NEW ZEALAND JOURNAL OF ARCHAEOLOGY

Of Boundaries, Drains and Crops: A Classification System for Traditional Maori Horticultural Ditches

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ABSTRACT

A variety of ditch systems or 'drains' associated with traditional Maori horticulture have been identified from early ethnographic sources and archaeological investigations. Functional interpretations include land unit demarcation, water reticulation and land drainage. A preliminary classification of traditional horticultural ditch systems in northern New Zealand identifies four categories. Categories A and B are steep and gentle slope ditch systems respectively. It is suggested these demarcated land units and reticulated water. The counteraction of water erosion was probably an important aspect of this last function. Category C ditches served as land boundaries only. Category D includes authentic wetland ditches constructed for drainage, reticulation, and probably simple irrigation in some instances. The classification provides a basis for modelling operational change over time and developing further research strategies. The categories suggest a sophisticated approach to catchment maintenance by traditional Maori cultivators in northern New Zealand.

Keywords: HORTICULTURE, WATER RETICULATION, LAND BOUNDARIES, SLOPE DITCHES, EROSION, CATCHMENT MANAGEMENT, WETLAND DRAINAGE, TARO, IRRIGATION, HUMAN ECOLOGY.

INTRODUCTION: THE ETHNOGRAPHIC AND ARCHAEOLOGICAL CONTEXT

The first published account of Captain James Cook's initial New Zealand visit included observations of unquestionably traditional horticultural practices at Tolaga Bay in late October, 1769. The anonymous chronicler described "regular flats... neatly disposed in small plantations; the ground appearing to be well broken as if designed for gardens." Sweet potatoes (kumara, *Ipomoea batatas*) "like those of Carolina, of which they have large quantities" commonly occupied a considerable part of these plantations. The narrative detailed the excursion of a young officer around the country, finally being led by a local man back to the ship's watering place. They proceeded by "a much better road; the other being in many places overflowed with water; and... as often as they came to a ditch or a rivulet, of which there are many for draining their fields, the Indian always carried him over dry" (Anon. 1771: 77, 79).

A journal entry dated April 27, 1772 gave an account of land drainage among Maori at Spirits Bay (Kapowairua) in the far northern Aupouri Peninsula. Roux, one of a party put ashore from *Le Mascarin*, observed a fertile plain dissected by streams that appeared to be cultivated. "Every ten paces or so there were little canals through which the water flowed" he noted (McNab 1914 (2): 361).[1]

Some early to mid-nineteenth century records also documented the use of land drainage techniques by Maori cultivators. Since European introduced cultigens were being grown in these gardens, however, the techniques cannot be assumed to have been traditional (Barber 1984: 20–21). The ethnographic record from this period also discussed supposedly authentic traditional evidence. Maning (1930: 181) referred to land "laid wild time out of mind" which had once been cultivated. "The ditches for draining the lands are still traceable... The old drains, and the peculiar growth of the timber, mark clearly the extent of these ancient cultivations." In a general discussion of kumara horticulture, Archdeacon Walsh (1902: 15) observed:

> 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 the 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.

Walsh (1907: 156) observed further that formerly cultivated clay hillsides of the north were covered with surface drains.

In spite of these references, claims that traditional Maori gardeners had drained land were disputed by prominent ethnologist H. D. Skinner in the early twentieth century. In a debate over the identification of allegedly prehistoric canals in swamps of far northern New Zealand, Skinner wrote that a drainage interpretation was pure speculation. "There is not, so far as I am aware, any authority whatever for the statement that the Maoris undertook draining operations" (Skinner 1921a: 94). The debate was carried on for almost a decade, principally in the *Journal of the Polynesian Society* (Barber 1984: 23–34). Elsdon Best's classic work *Maori Agriculture* was under preparation at this time. When it appeared in 1925, the work took a sympathetic but less than definitive position on horticultural drainage. Best (1976: 130, 141–142) cited verbatim and without comment Walsh's remarks as above. He also acknowledged some interesting papers on the subject of swamp drainage from the *Journal of the Polynesian Society* and observed, "it seems probable that the swamps were drained for the purposes of cultivation" (Best 1976: 243). Yet he also admitted "we have no satisfactory evidence from native tradition concerning any of these drainage systems."

Horticultural ditch systems were reconsidered again with the initiation of systematic site surveys by the New Zealand Archaeological Association in the late 1950s, when such features began to be recorded from northern and eastern North Island locations. A section in the Association's revised site-recording handbook referred to ditches and 'canals', often extending down slope and across flats, particularly behind bays and beaches. These were variously and tentatively identified as garden boundaries, eel or bird traps, or swamp ditches which may be associated with cultivation. After acknowledging that little is known of the latter category, the manual concluded, "ditch features are therefore variable and their functions uncertain" (Daniels 1979: 33). A number of archaeological examples, generally thought to be associated with horticulture, were published. These ditches were variously interpreted as 'drains', an interpretation sometimes expanded to incorporate functions of water reticulation and control (Nicholls 1965; Peters 1975; Lawlor 1981: 190; Leahy and Walsh 1982: 42; Irwin 1985: 82, 83, 84, 88, 90), or as land boundaries or agricultural alignments (Peters 1975; Phillips 1980; Spencer 1983; Sutton 1983: 110).

In a recent comprehensive treatment of traditional Maori horticulture, Leach (1984: 46, 49–50; Leach 1979: 244) has interpreted shallow trenches along cultivated slopes as boundary markers. She has also argued that genuine swamp drains from northern New Zealand in claimed horticultural association should be treated separately from the slope lines and trench boundaries (Leach 1984: 50). "There is a need for some thorough archaeological research into these [swamp drain] features so that their antiquity and precise function may be determined" (Leach 1984: 50; see also p. 68).

Clearly, the unstudied diversity of these systems has added to the interpretative uncertainties.

FIELD EVIDENCE AND INTERPRETATIVE DIFFICULTIES

Following the approach initiated in an earlier unpublished report (Barber 1982), the features which have been described functionally as drains, slope drains, field systems, slope or trench boundaries, garden lines, and swamp drains are considered in this paper under the broad term, 'ditch system'. This is consistent with the discussion of these sites in the New Zealand Archaeological Association's site recording handbook, as noted above (Daniels 1979: 33).

The classes identified in this essay all have a cultivation context and purpose. Thus they are to be distinguished from larger canal features, generally several metres in width, which were intended to function as canoe portages. Ditches were also constructed, as already noted, as bird traps or eel weirs (sometimes without a water flow function), in which case they are generally found singly or in relatively uncomplicated linear networks (Skinner 1912; Hongi ms; Best 1977; Barber 1982; Sheppard and Walton 1983; Marshall 1987; Cassels *et al.* 1988). Canoes and drift nets were reportedly used with some larger canal-ditches of this type to capture ducks in the Kaitaia region (Hongi ms; Barber 1982: 6). In general, ditch systems constructed for portage and/or faunal harvest alone do not affect extensive areas otherwise suitable for cultivation. An absolute distinction is not possible, however, since some ditch systems intended primarily for horticulture may also have been used for faunal harvest.

Further difficulties in classifying horticulture-associated ditches in their environmental context include the following.

1) 'Background noise' produced by natural and (more significantly) human-induced landscape changes and development.

2) The want of systematic and consistent reporting and interpretation.

3) A lack of excavations covering a range of site types.

The first difficulty referred to requires special attention. Following human-induced deforestation (McGlone 1983), a widespread pattern of accelerated or induced hillside erosion and slumping now characterises the New Zealand landscape (Cumberland 1944; Selby 1970). Water forces have been among the principal mechanisms of this accelerated or induced erosion, of which braids and rills in sandy and silt-clayey soils respectively are a common feature (Selby 1970: 14, 23–24; Carson and Kirby 1972: 191). Rills are defined by Tricart (1982: 39).

> Diffuse flow on hill slopes largely takes the form of discontinuous run-off. During storms, on a less permeable soil surface, often a bare surface pounded by raindrops, a film of water begins to flow and becomes concentrated in threads that entertain fine debris, silt, and sand. It can continue if there are no obstacles and, growing little by little, can cut a rill. This is the initial phase of concentrated run-off, a first order channel.

Rills are uncommon where a slope has dense vegetation cover. Where vegetation has been removed, however, "overland flow and seepage are greatly increased so that the water is able to erode the soil and produce a channel that grows large enough not to be filled in or obliterated before another storm occurs" (Carson and Kirby 1972: 192). Where master rills are formed, subsequent rills in the same area will tend inward toward the master rill, progressively developing a gully or small valley (Selby 1970: 24–27; Carson and Kirby 1972: 193–194). For the study area, Cumberland (1944: 21) confirms the existence of both shallow rill and incipient gully erosion on newly cleared pasture land, and also on sloping, tilled pasture where grass establishment has been unsuccessful. The dendritic or converging slope-drainage pattern of rill erosion may obscure earlier ditch systems, and even resemble them on occasion. Any consequent gullying or slumping effects will generally obliterate cultural landscape forms in their wake.

Pastoral and agricultural activities in the historic era pose even greater interpretative difficulties. Extensive land drainage by early European era land developers and kauri (*Agathis australis*) gum-diggers in northern New Zealand have confused the field evidence. Best (1976: 126) observed that a slope east of Tupetupe in the Taiamai district exhibited "parallel depressions like very shallow trenches such as are seen on land that has been ploughed, which this slope certainly has not been, so numerous are the rock boulders in situ." Best's argument for a traditional interpretation in this instance highlights the difficulty for field interpretation in other localities. Plough lines intended for land drainage (Walton 1982: 128; Barber 1989) may be especially difficult to distinguish from traditional Maori ditch systems on occasion.

Beyond confusing the existing field evidence, ploughing from intensive pastoral or agricultural activities may also have obliterated the shallow remnants of traditional cultivation ditches. This is highlighted in a series of Government aerial photographs from Awanui showing the impact of European drainage and ploughing patterns upon prehistoric ditch systems (Barber 1989).

For some ditch sites, there is probably no satisfactory resolution of these problems at present, especially where gentle slopes and relatively low-lying land is concerned. Less commonly, plough-lines occasionally even characterize slopes with a 15° gradient and greater (Walton 1982). Presumably, the difficulties inherent in ploughing such slopes would have caused early land developers to work at the lower limits of necessity, so interpretation of the field evidence on steep slopes may be less problematic. Ploughing was also generally impractical across the contours of steep slopes (Walton 1982: 128). Where aerial photographs are available, and especially where they predate intensive recent land development phases, it may be possible to distinguish historic and prehistoric land-use patterns in some lowlands as well (Cassels *et al.* 1988: 114; Barber 1989).

A DITCH SYSTEM CLASSIFICATION IN TAI TOKERAU

In considering the literature and available data, it appears that a relatively greater number of ditch system sites have been reported from Tai Tokerau than from any other comparable New Zealand region (Skinner 1921a, 1921b: 249n, 1922; Wilson 1921, 1922; Harding 1928; Nicholls 1965; Peters 1975; Hayward *et al.* 1979: 161, 162, 167; Phillips 1980; Barber 1982; Leahy and Walsh 1982: 42; Spencer 1983; Barber 1984; Irwin 1985: 82, 83, 84, 88, 90; Taylor and Sutton 1985; Johnson 1986; Smith 1986: 3). This is probably not just a sampling bias. Tai Tokerau includes an extensive inland region of friable volcanic loams, large tracts of peaty and sandy peaty soils in the north and northwest, and a generally varied relief offering well drained and warm northfacing slopes in many areas. Along with a subtropical climate, such a rich variety of free draining, organic, and relatively easily tilled soils favours this region as the most suitable locality in New Zealand for cultigens acclimatised to tropical environments. Ditch systems associated with horticulture might well be expected in greater profusion here (Fig. 1).

At the same time, a horticultural interpretation of Tai Tokerau ditch systems cannot be assumed in every instance, as indicated in previous discussion. The exercise which follows takes cognizance of the interpretative difficulties, considering (where possible) such factors as archaeological and environmental context, topography, folk-history, and ethnographic analogy.The classification is based on considerations of aspect, form, technology, and function, with the greatest emphasis on the last two categories. Traditional systems considered in this essay may have been constructed in the prehistoric or early historic eras. They are identified by their continuity from, and origins within, pre-European precedents.

The data base includes a 1982 survey by the author and subsequent investigations of ditch systems in Tai Tokerau, as well as relevant publications and reports. The sampling strategy incorporated a range of the principal landform and environmental types in the study region. Previous records and oral accounts were followed up, while environments favourable to traditional Maori horticulture were visited. However, no claim is made that all or even most traditional ditch sites in Tai Tokerau have been identified to date. The present exercise should be regarded as a preliminary rather than comprehensive classification, providing a basis for scientific model building and further investigation.

DITCH SYSTEM CLASSIFICATION

Four categories of traditional Maori ditch systems associated with horticulture have been identified in Tai Tokerau.

A. Steep slope ditches associated with gardening activities, drainage and boundary function

This category includes the usually extensive systems of parallel to converging or dendritic ditches on steep slopes, generally clay and clay loams to sandy loams, above a 15° gradient. The ethnographic literature contains references to steep slope gardens in many New Zealand locations (Best 1976: 223–224), such as the far northern Aupouri Peninsula where hillsides were "cultivated in some places to their very summits" (Nicholas 1817 (2): 210), and Tasman Bay, Nelson, where on August 30, 1842, John Barnicoat (ms) described Maori gardens "as steep as it was possible to climb much steeper than an [sic] European cultivator

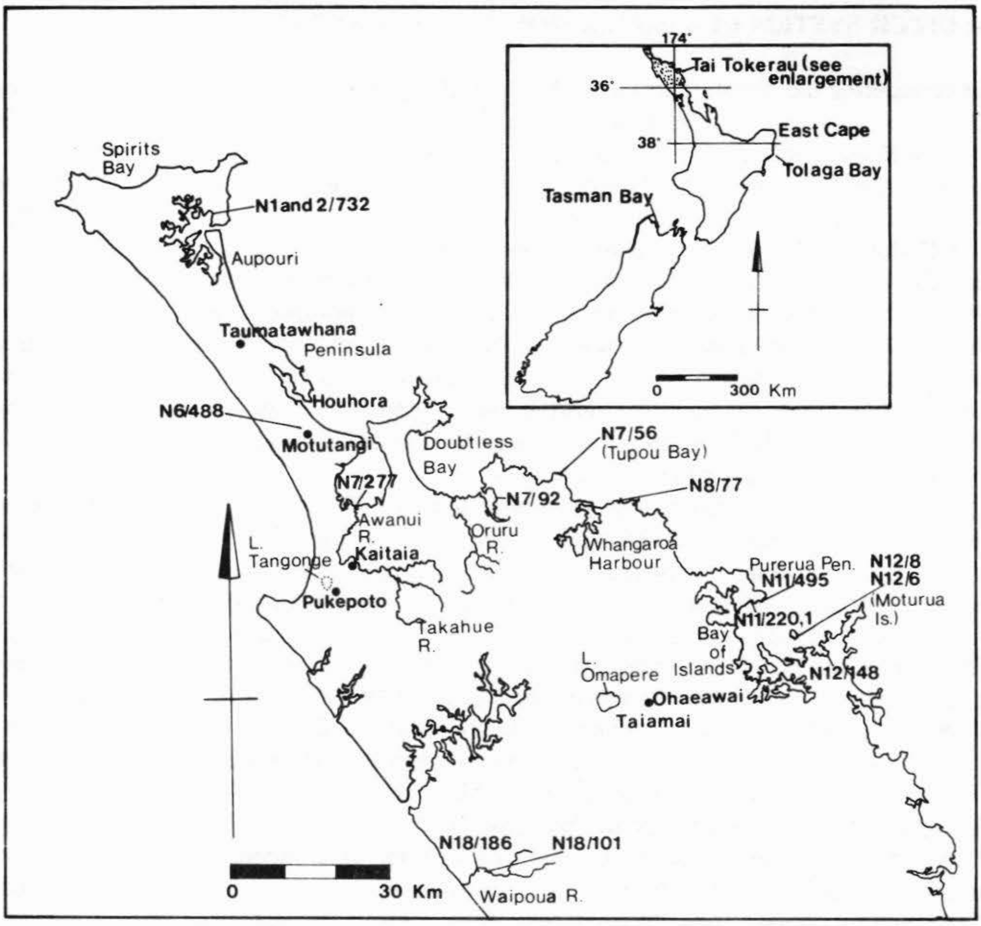

Figure 1: Location map showing sites referred to in the text.

would think of using." In 1840, an observer from the East Cape also claimed: "the natives appear very partial to cultivating the face of the hills; they contend that the crops are better in such situations, probably owing to alluvial deposits washed by the heavy rains from above" (cited by Best 1976: 224). The ethnographic literature suggests that steep slope gardens avoided the excessive wetness and frosts of lower areas, a particularly important consideration for the early planting of tropical cultigens. Defensive needs apparently also dictated the placement of gardens in relatively inaccessible situations on occasion (Nicholas 1817 (1): 277–78; Walsh 1902: 14).

Given the difficulties of ploughing such slopes, as already discussed, extensive evidence of steep slope ditching is likely to be traditional and, on ethnographic evidence, horticultural. The exact function of such ditches is more difficult to determine. The site N12/6 is a valuable aid to interpretation. Here, a series of at least four ditches extends down a greywacke clay slope with a 20° incline behind a small bay to the south of Paeroa Pā on Moturua Island (Fig. 2). The ditches were excavated by Peters (1975) in a series of squares laid out perpendicular to the slope to clarify the extent of gardening activities. Peters also intended to test the validity of the charcoal radiocarbon age of 1150 ± 90 B.P. (GAK 820, old half life) obtained by L. M. Groube for layer 6, a clay horizon incorporated into a modified garden soil (layer 5) along this slope which predates the ditches (Peters 1975: 171, 179).

From small fragments of twigs and specks of charcoal in layer 5 at N12/6, Peters (1975: 175, 178–179) obtained a radiocarbon age of 510 ± 85 B.P. (ANU 543, old half life). This compared favourably with a charcoal date obtained by Groube for this same layer, published as 530 ± 90 B.P. (NZ 647A, old half life) (Peters 1975: 179). From the most recently available terrestrial calibration based on tree ring data, which includes a recommended reduction of 30 years for southern hemisphere samples (Stuiver and Pearson 1986: 808; Stuiver and Reimer 1986), NZ 647 (conventional age given as 525 ± 89 B.P.) has the following 68% confidence interval.

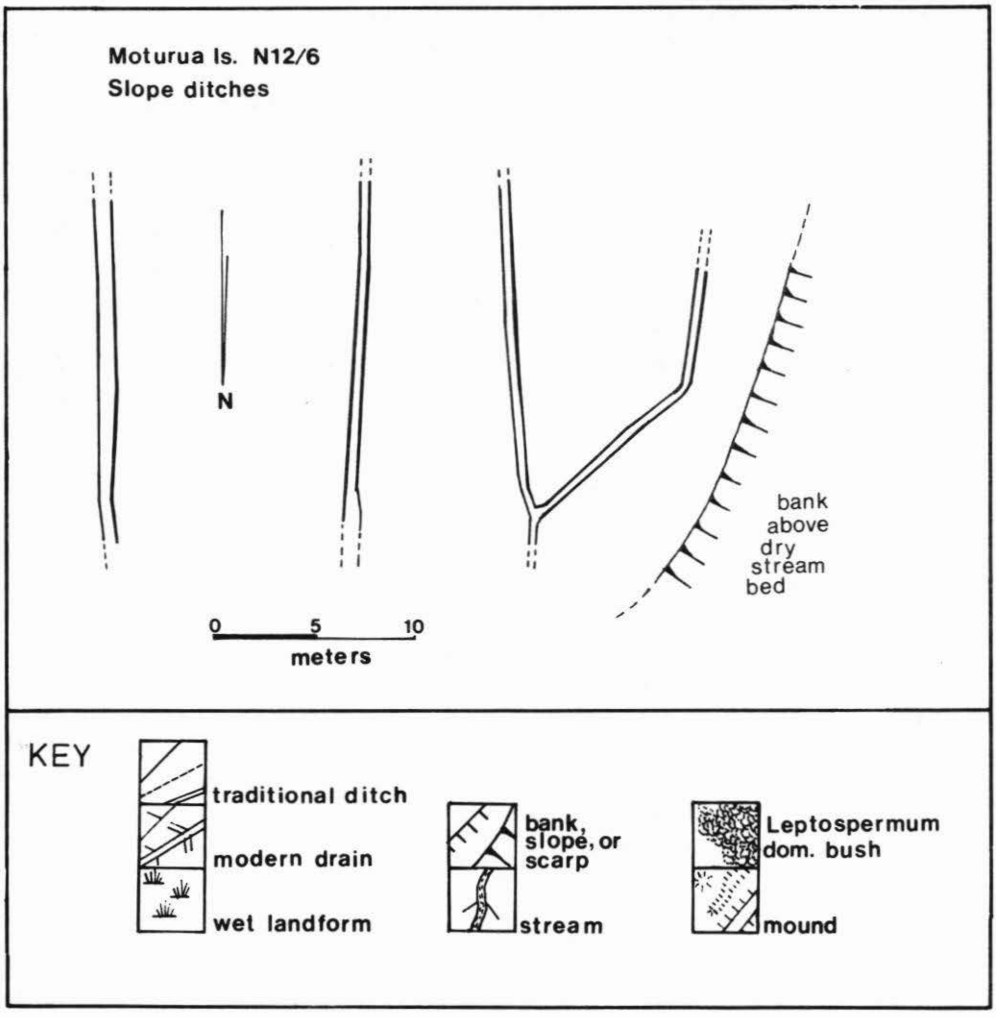

Figure 2: Ditch system N12/6, Moturua slope garden, Bay of Islands. Category A. Redrawn from Peters 1975. Slope gradient is approximately 20°. Key also applies to Figures 3 and 6–10.

1308 cal. A.D. to 1358 cal. A.D. (18%) and
1381 cal. A.D. to 1480 cal. A.D. (50%).

At the 68% confidence interval, this age is given as 1285 cal. A.D. to 1525 cal. A.D. (I.N.S. n.d.a).

By contrast, the southern hemisphere terrestrial calibration for GAK 820 (conventional age unchanged from earlier old half life calculation) is 810 cal. A.D. to 1001 cal. A.D. (68% confidence interval) (I.N.S. n.d.b). From layer 6, Peters (1975: 178) obtained a charcoal age of 720 ± 100 B.P. (ANU 542, old half life). Both of the ANU ages and Groube's now calibrated NZ 647 age imply that the undifferentiated charcoal dated as GAK 820 came from older wood with an in-built age. Layer 5 is therefore most accurately dated to within the general time range of the thirteenth to fifteenth centuries A.D. Ditch construction along these slopes occurred in association with a later and undated garden soil, layer 2. The formation of a developed paleosoil between layers 2 and 5 suggested to Peters (1975: 171, 173–175) that a substantial break in time existed between the two agricultural soils, although layer 2 was still considered prehistoric.

In a discussion of the use of the term 'drain' to define such field evidence as at N12/6, Peters (1975: 178) observed that similar prehistoric Maori field systems did not serve to drain the gardens in any obvious way. If the four Moturua Island slope ditches were intended for drainage, Peters argued, "one would have expected 'cross drains' above the garden, to collect the surface water running down the slope leading it away from the garden." Since the ditches run straight down slope, Peters considered they would not have served the function of drainage well, and would be better regarded as being primarily boundary markers. By contrast, Peters (1975: 178) suggested two other slope field systems on Moturua Island were intended for water diversion from garden plots, with diagonal cross drains designed to collect the surface water running down the slopes and divert it into drains running straight down the slope. Thus Peters argued that each field system must be interpreted in relation to its particular pattern and physical location.

With due regard to this sound advice and Peters' careful interpretation overall, it may still be considered whether simple steep slope systems such as N12/6 had at least an auxiliary drainage function. This would seem particularly appropriate for such systems in Tai Tokerau. It is well known that deforestation along slopes often leads to water erosion and denudation (Selby 1970: 19–21; Carson and Kirby 1972: 64–65). In 1936, Renner examined the effect of erosion on slopes he grouped within ascending 5° classes. He found an increasing incidence of water erosion in each successive class up to 35°, with a decline only at higher gradients (as summarised by Carson and Kirby 1972: 210–211, fig. 8.13). Cumberland (1944: 17) notes that rains of high volume and intensity, associated generally with tropical storm systems, characterise northern New Zealand. These may cause serious soil losses when aided by cultural practices which fail to give the soil adequate vegetation cover. Stabilisation and water diversion practices have thus been recommended for modern farmers facing these problems (Cumberland 1944: 120; Smith and Wischmeier 1973: 405–406). In cultivating steep slopes, prehistoric northern Maori gardeners presumably confronted similar challenges as a result of general deforestation, and swidden garden clearance in particular (Selby 1970: 43–45; McGlone 1983). By channelling slope run-off, prehistoric ditch systems may well have been constructed to manage and stabilise the broader catchment and soil profile, as much as to protect individual garden plots.

If one hypothesises plantings raised on mounds in generally built up plots, and perhaps even lateral fences along the slope, the parallel ditches at N12/6 spaced within 15 m of each other (and in the case of the western-most features, within 10 m) could also have channelled run-off to counteract the impact of surface flow as a result of heavy rains. Indeed, the two western-most down slope ditches at N12/6 ultimately converge (Fig. 2), which would seem consistent with water reticulation. The apparent absence of cross drains above the gardens at N12/6 might reflect a different natural drainage pattern here, or perhaps even a different cultigen regime. It is also interesting to consider stratigraphic evidence of clay erosion slipping down the slope to cover the earlier dated garden soil, layer 5 (Peters 1975: 173–175). This suggests a problem of slope instability following the earlier garden activities at N12/6. The ditches were associated with the later and more extensive garden soil constructed above the clay slip in layer 2 (Peters 1975: 173). Their interpretation as runoff channels to counter water erosion precipitated by earlier slope clearance seems strengthened, therefore.

A similar site was located by the writer during 1982 along a northeast-facing ridge slope behind a beach at Whale Bay on the Purerua Peninsula. From a relatively steep gradient well above 15°, two apparent ditches converge into a system of generally parallel trenches up to 30 m in length. These extend across a more gentle slope with a gradient of at least 10-15°. The pattern of down slope convergence includes at least one possible cross-slope feature, while the system terminates at a stream (Figs. 3 and 4). Associated archaeological evidence includes an apparently defensive ditch and bank system which intersects the ridge top above the western aspect of this system, and a small earthen terrace, banked up approximately 50 cm, which may have been intended for temporary field accommodation (see Fig. 3). The convergence of several of these features and their termination at a stream suggest the reticulation of surface water run-off. The problem of water induced erosion here is also demonstrated by a slump feature above stream, shown as the lower slope scarp at Figure 3.

A complicated example of slope side convergence can be seen in N8/77 in the Whangaroa region, where Stretton recorded a complex integrated system of converging down-slope drains, beginning from a gradient of 35°. In the lower fall of this system, at least one cross-slope feature intersects the down-slope ditches at a right angle (Barber 1982: 30, 32–33, fig.6).

The generally parallel linear systems of N11/220 and 221 near the Rangihoua pā site on the Purerua Peninsula may be a further case in point. Recently mapped and published in part as agricultural alignments (Spencer 1983), the systems almost certainly represent a traditional Maori garden strategy, despite a superficial resemblance to plough-lands enlarged through erosional wash.[2] The system of N11/221 covers the greater area. In down slope aspect, these ditches have apparently broadened through water erosion, while a gulch effect from surface water run-off is also apparent at the site (see Fig. 5). Site N11/220 also consists of downslope ditches intersected by erosional slump features. These last give the appearance at a distance of cross-slope ditches. Similarly, the north western slopes of Rangihoua pā (N11/58) are characterised by an apparently natural drainage pattern of rill erosion (Spencer 1983: 80, fig. 2; 94, fig. 8).[3]

Deforestation at Rangihoua began in earnest in prehistoric times, continuing through into the historic era (Spencer 1983: 78). This appears to have rendered local slopes susceptible to increased surface wash during periods of heavy rain. It seems especially significant that the slope ditches show evidence of differential alteration through water carriage (Fig. 5). Again, more than one function may have been involved. Nicholas (1817 (1): 171) observed, for example, that the steep slope gardens of Rangihoua had "an appearance of neatness and

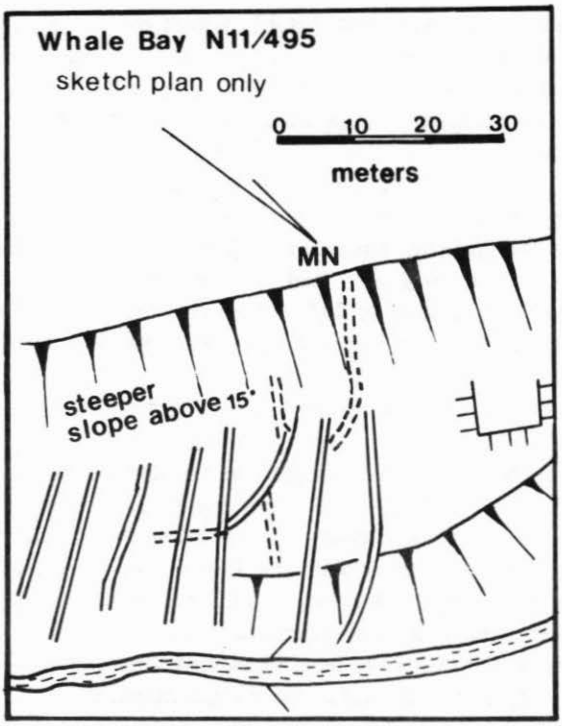

Figure 3: Ditch system N11/495, Whale Bay, Purerua Peninsula. Category A. Sketch Plan mapped by tape and compass, August 1982. For identification of map symbols, see key at Figure 2. The marked upper slope gradient shown as scarp lines extends well above 15°. Ditches extend on to a more gentle slope within the range of 10–15° at least.

regularity... carefully fenced in." Regularly spaced slope ditches could certainly have added to this effect and intention in clarifying boundaries.

There are also suggestions of erosion control associated with slope cultivation in the Oruru river valley. Here Johnson has identified a prehistoric steep slope ditch system as strip cultivation (1986: 189–191, 192, fig. 25). Consistent with water carriage, the convergent pattern of this relatively extensive ditch system becomes especially marked as it approaches the base of the Oruru River valley (see also note 2). Johnson (1986: 184) has recorded evidence of slope instability and slump erosion in various sections of the Oruru valley which are apparently related to long term deforestation.

B. Gentle slope ditches associated with gardening activities, drainage and boundary function

This site type differs from category A in that the ditch system occurs on land with a slope gradient below 15°. Soil types are generally recent and may vary from alluvial deposits, including gravel or silt loams on river terraces, to lower slope (colluvial) clay loams. There is also a distinction in form and perhaps technology, with a tendency for such ditch systems to include diagonal intersecting features as opposed to the generally parallel linear to dendritic ditches of type A above. This is plausibly related to the more complex reticulation

Figure 4: Ditch system N11/495. Whale Bay, Purerua Peninsula, showing principal region of ditches extending from the steeper upper slope gradient on to a more gentle slope. Category A. August 1982.

requirements along a gentle slope, where drainage may sometimes proceed across slope contours as well as directly down slope. A water reticulation function is also consistent with the ethnographic observations previously cited, which explicitly allow for the drainage of land at apparently low elevation in some instances.

N7/56 at Tupou Bay on the east coast (Fig. 6) appears to have combined features of both types A and B. A dendritic pattern of ditches extends from a slope above 20° (type A), linking with intersecting ditches forming quadrilateral and multilateral plots on the gently sloping flat (type B; shown in Figure 6 below the scarp lines). At least three of the lowland ditches proceed below the grid or plot network to terminate at the stream, at one stage bounded by a series of built up mounds. This, and the connected dendritic ditch pattern along the steeper slope, suggests water reticulation. The lower slope, plot-like enclosures are also consistent with a combined garden boundary and drainage interpretation.

Erosion control seems a likely function of the ditches at N7/56 given the site complexity. Indeed, it is interesting that low scarps about 15 to 30 cm high were recorded along the slope at right angles to the drains (Nicholls 1965: 148), suggesting erosion (see Fig. 6). The stabilisation of dry-land gardens on the steeper slopes may also have been integrated with a relatively wetter lowland cultigen regime, with the ditches functioning to maintain adequate drainage and perhaps even a flow of fresh water for effective cultivation (cf. evidence of European era drainage and swampy localities on the flat in Nicholls 1965).

Johnson (1986: 191, 194–95, fig. 27) also identifies such a system along an aggraded terrace of the Takahue River in the upper Kaitaia district. Evidence of water erosion in the

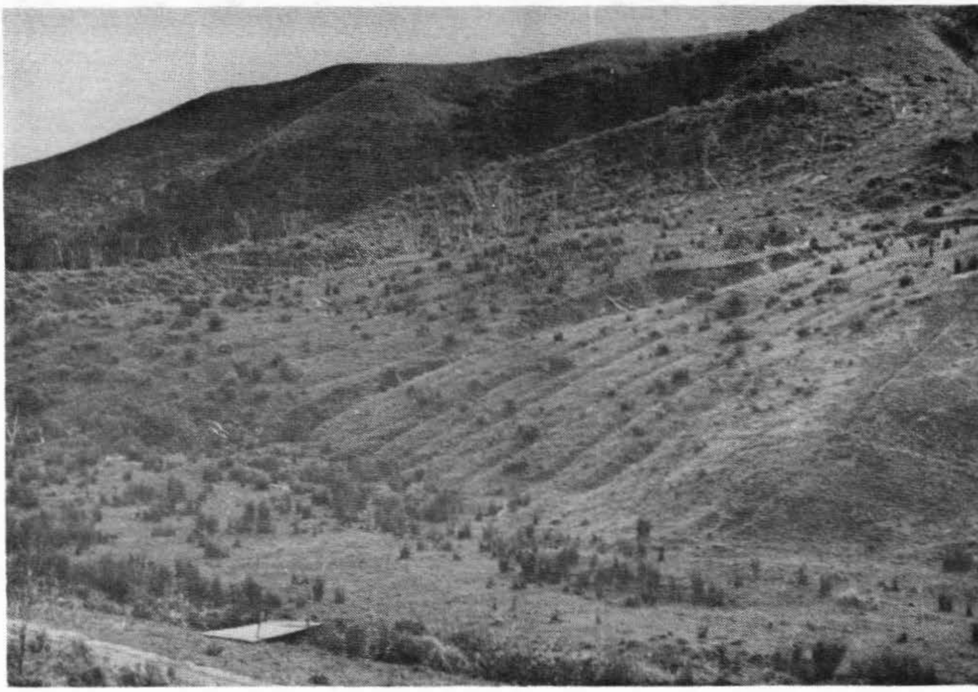

Figure 5: Steep slope ditch system N11/220, Rangihoua locality, Purerua Peninsula. Category A. Note indications of water-erosion in the lower slope outfall of the ditches, and an erosional gulch from the centre of the photograph. August 1982.

termination of two of the main ditches suggests the associated grid network, which feeds diagonally into the main ditches, drained surface water while demarcating garden plots. An even more regular intersecting network, N7/92 in Doubtless Bay, was recorded by Coster and Johnston. Exhibiting enclosed sides generally 20 to 30 m long in several square to rectangular plot shapes, N7/92 abuts a stream system on gently sloping land in the vicinity of other Maori archaeological sites, and appears to belong to category B (Barber 1982: 25–26, fig. 4). An intersecting network of channels also occurs on flats above the Waipoua River, below a group of prehistoric garden-related slope stone structures (N18/101). These channels are apparently river terrace drainage networks (Taylor and Sutton 1985; I. G. W. Smith pers. comm.).

Determining whether ditches were used for drainage/reticulation as well as boundaries can be difficult in these instances, of course. Since European cultivators and land developers generally preferred gentle slopes or flats, origin can also be problematic, leaving only folk-history and the uncertainties of ethnographic precedent as guides. At N12/148 at Parekura Bay in the southern Bay of Islands, a gently sloping flat exhibits a generally regular grid system with no obvious indications of function. However, the system appears to converge ultimately in its fall upon the bank of a stream, which would be consistent with surface water reticulation (Fig. 7). According to the landowner, older residents in the area remembered the site as the work of early Maori cultivators, with the ditches employed for land drainage (Barber 1982: 43–45). A ditch and bank boundary, which appears to mark the limits of the ditch system (Fig. 7), extends many metres over the property, ascending a slope at one stage. The bank is 50 cm high in the northern part of the site, where low forest has apparently provided a measure of protection. Since ditch and bank boundaries were used by both Maori and European cultivators in the early historic era as pig fences and/or pens (Smart 1966), the traditional status of N12/148 must remain uncertain, local folk history notwithstanding. In this and other instances, a careful excavation strategy would be required for further elucidation.[4]

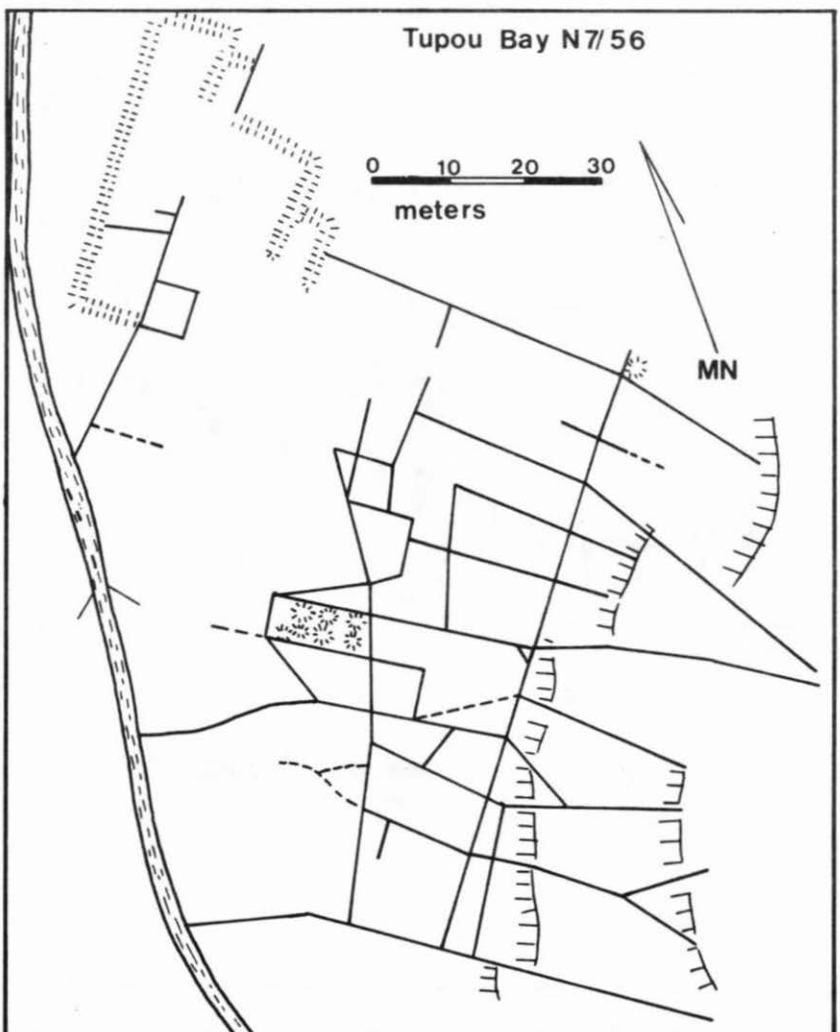

Figure 6: Ditch system N7/56, Tupou Bay. Categories A and B. Redrawn from Nicholls 1965. For identification of map symbols, see key at Figure 2.

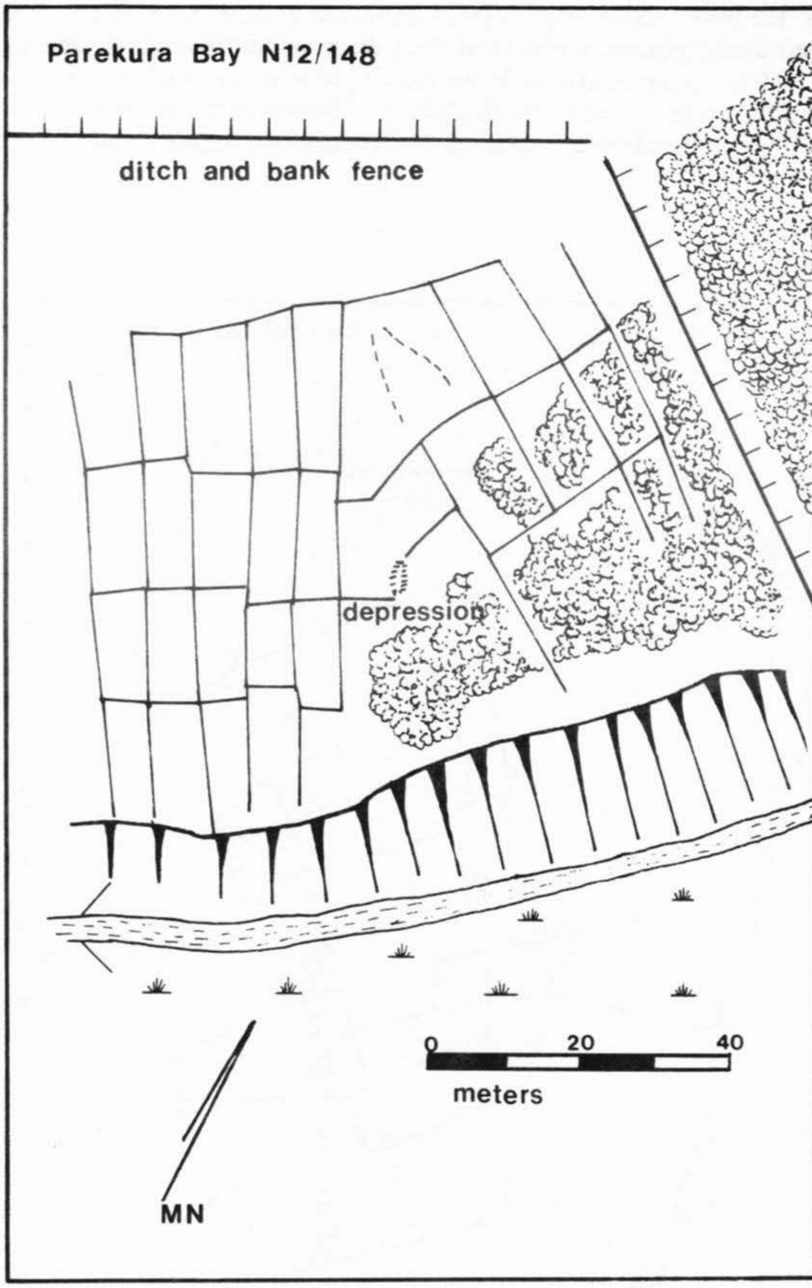

Figure 7: Ditch system N12/148, Parekura Bay. Gradient of slope generally less than 15°. Possibly category B. Mapped by plane table and alidade, with tape and compass offsets, August 1982. For identification of map symbols, see key at Figure 2.

C. Ditch boundary divisions only, well drained soils in various aspects

This category generally involves a well drained aspect in association with a friable or sandy soil type which would have precluded effective water carriage. In this interpretation, technology and function take precedence over aspect and form, although this category tends to be found in areas of relatively gentle relief. As with class B, these systems may be difficult to distinguish in preliminary field survey, with plough-lines posing a particular interpretative problem. It is assumed these ditch features demarcated land units in traditional Maori society. This was generally one function of other horticultural ditch systems as well. Although such ditches may have been explicitly excavated as plot boundaries, it is also possible these depressions formed as a by-product of tillage activities (Sutton 1983: 110), or along walking tracks between plot boundaries in some instances.

A prehistoric ditch of this type has been recorded from N12/8 on Moturua Island. The site is below the steep slope ditch site (N12/6) previously discussed, on a sandy flat behind a beach. At N12/8, Peters (1975: 176–177) excavated a garden soil and a possible drain which he nevertheless thought would not be required in sandy soil. On stratigraphic evidence, the ditch predated the garden soil, suggesting construction in the general time period of the thirteenth to fifteenth centuries A.D. (Peters 1975: 179; Leach 1982).

The volcanic loams of the Taiamai plain in the inland Bay of Islands incorporate the principal known examples of this site type in the study region. From this locality, Elsdon Best (1976: 126) described parallel depressions like very shallow trenches reminiscent of plough lines, on a slope apparently strewn with rock boulders. Between Ohaeawai and the rock named Taiamai Best also described several rows of stones arranged by the sides of depressed paths 8 inches (20 cm) below the level of the surrounding land. These rows were "probably *paenga māra kumara* showing the bounds of cultivated plots." "Other shallow depressions have no such rows of stones, and many of them are curved, not straight," Best observed.

More recently, the region of this plain adjacent to the terraced volcanic cone of Pouerua has been surveyed by Phillips (1980), who has documented three types of ditch systems. These were described as dendritic, branching from slopes into longer valley ditches; checkered in flat, rolling, gently hilly areas, which included ditches extending over 300 m crossing low hills and intersected by shorter ditches; and asteroid, or slope ditches joined in shallow basins, often with no outlet (Phillips 198: 157, fig. 7, 158). Phillips (1982: 158) suggested that few of the features could have fulfilled a drainage function in the porous volcanic soil and argued instead for a land boundary interpretation. While this seems a sensible conclusion, one wonders whether at least some branching ditches from the steepest slopes here may have had an auxiliary stabilisation function during heavy rainfall. Subsequent research at Pouerua, including a detailed contour map of archaeological features by Morgan and Leatherby (Sutton 1985: 106), may resolve this question.

D. Wetland drainage and reticulation ditches, poorly drained to water-logged soils

This category includes ditch features associated with wetland environments. Wetlands may be defined as basin, depression, lacustrine, or riverine landforms where a high water-table and/or poor drainage remains the dominant influence on the integrated edaphic and floral regime. These areas are generally considered transitional between terrestrial and aquatic systems (Turner and Denevan 1985: 12). In the study area, wetland soil types include alluvial or gley soils and peaty clay loams or loamy peats, generally in former lake bed or riverine environments, and sandy peaty loams in former tombolo swamps or coastal regions. Landslope depends on the environment and is therefore somewhat variable, but is generally less than 15°. There may sometimes be an overlap with type B ditches where wetlands in river catchments are concerned. In ditching wetlands, the most obvious intention was land drainage, of course, but a deliberate reticulation or canal effect was apparently also intended in some instances.

As previously noted, the identification of prehistoric wetland 'drains' in Kaitaia touched off a debate in the early part of this century. Wilson (1921: 185–86) documented the remains of "ancient drains...not confined to one locality, but scattered all over" the fertile alluvial south-eastern portion of the fast disappearing Kaitaia swamp. "Most noticeable is that portion south of Lake Tangonge," Wilson noted, which included Kaitaia itself, and other parts of Mangonui County. These features were observed in newly drained swampland, sometimes requiring the dehydration of a metre's depth of peat before becoming visible. Traditional wooden Maori artefacts were found in association with these features as well as stakes across the larger channels which suggested the remains of eel weirs. The curved lines of the main drains also suggested canoe transport, although Wilson believed the primary aim of the drains was cultivation (Fig. 8). The resulting swamp drainage debate pitted eel/bird capture and canoe portage interpretations against horticulture. By the early 1920s, however, a consensus developed, for prehistoric Tai Tokerau at least, that faunal harvest and horticultural drainage interpretations were not mutually exclusive (Barber 1984: 23–32; see also Hongi ms).

More recently, an extensive region of apparent wetland ditches has been identified as N7/277 in peaty soils near the coastal outlet of the Awanui River (Fig. 9; see also Barber 1984: 157–160; 1989). This large site complex includes ditches well over 50 m long. These are associated with diagonally connected and dendritic networks, some with complicated perambulations in their fall. Plot-like configurations are widespread and include quadrilateral and multilateral features. In the case of the larger ditches which connect directly with the Awanui River, canoe portage and faunal harvest interpretations seem plausible, but the overall plot-like pattern suggests horticultural drainage (perhaps integrated with deliberate reticulation in some cases) as the primary intention (Barber 1989). This is consistent with the observation that drained peaty soils provide important sources of the crucial crop nutrient Nitrogen (Vasey 1985: 237).

Other wetland systems have been located by the writer on the northern tombolo which forms the Aupouri peninsula (Barber 1982, 1984). Two relatively small and well preserved systems exhibit square to rectangular shapes with sides between 10 and 20 m long on poorly drained sandy peaty loam, adjacent to the prominent Taumatawhana pā site (Barber 1982: 147–151). The most extensive complex thus far located on the peninsula occurs near Houhora at Motutangi, a large former swamp which is now mostly drained (Barber 1984: 41–141). Given the relatively low-level contemporary pastoral regime and the absence of extensive land development until the twentieth century, site preservation over much of Motutangi has been good, and the history of land tenure is well documented. Field surveys suggest that at least 47 ha of peaty-sandy loam were directly affected by prehistoric wetland drainage at Motutangi. At N6/488, a complicated grid network transported water from natural springs into a down slope out-fall in two discrete western and eastern locations. The dominant pattern of enclosed plots at Motutangi argues for horticulture as the primary objective in ditch-system construction, with perhaps a subsidiary faunal harvest aim (Fig.10).

At two separate locations along a structurally integrated and downslope ditch at N6/488 west, samples of peat were collected directly above the water deposited basal lens within

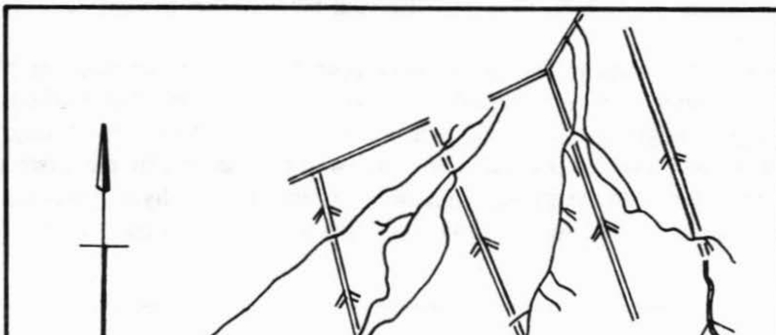

Figure 8: Ditch system in wetlands at Pukepoto, Kaitaia catchment. Category D. Redrawn from Wilson 1921. For identification of map symbols, see key at Figure 2.

the ditch for radiocarbon analysis (NZHPT excavation permit 1982/14). The conventional radiocarbon ages from the two locations are

NZ 5625 266 ± 54.79 yrs. B.P.
NZ 5626 343 ± 55.08 yrs. B.P.

These ages provide a ceiling date for desertion of at least a significant section of the western part of N6/488.[5] The difficulties of dating an undifferentiated bulk peat deposit must be acknowledged, of course. On the one hand, it is possible that carbon material older than the cultural event to be dated may have been incorporated into the peat. Even more likely, however, is the possibility that intrusive roots will have resulted in a date younger than the cultural event (Olsson 1986: 435). Given this likelihood, the earlier age NZ 5626 is probably more relevant. Using the southern hemisphere terrestrial calibration referred to above, the 68% confidence interval for NZ 5626 is 1511 cal. A.D. to 1643 cal. A.D. The 95% confidence interval is 1450 cal. A.D. to 1664 cal. A.D. (I.N.S. n.d.c). This age suggests that at least one section of N6/488 west was deserted between the fifteenth and seventeenth centuries A.D.

Although wetland drainage appears to have been the primary intention at Motutangi, deliberate reticulation is also suggested in the complicated perambulation of ditches from natural springs throughout multilateral plot-like features until their out-fall (e.g. Fig. 10). This action would have maintained a level of wetness throughout the system. Such a function is consistent with the growth requirements of the naturally hydrophytic cultigen taro (*Colocasia esculenta*) which requires a flow of fresh water to avoid stagnation and corm-rot

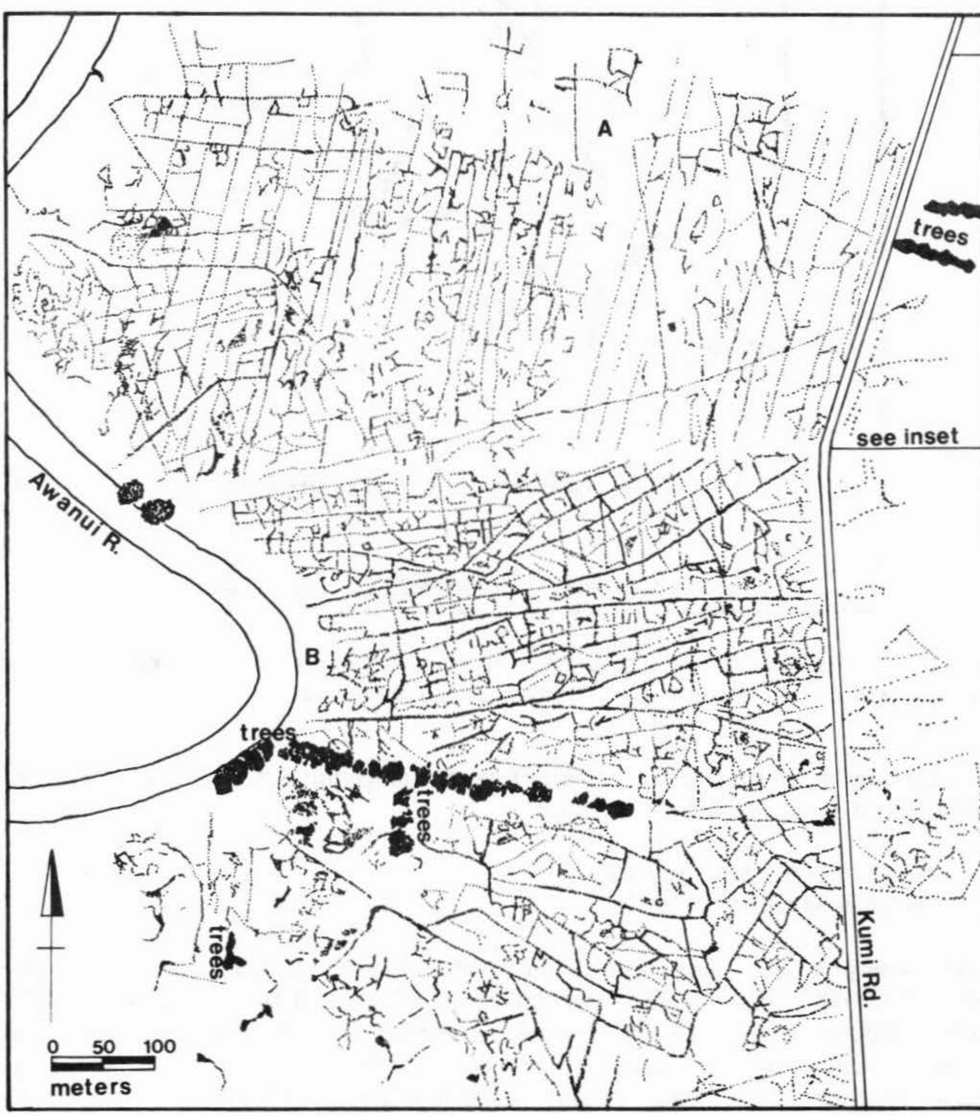

Figure 9: Extensive ditch networks in drained wetlands at Awanui, category D. Details traced from aerial photograph S.N. 350 1361/12, 12 October 1950, Crown Copyright (Department of Survey and Land Information). See Barber 1989: figs. 2 and 3.

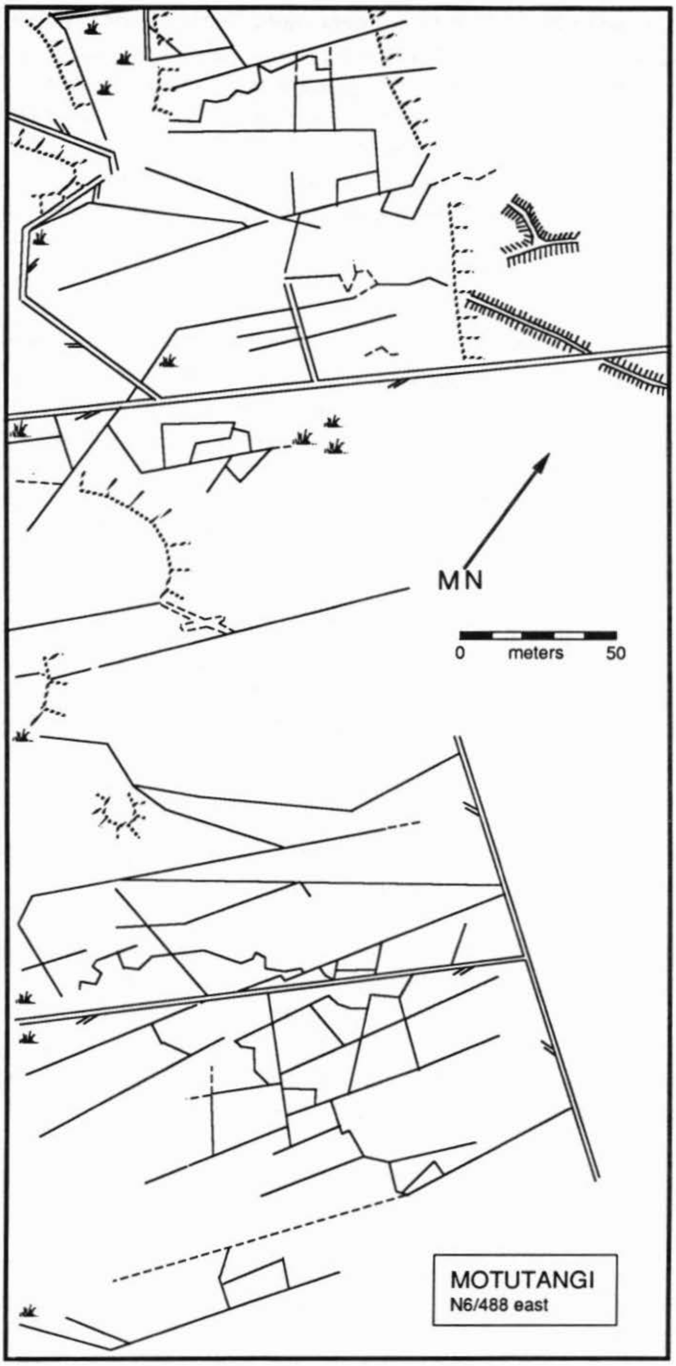

Figure 10: Ditch system N6/488, eastern aspect, Motutangi. Mapped by plane table, alidade, and tape and compass offsets, November 1982, with field checks in 1983. Gradient of slope generally less than 15°. For identification of map symbols, see key at Figure 2.

in wet environments. There is also excavation evidence that deposits in the base of the Motutangi drains were heaped on to adjacent plots (Barber 1984). These factors identify N6/488 as a raised field island bed wetland system, rather than simply a drained wetland field (cf. Vasey 1985: 236). Fed by fresh spring water, this system would have maintained a more consistent distribution of nutrients to the plants, especially since taro roots in island bed situations often extend into ditch base water and sediments (Vasey 1985: 240). In effect, such a system would have constituted a form of simple irrigation, an interpretation which may be relevant to other wetland ditch systems in Tai Tokerau as well (Barber 1984).

In a sophisticated and valuable analysis, Johnson (1986) has identified several wetland ditch systems in the catchment of the Oruru river valley. Both the Oruru and Kaitaia river valley ditch systems are interpreted as having utilised and adapted aspects of natural alluvial topography and hydrology in wetland cultivation (Johnson 1986: 141–183). According to Johnson, these riverine processes provided the primary context for far-northern prehistoric wetland drainage, rather than the more static wetlands of the Aupouri Peninsula. Such a distinction is not without parallels. Turner and Denevan (1985: 12) have identified two similar wetland types relevant to ancient wetland agriculture in the Americas. These are self-enclosed basin depression wetlands with little surface water flow, and more open riverine wetlands with cyclical inundation patterns and discernible surface water flow.

Given the extensive nature of the lower Kaitaia flood plain, however, the situation may be more complicated there. Ditch systems were apparently concentrated on extensive areas of poorly drained loamy peat and peaty clay loam on back-swamps adjacent to the Awanui River outlet and the former Lake Tangonge. This might suggest that many of these lower Kaitaia flood plain systems were at least as much oriented towards a low energy swamp environment as to dynamic riverine processes. Turner and Denevan (1985: 12) in fact allow for hybrids of their two wetland types, "such as depressions whose water tables are linked to local rivers or which receive surface water from rivers during floods." Such a model may be more appropriate to the lower Kaitaia systems.

For Tai Tokerau, the work of both Barber (1984) and Johnson (1986) highlights the need to discriminate between, and investigate further, wetland drainage in relatively static environments, as well as systems associated with the more dynamic processes of alluvial hydrology and 'hybrid' wetland types. Johnson's (1986) argument, that the systems of the Oruru river valley, and perhaps also the upper river wetlands of Kaitaia, were oriented towards a more dynamic alluvial hydrology, is convincing.

Finally, an interesting comparison can be made between these extensive northern field systems covering tens of hectares and a recently located traditional wetland garden site. On the west coast of Tai Tokerau, Smith (1986) identified a prehistoric hillside cultivation site above the Waipoua River, recorded as the Pawherowai Gardens, N18/186. In a shallow, damp bottomed basin which may have held more water before pine forest plantings, a section through one of three drain-like depressions revealed a clear ditch profile and a soil that had been mixed and deepened within the area bounded by the drains (Smith 1986: 3). This small garden is approximately 100 m^2 (Smith 1986: fig. 3; pers. comm.), and was subsidiary to the 12 ha of dryland gardens at N18/186 demarcated by stone structures.

DITCH SYSTEM TAXONOMY: MODELLING CHANGE

As only two cultivation ditch systems in the study region are dated, it is premature to attempt any definitive, broadly based chronological statement linked to systems change. The preliminary classification developed here is at least a basis for informed conjecture about operational change over time, however.

At a very basic level, a measure of continuity seems to characterise the grid or plot like patterns of classes B and C on the limited field evidence. Structural evidence at N12/148 (class B) suggests this site may have postdated European contact, as noted. In the Taiamai Plain with its extensive evidence of class C systems, there are also indications of gardening in the early historic era (Best 1976: 126–127). At the other end of the chronological scale, the approximate date for the ditch at N12/6 suggests some antiquity for type C at least. Evidence of prehistoric cultivation ditching for wetland drainage, water carriage and boundaries has also been documented from a number of Oceanic locations (see references in Barber 1984: 2–16 and Leach 1984: 19, 22). This suggests the ultimate origins of traditional Maori ditch systems may lie in the primal transfer of tropical agronomic practices and cultigens, as much as in convergent developments.

At least two scenarios for change can be suggested for types A and D, however. These are both related to inferred changes in prehistoric human ecology. For type A ditch systems, increasing population pressures upon cultivation resources in late prehistoric New Zealand may have seen more emphasis placed upon slope gardens. As already noted, there is evidence for widespread Maori slope cultivation in the early historic period. In a model of demographic stress, steep slope gardens would have provided greater protection for valuable crops, while supporting a broader strategy of resource use. Slope drains would have countered the expected increases in levels of water erosion following sustained deforestation in these situations. For example, the excavation evidence from N12/6, Moturua Island, suggests a cycle of steep slope gardening, slope erosion, and a later phase of more extensive slope gardening integrated with ditch construction.

On the other hand, category D wetland ditches may have declined in significance and extent over time. Indeed, Roux's previously cited report from Spirit's Bay is the only plausible early contact record of authentic wetland ditching from New Zealand, and it remains ambiguous (Barber 1984: 143–47). Best (1976: 243), as noted, claimed there was no satisfactory evidence from Maori tradition concerning wetland drainage systems. Wilson (1921: 188, see also p. 186) reported that "the Maoris of the present day living in this [Kaitaia] district do not know anything about the history of these drains," although there appears to have been a moderate use (or re-use, perhaps) of ditches for faunal harvest within the living memory of some nineteenth century Maori (Wilson 1922: 188; Hongi ms). Another oral history source claimed that nineteenth century Awanui Maori professed no history or traditions concerning wetland ditches there, which were ascribed instead to an earlier people (Barber 1982: 27–28; 1984: 157–158). The few broadly relevant traditions which have survived from the Kaitaia region place any significant drainage and wetland cultivation activities between 8 and 14 generations from the present (Barber 1984: 205–209, 264–272). The Mototangi swamp was also apparently uninhabited at the time of European contact (Barber 1984: 41–69), while at least part of N6/488 at Mototangi was deserted between the fifteenth and seventeenth centuries A.D., as noted.

The Awanui field evidence suggests that ditch systems there once covered at least 125 ha of former wetlands and poorly drained localities (Barber 1984: 160), an area which may have been matched in the upper Kaitaia river valley and Lake Tangonge systems. Although the oral testimony cited above is not conclusive, it suggests large scale wetland networks are unlikely to have continued in use to any great extent into the protohistoric era. In a model involving ecological and demographic stresses upon the limited far northern wetland catchment resources, it would not be surprising if spatially intensive drainage and reticulation strategies were eventually disrupted.[6] Such stress would have been especially marked if intensification demands upon the relatively sensitive growth requirements of wetland taro became a factor. An emphasis on taro is consistent with local tradition, which also appears to support a model of prehistoric stress upon these resources (Barber 1984: 205–206, 208–209, 264–272). The apparent confinement of extensive wetland systems to the warmer far north of New Zealand also reinforces the limits and stress potential underlying such a sub-tropical catchment adaptation in an otherwise climatically marginal island environment.

Obviously, further archaeological, environmental and ethnographic research is required if such models are to be adequately tested.

CONCLUSION

This survey has considered a representative selection of ditch systems apparently associated with cultivation activities in northern New Zealand. It is suggested that the fourfold classification system accounts for the field evidence as known at present, and is consistent with the ethnographic record. It is apparent that a single interpretation of ditch categories A, B and D as plot boundaries is inadequate. In this connection, generic categorisation may well have obscured specialised subsistence and resource management strategies in traditional horticulture. Slope ditching, including categories A and B, probably constituted both a long term approach to water erosion and ecological stress, and where appropriate an effective integration of discrete cultivation regimes. The extensive evidence of wetland ditching in the sub-tropical far north also argues for complex catchment management and the adaptation of central Pacific agronomic practices and cultigens. It is possible that ecological and/or population stress finally overtook the success of large-scale wetland horticulture in the far north, however. Although four separate categories of horticultural ditches can be proposed at a basic interpretative level, these may all at least be related in representing sophisticated strategies of environmental management by traditional Maori horticulturists.

ACKNOWLEDGEMENTS

Much of the preliminary data upon which this essay is based were gathered during an archaeological site survey undertaken for the New Zealand Historic Places Trust in 1982. I would like to acknowledge the supervision and encouragement of Auckland Regional Archaeologist Susan Bulmer. Kate Marshall and Talia also provided company and field assistance during the survey.

For hospitality, information and assistance in Tai Tokerau during the course of the 1982 survey and related field work in years following, I wish to thank Bert and Neville Beasley, Stan Bartlett, Norm and Sylvia Bryan, John Coster and Gabrielle Johnson, Judy Evans, the late Viv Gregory and Ross Gregory, Vic and Ann Hensley, Gordon Kirker, Charles Michie, David and Glenys Nevin, Violet Norman, Lois Nun, Les Shalders, the Te Hapua musterers, and Derric Vincent. Numerous Tai Tokerau landowners also allowed site access and provided relevant information. John Coster, Leigh Johnson, Helen Leach, Ann Leahy, Karel Peters, Ian Smith, Jeremy Spencer, Douglas Sutton and Wendy Walsh answered questions concerning ditch systems they had worked on. Leigh Johnson has also permitted the citation of material from his unpublished M.A. thesis. Foss Leach and Ian Smith helped to obtain conventional radiocarbon ages and recent calibrations for ^{14}C dates reported here, while the Institute of Nuclear Sciences, Lower Hutt, provided the ^{14}C ages from Motutangi. Janet Davidson and an anonymous referee also provided helpful criticism of an earlier draft.

Martin Fisher prepared photographic prints of the illustrations for publication.

NOTES

1. Leach (1976: 117, 1984: 68) gives an alternative translation of Roux's French here: "every ten paces one saw little ditches for the water to run along." While this is not the active principle of the McNab translation, the function at least is the same. It would seem a moot point as to whether the difference is to be considered significant.

2. The gradient of both sites extends to well above 15°. The unlikelihood that the sites were ploughed is further suggested by Samuel Marsden's records of the early Christian mission established in this locality. Thus in 1815, Marsden wrote concerning "Rangheehoo" that "the steepness of the hills, and the want of depth in the soil, disqualify the immediate vicinity for profitable cultivation" (Elder 1932: 161). Marsden observed further that Kerikeri was a preferred location for settlement, "the soil being rich, the land pretty level... easy to work with the plough" (Elder 1932: 147). In 1815, Nicholas (1817 (1): 171) also described Maori plantations of potato, kumara, and other vegetables, adjacent to the Rangihoua pā. They had "an appearance of neatness and regularity... carefully fenced in, and hanging down from the sides of steep hills."

3. Spencer (1983: 80, fig. 2) has mapped and identified these steep slope features below Rangihoua pā as agricultural alignments. However, the overall effect is of a somewhat irregular, convergent pattern more characteristic of a natural process of rill erosion (cf. Carson and Kirby 1972: 193–194, fig. 8.1). This pattern stands in marked contrast to the more regular, approximately parallel adjacent ditch systems of N11/200 and 221 (Fig. 5 and Spencer 1983: 80, fig.2; 94, fig. 9).

Johnson (1986: 189–191, 192, fig. 25) has identified and compared a similar pattern to the Rangihoua pā slope features on a steep slope above the Oruru river valley. In a convincing argument, Johnson has suggested the Oruru ditch systems functioned both as run-off channels and to delineate cultivation units in "strip cultivation" or category A of this paper. However, the Oruru features are more extensive and include a greater number of generally parallel trenches than the Rangihoua pā slope lines.

The Oruru features are also generally 15 m apart (Johnson 1986: 189, 192, fig. 25), while Spencer's (1983: 80, fig. 2) map suggests the Rangihoua pā slope lines vary widely within a range of 2 to 10 m apart.

4. Janet Davidson has identified a similar site, N1 and 2/732, on a gently sloping flat east of the Porutu Stream in the far northern Aupouri Peninsula which the writer has also visited. The ditch system forms at least 8 small rectangular plots, each approximately 2 m^2, behind the poorly drained shoreline of a small bay. An unsubstantiated oral account suggests that Maori people from the Three Kings Islands settled in this region in the 1840s and constructed such a ditch system, giving the locality its name of Takiwhetu (Barber 1982: 10). If confirmed, this account would also raise an interpretative problem about the traditional status of this site.

5. The event dated provides a minimum age only for desertion of the ditch, since water flow may have continued initially, precluding peat formation. This probably does not involve a significant time period, however. The rapid accretion of sandy silt within the relatively large present day drains

necessitates an annual dredge by Motutangi farmers (Barber 1984: 117). Smaller prehistoric canals left on their own may therefore have taken little time to block, restricting water flow and encouraging a build-up of organic material. The peat samples were collected directly above banded silt deposits in the base of the canal, and therefore represent the initial accumulation following the cessation of any significant water flow.

6. The writer now considers his previous elaboration of such a model (Barber 1984: 171-217) to be deficient in some respects, especially with regard to the Ngati Awa displacement traditions. Even so, elements of this earlier discussion are still considered relevant to the question of changes in wetland systems over time.

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Received 28 August 1988