land-use practices. Each of these is addressed briefly in this section. Some activities have an immediate, destructive impact on individual sites or on entire local cultural landscapes or selected parts of that landscape, while others affect sites slowly over time. Through the course of this research, it has become apparent that garden sites are particularly vulnerable, because the surface physical evidence is so subtle and so little is known about some of the site types that they cannot be put into a wider context. The lack of garden-related sites recorded, especially where the surface remains do not include stone or other obvious modifications, strongly supports the likelihood that garden sites are more vulnerable to damage because they are not highly visible like pa or pit and terrace sites. The more visible sites have action taken to avoid or mitigate damage. Many land-use activities, especially those associated with farming, are not subject to the resource consent process and therefore do not require evaluation of adverse effects on archaeological sites present.

Farming-related practices, such as ploughing, and the intensification of land-use through increased stock numbers, confinement into smaller, enclosed spaces, drainage of swamps and a shift in stock type, e.g. from sheep to cattle, or sheep to deer, have demonstrated adverse effects on garden sites. Ploughing, in particular, removes subtle changes on the surface of the land, and the removal of stone to facilitate ploughing has destroyed stone rows and associated gardening evidence. Examples of effects associated with ploughing are the absence of stone garden complexes on volcanic soils around cones such as Ahuahu on the Taiamai Plains, and the destruction of sites on the Marlborough coastal flat. Drainage of the Awanui swamp area near Kaitaia to form farmland has destroyed an extensive and complex system of Maori ditches.

Exotic afforestation and harvesting, and horticulture can be extremely damaging to garden sites. Considerable effort was expended to remove pine trees from garden areas in Waipoua Forest so that surface evidence was protected, but tree growth and development of root structures also affected sub-surface evidence of soil profiles and, in some instances, damaged stone heaps and rows. Intensive horticulture with tree cropping, vines and associated wind breaks, and pole-and-wire constructions can have a similar effect to forestry on sub-surface remains.

The land-use practices associated with farming and forestry described above have affected gardening sites. Urbanisation and the development of land for industrial purposes have also had a significant impact. For example, almost all of the Maori garden areas surrounding volcanic cones in central Auckland, South Auckland and the East Tamaki area of Auckland have been destroyed. This destruction

started in the 19th century on the volcanic soils in the inner city areas of Mt Eden, One Tree Hill, Three Kings, Mt St John, Mt Albert, Mt Roskill and Devonport. It is difficult to assess the total area of gardens that existed until the mid-19th century. Approximately 8000 ha of red and brown loam volcanic soils surrounded the cones in the wider Auckland area and, at a conservative estimate, 4000 ha of these soils were gardened. Less than 5% of the total possible garden area survives in protected land. There are reserves at Otuataua (100 ha) and at Matukutureia (McLaughlins Mountain) (60 ha), and a proposed reserve at Wiri. Smaller areas, such as Puketutu Island (20 ha) and Maungataketake/Ellett's Mt, both in private ownership, complete the list of remnant portions of volcanic stone field gardens in Auckland (Clough & Plowman 1996). Much of the destruction of gardens on the volcanic loams took place prior to the Historic Places legislation, which allowed for controlled destruction of sites with recovery of archaeological information. However, in the 1980s, archaeological assessments and excavations were carried out in large areas of gardens at Wiri and East Tamaki before they were destroyed. The results of some of that work are referred to here.

A similar impact is apparent in the Waikato area, where the urban and industrial areas of Hamilton are encroaching into farmland on river terraces to the north and south of the city, destroying Maori gardens and borrow pits, and leaving a remnant cultural landscape devoid of the full range of sites representing the settlement pattern. A review of garden site locations and borrow pits in the middle Waikato, between Ngaruawahia and Cambridge, indicated that only 1 of 20 sites was in a good state of preservation (Gumbley & Higham 1999b: fig. 5). The intensification of land-use and development of small lifestyle blocks, not necessarily accompanied by large-scale earthworks, is particularly affecting borrow pits, which are being filled in, and destroying associated soils. Earthworks at Chartwell have allowed archaeological examination of modified soils and the recognition of previously unrecorded features (Gumbley & Higham 1999a, 2000) and, perhaps equally significantly, have highlighted what has been, and continues to be, lost.

Garden sites on Crown-protected land are not immune to damage, although the damage is usually not the result of direct human actions. The offshore islands of the northern east coast are home to petrels, which burrow into archaeological sites and garden terraces to nest. This bird activity may well have been seen as an advantage by Maori gardeners—the earth was loosened and had a high fertility level through being continually enriched by guano—but given that protection is now the concern on remnant and non-renewable cultural landscapes, consideration should be given to assessing adverse effects and possible solutions.

10. Conclusions

The distribution of Maori gardening sites shows regional variation. This is mostly related to climatic variables, especially temperature. Critical factors were a cold, wet spring, which retarded tuber propagation and root growth, and frosts early and late in the growing season. The southern limit of pre-European gardening was near Banks Peninsula in Canterbury, but conditions on the east coast of the South Island north of Banks Peninsula are also likely to have been marginal, resulting in inconsistent yields from year to year and possibly even complete crop failure in some years. Gardeners in the southern one-third of the North Island may also have experienced difficulties, and gardening was restricted to a few coastal locations. Microclimates and shelter from cool winds may have enhanced crop success in some places. Maori gardeners were innovative and adopted various techniques to improve soil temperature and conditions, and thus enhance the chances of crops being successful.

Kumara was the most climatically tolerant of the Polynesian cultigens and could be grown as far south as Banks Peninsula. Gourd may not have been successfully grown in the South Island, and there are no accounts of pre-European varieties of taro or yam being grown south of Hawke's Bay. Taro, although having the advantage of being perennial and able to be stored in the ground rather than lifted and stored under special conditions, appears to have been a relatively minor crop. Likewise, yam did not attain the favoured-crop status that kumara did, and its disappearance from gardens after European vegetable crops were introduced suggests that it was retained to add variety to the diet rather than for any strict traditional cultural reasons. There is little information about the growing of taro and yam, or in what proportions they were grown compared with kumara.

Visible remains of garden sites take several forms, including stone rows, mounds, modified soils, slope trenches and swamp ditches. More difficult to detect are soils that have been gardened but have no physical alteration to the soil or surface. These soils constitute the majority of Maori gardens, and failure to recognise them does distort the national distribution pattern of gardening sites. However, storage pits may be used as proxy evidence of gardening. The distribution of evidence indicates that the northern two-thirds of the North Island was the most productive area for gardening, with sites usually confined to coastal areas. The evidence indicates that favoured garden areas were hill slopes with a north-west to north-east aspect, shingle fans and coastal beach ridges, stony or gravelly river terraces, and volcanic soils. The availability of all of these features was variable from region to region, but even if suitable soils and topographic requirements were present, the overriding influence was climate.

As in many other aspects of archaeology, general interpretations obscure the variety of evidence and local influences and, therefore, the ability to recognise change geographically and through time. Within a defined area, soils could be modified through the addition of sand and gravel, or not modified at all. Slopes might be gardened directly or modified to form large level terraces. Stone rows might have soil incorporated or trenches underneath or adjacent, or they might have organic matter incorporated. Soils in plots enclosed by stone rows might

still have large amounts of stone present. Even though there were restrictions imposed by the landscape, and cultural constraints of observing tapu and ritual, people practised gardening according to their own preferences. Just as modern gardeners plant and nurture crops by their own methods or idiosyncrasies, or use practices handed down through generations, Maori gardeners must also have exhibited some individuality. Best (1976) portrays a rigid gardening system controlled by ritual, yet individual sources outlined differing techniques, or similar techniques with differing justification, suggesting that there was flexibility in practice.

The field remains suggest that Maori gardening methods did change both geographically and through time. Catalysts could have been climatic variation, attempts to increase production, experimentation, or the adoption of new ideas. The speed with which new crops were adopted in the 19th century demonstrates that Maori gardeners were receptive to new ideas and showed adaptability and the ability to change or to fit new crops into the old system. The traditionally grown kumara, while supposedly rigidly controlled in all aspects of planting, growth and harvesting, was soon replaced by new varieties with different shape and flavour. Similarly, the first gardeners to arrive in New Zealand encountered a completely different set of conditions to those left behind in their homeland, yet the crops were nursed to survive, increase in number and provide a vital source of food for the majority of the population.

Within the overall system of gardening, there are some common features; in particular, the physical definition of the garden boundary. This could take the form of permanent boundaries, such as stone rows, or less permanent structures, such as fences and trenches, or logs. Both rows and fences are likely to have also served as wind breaks. Some landscapes, such as the volcanic soil areas of Auckland and the inland Bay of Islands, were occupied over many hundreds of years. Whether the divisions imposed at the very earliest stages of gardening were adhered to, or whether the broad layout of garden systems changed over time, has yet to be investigated. Emphasis to date has been on identifying the physical characteristics of gardening, and not on the change in garden systems through time. It is only in Palliser Bay that a number of complete garden complexes have been mapped in detail, but the gardens here are a relict landscape, abandoned after a relatively short period of use. Identification of the base system and any subsequent subdivision into smaller units over time could be the next phase in the analysis of a major garden system.

It has been suggested that the use of stone rows was an advantageous adaptive technique in southern regions (McFadgen 1980a,b), but the overall evidence suggests that in addition to having a boundary function, the rows were a convenient way of disposing of the rocks cleared from the garden soil. The removal of stones from soil was labour intensive, so the advantages to the soils must have outweighed the disadvantages of extra labour input. More research is needed in places such as Auckland or the inland Bay of Islands, where there were a variety of soil characteristics, one containing stones, the other having no or considerably fewer stones; or in the eastern Bay of Plenty, where there were stone-free coastal terraces with high fertility adjacent to the steep, stony slopes of Tahurua Point and Potikirua near Cape Runaway. In-depth examination of the relative merits of each soil type or location, through the collection of data relating to soil fertility, moisture retention and temperature, coupled with more

archaeological work, could help to identify why particular locations or soil types were chosen. To date, there has been little emphasis on the collection of data on soil conditions and climate at a micro-level.

Radiocarbon dates from gardens span the accepted length of Maori occupation of New Zealand. Only from Palliser Bay is there undisturbed evidence of gardening in the first few centuries after settlement. It is believed that the removal of forest cover led to increased siltation and erosion and, more directly, that the removal of vegetation shelter in a very exposed coastal situation led to the abandonment of the gardens in the 15th century (Leach, H.M. & Leach, B.F. 1979). Gardening continued to be carried out in the southern Wairarapa area, but the focus shifted from the coastal platform at Palliser Bay to sheltered valleys and the Wairarapa Plain although, as suggested by historic accounts, the narrow coastal platform of the east Wairarapa coast continued to be used throughout prehistory (ibid).

Gardening was undoubtedly carried out over a wide area by the first settlers, but because the most favourable gardening areas have been used repeatedly, any direct evidence of initial gardening has been obliterated. Only through the dating of the construction of rows, storage pits and vegetation clearance, and detection of changes in pollen frequencies can early gardening be inferred.

Kumara, being a sub-tropical plant, is much more likely to have adapted to conditions in the warmer parts of New Zealand than the Wairarapa and northern South Island. Even so, to multiply the available tubers to a number that could produce enough for eating as well as storing for the next year's seed crop must have been a test of skills and a result of trial and error over several years, on the part of the early gardeners. The role of cultigens in the diet of early settlers has not been investigated in any detail. Storage pits, believed to be a uniquely New Zealand adaptation to preserve the seed crop in a constant environment over the winter, have not been found in unequivocal early contexts, except at Skipper's Ridge and Sarah's Gully, Opito, and the dating of the pits at those site are not sufficiently controlled to assign them to the very beginning of the sequence. Further investigation of sites from the early end of the cultural sequence, focusing on village or base sites rather than hunting camps and middens, should provide broader evidence than faunal remains. The presence of storage pits, combined with the examination of deposits for relevant microfossils and starch grains, will enable archaeologists to document further the presence and role of horticulture on a regional basis, and predictive analysis of the most favourable microclimates and conditions in the early period of settlement.

A relationship between horticultural land and warfare has been proposed by a number of authors (e.g. Vayda 1960). Scarce good land was competed for, and there is a correlation between the density of pa and storage pit sites in the North Island, and between pa and good horticultural land (Allen 1996; Groube 1970). The greater number of pa are in the upper two-thirds of the North Island, as are storage pits and garden sites. There is no doubt that some pa were constructed to defend food stores, emphasising the value placed on the kumara crop; however, on other pa, such as Pouerua in the inland Bay of Islands, semi-subterranean storage pits were no longer in use when the fortifications were built (Sutton et al. 2003). The association between good soils and climate, conflict, group identity, display and mana is complex, and given the fluid nature of groups and their relationships, and change through time, no general explanation can be made.

There was a strong cooperative component in gardening and Maori Land Court records from various parts of the country are consistent on the importance of the community in the annual cycle (Sullivan 1985; Ballara 1998: 196–197). A large, organised labour input was required to achieve successful results. Vegetation clearance and large plantings were carried out on a shared basis involving multiple hapu, with each smaller group cultivating a defined portion of the new garden area. New small cultivations could be developed away from the main gardens by small (e.g. whanau-based) groups, and planted for specific purposes, such as to provide food during birding or fishing expeditions. In Tamaki, small gardens were planted in early spring in clearings near summer fishing camps and were then left untended while people returned to the main living place to participate in planting of the principal gardens. The kumara grown near fishing camps was eaten in summer while people collected and preserved fish and shellfish, before they returned to the main settlement to harvest the main crop (Sullivan 1985: 482). Rights to these clearings were passed down from individual to individual, male or female (Ballara 1998: 196–197). In Tamaki, traditional accounts indicate that by the mid-18th century, garden plots on stony soils had become family acquisitions; however, this was less apparent in the stone-free areas, where boundaries were less permanent (Sullivan 1985: 485). This suggests that stone rows had an important role in defining plot boundaries. Since their location was fixed and indisputable through time, there were likely to have been fewer internal land conflicts in areas with stone rows.

Sullivan (1985) proposed a settlement model based on her archaeological gardening research at Wiri for the earliest settlement period, and incorporated details from traditional accounts and Maori Land Court Minute Books for the later period. At Wiri, the focus for settlement and gardening initially was the sides of the volcanic cones, with small, scattered clearings in forest. The gardening system expanded in the 14th–15th centuries, and down-slope and cross-slope stone rows were constructed. The rims of the volcanic cones were being modified for residential structures, but defences were not yet present. The next phase of expansion was the clearance of forest on the lava fields surrounding the cones, including stone-free volcanic ash soils. Residential sites incorporating storage pits were built within the enlarged garden area, while on the slopes of the cones, terraces were being constructed over previous garden areas. These terraces also contained storage pits. Defensive structures were then built on the upper slopes of the volcano, near the rim. The model for the evolving construction of terraces and defences at Pouerua in Northland follows a similar argument, with occupation of the cone retreating towards the rim, associated with the construction of defences. Occupation of open settlements and first modifications to the cone were probably contemporaneous with initial forest clearance on the lava fields (Sutton et al. 2003).

A recurring pattern in Tamaki, from traditional accounts, was the abandonment of an area for a time if conflicts developed that did not involve the acquisition of land by the opposing parties (Sullivan 1985). (The most notable example of this was the desertion of parts of Tamaki and most of Hauraki for upwards of 10 years after the raids by Nga Puhi in the early 1820s.) The disruption to the annual gardening cycle had serious consequences for the maintenance of kumara production levels. Recovery may have taken several years, as seed stocks had to be built up again to previous levels (Sullivan 1985), and may have resulted in critical periods of food shortage.

Shawcross (1967), in a review of historic accounts, also concluded that garden produce was not consistently available. In pre-European and early historic times, gardens were not large enough to sustain the population that they supplied, and adverse weather conditions and social disruption often resulted in reduced yields and crop failure. The root of bracken fern, which grew well in fertile soils, was a more reliable source of carbohydrate. Bracken fern is a natural coloniser of cleared land; consequently, garden areas lying fallow provided ideal conditions for its growth (Leach 1980). Since bracken fern roots are difficult to remove entirely from soil and regrowth commonly occurs, crops planted on fern land would be in constant state of competition, and a large labour input would be required to keep bracken fern under control. Shawcross argued that as a result of this, gardening declined over time and bracken fern root consumption increased, because more of the favourable land (already in limited supply) was under bracken fern than in garden. Bracken fern root was acknowledged as an important resource and was mentioned frequently in Maori Land Court testimony (Ballara 1998: 198). It was actively managed to maintain its vitality and eventually attained the status of a semi-cultivated crop.

Although gardening might have been confined to particular geographic areas, through securing alliances and mutual access to resources, people outside those areas are also likely to have had access to kumara and other garden produce. Kumara was not a year-round staple, yet considerable energy went into producing it on a year-round basis, either through planting, tending or harvesting crops, or clearing new garden plots or fallowed land ready for new gardens. Kumara was very important from a social perspective—decision-making and directing the cycle of gardening reinforced the status of particular individuals within a hapu or group of hapu, and enhanced mana of individuals and groups through social obligations of hospitable provision of food and food exchange. Mana was also derived from having quality kumara to present to guests, and techniques and opportunities to increase the size of tubers paid dividends in the social sense as well as in producing more food. It is the social dimension that ensured the survival and importance of kumara and gardening in New Zealand, in the face of what were often difficult conditions and variable results.

Garden sites are vulnerable to destruction for a number of reasons. In many regions, in the absence of visible evidence, we do not even know what was or is there, much less what has been lost. The majority of the Auckland stone fields have already been destroyed through urban or industrial development. Subdivision of rural land into smaller lifestyle blocks and intensification of land-use, is having an unknown impact on soils and small sites where there is no visible evidence of gardening. It is no coincidence that prime horticultural land today was also prime land for Maori gardening. Sites can be investigated in response to a development threat, but a proportion of sites need protection into the future. Protection can be achieved through land being in the protected network system, i.e. the land gaining reserve status, whether in private or public ownership, or through the covenanting of private land and the development of management plans to protect the site features. Ideally, gardening sites should not be singled out for protection in isolation from the other archaeological features that collectively form evidence for an area of settlement. Thus, protection of the pa but not the pits and gardens, or the gardens but not the living terraces and pits, curtails the ability of those sites and that landscape to contribute meaningful

information in the future. In addition, cultural landscapes have an integrity that goes beyond the ability to recover information. The visual impact of a stone row system, or stone rows in a now wind-swept and exposed situation, also tells a story that is not dependent on archaeological techniques.

Volcanic garden areas have been well investigated in the Auckland region. The reports are data-rich and the stone systems have, wherever possible, been mapped. The garden systems of Palliser Bay have been well studied, providing a good study of a garden regime from the early end of the cultural sequence. What is lacking is an analysis of an area looking at change through time in a particular area—alteration to the size of plots, orientation of plots and superimposition of new patterns over old. Pouerua, being largely intact, is the ideal place for such a study.

The ditch systems and slope trenches of Northland are still an enigma. Swamp ditches are confined to the Northland area and, although investigated at two sites, it is still not known with any certainty what was grown there or when. Similarly, slope trenches, while present elsewhere in small numbers, also have a distribution largely confined to Northland. More research is needed on these features to establish chronology and to investigate why, if taro was the crop grown, the regime of wetland taro ceased to be used prior to European arrival. Microfossil studies to investigate which plants were grown will contribute significantly to our understanding of where particular plants were grown. Kumara was grown widely and gourds (in some situations at least) were grown on mounds; however, there is little archaeological evidence for either yam or taro cultivation, and the conditions under which ti pore and aute were grown are also, archaeologically, a mystery.

Microfossil studies have great potential, but careful consideration also needs to be given to possible contamination and the processes by which pollens, phytoliths and starch grains end up in sites. This will involve examination of the ethnographic accounts of gardening, where waste material was disposed of, and the effects of fire on remaining evidence. Archaeology must, however, remain the primary tool in the identification of gardens.

Over the last 50 years, since the debate on whether the first settlers brought cultigens with them or whether they were introduced by a later group began, there has been a considerable amount written about Maori gardening. However, the majority of this literature is in the form of unpublished, limited-distribution reports produced not under a research programme with clear theoretical framework but as a result of collecting information prior to site destruction. This work, while data-rich, warrants detailed analysis and synthesis on a regional basis to make it useful. That level of analysis is beyond this study.

On a national level, there is a range of evidence of Maori gardening, and due to the limitations imposed by the climate in some areas, it is unlikely that there is a general explanation for the variation in site types. Regional studies of Maori gardening are necessary to make sense of the distribution of sites and cultural responses through time. The physical remains of gardens are being documented, but the interaction between gardening and other aspects of the economy and settlement pattern in a cultural sense is lacking. Until a more inclusive approach is routinely being addressed in relation to gardening, we will continue to lack an understanding of what precipitated any change in gardening techniques and social responses through time.

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12. References

Albert, H. 1987: Archaeological survey of a volcanic field at Cryer's Road, East Tamaki. New Zealand Historic Places Trust, Auckland. 1987/4.

Allen, M. 1996: Pathways to economic power in Maori Chiefdoms: ecology and warfare in prehistoric Hawke's Bay. *Research in Economic Anthropology 17*: 171–225.

Ambrose, W. n.d.: Kauri Point. Unpublished paper delivered to New Zealand Archaeological Association Conference 1967.

Bain, P. 1987: Motuhora Island, Bay of Plenty. *New Zealand Archaeological Association Newsletter 30*: 41–48.

Ballara, A. 1998: Iwi. The dynamics of Maori tribal organisation from c.1769 to c.1945. Victoria University Press, Wellington. 400 p.

Ballara, A. 2003: Taua. 'Musket wars', 'land wars' or tikanga? Warfare in Maori society in the early nineteenth century. Penguin Books. 543 p.

Barber, I. 1982: Archaeological ditch systems in Tai Tokerau (Northland). New Zealand Historic Places Trust, Auckland. 1982/9.

Barber, I. 1983: Prehistoric wetland cultivation in Far Northern Aotearoa: an archaeological investigation. Unpublished MA thesis, Department of Anthropology, University of Auckland. 288 p.

Barber, I. 1989a: Competing patterns: distinguishing historic and prehistoric era wetland modification through aerial photography. *Archaeology in New Zealand 32*: 8–16.

Barber, I. 1989b: Of boundaries, drains and crops: a classification system for traditional Maori horticultural ditches. *New Zealand Journal of Archaeology 11*: 23–50.

Barber, I. 2001: Wet or dry: an evaluation of extensive archaeological ditch systems from Far Northern New Zealand. Pp. 41–50 in Stevenson, C.; Lee, G.; Morin, F. (Eds): Pacific 2000. Proceedings of the fifth international conference on Easter Island and the Pacific. Bearsville Press, Los Osos.

Barber, I. 2004: Crops on the border: the growth of archaeological knowledge of Polynesian cultivation in New Zealand. Pp. 169–192 in Furey, L.; Holdaway, S. (Eds): Change through time. 50 years of New Zealand archaeology. *New Zealand Archaeological Association Monograph 26.*

Beaglehole, J. 1962: The Endeavour Journal of Joseph Banks, 1768–1771, Vols 1 and II. Angus and Robertson, Sydney.

Beever, J. 1981: A map of the pre-European vegetation of lower Northland, New Zealand. *New Zealand Journal of Botany 19*: 105–110.

Best, E. 1976: Maori agriculture. Government Printer, Wellington. 315 p.

Brailsford, B. 1981: The tattooed land: the southern frontiers of the pa Maori. Reed, Wellington. 262 p.

Bruce, J.G. 1978: Soils of part Raglan County, South Auckland. *New Zealand Soil Bureau Bulletin 41*. 101 p.

Bruce, J.G. 1979: Soils of Hamilton City, North Island, New Zealand. *New Zealand Soil Survey Report 31*.

Buist, A. 1993: South Taranaki quarry sites. *Archaeology in New Zealand 36*: 66–74.

Bulmer, S. 1987: Prehistoric settlement patterns in the volcanic fields of Taamaki: a review. *Man and Culture in Oceania 3* Special Issue: 133–156.

Bulmer, S. 1989: Gardens in the south: diversity and change in prehistoric Maori agriculture. Pp. 688–705 in Harris, D.; Hillman, G. (Eds): Foraging and farming: the evolution of plant exploitation. *One World Archaeology 13*. Unwin Hyman, London.

Burtenshaw, M.; Harris, G.; Davidson, J.; Leach, F. 2003: Experimental growing of pre-European cultivars of Kumara (Sweet Potato, *Ipomoea batatas* [L.] Lam.) at the southern margins of Maori horticulture. *New Zealand Journal of Archaeology 23*(2001): 161–188.

Cassels, R. 1979: Early prehistoric wooden artefacts from the Waitore site (N136/16) near Patea, Taranaki. *New Zealand Journal of Archaeology 1*: 85–108.

Cassels, R.; Walton, T. 1992: Some historical agricultural features near Waverley, South Taranaki. *Archaeology in New Zealand 35*: 101–108.

Challis, A. 1976: Physical and chemical examination of a Maori gravel soil near Motueka, New Zealand. *New Zealand Journal of Science 19*: 249–254.

Challis, A. 1978: Motueka. An archaeological survey. Longman Paul. *New Zealand Archaeological Association Monograph No. 17*. 118 p.

Challis, A. 1991: The Nelson-Marlborough region: an archaeological synthesis. *New Zealand Journal of Archaeology 13*: 101–142.

Challis, A. 1992: A review of archaeological site records for the Canterbury region. *Science & Research Series 45*. Department of Conservation, Wellington. 20 p.

Challis, A.; Walton, T. 1993: An archaeological site survey of the margins of the Pouerua volcanic apron. New Zealand Historic Places Trust (unpublished). Copy held at New Zealand Historic Places Trust, Wellington.

Chittenden, E.; Hodgson, L.; Dodson, K. 1966: Soils and agriculture of Waimea Country, New Zealand. *Soil Bureau Bulletin 30*.

Clough, R.; Plowman, M. 1996: Independent comparative archaeological study of stonefields in the North Island, New Zealand. Clough & Associates, Auckland. Copy held at New Zealand Historic Places Trust, Wellington.

Coates, J. 1992: An experimental approach to the archaeology of earth and rock mounds in New Zealand. *Auckland Conservancy Historic Resource Series 4*. Department of Conservation.

Coates, J.; Rickard, V. 1985: Test excavation of a terrace at site R10/306, Weiti Station, Karepiro Bay (Rodney County). New Zealand Historic Places Trust, Auckland. 1985/14.

Coleman, B. 1972: Kumara growing. New Zealand. *Department of Agriculture Bulletin 294*. 42 p.

Colenso, W. 1880: On the vegetable food of the ancient New Zealanders before Cook's visit. *Transactions of the New Zealand Institute 13*: 3–38.

Cook, E.; Palmer, J.; D'Arrigo, R. 2002: Evidence for a 'Medieval Warm Period' in a 1,100 year tree-ring reconstruction of past austral summer temperatures in New Zealand. *Geophysical Research Letters 29(14)*: 12-1–12-4.

Cramond, B.; Bulmer, S.; Lilburn, K. 1982: Archaeological survey of the Wiri Oil Terminal N42/1224. New Zealand Historic Places Trust, Auckland. 1982/66.

Davidson, J. 1974: Radiocarbon dates from the Sunde site, Motutapu Island. *Records of the Auckland Institute and Museum 11*: 9–10.

Davidson, J. 1987: Fourteen years of site recording on Motutapu Island: a cautionary tale. *New Zealand Archaeological Association Newsletter 30*: 227–238.

Davis, S. 1962: Interim report: Makara Beach (Wellington) excavation. *New Zealand Archaeological Association Newsletter 5*: 145–150.

Diamond, J. 1966: Practical uses of ditch-and-bank fences in the Auckland district. *New Zealand Archaeological Association Newsletter 9*: 166–167.

Douglas, P. 1987: Radiocarbon dates from the Harris Road site N42/1203–East Tamaki, Auckland. *New Zealand Archaeological Association Newsletter 30*: 49–53.

Edson, S. 1973: Human ecology and prehistoric settlement on some offshore islands (East Cape to Cape Reinga) New Zealand. Unpublished MA thesis, Department of Anthropology, University of Auckland. 181 p.

Edson, S. 1979: Historical archaeology in the Waikato. An interim report on the Te Miro Project. *New Zealand Archaeological Association Newsletter 22*: 65–75.

Elder, J.R. (Ed.) 1932: The letters and journals of Samuel Marsden 1765–1838. Coulls Somerville Wilkie and A.H. Reed, Dunedin. 580 p.

Fankhauser, B. 1990: The Maori use of ti (cabbage trees) for food. Pp. 43–47 in Harris, W; Kapoor, P. (Eds): Nga mahi Maori o te wao nui a Tane. Botany Division, DSIR, Christchurch.

Foster, R. 1988: Archaeological survey of the remnant of Wiri Mountain (Matukururu), Manukau City. *Science and Research Internal Report 4.* Department of Conservation, Wellington. 19 p.

Foster, R.; Sewell, B.; Veart, D. 1985: Crater Hill, South Auckland: preliminary excavation. New Zealand Historic Places Trust, Auckland. 1985/1.

Foster, R.; Veart, D. 1985: Archaeological mapping of the Wilkins Davies proposed quarry, Otuataua. New Zealand Historic Places Trust, Auckland.

Foster, R.; Veart, D. 1986: Harris Road West mound complex: an archaeological survey. New Zealand Historic Places Trust, Auckland. 1986/8.

Fox, A. 1982: Hawke's Bay. Pp. 62–82 in Prickett, N. (Ed.): The first thousand years. Dunmore Press, Palmerston North.

Fredericksen, C.; Visser, E. 1988: Excavation of the Cryers Road Site (R11/1519) East Tamaki Auckland. *Archaeology in New Zealand 31*: 233–250.

Fredericksen, C.; Visser, E. 1991: Calibrated radiocarbon dates from Cryers Road (R11/1519): a correction. *Archaeology in New Zealand 34*: 161–162.

Furey, L. 1996: Oruarangi. The archaeology and material culture of a Hauraki pa. *Bulletin of the Auckland Institute and Museum 17*. 222 p.

Furey, L. 2000: Archaeological report Ngati Hei Wai 110. Evidence given to Waitangi Tribunal hearings October 2000, Hauraki Claim.

Gibbs, H. 1980: New Zealand soils. An introduction. Oxford University Press, Wellington. 115 p.

Goff, J.; McFadgen, B. 2001: Catastrophic seismic-related events and their impact on prehistoric human occupation, coastal New Zealand. *Antiquity* 75: 155–162.

Gordon, H.; Bassett, K.; Nobes, D.; Jacomb, C. 2004: Gardening at the edge: documenting the limits of tropical Polynesian horticulture in southern New Zealand. *Geoarchaeology 19:* 185–218.

Grange, L.I.; Taylor, N.H.; Sutherland, C.F.; Dixon, J.K.; Hodgson, L.; Steelye, F.T.; Kidson, E.; Cranwell, L.M.; Smallfield P.W. 1939: Soils and agriculture of part of Waipa County. *DSIR Bulletin 76*.

Green, R.C. 2005: Sweet potato transfers in Polynesian prehistory. Pp. 43–62 in Ballard, C.; Brown, P.; Bourke, R.M.; Harwood, T. (Eds): The sweet potato in Oceania: a reappraisal. *Ethnology Monographs 19*, University of Pittsburgh; *Oceania Monograph 56*, University of Sydney.

Groube, L. 1966: Rescue excavations in the Bay of Islands. *New Zealand Archaeological Association Newsletter 9*: 108–114.

Groube, L. 1970: The origin and development of earthwork fortifications in the Pacific. Pp. 133–164 in Green, R.C.; Kelly, M. (Eds): Studies in Oceanic culture history 1. *Pacific Anthropological Records 11*. Bishop Museum, Honolulu.

Gumbley, W. 1999: Archaeology of pre-European garden soils at Papamoa, Bay of Plenty. Project 2156. Unpublished report to Science & Research Unit, Department of Conservation, Wellington.

Gumbley, W.; Higham, T. 1999a: Archaeological investigation of a prehistoric garden (S14/203), Horotiu, Waikato. Unpublished report. Copy held at New Zealand Historic Places Trust, Wellington.

Gumbley, W.; Higham, T. 1999b: State Highway 1 four-laning: Ngaruawahia bypass: assessment of effects on the archaeological values of prehistoric Maori garden soils and borrow pits at archaeological site S14/164, Horotiu. Unpublished report. Copy held at New Zealand Historic Places Trust, Wellington.

Gumbley, W.; Higham, T. 2000: Archaeological investigation of prehistoric garden complexes affected by R1 and N1 arterial routes, Chartwell, Hamilton. Unpublished report. Copy held at New Zealand Historic Places Trust, Wellington.

Gumbley, W.; Higham, T.; Low, D. 2003: Prehistoric horticultural adaptation of soils in the Middle Waikato Basin: review and evidence from S14/201 and S14/185, Hamilton. *New Zealand Journal of Archaeology 25*(2003): 5–30.

Harding, E. 1928: Prehistoric drains on the Kaipara, west coast. *Journal of the Polynesian Society 37*: 367–368.

Hargraves, R.P. 1963: Changing Maori agriculture in pre-Waitangi New Zealand. *Journal of the Polynesian Society 72*: 101–117.

Harris, G.; Burtenshaw, M.; Davidson, J.; Leach, F. 2000: An experimental kumara garden at Robin Hood Bay, near Port Underwood, Marlborough. *Archaeology in New Zealand 43*: 301–313.

Harrowfield, D. 1969: A study of the types and distribution of archaeological sites on Banks Peninsula, Canterbury. *New Zealand Archaeological Association Newsletter 12*: 94–102.

Harvey, C.; Gill, G.; Crossman, C.; Fraser, L. 1997: Assessing relationships of kumara cultivars by RAPD analysis. *New Zealand Journal of Botany 35*: 479–485.

Higham, T.; Gumbley, W. 2001: Early preserved Polynesian kumara cultivations in New Zealand. *Antiquity 75*: 511–512.

Horn, H. 1993: Rekamaroa kumara, sand and soil. *Archaeology in New Zealand 36*: 185–189.

Horrocks, M. 2004: Polynesian plant subsistence in prehistoric New Zealand: a summary of the microfossil evidence. *New Zealand Journal of Botany 42*: 321–334.

Horrocks, M.; Barber, I. 2005: Microfossils of introduced starch cultigens from an early wetland ditch in New Zealand. *Archaeology in Oceania 40*: 106–114.

Horrocks, M.; Irwin, G.; Jones, M.; Sutton, D. 2004: Starch grains and xylem cells of sweet potato (*Ipomoea batatas*) and bracken (*Pteridium esculentum*) in archaeological deposits from northern New Zealand. *Journal of Archaeological Science 31:* 251–258.

Horrocks, M.; Jones, M.D.; Beever, R.D.; Sutton, D.G. 2002: Analysis of plant microfossils in prehistoric coprolites from Harataonga Bay, Great Barrier Island, New Zealand. *Journal of the Royal Society of New Zealand 32(4)*: 617–628.

Horrocks, M.; Jones, M.D.; Carter, J.A.; Sutton, D.G. 2000: Pollen and phytoliths in stone mounds at Pouerua, Northland, New Zealand: implications for the study of Polynesian farming. *Antiquity 74*: 863–867.

Hosking, T.; Leahy, A. 1982: Investigations at rock shelter N93/5 Waihora Bay, Taupo, New Zealand. *Records of the Auckland Institute and Museum 19*: 81–99.

Irwin, G. 2004: Excavations and site history at Kohika. Pp. 45–75 in Irwin, G. (Ed.): Kohika. The archaeology of a late Maori lake village in the Ngati Awa rohe Bay of Plenty New Zealand. Auckland University Press, Auckland.

Jacomb, C. 1995: Panau, periodisation and northeast South Island prehistory. Unpublished MA thesis, Department of Anthropology, University of Otago, Dunedin.

Jacomb, C. 2000: Panau. The archaeology of a Banks Peninsula Maori village. *Canterbury Museum Bulletin No. 9*. 137 p.

Johnson, L. 1986: Aspects of the prehistory of the far northern valley systems. Unpublished MA thesis, Department of Anthropology, University of Auckland. 257 p.

Johnson, L. 1997: Archaeological investigations of sites N12/8 (Q05/46) and N12/35 (Q05/73), Opunga Bay, Moturua Island, Bay of Islands. Unpublished report. Copy held at New Zealand Historic Places Trust, Wellington.

Jones, K. 1986: Polynesian settlement and horticulture in two river catchments of the eastern North Island, New Zealand. *New Zealand Journal of Archaeology 8*: 5–32.

Jones, K. 1988: Horticulture and settlement chronology of the Waipaoa River catchment, East Coast, New Zealand. *New Zealand Journal of Archaeology 10*: 19–52.

Jones, K. 1989: "In much greater affluence": productivity and welfare in Maori gardening at Anaura Bay, October 1769. *Journal of the Polynesian Society 98*: 49–75.

Jones, K. 1991: Maori settlement and horticulture on the Rangitaiki Plains, Bay of Plenty, New Zealand. *New Zealand. Journal of Archaeology 13*: 143–175.

Jones, K. 1994: Nga tohuwhenua mai te rangi. A New Zealand archaeology in aerial photographs. Victoria University Press, Wellington. 249 p.

Law, G. 1968: Maori soils in the lower Waikato. *New Zealand Archaeological Association Newsletter 11*: 67–75.

Law, G. 1969: Pits and kumara agriculture in the South Island. *Journal of the Polynesian Society 78*: 223–251.

Law, G. 1975: Age and function of made soils. A comment on the state of knowledge. *New Zealand Archaeological Association Newsletter 18*: 180–182.

Lawlor, I. 1981a: Maruka excavations, Kawerau, 1981: an interim report. *New Zealand Archaeological Association Newsletter 24*: 184–191.

Lawlor, I. 1981b: Puhinui excavation report N42/17. Department of Anthropology, University of Auckland (unpublished). Copy held at New Zealand Historic Places Trust, Wellington.

Lawlor, I. 1981c: Radiocarbon dates from Puhinui (N42/17), South Auckland. *New Zealand Archaeological Association Newsletter 24*: 160–163.

Lawlor, I. 1983: Maruka investigations Stage IV: excavation of valley areas associated with site N77/606. Department of Anthropology, University of Auckland (unpublished). Copy held at New Zealand Historic Places Trust, Wellington.

Lawlor, I. 1984: Interim report on Stages IV and V of the Maruka Investigations, Kawerau, Bay of Plenty. *New Zealand Archaeological Association Newsletter 27*: 232–246.

Leach, B.F. 1979: Excavations in the Washpool Valley, Palliser Bay. Pp. 67–136 in Leach, B.F.; Leach, H.M. (Eds): Prehistoric man in Palliser Bay. *National Museum of New Zealand Bulletin 21*. Wellington.

Leach, B.F.; Leach, H.M. 1979: The Wairarapa archaeological research programme. Pp. 1–10 in Leach, B.F.; Leach, H.M. (Eds): Prehistoric man in Palliser Bay. *National Museum of New Zealand Bulletin 21*. Wellington.

Leach, H.M. 1976: Horticulture in prehistoric New Zealand: an investigation of the function of the stone walls of Palliser Bay. Unpublished PhD thesis, University of Otago, Dunedin. 221 p.

Leach, H.M. 1979a: Evidence of prehistoric gardens in eastern Palliser Bay. Pp. 137–161 in Leach, B.F.; Leach, H.M. (Eds): Prehistoric man in Palliser Bay. *National Museum of New Zealand Bulletin 21*. Wellington.

Leach, H.M. 1979b: The significance of early horticulture in Palliser Bay for New Zealand prehistory. Pp. 241–249 in Leach, B.F.; Leach, H.M. (Eds): Prehistoric man in Palliser Bay. *National Museum of New Zealand Bulletin 21*. Wellington.

Leach, H.M. 1980: Incompatible land use patterns in Maori food production. *New Zealand Archaeological Association Newsletter 23*: 135–147.

Leach, H.M. 1983: Model gardens and the acceptability of new crops to Polynesian horticulturalists. *New Zealand Journal of Archaeology 5:* 139–149.

Leach, H.M. 1984: 1,000 years of gardening in New Zealand. Reed, Wellington. 157 p.

Leach, H.M. 2000: European perceptions of the roles of bracken rhizomes (*Pteridium esculentum* (Forst. f.) Cockayne) in traditional Maori diet. *New Zealand Journal of Archaeology 22* (2000): 31–43.

Leach, H.M. 2005: Ufi kumara, the sweet potato as yam. Pp. 63–70 in Ballard, C.; Brown, P.; Bourke, R.M.; Harwood, T. (Eds): The sweet potato in Oceania: a reappraisal. *Ethnology Monographs 19*, University of Pittsburgh; *Oceania Monograph 56*, University of Sydney.

Leach, H.M.; Leach B.F. 1979: Environmental change in Palliser Bay. Pp. 229–240 in Leach, B.F.; Leach, H.M. (Eds): Prehistoric man in Palliser Bay. *National Museum of New Zealand Bulletin 21*. Wellington.

Leahy, A. 1976: Whakamoenga Cave, Taupo, N94/7. A report on the ecology, economy and stratigraphy. *Records of the Auckland Institute and Museum 13*: 29–75.

Leahy, A; Nevin, D. 1993: Excavations at site P5/228. Pp. 27–55 in Sutton, D.G. (Ed.): The archaeology of the peripheral Pa at Pouerua, Northland, New Zealand. Auckland University Press, Auckland.

Leahy, A.; Walsh, W. 1982: Site surveying in the eastern Bay of Plenty. *New Zealand Archaeological Association Newsletter 25*: 6–15.

Leathwick, J. 2000: Predictive models of archaeological site distribution in New Zealand. *Science and Research Internal Report 181*. Department of Conservation, Wellington. 12 p.

Maingay, J. 1984: Te hue: people and a plant. Unpublished MA thesis, Department of Anthropology, University of Auckland.

Marshall, Y.; Paama, M.; Samuels, M.; Sutton, D.; Taikato, T. 1994: Archaeological survey of Matakana Island Forest Compartment 3, Stands 2–4; Compartment 12, Stands 1–5; Compartment 14, Stand 2 and Compartment 20, Stands 1–5. Final Report. Auckland Uniservices Ltd, University of Auckland (unpublished). Copy held at New Zealand Historic Places Trust, Wellington.

Matthews, P. 1985: Nga taro o Aotearoa. *Journal of the Polynesian Society 94*: 253–272.

Matthews, P. 1996: Ethnobotany, and the origins of *Broussonetia papyrifera* in Polynesia: an essay on tapa prehistory. Pp. 117–132 in Davidson, J.; Irwin, G.; Leach, F.; Pawley, A.; Brown, D. (Eds): Oceanic culture history. Essays in honour of Roger Green. New Zealand Journal of Archaeology Special Publication, Dunedin.

Matthews, P. 2002: Taro storage systems. Pp. 135–163 in Shuji, Y.; Matthews, P. (Eds): Vegeculture in Eastern Asia and Oceania. The Japan Center for Area Studies, National Museum of Ethnology, Osaka.

McFadgen, B. 1980a: Maori plaggen soils in New Zealand, their origin and properties. *Journal of the Royal Society of New Zealand 10*: 3–18.

McFadgen, B. 1980b: A stone row system at Okoropunga on the southeast Wairarapa coast and inferences about coastal stone rows elsewhere in central New Zealand. *New Zealand Journal of Science 23*: 189–197.

McFadgen, B. 1997: Archaeology of the Wellington Conservancy: Kapiti-Horowhenua. A prehistoric and palaeoenvironmental study. Department of Conservation, Wellington. 43 p.

McFadgen, B. 2003: Archaeology of the Wellington Conservancy: Wairarapa. A study in tectonic archaeology. Department of Conservation, Wellington. 94 p.

McFadgen, B.; Walton, T. n.d.: Report of investigations for the New Zealand Historic Places Trust into garden soils at the Johnston Trust Estate Papamoa. Unpublished report. Filed with U14/2844.

Mitcalfe, B. 1970: Stone mounds and ridges in Maori agriculture. *New Zealand Archaeological Association Newsletter 13*: 173–177.

Monin, P. 2001: This is my place. Hauraki contested 1769–1875. Bridget Williams Books, Wellington. 284 p.

Neich, R. 1996: New Zealand Maori barkcloth and barkcloth beaters. *Records of the Auckland Institute and Museum 33*: 111–158.

Nevin, G. 1983: Site survey of the south-west Whangarei district. *New Zealand Archaeological Association Newsletter 26*: 119–144.

Nichol, R. 1988: Tipping the feather against a scale: archaeozoology from the tail of the fish. Unpublished PhD thesis, Department of Anthropology, University of Auckland. 572 p.

Nicholas, J.L. 1817: Narrative of voyage to New Zealand, Vol. 1. James Black & Son, London.

Nicholls, M. 1965: Some probable pre-European agricultural evidence in Northland. *New Zealand Archaeological Association Newsletter 8*: 148–149.

Ollivier, I.; Hingley, C. 1987: Extracts from journals relating to the visit to New Zealand of the French ship *St Jean Baptiste* in December 1769 under the command of J.F.M. de Surville. Alexander Turnbull Library Endowment Trust with Indosuez New Zealand Ltd, Wellington. 227 p.

Ollivier, I.; Spencer, J. 1985: Extracts from journals relating to the visit to New Zealand in May–July 1772 of the French ships *Mascarin* and *Marquis de Castries* under the command of J.F.M. de Surville. Alexander Turnbull Library Endowment Trust with Indosuez New Zealand Ltd, Wellington. 396 p.

Papworth, M. 1980: Waipoua River Valley archaeological site survey May 1980. Unpublished report to New Zealand Forest Service, Auckland Conservancy. Copy held at New Zealand Historic Places Trust, Wellington.

Peters, K.M. 1975: Agricultural gardens on Moturua Island in the Bay of Islands. *New Zealand Archaeological Association Newsletter 18*: 171–182.

Phillips, C. 1980: Site recording at Pouerua, Bay of Islands. *New Zealand Archaeological Association Newsletter 23*: 148–160.

Phillips, C. 2000: Waihou journeys. The archaeology of 400 years of Maori settlement. Auckland University Press, Auckland. 194 p.

Prickett, N. 1979: Prehistoric occupation in the Moikau Valley, Palliser Bay. Pp. 29–47 in Leach, B.F.; Leach, H.M. (Eds): Prehistoric man in Palliser Bay. *National Museum of New Zealand Bulletin 21*. Wellington.

Prickett, N; Prickett, K. 1975: D'Urville Island archaeological survey—1973. *New Zealand Archaeological Association Newsletter 18*: 108–131.

Pullar, W.A.; Vucetich, C.G. 1960: Problems of site interpretation in archaeology. *New Zealand Archaeological Association Newsletter 3(4)*: 4–8.

Rickard, V.; Veart, D.; Bulmer, S. 1983*:* A review of archaeological stone structures of South Auckland. New Zealand Historic Places Trust, Auckland. 1983/4.

Rigg, T.; Bruce, J. 1923: Maori gravel soils of Waimea West, Nelson, New Zealand. *Journal of the Polynesian Society 32*: 85–92.

Salmond, A. 1991: Two worlds. First meetings between Maori and Europeans 1642–1772. Viking, Auckland. 477 p.

Searle, E.J. 1981: City of volcanoes. A geology of Auckland. Longman Paul, Auckland. 112 p.

Sewell, B. 1994: Excavation of two stone heaps at site S11/245 in the Tapapakanga Regional Park, South Auckland. Department of Conservation, Auckland.

Shawcross, F.W. 1966: Ongari Point—second season. *New Zealand Archaeological Association Newsletter 9*: 53–70.

Shawcross, K. 1967: Fernroot, and the total scheme of 18th century Maori food production in agricultural areas. *Journal of the Polynesian Society 76*: 330–352.

Simmons, A. 2003: Summary report outlining archaeological work and preliminary results for part of Kirikiriroa Pa S14/39, Hamilton. Prepared for Roydon Hooker, Director Araldon Holdings. Copy held at New Zealand Historic Places Trust, Wellington.

Simpson, P. 2000: Dancing leaves. The story of New Zealand's cabbage tree, ti kouka. Canterbury University Press, Christchurch. 324 p.

Slocombe, A.; Veart, D. 1989: Archaeological investigation at the Shaw Block (R11/1525), East Tamaki. *Science and Research Internal Report 45*. Regional Archaeology Unit for Science and Research Directorate, Department of Conservation, Auckland. 42 p.

Smart, C. 1966: The ditch-and-bank fence. *New Zealand Archaeological Association Newsletter 9*: 19–28.

Spencer, J. 1983: Rangihoua paa and Oihi Mission Station, Purerua Peninsula, Bay of Islands. Pp. 77–110 in Bulmer, S.; Law, R.G.; Sutton, D. (Eds): A lot of spadework to be done. Essays in honour of Lady Aileen Fox by her New Zealand friends. *New Zealand Archaeological Association Monograph 14*. Auckland.

Stafford, D. 1994: Landmarks of Te Arawa. Vol. 1: Rotorua. Reed Books, Auckland.

Stone, R. 2001: From Tamaki-Makau-Rau to Auckland. Auckland University Press, Auckland. 342 p.

Sullivan, A. 1972: Stone walled complexes of Central Auckland. *New Zealand Archaeological Association Newsletter 15*: 148–160.

Sullivan, A. 1974: Scoria mounds at Wiri. *New Zealand Archaeological Association Newsletter 17*: 128–143.

Sullivan, A. 1975a: Radiocarbon ages from Wiri (N42/24). *New Zealand Archaeological Association Newsletter 18*: 206–207.

Sullivan, A. 1975b: Slope gardens at Wiri Mt, Manurewa. *Working Papers in Anthropology No. 31*. 89 p.

Sullivan, A. 1985: Intensification in volcanic zone gardening in northern New Zealand. Pp. 475–489 in Farrington, I. (Ed.): Prehistoric intensive agriculture in the tropics. *BAR International Series 232*.

Sutton, D. 1982: Proposed archaeological research in the inland Bay of Islands. *New Zealand Archaeological Association Newsletter 25*: 183–190.

Sutton, D. 1983: The Pouerua Archaeological Project: Phase I, 1982–1983. *New Zealand Archaeological Association Newsletter 26*: 107–118.

Sutton, D. 1994: Preface to the first edition The Pouerua Archaeological Project. Pp. ix–xvi in Sutton, D. (Ed.): The archaeology of the kainga. A study of precontact Maori undefended settlements at Pouerua, Northland, New Zealand. 2nd edition. Auckland University Press, Auckland.

Sutton, D.; Furey, L.; Marshall, Y. 2003: The archaeology of Pouerua. Auckland University Press, Auckland. 262 p.

Taylor, N. 1958: Soil science and New Zealand prehistory. *New Zealand Science Review 16 (9–10)*: 71–79.

Trotter, M. 1977: Titirangi archaeology: an interim report. Marlborough Sounds Maritime Park Board, Blenheim. 18 p.

Trotter, M.; McCulloch, B. 1979: Prehistory at Clarence Bridge. Kaikoura Coastal Reserves Board. 22 p.

Trotter, M.; McCulloch, B. 1999a: How far south: the southern limits of kumara growing in pre-European New Zealand. *Archaeology in New Zealand 42*: 129–133.

Trotter, M.; McCulloch, B. 1999b: How many sites: the Clarence complex. *Archaeology in New Zealand 42*: 230–237.

Trotter, M.; McCulloch, B. 2001: Once were borrowers. *Archaeology in New Zealand 44*: 206–214.

Vayda, A.P. 1960: Maori warfare. *Polynesian Society Maori Monograph 2*. A.H. & A.W. Reed, Auckland.

Veart, D. 1986: Stone structures and landuse at three South Auckland volcanic sites. Unpublished MA thesis, Department of Anthropology, University of Auckland. 248 p.

Veart, D.; Foster, R; Bulmer, S. 1984: Archaeological mapping of the Wiri Railway Site N42/1225. New Zealand Historic Places Trust, Auckland. 1984/7.

Walsh, Archdeacon 1902: The cultivation and treatment of kumara by the primitive Maori. *Transactions and Proceedings of the New Zealand Institute 35*: 12–24.

Walsh, Rev. Canon 1900: On the occurrence of *Cordyline terminalis* in New Zealand. *Transactions and Proceedings of the New Zealand Institute 33*: 301–306.

Walton, T. 1978: Maori soils. Unpublished MA research essay, Department of Anthropology, University of Auckland. 41 p.

Walton, T. 1982a: Rethinking made soils. *New Zealand Archaeological Association Newsletter 25*: 16–29.

Walton, T. 1982b: "Such as are seen on land that has been ploughed": slope lines and ploughing methods. *New Zealand Archaeological Association Newsletter 25*: 125–131.

Walton, T. 1983: Made soils in the vicinity of Aotea Harbour. *New Zealand Archaeological Association Newsletter 26*: 86–93.

Walton, T. 1985a: The distribution and extent of quarry pits near Kaiapoi, Canterbury. *New Zealand Archaeological Association Newsletter 28*: 113–115.

Walton, T. 1985b: Site distribution, environmental potential, and frontiers in the Manukau lowlands. *New Zealand Archaeological Association Newsletter 28*: 165–171.

Walton, T. 1986: Terraces and gravel-added soils of Whitireia Peninsula, Porirua. *New Zealand Archaeological Association Newsletter 29*: 78–85.

Walton, T. 1992: Investigation of a terrace at R26/111, Whitireia Peninsula, Porirua. *Archaeology in New Zealand 35*: 45–51.

Walton, T. 1999: Archaeological site recording in New Zealand. *New Zealand Archaeological Association Monograph 23*. 138 p.

Walton, T. 2000: Archaeology of the Taranaki–Wanganui region. *Science for Conservation 154*. Department of Conservation, Wellington. 64 p.

Walton, T.; Cassels, R. 1992: Borrow pits and made soils near Waverley, South Taranaki. *Archaeology in New Zealand 35*: 160–171.

Welch, J. 2000: The prehistoric stone row and wall systems of New Zealand and related factors of climate and soil. Unpublished MA thesis, Department of Anthropology, University of Auckland. 206 p.

Wilkes, C. 1845: Narrative of the United States exploring expedition during the years 1838, 1839, 1840, 1841, 1842. Vol II. Wiley and Putnam, London.

Wilkes, O. 1998: Another look at stone structures near Mount Karioi. *Archaeology in New Zealand 41*: 65–74.

Wilson, D.M. 1921: Ancient drains Kaitaia swamp. *Journal of the Polynesian Society 30*: 185–188.

Wilson, D.M. 1922: Ancient drains. Maori drains, North Auckland. *Journal of the Polynesian Society 31*: 130–133.

Worrall, J. 1993: An ethnobotanical study of the effect of sand and gravel addition to soils on soil temperature and plant growth. Unpublished BAgrSc dissertation, Lincoln University. 92 p.

Yate, W. 1835: An account of New Zealand. Seely and Burnside, London.

Yen, D. 1961: The adaptation of kumara by the New Zealand Maori. *Journal of the Polynesian Society 70*: 338–348.

Yen, D. 1990: The achievements of the Maori agriculturalist. Pp. 37–42 in Harris, W.; Kapoor, P. (Eds): Nga mahi Maori o te wao nui a Tane. Botany Division, DSIR, Christchurch. 310 p.

Yen, D.; Head, J. 1993: Kumara remains in Pit O at P5/288. Pp. 56–64 in Sutton, D.G. (Ed.): The archaeology of the peripheral pa at Pouerua, Northland, New Zealand. Auckland University Press, Auckland.

Appendix 1

MAORI GARDEN SITES INVESTIGATED

The following is a brief list of gardening evidence excavated in New Zealand, showing site number and name, date excavated and name(s) of excavator(s), a description of the gardening evidence excavated, whether or not the evidence was radiocarbon dated (RC date: Y = yes; N = no), and the reference from which this information was obtained.

SITE NO.	SITE NAME	DATE EXCAVATED	EXCAVATOR	DESCRIPTION	RC DATE	REFERENCES
Northland						
N03/639, 640	Motutangi	–	Barber	Ditches sectioned	Y	Barber 1983
O04/580	Waimutu Swamp, Taipa	1990	Johnston	Ditches	N	–
Q05/44	Moturua	1966	Groube	Soil	Y	Groube 1966
Q05/44, 46	Moturua	1968	Peters	Slope trenches, soil	Y	Peters 1975
Q05/46	Moturua	1996	Johnson	Slope trenches, soil	Y	Johnson 1997
–	Pouerua	1982	Sutton	Mounds, footpaths, row	Y	Sutton 1983
Auckland						
R11/25	McLaughlins	1979–80	Lawlor	Soils, rows, mounds, small shelter	Y	Lawlor 1981b,c
R11/32	Wiri	1974	Sullivan	Soil, stone row	Y	Sullivan 1975a,b
R11/245	Tapapakanga	1984	Sewell	Stone heaps		Sewell 1994
R11/664, 665	Crater Hill	1984	Foster, Sewell, Veart	Mounds, paved living area, storage pits	N	Foster et al. 1985
R11/1123, 1129	Ambury Park	1982	Lilburn	Mounds, garden	N	–
R11/1187	Wiri Oil Terminal	1982–83	Bulmer	Soils, rows, mounds, shelters	Y	–
R11/1188	Wiri Railway	1983–86	Coates, Rickard	Mounds	N	Coates 1992
R11/1301	Harris Road/Stevensons, Green Mt, East Tamaki	1985	Douglas	Mounds	Y	Douglas 1987
R11/1497	Allen's Road	1986	Albert	Settlement/garden		Albert 1987
R11/1519	Cryers Road	1988	Fredericksen, Visser	Settlement/garden	Y	Fredericksen & Visser 1988, 1991
R11/1525	Shaw Block	1987	Slocombe, Veart	Mounds	N	Slocombe & Veart 1989
Waikato						
S14/39	Kirikiriroa	2002	Simmons	Garden soil, circular depressions	N	Simmons 2003
S14/201	Chartwell	2000	Gumbley, Higham	Garden soil, circular depressions	Y	Gumbley & Higham 2000; Gumbley et al. 2003
S14/203	Horotiu	1999	Gumbley, Higham	Garden soil, drains	N	Gumbley & Higham 1999a
R15/95	Aotea	1976–78	Walton	Garden soil, terraces, borrow pit	Y	Walton 1983

Continued on next page

Appendix 1—continued

SITE NO.	SITE NAME	DATE EXCAVATED	EXCAVATOR	DESCRIPTION	RC DATE	REFERENCES
Taranaki						
Q21/234	Dickie, Waverley	1974	Walton, Cassels	Borrow pit, soil	N	Walton & Cassels 1992
Q21/239	Waverley	1974	Cassels, Walton	Earthen banks	N	Cassels & Walton 1992
Q22/36	Wilson-Train, Waverley	1974	Walton, Cassels	Borrow pit, soil	N	Walton & Cassels 1992
R22/42	Waverley	1988	Jacomb	Borrow pit	N	–
Bay of Plenty						
U14/2844	Papamoa	–	Walton, McFadgen	Modified soil	N	McFadgen & Walton n.d.
U14/2860	Papamoa	?	Gumbley	Modified soil	N	Gumbley 1999
Trenches 4 & 7	Kawerau	1981	Lawlor	Garden soil	N	Lawlor 1983
Wellington						
R26/111	Whitireia	1989	Walton	Terraces	N	Walton 1992
R27/42	Makara	1967	Davis	Garden soil	Y	Davis 1962; McFadgen 1980a
Wairarapa						
S28/43	Whatarangi		H. Leach	Stone row	Y	Leach, H.M. 1979b
S28/47	Washpool		H. Leach	Stone row, alignment	Y	Leach, H.M. 1979b
S28/51	Washpool Terrace	1969	F. Leach	Terrace	Y	Leach, B.F. 1979
S28/56	Cross Site, Makotukutuku	1969	F. Leach	Stone mound, garden terrace	Y	Leach, B.F. 1979
S28/66	Te Humenga	1969	H. Leach	Stone rows	Y	Leach, H.M. 1979b
S28/68	Pararaki North	1969	H. Leach	Stone row, soil	Y	Leach, H.M. 1979b
S28/79	North Kawakawa	1969	H. Leach	Stone row, underlying trench	Y	Leach, H.M. 1979b
S28/96	North Waiwhero	1969	H. Leach	Stone alignment, stone row, soil	Y	Leach, H.M. 1979b
S28/103	Black Rocks	1969 1984	H. Leach McFadgen	Soil Row	Y	Leach, H.M. 1979b
T28/47	Okoropunga		McFadgen	Stone row, soil	Y	McFadgen 1980b
Marlborough						
P26/217	Cattleyards Flat		Trotter	Stone row, soil	Y	Trotter 1977
P30/5&6	Clarence River	1977	Trotter	Stone row	Y	Trotter & McCulloch 1979
P30/5&6	Clarence River		McFadgen	Stone row, modified soil	Y	McFadgen 1980a
M24/11	Triangle Flat	2000	Barber	Cultivation pits, modified soil		Barber 2004
Canterbury						
–	Okuora Farm, Birdlings Flat	–	Jacomb & others	Modified soil	N	Gordon et al. 2004

Appendix 2

RADIOCARBON DATES OF MAORI GARDEN SITES

The radiocarbon results have been taken from reports and published articles or, where indicated, from the New Zealand Radiocarbon Database (www.waikato.ac.nz/cgi-bin/nzcd/search). Where results differ from those published, the calibrated results from the database have been used in preference. Sites and dates have only been included where the gardening activity has been dated. There are a number of sites e.g. Wiri, Puhinui, Wiri Oil Terminal Site, Pouerua and Papamoa, where features or structures within the area of gardens have been dated but are not reported here.

SITE NAME	SITE NO.	SITE TYPE	DATE (BP)	LAB. NO.	MATERIAL	LAYER	CONTEXT	REFERENCE
Northland								
Moturua Island	Q05/44	Garden soil	510 ± 70*	ANU543	Charcoal	L5		Peters 1975
Moturua Island	Q05/44	Garden soil	740 ± 90*	ANU542	Charcoal	L6		Peters 1975
Moturua Island	Q05/44	Garden soil	525 ± 89*	NZ647	Charcoal	L5		Groube 1966
Moturua Island	Q05/44	Garden soil	1150 ± 90	GaK820	Charcoal	L6		Groube 1966
Moturua Island	Q05/46	Garden soil	670 ± 50	Wk4963	Shell			Johnson 1997
Motutangi Swamp	N03/639	Swamp ditch system	377 ± 57	NZ6447	Peat			Barber 1983
Motutangi Swamp	N03/639	Swamp ditch system	425 ± 58	NZ6448	Peat			Barber 1983
Pouerua	P05/195	Garden	250 ± 50*	NZ7249	Charcoal	L3	Area A, garden soil	Radiocarbon Database
	P05/195	Garden	430 ± 60*	NZ7251	Charcoal	L2	Valley system, base L2	Radiocarbon Database
	P05/195	Garden	250 ± 50*	NZ7255	Charcoal	L2A	Garden soil, lens A, L2	Radiocarbon Database
Auckland								
Sunde site	R10/25		624 ± 85	NZ1899	Charcoal	L4	Occupation after Rangitoto ash	Davidson 1974
	R10/25	Garden	781 ± 28	NZ6954	Shell	L2B	Garden soil	Nichol 1988
Puhinui (Oyster Pt)	R11/25	Garden	305 ± 76	NZ5144	Charcoal		Charcoal in stone row	Lawlor 1981b,c
	R11/25		566 ± 85	NZ5167	Charcoal		Base of garden soil	Lawlor 1981b,c
	R11/25		305 ± 75	NZ5168	Charcoal		Charcoal in wall	Lawlor 1981b,c
	R11/25		690 ± 32	NZ6198	Shell		Posthole in wall	Lawlor 1981b,c
Wiri	R11/32	Garden	344 ± 132	NZ1887	Charcoal		Soil under wall	Sullivan 1975a
	R11/32		727 ± 156	NZ1888	Charcoal		Charcoal under wall	Sullivan 1975a
	R11/32		804 ± 324	NZ1909	Charcoal		Soil under wall	Sullivan 1975a
Harris Road	R11/1301	Garden	762 ± 36	NZ7098	Shell	II	From earth and stone mound	Douglas 1987
	R11/1301		380 ± 60	NZ7324	Shell		Topsoil on wall	Douglas 1987
	R11/1301		2650 ± 70	NZ7160	Charcoal	II-III	Lens at base of mound	Douglas 1987
Rocky Bay, Waiheke	S11/88	Soil	410 ± 58*	NZ1900		L3	Early limit garden soil	Law 1975
Waikato								
Aotea	R15/95	Borrow pit	747 ± 33*	NZ4523	Shell		Base of borrow pit	Walton 1983
Horotiu	S14/16	Garden soil	670 ± 45	Wk503	Shell			Gumbley & Higham 2000
Horotiu	S14/164	Borrow pit	1100 ± 80	Wk2702	Charcoal		Soil in borrow pit	Radiocarbon Database
	S14/164	Borrow pit	900 ± 70	Wk2703	Charcoal		Soil in borrow pit	Radiocarbon Database
	S14/164	Borrow pit	800 ± 50	Wk2704	Charcoal		Soil in borrow pit	Radiocarbon Database
Chartwell, Hamilton	S14/201	Occupation	440 ± 65	Wk7928	Charcoal		Prior to modified soil	Gumbley & Higham 2000

Continued on next page

Appendix 2—continued

SITE NAME	SITE NO.	SITE TYPE	DATE (BP)	LAB. NO.	MATERIAL	LAYER	CONTEXT	REFERENCE
Bay of Plenty								
Papamoa	U14/534	Garden soil	640 ± 50	Wk5818	Shell		Midden at base of soil	Gumbley 1999
Papamoa	U14/2860	Garden soil	770 ± 50	Wk5814	Shell		Trench C, min. age for soil	Gumbley 1999
Papamoa	U14/2860	Garden soil	850 ± 50	Wk5815	Shell		Max. age for soil	Gumbley 1999
Papamoa	U14/2860	Garden soil	820 ± 50	Wk5816	Shell		Max. age for soil	Gumbley 1999
Papamoa	U14/1722	Garden soil	710 ± 40	Wk5817	Shell	L1c	Min. age for soil	Gumbley 1999
Papamoa (Longview)	U14/2844	Garden soil	750 ± 40	Wk4493				Radiocarbon Database
Papamoa (Longview)	U14/2844	Garden soil	730 ± 40	Wk4494				Radiocarbon Database
Papamoa (Longview)	U14/2844	Garden soil	710 ± 40	Wk4495				Radiocarbon Database
Kawerau	V15/1193	Garden soil	194 ± 48*	NZ7546	Charcoal			Radiocarbon Database
Wellington								
Makara	R27/42	Garden soil	840 ± 58	NZ1877	Shell		Max. date soil	McFadgen 1997
Pauatahanui	R26/159	Midden	804 ± 57	NZ1878	Shell		Min. date soil	McFadgen 1997
Whatarangi, Palliser Bay	S28/43	Stone row	546 ± 86	NZ1309	Charcoal		Soil disturbance	Leach, H.M. 1979a; McFadgen 2003
Te Humenga, Palliser Bay	S28/66	Stone row	784 ± 70	NZ1310	Charcoal		Stone row	Leach, H.M. 1979a; McFadgen 2003
Nth Pararaki, Palliser Bay	S28/68	Stone row	676 ± 86	NZ1311	Charcoal		Construction of stone row	Leach, H.M. 1979a; McFadgen 2003
Nth Pararaki, Palliser Bay	S28/68	Stone row	737 ± 86	NZ1312	Charcoal		Construction of stone row	Leach, H.M. 1979a; McFadgen 2003
Nth Pararaki, Palliser Bay	S28/68	Stone row	712 ± 86	NZ1313	Charcoal		Construction of stone row	Leach, H.M. 1979a; McFadgen 2003
Nth Pararaki, Palliser Bay	S28/68	Stone row	790 ± 50	Wk7457	Shell		Wall matrix	Goff & McFadgen 2001
Sth Pararaki, Palliser Bay	S28/73	Stone row	817 ± 86	NZ1314	Charcoal		Pathway	Leach, H.M. 1979a; McFadgen 2003
Nth Kawakawa, Palliser Bay	S28/79	Stone row	692 ± 86	NZ1315	Charcoal		Trench infilling	Leach, H.M. 1979a; McFadgen 2003
Nth Waiwhero, Palliser Bay	S28/96	Stone row	484 ± 72	NZ1316	Charcoal		Construction of stone row	Leach, H.M. 1979a; McFadgen 2003
Black Rocks, Palliser Bay	S28/103	Stone row	566 ± 86	NZ1317	Charcoal		Soil disturbance	Leach, H.M. 1979a; McFadgen 2003
Washpool, Palliser Bay	S28/47	Stone row	390 ± 87	NZ1512	Charcoal		Construction of stone row	McFadgen 2003

Continued on next page

Appendix 2—continued

SITE NAME	SITE NO.	SITE TYPE	DATE (BP)	LAB. NO.	MATERIAL	LAYER	CONTEXT	REFERENCE
Washpool, Palliser Bay	S28/47	Stone row	344 ± 86	NZ1513	Charcoal		Construction of stone row	Leach, H.M. 1979a; McFadgen 2003
Washpool, Palliser Bay	S28/47	Stone row	514 ± 87	NZ1514	Charcoal		Soil disturbance	Leach, H.M. 1979a; McFadgen 2003
Washpool Garden Terrace, Palliser Bay	S28/51	Garden tce	583 ± 86	NZ1637	Charcoal	L2	Maximum age of garden soil	Leach, B.F. 1979; McFadgen 2003
Washpool Cross Site, Palliser Bay	S28/56	Mound	701 ± 86	NZ1641	Charcoal	L6	Construction mound	Leach, B.F. 1979; McFadgen 2003
Whitireia Peninsula	R26/115	Terrace	75 ± 32	NZ2696	Bracken root		Terrace construction	McFadgen 2003
Okoropunga, Palliser Bay	T28/47	Stone row	337 ± 79	NZ3114	Charcoal		Construction of stone row	McFadgen 2003
Okoropunga, Palliser Bay	T28/47	Stone row	531 ± 58	NZ3115	Charcoal		Construction of stone row	McFadgen 2003
Okoropunga, Palliser Bay	T28/47	Stone row	746 ± 41	NZ3116	Charcoal		Vegetation clearance	McFadgen 2003
Nelson/Marlborough								
Waimea West	N27/122	Borrow pit	360 ± 50	Wk1776	Charcoal		Base of borrow pit	Challis 1991
Cattleyards Flat	P26/217	Stone row	706 ± 26	NZ4498	Shell		Interior of mound	Challis 1991
Cattleyards Flat	P26/217	Stone row	758 ± 45	NZ4499	Shell		Interior of mound	Challis 1991
Clarence River	P30/5	Stone row	382 ± 59	NZ3113	Charcoal		Modified soil below stone row	McFadgen 1980a
Clarence River	P30/5	Borrow pit	355 ± 41*	NZ3397	Charcoal		Bottom borrow pit	McFadgen 1980a
Avoca, Kaikoura	O31/30	Stone row	871 ± 41	NZ6472	Shell		Formation of beach ridge	Challis 1991
Avoca, Kaikoura	O31/30	Stone row	529 ± 42	NZ6496	Moa coll.		Base of wall	Challis 1991

* Revised calibrations taken from the New Zealand Radiocarbon Database (www.waikato.ac.nz/cgi-bin/nzcd/search).