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 supposedly 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 1994), 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.
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 m² and 50 m² 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
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 Whakareia 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 Whakareia 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 gardening-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.