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Harakeke (*Phormium tenax*) ecology and historical management by Māori: The changing landscape in New Zealand

A thesis
submitted in partial fulfilment
of the requirements for the Degree
of
Doctor of Philosophy

by
Priscilla Mary McAllum Wehi

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Abstract

Harakeke (*Phormium tenax*: Phormiaceae) is an important weaving resource for the indigenous Māori people of New Zealand. This research project investigates Māori knowledge of harakeke ecology and management practices prior to the early 20th century within the context of a study of relevant environmental parameters that limit its natural distribution. Ecological information referring to harakeke was analysed from interviews with elders and ancestral sayings (*whakataukī*). As well, documents from the late 18th to the early 20th century were examined, and environmental parameters for both harakeke and wharariki (*Phormium cookianum*) were quantified and analysed using correlative models.

Interviews with 11 elders (from Waikato and Northland) identified key issues in harakeke management, including 'correct' harvesting procedures, use of natural harakeke stands, and specific use of different varieties. Planting practices varied regionally. Three different methods of excess harakeke disposal were reported, including burning. The 15 *whakataukī* analysed emphasise the interconnectedness of ecosystems, including pollinator-plant relationships for kākā and bellbirds. Four *whakataukī* refer to environmental tolerances for harakeke and two to the use of fire to stimulate harakeke growth. Others refer to competition between shoots, nutrient requirements, and the growth and multiplication of harakeke offsets.

Numerous early reports indicate that harakeke has been cultivated throughout much of New Zealand, with cultivations ranging in size from a few bushes to at least several acres. Thirty six varieties were linked to specific weaving uses. Twenty varieties were cultivated, but ten prized fibre varieties were also harvested from natural stands. Numbers of recorded varieties varied between districts, with 31 recorded in Taranaki but only two recorded by name for Northland. Valued varieties, including *raumoa* and *oue*, were dispersed throughout the North Island. Mapping different varieties revealed a wide spatial spread for varieties such as *rataroa* and *oue*. Specific management techniques included seed germination as well as vegetative propagation. Early records of harakeke pests were not found. Records of harakeke irrigation and the use of fire indicate that Māori created

suitable conditions for new cultivations or *pā harakeke*, which may also have prevented insect infestation. Cumulatively, there is evidence of extensive active management of harakeke.

Wharariki and harakeke were found to have distinct environmental niches, with wharariki better able to withstand cooler temperatures, higher rainfall and greater frequency of ground frost than harakeke. Predictive mapping of harakeke for the northern region of New Zealand shows a low probability of naturally occurring harakeke in much of the Northland and Waikato interior, and a high probability in coastal areas with warm temperatures. It seems likely that Māori transported harakeke into areas where it was unlikely to have occurred naturally and that some apparently 'natural' stands of harakeke were created and maintained by Māori.

Māori cultivation, dispersal and active management of harakeke, as well as possible creation of wetland areas, emphasises the importance of harakeke as an economic resource prior to European colonisation, and indicates how the New Zealand landscape may have been transformed. Māori ecological knowledge can contribute new perspectives to restoration ecology and ecosystem research.

Keywords: ethnobotany, harakeke, historical ecology, Māori resource management, *Phormium cookianum*, *Phormium tenax*, traditional ecological knowledge, weaving, wharariki.

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List of Abbreviations

AJHR Appendices of the Journals of the House of Representatives

JHR Journal of the House of Representatives

n.d. no date recorded for a publication

RFC Report of the Flax Commissioners 1870-1872

AHM The Ancient History of the Māori (by John White)

"The natural world is far more dynamic, far more changeable, and far more entangled with human history than popular beliefs . . . have typically acknowledged."

(William Cronon, quoted in *Environmental Histories of New Zealand*, p.6)[1]

[1] Pawson & Brooking (2002).

1951; Johnson & Brooke, 1989 p.86)[7]. It is an herbaceous perennial; that is, it grows vigorously all year round. The leaves are green, distichous[8] and sword-like, and grow up to 3m long in fan-like tufts (*Figure 1.1*). The flower stalks are also tall and distinctive, growing between 3 - 5 m high, and flowering in summer[9]. Harakeke is widespread throughout the country, as might be expected for such an essential Māori resource, and often found in, or along the edge of, swamps. It is thus frequently referred to as "swamp flax" while its close relative wharariki (*Phormium cookianum* Le Jolis: Phormiaceae) is often associated with coastal or alpine areas. The two species sometimes grow together, and can be distinguished by their flowers and fruits as well as other features (Wardle, 1979).

***Figure 1.1:* Harakeke (*Phormium tenax*) with dead flower stalks from two seasons showing**

[7] It is thought to have been introduced to the Auckland Islands (Critchfield, 1951; Johnson & Brooke, 1989 p.86).

[8] The leaves lying in one plane.

[9] Usually about November in New Zealand.

There has been debate over the scientific classification of harakeke since European contact. Previously classified as part of the Liliaceae and Agavaceae[10] families (Moore & Edgar, 1970 p.51; Watson & Dallwitz, 1992), harakeke is now commonly regarded as part of the Phormiaceae[11]. This small family currently has around seven[12] genera and 30 species worldwide, and includes *Dianella, Stypandra* and *Thelionema* spp. (Watson & Dallwitz, 1992). The genus *Phormium* has only two representatives, *Phormium tenax* and *Phormium cookianum*[13] which are both New Zealand 'flaxes' (Moore & Edgar, 1970 p.52).

Harakeke is well recognised by New Zealanders, and grows readily along roadsides and in gardens. It is described on internet sites as a species useful for erosion control, farm shelter and hedging, and riparian margin management (www.tauponativeplant.co.nz 8.11.04), while also supporting a large community of animals (www.doc.govt.nz/plants 8.11.04) and providing a significant food source for birds (www.ccc.govt.nz/parks/TheEnvironment/ 8.11.04). It is also increasingly planted for weaving purposes by Māori, particularly around marae, as traditional weaving experiences a strong resurgence.

Harakeke leaves are tough and fibrous, and can be 5 -12 cm wide. These qualities are important in its usefulness to Māori weavers. Morphologically, harakeke has a number of different forms which are generally termed varieties or cultivars, and these vary in strength of fibre as well as morphology. Māori have developed a classification system of harakeke varieties, based primarily on the strength and quality of fibre (Cross, 1912 p.30; Heenan, 1991 p.6).

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[10] It had previously been placed in the Liliaceae or lily family along with the tī tree *Cordyline australis* because of the lily like flowers, and in the Agavaceae family which now includes the tī. The Liliales ("lilies", growing from bulbs or corms) superfamily has also now been redefined on both molecular and morphological evidence to exclude the Asparagales, to which both the Agavaceae and Phormiaceae belong (Watson & Dallwitz, 1992).

[11] Subclass Monocotyledonae. Suborder Liliiflorae; Asparagales. Family Phormiaceae.

[12] In this thesis, the convention of indicating numbers one to nine in written form, and 10 onwards numerically, is used.

[13] Listed [wrongly] in some texts as *Phormium colensoi*.

After initial European contact in the late 18th century, harakeke was quickly identified as a potentially valuable plant (see, for example, Elder, 1932[14] p.227). Early Pākehā immigrants built upon Māori knowledge of harakeke, and particularly knowledge of its fibre or *muka*, to develop an economically important export industry based on fibre extraction to make cordage (see, for example, Critchfield, 1951). Initially Māori stripped the fibre by hand for this industry, and received payment of muskets or other goods, and later money. However the invention of a mechanical flax stripper in the 1860s greatly increased the amount of harakeke that could be stripped, although the quality was regarded as inferior to that stripped by Māori (Hector, 1889). In spite of a number of highs and lows, the industry endured for most of the 19th and 20th centuries (Critchfield, 1951; McLennan, 1970; Cooper, Cambie & Brooker, 1991; Matheson, 2000) and swamp management and harakeke cultivation techniques were developed to improve production, especially in the Manawatu district of the North Island (Poole & Boyce, 1949; Matheson, 2000). Surprisingly, then, in the light of its economic importance, the ecology and general biology of harakeke remains comparatively unknown.

1.2 Review of the scientific literature

Early research on harakeke was strongly influenced by interest in the economic potential of its fibre (see, for example, Hector, 1889), although Cross (1912, 1915) systematically described the vegetative and floristic characteristics of harakeke. She identified 32 varieties of *Phormium tenax*, based on their habit, leaves, inflorescences, flowers and capsules, and dismissed the Māori classification system as "entirely artificial". Allan & Zotov (1937), however, reframed this view, noting that Māori clearly recognized the "great polymorphy" found in harakeke, and added that, in their view, Māori classification has "not yet been surpassed by modern investigation". Both species of *Phormium* are extremely variable, and taxonomic distinctions between some variants are believed possible (Wardle 1979; de Lange & Cameron, 1999), although not on the basis of chromosome number (de Lange & Murray, 2002). However, it is also

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[14] Elder (1932) edited Samuel Marsden's journals and letters which were written during the period 1814-1820.

clear that *Phormium* responds phenotypically to different environments (Harris et al., 2005).

Harakeke is often found in fertile lowland swamps on mineral or peat soils (Duncan, Norton & Woolmore, 1990; Wardle, 1991 p.73; Johnson & Brooke, 1989 p.17; Clarkson, 2002 p.53). These swamps are frequently a mixture of harakeke, raupo (*Typha orientalis*), toetoe (*Cortaderia* spp.) and sedges (*Carex secta*). As peat builds up in the wetland, swamp conditions become more acidic and less fertile over time, and harakeke is replaced by less nutrient-demanding species (Clarkson, 2002 p.53). However, harakeke is also found in communities as diverse as tussockland on beach platforms and peaty alluvial soils (Bagnall, 1975; Bagnall & Ogle, 1981), manuka (*Leptospermum scoparium*) shrubland (Robertson, Mark & Wilson, 1991) and restiad bogs[15] (Clarkson, Schipper & Clarkson, 2004). Soil composition affects harakeke growth, so that although harakeke may be scattered across many wetlands with low nutrient status, plants tend to be tall but narrow (as opposed to the usual dense clumps) (Johnson & Brooke, 1989 p.17).

Easterfield, Rigg & Bruce (1929) experimented with the application of fertilisers when planting harakeke on pakihi soil, and found marked improvement in root and leaf development with the addition of phosphate. A similar result occurred when a dressing of flax refuse was applied. Rigg & Watson (1945) also investigated conditions for growth and the effects of fertilisers when harakeke was planted on phosphate deficient pakihi soil. Similarly to Easterfield et al. (1929), they found that the addition of phosphate had a notable effect on growth, although the quantities used were not suitable for commercial application. Harris et al. (2005) have also reported more recently that phosphate deficiency appears to be a limiting factor for harakeke growth. Perhaps one of the more interesting features of the experiments carried out by Rigg & Watson (1945) was their observation that harakeke can grow on a very acid soil deficient of lime. Rigg & Watson also

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[15] Restiad bogs are low nutrient, acidic, rain fed wetlands dominated by the jointed rush family the Restionaceae (such as wire rush *Empodisma minus* and cane rush *Sporadnathus ferrugineus*), and can form extensive raised peat domes (Clarkson, 2002 pp.49-51).

examined the nutritional status of the leaves, presumably based on harakeke use as stock browse, but found that the chemical composition of plants did not reflect the extreme growth differences exhibited by harakeke in different experimental treatments.

These experiments provide indications of soil types which might promote harakeke growth, but further ecological research, identifying environmental parameters for harakeke for example, was clearly not a major concern in these early industry-driven designs. Craig (1989b) has proposed that maternal nutrition in harakeke plants may set the overall limit of annual investment in seed. Presumably this would relate to soil conditions, but no further work along these lines has been carried out.

Surprisingly, the distribution of harakeke in relation to environmental and landform variables is not well defined. Miller (1930) commented that harakeke may be grouped according to whether it grows in swamp, mountain and hill areas, but this classification seems to be based on ease of milling for fibre rather than on differences in ecological community. However, hill stands were perhaps closer to the "natural state" of the plant than were swamp growths, because swamps were frequently drained to alter the original swamp vegetation and encourage dense stands of harakeke suitable for harvesting (Esler, 1978 p.57; Ravine, 1995). Wardle (1979) summarised harakeke habitat as swamps, sluggish streams, coastal slopes, dune hollows, and open hillsides in the lowland and montane belts. One could be forgiven for thinking that this does not leave much out. However, habitats where harakeke is absent or not readily found are of great interest, as these indicate the limits of harakeke in terms of temperature, frost tolerance, altitude, soil conditions and other environmental parameters. Critchfield (1951) reported that harakeke grows naturally in a wide range of soils and topography, from sea level up to 4000 feet and under rainfalls of 20 to 150 inches. Although frost tolerance was investigated in some varieties of *Phormium* by Warrington & Stanley (1987), these were ornamental cultivars with a probably hybridised origin. Investigations into other environmental variables have not been published although understanding the limits of environmental parameters allows us to predict the likely occurrence of harakeke and its prevalence across the New

Zealand landscape. Furthermore, although the successional nature of swamps, and changing distribution of plants such as harakeke, is sometimes acknowledged as edaphic (see, for example, Ravine, 1995; Clarkson, 2002), the historical management of these communities through human intervention has not yet been considered.

Wardle (1979) has demonstrated with wharariki (*Phormium cookianum*) how the use of distribution data can illuminate variability in morphology and other characteristics, provide useful information and raise interesting questions about a species. Wardle distinguished two forms of *Phormium cookianum*, one of which he called a 'northland-lowland' and one a 'southern-mountain' form. These differ in appearance, habitat and geographic range. He noted that the southern-mountain form, appearing in the central South Island district, appears more closely related to harakeke although it is geographically distant, while the northern-lowland form is very distinct from harakeke although it can hybridise. Wardle discussed glaciation as a possible origin for the southern form, as it hybridised with remnant harakeke populations, but did not include any consideration of Māori use or other possible causes for this variation in morphology. He proposed the separation of *Phormium cookianum* into subspecies, with *Phormium cookianum* subsp. *cookianum* applied to the southern form and *Phormium cookianum* subsp. *hookeri* to the northern.

Because of the export market for harakeke, studies of pests and diseases have also been important[16] (see, for example, Miller, 1930; Cumber, 1952; Boyce et al., 1953; Boyce, 1958; Liefting et al., 1997; Andersen et al., 1998). Much of this earlier research on pests has been collated by Scheele (1997) in a more readable form, useful to current resource managers of harakeke.

Miller (1930) separated the insects living in harakeke plants into four groups. These were species which attack the leaf, the crown of the plant, and the seed respectively; and finally predators and parasites. From an economic point of

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[16] For example, there was an outbreak of yellow leaf disease which devastated the fibre industry in the 1950s.

view, however, the first group remains the most important one as it not only includes the greatest number of species, but also the species with the most damaging impacts. Miller considered the looping grub[17] *Orthoclydon praefectata* the worst, although the notching grub *Tmetolophota steropastis* also devastated some areas. Moreover, Miller (1930) identified two major factors which affect insect numbers. First, harakeke which is flooded benefits from reduced insect numbers as immersion in water interrupts the life cycle of the looping grub moth[18]. Secondly, more leaf tubes were observed to be present in harakeke growing in drained swamps. These leaf tubes, formed by the dying and dead leaves, act as an important shelter for the moth grubs.

Miller (1930) identified all of the insect pests as endemic. This indicates that Māori in the pre-European period would have contended with an identical array of pests. Although Miller did not mention control of pests by Māori, he made two interesting comments. First, he considered that prior to the development of the export industry harakeke did not seriously suffer from insect depredation, a view also shared by Atkinson (1921e) and others. Secondly, he believed that harakeke, and especially swamp harakeke, was of "a quality inferior to the requirements of the flax-miller". That is, draining the swamps for commercial harvesting purposes provided better quality harakeke and more extensive plant growth, but resulted in a large increase in pests. These comments will be considered more fully in *Chapter 5* in relation to Māori use and management of harakeke.

Yellowleaf disease became a major problem for the harakeke fibre industry at the beginning of the 20th century (Atkinson, 1921e). It was finally identified as the result of a phytoplasma detected in the phloem tissue (Ushiyama, Bullivant & Matthews, 1969) which is transmitted via the native leaf hopper (*Oliarus atkinsoni*), rather than a virus as previously thought. Work has continued on the detection of phytoplasmas: Andersen et al. (1998), for example, have developed a method for detecting phytoplasmas which they regard as suitable for large scale

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[17] The larval stage of this endemic moth.

[18] It is thought the insects die after around ten minutes in water.

testing of harakeke. The inference seems to be that commercial cropping of harakeke remains a possibility.

Research on the ecology of harakeke is somewhat sparse. Harakeke flowers are hermaphroditic and protandrous[19], and sexual reproduction is by large inflorescences (Craig & Stewart, 1988). In his American research, Puri (1960) noted daily peaks in harakeke flower opening, which appeared to be related to temperature and relative humidity, but this has not yet been corroborated by other researchers. Early authors were divided as to pollination agents. Ovules have previously been reported as wind (Atkinson, 1921b), water, and bee (Atkinson, 1921b; Puri, 1960) pollinated. Craig & Stewart (1988) conducted pollination and breeding experiments as a prelude to explorations of the relationship with birds. Thomson (1927) observed that tūī (*Prosthemadera novaeseelandiae*), bellbirds (*Anthornis melanura*), stitchbirds (*Notiomystis cincta*), parrots (*Nestor meridionalis*), parakeets (*Cyanoramphus* spp.), and silvereyes (*Zosterops lateralis*) visited harakeke to collect nectar, noting that their feathers pick up the pollen and carry it from flower to flower. Ornithophily is currently thought to be the primary pollination mechanism (Stewart & Craig, 1985; Craig & Stewart, 1988): however, many of the birds observed by Thomson are now scarce in the New Zealand landscape.

After fertilisation, the ovules develop into seeds. Craig (1989b) has concluded from his study on Tiritiri-Matangi Island that resident tūī account for almost all the viable seeds produced by harakeke, playing a far more important role than tūī that are not resident. Craig & Stewart (1988) also proposed that outcrossed seeds are preferentially retained by harakeke plants and this hypothesis was explored further by Becerra & Lloyd (1992). Cross (1915) suggested that harakeke was not self-fertile, and later experimental work by Craig (1989a) concurs with her overall findings, showing that harakeke naturally outcrosses, producing few seeds from self-fertilised harakeke flowers. Craig (1989a) found that these outcrossed flowers produced mainly large seeds with the greatest amount of endosperm,

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[19] High flowering intensity indicates that many female and male flowers are available on each inflorescence at the same time.

while also promoting the greatest genetic diversity. Although sample sizes were small, there were clear relationships between seed size and whether the seeds were from the same inflorescence, a different inflorescence on the same plant, or from a different plant altogether. Craig (1989b) extended this work, concluding that harakeke receives a great majority of self-pollen on its flowers, and sets seed from only 20% of these. Bird visitation is therefore an essential part of harakeke functioning.

Harakeke flowers irregularly, and Brockie (1986) recorded its flowering performance over a 10 year period. He concluded that the flowering intensity[20] fluctuates annually, and believed that the data supported a quasi-triennial cycle triggered by high air temperatures the previous late summer or autumn, as suggested by Connor (1966). Correlations with environmental variables explained the data better than geographical synchrony or cyclic depletion of resources, and in particular he suggested that summed April to June maximum air temperatures in excess of 54°C were required to stimulate heavy flowering. Craig & Stewart (1988) also noted the seasonal development of inflorescences, and relationship to mean temperature the prior April, May and June. However, later work by Schauber et al. (2002) found no statistically significant correlation with temperatures during the prior summer or autumn when further data was analysed from the same sites over an 18 year time series. It is possible, however, that harakeke masting may respond to more subtle temperature cues missed in their analysis, as they found strong correlations between mass flowering and temperature in many other New Zealand genera.

Information from different sources about seed germination data is somewhat contradictory: Puri (1960) reported that alternating low and high temperatures were required for high seed germination, whereas experiments by Mackay et al. (2002) have demonstrated that *Phormium tenax* seed has increased germination rates after a period of stratification or chilling to overcome dormancy. These researchers also noted that *Phormium tenax* seed tolerates drying, remaining viable when desiccated to a moisture content of less than 20%. This indicates its

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[20] Mass seeding or flowering is often termed masting.

persistence in the seed bank, and subsequent ability to recolonise cleared areas, such as after fire.

Craig & Stewart (1988) also noted the distinctive mode of asexual harakeke reproduction via the production of offshoots or fans, so that the typical plant consists of tens of fans of the same genetic stock. These identical fans have been used extensively to develop harakeke cultivations of desirable varieties in New Zealand. However, this form of reproduction has implications for genetic diversity and the spread of, and resistance to, disease.

Ecological papers on harakeke are thus clustered around a small number of topics. There are few other areas which have been addressed. Few studies have investigated the relationships between harakeke and other animals although *Phormium tenax* acts as valuable habitat for both insects and molluscs (Forster & Forster, 1973; Taylor & Jackson, 1999; Brook, 2002) as well as providing nectar for lizards (Whittaker, 1987). Additionally, the potential of harakeke as a nurse plant for other species was noted by Reay & Norton (1999). Even so, much of its ecology, essential for restoration ecology and ecosystem management, has not yet been elucidated.

On the other hand, a number of recent publications provide information based on Māori traditional knowledge of harakeke, such as a checklist of harakeke cultivar nomenclature (Heenan, 1991). Beever's dictionary of Māori plant names (1991) also includes the names of many varieties identified by Māori, but without further elaboration. Although Heenan's checklist usefully outlines the large numbers of cultivars, including varieties used and developed by both Māori and commercial growers, the descriptions and origins of traditional Māori harakeke cultivars held in the Rene Orchiston collection are more useful for Māori weavers and those interested in traditional varieties. These have been compiled by Scheele & Walls (1994).

It appears that there is a recent trend towards scientific research on harakeke which may be of interest or benefit to Māori weavers. This has included analysis of structural stiffness of leaves (King, Vincent & Harris, 1996), fracture properties

(King & Vincent, 1996), and the effects of fibre extraction on leaf anatomy (King, 2003). Some of these studies attempt to determine the relationship between Māori understandings of harakeke and aspects of its biology, such as an investigation by McBreen et al. (2003) into the genetic relationships between weaving cultivars. They attempt to work with both traditional knowledge and modern scientific techniques to uncover new knowledge. Collaboration of Māori weavers and scientists in areas of common interest is an emerging feature of recent scientific research on harakeke (see, for example, Harris & Woodcock-Sharp, 2000; More et al., 2003).

Nonetheless, the total research into this plant remains small. Moreover, the literature remains closely involved with topics relevant to its economic potential, including the properties of its fibre, and research on cultivars from the Rene Orchiston Collection. Research on the broader ecology of harakeke, its growth and habitat, relationships with other plants and animals, distribution and environmental tolerance would play an important role in increasing our understanding of harakeke and the relationship between Māori and harakeke.

1.3 Traditional ecological knowledge

Two main areas of knowledge are investigated in this research. Papers published by the scientific community investigating aspects of harakeke ecology have been reviewed above. Much of this research project, however, investigates Māori ecological knowledge and management of harakeke. In this section, I present a context of traditional ecological knowledge and its relationship with modern scientific knowledge. Synergies between Māori knowledge and scientific understanding are identified in order to address the hypotheses that Māori have actively managed harakeke, and that this has resulted in changes to the New Zealand landscape. Although the spiritual aspects of traditional ecological knowledge are not examined in this research project, I have included an outline of some basic philosophical concepts which are important in a Māori world view, and, hence, in Māori resource management (see *Appendix 1*).

1.3.1 Context and meaning

Detailed environmental knowledge held by indigenous peoples is sometimes referred to as traditional ecological knowledge. Huntington & Mymrin (2001) have defined traditional ecological knowledge as:

> a system of understanding one's environment. It is built over generations, as people depend on the land and sea for their food, materials, and culture. Traditional ecological knowledge is based on observations and experience, evaluated in the light of what one has learned from one's elders. People have relied on this detailed knowledge for their survival - they have literally staked their lives on its accuracy and repeatability.

This can be placed within the wider context of indigenous knowledge, which is "the unique, traditional, local knowledge existing within and developed around the specific conditions of women and men indigenous to a particular geographic area" (Grenier, 1998 p.1). Berkes (1995) included the following within the social context of traditional ecological knowledge: symbolic meaning (conveyed through oral history, place names and spiritual relationships), relations based on reciprocity and obligations towards both community members and other beings, and communal resource management institutions based on shared knowledge and meaning. These components are all incorporated within the context of a "world view". The importance of world view is also identifed in Berkes' (1999) work which emphasises the knowledge-practice-belief complex which lies at the heart of traditional knowledge. Sillitoe (2002, p.9) summarised indigenous knowledge as knowledge which is held collectively, informs an understanding of the world, is community-based and culturally informed, and embedded in, and conditioned by, local tradition. Other authors also describe traditional ecological knowledge in similar terms, emphasising collectivity, cumulative experience, and the interconnected relationship of humans with the earth (see, for example, Berkes, 1995, 1999; Doubleday, 1995).

Detailed traditional environmental knowledge is generally recognised to be:

- local and specific to place (Berkes, Folke & Gadgil, 1995; Grenier, 1998; Berkes, 1999; Macedo, 1999; Posey, 2002);
- cumulative (Berkes, 1995, 1999; Given & Harris, 1994; Grenier, 1998; Zent, 1999);
- transgenerational (Berkes, 1995, 1999; Grenier, 1998; Sillitoe, 2002; Posey, 2002);
- asymmetric within a population, for example being gender- or age-specific (Grenier, 1998; Sillitoe, 2002);
- dynamic (Grenier, 1998; Berkes, 1999; Macedo, 1999; Viergever, 1999);
- holistic, that is, incorporating spiritual as well as biophysical realities (Given & Harris, 1994; Berkes, 1999; Semali & Kincheloe, 1999; Sillitoe, 2002); and
- collectively held (Grenier, 1998; Berkes, 1999; Posey, 2002; Sillitoe, 2002).

The first of the above points emphasises the close relationship between these societies and *place*, that is, the environment in which people live. Therefore, as topography and climatic conditions change across a country, specific resources, their level of use, and the knowledge associated with them might also be expected to change from place to place. Flowering periods may differ with sheltered inland conditions for example; or different resources may be used for activities because of local abundance. Long-term sustainable use requires an understanding of the biology and seasonal cycles of abundance and decline of different plants or animals.

New Zealand publications relating to indigenous resource management practices emphasise the importance of detailed environmental knowledge along with cultural and spiritual beliefs as principles for sustainable management. Thus, in *Te Whakatau Kaupapa* (the Ngāi Tahu Resource Management Strategy for the Canterbury Region), Tau et al. (1990) have suggested that "a combination of pragmatism and concepts concerning the environment provide the guidelines for resource management and control, and sustainability is the over-riding

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consideration". Pragmatism relies on detailed knowledge of a resource, such as knowledge of its biology and its relationships to other organisms.

Although there have been spatial shifts within New Zealand by different tribal groups (see, for example, Woolford, 1998; Jones & Biggs, 1995), specific local knowledge has also developed. This reflects the essential nature of activities such as weaving and food gathering and, hence, the value placed on ecological knowledge related to these activities. Additionally, many plant and animal species in New Zealand have (or had) broad distributions, perhaps allowing Māori to build up general knowledge of different species and ecosystems while also focusing on novel species, or the response of species, in a particular area.

Viergever (1999, p.338) has drawn attention to the changing nature of traditional ecological knowledge, calling indigenous knowledge the "product of a dynamic and creative system to resolve perceived problems"; that is, it is collected in a deliberate, non-accidental way. Since the information is based on lived experience, it is not possible to "preserve" traditional knowledge by simply documenting it. Such knowledge is continually being added to, as well as evaluated, in the light of changing natural patterns, and of the impact of use on the environment. Traditional ecological knowledge is the result of merging personal observation and the lessons of others: it cannot be maintained without a component of practical experience. If we wish, therefore, to preserve the expertise that is shown in traditional ecological knowledge, we must work to preserve the way of life from which it has developed. Traditional ecological knowledge research, in this context, can serve to show why this expertise is valuable and worth preserving (Huntington & Mymrin, 2001).

Zent (1999, p.94) has discussed the interconnected and dynamic relationship between people and biological diversity from a different perspective, noting that local people can contribute substantially to genetic diversity through experimentation, patterns of micro environmental use and manipulation, and individual management styles. These types of experimentation and selective use are examined in relation to the cultivation and management of harakeke by Māori. Restoration ecology relies on accurate reference ecosystem information (such as

that gained from historical ecology) in order to restore natural areas. Understanding historical biodiversity, management, and local patterns of genetic diversity, including those promoted by indigenous communities, is important in this process. Severe disruption of indigenous resource management systems can have far-reaching effects on biological diversity.

A major feature of traditional ecological knowledge is its holistic nature. It has been described as "a system of knowledge production grounded in the cohesiveness of the human, natural and spiritual world" (Semali & Kincheloe, 1999 p.42). As Posey has reminded us, these links between life, land and society may be referred to as a "sacred balance". Thus, Posey has noted that "[indigenous] knowledge of the environment . . . depends not only on the relationship between humans and nature, but also between the visible world and the invisible spirit world" (p.28), something that becomes clear in any examination of the resource management tools of indigenous peoples.

'Ethnobotany' is a term used by scientists and anthropologists to describe the relationships between people and plants and, in particular, the utilisation of plants by people. It is concerned with "how plants are cultivated and harvested and their sustainable use" (Given & Harris, 1994 p.5). This term has been criticised as failing to acknowledge the unique role of the spiritual aspects of a culture (also see Berkes, 1999 pp. 38ff. for further discussion of the intellectual roots of ethnoscience). Given & Harris have, however, recognised the spiritual and cultural dimension implicit in many aspects of traditional use (Given & Harris, 1994 p.11[21]). Traditional ecological knowledge extends to knowledge of plants, animals and all other resources, both animate and inanimate. In the context of this research, ethnobotany is, however, an appropriate term because of the specific focus on a plant, harakeke.

In many societies, older people frequently hold detailed knowledge. An "expert elder" system may operate, in which specific individuals (selected from a young age) or specific families may be the predominant guardians of certain types of

[21] See Viergever (1999) and Posey (2002) for discussions of the ongoing debate over terminology.

knowledge; this has certainly been the case in New Zealand. It has been a basic tenet of Māori society that 'higher' levels of sacred knowledge should be shared only with suitable students who have served a long apprenticeship and shown themselves worthy to hold such knowledge (see, for example, Beattie, 1939 p.67 and p.70; Buck, 1950 p.476; Marsden & Henare, 1992 pp.4-5). The entry of Māori weavers into the *whare pora* is an indication that weavers were recognised experts in Māori society, and that this kind of system operated with regard to weaving knowledge. Because most weavers are women, weaving knowledge has tended to be asymmetric between the sexes, although care and management of harakeke appears to have been carried out by both sexes.

1.3.2 Transmission and storage of traditional ecological knowledge

Chief Robert Wavey (1995, p.13), from the Fox Lake Nation in Canada, described the transmission of knowledge and its benefits in his own area of Manitoba as follows:

> The forest is the First Nations homeland. . . . The boreal forest provides considerable direct economic value to the communities, values which are largely invisible to resource developers, mangers and politicians. In addition to the teaching of skills, each elder maintains continuity and links to the community resource area by transferring a highly detailed oral "map" and inventory of resource values and land use locations. These individuals and family maps knit together into a rich and complete mosaic which provides integrated knowledge of the ecosystems within the community's traditional resource area.

In his view, stewardship of resources and use of resources are closely tied together. Without direct links to the land, information about location, movements, and other factors explaining spatial patterns and timing in the ecosystem, including sequences of events, cycles and trends may become obsolete (Posey, 2002). Both elders and the younger family members to whom such knowledge will be passed must maintain such links. Furthermore, as families often hold complementary knowledge and may be interdependent in their resource use requirements, traditional ecological knowledge transmission and maintenance can

quickly become fragmented if the community becomes fragmented. Continuity of resource use practices is an essential element in its transmission, and the understanding and research of resource management in traditional communities and cultures therefore poses greater challenges where resource use has drastically altered, or been interrupted, as has been the case for Māori.

The decline of traditional systems of knowledge has variously been attributed to changes in technology, commercialisation, pressure from population growth, breakdown of traditional land tenure systems and loss of control over these lands and resources, and changes in world view among other things (Berkes et al., 1995; Zent, 1999) or, put more simply, acculturation. All of these issues can be identified within the colonisation process in New Zealand that began in the late 18th century and accelerated in the 19th century.

There is strong contemporary interest in traditional ecological knowledge around the world, perhaps increasingly so as researchers have become aware of the large amount of knowledge being lost. However, an emerging concern is the dissociation of indigenous knowledge from the people to whom it belongs, severing it from its cultural connections, particularly when archived and classified in Western databases. This has been called ex-situ conservation (Agrawal, 1995; Macedo, 1999) or extractive conservation (Zent, 1999) and is identified as generally only useful as a 'rescue mission' where there is no longer a vital culture (Given & Harris, 1994 p.9). Worse, indigenous people may not be able to access such collections, including collections of genetic material, and concerns have been raised about the problems involved in tracking and controlling the successive use of these collections (Laird & ten Kate, 2002 p.269). Indigenous peoples themselves prefer initiatives and research that revive or strengthen traditional skills and associated resource use, and, where possible, enhance that use through modern scientific methods (Given & Harris, 1994 p.9).

1.3.3 Modern applications of traditional ecological knowledge

Current research into resource management by indigenous peoples examines practices and systems as diverse as Arctic peoples' management of traditional resources (Kendrick & Lyver, 2005) and the use of fire to manage ecosystems in

the Philippines (Masipiquena, Persoon & Snelder, 2000). Much of the research on traditional ecological knowledge appears to be focused on providing input to government resource management strategies and to environmental assessments of risk. For example, Duerden & Kuhn (1998) examined the application of traditional ecological knowledge to land and resource management in the Canadian north. However, the removal of traditional ecological knowledge from its cultural context and insertion into another management framework may lead to the benefits of such knowledge being skewed towards the dominant culture (Doubleday, 1995).

On the other hand, Huntington & Mymrin (2001) have emphasised that traditional ecological knowledge research "also helps communities realize their own expertise, and apply their own knowledge and practices to help protect their way of life" thereby acting as a positive tool for those communities. The need to respect, preserve and maintain indigenous knowledge, especially that relevant for the conservation and sustainable use of biological diversity, was also recognised at the 1992 Convention on Biological Diversity in Article 8(j) which required Member States:

> Subject to . . . national legislation, [to] respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote the wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilisation of such knowledge, innovations and practices.

1.3.4 Traditional ecological knowledge in the New Zealand context

Polynesian and Māori history is a voyaging history notable for the sequential colonisation of islands throughout the Pacific Ocean over hundreds of years. Māori traditional ecological knowledge is therefore based not only on around 1000 years of specific experience in New Zealand (Davidson, 1984; Finney, 1994 p.71), but also on experience with many closely related species of plants and

animals throughout the Pacific. Māori weaving techniques and the use of different resources for different purposes have been influenced by this collective experience. The use of tī (*Cordyline australis*) to weave *kete kai*, and the use of fire to singe the cuticle of plants (and thus soften them for weaving) are examples of practices used by both Māori and other Polynesian weavers. However, Māori have also developed specific new techniques based on increasing ecological knowledge in New Zealand, such as using *whatu* to weave dress cloaks in response to the non-availability of aute for clothing (Buck, 1950 p.63), and preserving birds in their own fat (Buck, 1950 p.102).

In common with all other cultures that are indigenous to a particular place, Māori have developed a corpus of detailed environmental knowledge. We might, therefore, expect that there is a substantial body of knowledge relating to plants utilised in weaving (and, in particular, relating to harakeke) as these have traditionally supplied the raw materials for clothing and other essential woven items (such as nets, bedding and many types of container). Because of the significance of harakeke to Māori, and particularly to Māori weavers, I hypothesised that Māori elders would hold considerable knowledge about harakeke, both in terms of philosophical understanding and historical and ecological knowledge, and that Māori have actively managed harakeke based on this type of knowledge. Experience and transmission from one generation to the next are essential elements of traditional ecological knowledge, and many aspects of traditional ecological knowledge within New Zealand have undergone breaks in continuity of experience, primarily because of the effects of colonisation over the last 200 years.

Knowledge gaps can be difficult to fill. Thus, although harakeke continues to be abundant in some areas and available for weavers to harvest, knowledge of harvesting methods, the differences between varieties, and management practices has fluctuated, particularly over the last 100 years. Many harakeke swamps have been drained for farming throughout the country and the harakeke burned or destroyed, along with associated use and knowledge. This kind of loss is not restricted to harakeke: other customary use plant and animal species are either prohibited or severely restricted for weaving use. These include, for example,

pīngao (*Desmoschoenus spiralis*), a valued weaving fibre, and the barks from trees such as tānekaha (*Phyllocladus trichomanoides*) which are used for dyeing. Some resources, such as the native bird feathers traditionally used for cloak making, have become generally unavailable: legislative prohibitions prevent the harvest of native species primarily because many have become scarce or endangered. Weaving resources and their availability have therefore changed considerably over the last 100 years. These issues have repercussions for the maintenance of cultural integrity. Because of processes of colonisation, migration and other factors, the transition of knowledge through the generations has not been complete. For this reason, a critical analysis of historical documents is an essential part of the recovery of traditional knowledge.

1.3.5 A Māori world view relating to environmental management

Although many Māori identify tribally (by iwi) rather than as a homogenous group, a core set of values, which are common to all iwi, are identifiable. Such values stem from cultural conceptualisations of what reality is perceived to be (Marsden & Henare, 1992 p.3). These values and beliefs can be termed a 'world view' and form an essential underlying element of the management of resources by indigenous peoples.

So far as Māori are concerned, what has been referred to as a 'world view' can also be expressed in terms of the Māori concept of *tikanga*. Matunga (1995, p.26) suggested one interpretation of *tikanga*, in its most fundamental sense, is what is "correct and right, normal and usual", while Marsden & Henare (1992, p.17) translated *tikanga* simply as "Māori custom". Norms, rituals and protocols, and the moral principles, beliefs or standards held by iwi, hapū and whānau are central to guiding behaviour (Matunga 1995, p.26; Kawharu, 1998 p.20; Hodges, 1994). *Tikanga* is therefore at the core of any Māori resource use or conservation ethic.

Hodges (1994, p.6) has clarified the distinction between the Māori terms *ritenga* and *tikanga*, describing *ritenga* and *kawa* as the set of processes and protocols by which *tikanga* is applied. He explained that *ritenga* and *kawa* are the dynamic processes that allow Māori to apply *tikanga* to *taonga* in order to arrive at an ethic for conservation. Because they are not fixed, *ritenga* and *kawa* allow Māori to

take advantage of new technologies for the use, development and conservation of *taonga*. Traditional *ritenga* are referred to in this thesis as "resource management strategies and practices".

1.3.6 Traditional ecological knowledge and western science

Science and indigenous knowledge are often seen as diametrically opposed in terms of philosophy and methodology. For example, science knowledge is often associated with positivism, which is generally hostile to the supposed existence of things that can be neither seen nor heard (Burns, 2000 p.7). Cunningham (1998) has cautioned that modern science attempts to codify Māori knowledge in terms of western scientific branches and disciplines, treating it as scientific data and divorcing these data from an holistic analysis. On the other hand, traditional ecological knowledge and a western scientific paradigm can also be regarded as distinct but not altogether dissimilar (Roberts, 1996). Traditional ecological knowledge allows people to theorise about the environment, as can be seen in the following letter by Te Wehi (1874) who considered why the birds are disappearing:

> I nāianei kua kore te manu, kua mate kua ngaro te kaka me te kakariki. Ka matau ahau ka toru nga nanakia o te ngahere nana i huna i ngaro ai nga manu. Te tuatahi, ko ngeru raua ko kiore-hawaiki; na ratou i kai nga kuao a ngā manu ki roto ki o ratou kohanga me o ratou rua. Ko te tokotoru o nga nanakia he pi-ngaro." [22]

Nor was Te Wehi alone in his thinking. For example, a letter from Hapurona Tohikura to Te Waka Maori o Niu Tirani (1873) also outlined concerns at the disappearance of many species, and pinpointed introduced species as the root of this problem.

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[22] The published English translation is "In the present day the birds are but few, and the kākā and the kākāriki have almost disappeared. In my opinion there are three pests of the forest which are destroying the birds. First, the cat and the rat, which eat the young birds in the nests and holes (of the trees). The third pest is the honey-bee."

Science can be regarded as the acquisition of knowledge based on careful observation and experimental tests of theory (Balick & Cox, 1996 p.3). The similarity of methodology used by the scientific community and traditional ecological managers can be seen in these letters written by Māori in the 19th century. The letter writers have formulated their hypotheses based on prior ecological knowledge of fauna and flora followed by close observation of the changing conditions, that is, within the context of traditional ecological knowledge.

Traditional ecological knowledge and western scientific knowledge can also combine to create 'best practice' management techniques, within bicultural partnerships (see, for example, Moller, 1996). Numerous situations now arise where this combination may be useful (see, for example, Joyal, 1994; Moller et al., 2004; Newman & Moller, 2005). For example, sustainable harvesting of species using different 'non-traditional' technology, combating invasive pests, and restoring environments are current concerns in New Zealand. Additionally, habitat loss remains an ongoing issue if many species, with their local variants, are not to become extinct. Both indigenous knowledge and modern ecological research can contribute to understanding underlying causes and effects. Put another way, it can be argued that future knowledge stems from past knowledge but also takes into account predictions concerning future environmental conditions. That is, it recognises a contemporary world view including the effects of social and cultural diversity (Cunningham, 1998).

Societies around the world have developed practices based on their ecological knowledge that act as regulatory mechanisms. However, in developed societies such as ours, greater mobility, more effective hunting or harvesting techniques and better storage facilities have led to greater harvest of some species (Lyver, 2000). Modern resource management studies can therefore be important monitoring tools to ensure viable harvesting of species. In some cases, this will help ensure the persistence of populations and a continuing harvest (such as in the case of the tītī (*Puffinus griseus*) (Lyver, 2000; Newman & Moller, 2005). For other species, it may encourage the trialling of alternative harvesting options. If we begin from a premise that a *kaitiaki*'s first responsibility is to the resource, it

follows that any knowledge that will help sustain that resource (including western scientific knowledge) is likely to be of interest[23].

The invasion of exotic organisms is another global concern. Wavey (1995) considered that where there has been severe modification of the environment (for example, by predators), additional methods are more likely to be needed in conjunction with traditional ecological knowledge. He argued that in Manitoba, Canada, for example, the need to link traditional resource management systems and science-based environmental technologies has increased in areas which have been ecologically disrupted. In New Zealand, birds such as the kiwi evolved for over 80 million years without mammalian predators. The arrival of such predators placed these species in a highly vulnerable position (Holdaway, 1989; King, 1989). The first of these predators, introduced by Māori, was the kiore (*Rattus exulans*). Kiore were followed by many other predators which arrived with Pākehā, such as mustelids (stoats and ferrets; *Mustela erminea* and *Mustela furo*), two additional rat species (*Rattus rattus* and *Rattus norvegicus*), and possums (*Trichosurus vulpecula*). New Zealand now hosts a wide array of introduced pests that have had devastating effects on many native plants and animals, signalling that a high level of intervention is required. It is thought that at least 14 species and sub-species of birds alone are now threatened by predation from introduced mammals (Innes & Hay, 1991). Other animals and plants have likewise been affected. The development of control methods for invasive species has become an important research area in New Zealand, and some recent studies demonstrate that this can be accomplished in conjunction with indigenous priorities. For example, Ngāi Tahu has expressed enthusiasm to work in a way which combines restorative management, indigenous knowledge and modern ecological research: the revitalisation of mainland colonies of tītī using predator control as a key technique is now underway (Jones, Moller & Ellison, 1997).

Environmental restoration initiates or accelerates the recovery of past ecosystems that have been degraded, damaged, or destroyed (SER Primer on Ecological Restoration, 2004). Important factors to consider in restoration projects include

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[23] This does not, of course, invalidate the application of appropriate *ritenga*.

form (species composition and community structure), function, physical environment (such as soils, salinity and fire regime) and landscape integration (for example, the removal of pests) (Society for Ecological Restoration International Science & Policy Working Group, 2004). Thus, environmental restoration requires detailed knowledge of past processes and ecological parameters to create an historical reference ecosystem. Although historical authenticity is impossible to achieve, knowledge of historical reference systems promotes appropriate decision-making in terms of the planned species composition, biodiversity, succession trajectory and management interventions in relation to the restoration project. Historical ecological research provides information about reference ecosystems, including some of the original species, historical processes and management events: indigenous knowledge can provide information on, for example, species previously present on degraded sites, local conditions, and cultural site values (see, for example, Joyal, 1994; Anderson, 1996). An urban ecological project in Hamilton at Waiwhakareke (Horseshoe Lake) is one local example of a restoration project which combines Māori knowledge of the past local environment with modern ecological restoration expertise in a severely degraded habitat (Clarkson & McQueen, 2004). This research project attempts to visualise the past human-plant ecological relationship for one culturally important plant species, harakeke.

1.4 Background to the research

The motivation for this research arose, in part, out of discussions within my own extended Māori whānau (through marriage) about the loss of weaving skills. My mother-in law had often talked about her childhood experiences, growing up with her extended whānau at Aotea harbour near Kāwhia[24]. There, she helped her grandmothers with the collection of plants for dyeing and weaving. After leaving home at around fifteen years of age, however, she ceased to be involved in learning these skills. It became clear to me that she, and others, knew many stories about weaving and harakeke which were likely to be of great interest not

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[24] A number of iwi are represented in this district, including Ngāti Te Wehi at Okapu and other pā around Aotea harbour; and Ngāti Hikairo, Ngāti Mahuta, Ngāti Maniapoto and others around Kāwhia.

only to her family and hapū, but also to others. Furthermore, there was the very real possibility that many of these stories (and the associated knowledge) would be lost to the whānau. Thus, my own daughters, and their cousins, might be denied the opportunity of sharing in their ancestral knowledge and of passing that knowledge on to the next generation. This thesis aims to record some of these stories, and to place them in a broader context of Māori resource use and management of harakeke. It is intended as a small contribution to the understanding, maintenance and development of one aspect of Māori weaving, that is, the management of resources. Furthermore, I hope to make a contribution to ensuring the health of traditional knowledge of harakeke within our family area by providing information which can inform future directions. For this reason, information about the patterns of resource use in Kāwhia and southern Aotea harbour, and also parts of Northland, has been included where possible.

Discussions with whānau revealed that there had been enormous changes in the natural resources of the area over time. Much of the bush has gone from Kāwhia in the last one hundred and fifty years (Leathwick, Clarkson & Whaley, 1995), there has been a dramatic increase in both farmland and forestry, and many of the weaving resources have therefore also disappeared. Northland has also largely been converted to farmland and forestry over many years. This problem appears to be widespread: many different weaving whānau in different areas of the country have been affected by it.

During a symposium for weavers in 1993, Te Aue Davis said:

> [Twenty years ago] we never thought that the harakeke would be one of those plants that we would not be able to get hold of - or the pingao, or any of the other things used for our work.
>
> But suddenly, people all over the country are weaving. They are beginning to realise that 'hello', where my grandmother used to go and gather harakeke, it's no longer there. There's no more there. That went on right around the country, and we decided, right, we will do something about that ourselves. So we went around and we planted flax. . . . In some areas where there has been enough surplus land around they are planting totara trees. . . . The

> marae are planting different varieties of harakeke . . . some of them you can get fibre from, some of them you can't. Some are short. Some are long. We planted all those varieties for their different uses (Brown & Maihi, 1993).

As this quote reveals, expert weavers have long been aware of many of the resource issues associated with weaving and have proposed a range of responses to these issues, responses that have been disseminated at weaving hui over the years. Even so, many of the problems remain and many whānau, my own included, are still in danger of losing both traditional knowledge and resources. There are many reasons for this: whānau may have become scattered; their lands may have reduced in size and type. Although the loss of traditional weaving resources is only one of many factors that have impacted negatively on the traditional skills involved in Māori weaving, it remains a significant one, and one that needs to be addressed.

1.5 Research hypotheses and aims

McBreen et al. (2003) have described the current distribution of harakeke as largely restricted to highly disturbed or exposed areas, and those unsuitable for conversion to agriculture, although they observed that harakeke is able to occupy a variety of habitats. However, given the changing landscape in New Zealand over the last 200 years, the historical distribution of harakeke, as experienced by Māori, may have been quite different. Furthermore, because of its role as an essential weaving resource, Māori may have actively managed harakeke in a number of ways, in turn affecting its natural distribution.

The focus of this thesis is the historical management of harakeke by Māori, and as such, the use of harakeke by Māori for weaving purposes is of particular importance. Underlying this research are two main, inter-related hypotheses. These are that:

i) harakeke has been actively managed by Māori as a weaving fibre; and

ii) active management of harakeke by Māori has modified the New Zealand landscape.

To investigate these hypotheses requires exploration of the body of ecological knowledge held by Māori in relation to harakeke. The reconstruction of knowledge about historical management of harakeke by Māori is crucial. That reconstruction involves both oral sources and late 18th to early 20th century literature. As well, I attempt to quantify the distribution and likely occurrence of harakeke in relation to environmental parameters and thus to determine whether changes from expected natural distributions may have occurred.

In relation to these aims, the overall objective is to encourage discussion and debate within Māori communities and to provide Māori weavers with information that is of value in understanding past resource management strategies and determining future ones. Because the thesis itself may not be readily available to Māori communities, posters outlining the main findings have also been prepared for distribution (see *Appendix 2*).

1.6 Subsidiary questions

Arising out of the primary research hypotheses are a range of more specific, subsidiary questions. These subsidiary research questions are:

i) What was the extent of harakeke cultivation by Māori prior to the early 20th century?

ii) To what extent did Māori actively transport harakeke?

iii) How did Māori use of harakeke contribute to active management of this species?

iv) What were the main methods of cultivation and management by Māori?

v) What was the role of fire in historical resource management of harakeke?

vi) What are the main environmental parameters predicting harakeke occurrence?

vii) Can changes in distribution from the expected occurrence of harakeke be identified?

1.7 Outline of the research (scope of the study)

A critical analysis of oral sources to provide direction on critical issues (including semi-structured interviews conducted as part of this research project) is included in *Chapter 3*. Particular emphasis is placed on the Northland and southern Aotea harbour areas. As well, an analysis of ecological information in ancestral sayings or *whakataukī* relating to harakeke is presented. The research questions are then addressed in a critical analysis of historical sources - see *Chapters 4* and *5*. An analysis of environmental parameters in relation to both harakeke and wharariki, and a predictive map of probable natural occurrence for harakeke in northern New Zealand are presented in *Chapter 6*. *Chapter 7* considers the lines of evidence identified in *Chapters 1 – 6* in relation to the hypothesis of active harakeke management by Māori. The possible effects of Māori management of harakeke on the historical New Zealand landscape are discussed. I conclude the thesis with a discussion of the limitations of the research and suggestions for future research.

In this thesis, common Māori words are used in the text without further explanation. However, a glossary is provided for those readers who are unfamiliar with the vocabulary used. Māori words which may not be immediately understood by the reader are also italicised. However, italics are not used for Māori words in quoted material unless they are already marked in this way by the writers themselves. Macrons are used throughout the thesis to indicate correct Māori spelling, but are omitted in direct quotations where writers have themselves omitted them, or speakers indicated a preference to omit them.

Harakeke cultivar names are likewise italicised to avoid confusion, as these will be new to the majority of readers, but the common names harakeke and wharariki, used for *Phormium tenax* and *Phormium cookianum* respectively, are not. Scientific names for plants and animals are supplied on the first mention in the thesis, and a glossary of scientific and Māori names is provided. Māori plant and animal names which are commonly used are not italicised in the text.

Chapter 2 Research methods

Ko taku rourou ko tou rourou ka ora te iwi[25]

2.1 The research framework

I observed in *Chapter 1* that I came to this topic through my personal interest in weaving, my family relationships, and my training as a scientific researcher. The research methods in turn reflect these cultural, scientific and historical contexts. That is, a multidisciplinary approach is used to analyse information, evaluate data and test the hypotheses. These methods are:

- **(i)** interviews with some expert weavers and *kaumātua*, focussing on the Waikato and Northland areas;
- **(ii)** analysis of *whakataukī* for information about ecology and historical resource management of harakeke;
- **(iii)** critical analysis of historical publications, records and documents, including archival material from the National Archives and other library resources;
- **(iv)** examination of archaeological records for evidence of harakeke at pā sites;
- **(v)** examination of herbarium records, and analysis of climatological and other environmental variables in relation to harakeke and wharariki to model predictive maps of natural distributions[26].

The collection of evidence from a variety of sources and the use of a variety of techniques provides a form of data 'triangulation' which increases the validity and reliability of conclusions.

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[25] This can be translated as 'With your contribution, and mine, the wellbeing of the people is assured'. An ancestral saying commonly heard in Māori communities.

[26] The methods associated with predictive mapping and the analysis of environmental parameters are outlined in detail in *Chapter 6*.

The research hypotheses are centred on *past* management of harakeke by Māori (particularly in the 19th century) and so direct experimentation to test the hypotheses is not possible. Even so, as demonstrated above, data about past harakeke management can be gathered and analysed through a number of different approaches. Some of these have proved to be more productive than others.

Qualitative research helps us to interpret, contextualise and understand the perspectives of others (Barton & Lazarsfeld, 1969). It can uncover normative patterns, something that is particularly useful where there is a lack of quantitative data, or very little preliminary data about a topic. Because it tends to be inductive rather than deductive, hypotheses may *follow* the accumulation of data, as the researcher attempts to make sense of it. Even so, the analysis must be logical, descriptive and analytic in its presentation of the evidence (Burns, 2000 p.491). Quantitative data, on the other hand, can specifically identify significant events or findings, indicate trends which may be anti-intuitive or unusual, and provide evidence which is not part of human memory (Burns, 2000 p.394). For example, a close examination of harakeke ecological parameters provides specific information on the natural distribution of the species.

Qualitative research often has a more diverse audience than does quantitative (Burns, 2000 p.492). This is certainly the case here. This research project explores aspects of the relationship between harakeke and Māori. The cultural context, therefore, provides resonance and understanding of aspects of this ecological relationship. Critical review of historical sources, and the evaluation of oral sources, both tending to be qualitative in nature, can help to inform Māori (especially those with an interest in harakeke) about aspects of the research findings relevant to their own concerns. To address this issue, I have included two different examples of posters presenting some of the findings of this thesis, the aim being to increase their availability to Māori communities (see *Appendix 2*).

The methods, and some of the issues associated with historical research are discussed in *Sections 2.2* and *2.3*. Critical review and evaluation of historical documents is a commonly employed historical research method. This can reveal, for

example, gender and cultural biases which may be of very real significance in the case of pre-literate peoples. Oral tradition is discussed in *Section 2.4.* Many indigenous cultures, including that of Māori, have strong oral traditions which support the retention of past knowledge. The evaluation of oral sources can therefore contribute to critical themes and issues, and can also provide data about past events. Scientific techniques which provide quantitative data concerning past harakeke distribution and environmental parameters are presented in *Chapter 6*, as the data is easier to interpret with the methodology close to hand (*Section 6.2*). Both quantitative and qualitative analyses are valuable in the context of this research project.

2.2 Historical research

Historical research has been defined as the systematic and objective location, evaluation and synthesis of evidence in order to establish facts and draw conclusions about past events (Borg, 1963). It is therefore subject to the same principles of validity and reliability that characterise all scientific endeavours (Burns, 2000 p.481). However, because the events to which reference is made have already happened, variables cannot be manipulated, and observation relies on the documents of others. Several types of historical data sources can be used for historical research: documents and quantitative records, oral records, and artefacts (Burns, 2000 p.485). Borg (1963) has observed that without specific hypotheses, there is little chance of extracting from the available documents a body of data that can be synthesised to provide new knowledge or new understanding. The function of a literature review in historical research is different from that involved in other disciplines in that it provides the data for the research; the researchers' acceptance (or otherwise) of specific hypotheses will depend on their selection of information from the review and the interpretation they put on it (Cohen et al., 2000 pp.161-2). The systematic collection and objective evaluation of data relating to past occurrences, in this case the historical management of harakeke by Māori, provides data which will contribute to assessment of the accuracy of the hypotheses.

Historical criticism, or the evaluation of historical data, is usually done in two stages: first, appraisal of the authenticity of the source (external criticism); and secondly evaluation of the accuracy or worth of the data (internal criticism) (Platt,

1981). In cross-cultural research, internal criticism is paramount. As Hockett (1955) has observed, those whose observations the researcher must depend upon will generally be untrained observers. This is the case with much of the historical information analysed in this research project (see *Chapters 4* and *5*). Factors that might affect the accuracy of the evidence include attitudes towards the subject (antipathy, sympathy etc), and extent of agreement with other independent witnesses. Many documents are written with a specific audience in mind, for a specific purpose. Many are, therefore, deliberately edited before issue. An example of this is the provision of written information to potential settlers of New Zealand in the 19th century, often describing conditions, export opportunities and so on, in superlative terms. These documents include publications which described in glowing terms the potential of the flax industry to potential settlers. Many publications, letters, and other documents about harakeke from the 19th century are inextricably linked to Pākehā aspirations to commercialise the extraction of fibre from the leaf. It is therefore apparent that historical research must evaluate the truthfulness of reports.

2.2.1 New Zealand sources: A broad classification

Cheeseman (1925, p.1) separated what he called 'the history of botanical discovery' in New Zealand into three main eras, the first beginning in 1769. He called the first period (from 1769 to 1840), 'the period of investigation of visitors from overseas', and the second period (from around 1840 to the 1920s), a period of investigation by 'resident naturalists'. The third period, that of scientific method and experimentation, produced increasingly experimental scientific work (reviewed in *Chapter 1*). This broad categorisation can also be applied to the ethnological historical literature. I have called the first period the '***pioneer*** period' as most writers from the period up to around the 1830s were outside observers of Māori life in particular. The second period I have called the '***establishment*** period', which continues up to around the 1920s, and mainly consists of writings by resident Pākehā and Māori New Zealanders, who provide more detailed observations of Māori practices than earlier writers. The third, or '***contemporary*** period', refers to work published from around the 1930s onward. Generally, there has been a dearth of information about weaving and harakeke during much of the 20th century, although a revival in the latter part of the 20th

century has been most welcome. Most of the writings from the contemporary period reflect the oral tradition which has handed down information about weaving and *tikanga* to practicing weavers. In the first part of the thesis, my focus is on the retrieval of information from the oral tradition, followed by written information relating to resource use and management from the19th century.

A number of early visitors to New Zealand in the pioneer period made observations in diaries, journals and letters, mainly describing life in the first half of the 19th century. This group includes Cruise (1957[27]), Bidwill (1952[28]), Savage (1966[29]), Polack (1976[30]) and Dieffenbach (1843). Binney (1997) observed that texts that refer to other cultures, such as these sources, generally record what is strange or unexpected from the perspective of the writer's own society or community (which provides the political, cultural and social norms).

The establishment period saw a later group of mainly Pākehā New Zealand writers (who could perhaps be described as 'resident ethnographers') demonstrate their keen interest in ethnography in late 19th and early 20th century publications. Colenso (see, for example, 1868b, 1881, 1891), Beattie (see, for example, 1939, 1994a, 1994b) and Best (see, for example, 1898a, 1898b, 1908) were part of this group. Botanists such as Cheeseman (1896, 1900), Kirk (1870) and Hector (1889) also referred, at times, to Māori knowledge of the biota, as well as providing detail about plant characteristics, habitats, distributions, and so on. The period includes field work carried out during the early part of the 20th century by the Māori ethnographers Makereti and Buck (Te Rangi Hiroa).

Some of the material, and ethnographic material in particular, was published long after the research took place, or has since been republished, so that publication dates can be misleading in terms of the time period to which the documents belong. For example, Best's *Forest Lore of the Maori* was published in 1942, and

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[27] First published 1823.

[28] First published 1841.

[29] First published 1807.

[30] First published 1840.

republished in 1977, although the work was undertaken around the turn of the 20th century. Evidence from the 19th and early 20th century literature is examined in this chapter and critically analysed along with other historical material for clues relating to Māori experience and knowledge of harakeke.

2.2.2 Archaeological records: (lack of) evidence of harakeke

Archaeologists record evidence of previous occupation through time, including middens (rubbish heaps), evidence of structures including fences and housing posts, pits (often used for storing food) and so forth. Artefacts, or *taonga*, are an important source of historical information for the researcher. However, although the remains of some early cloaks have been found, as have some implements such as mussel shells that are likely to have been used for weaving purposes, it is difficult to make assessments of resource management based on this kind of evidence. More potentially useful are records of cultivations, such as karaka (*Corynocarpus laevigatus*) trees, near pā sites.

To ascertain what archaeological records exist which refer to harakeke, I contacted the file keeper for the Central Index of New Zealand Archaeological Sites (CINZAS) database (administered by the Department of Conservation). This database contains more than 53,000 electronic records, including 11,251 of pā and pit site locations. These records are maintained by the national file keeper in the head office of the Department of Conservation, while regional records are also available through district offices in some cases. A search of the CINZAS database for evidence of harakeke near pā sites proved unproductive: the occurrence of harakeke is not generally recorded by archaeologists (T. Walton, pers. comm. 4.10.04). None of the file keepers from head office, Taranaki or Waikato were able to supply records of harakeke, or *pā harakeke*[31]. Evidence of harakeke cultivation is either unrecorded or inaccessible.

2.3 Critical analysis of historical publications, records and documents

There are many problems associated with the historical texts which form the basis for an enquiry into Māori knowledge and experience of harakeke in the 19th

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[31] I would particularly like to thank Tony Walton and Owen Wilkes for their assistance.

century and earlier. Williams (2001) has argued that Crown policy on the preservation of Māori knowledge was generally indifference, apathy or active challenge. Thus, the transmission of cultural knowledge became fragmented and incomplete, replacing the coherent and intensive transmission from one generation to the next characteristic of the *whare wānanga* (Williams, 2001 p.217)[32]. Moreover, implicit cultural judgments about the relative value of different kinds of knowledge influenced what was recorded and how it was interpreted. Reilly (1989, 1990, 1995) has discussed the contributions of John White and Elsdon Best in relation to their limitations as well as their strengths[33]. McRae (1991, p.15) observed that John White began collecting information in the 1840s and acquired information by writing to elders with specific questions. The Māori knowledge he obtained was therefore pre-selected according to his own interests and ideas. Furthermore, White, and many others, frequently failed to record information according to tribal area or informant, so that details have less value than would otherwise be the case. In a similar vein, although the ethnographic work of Elsdon Best is of considerable value, Best actually neglected to preserve the original material of *tōhunga* Te Matorohanga, which was written down at a specially convened *wānanga* or gathering. What remains for posterity in Best's notes are only fragments of Te Matorohanga's works (Williams, 2001, p.224).

Limitations placed on the knowledge imparted to ethnographers and others must also be considered in relation to the customs of the people concerned. Māori knowledge has never been universally available (Walker, 1992). Māori consider knowledge valuable and have therefore generally ensured that it is protected and used appropriately. For these reasons, omissions or misleading statements are not uncommon (Pere, 1991; Royal, 1992 p.26 and p.30). This raises questions about many historical documents and publications which purport to record Māori customs and beliefs, including for example, Best's works (1898b, 1942, 1972[34]).

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[32] Williams did, however, note that there was also an element of Crown policy that did seek to preserve Māori knowledge, albeit within the context of evolutionary and racial ideas of the time.

[33] Detailed biographical information and context about many of the ethnographers from the 19th century can also be found in Yates-Smith (1998).

[34] First published 1925.

In spite of these limitations, written historical documents are invaluable in providing clues to cultural knowledge held by Māori.

Māori writers are represented in the Māori newspapers, published letters and other manuscripts held in private collections. The Māori Land Court records are another source of information, although there are problems, for example, with representation and accuracy of translation. Many *tōhunga* or experts spoke at the Land Courts in the 19th and 20th century, and much of this knowledge may otherwise have been lost. McRae (1991) has observed that Māori became a written language in 1815, arguing that by the 1850s many Māori recognised that writing was a necessary means of preserving traditional knowledge. The creation of personal manuscripts and other documents from this era, many still in family hands, testifies to this. Māori newspapers also flourished through much of the late 19th century and early 20th century. Newspapers under Māori control, such as *Te Toa Takitini* (1921-1937), published *waiata* and *whakataukī*. However, the cultural knowledge held by Māori women has been poorly documented, and our knowledge of traditional practices has suffered as a result. Of the early ethnographers, only Best, Beattie and Shortland are recorded as having female informants (Yates-Smith, 1998 p.27). Because Māori women have generally been the weavers, holding a great deal of knowledge concerning harakeke, this is of particular concern here.

Both the pioneer and the establishment period are characterised by a lack of direct information on resources and their use. It was not possible, for example, to find writings by Māori weavers which related directly to the management of harakeke. However, historical information on harakeke from documents produced in relation to the flax industry, letters to the Māori newspapers of the time and other observations of life allow for inferences about resource management during the 19th century.

This research focuses on the recovery and analysis of information about harakeke management from the pioneer and establishment periods of New Zealand. It also discusses the evidence revealed in the light of contemporary written records of traditional resource use and management, records that have been passed down

through oral tradition. These tend to have been written by, and collected by, women. In general, the contemporary literature falls into three main groups. The first group consists of books written by weavers, such as those on piupiu weaving (Hopa, 1971), cloak making (Te Kanawa, 1992) and a range of weaving techniques and plant identification (Puketapu-Hetet, 1989). A second group consists of biographies and recollections by elders. Examples include those of Tainui elder Heeni Wharemaru (Wharemaru & Duffie, 1997), expert weaver Rangimarie Hetet (Paki-Titi, 1998) and King Koroki (Kirkwood, 1999). A third group comprises items such as exhibition catalogues and commentaries on weavers' hui as well as booklets commemorating marae openings which sometimes include details relevant to resource use and management (see, for example, University of Auckland, 1988; Catalogue published to accompany the exhibition *Ngā Puna Roimata o Te Arawa*, 1993). Additionally, I have attempted to trace videos and other recordings of weavers either demonstrating or talking about their art (such as segments from programmes such as *Marae*, *Koha* and from programmes including the Radio New Zealand Sound Archives which feature expert weavers such as Emily Schuster). These publications provide a context for discussion.

2.4 Oral traditions

Historical knowledge can be retrieved not only through contemporary analysis of past documents, but also through understanding oral tradition. Binney (1987), in a discussion of the historical process involved in writing the life of Te Kooti Te Arikirangi, distinguished between two forms of history-telling. The first she called the written narrative of the 'coloniser', the second the oral narrative of Māori. Oral traditions are generally of primary importance in indigenous cultures, taking the form of *pūrakau* (myths) and other narratives, *whakataukī* (proverbs), *waiata* (songs), and *pepeha* (sayings). *Waiata* and *karakia* have been described as "reliable indicators of traditional concepts" because they rarely change (Yates-Smith, 1998 p.26), and this description can be generalised to other forms of oral tradition.

Reilly (1995) has argued that the production of 'Maori history' must recognise the maintenance of traditional knowledge in written texts (also see Binney, 1987). In

this research project, records of *whakataukī* (ancestral sayings) from the oral tradition have been particularly valuable[35].

Many examples of oral traditions are still extant today in Māori communities. Legends, and what are sometimes referred to as 'myths', are examples of traditional narrative forms which are seen as "an integral part of the corpus of fundamental knowledge held by the philosophers and seers of the Maori . . . from ancient times" (Marsden & Henare, 1992 pp.2-3)[36]. Kawharu (1998, p.18) has argued that myth messages have played a vital role in shaping the ways in which hapū interact with their surroundings. Because this narrative form is structured by *whakapapa* (where particular gods have responsibilities of management over particular domains), it instils a sense of order and logic into the way things have been, are now and ought to be in the future. In doing so, it indicates why matters of resource management are spiritually important. Traditional narratives embody ecological messages and are thus used to teach and pass on Māori environmental ethics or constructs (Patterson, 1992). Thus, Tau (2001a) has suggested that one of the functions of Ngāi Tahu *whare pūrakau,* or houses of learning (re-established in 1841) was to ritualise aspects of the mythic world view, including seasonal rituals of harvest.

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[35] McRae (1991) and Royal (1999) have both drawn attention to the long history of Māori people recording knowledge to ensure its survival.

[36] In their view, "myth and legend in the Maori cultural context . . . were deliberate constructs employed . . . to encapsulate and condense into easily assimilable forms their view of the World, of ultimate reality and the relationship between the Creator the universe and man", a view supported by other authors such as Roberts et al. (1995) and Sharp (2000, p.23). Storytellers typically convey tribal information on multiple topics including *whakapapa* and cosmology, also incorporating geography and history (including stories of famous journeys by major ancestors that explain the origins of place names, prominent landscape features, description of tribal boundaries, and the location of key resources). This type of information can be critical for resource use and management, including, for example, information that the use of another tribe's resources (perhaps even under *rāhui* to allow regeneration) could draw severe penalties. Traditional narratives such as the well-known story of Rata (who chops down a tree without following the correct procedures and suffers the consequences when the tree is repeatedly reconstituted) show the importance of the concept of receiving permission in relation to forest resources (Whiting, 1990 p.32).

Patterson (1992) specifically examined environmental values embedded in another form of oral tradition, *whakataukī* or ancestral sayings, as well as collective origin stories, identifying values such as respect (1992, p.48) and *whanaungatanga*, with its ensuing responsibilities to all life forms including the land (pp.146-147). Traditional ecological knowledge is therefore an important component of oral tradition, but has often been overlooked by the broader scientific community even though it has the potential to illuminate scientific understandings (Huntington, 1998).

I have analysed material drawn from oral tradition from two main sources. First, I interviewed elders and weavers to identify key research themes and patterns of resource management practice in two distinct regions of the country. Secondly, I have considered a corpus of *whakataukī* in the light of their possible implications for harakeke ecology and resource management. Many, although not all, of these have been drawn from historical records. Other forms of traditional knowledge, such as *waiata*, have not generally been included, although these may offer rich resources for future research. Tau (2003) has analysed the oral traditions of Ngāi Tahu by triangulating information expressed in the form of genealogy, song, ancestral sayings and oral interviews, as well as historical documents. He argued that his oral sources needed to be compared with external source material to elevate the events of oral records from untested recollection to historical probability (Tau, 2003 p.121). In this research project, I discuss interview material and *whakataukī* in relation to written historical sources as well as scientific papers. I also consider the material in relation to the ecological parameters quantified for harakeke using predictive maps.

2.4.1 Interviews

Interviews facilitate access to events that cannot be observed directly because they have occurred in the past (Burns, 2000 p.425) and are therefore an important tool for historical research. Furthermore, in this context, they provide access to ecological knowledge about harakeke held as part of the oral tradition.

Interview methods

Interviews focus on the informant's perception of his or her experiences. For this research project, I interviewed a number of family members and others (who are

mainly weavers) about their experience and knowledge of harakeke management. Interviews carried out as part of this research project were generally open-ended and semi-structured. Such interviews involve preparation by the researcher to identify what the crucial issues might be and how they might be introduced during the interview (but without fixed wording or ordering of questions). This process, through being open-ended, allows other issues to arise which the researcher may *not* have identified as critical. Additionally, it allows participants to talk about areas of knowledge where they have particular strengths. A more creative approach to knowledge can also be employed: for example, Huntington & Mymrin (2001) noted that using and discussing maps or other pictorial resources in interviews can be informative[37]. Bishop (1996a, 1996b) has supported narrative inquiry as a technique which addresses Māori concerns that research into their lives should be conducted in an holistic, culturally appropriate manner: it allows the research participants to select, recollect and reflect on stories within their own cultural context and language rather than in the cultural context and language chosen by the researcher.

Open–ended interviewing entails return visits to research participants. I taped or made notes during initial interviews. A draft was then created which grouped the discussion according to themes. With each research participant, I returned with the draft so that they had the opportunity to review or embellish their comments, or to correct information that I may have misunderstood. Checking back with participants was an important part of the process, ensuring that the final transcript represented what the participants wished to communicate rather than simply the words that they had uttered. That is, power and control remains within the domain of the research participant. Jackson (1998) has identified this control as "the power to define" what knowledge is created and how it is created/defined.

I interviewed people either individually or in small groups, and asked questions that started a discussion. I was interested in whom the weavers in the family were, what resources they used to weave, where these resources came from and what practices they or their grandparents followed. As the participants talked

[37] This was very successful with one older participant from Aotea harbour who identified traditional dyeing areas.

about what they had seen and learned, new topics arose. This allowed the participants to make connections that a scientist such as myself might not have anticipated[38] and led to some interesting observations and new ideas.

These interviews did not seek to exhaustively identify all resource management practices associated with harakeke. The main purpose was two-fold. First, I aimed to identify key issues related to harakeke use and management, as seen by the whānau and others. Secondly, I sought to supplement information about areas of resource use and practice that were not readily identified, or unclear, in the literature. Interviews with elders also attempted to clarify ancestral sayings in terms of their resource management implications.

Research participants

Most of the interviewees, or research participants, are members of my extended family from within Waikato and Northland. Some elders or expert weavers from other areas who were known to me, or whose names were given to me by friends or family, also agreed to participate in the research. All were generous with their time and knowledge. The interviews for this research were carried out between 2000 and 2005, according to the availability of the participants. In most cases, the research participants are named (with their permission) as it was considered important to acknowledge, where possible, the experts and elders who are repositories of knowledge in their areas. However, some elders did not wish their personal contribution to be identified, and their wishes have been respected. The participants were interviewed in their homes, paddocks, woolsheds, at the marae or wherever else they felt comfortable and wished to talk.

One of the tensions in academic research such as this is the removal of both people and their knowledge and experiences from a traditional framework. In this chapter, I have generally referred to research participants by both their first and family name. To refer to elders by their family name only (as is generally the academic convention), could be considered ill-mannered; on the other hand, I

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[38] As Barton and Lazarsfeld (1969, p.166) have observed, "like the nets of deep-sea explorers, qualitative studies may pull up unexpected and striking things for us to gaze on."

have not included the titles of these elders, but acknowledge that they would not be addressed simply by name by younger or junior members of their communities. It is hoped that taking an intermediate approach to the demands of academic convention and community values is acceptable in this case.

During the conduct of the research project, different approaches evolved for the two main areas investigated - Waikato and Northland. In the Waikato, the majority of research participants are from my extended family, and associated with marae at Kāwhia and Aotea harbour. Although some informants are not currently practising weavers, all have an intimate knowledge of the area, and have previously been involved with family weaving activities. These elders grew up in the southern Aotea or Kāwhia district, and their experiences generally relate to this district[39]. A smaller number are included (because of their knowledge and because they are known to me) from different marae in the Waikato-Maniapoto area.

In Northland, access to several of the research participants was facilitated through one of the mentors for this project, while one belongs to my extended family. All of those interviewed can be regarded as expert weavers, and this has resulted in information with a different emphasis from the Waikato research material gathered. The Waikato material was also treated differently in that I also collated data from historical records of harakeke relevant to the southern Aotea harbour. This helped to provide further insight into the practices and context of the period.

In total, 11 research participants were interviewed: their age range, relevant tribal affiliation and gender is recorded in *Table 2.1*. Of these, seven are from Waikato/Tainui, and four from Northland. At the time of interviewing, participants ranged in age from the early 30s (one) to the late 80s (two). Eight are women and three are men. The men were included either because they are themselves weavers (one), or because they have been involved in the harvesting and management of

[39] Four of these are grandchildren of Rihi Tauwhitu and Te Ngaru Poutu, and lived with their grandmother Rihi as children. They consequently accompanied and helped her in her collection of weaving resources and preparation of resources for weaving during the 1950s.

harakeke (two). Three of the research participants from Northland are expert weavers, while another was involved in harvesting and weaving alongside her elders while younger.

Table 2.1: **Research participants: district, gender and classification**

District	Name	Gender	Classification relevant to this research
Waikato	John Apiti	M	Elder
Waikato	Tawa Mahara	M	Elder
Waikato	Maude Miriama Wehi	F	Elder
Waikato	Vera Tauwera Uerata	F	Elder
Waikato	Elva Kui Te Ngaru	F	Elder
Waikato	Nancy Awhitu	F	Elder
Waikato	Pita Te Ngaru	M	Weaver
Northland	Toi Te Rito Maihi	F	Elder and expert weaver
Northland	Te Hemoata Henare and Moe Milne	Both F	Elder and expert weaver; elder
Northland	Ta Kauwhata	F	Elder, expert weaver

Information from other areas has also been incorporated into this research project (due to the generosity of weavers or elders who wished to participate). These contributions are acknowledged as personal communications in the text. Even so, there are many districts untouched in this research. Furthermore, it should be borne in mind that only small numbers of participants were interviewed from each region. There is, therefore, a great deal of scope for further study.

2.4.2 Sound archives

A search of sound archives, such as those of Television New Zealand, Radio New Zealand and the Turnbull Library, revealed a small number of recordings made by elders who are no longer living. These are referred to where relevant.

2.4.3 *Whakataukī* (ancestral sayings)

Many oral tradition sources place emphasis on a Māori world view. Others provide detailed information of a type that is directly relevant to my particular interest in harakeke management. A corpus of *whakataukī* which might be relevant to harakeke ecology and management was identified through interviews and a search of written sources, both historical and contemporary. I searched published and

unpublished sources such as Kohere (1951), the Māori newspapers published in the second half of the nineteenth century[40], and other works such as Mead & Grove (2001) which are compilations of *whakataukī*. These *whakataukī* were discussed with a number of elders for clarification of the ecological understandings and management that they refer to. As well, on a number of occasions I took the opportunity to ask research participants about their knowledge of *whakataukī* relating to harakeke, or for their assistance in interpreting *whakataukī* which had emerged from the literature search. A core group of elders who offered assistance with this interpretative task was based at the School of Māori and Pacific Development (University of Waikato). Guidance was received from members of a number of iwi including Waikato, Ngāti Porou and Tūhoe.

2.5 Research ethics and cultural context

All research, whatever the topic and whatever the methodologies employed, has ethical dimensions and implications. In the case of this project, the very fact that the topic concerns Māori knowledge means that particular care has to be taken in relation to perspective. So far as the interpretation of historical sources is concerned, issues of perspective are critical, as they are when dealing with the representation of the information provided by research participants. This is something that I have been conscious of throughout. In particular, I have been conscious of the need to accommodate as much as possible of the information and advice provided by those involved in the articulation of a 'kaupapa Māori' perspective. A *kaupapa Māori* research model strives to ensure research is culturally safe, involves the mentorship of elders, and is culturally relevant and appropriate, while also satisfying the rigour of research[41]. In doing so, it promotes the self-determination of research participants (Bishop, 1996b p.11). Thus, for example, I have been careful, wherever possible, to compare and contrast different sources (Māori and non-Māori) of information, to provide informants with opportunities to select the location of interviews and to discuss topics they

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[40] Now online.

[41] Irwin (1994) has argued that kaupapa Māori research is conducted by a Māori researcher, not a researcher who happens to be Māori; also see Stokes (1985, p.8) who has argued that cultural competency is a vital quality in the researcher.

consider relevant. I have provided research participants with as many opportunities as possible to review material based on their contributions. The identification of expert informants (where they are in agreement) in this research project is one way of acknowledging the expertise within the Māori community, while also bringing knowledge to a wider forum. Ensuring that benefit returns to the community can be achieved in a number of ways, including the production of relevant resources based on the research (see, for example, Keegan, 1997).

This research proposal was initiated within the School of Māori and Pacific Development at the University of Waikato, and supervision shared between the School of Māori and Pacific Development and the Department of Biological Sciences. The School of Māori and Pacific Development research ethics committee approved the format and process for research interviews. Moana Rāhui o Aotea, the environmental project team for Okapu marae, also approved the research project. Mentors, in addition to the supervisory panel, helped to guide the research project.

2.6 Study areas

The Kāwhia and southern Aotea harbour area is where our extended family, through my husband and mother-in-law, has its strongest relationship with the land. For this reason, I have focused on the use and management of weaving resources on the southern side of Aotea harbour whenever possible. However, central Northland is the ancestral home of my father-in-law so I also turned my attention to Northland, particularly to the area around Ngāwhā and Kaikohe, to select research participants.

Aotea harbour lies immediately to the north of Kāwhia on the western coast of the North Island of New Zealand (*Figure 2.1*) and is the landing site of the Aotea canoe around 1000 years ago. The Tainui canoe also came to rest at Kāwhia about that time and the area has been continuously occupied since. The history is therefore long, and at times turbulent, with different family and tribal groups moving around and through the area. The presence of sacred sites, such as that

where the bird Korotangi[42] was found, adds to the historical importance of this area. A number of tribal groups are now resident in the Kāwhia-Aotea harbour area, including Ngāti Te Wehi, Te Patupō, Ngāti Hikairo, Ngāti Mahuta, Ngāti Maniapoto, and Ngāti Apakura. Many of the research participants from Waikato have genealogical links to a number of these tribal groups.

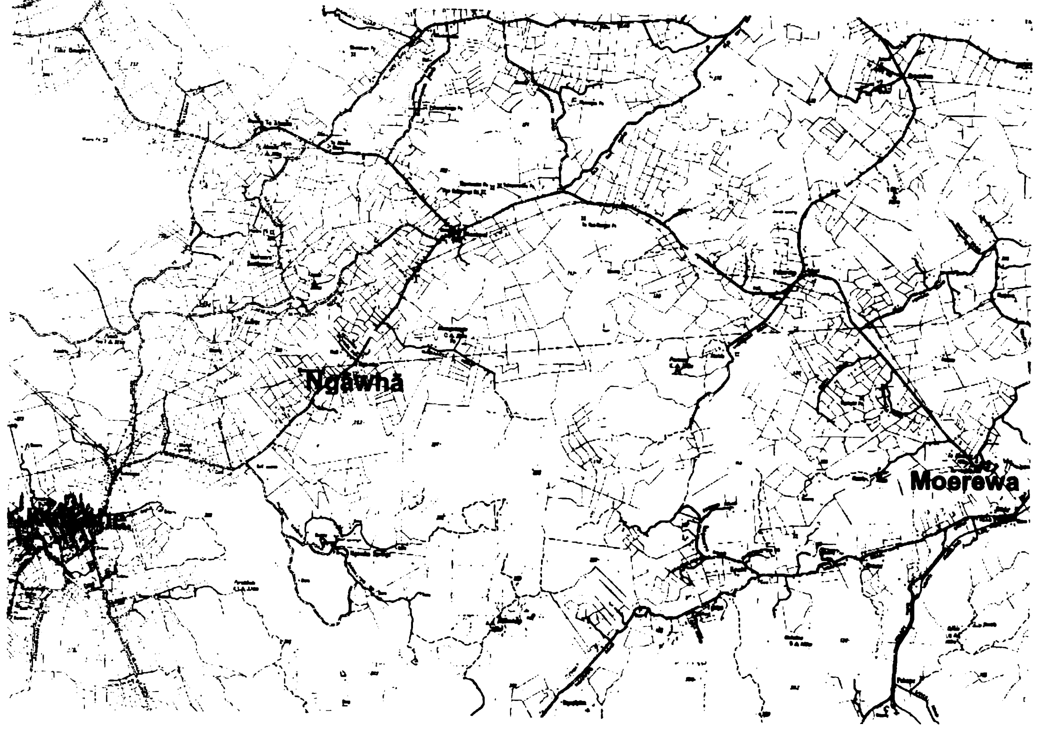
Figure 2.1: **Map of southern Aotea harbour research area, with Okapu marae marked, New Zealand**

Northland likewise has a long history of encounter between Māori and Pākehā, as well as numerous local tribal groups. Ngāpuhi nui tonu, Ngāti Hine, Ngāti Wai, Te Rarawa, and Te Aupouri are classified as the main iwi in this area. Again, many locals belong to more than one iwi or hapū. In pre-European times, Kaikohe was prominent as the seat of Ngāpuhi, but it is now a quiet town of around 3,000 residents. Much of the land has been converted for farming, so the landscape has been extensively modified. Forests were logged extensively for kauri (*Agathis australis*) in the nineteenth century, although there are a few remaining patches of forest. Northland remains predominantly rural, and many local Māori are first language speakers of Māori. Research participants were

[42] Korotangi is a sacred bird said to have helped guide the Tainui canoe to Aotearoa/New Zealand, turning into stone thereafter.

primarily based around Kaikohe, and Moerewa in the mid north (*Figure 2.2*), and living within their ancestral area at the time of the interviews.

Figure 2.2: **Map of the mid north area of Northland, New Zealand showing the relationship of Kaikohe, Ngāwhā and Moerewa where the research participants were based**



2.7 Environmental modelling

Detailed environmental modelling methods are outlined in *Chapter 6*. This modelling required acquisition of data from herbaria throughout the country. I used these data to investigate environmental parameters for harakeke and wharariki and to determine their environmental niches. A predictive map of the probability of natural harakeke occurrence was created using harakeke data from the northern region of New Zealand only. Generalised regression analysis and spatial prediction (GRASP) identified which environmental variables are significant in predicting the probability of natural harakeke occurrence in this region.

2.8 Conclusions

The aim of this research is to uncover and analyse evidence about historical harakeke management by Māori. Papers published by the scientific community investigating aspects of harakeke ecology were reviewed in *Chapter 1*. The methods outlined in this chapter form the backbone for the research described in the next three chapters: methods for *Chapter 6* are included within the chapter for ease of reference. In the next chapter, I begin with the identification of key themes in traditional ecological knowledge of harakeke and historical Māori resource management obtained from interviews with research participants and from the analysis of *whakataukī.*

Chapter 3

Identifying key issues: *He kōrari, he kōrero*

Ahakoa iti te pipi o tōku kainga he wai ū tangata tonu[43]

3.1 Introduction

Māori ecological knowledge of harakeke that is embedded in oral tradition forms the focus of this chapter. Oral history is one of the richest strands of Māori knowledge and incorporates around 1000 years of New Zealand experience. Oral history can be approached in a number of ways; for example, through interviews with elders or experts, analysis of songs or genealogical strands, or through ancestral sayings or *whakataukī*. Although *whakataukī* are frequently metaphorical, the metaphor itself is, in many cases, based on detailed observation of ecological processes. Even so, oral tradition has often been undervalued by scholars as a source of ecological knowledge. Huntington & Mymrin (2001), for example, have observed that natural scientists are often poorly equipped to conduct interviews or work in a cross-cultural setting.

Oral tradition links the past with the present and can provide significant insight into the evolution of practices. Much of the interview material which is discussed here refers to the mid 20th century and later, and is thus positioned between contemporary and more distant practice (such as pre-European practice). The observations reported here have assisted in the development of ideas and hypotheses about the historical management of harakeke by Māori. Discussions with research participants were intended to facilitate that process of progressive focusing which commonly occurs when dealing with ethnographic data (Burns, 2000 p.404).

Māori are people for whom the concepts of iwi and hapū are central (see, for example, Royal, 1992), yet this is not explicitly reflected in many weaving texts

[43] The shellfish of my home may be small but they nourish the people (Mead & Grove, 2001 p.13).

(Brown, 1971; Hopa, 1971; Mead, 1968, 1969). Notable exceptions are Moeke-Pickering & Kete (2002) who investigated traditional dye processes in the Tai Hauāuru region around Kāwhia, and Pendergrast (2000; 2003) who has consistently acknowledged the assistance of Ngāi Tai in his work on weaving techniques and patterns. It seems likely, however, that both weaving resources and the needs of weavers varied considerably in different parts of the country, as is currently the case, and that different practices may be appropriate in different areas. Ethnographic studies emphasise the fact that human behaviour occurs within a context and that without an understanding of contextual factors issues can be misunderstood and distorted (Burns, 2000 p.394). The interviews with elders which are reported here provided context for a consideration of the resource management of harakeke.

My aim in this chapter is to identify key themes in historical harakeke management and ecology from interviews with elders and from the analysis of *whakataukī*. These themes will inform the hypotheses concerning the active management of harakeke by Māori. I report first on key harakeke resource management themes identified from interviews with elders (see *Section 3.3.1*). These key themes provide a *whāriki* or floor mat from which to begin. In addition, I examine the material from southern Aotea harbour in relation to written historical sources from the area. Finally, I consider a number of *whakataukī* which can be related to observations of harakeke and its ecology and management. My interest lies in identifying ecological processes observed and experienced by Māori, and linking these key ideas to active harakeke management and harakeke ecology as currently understood by the western scientific community. As Huntington & Mymrin (2001) have argued, "working together is the best way of helping us achieve a better common understanding of nature."

3.2 Methods

Interviewing methods are described in *Section 2.4.1*. The participants who were interviewed for this research are (as indicated in *Chapter 2*) primarily based in two different parts of the country: Northland and southern Aotea harbour.

In the section on *whakataukī*, I have focused on sayings which I have selected for their particular relevance to harakeke management and ecological understanding. The majority of these are from Mead & Grove (2001), who collated, translated and interpreted more than 2000 *whakataukī*. I have also searched other sources of *whakataukī* (Kohere, 1951, Grey, 1857; Smith, 1889; McDonnell, 1923; Ihaka, 1957; Brougham & Reed, 1987) as well as Māori newspapers from the end of the 19th century and early 20th century, and other historical and contemporary sources which seemed likely to have recorded *whakataukī*. Finally, I consulted a core group of elders[44] both to identify further sayings that they might consider relevant, and to discuss interpretations of those presented here.

3.3 Results

3.3.1 Common interview themes

A group of central themes arose repeatedly in interviews with research participants. *Table 3.1* lists the main themes addressed by research participants, and gives examples of typical responses. These seven themes are discussed further below.

Table 3.1: **Central themes and typical responses emerging from interviews with research participants**

Theme	Typical response
Karakia before harvesting	"I used to hear her saying karakia before she picked the flax, but I don't recall the words" (Tawa Mahara, Aotea harbour).
Harvesting practices	"When you cut flax, you always clean it" (Ta Kauwhata, Northland).
Varieties	"All weavers I know favour different varieties for particular uses" (Toi Te Rito Maihi, Northland).
Use of natural areas	"Most of our flax is swamp flax, which is the best flax to use as it's more durable than most flaxes I know" (Te Hemoata Henare, Northland).
Planting and cultivation	"One of our *whaea* gave me this one to plant down at the pā" (Nancy Awhitu, Aotea harbour).
Excess material	"You put the rubbish back around the plants" (Ta Kauwhata, Northland): note there was some variation in responses in this area.
Burning harakeke	Varied responses; including recall of elders burning excess harakeke: "My aunty burns the left over stuff" (Te Hemoata Henare, Northland).

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[44] These elders consisted of senior academics from the Māori Department (*Te Tari Māori*), School of Māori and Pacific Development, University of Waikato, and are referred to elsewhere in this chapter.

Karakia

The use of *karakia* in relation to weaving arose as an important theme, although few details were revealed. None of my research participants identified specific *karakia* that were used prior to harvesting harakeke. At Aotea harbour, both Tawa Mahara and Vera Uerata noted that their grandmother said *karakia* before harvesting harakeke, although they were unable to recall the actual *karakia*. They considered, however, that she was "very traditional". Another Northland participant described how she said *karakia* every morning, rather than saying specific *karakia* before different activities during the day.

Harvesting

The participants who talked about harvesting considered the 'correct' cutting practice critical. All of these participants mentioned the traditional method of harvesting, that is, cutting on an angle and leaving the central three leaves of each fan (known as the *rito* and *mātua*). There was no difference in description of this general practice between districts. At Aotea, one grandchild of Rihi Tauwhitu, who was aged 10-12 years at the time she accompanied her grandmother to harvest harakeke, observed:

> Nanny Rihi . . . always said karakia. When we went to cut, she always knew exactly what she wanted. She cut with an old-fashioned butcher's knife and had a pocket knife also. She'd get up early. We cut mainly on Saturdays, because the kids were home from school. We'd go down the hill to the swamp. We kids were not allowed to cut: we didn't know how.

Although the *rito* and two surrounding leaves known as the *mātua* were not generally cut, at times experienced weavers were more flexible in practice according to their personal judgement. Two older participants from Northland mentioned that the *rito* or growing shoot was cut on special occasions because of the whiteness of this leaf's fibre. One of these participants explained: "You want to clear away some of the *rito* on the inside of the bush so the rest can grow." One of these elders further noted that, in her view, the *mātua* were the strongest leaves, and she would on occasion cut some of these. These two participants both strongly emphasised the importance of 'cleaning' a harakeke bush (as did another

from Aotea harbour) and related this practice to further growth as well as safety for the harvesters.

Participants from both Northland and Aotea harbour described how they would harvest in groups. These groups might consist of a grandmother and several grandchildren, or an extended family group. Although this was not always the case, harvesting as a group enabled the learning of appropriate practice through shared experience.

There was no clear consensus among research participants on the best season to harvest harakeke. The research participants at Aotea harbour did not discuss seasonality. One Northland participant considered March until May the best time, although she also harvested at other times. She did, however, avoid winter harvesting. Two others mentioned that harvesting in the rain was to be avoided. Therefore, climatic conditions seemed important. One participant, who had previously been involved in the flax milling industry, observed that he was unaware of any seasonality of harvest. This may be because of the commercial nature of his work at the flax mill, or because of different patterns of harvesting at Aotea.

Harakeke varieties

Research participants were able to describe the varieties used for weaving. This included descriptions of harakeke according to colour, leaf length, and leaf rigidity. Thus, for example, Miriama Wehi recalled the harakeke itself as "straight upright green flax; [with] stems [that] may have had yellow underneath . . . ." She further observed that her grandmother selected the really tall ones.

Although the names of particular varieties were not necessarily known by all participants, harakeke varieties were still distinguished and used for different purposes. One participant from Northland described how she distinguishes suitable harakeke by sight for different tasks. Furthermore, it appears that Ngāpuhi have names for many varieties (which may still be known by some living experts). Toi Te Rito Maihi reported that"[an] old kuia then living at Poroti [in 1956] offered to go with [me] and name them all". Unfortunately, neither had a

vehicle and the opportunity was lost. Tame Roa[45] from Waikato observed that his aunt also distinguished, in the care of the bushes, between *muka* harakeke and other types.

Two participants mentioned a number of words from Northland in relation to the practice of weaving which are not often heard elsewhere now[46]. This suggests a strong weaving tradition (as well as language) among Northland peoples. Two of the research participants in Northland were also familiar with variety names such as *taeore, paritaniwha* and *kōhungahunga*, types which have been transported to Northland for their weaving qualities.

Natural stands and cultivations

All Northland research participants talked about the importance of 'swamp' harakeke, or naturally growing harakeke (as opposed to specific plantings) for use. It seems that older weavers have actively harvested naturally growing harakeke from the sides of the roads, on family lands, and from along the coast, for many years. All participants, from both Northland and Aotea harbour, were able to specifically identify areas of high quality harakeke that they referred to by name.

Weavers also discussed the history associated with natural stands of harakeke. Thus, for example, both Te Hemoata Henare and Toi Te Rito Maihi talked about some of the renowned harakeke around Lake Omapere and the Kaikohe area. Toi Te Rito Maihi said:

> Alongside the Utakura river near its origin at Lake Omapere, there still remains a magnificent pa korari. . . . The flax of the greatly reduced Hukerenui swamp is excellent for raranga - whāriki.

In the southern Aotea harbour area, Hawaiki emerged as an important area for resources. This area was mentioned in association with harakeke used for *whāriki*

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[45] Tame Roa, from a discussion on 14.5.04, hereafter referred to as Roa (2004).

[46] For example, the words *pahuhu* 'to scrape', and *hipora* and *tamata* (which are kinds of mats), were discussed.

by Miriama Wehi, Tawa Mahara and Vera Uerata. Another elder recalled that in the late 1940s the family went to Maukutea for their harakeke needs, and only in the 1950s turned to Hawaiki. None of these harakeke stands are currently on Māori owned land.

It is clear that many of the natural harakeke areas have been destroyed or are under threat (from farming practices in particular). Toi Te Rito Maihi noted:

> The roadside brown flax is a remnant of the renowned flaxes that Wiremu Wihongi attempted to save by removing plants from the endangered Lake Omapere. The lake was originally lowered by the government to permit a cheaper route for the railway to Okaihau to be built, then by a farmer determined to gain more land by exposing more lake-bed, and again by the government . . .

She made an interesting observation about her travels when, as newly weds, she and her husband taught in different Mangakāhia settlements at Parakao and Pakotai and travelled weekly to Whangārei to see each other:

> In 1957 . . . [you] could see all the pa korari along the way at different settlements, but so many have gone now. At Pakotai and Parakao the swamps have been drained. Just down the hill south of the Parakao School and Hall there was a wonderful pa korari, but it has gone - it was drained and grassed. But those korari were so clean. No bugs survived the swamp waters.

In 1956, many *pā kōrari* were visible from the roads around Tautoro and Pakotai. As Toi Te Rito Maihi noted: "This was an ancient trading route, with many pā and kāinga stretching from Kaikohe to Maungatapere." Most of these have since disappeared. Similarly, at Aotea harbour, the harakeke that used to be found at Maukutea is no longer present.

The Aotea harbour participants emphasised the use of natural stands of harakeke, although one recalled her grandmother transplanting harakeke from Hawaiki and

Maukutea to an area at Te Kakawa where they were living. Miriama Wehi believed her grandmother never planted any in her garden. This may have been because the family had a swampy area alongside a stream at the side of the garden where suitable weaving harakeke grew. This area has now been drained and no longer exists.

Planting and cultivation practices

All of the participants were familiar with the practice of planting fans to propagate harakeke, even where they had not carried it out themselves. Te Hemoata Henare from Northland described how she plants harakeke with the *puku* facing the East. This method appears to be used in a number of different districts as it was also mentioned by an elder from Te Whānau-ā-Apanui in the East Coast area[47]. This kind of information did not emerge in discussions with family at Aotea. Nonetheless, while planting a *pā harakeke* at Okapu marae during the process of an interview for this research, elder Nancy Awhitu observed that she always liked to plant according to the moon and tides, as is the tradition amongst the family there.

One respondent from Waikato referred to the use of small stones when planting harakeke[48]; a planting practice which the respondents from Northland were not familiar with. Another elder from Tainui, Tame Roa, recalled an aunt from Ngāti Apakura who, when she planted harakeke, always put in a few stones to wrap the roots around. The stones were bigger than gravel, perhaps around the size of a 50 cent piece. When asked for the reason for this practice, she had answered "hei awhina i ngā patupaiarehe"[49] (Roa, 2004). This reflects the intertwined nature of the physical and spiritual for many Māori, suggesting that this practice could be considered to be one aspect of *kaitiakitanga* for these people. One of the participants, from Aotea harbour, believed that this planting method was not used

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[47] Personal communication of an elder from Te Whānau-ā-Apanui.

[48] Sometimes also called "mauri stones."

[49] The *patupaiarehe* are often described as supernatural creatures who may have a guardianship role. The people of Ngāti Apakura have a strong relationship with these creatures according to their local stories.

by the people at Okapu Pā, although she thought that Mōkai Kāinga[50] weavers might use this method. This marae has a stronger relationship with Ngāti Apakura, so it is possible that this practice is strongly associated with particular tribal groups.

Another elder, Waratau Houia, from Ngāti Porou, observed that when he was a child, harakeke was often to be found in a corner of the *māra*, or gardens[51]. Very few groves could be found in open areas as they were eaten by stock. This contrasts with the planting of designated *pā harakeke* in many contemporary situations such as schools and marae, which tend to be strongly fenced, with only harakeke and no other species present.

Several participants from Northland discussed the importance of soil type or location of harakeke in determining the final quality of harakeke fibre. They observed, for example, that varieties may change appearance, depending on soil conditions, and become stunted. Te Hemoata Henare considered the water table when planting, observing such factors as naturally occurring drainage. She further added that some harakeke grew vigorously in peaty soil. Another expert weaver noted that a gift of brown harakeke from Omapere no longer turned brown when she planted it at Ahipara. Toi Te Rito Maihi referred to the mineral deposits in the soil at Ngāwhā, compared to the different soil conditions at Kohewhata marae, as one reason for a planted gold and brown harakeke growing "true" only at Ngāwhā. She also observed, however, that one division of this harakeke at Ngāwhā Springs had since died. Toi Te Rito Maihi also described how she had been shown another plant which had been gifted by weavers from Tokomaru Bay to the people of Minginui. Although vigorous and tall at the place of origin, it was spindly and stunted at Minginui. In her view, local soil conditions were important in explaining this change. Two Northland participants also specifically observed that excellent harakeke for weaving grows by the sea at both Takahiwai and Ahipara.

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[50] A marae lying between Aotea and Kāwhia harbours, with family from both Ngāti Hikairo and Ngāti Apakura.

[51] Waratau Houia personal communication 26.5.05, henceforth referred to as Houia (2005).

The management of harakeke to prevent flowering was discussed by one participant. Toi Te Rito Maihi observed:

> When a pa korari contained different plants, only one type was permitted to seed each season. The flower stalks of the others were removed to prevent cross-pollination. In this way each type remained true to its particular qualities. As the seasons passed, each type would be given its opportunity to seed.

Disposal of excess harakeke

The return of excess harakeke to the plant was another common theme amongst research participants. Several emphasised the importance of cleaning a harakeke bush at the time of harvesting. Some respondents noted that returning harakeke to a pit of some kind was also carried out. Tawa Mahara, from Aotea harbour, recalled that his grandmother "would take [the harakeke] home bundled up. I carried them, and she'd then strip them outside at home. . . . She took the rubbish bits and buried them." Other participants discussed the use of fire to burn excess material from weaving. Three different methods of waste harakeke disposal were therefore identified.

Fire

Many weavers today believe that harakeke should not be burned (see, for example, Puketapu-Hetet, 1989 p.5). However, research participants, from both Northland and Waikato, recalled elders who had previously burned the excess harakeke from weaving, including some who still follow this practice. As one research participant stated "[a] lot of people burn the left over stuff, because after a while you choke your plant if you give everything back." Similarly, another participant from Waikato had observed that his mother, after she had been making *kono*, would "throw the remains of harakeke on to the fire" if there was too much rubbish. Another Northland participant recalled an aunt drying harakeke over an open fire - and later burning the left over harakeke. Moreover, one expert weaver observed that she had always regarded the placing of discards around the base of the plant as an invitation to insect infestation, so was fascinated to hear when

talking to a Hawaiian weaver that the discards were burnt and their ashes returned to the base of the parent plant. This indicates that the burning of weaving materials is more acceptable in at least some other Pacific cultures.

Two research participants from Waikato recalled harakeke bushes being burned to clean up the surrounding area. Another Northland participant recounted how harakeke ash was used as a medicine in the North by one family that she knew. She also considered that the ash from harakeke would benefit the plant in a similar way to the returned excess, without the complications of providing pest habitat.

Elder Tame Roa discussed the difference between *kawa* and *tikanga* in relation to this topic. He noted "Kawa is ordained by God, and hence is 'sour' as it is not always what we want to do, but what we have to follow. So it can't be changed by humans. Tikanga is a contract between people, based on what is right for people, for the group, in that time, at that place. Hence it is changeable, but only after a considerable depth of thought and a period of time for that thought. To fully understand tikanga you need breadth of knowledge, not depth, but breadth, a wide understanding of things" (Roa, 2004). These comments suggest that *tikanga* around the burning of harakeke are likely to have been more complex than is commonly understood now.

3.3.2 Other emerging themes

Insects and pests

Several of the main themes are linked to the control of insects and pests. Expert weavers among the research participants were aware that returning excess material to the base of a harakeke plant could encourage insects. For example, Te Hemoata Henare considered that this had been a suitable method in previous times, because there were fewer insect pests. She observed that many weavers still carried out this custom. However, because many areas of harakeke are swampy in the north, she felt the regular flooding helped to reduce pest numbers. She noted, however, that burning the unused remains of cut harakeke, as an alternative to returning them to the bush, also acts to reduce insect numbers by reducing available habitat. It was her observation that some weavers did burn their excess harakeke. Toi Te Rito Maihi drew attention to the practice of burning

the remains of the weaving plant pandanus (*Pandanus* spp.) in the Pacific Islands to reduce vermin.

All of the expert weavers interviewed emphasised the 'cleaning' of harakeke bushes while harvesting. These weavers, therefore, appear to be particular in relation to pest prevention. However, no methods of direct insect elimination were described by the research participants. 'Cleaning' harakeke is commonly associated with reduction of pests and insects which damage the harakeke leaf by reducing the availability of suitable habitat (Scheele, 1997; Schuster, n.d.[52]).

Reflexivity of practice

A number of the research participants commented on the apparent inflexibility of 'rules' associated with weaving nowadays, and indicated that they believed this has not always been the case. The participants commented on the lack of rigidity in previous times, with certain exceptions, and also noted the practical nature of Māori. One, for example, commented:

> We've gone and mystified every thing so much . . . [but] the more you know your reo and your tikanga, [the more things] makes sense. Don't make everything so taputapu you can't do anything! People want to make rules around a whole lot of things. . . .
>
> We are very practical people. I sat with my nanny to make kete, and I was taught by her. We'd go and have a cup of tea and a feed. There were things around the harvesting but after that, once you'd got it - well when you'd finish she'd say "throw it!" and I'd throw it. If it landed like *that* it was a good kete!

Transmission of knowledge

The transmission of knowledge was a theme which emerged from discussions with the Northland weavers. Although not directly related to ecological processes, the comments in this area emphasise the significance of weaving

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[52] In this research, undated sources are referred to as 'n.d.'

knowledge to weavers, and the belief of the participants that the 'right' people should hold that knowledge. The research participants approached this in different ways. Two noted that some areas of knowledge were not revealed during discussions between weavers and an outside [non-weaving] group. The response of another elderly research participant was as follows:

> When I was a child, I went to the river and played with the flax. I believe I was taught by the spirit of my ancestors. I didn't ever "learn". . . . When I went to Ngāwhā when I married, there were only a few weaving. I was taught to share knowledge with people.

I have also referred to the learning of appropriate practices during harvesting when families harvested together (*Section 3.3.1.*). Transmission of knowledge is critical to maintain appropriate care of resources such as harakeke, but the timing, opportunity for, and direction of, knowledge sharing is important.

Regional knowledge

The essential nature of the harakeke resource, and the likelihood of regional differences, was emphasised in a discussion of fishing traditions at Aotea harbour with John Apiti, who is now one of the oldest surviving elders from the Aotea south area, aged in his nineties. At Aotea, fishing has been an essential part of maintaining the wellbeing and *mana* of the local people for many centuries. This elder has mainly been involved in making nets, as well as the dyeing of items such as nets and *kete pipi*. He recounted the dyeing process as follows:

> You put the bark and green kit in the mud. The flax was pliable as a kit, so you trampled it down. It gets pliable. The mud – it's the stuff you get bogged down in on the beach, the soft sinking places. You can put an oar down into it. You can put in kits, or nets, like kete pipi. Mud has ideal properties for mats and kits. . . . There isn't any boggy mud near the pā [Okapu]. They would use the mud here [as marked on the map[53]]. You

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[53] The exact location of this mud is not divulged here: details of the mud location were considered inappropriate in a public document. This resource would normally be used by local weavers from the nearby marae.

put the bark and kete in the mud. It comes out red if you put it in tānekaha bark; grey- brown if you use mangeao. Mud acts as preservative. The nets last longer.

Harakeke use, and the dyeing of harakeke, is intricately entwined with these traditions. These observations of net preparation are markedly different from the few other records available (Hamilton, 1908; Buck, 1926), and demonstrate some of the huge variation in regional knowledge. Although variation in dyeing resources has been previously recorded, some of the traditional bark dyes (such as puketea (*Laurelia novae-zelandiae*), and mangeao (*Litsea calicaris)* mentioned in the quote above) do not appear to be used or known by weaving experts from other areas. The use of sea mud is likewise unusual, being previously recorded only by Moeke-Pickering & Kete (2002), also in the Kāwhia district. It seems likely that use and management of harakeke might also vary in a similar way: this is indicated, for example, in the discussion of planting practices in *Section 3.3.1*.

3.3.3 Frequency of reference to key themes

Table 3.2 lists the main practices mentioned by research participants, ranking them according to the number of participants who discussed them.

Table 3.2: **Resource management practices discussed by research participants, in order of ranking from most often to least often mentioned**

Practice	Percentage of participants who discussed this aspect of management[54]
Use of natural stands	100%
Use of appropriate harakeke for task	70%
Cutting harakeke in traditional manner	60%
'Cleaning' harakeke bush	50%
Karakia	50%
Returning excess harakeke to plant	40%
Transplanting of fans for cultivation	30%
Use of fire to dispose of excess	30%

[54] For these percentages, one simultaneous interview with two participants was treated as 'one participant' as their responses were not independent.

It could be argued that the rankings of management practices in *Table 3.2* reflect, to some extent, the degree of importance to sustainable management. For example, cutting the *mātua* or *rito* leaf blades might result in death (either by removing necessary frost protection for the *rito* (Harris et al., 2005), or preventing regeneration). Angling the cut towards the centre so that water collects in the bush might allow rot to develop in the centre of the bush (Schuster, n.d.). As well, the ramifications of failure to follow *tikanga* may be important: using an appropriate variety of harakeke for a task might have been vital in previous times, so that fishing nets, for example, did not break. However, other interpretations are possible. For example, it could be argued that from a Māori perspective *karakia* might be of critical significance. *Karakia* may have been mentioned less often in this study because traditional *karakia* before harvesting are no longer known, or because of their *tapu* nature.

3.4 Discussion of interview themes

A number of resource management practices arose repeatedly during discussions with the research participants and helped to identify key themes for further exploration via the historical literature. These were:

- loss of *karakia* that were formerly said prior to harvesting;
- 'correct' harvesting procedures;
- 'cleaning' harakeke bushes to prevent or reduce insect infestation;
- use of specific harakeke varieties suited to a task;
- use of natural stands;
- planting and cultivation practices;
- disposal of excess harakeke after weaving; and
- a complex relationship between harakeke and fire. [55]

Recently published work has discussed the presence of *ātua kaitiaki* or spiritual guardians who were believed to protect and uphold weavers' mana (Yates-Smith,

[55] These themes are investigated further in *Chapters 4* and *5*.

1998 p. 240; Huata, 2000).[56] One such guardian, Huna, is described by Paki Harrison, a contemporary master carver, as "he atua kaitiaki i te harakeke. Koinā te atua e whakapiri tata nei ki ngā pā harakeke o te ao Māori, ko Huna" [57] (interviewed by Yates-Smith (1998, p. 240)). Ngamoni Huata recalled how her mother included Pakoti in a prayer prior to collecting flax. Huata described Pakoti as the personification of superior forms of harakeke (Huata, 2000 p.3). *Karakia* before planting is also mentioned in other sources, such as a letter written by Eruera Tekahuoterangi of Kaikohe, Northland, albeit within a Christian context (Tekahuoterangi, 1899). These reports match up with the observations of my research participants, some of whom also recalled *karakia* prior to harvesting, but were unable to provide further detail of the *karakia*. Without such detail, it is impossible to know whether these were traditional Māori or Christian prayers.

Genealogical or *whakapapa* charts of harakeke recited by elder Hohepa Delamere, and on display at Auckland Museum, indicate some of the relationships between different varieties of harakeke. Haami & Roberts (2002) have discussed the ecological relationships embodied in these types of genealogy, and believe that these relationships provide a Māori taxonomy. The subject of harakeke genealogy, however, and its relationship to ecological knowledge, did not arise in the interviews although research participants all discussed the use of different varieties of harakeke for different purposes.

Based on the expertise of some of the participants, and their relationships with other experts, it is possible that some of the research participants are aware of these *whakapapa*, although they are not widely known. There are a number of possible reasons for the omission of reference to *whakapapa*. First, it may be that research participants did not consider it relevant in the context of interviews which focused predominantly on practical measures of resource management. On the other hand, some participants may have considered that it was not a suitable

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[56] Guthrie-Smith (1969) quoted a lullaby recited to him by Māori elders in the Hawkes Bay which refers to Hine-rau-wharariki, who is another *atua wahine* or female deity (Yates-Smith, 1998 p.240; traditional songs also refer to *atua* (Ngata & Jones, 2004).

[57] Huna is a spiritual guardian of the harakeke. She is the one who is closest to the *pā harakeke* of the Māori world.

subject of conversation, particularly for inclusion in a public document. Thirdly, because knowledge of harakeke *whakapapa* has largely been revived and promulgated only recently, contemporary understanding and discussion of this area is still a relatively new phenomenon. Additionally, some of the Aotea harbour participants hold strongly Christian beliefs which may have precluded their search for, or acceptance of, this kind of knowledge.

Missionaries settled in both Kāwhia and Northland early in the European colonising period. In the Kāwhia district, a mission station was founded by Rev. H. Turton in 1840 at Aotea harbour, for example, after eloquent pleas from local chiefs (Leadley, 1994). Mission stations had already been established elsewhere in the Kāwhia district. It is clear from the Māori Land Court Records for Kāwhia that missionaries had a profound effect on Māori customs and practices. Methodist minister Cort Schnackenberg was a pioneer missionary in the Aotea District from 1844-1880 (Hammer, 1991). He recorded in his Journal in 1865:

> I have been asked to baptize children Taihuri, Tautiti etc but I refuse on the ground that some of these names mean or commemorate evil. They tell me it is love to tupunas etc, but they submit nevertheless and choose pakeha or Scripture names (Schnackenberg, 1865 p.27).

This suggests that Schnackenberg (and one would suspect other missionaries) had a low tolerance for Māori customs, particularly when there was a suspicion that they involved 'heathen' beliefs. It seems likely that missionaries such as Schnackenberg had a substantial effect on traditional *karakia*, including *karakia* to those *ātua* responsible for the plants and animals used by weavers.

Harvesting practices were well known and recognised by all the research participants. Cutting appropriately is one of the most fundamental practices for a weaver (see, for example, Pendergrast, 2000 pp.12 and 16). Although my participants did not explain the reasons for 'correct' harvesting practices, expert weaver Emily Schuster observed that the slope used in cutting[58] allows the rain to

[58] The essence is to cut "*whakawaho*" and "*whakaheke*"; that is, outward and downward.

wash insects out (Schuster, n.d.). She further considered that if the harakeke is cut the other way, the *rito* would die.

There was no consensus on harvesting in relation to seasonality. Contemporary weaving literature suggests that weavers avoid harvesting in winter (see, for example, Te Kanawa, 1992; Pendergrast, 2000). This concurs with the views of some of my participants, who are active weavers, but more variation was evident in the views expressed than in the literature. Some research participants did not recall seasonal patterns of harvesting amongst their elders. One, however, mentioned the different seasonal activities undertaken, such as making nets, which would in turn affect the amount and types of harakeke cut in each season.

As yet, there is not a great deal of modern work published which is based on the oral tradition and reflects weavers' preferences for different varieties, and local traditions. Hopa (1971, p.13) listed a number of varieties which are best suited to making *piupiu*, and which she considered also suitable for making fine cloaks. However, these are exactly the same as those found in the Report of the Flax Commissioners (1870-1871; see *Chapter 4* for details), so it seems that her suggestions may not have been based on oral tradition. Heeni Wharemaru, a kuia from Tainui, recalled that different varieties were used for different purposes, with the fine varieties used for clothing "gathered from special places, or . . . grown specially by the weaver herself" (Wharemaru & Duffie, 1997 p.143). These varieties are not revealed in her book.

Discussion of the use of natural stands provides evidence that Aotea and Kāwhia already had flourishing harakeke resources. The richness of resources at Aotea and Kāwhia is also well known through *whakataukī* such as, for example, *Kāwhia kai, Kāwhia moana, Kāwhia tangata, Aotea whenua.*[59] The dining room at Okapu marae at Aotea commemorates this *whakataukī* in its name "Aotea whenua". I consider that natural harakeke stands would almost certainly be included in any

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[59] Kāwhia, known for its food, bounty from the sea, and its people; Aotea, known for the richness of its land.

definition of natural richness, despite the fact that they have often been overlooked as such by outside commentators.

Research participants over the age of 60, such as John Apiti, described seeing extensive growth of harakeke around in their youth. This historical abundance is also evident in other sources. For example, Cort Schnackenberg wrote to the Hon. Donald McLean that "[some] time ago a Mr Illbury agreed to rent a certain portion of flaxland at Aotea" (Schnackenberg 1870a). In another letter in July 1870, McLean noted that "Mr Illbury paid the Aotea Natives £25 as rent for one half year for land there, or rather the flax upon the land . . ." (Schnackenberg, 1870b). That is, the resource was so abundant that non-Māori were interested in harvesting the harakeke for the flax milling industry and a flax mill existed at Raoraokauere in Aotea harbour for a number of years. Evidence of managed *pā harakeke* also exists from Aotea harbour. In the Manuaitu Aotea claim (Manuaitu Aotea Title Investigation, 1887 pp.238-9), Pouwhare is recorded as follows:

> It has also been stated that a flax plantation was formed at Papapoporo as a boundary mark. I deny the existence of it. But there is a flax field there belonging to Te Hera-wira-a-pupu of Taranaki; it is not a boundary mark.

This appears to have been a planted cultivation over which *kaitiakitanga* was clearly being asserted.

Detailed planting practices, such as those described by Pendergrast (2000), were not generally reported by my research participants, although both Te Hemoata Henare from Northland and another elder from Te Whānau-ā-Apanui described the planting of harakeke with the *puku* facing east. Further research is needed to understand more about regional differences in planting practices for harakeke. Even so, all participants who talked about planting were able to describe protocols that they followed. For example, planting by the moon and tides was important at Aotea harbour. Planting by the moon has been recorded by Best (n.d.), with specific days (in relation to either the full or new moon) considered to be good planting days. The continued expression of this tradition at Aotea harbour for harakeke planting is consistent with strong traditional practices at Aotea in

relation to both growing crops and fishing (which is also frequently guided by the phases of the moon).

It is considered common practice by weavers today to allow waste material to decay under the harakeke plant (Pendergrast, 2000 p.11). However, recent writers have noted that the placing of bundles of waste flax leaves around the base of the plant may attract harmful insects to the plant (Scheele, 1997). Pendergrast, however, recorded this method in the eastern Bay of Plenty where he considered the sea winds and friable soil would probably prevent such a problem. Likewise, weavers who consistently use natural stands of harakeke in swampy areas may not encounter this problem to the same degree as weavers with cultivated stands, as was suggested by Te Hemoata Henare in Northland (see *Section 3.3.1.*).

The comments of Northland and Waikato participants were consistent in relation to the burning of harakeke. A number recalled their elders burning both the harakeke bushes themselves and the excess material after weaving. One, however, remarked on the difference between *muka* and other harakeke varieties in this regard. That is, harakeke varieties were treated differently according to whether they were *muka* varieties used for clothing, or varieties where the leaf was used to weave mats, baskets and so on. The practice of burning harakeke is often now considered abhorrent, and is contrary to advice given in recent publications or interviews (see, for example, Puketapu-Hetet, 1989 p.5; Pendergrast, 2000 p.15; Schuster, n.d.). One explanation for this might be that this advice is often directed at a novice audience, whereas my research participants were describing weavers who were confident in their skills and knowledge, with many years of experience.

It is possible that practices such as the burning of harakeke, frequently identified as unacceptable today, may have originated in response to the commercialisation of harakeke. It is impossible to determine the full influence of the harakeke trade on Māori management practices, but certainly this trade changed the structure of many local economies. The first Pākehā trader, Captain Amos Kent, arrived in Kāwhia in 1824. After 1828 he concentrated on setting up a flax station at Kāwhia (Bass, 1993). Furthermore, there was net immigration to the Kāwhia area

in response to the opportunities to trade harakeke for guns, mainly because of the threat from Ngāpuhi (who had gained guns prior to other tribal groups, and hence were able to settle some longstanding grievances in their favour, including grievances with Waikato). The chief, Pouwhare (from Aotea) stated:

> Kawhia was the first place visited by the traders, and the people there were engaged in dressing flax in exchange for arms. The Waikatos lived here on the Waipa whence they went to Kawhia which was the first place that they went to, to trade in flax (Manuaitu Aotea Title Investigation, 1887 p.231).

In Northland, early missionaries such as Samuel Marsden also showed considerable interest in the economic potential of harakeke (Elder, 1932 pp.241-2).

The subject of insects and pests was not directly discussed in most interviews. However, two of the research participants from Northland, who are also expert weavers, did note a connection between insect numbers and the amount of excess material returned to a bush. Furthermore, all of the expert weavers among the research participants emphasised the importance of 'cleaning' harakeke, which severely reduces the amount of dead and old leaf material in and around a bush, whereas non-weavers did not report this practice. The topic of returning excess material to the harakeke bush is one that has come under scrutiny in recent years (see, for example, Scheele, 1997), because of the desire for bushes with little insect damage. However, Schuster (n.d) and Mihinui (2002) both considered that the principle behind this practice was to "*whangai i te harakeke*" or nurture the plant. Interestingly, at Aotea harbour at least three methods of disposing of remaining leaf appear to have been in use. Research participants recalled the use of pits for excess harakeke, returning excess to the plant, and also burning of harakeke.

Kerlinger (1986) has described four general ways of knowing. These are the methods of tenacity, authority, intuition and science. Traditional ecological knowledge is a form of scientific knowing, which, because of its experiential

nature, has the characteristic of "self correction" which the other forms of knowing do not have, so that practices or understandings may be moderated and knowledge modified over time. However, the knowledge presented by research participants in interviews may be a mixture of traditional ecological knowledge (passed down through generations and actively practiced by those experts), and other types of knowledge, such as knowledge based on authority. This may be so particularly where research participants are no longer actively involved in the practice of their knowledge, and where there have been breaks in the oral tradition. In other words, the presumed competence of another authority may be assumed, leading to the potential for inaccuracy in what is communicated.

The research participants from Northland are all actively involved with weaving on a daily basis, so that their knowledge is continually being extended and reinforced. At Aotea harbour, the position was somewhat different as the focus was on retrieval of family knowledge of harakeke resource management. This led to the potential for ways of knowing based on, for example, the authority of others. In this case, however, validity was increased through the triangulation of data recalled by research participants. In general, participants presented similar themes and recalled similar details about processes. The next section examines *whakataukī*, another form of the oral tradition, for ecological knowledge of harakeke.

3.5 *Whakataukī*, harakeke ecology and management

Many *whakataukī*, or sayings of the ancestors, refer to harakeke, both as a plant and in its woven form. These sayings are rich in metaphorical meaning. Hirini Moko Mead observed that for modern Māori, these sayings constitute communication with the ancestors, rather than being mere historical relics (Mead & Grove, 2001 p.9). He added that Māori "use of metaphor and their economy of words become a beautiful legacy to pass on to generations yet unborn."

Because of the cultural significance of these metaphorical meanings, I begin this section with a discussion of some of the metaphors associated with harakeke. From there, I explore the embedded ecological knowledge which is encapsulated in a group of these sayings. I discuss this knowledge, and the clues provided

therein, in relation to ecological research by the modern scientific community, and past Māori harakeke management practices. That is, my focus here is on understanding the probable literal meaning of the sayings.

Table 3.3 lists particular *whakataukī* that I have found and selected, together with their meanings and explanations from either Mead & Grove (2001), or from other recorded sources. Elder Meto Hopa has observed that knowledge of harakeke is also implied in other *whakataukī* which do not explicitly mention it[60].

***Table 3.3:* A selection of *whakataukī* with particular reference to observations of the harakeke plant**

No.	*Whakataukī*	Reference
1	*E kore a Taranaki e ngaro, he harakeke tōngai nui no roto Waiwiri.* Taranaki shall not perish: it is like the self sustaining flax of Waiwiri. The flax is nourished by the dead leaves that fall around its base (Mead & Grove, 2001 p.30).	Gudgeon, 1885, p.24; Stowell, 1911 p.125; Taylor, 1974[61] p.147; all reported in Mead & Grove, 2001 p.30. Buck, n.d.
2	*E kore au e ngaro, e kore au e ngaro, he harakeke tōngai nui no roto no Māngāmuka.* I shall not perish for I am like the dried flax plants of Mangamuka. The species survives through periods of drought and also lives on figuratively through the use of its leaves in the thatching of houses (Mead & Grove, 2001 p.30)	Stowell, n.d. in Mead & Grove, 2001 p.30.
3	*He pā harakeke he rito whakakīkī nga whāruarua.* The *pā harakeke* contains the new centre shoots which will fill the many gaps. Replacement is an underlying theme of this image.	Pou Temara, 2005[62].

[60] Meto Hopa personal communication, from a discussion on 15.6.05. Hereafter referred to as Hopa (2005). As one example, Hopa (2005) cited the saying *Ki te ngaro a reo tangata, me kīkī he manu hei tiu anō ki te muri* which notes that the voices of our ancestors cannot be heard as they have passed on, and it is therefore for the offspring (*manu* or birds) to fulfil their role in the future.

[61] First published 1855.

[62] Pou Temara personal communication, from a discussion on 2.7.05. Hereafter referred to as Temara (2005).

Table 3.3 (continued): **A selection of *whakataukī* with particular reference to observations of the harakeke plant.**

No.	*Whakataukī*	Reference
4	*He pā tīkapu e takahia e au, he pā harakeke kore e takahia, he tapu, he tapu, he tapu.* A *pā harakeke* is tapu and not to be treated as if it were a grove of tī trees.	Temara, 2005.
5	*He puawaitanga nō te harakeke* *he rito whakakī i ngā whāruarua.* The flax flowers; new shoots fill the empty gaps (Metge, 1995 p.290).	Metge, 1995 p.290.
6	*Hutia te rito o te harakeke* *Kei hea te komako e ko?* *Kī mai kī ahau* *He aha te mea nui?* *He aha te mea nui o te ao?* *māku e kī atu* *He tangata, he tangata, he tangata hi!* This *waiata* is reported by Joan Metge (1995, p.314) as a *whakataukī*: *hutia te rito o te harakeke* *kei hea te komako e ko?* *Rere ki uta* *rere ki tai.* *Ki mai koe ki au,* *'He aha te mea nui o te ao?'* *Maku e ki, 'He tangata, he tangata, he tangata.'* If the centre shoot of the flax bush were plucked, Where would the bellbird sing? It will fly inland It will fly to the sea. If you ask me, 'What is most important in the world?' I would say, 'Tis people, 'tis people, 'tis people.' (Metge, 1995 p.314)	Ngāpuhi or Ngāti Porou origin (Houia, 2005).

Table 3.3 (continued): **A selection of *whakataukī* with particular reference to observations of the harakeke plant.**

No.	*Whakataukī*	Reference
7	*Ka mahi koe i te whare o te mātā.* You are making a nest for the fernbird. This bird nests in flax swamps and thus the saying was for a person making a *pūreke*, a garment of undressed flax (Mead & Grove, 2001 p.164).	Grey, 1857 p.37; Mead & Grove, 2001 p. 164.
8	*Ka nui te harakeke, ka ua te ua. E haere ana, ka kiia, ka mate koe i te ua, ka rukuruku Hunā, ka horahora Pāpakanui.* When the flax plants are plentiful, it is a sign of much rain. So if you are travelling be warned, wrap up your fine clothing from Hunā and don your rough cape from Papakanui. The adage warns that signs should be considered and appropriate clothing worn (Mead & Grove, 2001 p.172).	Williams, 1971 p.351 in Mead & Grove, 2001 p.172.
9	*Kua tupu te pā harakeke.* The flax plantation is growing. This expression means the family is being successfully reared and is heard often at tangihanga (Mead & Grove, 2001 p. 275).	Department of Lands and Survey, 1983 p.20 in Mead & Grove, 2001 p.275; Houia, 2005.
10	*Kua tupu tōu pā harakeke* *kua aroha ki te pīpī nei, ki te kākā.* Your flax bush has grown vigorously, it has nurtured the fledgling, and the full-grown kākā. Like the flax bush the whānau in its maturity provides sustenance for all, young and old, with their varied needs. Like the flax bush, real life whānau pass through a cycle of growth, decay and regeneration (Metge, 1995 p.114).	Metge, 1995 p.114.
11	*Me he muka tāpoto.* Soft as flax which can be cleaned (without being scraped); ie quickly (Grey, 1857 p.69). Kāretu translated this as "Like a superior kind of flax fibre." (Brougham & Reed, 1987 p.117).	Grey, 1857 p.69; Brougham & Reed, 1987 p.117; Te Rangikaheke, 1849 p.111 in Mead & Grove, 2001 p. 296.

Table 3.3 (continued): **A selection of *whakataukī* with particular reference to observations of the harakeke plant.**

No.	*Whakataukī*	Reference
12	*Me te wera harakeke, me te ahi tōtara.* Like a flax fire and burning tōtara. The loud cracking noise which accompanies these events was said to resemble the gunfire of Ngāpuhi at Toka-a-kuku, Te Kaha, where under the leadership of Te Wera Hauraki they combined with Ngāti Porou to attack Te Whānau-ā-Apanui (Mead & Grove, 2001 p.307).	**Tarakawa, 1900 p.69 in Mead & Grove, 2001 p.307.**
13	*Parapara waerea a ururua.* *kia tupu whakaritorito te tupu o te harakeke.* Clear away the overgrowth so that the flax will put forth many young shoots (Metge, 1995 p.134).	**Metge, 1995 p.134.**
14	*Ruatāhuna kākahu mauku.* Ruatahuna clad in fern cloaks. The absence of flax of an acceptable variety for weaving meant that at times dwellers of this Urewera region had to make do with mauku (*Asplenium bulbiferum* and *Hymenophylllum* sp.), a kind of fern, for rough clothing. This gives an indication of the limited resources available to people of the region. Interpreted by those people as a positive statement of a hardy tribe (Mead & Grove, 2001 p.351).	**Best, 1942 p. 355; Brougham, 1975 p.86 in Mead & Grove, 2001 p.351.**
15	*Taranaki te tama a Mahirua* *Te tamure unahi nui* *Te harakeke to mai i roto o Waiwiri.* Taranaki is descended from Mahirua, who was like the many scaled snapper, for his warriors were as numerous as the snapper's scales. They were also like the flax plants drawn out of the lake of Waiwiri which is full of flax. (Grey, 1857 p.84). Karetu's revised version of Brougham & Reed noted that "the flax of Waiwiri grew in such profusion that when gathered, the multitude of bushes seemed as great as ever" (Brougham & Reed, 1987).	**Grey, 1857 p.84; Brougham & Reed, 1987 p.110.**

Table 3.3 (continued): **A selection of *whakataukī* with particular reference to observations of the harakeke plant.**

No.	*Whakataukī*	Reference
16	*Tūngia te ururoa, kia tupu whakaritorito te tupu o te harakeke.* When the scrub grows too thick, burn it down and the flax will shoot up in sprouts. Clear away what is bad and the good will flourish (Grey, 1857 p.93). Kāretu has translated this as "Set the overgrown bush alight and the new flax shoots will spring up" (Brougham & Reed, 1987 p.96).	Grey, 1857 p.93; Ihaka, 1957 p.42; Colenso, 1879 p.119 and Williams, 1908 p.11, both in Mead & Grove, 2001 p. 410; Brougham & Reed, 1987 p.96.

3.5.1 Metaphorical associations: *He harakeke, he whānau*

Weaver Toi Te Rito Maihi (1990) referred to one of the most important ideas associated with the harakeke plant when she described how the folds of the harakeke, the flax leaves, resemble the family:

> The mother enfolds the child, the father encloses both, the grandparents enclose them all. The tremendous binding strength of the flax, as of the family, is invisible to the eye and lies in its roots.

This central idea of the harakeke plant as the family is prevalent in many contexts, and this can be seen in the sayings in *Table 3.4*. Pou Temara described this image of the family as an essential part of formal speaking or *whaikōrero* (Temara, 2005). Thus, for example, on attending *tangi*, or mourning ceremonies, one will sometimes hear the saying *kua tupu te pā harakeke*. The deceased is seen as the young shoot of the harakeke who has grown within the embrace of his or her family, and now makes way for the new shoots to grow in turn (Houia, 2005). The *pā harakeke* is a well known metaphor for the wider family, and is seen in the sayings such as *aitia te wahine o te pa harakeke*[63] (Pendergrast, 2000 foreword; Mead & Grove, 2001 p.15). This exhorts a man to marry a woman capable of rearing a family. As with many sayings, however, there is information on a number

[63] Marry the woman of the flax cultivation.

of levels, and the virtue of a woman who weaves is also acknowledged. The images also provide a blueprint for human behaviour and whānau togetherness, such as *he pā harakeke, he rito whakakīkī* (Temara, 2005; *Table 3.3*). Nurturing the young harakeke shoots is inherent to these images. By providing a blueprint for human relationships and behaviour, the *tuakana – teina* relationship of harakeke and humans is emphasised (Temara, 2005).

The linking of harakeke with people must surely be one of the most potent images in the Māori language. As Meto Hopa observed, the reference to burning harakeke in proverb no. 12 (see *Table 3.4*) also describes the "burning of our tūpuna with musket fire. It says that the harakeke are our tūpuna. We here today are the rito" (Hopa, 2005). Tōtara (*Podocarpus totara*) is excellent kindling wood, although it crackles and throws out sparks. These combine in a graphic image which may well date from the time of the conflict in the 1820s.

Another image of the *pā harakeke* is inscribed in Best's retelling of the tale of why some Tūhoe chiefs decided not to go to war against Ngāti Whare and Ngāti Manawa when asked to do so (Best, 1972 pp.466-467). Best translated their reply as "It would be well, had not the pa ti and pa harakeke not grown up at Te Whaiti. I can scale a lofty mountain, but I cannot disregard important persons."[64] Here, the *pā tī* and the *pā harakeke* are used as terms for the Ngāti Whare and Ngāti Manawa peoples: both tī and harakeke were cultivated by Māori. Thus Tūhoe were growing children at Te Whaiti, because of their close links through marriage to the people there. The *pā harakeke* is therefore used as a potent symbol for people. Indeed many weavers might consider that they care for their harakeke bushes as they might nurture a child.

These resonances are also apparent in the ways in which Māori see the art of weaving. One of the greatest contemporary Māori poets, Hirini Melbourne, wrote in Toiapiapi "[o] nga io me nga whenu o te whariki matauranga Māori . . ." [65]

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[64] Best's own translation of the Māori: *E pai ana to kupu, mehemea kaore te pa ti, te pa harakeke, kua tupu ki roto o Te Whaiti. He maunga tiketike ka taea e au; he tangata tiketike e kore e taea.*

[65] Of all the threads that make up the warp and weft of the *whāriki* of traditional knowledge.

(Melbourne, 1993). Another elder described the ritual welcome or *karanga* given by the women in terms of harakeke, saying metaphorically that "The welcome mat is unrolled. The *karanga* is a weaving between the women of the *tangata whenua* and *manuhiri*, and thus Hineteiwaiwa the goddess of weaving is present. Metaphorically, harakeke is embedded in the welcome" (Houia, 2005). Even the simplest woven article is imbued with deeper meaning. Thus, the commonly heard saying: *ko taku rourou, ko tou rourou, ka ora te iwi*[66] demonstrates that *kete* were not just receptacles for containing and carrying things. Buck (1923, p.725) mentioned the use of *kete* in relation to "incantations and mystic rites to enclose the miraculous", and briefly related the story of Tāne collecting stars in four named baskets to adorn Rangi the sky father, and that of Tāne and the three baskets of knowledge. Best (n.d., p.66) mentioned that the *kete rauroha* was the mat in which the *whānau riki* and *whānau punga*, both stars, were placed. Yet another writer compared the process of analytical thought to creating a *kete*, writing: "Tenei aku mahara kai te ruru, me he kete, i taku whanaketanga i te iti mai te kore"[67] (Anon., 1928).

Allusion and metaphor in Māori thought frequently link the human family and the whānau of the forest, swamp, seashore and other natural areas. In 1983, weavers from throughout the country met together at a national weaving *hui* at Tokomaru Bay. Their vision was "Ka raranga tonu tatou i a tatou"[68]. This alludes to the ways in which the whānau weaves itself together, and our relationship with the natural world, including plants such as harakeke. This is true not only of harakeke, but also of other plants such as pīngao[69]. One moving example alludes to the mounds of pīngao lost in the seafoam in the farewell or *poroporoaki* for Heemi Waitere ki Papawai, a child who died on 8 June 1903 (Waitere, 1904)[70].

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[66] With the contribution of both your food basket and mine, the wellbeing of the people is assured.

[67] These are my thoughts which are being woven together like a kete from nothing to something small.

[68] Let us weave ourselves together (Brown & Maihi, 1993).

[69] Pīngao is a sought after weaving plant which grows primarily on the sand dunes, and was previously common in many parts of New Zealand.

[70] Another reference linking pīngao and people who live by the sea is included in a letter by Hapi Takimoana from Te Kao about *aroha*, called '*Te Rerenga Wairua*' (Takimoana, 1922).

Other *whakataukī* refer to the inherent qualities of harakeke. Thus, *te tīpona harakeke e taea te wetewete, te tīpona o te aroha, mau tonu*[71] takes the strength of the harakeke as a starting point to comment on the durability of human bonds (Houia, 2005). Salmond (1997, p.207) has discussed the phrase '*muka tangata*' suggesting that the *muka* threads represent genealogical lines. In her view, harakeke threads, strands, ropes and lines are persistently linked in Māori language with talk of relationship and ancestral power (Salmond, 1997 p.207). These are but a few examples of sayings which are rich with metaphorical meaning. A full analysis and discussion of these would demand another, different thesis. However, these few sayings *do* demonstrate the acute observation of nature woven into Māori values and experience.

3.5.2 Ecological themes and processes

The ecological themes embedded in these *whakataukī* relate not only to the autecology of the harakeke but also to the ecological processes which operate in the plant and animal communities. These are recognisable in a modern ecological context. I have summarised some of the processes embedded in these *whakataukī*, using terminology from modern scientific work (see *Table 3.4)*.

Growth and nutrients

A number of the ancestral sayings refer to the growth of young shoots into gaps left by removal of adult leaves, or by the removal of the flower stalk. This most central of observations refers to the need for light and space by young plants in order to grow. Similarly, the need to weed, and to destroy overgrowth that competes with young plants in particular, is identified.

[71] The knots of the harakeke can be undone, but the bonds of relationships between people remain.

Table 3.4: **Ecological processes identified in *whakataukī*, and associated scientific explanations**

Whakataukī number[72]	Ecological process	Scientific explanations
3, 6, 9, 13, 16	appropriate thinning or removal of harakeke or weeds, to allow the shoots room to grow	• space and light requirements identified for growth of young shoots • competition
3, 5	growth and multiplication of harakeke fans	• rhizatomous root growth habit • identical genetic complement of vegetative stock
1	dead leaves left to nourish plant	• decomposition and breakdown of leaf material to release nutrients
1, 3, 5, 9, 10, 16	life cycle of growth, degeneration and decay	• nutrient cycling and organic processes • inter-relationships distinct at different life cycle stages
2, 8, 14, 15	environmental tolerances and limitations	• distribution and growth is limited by environmental conditions such as rainfall, drought, sunshine hours, nutrient availability
12, 16	fire ecology: burning of undergrowth, new shoots arise	• seed germination processes in response to fire • regeneration of plant • fertilisation of soil with ash
5, 6	flowering[73]	• nutrient requirements for flowering • seasonal cycles • indicator of plant vigour
6, 10	pollination	• pollination by bellbirds and kākā • mutual relationships of plants and animals
6, 7, 10	ecological niches	• nesting habitat of fernbird in harakeke swamps
1, 6, 7, 10, 15	understanding ecological communities	• relationship of kākā and harakeke • relationship of bellbird and harakeke • swamp community interrelationships

[72] *Whakataukī* number refers to the number in *Table 3.3*.

[73] Note too that flowering of particular species is also often used by Māori as an indicator of vigour (or potential harvesting success) of other species, such as shellfish (see, for example, the Hauraki Customary Indicators Report (Hauraki Māori Trust Board, 1999)).

Some of the *whakataukī* appear to describe landscape scale processes. *Parapara waerea te ururua kia tupu whakaritorito te tupu o te harakeke* (no.13, *Table 3.4*) is one of these. Leach (2005) has examined the pragmatic meaning of 'waere', suggesting that it implies the process of clearing for cultivation by cutting down wood or trees. As Meto Hopa explained, *waerea* is a powerful word in this context, as *karakia waerea* are one of the most important forms of *karakia* for Māori. These *karakia* are often associated with Taranaki and Waikato people, and are recited when a group enters a marae. The purpose is "to safeguard the people by clearing the pathway of anything evil" (Hopa, 2005). The pragmatic origin here may refer to the need to ensure harakeke growth through clearing the land of overgrowth. This will provide the best results, and the best quality harakeke required by the people (Hopa, 2005).

The *harakeke tōngai nui* referred to in several of the *whakataukī* in *Table 3.3* literally means a great abundance of harakeke, such as that found in many swamp areas. The commentaries also describe it as "self-sustaining" harakeke, an idea that was supported by the elders to whom I spoke. The reference to dead leaves providing nourishment to the living plant which appears to be embedded in the *whakataukī* seems to refer to the nutrient requirements of harakeke for growth, and maintenance of the high fertility required to prevent wetland succession. Harakeke favours a relatively high nutrient environment and can be classed as an initial coloniser of, for example, poorly drained depressions on river terraces or basins (Clarkson, 2002 p.53). It is possible that the maintenance of high nutrient levels through this type of nourishment may help prolong this phase of swamp development, thus making it "self-sustaining".

Habitat and environmental parameters

Information about harakeke habitat is also provided. One *whakataukī* suggests that harakeke may grow in areas with a high rainfall. On the other hand, it is also suggested that harakeke can withstand drought (at Māngāmuka). Sayings such as these assume an understanding by the listener of the environmental conditions where harakeke is generally found. Otherwise, the *whakataukī* would make little sense. It therefore appears likely that basic knowledge of harakeke ecology and management was previously well known by Māori.

Regional differences are remarked on, so we know, for example, that harakeke in Taranaki was abundant, but lacking in Ruatāhuna (no.14, *Table 3.4*). Both of these sayings suggest that harakeke is synonymous with great riches, and indicate its value in society. However, its lack in Ruatāhuna in the Urewera, a primarily forested area, and consequent replacement with mauku, also provides information about environmental tolerances. Environmental tolerances of harakeke are investigated further using herbaria data in *Chapter 6.*

Fire responses

Mead & Grove (2001, p.410; no.16, *Table 3.4*) have suggested that the real lesson of the ancestral saying *tūngia te ururoa kia tupu whakaritorito te tupu o te harakeke* is to clear away the old and redundant plants so that the good may grow vigorously. However, in ecological terms, there is a great deal more to this *whakataukī.* It indicates that Māori observed the regrowth of harakeke shoots after fire. Further, it seems to refer to the burning of overgrowth or brushwood as a means of germinating shoots. This *whakataukī* therefore seems to suggest the deliberate use of fire to invigorate *pā harakeke.* This management practice has implications for landscape use and change.

Another *whakataukī* which refers to the crackling of harakeke as it burns (no.12, *Table 3.4*) again emphasises that Māori had indeed observed the burning of harakeke, and were familiar with the accompanying sound. Together with *tūngia te ururoa,* it suggests an emerging agent of landscape modification which has not previously been considered for harakeke. Harakeke is one of a small number New Zealand plants which recovers well after fire (Johnson, 2001), both via rhizatomous growth and seed germination[74].

Ecological niches and ecological communities

A number of *whakataukī* demonstrate systemic understandings in connection with harakeke ecology. In particular, the ecological relationships of bellbirds, kākā (*Nestor meridionalis*) and fernbirds or *mātā (Bowdleria punctata)* are mentioned.

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[74] Cockayne (1898) observed a similar result for wharariki.

First is the observation that fernbirds nest in harakeke swamps: this *whakataukī* (no. 7, *Table 3.4*) refers to a person making a *pūreke*, a garment of undressed flax. Two similar *whakataukī*, *ka mahi koe i te whare o te tieke*[75] and *ka mahi koe i te whare o te pītongatonga*[76] (Grey, 1857 p.37; not listed in *Table 3.4*) refer to associations between saddlebacks (*Philesturnus carunculatus*) and kiekie (*Freycinetia banksii* var. *baueriana*), and the nests of pitongatonga[77] with toetoe (*Cortaderia toetoe*) in swamps. Different bird habitats are clearly identified in this group of *whakataukī.*

The image in *hutia te rito* emphasises the interdependent relationship of plants and animals. Bellbirds (or korimako) are nectar drinkers and have an essential role in the pollination of the harakeke (Craig & Stewart, 1988). Further, it reminds us of weaving resource management practice, which emphasises the importance of leaving the young growing shoots or *rito* in the harakeke bush. If these shoots are removed, the bush would be destroyed, so that the bellbird would have nowhere to land and would be forced to fly elsewhere. Reference is also made to bird fledglings of any species, and adult kākā, both of which receive sustenance from the harakeke bush. Kākā do not appear to have been recorded in association with harakeke in modern scientific work. In fact, the only other source for this is Thomson (1909, 1927). This *whakataukī*, therefore, highlights the important role that oral traditions have in providing reference points for restoration of natural areas. Knowledge and understanding of historical ecosystems is essential prior to embarking upon restoration projects. Kākā populations have severely declined over the last 100 years, so that only limited opportunity for observing this phenomenon is possible. However, both harakeke pollination and the provision of nectar for kākā are important ecosystem functions. Metge's translation of this *whakataukī* refers to the fledgling bird (of any species) being sustained by the harakeke bush, as well as adult

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[75] You are making a saddleback's nest.

[76] You are making a pitongatonga's nest.

[77] This name seems to have fallen somewhat into disuse. However, Hopa (2005) believes that it possibly refers to the silvereye (*Zosterops lateralis novae-seelandiae*), an immigrant from Australia in the early 19th century, which is known to nest in swamps.

kākā. Again, this suggests ecosystem interconnectedness which is now often absent or under threat because of ecosystem and habitat fragmentation.

A number of themes relevant to the resource management of harakeke emerge from these *whakataukī* (see below). For example, one of the important principles exemplified in *hutia te rito o te harakeke* (no.6, *Table 3.4*) is the replacement of whatever has been taken away. Beneath the question *kei hea te kōmako, e ko*?" lies the requirement that "something must be left to take the place of what has been taken" (Hopa, 2005). This applies not only to people, but also to sustainable management of resources.

Hutia te rito begins by asking where the bellbird would sing, if the central shoot of the harakeke plant was to be pulled out. According to Metge (1995) the song emphasizes the importance both of people generally, and of each individual. On one level, this draws attention to the fact that the actions of each one of us are important. This tenet is certainly true in terms of resource management. Interestingly, the central shoot is used by *tōhunga* (for example, to launch a new net; Best, 1952 p.264) and has other links to the spiritual world. Best (1942, p.27) recorded that harakeke leaves were often used in divinatory rites. The relationship between the central leaf and spiritual practices underscores the importance of this leaf.

It is possible that *hutia te rito* is of later origin than many other *whakataukī*, as the philosophical thrust of the *whakataukī* is different. In Māori thought, the *tuakana-teina* (older and younger sibling) relationship of humans and the natural world is emphasised. Thus, the *tuakana* status of harakeke is recognised through its role in creating a blueprint for human behaviour. However, *hutia te rito* states that people are the most important thing in the world. This seems to contradict traditional Māori thought, and one reason for this might be that this *whakataukī* originates from a Judeo-Christian world view rather than a Māori one (Temara, 2005).

3.6 General Discussion

Key themes relevant to harakeke ecology and management were identified by research participants. As well, ecological information embedded in *whakataukī* has been highlighted. Both cultivation of harakeke and use of natural areas were

discussed by research participants, as well as particular use of harakeke varieties, and practices associated with harvesting. These practices have implications for harakeke pest management, nutrients and soil enrichment, and growth. The abundance of harakeke in Taranaki (and its absence in Ruatāhuna) was noted in the *whakataukī*, again emphasising the importance of the natural resource. Similarly, the fame of Taranaki in relation to its harakeke supports the idea that 'natural' stands of harakeke were highly valued (see *Chapter 4* for further details). Management practices in relation to harakeke cultivation were referred to by the research participants, and embedded in *whakataukī*, although the details differ. Both interviews and *whakataukī* seem to suggest that active management of harakeke was undertaken. However, interview material tended to focus on care of harakeke bushes, while *whakataukī* provided information relevant to ecological inter-relationships and processes and landscape scale transformation.

There are some interesting relationships between the two groups of material. For example, research participants recalled the use of fire to burn excess harakeke, and the occasional burning of harakeke bushes to clear areas of land, but the use of fire to germinate harakeke or enable new growth was not discussed. On the other hand, the germination of harakeke after fire was clearly identified in *whakataukī*. The use of fire in relation to harakeke is an area which requires further exploration. However, research participants indicated the value and use of natural stands of harakeke in both Waikato and Northland. It can therefore be seen that there is great value in maintaining the many different parts of an oral tradition as, taken together, they form a coherent whole. The observations and practices identified in this chapter form a baseline level of information to be explored further in the subsequent chapters. In *Chapters 4 and 5*, I critically analyse written historical sources pertaining mainly to the 19th century and the first 20 years of the 20th century.

Chapter 4

Analysis of Māori use, cultivation and dispersal of *Phormium* varieties as indicated in written historical record

Kua tupu te pā harakeke

4.1 Introduction

One of the central aims of this thesis is to recover and explore the Māori ecological knowledge and historical experience of harakeke which underlies an hypothesis of active management of harakeke by Māori with resulting modification of the New Zealand landscape. Although there is considerable evidence to indicate that harakeke has been an essential weaving resource for Māori for hundreds of years (see *Chapter 1*), New Zealand scientists have only recently begun to consider the possible significance of Māori ecological knowledge of harakeke. This chapter provides a critical analysis of historical records ranging from the late 18th century to the early 20th century in relation to active management of harakeke by Māori, and particularly cultivation and dispersal. The aim of this chapter is to illuminate Māori experience and knowledge of harakeke prior to the 20th century with regard to the main hypotheses (see p. 28). The central research questions here are:

- How did Māori use of harakeke contribute to active management of this species?
- What was the extent of harakeke cultivation?
- To what extent did Māori actively transport harakeke around the country?

Although I refer to historical classifications, uses, and management of harakeke, it should be borne in mind that harakeke use and management is an ongoing and dynamic tradition, so that the type of knowledge referred to here also remains part of contemporary oral tradition. In this chapter, however, the focus of the research is past use and management.

Lack of awareness of Māori ecological knowledge by botanists in the early 20th century is evident in the fact that Cheeseman (1925, p. 1) begins what he refers to as 'the history of botanical discovery' with the arrival of Europeans in New Zealand. A similar lack of awareness is evident in the work of other early 20th century botanists. Thomson (1909) omitted Māori knowledge from his naturalists' calendar. Although Cockayne (1923) included harakeke in his book on the cultivation of New Zealand plants, he made no reference to Māori knowledge. Crookes (1926), in a publication entitled *Plantlife in Maoriland*, provided a brief romantic presentation of harakeke as the offspring of Tane and Pakoiti [sic] and then went on to describe the environmental conditions suitable for harakeke and its industrial potential without any reference to Māori knowledge. Other works by botanists such as Cockayne (1919, 1958, 1967) and Easterfield (1917) also omit any reference to Māori ecological knowledge, remaining firmly within a European context in terms of description, taxonomy and botanical classification. Cockayne's letters to botanical colleagues briefly mentioned harakeke (Thomson, 1979), but only in the context of its economic value. Even work as recent as that of Poole (1967) begins an account of land and vegetation use with European settlement.

As early as 1855, Taylor (1855, p.vi), had lamented that the customs and traditions of Māori people were being rapidly forgotten. Certainly, by the 20th century, the picture presented is one of eroded knowledge and practice. Even so, there were some exceptions to a general trend towards the marginalisation of Māori knowledge. Cheeseman (1900) mentioned Māori cultivation of food plants, and, in a book on naturalised plants in New Zealand, Thomson (1922, p.7) pointed out that the Polynesians were 'great cultivators', providing a brief discussion of food crops such as kumara (*Ipomoea chrysorrhiza*), taro (*Colocasia esculenta*), gourds (*hue; Cucurbita* sp.) and tī (pp.11-12). Martin (n.d., p.142) briefly recorded Māori uses for harakeke and some other plants (although he provided very little detail). With regard to harakeke, Bledisloe noted in a lecture to the Cawthron Institute (1932, p.49):

> There promises to be a healthy revival of a form of husbandry, about which enlightened growers of the Māori race a century ago appear to have

had more botanical knowledge, although empirical, than that possessed by the present generation.

However, comments by Colenso (1868a) indicate uncertainty in relation to the concept of harakeke cultivation:

> The Harakeke. . . of which there are many varieties, was sometimes planted but not largely so; more to have it handy, or to secure a prized variety, than with a view to cultivation or to improve its fibre.

Moreover, influential scholars such as Roth (1979[78], p.18), who examined Māori weaving in the early 20th century, wrote that "there does not appear to have been much cultivation of the plant [harakeke] before the advent of Europeans, although what they cultivated was well done". McCay's 176 page analysis of harakeke in history included only 18 pages on Māori usage, much of which described the process of stripping (McCay, 1952). Furthermore, Critchfield (1951) claimed that Māori "did not actively cultivate *Phormium* but for convenience did transplant a few of their most desired varieties near their settlements". These views have not been effectively challenged although Harris et al. (2005), for example, have recently stated that "[it] is *uncertain to what extent* early Māori cultivated selected varieties" (emphasis mine). Cultivation is an important method of ensuring supply of a valuable plant resource, yet Māori use and cultivation of harakeke appear to be largely disregarded.

It is clear from contemporary literature and oral tradition that Māori knowledge of harakeke remains part of contemporary weaving practice (see, for example, Te Kanawa, 1992; Schuster, n.d.). Recent literature has indicated a revived interest in traditional Māori management of harakeke (see, for example, Puketapu-Hetet, 1989; Scheele & Walls, 1994; Mihinui, 2002). This literature provides detailed evidence of some aspects of the resource management of harakeke. Expert weaver Puketapu-Hetet (1989) has described the management and use of harakeke by weavers in an holistic manner, while Mihinui (2002), also a weaver of many years experience, detailed some of the practices undertaken by contemporary

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[78] Originally published in 1923.

weavers in caring for their harakeke bushes, and noted the importance of sustainable use principles. These writings have focused on current use and practice which has been passed down through families. As is the case with much Māori knowledge, these writers have emphasised the learning and experience of knowledge within their own families and hapū. It is therefore not possible to determine directly from these writings how harakeke was used and managed more generally in the 19th century (although some useful hypotheses can be derived from them). Furthermore, oral traditions are constrained by their tendency to say less about remoter periods. For example, Puketapu-Hetet (1989, p.10) and Pendergrast (1987, p.11) have both suggested that in pre-European times harakeke plantations were found near settlements, but it is difficult to present supporting evidence from the oral tradition. The recollections of expert weaver Rangimarie Hetet, growing up in the 1920s around Oparure in the King Country, also indicated that harakeke was cultivated (Paki-Titi, 1998), but explicit details were not provided. Nor are issues relating to the *extent* of cultivation directly addressed. Thus, the extent, the details and importance of cultivation, particularly prior to the 20th century, remain uncertain. One aim of this research project, therefore, is to identify and analyse early references to cultivation and cultivation methods of harakeke.

I have hypothesised that cultivation of selected harakeke varieties was an important long-term strategy for Māori to ensure ongoing access to, and sustainability of, this resource. If harakeke was, in fact, widely cultivated, this would also have resulted in changes to the New Zealand landscape. In this chapter, I search the historical literature for evidence of harakeke cultivation or otherwise.

Plants from one species, such as harakeke, may have different morphological characteristics, and thus be termed varieties. Varieties, often called 'cultivars' by horticulturalists, can be defined as "deliberate selections from wild plants, maintained in cultivation" (Walls, 1988 p.14). Although morphological variation may arise where plants are subject to different environmental conditions, different cultivars occur when plant seed outcrosses when flowering to create plants that are genetically different from their parent plants. This genetic difference may be

expressed morphologically, and the categorisation of varieties generally relates to morphological characteristics. The classification of different cultivars may not be a pressing concern for botanists (although this was investigated in some detail by Cross (1912, pp.30 ff.)), but is culturally important to Māori weavers because of the importance of harakeke, and its fibre extract, *muka*. The names used by Māori refer both to varieties in cultivation and selected plants growing in the wild (Heenan, 1991 p.6). There is, however, considerable contemporary confusion about variety nomenclature, and I address this confusion in relation to wharariki, *tīhore, tākirikau* and *tāpoto* in *Appendix 3*.

There is widespread agreement in the botanical literature that Māori identified particular varieties for use (see, for example, Cross, 1912; Allan & Zotov, 1937; Poole, 1940; Poole, 1946; Critchfield, 1951; Anderson, 1954; Harris & Woodcock-Sharp, 2000). Recent publications on harakeke and weaving also emphasise the traditional selection of particular cultivars for use. A catalogue of harakeke varieties was created in the 20th century by Rene Orchiston, who collected specimens now maintained as a national collection at Landcare Research in Lincoln (hereafter referred to as the National Flax Collection). Rene Orchiston began this task in the early 1960s when she saw weavers on the East Coast using inferior kinds of harakeke for their work due to an extreme shortage of the special varieties needed for different types of articles being produced (Orchiston, 1987; Scheele & Walls, 1994 p.4). She visited marae in the Gisborne district, along the East Coast and further afield in order to collect plants. She also collected plants from elderly weavers, old camp sites in the high country and other sources. Rene Orchiston also recorded information about their qualities and uses[79]. The management and use of different varieties appears therefore to have been important and so should be reflected in any assessment of landscape change and modification with regard to harakeke. I have therefore attempted to analyse the information that does exist about cultivars to determine patterns of possible use.

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[79] The only written records currently available which contain the information she has gathered are the Orchiston papers (1987) in the Turnbull library, and what is published in Scheele and Walls (1994).

Contemporary weavers share valued varieties which are thus dispersed around the country. Dispersal of highly valued varieties of harakeke can be seen as a useful resource management strategy which is linked to cultivation. It was, however, only with limited success that McBreen et al. (2003) attempted to determine origins and interrelationships of cultivars represented in the Rene Orchiston Collection using molecular techniques. This research project includes an attempt to analyse evidence of the extent and specifics of harakeke dispersal from historical records.

4.2 Methods

Critical issues in historical research are outlined in *Chapter 2*. Here, I describe the main information source on harakeke for both this chapter and *Chapter 5*, the Report of the Flax Commissioners and Appendices, and describe specific methods used in the data analysis.

The Report of the Flax Commissioners and Appendices (also abbreviated as RFC; 1870-1872) form the most comprehensive historical records referring to harakeke. For this reason, a brief introduction to this source is provided here. The Flax Commission reported to the House of Representatives from 1870 to 1872. Its primary purpose was to investigate different varieties of harakeke with a view to determining which might have fibre suitable for commercial use. The Commissioners scrutinised aspects of Māori practice in relation to different varieties, mainly via reports received from different districts. These provide valuable information about harakeke from around the country. The information recorded covers a range of material provided by both Māori and non-Māori, with Wi Tako, for example, being a prominent informant in the Waikanae district. Unfortunately, most Māori informants were not named. It seems, however, that at least one knowledgeable Māori woman was involved in the process. Nonetheless, most reports were from Europeans involved in the fibre export industry, including Kelly, Hutton, Heaphy, Woon and Hursthouse. The great majority of other historical records were written by European (that is, non-Māori) men despite the fact that almost all weavers in 19th century New Zealand were Māori women. This relates generally to the *raison d'etre* of European investigation into harakeke,

which was to extract fibre from harakeke on a commercial scale for export. As such, clear biases in the type of information recorded are evident.

In the following analysis, I have treated different informants as separate sources when they appear in the same report or document but the information is individually attributed. For example Nairn, who contributed information from Hawke's Bay, is listed separately from Wi Tako, who reported on harakeke from Waikanae, although both appear in the Report of the Flax Commission. Unidentified Māori have also been listed as separate sources where it is possible to separate them by district.[80] In a small number of cases, however, it has been impossible to separate unidentified Māori from the same place in the same document, and these have been treated as one source in lieu of any further material to determine whether they are the same or different individuals. Identical information from the same source is listed under the first publication record although it may also have been republished in subsequent years.

Where the same variety name is given by different authors, I have assumed that it does, in fact, refer to the same variety, although in a small number of cases this may not be the case. Likewise, I have assumed that different variety names represent different varieties, unless otherwise indicated. Where early authors have indicated that different variety names are synonyms, I have in most cases combined the data (see *Table 4.1* for synonyms which may not be immediately evident). Thus, for example, data for *atiraukawa* and *hateraukawa* have been considered together because Best (n.d., p.33) has identified them as the same variety. However, if there seems to be some doubt, as there is in the case of, for example, *atiraukawa* and *oue*[81], these have been identified separately. Spelling inconsistencies are a feature of early sources, particularly those written by authors with little knowledge of the Māori language. Thus, for example, *aonga*, *aohanga*

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[80] Many early commentators such as Hursthouse unfortunately use terminology and present ideas which are unacceptable and often highly offensive to readers today. In reporting these, I do not endorse the attitudes conveyed in the source literature although it *is* important to note that sources must be viewed in the context of the historical period out of which they emerge.

[81] Heaphy (1869) claimed they were the same; but cf. Kelly (1866) who identified atiraukawa as a *hāro* variety.

and *awanga* are all variations of the same name, while 'wharariki' is listed variously as *wahararipi*, *warariki*, and *wharaeki*. These variant spellings have been standardised where the representation appears straightforward. Additionally, there are a number of names listed which may not be varieties, but rather classes of harakeke (such as *tīhore, tāpoto,* and *wharanui*; see *Appendix 3*) so it is impossible to count varieties exactly. The three classes above are not included in counts of varieties.

Table 4.1: **Variety synonyms identified in 19th and early 20th century sources**

Variety	Also said to be called	Source
aonga	*awanga, aohanga*	Kelly, 1866; Tregear 1904; Best, 1942 p.101
atiraukawa	*hateraukawa, katiraukawa*	Buck, 1911
awanga	*tamure*	Colenso in Best, 1908
kopakipaki-ika	*aroro-wharawhara*	McGregor in Best, 1908; Department of Agriculture Report, 1908
mataroa (Whanganui River)	*tākirikau (East Coast)*	Buck, 1911
*motu-o-rui**	*awanga*	Heaphy, 1869; Buck, 1926
ngutuparera	*parera*	An unidentified Māori in RFC, 1871
*oue**	*tāpoto*	Heaphy in RFC, 1871; Hector, 1889
paritaniwha	*poitaniwha, ngutukaka*	Jenkins in RFC, 1871
*rataroa**	*motu-o-ruhi*	Best, 1908; Te Hiko in Best, n.d. p.33
rauwharariki	*wharariki*	Ngata & Jones, 2004 Vol 2 pp. 64-66
takaiapu	*kiapu*	An unnamed Māori in RFC, 1871; Kelly in Hector, 1889
tāpoto[82]	*tīhore, tākiri, tākirikau (East Coast)*	Locke in RFC, 1870 p.9
tarariki	*wharariki*	Buck, 1911; Best, 1942 p.101
tīhore	*oue=tāpoto*[83]	Hutton in Hector, 1889
tutaewheke	*tutaiwiki*	Hursthouse in Hector, 1889
wharariki	*kōrari-tuahu*	Best, 1942 p.101

* records considered separately

[82] This is a class rather than a variety (see *Appendix 3*) but is included in this variety list for clarification of synonyms.

[83] For a discussion of *tīhore, takirikau, tāpoto* and *oue*, see *Appendix 3*.

For the regional analysis of varieties, nine broad categories were constructed to reflect regional differences (*Table 4.2*). Records which could not be clearly located using tribal or regional markers are excluded from this data set.

***Table 4.2:* Regional categories used in the analysis of regional differences, showing the contributing districts and iwi**

Broad Regional Category	Contributing Districts or Iwi
Bay of Plenty	Ngāti Awa, Tūhoe, Whakatāne, Bay of Plenty
East Coast	East Cape, Hawke's Bay, Napier, Te Whānau-ā-Apanui
Hauraki	Hauraki, Thames
Ngāti Tūwharetoa	Ngāti Tūwharetoa, Taupo
Northland	Bay of Islands, Northland
Taranaki	Ngāti Ruanui, Taranaki, Opunake, Urunui, Patea, Waitara
Waikanae/Manawatu	Otaki, Ngāti Awa from the Hutt Valley, Waikanae, Manawatu
Waikato	Maungatautari, Raglan, Ngāti Apakura, Waikato, Waiuku
Whanganui River	Whanganui River, Pipiriki, Ngā Rauru

4.3 Classification, identification, and variety numbers

Descriptions of New Zealand 'flax' by Māori in the 19th century can be organised into hierarchies, or levels, of classification. First, Māori distinguished between harakeke and wharariki[84], which are generally thought to correspond to the two species of *Phormium*, known to botanists as *Phormium tenax* and *Phormium cookianum* respectively. Representations of Māori classification systems for *Phormium* from the 19th and early 20th century are discussed in *Appendix 3*, so only an outline is given here. However, in the descriptions which seem to best represent Māori classification systems, harakeke stripped with the nails of the hand is referred to as *tīhore*, while that stripped with a *kūkū* shell (*Mytilus* spp.) is

[84] *harareke* and *kōrari* are listed as alternate names for harakeke, and *kōrari-tuauru* and *tarariki* for wharariki by Best (1942, p.101).

referred to as *hāro*. This classification is consistent with the methods used for extracting fibre in traditional Māori garment manufacture. Hori Ropiha emphasised this delineation, writing "[ko] o te maori kakahu he mea haaro ki te harakeke, ka whatua hei pokeka; na, ka oti he kahu pai tena. Na, ko te koroai, me te kakahu, he mea takiri ki te harakeke. Ka riro mai te whitau, na, ka mirohia e te wahine . . . " (Ropiha in Best, n.d.).[85] The differentiation of harakeke into *tīhore* and *haro* varieties is a fundamental one for weavers (clearly identified by Hector, 1889 p.3), and forms the basis of harakeke fibre use by Māori.

Some 19th century writers such as Kelly (1866) provided examples of varieties which represented types of *tīhore* or other classes of harakeke (see *Appendix 3*). Large numbers of harakeke varieties were listed in the Report of the Flax Commissioners and the Appendices to that report, along with their place of origin and authority (Appendix IX to the Report of the Flax Commission, 1871). Further varieties are listed in the Catalogue and list of exhibits attached to the report. However, the brief of this report was such as to place limitations on the kind of information that would be recorded. The focus was on fibre, particularly that relevant to commercial Pākehā use, and harakeke with particularly valuable plaiting properties was not of interest. Additionally, the Commissioners focused on districts which they considered to be 'superior' in terms of harakeke. In the Report (1872), Hector argued that many cultivars were difficult to tell apart and claimed that there were probably no more than 20 marked varieties which could be distinguished[86]. In fact, many 19th century writers viewed Māori weaving knowledge with very limited interest: harakeke was seen largely as a commercial prospect for new settlers and was thus generally considered in those terms. This can be seen, for example, in letters from Hutton to Hector between 1869 and 1871

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[85] Māori garments are made from scraped harakeke and fashioned into rough cloaks; once completed it is a well made garment. Korowai and other garments are made from harakeke which is stripped with the fingernails. The fibre is released and rolled on the thigh by the women . . ."

[86] The basis of the current National Flax Collection is around 60 named varieties (Walls, 1988 p.15), although it is possible that some are duplicates. Forty seven varieties are named in this source (Scheele & Walls, 1994).

which referred repeatedly to aspects of the commercial stripping process and only briefly mentioned *tīhore* in terms of fibre quality (Hutton, 1869).

Compilation of the historical information on harakeke varieties shows that around 80 varieties, or names of varieties, were identified collectively by authors such as Selwyn (1847), Moore (1849), Kelly (1866), Hector (1889), Buck (1911), and Best (1908, 1942). Even so, the vast majority of varieties listed are mentioned only once or twice, generally with very little additional information. There is, therefore, considerable confusion about the actual number of different varieties, and their identification[87]. Despite this, the large number of named varieties suggests that apparently small differences between varieties may be important in terms of weaving qualities. In addition, variety names may have changed in response to local histories and events. The problems of identifying varieties precisely were remarked upon by Best (1952, p.213), who noted that names from one region were completely different from those in another, and that only two of the names provided by Whanganui were the same as those provided by Tūhoe.

South Island harakeke knowledge is poorly represented in the historical literature. Varieties identified in the Report of the Flax Commissioners were from the North Island. Although Hector did note some cultivars sourced from the Christchurch Domain in the South Island, it appears these were deliberately planted from North Island root stock to test growth in South Island conditions. As such, they are not representative of South Island knowledge (and are therefore not included in analyses). Herries Beattie, an ethnographer who researched South Island Māori traditional knowledge in the early 20th century, recorded that his informants all agreed that there was only one kind of flax called 'harakeke' or 'harareke' (Beattie, 1994b p.52). He added that his informants did not recognise the harakeke varieties listed by Tregear which he showed them (Beattie, 1994b p.53).

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[87] For example, *putaiore* is referred to as a variety only in the Department of Agriculture Reports (1908, 1909) and by Cross (1912) (whose scientific thesis on harakeke was not based on Māori knowledge of harakeke) and is not mentioned elsewhere. One likely explanation is that this is not a variety *per se*, but rather the amalgam of two words, *pū* meaning a bush, and *taiore* being the name of a well known variety.

A misunderstanding between interviewer and research informants may have been responsible for the apparent lack of knowledge of harakeke varieties among informants. Equally, Beattie's research informants may have been unwilling to divulge information, or Ngāi Tahu may have used different variety names which were unknown to Beattie. Harakeke appears to be of minor concern in other ethnographic work carried out by Beattie (1939; 1994a).

The historical literature appears to reflect growing awareness by Pākehā of Māori harakeke knowledge. It appears not, however, to provide an accurate reflection of Māori knowledge. Hence, the number of reported harakeke varieties fluctuated during the 19th and early 20th century (*Table 4.3*). For example, in 1820, early in the colonial period, it was recorded that missionary Samuel Marsden knew of seven varieties, although "no doubt research will soon add to the number" (Elder, 1932 pp.241-2). However, Colenso (1881, p.61), believed that Māori were generally able to differentiate more than 50 varieties by the hue of the leaves alone, and was one of the few Pākehā to make an assessment of the number of varieties based on longstanding knowledge of Māori culture. Differences in the accounts may also be attributable to the fact that some ethnographers were estimating varieties within a region (such as Northland, or the Bay of Plenty) whilst others may have been basing their estimates on a broad knowledge of the North Island. In addition, Best almost certainly included some varieties in his list that were in fact synonyms, descriptions, or classes, of harakeke (for example, *motu-a-ruhi*, *whararahi*, *wharanui*, and *tīhore*) so this list is probably an over-estimate. For others, interest may have focused on a few prominent varieties rather than a total number in use: Buck (1911, p.73) listed eight "chief varieties" growing in the Whanganui River region but his field notebooks include 21 harakeke cultivar names and two types of wharariki[88] (Buck, n.d.).

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[88] The harakeke listed are: *ngaro, ate, raumoa, parekawariki, taeore, rataroa, tihore, paretaniwha, okaoka, oue, rangihaka, kohunga, tutaemanu, atiraukawa, heihei matariki, rerehape, parekoritawa, ngaromahoe, waiari, huhiroa,* and one which is difficult to read but which may be *koara.*

Table 4.3: **Reported numbers of harakeke varieties in the 19th century**

Number of varieties reported	**District**	**Source**
7	Northland	Marsden in Elder, 1932 pp.241-2
6 "of the best sorts"	Not specific to district	Moore, 1849
"nearly a dozen varieties"	Not specific to district	Hursthouse, 1849 p.134
10	Whanganui	Taylor, 1855
14	Taranaki	Kelly, 1866
"4 kinds"	Hawke's Bay	Nairn in RFC, 1871
more than 50	Not specific to district	Colenso, 1881 p.61
9 and 9	Tūhoe and Whanganui respectively	Best, 1952 p.213
46	Unspecified	Best, 1942 p.101
21 harakeke and 2 wharariki	Whanganui	Buck, n.d. (field notebook no.6)
8 "chief varieties"	Whanganui	Buck, 1911 p.73

4.4 Varieties and specific use

The specific use of different varieties of harakeke is an important aspect of traditional resource management. For example, harakeke varieties in everyday use might be managed differently from those occasionally used; those with a specific purpose, such as making nets, might be planted or managed in areas close to the site of use.

It was apparent early on to non-Māori visitors that there were significant differences among harakeke varieties. The careful matching of varieties to different uses is noted in the 19th century literature. Samuel Marsden, who visited New Zealand a number of times from 1814, identified one variety according to the ease of extracting muka, commenting:

> The others most probably possess distinctive properties which may render them fit objects of attention, as while one variety may be superior for cordage, another may answer better for linen and a third for the use of the papermaker (Elder, 1932 pp. 241-2).

It seems likely that Marsden had observed Māori using different varieties of harakeke, and had considered these in the light of Pākehā usage and needs. Although other late 18th and early 19th century European observers did not show *detailed* awareness of specific harakeke varieties in their writings (see, for example, Hursthouse, 1849 p.20; Dieffenbach, 1843 Vol. II p.52), they did realise that the attractive qualities of *kaitaka* and other prestigious garments were in part due to the type of harakeke chosen by the weaver. Colenso (1880, p.18), for example, made clear distinctions between ordinary varieties and those which were for more permanent items:

> The variety which was suited (in its prepared fibre) for making into fishing lines, would not serve for making nets (which were made of unscraped flax); and what was required for the woof of their superior woven flax garments, would not serve for the warp of the same,- while another kind again was used for their dyed borders; they also used a different variety for the girdles of their chiefs; another variety for the hard, almost closely woven, sack-cloth-like lining of their prized dogskin and kiwi-feather garments; another kind was used for the inner garment (or small apron) of the young girls of rank; another sort for common shaggy rain-protecting shoulder mats; and yet another sort for making the all but impenetrable hard shield, or arm-buckler, used to receive and ward-off spear thrusts . . .

Colenso went on to describe differences in the *muka* fibre in terms of silkiness and glossiness. In a later article, he elaborated further still, describing how "the cross-threads in weaving were always of a different sort of flax - the weft and the woof of these mats were not both taken from the same kind of flax" (Colenso, 1891). Tregear similarly noted differences in use and variety without being specific as to the cultivars used (Tregear, 1904 p.222). However, some writers did record associations between specific varieties and their specific use (see *Table 4.4*). It can be seen that approximately 36 different varieties of harakeke were closely matched to the function of weaving and were not used interchangeably, although some varieties appear to have been used for different activities that required similar qualities. *Ngutunui* is one such example, used for both fine clothing and nets and snares, presumably because of the strength and flexibility of the fibre.

Surprisingly, however, the majority of varieties are not associated with a specific use in the 19th and early 20th century literature.

***Table 4.4*: The specific use of different varieties (or classes) recorded in the historical literature**

Variety	Purpose	Source
Ate	Eel nets and baskets	Woon in the RFC, 1871
Atewhiki	Fine clothing	An unidentified Māori in the RFC, 1870; Kelly in the RFC, 1871
Atiraukawa	Fibre for clothes	Andersen, 1907 p.324; Department of Agriculture Report, 1908
Atiraukawa	*Tāniko* often decorated cloak borders	Buck, 1911; Buck, 1923
Atiraukawa	Fine clothing	Hursthouse,1849 p.134; Heaphy, 1869; an unidentified Māori in the RFC, 1870; Department of Agriculture Report, 1908; Buck, 1911, 1923
*Atiraukawa (*East Coast, Taranaki and at Opunake*)*	*Piupiu* and fine cloaks	The RFC, 1870-1872
Atiraukawa	Basket making	Department of Agriculture Report, 1908
Awanga	"Shawls" and strong lines	Department of Agriculture Report, 1908
Awanga	Ornamental	Tregear, 1904 p.222; Andersen, 1907 p.325
Awanga	Rough garments	Selwyn, 1847; Kelly, 1866
Awanga	Baskets	Best, 1908
Awanga	Sleeping mats	Selwyn, 1847; Kelly, 1866; Best, 1908
Huhi	Roots chewed for constipation	Best, 1908
Huhiroa	Fishing lines, nets, ropes	Woon in the RFC, 1871
Huhiroa	*Korowai* and *tāniko*	Buck, 1911
Huhiroa	Fine clothing	RFC, 1870; an unidentified Māori in the RFC, 1870; Woon in the RFC, 1871
Huruhika	Superior clothing	Tregear, 1904 p.222; Andersen, 1907 p.324
Huruhuruhika	Rough garments	Kelly in the RFC, 1870
Kauhangaroa	Mats and baskets	Nairn in Hector, 1889
*Kōhunga (*Waikato-Maniapoto*)*	*Piupiu* and fine cloaks	The RFC, 1870-1872
Kopakipakiika	Edible root	Best, 1908; Department of Agriculture Report, 1908
Korako	Fine garments	An unidentified Māori in the RFC, 1870; Kelly in the RFC, 1871
Koura	*Korowai*	Buller in the RFC, 1871
Manunu, manununui	Cordage	Heaphy, 1869
Mataroa	Borders of fine garments	Woon in the RFC, 1871
Mataroa	*Parawai* cloaks	Buck, 1911

Table 4.4 (continued): **The specific use of different varieties (or classes) recorded in the historical literature**

Variety	**Purpose**	**Source**
Ngaro	Illegible	Buck, n.d.
Ngaro	Rough garments	Kelly in the RFC, 1871
Ngutunui	Fine garments	An unnamed Māori in the RFC, 1870; Kelly in Hector, 1889; Department of Agriculture Report, 1908
Ngutunui	Bird snares	Best, 1898a, 1908
Ngutunui	Nets	Best, 1898a, 1908; Tregear, 1904 p.222; Andersen, 1907 p.324
Ngutunui	Fishing lines	Department of Agriculture Report, 1908
Ngutunui	*Piupiu* and fine cloaks	The RFC1870-1872
Ngutuwahine	Finer shawls	Department of Agriculture Report, 1908
Ngutuparera	Rough garments	Kelly in Hector, 1889
Oue	Superior sorts of garments	An unnamed Māori in the RFC, 1870; Kelly in the RFC, 1871; Tregear, 1904 p.222; Andersen, 1907 p. 324; Best, 1908
Oue	*Piupiu* and fine cloaks	RFC, 1870-1872
Oue	*kaitaka*	Heaphy, 1869
Parekawariki	Nets – *whakaheke* and *apurangi*	Buck, n.d.
Parekoritawa	Ornamental	Tregear, 1904 p.222; Andersen, 1907 p.325
Parekoritawa	Fine clothing	An unnamed Māori in the RFC, 1870
Paretaniwha	Superior sorts of garments	Tregear, 1904 p.222; Andersen, 1907 p.324
Paretaniwha	Fishing lines and nets	An unnamed Māori in the RFC, 1871
Putaiore	Kits, floor mats, and in some places finer garments	Department of Agriculture Report, 1908
Rauehu	*Parawai* garments and *korowai*	Buck, 1911
Raumoa	Rough garments	Kelly in the RFC, 1871
Raumoa	Cordage	Heaphy, 1869
Raumoa	Floor mats	Buck, 1911
Rerehape	Cordage	Heaphy in Hector, 1889
Rongotainui	Fishing nets and cordage	Heaphy, 1869
Rongotainui	Superior sorts of garments	Heaphy in the RFC, 1871; Tregear, 1904 p.222; Andersen, 1907 p.324
Ruatapu	Hair fillets only	Best, 1898, 1908; Tregear, 1904 p.222; Andersen, 1907 p.324
Rukutia	Superior sorts of clothing	Tregear, 1904 p.222; Andersen, 1907 p.324
Taeore	Fine clothing (when other sorts unavailable)	Buck, 1911
Takaiapu	Fishing lines	Kelly in the RFC, 1870; Catalogue, 1871; Andersen, 1907 p.324

***Table 4.4 (continued)*: The specific use of different varieties (or classes) recorded in the historical literature**

Variety	**Purpose**	**Source**
Taneāwai	Ornamental	Tregear, 1904 p.222; Andersen, 1907 p. 324
Tāpoto	*Kaitaka*	Heaphy in the RFC, 1871
Tāpoto	Sewing threads, the weft of fine clothing	Nairn in the RFC, 1871
Tarariki	Basket making	Best, n.d. (notebook no.11 p.146, from Stowell, 1911); Buck, 1911
Tarariki	Ornamented "mats"	Woon in RFC, 1871
Tarariki	Floor mats	Buck, 1911
Tarariki	*Korowai*	Ropata in Catalogue, 1871
Tihoi	Superior sorts of garments	Tregear, 1904 p.222
Tīhore	Fine garments	Andersen, 1907 p.324
Tīhore (Raglan and Taranaki districts)	*Piupiu* and fine cloaks	The RFC, 1870-1872
Tipuna	Rough garments	Kelly in the RFC, 1871
Tito-o-moe-wai	Rough garments	Kelly in the RFC, 1871
Tuao	Ropes	Moore, 1849
Tuhara	Ropes etc.	Hochstetter in Best, n.d (notebook no.12)
Tutaemanu	Sea net lasts, long (15ft)	Buck, n.d.
Wharanui	Nets called *matarau*	Best, 1952 p.260
Wharanui	Fine mats	Nairn in RFC, 1871
Wharanui	Nets	Colenso, 1891
Wharariki	Ropes	Moore, 1849
Wharariki	Fishing nets	Kirk, 1870
Wharariki	Mats (plaited)	Selwyn, 1847; Best, 1898a, 1908; Department of Agriculture Report, 1908; Andersen, 1907 p.324; Buck, 1911, 1923; Nairn in the RFC, 1871; Tregear, 1904 p.222 ; Ngata & Jones, 2004 Vol. 2 pp.64-66
Wharariki	Garments	White, AHM Vol. IV p.48
Wharariki	Baskets	Nairn in the RFC, 1871; Buck, 1911, 1923
Wharariki	Rough garments	Selwyn, 1847
Wharariki	Thrums of cloaks	Buck, 1911
Wharariki	*Kawe*	Buck, 1923

The paucity of information available may be due in part to the focus of Pākehā on the use of harakeke for the fibre industry. A hierarchy of value is apparent in the comments, with fibre used for 'high quality' garments of greater interest than that used for 'rough purposes.' One of the difficulties associated with an attempt to understand the relationship between particular varieties and their use, and hence management, is the perception that harakeke used for purposes other than fine clothing was 'poor.' In the Appendices to the Report of the Flax Commissioners (1870-1872), there are very few reports of varieties used for making floor mats

(*whāriki*), and baskets (*kete*). Fortunately, writers such as Buck had a broader view and identified varieties used for items such as sea nets or floor mats.

Additionally, writers are often somewhat vague about specific use of varieties, although it is possible to guess the purposes the varieties might be used for: Tregear (1904, p.222), for example, noted that *oue* and *kōhunga* were known to produce excellent *muka*; Best (1942, p.101) likewise claimed that *rataroa* and *parekawariki*, for example, were "superior". These varieties were probably recorded in association with fine cloak-making. Māori clearly paid a great deal more attention to the qualities of both the leaf and the fibre than did non-Māori commentators.

4.5 Cultivation: extent, varieties, and location of cultivations

4.5.1 Extent of cultivations

A preliminary reading of 19th century writers seems to suggest that harakeke was not cultivated widely. Early authors such as Markham (1963[89]) commented on the cultivation of various plants, and in particular on food plants such as kumara, without any specific mention of harakeke. Crawford (1880, p.54) briefly indicated the presence of cultivations at Moutoa in the Manawatu without indicating what type of cultivations these were: Moutoa later became famous for its harakeke (Poole & Boyce, 1949). Similarly, Colenso (1868b) and Best (1925) described cultivations of food plants, including kumara and tī in detail, but omitted harakeke from their descriptions of Māori agriculture. In another paper, Colenso dismissed wide scale cultivation of harakeke as a possibility (Colenso, 1868a), although he later appeared to revise some of his earlier views, noting that both the aute tree and harakeke were "formerly cultivated for their textile uses" (1880, p.18).

Perhaps surprisingly, then, there is ample evidence that harakeke *was* cultivated when the historical records are considered as a group. Numerous historical sources record harakeke cultivation by Māori. These are listed in *Table 4.5*.

[89] First published 1834.

***Table 4.5*: Evidence of cultivation of harakeke in the historical literature**

Description	Source	Time period
Te Kahui of Taranaki wrote in his documents about Mataaho, an unfortified village (which no longer exists): "Ko te maara i te nukuhanga, [h]e aukahanga waka. . ." which is translated by his descendant Ailsa Smith as "The wide extent of cultivated land provided flax for lashing the bulwarks of canoes."	Smith, 1993 pp.17-18	Uncertain- possibly early 19th century
"They also cultivate . . . a sort of reed [*Phormium* sp.] which, when ripe, furnishes them, after retting, with thread to make their cloth and cords for various uses. In the cultivation of these crops they make use of the same instrument [the kō] ...They have... some small fields planted with potatoes, gourds, aloes-pite, and very small flax. . ."	Crozet, 1999 pp.40 and p.43	1772
A description of cultivations was included in a story about Hongi Hika and his people from Ngāpuhi: "tae atu ano ki nga putake harakeke e tipu ana he hanga ataahua. Ko nga kakano o aua harakeke naku ano i hoatu mana." which could be translated as "including the roots [fans] of harakeke, had a fine form. I passed the seeds of those harakeke plants to him." This may refer to commercial harakeke growing by Māori.	Anon., 1911	Early 19th century
A ropemaker, whose task was to find suitable harakeke for commercial trade, reported that "On the eve of returning I fell in with an old beaten path that took me through to Duck Bay, where I found a large valley of the best hemp [harakeke] we had seen, and as regularly set as if planted by the hands of man. . ." He had enlisted the help of Māori at a nearby village to find harakeke and they gave directions to that place.	McNab, 1908 Vol. I p.461	1819
Yate described villages as having "bunches of flax growing in all directions; to serve the purpose of lines or fastenings for their loads. . ."	Yate, 1835 p.155	1827-35
Dieffenbach described the set up of houses and wrote that "sometimes a few bushes of the *Phormium tenax* are cultivated . . . for daily use" within an enclosure around a house.	Dieffenbach, 1843 Vol. II p.70	First part of 19th century
Dieffenbach described the seasonal movements of Māori between plantations, which might be at great distances from each other or from the principal village. It is unclear here what kind of plantations he is referring to; although it seems likely that these are crops, it is worth considering the possibility that these plantations included harakeke.	Dieffenbach, 1843 Vol. II p.71	First part of 19th century
". . . at every pah you would see covered with cabbage trees, ferns, flax, toi-grass and the pretty light bush mixed here and there with karaka." He also observed that Māori cultivations were extensive.	Bevan, 1901, pp. 10 and 20	Pre- 1855
Large plantations near pā.	Moore, 1849	First half of 19th century
Both *tāpoto* (from Waimarama on the East Coast) and *awanga* mentioned as being cultivated, *tāpoto* for its fibre.	Colenso, 1852	Mid 19th century

***Table 4.5 (continued)*: Evidence of cultivation of harakeke in the historical literature**

Description	Source	Time period
"The native flax also grows luxuriantly here, the country being famed for its growth. Among the natives it had been extensively and carefully cultivated by them in the earlier days of their intercourse with Europeans."	Kelly, 1866 p.6	Mid 19th century
Kelly noted that the "first class" of harakeke varieties could be found in native plantations in the North Island especially near Manawatu, and the Whanganui and Patea rivers.	Kelly, 1866 p.12	Mid 19th century
"[The] finer varieties, from the fibre of which the natives were in the habit of manufacturing garments…were extensively and carefully cultivated by them until the general adoption of blankets and other articles of European clothing put an end to the native manufacture."	Kelly, 1866 p.12	Mid 19th century
Kirk recorded cultivations in Waikato and Thames.	Kirk, 1870	Mid to late 19th century
"It has been ascertained that all large fields contain some plants of those kinds that are most esteemed by the Maoris, who were accustomed to transplant them to spots near their settlements."	Hector, 1889 p.4	2nd half 19th century
Hector noted of the *tīhore* variety of harakeke that "I have never seen it except where planted by the Maoris". He used *tīhore* to refer to the variety called *tīhore* in the Waikato, which he thought was probably identical to *oue* and *tāpoto*.	Hector, 1889 p.4	2nd half 19th century
Ui-roa worked the land cultivated by his father, and planted harakeke (as well as tī, and toetoe, and trees including the karaka).	White, 2001 Vol. I p.33	Pre 19th century
The chief Pouwhare stated that "there is a flax field there [at Papapoporo] belonging to Te Hera-wira-a-pupu of Taranaki."	Manuaitu-Aotea Title Investigation, 1887 pp.238-9	Late 19th century
"In many places it [harakeke] was most abundant, and where little was seen, and in forest areas where none grew, then it was planted at or near every hamlet. Where only the inferior *P. colensoi* was found, superior kinds would be cultivated. Highly esteemed varieties would often be planted around hamlets which had a plentiful supply of the less esteemed varieties."	Best, 1942 p.100	Late 19th century/ early 20th century
"It is only in recent times that the better kinds of flax have been introduced and cultivated here [in Tūhoe]. It is said that Taitua first introduced the better flax, from Waikato, some six generations ago."	Best, 1898a	Late 19th century
Awanga and other varieties cultivated by Māori in the district extending from the Turakina to the Waitara Rivers.	Department of Agriculture Report, 1908	For generations prior to the early 20th century
Ngutunui and *ngutuwahine* cultivated between the Rangitikei and Tongaporutu.	Department of Agriculture Report, 1908	For generations prior to the early 20th century

***Table 4.5 (continued)*: Evidence of cultivation of harakeke in the historical literature**

Description	Source	Time period
Putaiore and *huhiroa* cultivated from Whanganui to Waitara.	Department of Agriculture Report, 1908	For generations prior to the early 20th century
Putaiore and *huhiroa* cultivated from Whanganui to Waitara.	Department of Agriculture Report, 1908	For generations prior to the early 20th century
Atiraukawa cultivated between Whanganui and New Plymouth.	Department of Agriculture Report, 1908	For generations prior to the early 20th century
Oue cultivated on the East Coast.	Department of Agriculture Report, 1908	For generations prior to the early 20th century
". . . up the Whanganui river it[harakeke] was introduced and cultivated, so that each village had its pa harakeke or flax-garden. . . . Even in villages close to flax swamps, flax was grown close to the houses for immediate use."	Buck, 1923	Early 20th century
The parts where the flax grew plentifully in its uncultivated state were near the mouth of the river known at Kokohuia and at Okui and in the Matarawa valley. The only flax that grew wild in the upper part of the river was a thin-bladed variety known as wharariki (*P. cookianum*) which contains very little fibre thus fibre-bearing varieties had to be cultivated.	Buck, 1911	Early 20th century

In the early 19th century, Marsden (in Elder, 1932 pp.241-242) instructed a young curate who was about to come out to New Zealand, that he should

> . . . have at least an acre of suitable land prepared and plant it in roots of the different varieties. Specimens of fibre, of a silky lustre and softness, are brought from the southward: you should endeavour to ascertain the place of its growth, and obtain one or more roots from which to propagate it.

These instructions are almost certainly based on observation of Māori cultivations. However, one of the earliest recorded *sightings* of harakeke cultivation by non-Māori is probably that from Bluff harbour in the report of a rope-maker who was sent, in 1819, to New Zealand to find harakeke sites for possible commercial use (McNab, 1908 p.461; *Table 4.5*). When the evidence is considered, it is apparent that the stand he described was probably a harakeke cultivation belonging to the local people. First, the rope-maker was directed to this stand of harakeke by local Māori. Further, he reported potato cultivations of

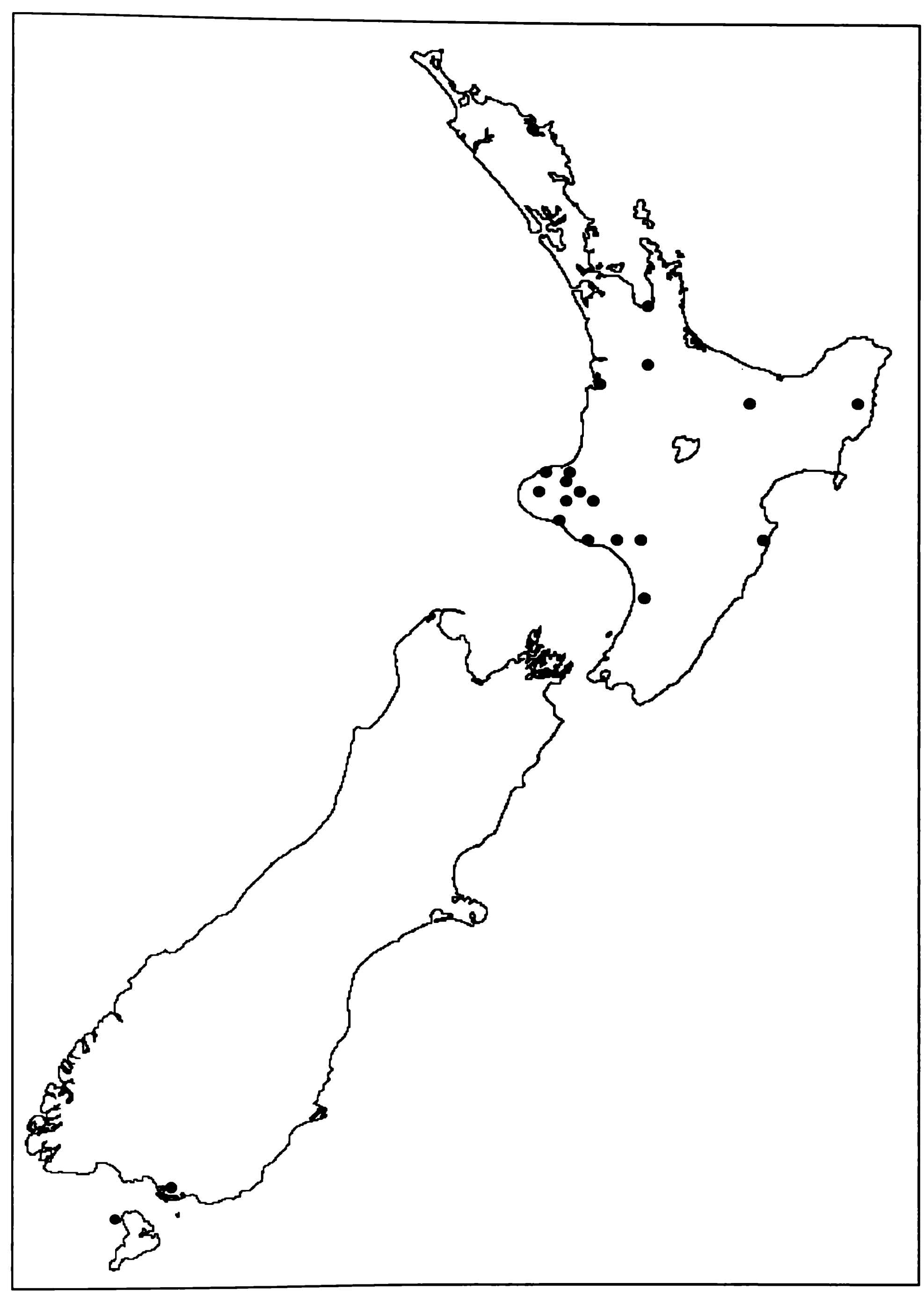
100 acres in size near the same hamlet, which in turn indicates that the local people had some substantially sized cultivations.

The early reports of harakeke cultivation (see *Table 4.5*) suggest that the subsequent paucity of references to harakeke cultivation may have been attributable to European preconceptions. It may be that they simply overlooked evidence of harakeke cultivation because they did not expect to find it. They may have believed that cultivation was limited to food crops, or they may have considered Māori not to be capable of large-scale cultivation. Whatever the reason, it appears that cultivated harakeke was often not recognised as such. The fact is, however, that the cultivation recorded at Bluff harbour by the rope-maker is in close vicinity to another harakeke cultivation site on Codfish Island off the coast of Stewart Island identified by Wilson (1987). Taken together, these records indicate that harakeke cultivation was carried out in the far South.

The cultivations reported have a broad geographical spread, from Bluff harbour in the south of the South Island, to Aotea harbour and Taranaki in the west, and Hawke's Bay in the east of the North Island (*Figure 4.1*). These reports suggest that harakeke cultivation was widespread throughout the country, and occurred in a number of different tribal areas.

The records also provide some evidence of the extent and scale of harakeke cultivations (see, for example, Kelly, 1866; Smith, 1993). Colenso (1880) recorded that while travelling through forest he came across a plantation of harakeke of around an acre in size, but other records seem to indicate even larger areas of cultivation (Moore, 1849; McNab, 1908; Smith, 1993; Crozet, 1999). The combined evidence throws considerable doubt on Colenso's (1868a) comment that "[the] Harakeke. . . was sometimes planted but not largely so."

Figure 4.1: **Geographical distribution of probable cultivation sites for harakeke**



In some districts, writers reported specific areas where women went to collect harakeke, without indicating whether these areas could be regarded as 'cultivations' in the strict sense of the word. Thus, for example, Stack (1898, pp.42-43; also see White, 2001 Vol. III p.233) recorded Kaihinu as such a site for

Ngāi Tahu women in the South Island, while Makereti (1938) recorded similar areas in the Rotorua area. A lullaby for Te Rangitumua of Ngāti Kahungunu by Te Motu also refers to a woman, Kurapatiu, who was turned to stone while cutting harakeke in a swamp (Ngata & Jones, 2004, p.363). In these cases, active management of existing harakeke areas may have occurred rather than specific plantings. What is clear is that active management of harakeke was occurring throughout the country, with the potential for landscape change.

4.5.2 Varieties of cultivated harakeke

Around 60 named varieties of harakeke are estimated to have been used by Māori[90]. Although many writers provided only minimal information about which varieties were cultivated, there is general agreement amongst writers in the 19th century that the 'finer' varieties of harakeke were cultivated. For example, Kelly (1866) stated that "[the] finer varieties, from the fibre of which the natives were in the habit of manufacturing garments of a beautiful silky texture, were extensively and carefully cultivated by them. . . ." Moreover, Colenso records that as well as 'superior' varieties, the commoner sorts of harakeke were also planted (Colenso, 1880). It is impossible to know exactly which varieties Colenso meant by "the commoner sorts" although he described them as "constantly used by them [Māori] in its green state for the daily making into baskets and dishes for cooked food (all such woven dishes not being used a second time), and, also, for common and hasty tying purposes". He also noted, however, that the common kinds grew almost everywhere, except in the deep forests, raising the question of why Māori might cultivate these kinds further. Convenience is one obvious answer. Yate and Dieffenbach's writings suggest that harakeke planted closely around settlements was for daily needs, also described by Buck (1923) as "immediate use". That is, harakeke cultivated around houses or close to villages was for daily use, for items such as food baskets and lashings. Cultivation of harakeke varieties can therefore be broken down into two main subcategories, those used for everyday purposes (such as production of food baskets), and those with fine fibre which were cultivated for clothing production.

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[90] This estimation varies considerably; cf. Hector (1889) who suggested a total of around 20 varieties.

Records of harakeke varieties which have been identified in cultivation from 19th and early 20th century documents are listed in *Table 4.6,* along with varieties which are recorded as being harvested from natural stands.

Table 4.6: **Historical records of harakeke varieties growing in cultivation and naturally occurring situations, generally swamps, with the information source. Underlined varieties are listed in both categories**

In cultivation	In natural situation
Atiraukawa (Department of Agriculture Report, 1908; Buck, 1911)	*Ate* (Kelly, 1866)
Awanga (Colenso, 1852; Department of Agriculture Report, 1908)	*Atewhiki* (an unidentified Māori in the Catalogue, 1871; Wi Tako in Hector, 1889)
Huhiroa (an unidentified Māori in the Catalogue, 1871; Department of Agriculture Report, 1908; Buck, 1911)	*Atiraukawa* (Kelly, 1866; an unidentified Māori in the Catalogue, 1871; Wi Tako in Hector, 1889)
Kōhunga (Selwyn, 1847; Kelly, 1866)	*Huhi* (Best, 1908)
Mataroa (also identified as *tākirikau*) (an unidentified Māori in the Catalogue, 1871; Buck, 1911)	*Huhiroa* (Kelly, 1866; Wi Tako in Hector, 1889)
Ngutukaka (Jenkins in Hector, 1889)	*Kauhangaroa* (Nairn in Hector, 1889)
Ngutunui (Department of Agriculture Report, 1908)	*Manunu* (Kelly, 1866)
Ngutuwahine (Department of Agriculture Report, 1908)	*Ngutunui* (an unidentified Māori in the Catalogue, 1871; Wi Tako in Hector, 1889)
Okaoka (Constable in the RFC, 1871)	*Oue* (Wi Tako in Hector, 1889)
Oue (Selwyn, 1847; Kelly, 1866; Heaphy, 1869; Catalogue, 1871; Colenso, 1852, 1880; Department of Agriculture Report, 1908; Best, 1972 p.467)	*Parekoritawa* (implied in Moore, 1849)
Parekoritawa (Department of Agriculture Report, 1908; Buck, n.d.)	*Rataroa* (an unidentified Māori in the RFC, 1871; Wi Tako in Hector, 1889)
Paretaniwha (Selwyn, 1847; Kelly, 1866; Catalogue, 1871; Department of Agriculture Report, 1908)	*Raumoa* (Kelly, 1866; Wi Tako in Hector, 1889)
Putaiore (Department of Agriculture Report, 1908)	*Rongotainui* (Heaphy, 1869)
Rataroa (Selwyn, 1847; Kelly, 1866)	*Taeore* (Catalogue, 1871)
Rauehu (Buck, 1911)	*Tāpoto* (Colenso, 1852; Nairn in the RFC, 1871)

Table 4.6 (continued): **Historical records of harakeke varieties growing in cultivation and naturally occurring situations, generally swamps, with the information source. Underlined varieties are listed in both categories.**

In cultivation	**In natural situation**
Raumoa (Buck, 1911)	*Tarariki* (Kell, 1866; Wi Tako in Hector, 1889)
Rerehape (Selwyn, 1847; Kelly, 1866)	*Tīhore* (Moore, 1849; Catalogue, 1871; Hutton in Hector, 1889)
Rongotainui (Heaphy, 1869)	*Tuao* (Moore, 1849)
Taeore (Hutton, 1870; Buck, 1911)	*Tuhara* (Hochstetter 1867 in Best, n.d.)
Takaiapu (Department of Agriculture Report, 1908)	*Tukura* (Best, 1908)
Tāpoto (Colenso, 1852, 1880; Nairn in the RFC, 1871)	*Turepo* (an unidentified Māori in the RFC, 1871)
Tīhore (Moore, 1849; Field in Cross, 1912)	*Wharanui* (Colenso, 1852; Nairn in the RFC, 1871)
Tīhore=oue=tāpoto (Hutton in Hector, 1889)	*Wharariki* (Moore, 1849; Colenso, 1852; Nairn in the RFC, 1871)
Wharanui (Nairn in the RFC, 1871)	
Wharariki (Kirk, 1870; Department of Agriculture Report, 1908; Buck, 1911)	

From the information in *Table 4.6*, it appears that approximately 20 varieties are recorded as cultivated and 20 as growing in natural situations. Eighteen of the 20 cultivated varieties are known to have specific uses (see *Table 4.4; Figure 4.2*). Of these, thirteen have been recorded as being used for fine clothing, while nine varieties have been recorded as being used for cordage, and six for nets (note that some varieties have more than one specific recorded use). Of the three varieties which do not have a specific recorded use, *okaoka* is referred to as a high quality fibre (Constable in the RFC, 1871), so is likely to have been cultivated for fine clothing. *Rataroa* was also considered to be a high quality fibre in most areas, although Tregear (1904, p.222) and Andersen (1907, p.324) both claimed it was poor quality. Nonetheless, the perception amongst historical writers that the 'finer' varieties of harakeke were cultivated (see, for example, Selwyn, 1847; Colenso, 1868a, 1880; Hector, 1889) seems to be clearly endorsed.

Figure 4.2: **Comparison of specific use for varieties growing in cultivations and in natural areas, as a percentage of the total number of varieties with known specific uses recorded in these situations. Percentage totals of more than 100% occur as some varieties have more than one specific use recorded.**

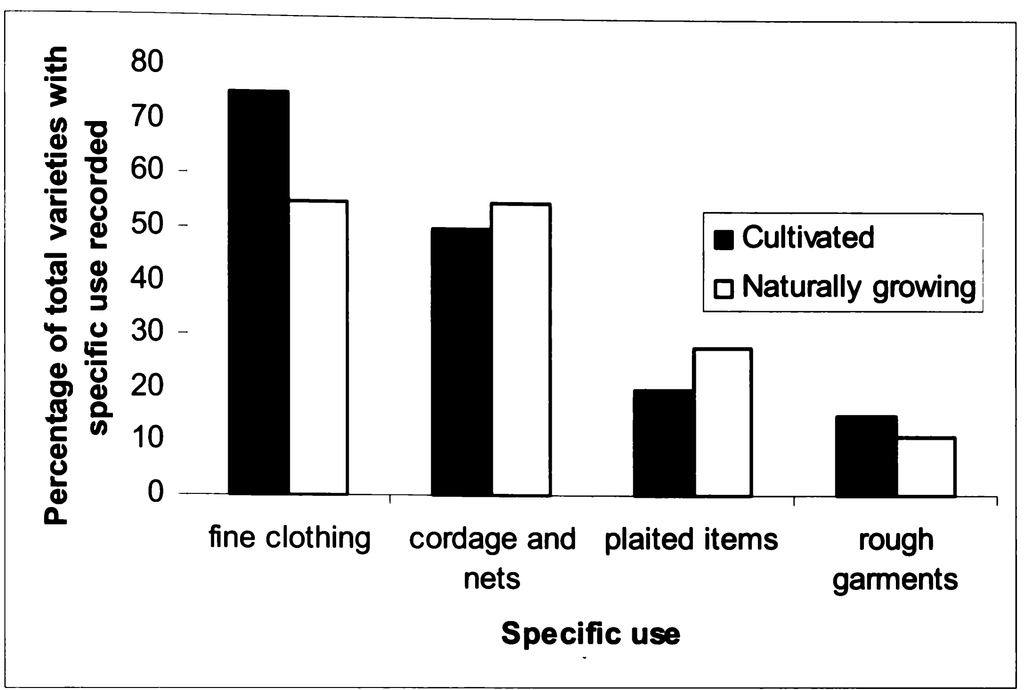


Figure 4.2 shows that naturally occurring stands of harakeke included varieties, or classes, such as *tīhore, oue*, and *tāpoto* which were preferred for fine work. It appears, then, that these varieties, valued for their fibre, were not *always* cultivated. Moreover, varieties valued by weavers for plaiting (*raranga*) were also present in natural stands, as well as varieties such as *ngutunui* which might have been used for nets (see *Table 4.4*). Approximately 18 varieties with specific uses have been recorded as harvested from natural situations, including sandhills and swamps. Of these, ten were recorded as the raw material for fine clothing, eight for cordage and six for net making. Five appear to have been primarily used for plaiting and two for rough garments (*Figure 4.2*). Natural areas therefore also seem to have been important as a source of harakeke for many tasks, including the manufacture of fine clothing. However, if a variety was scarce in the wild, for example as was suggested by Shortland (1856, p.209) for *oue*, then cultivating that variety to increase the resource might also be expected. It is interesting that nearly 30% of varieties from these natural situations are recorded in association with plaiting; one important use may be the weaving of baskets as the need arises

in the 'field.' Likewise, the high number of varieties used for cordage or net-making may also reflect proximity to the task for which they were required.

Ten varieties were recorded as both cultivated and harvested in natural situations: *atiraukawa, huhiroa, ngutunui, parekoritawa, oue, rataroa, raumoa, rongotainui, taeore* and wharariki (wharariki being counted as a 'variety' in this instance), as well as the harakeke classes *tāpoto* and *tīhore.* Of these varieties, eight were recorded as being used for the manufacture of fine clothing, and six were recorded as having multiple uses. It is impossible, however, to differentiate between their uses in either cultivation or natural situations without further information. Furthermore, no mention is made of varieties used for food baskets, or other such everyday purposes. This suggests that there are gaps in our current knowledge of past practices.

The historical records do not generally indicate whether a recorded cultivation consisted of one, or several, varieties grown together. However, Colenso (1880, p.19) recorded that he came across a plantation planted with the *oue* variety, also noting that, when in Hawke's Bay in 1845, he saw the remains of plantations of several varieties, one of which had *tāpoto*. The Hawke's Bay reference is difficult to interpret: it could refer to several plantations of different varieties or to plantations of mixed varieties. Heenan (1991, p.6) has noted that several varieties of harakeke can be found in a single wild population at one locality. In fact, there are records of natural areas of harakeke with "all varieties" at Napier, Otaki, Manawatu, Opunake and Waikanae (Hector, 1889 pp.16-19; Wi Tako in Hector, 1889). Using natural populations could, therefore, have been advantageous in some instances in that it provided access to several different varieties. *Table 4.6* and *Figure 4.2* indicate that naturally growing harakeke was an important source of weaving material. Kelly's (1866) view that the only sort of harakeke found growing in the wild was what he termed "second class" varieties (that is, *atiraukawa, manunu, huhiroa, raumoa, ate, tarariki* and common swamp flax) is not supported by the data presented here.

4.5.3 Location of cultivations

There is evidence for harakeke cultivations being both near to villages, and more scattered. Hector (1889) noted that Māori established plantations near their villages, but believed this was only the case for Māori who lived in forest or inland areas where harakeke was not abundant. Furthermore, it was reported in the Appendices to the Report to the Flax Commission (RFC, 1871 p.66) that Māori who did not live within easy reach of any large flax field made plantations near their villages. Unfortunately, because no measurements of distance are indicated, it is difficult to know what "near" and "far" mean in this context.

Several early authors commented on the scattered nature of Māori cultivations, such as those for kumara and potato (*Solanum tuberosum*) (Markham, 1963 p.70; Yate, 1835 p.155), an observation reinforced by later writers (Colenso, 1880; Tregear, 1904; Makereti, 1938 p.198). This reflects the migratory nature of many Māori activities, and one might expect harakeke cultivations also to have been scattered. In fact, Colenso (1880, p.19) recorded that while travelling through forest he came across a plantation which he believed had no one living within miles of it. This kind of plantation accords with descriptions of migratory life. These migratory patterns of life, however, were very different from patterns experienced by Europeans in everyday life. For this reason, harakeke cultivations may not have been recognised as such by early Europeans. Harakeke cultivations may therefore be under- reported in the literature.

Colenso's claim, in the 1880s, that Māori "always had planted near to, if not adjoining, their food cultivations and their towns and villages, the commoner sorts of this useful plant" suggests (by implication) that plantations of highly valued varieties used for clothing might be more scattered or located elsewhere. On the other hand, Best (1942) described harakeke planted around settlements as being "esteemed varieties". Yet other records describe Māori as migrating for the specific purpose of accessing harakeke (Bidwill, 1952 pp.31-32; Guthrie-Smith, 1969 p.68). Bidwill, for example, recorded in his February diary:

> [I] found about 200 natives in temporary huts. I could not find out what brought them there. They said it was to make flax, which grew there in

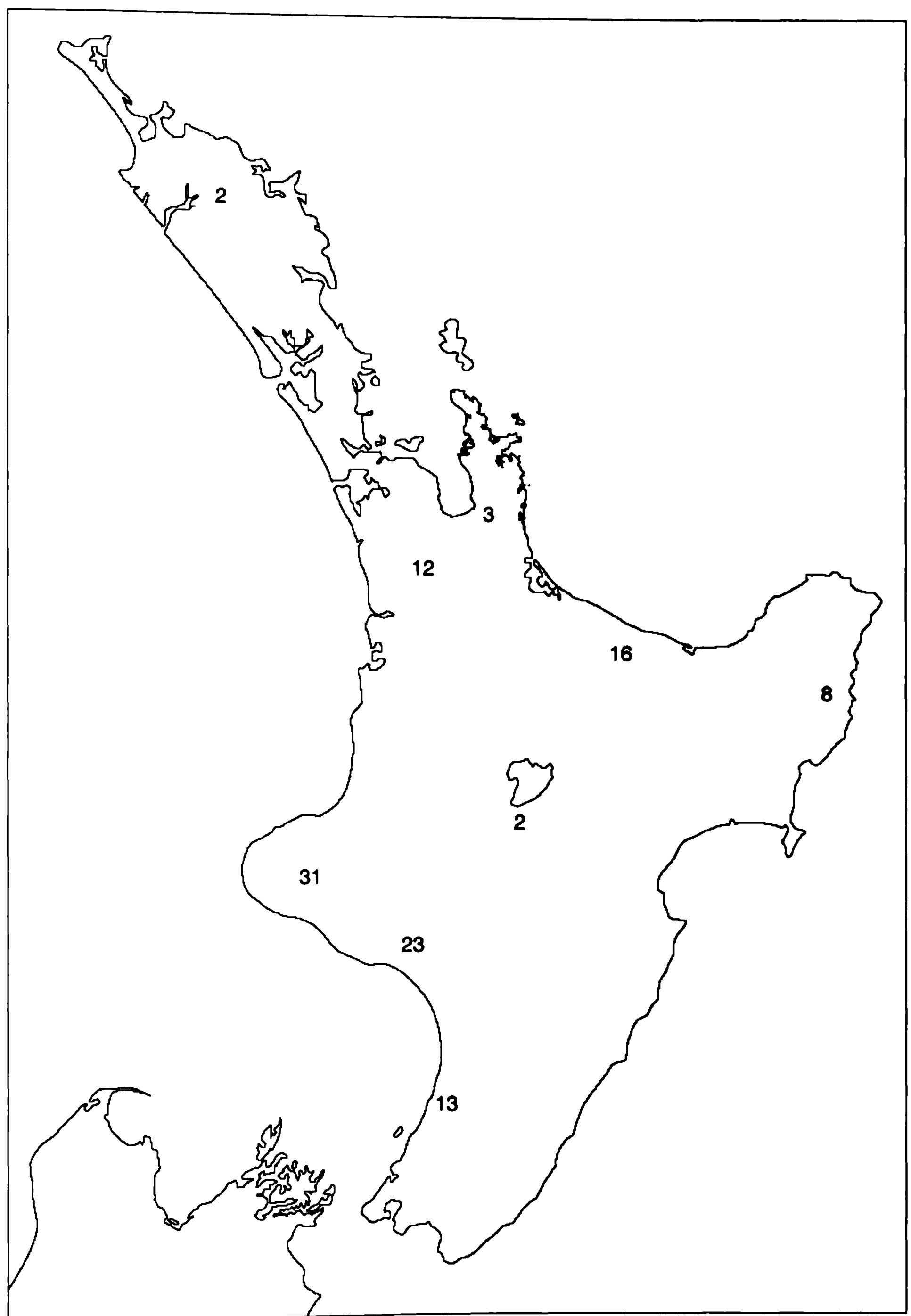
great abundance; but in other parts of the Waikato country which I have seen it has been much more abundant.

Environmental modelling, which links the probability of harakeke occurrence to known pā sites (based on known environmental variables, archaeological and landform data), offers one method of further investigating this issue (see *Chapter 6* for a preliminary investigation into environmental variables and probabilities for harakeke occurrence in relation to an 'environmental envelope').

4.6 Distribution and dispersal

Analysis of the historical records reveals that a larger number of varieties were recorded for some districts than others (*Figure 4.3*). Only a handful of varieties have been recorded for areas such as Northland, Hauraki, and the central North Island. In fact, in the Report of the Department of Agriculture (1908), McGregor claimed that "a variety called Tihare [sic] . . . appears to be the only variety known by name in the Bay of Islands district". It is unlikely that this claim was accurate since another variety, *tuawhitu*, was recorded in the Bay of Islands, Northland (RFC, 1871): Buck (1911) has also recorded that *raumoa* came from Northland. Records of regional differences in the number of varieties in the Appendices to the Report of the Flax Commissioners are almost certainly unreliable, appearing to be attributable to the limitations of the research involved. Knowledgeable informants, such as Buck (in Whanganui) and Wi Tako (in Waikanae) provided information about varieties and their use which at times contradicted information from other researchers or contributors to the Appendices of the Report of the Flax Commissioners. Furthermore, data is frequently shaped by the rapport of the researcher with informants, the choice of districts visited and time spent there, as well as the researcher's own interests. Best (1942, p.101), for example, provided minimal information with his list of harakeke varieties, reflecting, no doubt, his own lack of interest in the specific details. However, despite these limitations, it is clear that some districts *did* have a large number of identified harakeke varieties (including Taranaki, the Whanganui river district, and Waikato.

***Figure 4.3*: Numbers of harakeke varieties mentioned by name in regional areas of the North Island of New Zealand in 19th and early 20th century sources**



Taranaki was famous for the quality of both its harakeke and its weaving (see *Table 4.7*) so it is probable that the large number of named varieties recorded from the West Coast (Whanganui and Taranaki districts) reflects this. Nonetheless, 26 out of 48 varieties now growing in the National Flax Collection

were collected from the East Coast area (Scheele & Walls, 1994), and only six from Taranaki, indicating that sampling bias is an issue. The collection methods of both the 1870-72 Flax Commission and the National Flax Collection have resulted in information gathered being more representative of some areas than others.

***Table 4.7*: Historical sources referring to the excellence of weaving resources in different localities**

Region	Source	Comment
Taranaki	Hursthouse, 1849 p.134	He believed that the variety most prized by Māori was the "Hateraukawa . . . [which] is confined almost to the Taranaki district."
Taranaki	Smith, 1910 pp.271-2 from oral sources	He attributed many of the early northern raids on the west coast of the southern North Island to "the desire to acquire the fine flax garments made from the superior kinds of *Phormium*, for which the Taranaki coast is celebrated."
Taranaki	Smith, 1910 p.272	He wrote that Murupaenga, a chief from Ngāti Whātua in Kaipara, was delighted with Taranaki, noting "the beauty and variety of the flax growing so luxuriantly in all parts, the quality of the mats, or Kaitaka cloaks - the finest and best in all New Zealand it is said."
Taranaki	Buck, 1911 p.69	Taranaki was once famous for its harakeke and fine garments although, because of the Land Wars, only the rough rain cloaks used in the military campaigns were woven at the time of writing.
Kāwhia	Bevan, 1901 p.19	Harakeke was exported from Kāwhia to Wellington because of its quality.
Waikato	Purchas, 1868 p.67	He reported that there were several distinct kinds of Tihore, and the best flax was to be found at Maungatautari.
Waikato/ West Coast	Elder, 1932 p.219	Marsden wanted to see the area to the south and west of Thames, as he was told in 1819 that "the [Waikato] river empties itself into the sea on the west side of the island, and it is there that all the fine mats are made".
Wairoa in Hawke's Bay	Buck, 1911 p.69	Buck noted that this area was also famous for weaving fine clothing.

The geographical analysis of harakeke varieties also indicates that the same cultivar names recur in a number of districts, suggesting the likelihood of cultivar movement from one area to another. For example, *atiraukawa* occurs in

Taranaki, the Whanganui river area, and on the East Coast; *hewara* occurs in Opunake and Waikanae; *kōhunga* occurs in the Waikato and Whanganui districts, and *motu-o-ruhi* is mentioned by Buck in relation to the central North Island peoples, and by Best in relation to Tūhoe in the Bay of Plenty. Localities where the varieties *ngaro, oue, paritaniwha, rataroa* and *raumoa* have previously been recorded are mapped in *Figures 4.4 - 4.8.*

Figure 4.4: **Distribution of five harakeke varieties identified in the historical literature: *Ngaro***

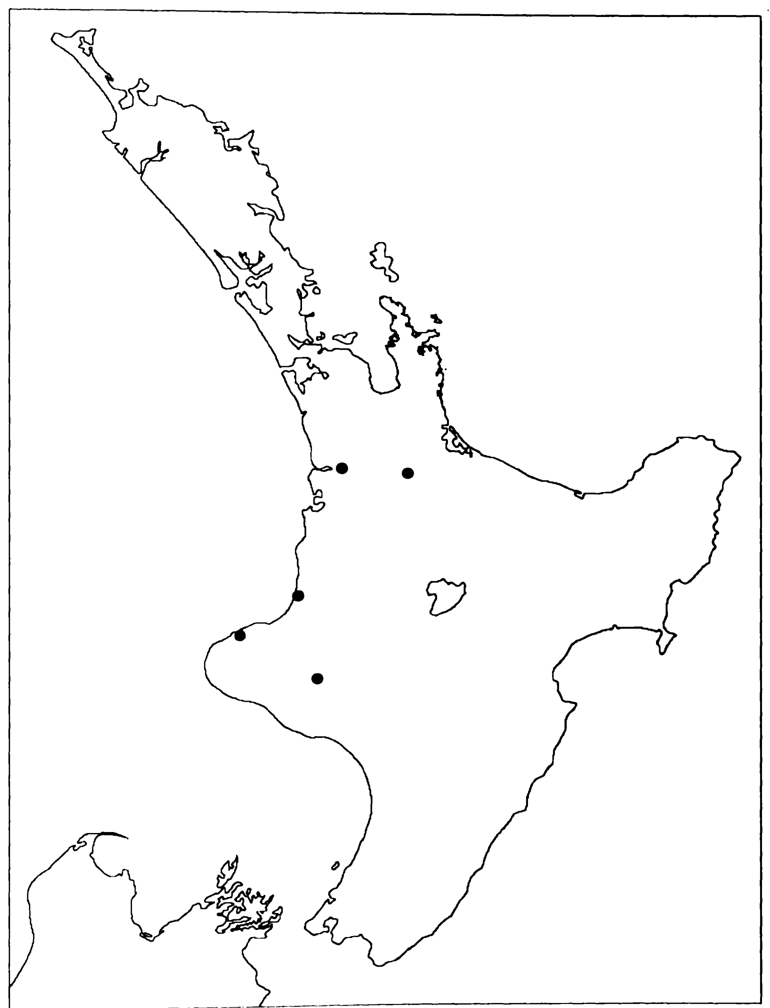


Figure 4.5: **Distribution of five harakeke varieties identified in the historical literature:** ***Oue***

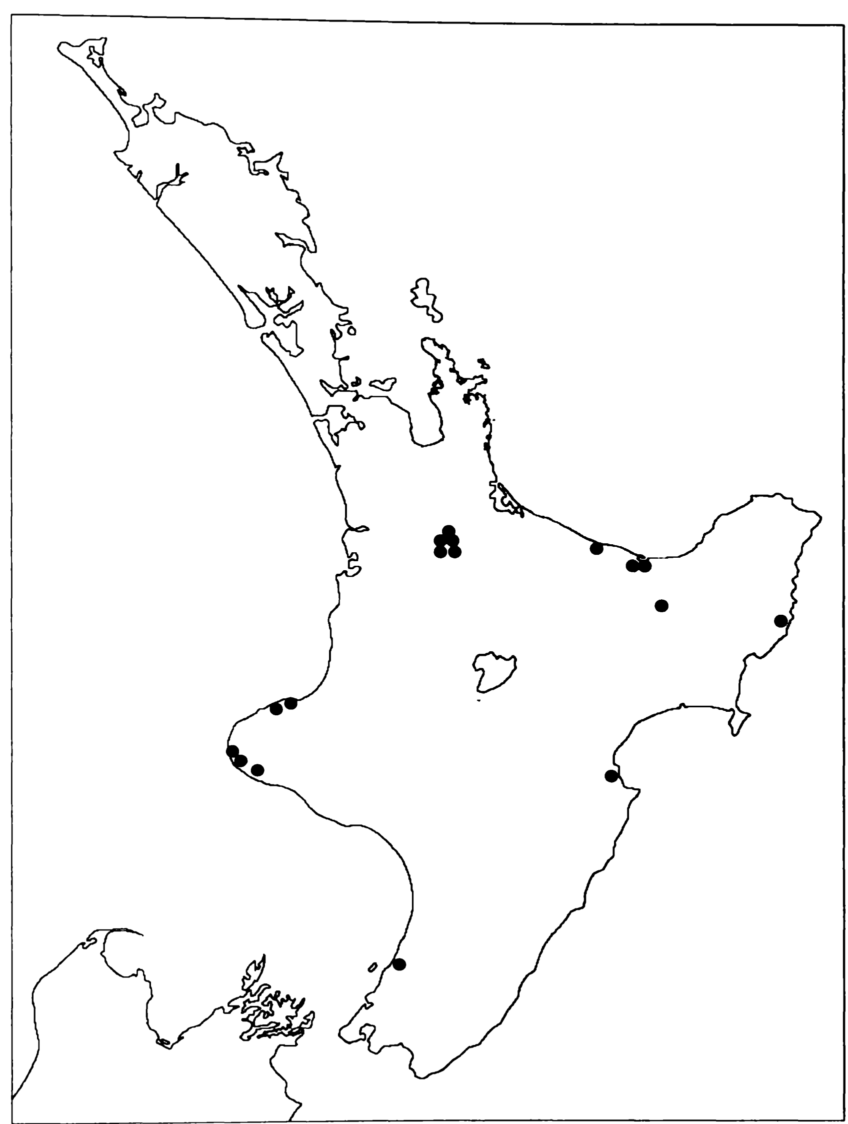


Figure 4.6: Distribution of five harakeke varieties identified in the historical literature: *Raumoa*

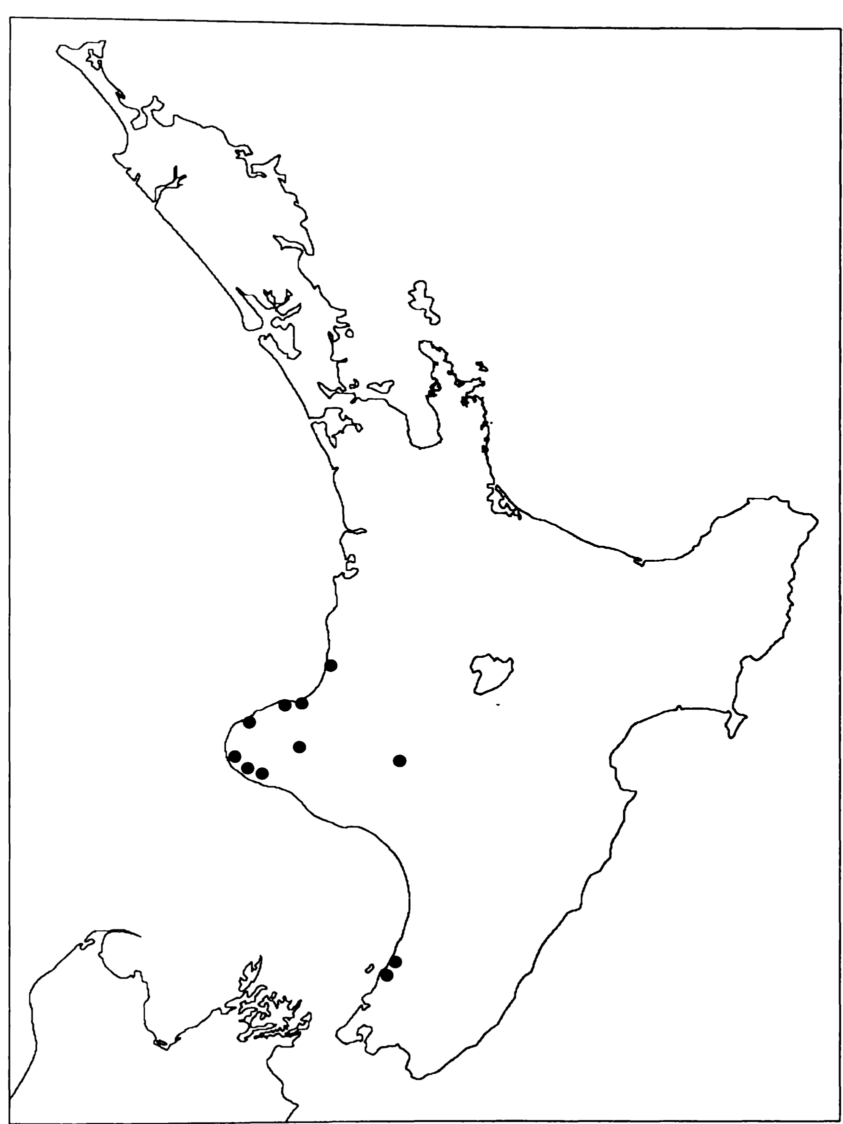


Figure 4.7: **Distribution of five harakeke varieties identified in the historical literature:** ***Paretaniwha***

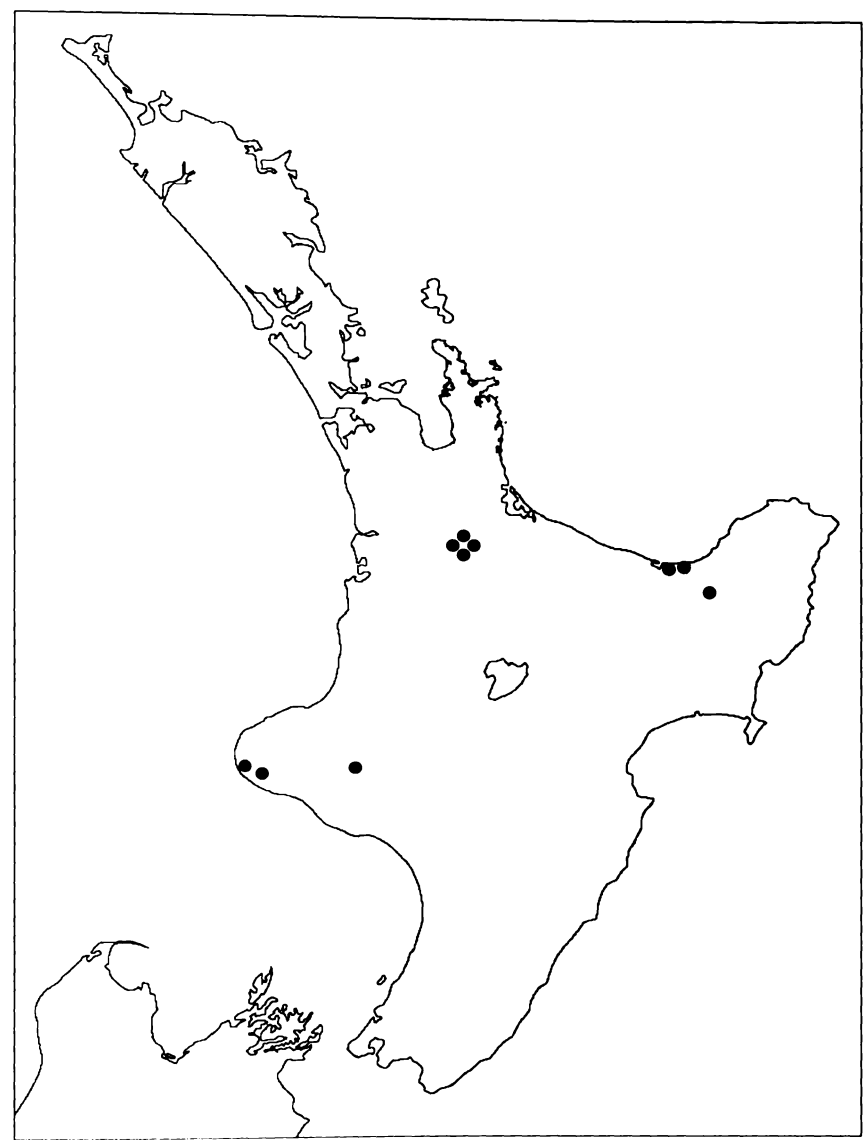
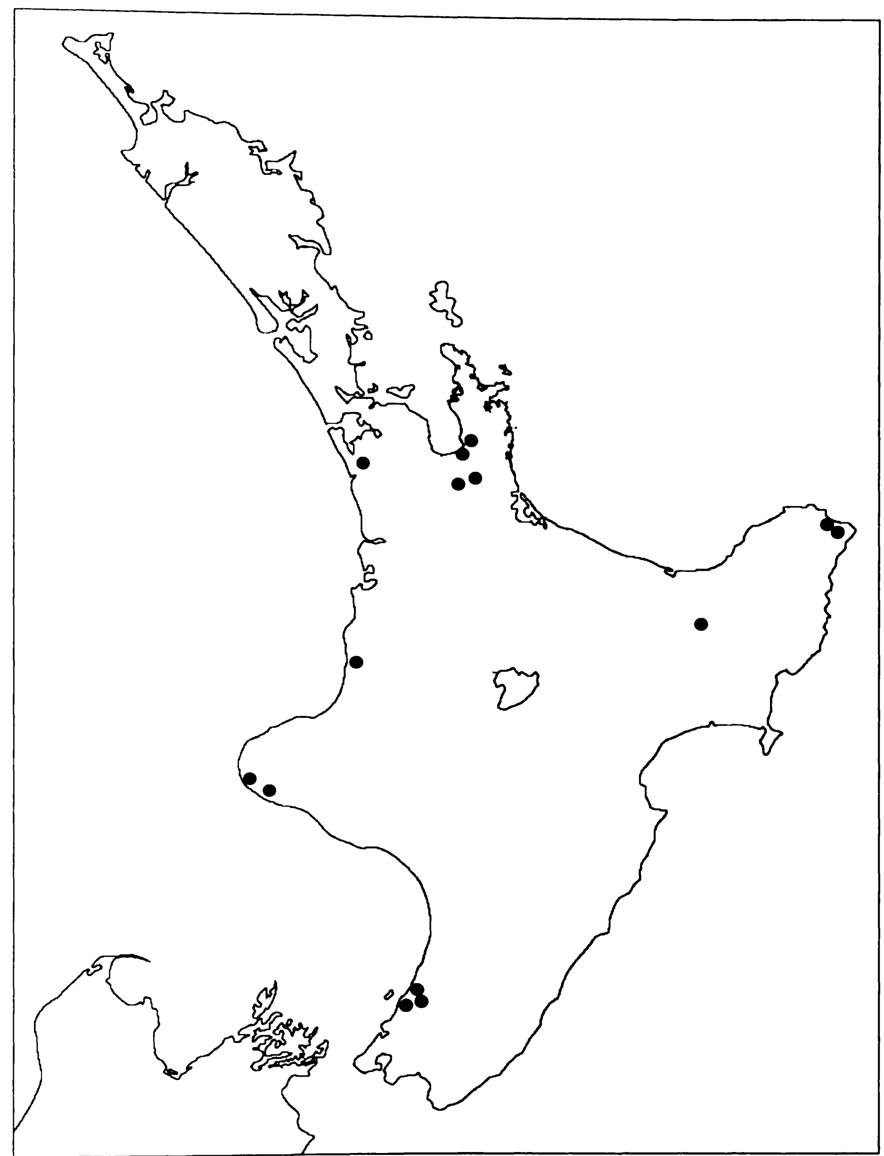


Figure 4.8: **Distribution of five harakeke varieties identified in the historical literature: *Rataroa***



From these maps, it appears that *ngaro* may have been more localised on the western side of the North Island, while *oue* and *rataroa* appear to occur in a number of districts. *Oue* is described as a prized variety by a number of authors, so its wider dispersal seems a likely consequence of demand. Although patterns of dispersal can not be determined accurately, it is possible to picture, for example, a logical progression of this variety from east to west, and down (or up) the North Island towards Waikanae.

Examples of trade in the raw resources used by weavers can also be found. Movement of harakeke varieties through the North Island, as recorded in the 19th and early 20th century literature, is summarised in *Figure 4.9.* The records are identified in *Table 4.8.*

Figure 4.9: **Dispersal of harakeke varieties identified in the historical literature**

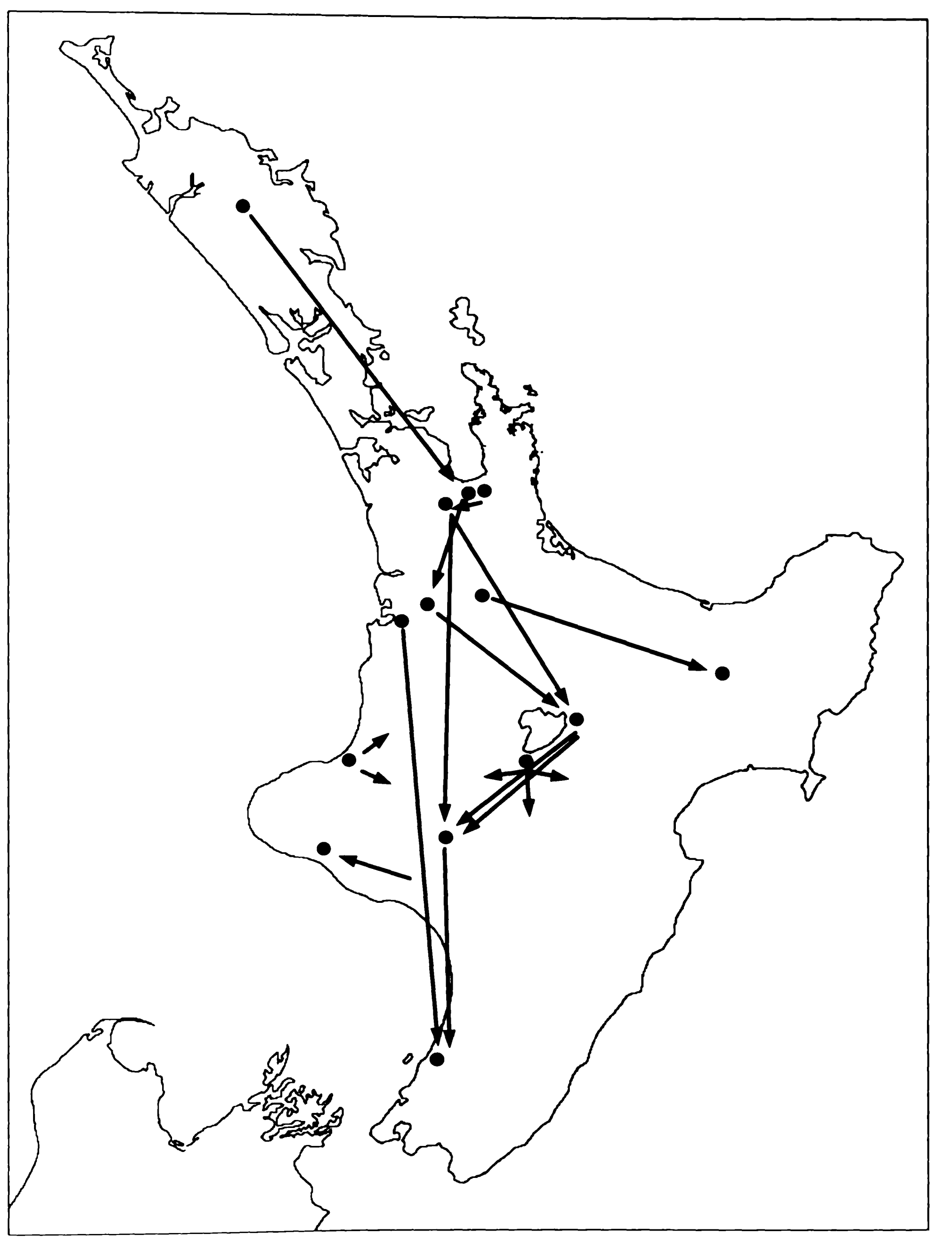


Table 4.8: **Dispersal of desirable harakeke varieties throughout the North Island, from 19th and early 20th century records**

Variety	Dispersal	Source
oue	Waikato to Tuhoe	Best, 1898a; Best, 1972 p.467
raumoa	Ngāpuhi to Hauraki, to Whatiwhatihoe in Waikato, and then to Taupo and Whanganui at the time of the King movement	Buck, 1911
parekoritawa	Taranaki Ngāti Awa to other places, although this origin was "somewhat disputed".	Buck, 1911
wharariki	From elsewhere to Ngā Rauru in south Taranaki	Buck, 1923
wharariki	Hauraki to Whakatiwai Pā	White, 2001 Vol. III pp.48-49
motu-o-ruhi	The southern shores of Lake Taupo to neighbouring tribes (who obtained it by gift giving or through an *ara whanaunga*, a channel of relationship).	Buck, 1926 p.61
kopakipaki-ika or *aroro-wharawhara* (an edible harakeke)	Waikato to Taupo to the Whanganui river	Department of Agriculture Report, 1908
tīhore	Waikato to Whanganui (classified as type A no. 5 in her system)	Cross, 1912 p.18, based on the information of a Mr Field, the son of a flax grower
tīhore	The upper part of the Whanganui River, or from Kāwhia, to Otaki and the Manawatu	Appendix 4 of the RFC, 1871 p.25

Many varieties are not reported in *Table 4.8*, including, for example, *rataroa* which appears to have been widely dispersed (*Figure 4.8*). As well, although Buck (1911) identified *raumoa* as originating from Northland, it was not recorded as occurring there in any other sources (see *Figure 4.6*). Again, the incompleteness of the historical records is evident. Some of the channels by which varieties were dispersed, however, are demonstrated in *Table 4.8*; these may have been similarly used to disperse the other varieties which were recorded in different regions. Nor was the trade in weaving materials limited to harakeke:

Buck also reported that inland tribes imported the "prepared material" of pīngao[91] from coastal friends (Buck, 1923).

Given that large harakeke swamps previously existed in the Manawatu area in the 19th century, the report of harakeke importation into the Manawatu (*Table 4.8*) emphasises the value placed on desirable varieties by Māori weavers. It also indicates the careful planning that went into variety selection and use, and demonstrates that active management of harakeke by Māori consisted of much more than the management of existing natural stands. The available evidence suggests that resource management involved the acquisition of the best quality resources for use, and whenever possible, for cultivation. Informal sharing of desired resources is a continuing practice today among expert weavers from different regions, a practice that is consistent with Māori values such as reciprocation and *manaakitanga.* The records of harakeke trade or exchange support the contention that although harakeke was ubiquitous, varieties for harvesting were carefully selected, and then actively managed through cultivation.

4.7 Discussion

Māori have an extensive classification system to identify many different varieties of harakeke, a system which is still in use today. Although our understanding of this classification system may no longer be complete, many references to classification indicators (such as weaving qualities as well as hue, leaf length and width) occur in the 19th and early 20th century literature. Estimates of the number of varieties known to Māori in the 19th century vary considerably, something that appears to reflect different levels of knowledge and understanding among different writers. In spite of the fact that a large number of varieties have been reported, there is little recorded information about many of these varieties or about their specific uses at the time. Furthermore, 28 of the total number of varieties in the National Flax Collection appear not to have been recorded at all in 19th century and early 20th century literature (unless, that is, they were recorded under different names). One thing that *is* clear is that 19th and early 20th century

[91] Pīngao (*Desmoschoenus spiralis*) is a sandbinder used by weavers, being particularly valued for its golden colour when dry.

records regarding harakeke are often incomplete, contradictory and confusing and are sometimes also clearly wrong.

Many harakeke cultivars remain largely unknown. For example, Williams (1971, p.483) lists *wini* as a variety of flax with a dark purple edge to the leaf. This variety was also noted in the notes associated with a lament for Te Wano (Ngata & Jones, 2004 p.317). It appears not, however, to have been recorded elsewhere. Moore (1849) recorded two of the best varieties as being *kuhiora*, and *tuao*. However, these two varieties also appear not to have been referred to elsewhere. There are a number of possible reasons for this. For example, Pākehā authors may have believed that a particular variety was less important to Māori than it actually was, simply because it was not a variety that they had any particular interest in. Equally, a particular variety may have been important in one area but may not have been exchanged with weavers in another area. It may, therefore, not be recorded in the literature simply because Pākehā were unaware of its existence. Where varieties were exchanged, that exchange may have been accompanied by a change of name, something that may have led Pākehā observers to assume that two different varieties were involved. There are, no doubt, many different reasons for the confusing nature of much 19th and early 20th century literature in which reference is made to harakeke. Nonetheless, specific use of harakeke (and wharariki) varieties is clearly signalled in that literature. Thus, for example, a large number of varieties are indicated in connection with the making of fine clothing. However, although Māori clearly used harakeke extensively for plaiting items such as *whāriki* and baskets, the varieties used for these purposes are almost certainly under-reported in the 19th and early 20th century literature.

The historical evidence for the use of cultivation of harakeke as a management strategy by Māori is unequivocal. Both highly valued cloak-making varieties and varieties that were associated with everyday use were cultivated. Furthermore, cultivation is recorded in many different parts of the country. In view of this, the fact that Māori cultivation of harakeke has not been universally accepted by some 19th and 20th century authors is surprising. It is likely that more extensive searches, including searches of Māori Land Court Records, will reveal yet more information about the extent of Māori cultivation of harakeke and management of

natural stands. Information on both cultivation and extensive natural harvesting will inevitably have significance for any studies of human modification of the New Zealand landscape.

Contemporary evidence supports the contention that there was cultivation of mixed variety plantations, at least on a small scale. Rene Orchiston, during her search for harakeke varieties in the 1960s and 1970s, found three bushes (later identified as *motu-o-ruhi*, *oue* and *parekoritawa*) at an old Māori camp site. These three varieties were all of high quality but not indigenous to this high country area (Orchiston, 1987). The implication is that they formed a mixed variety plantation. Mixed variety stands may have been subject to different management regimes from single variety stands. Thus, for example, one possible explanation of the fact that Māori weavers do not generally allow their bushes to flower is that simultaneous flowering of bushes in mixed variety plantations would allow genetic mixing so that any future harakeke plants which grew from seed would not breed 'true'. On the other hand, it may be that removal of flower heads relates to the maintenance of harakeke fibre properties.

It appears that both natural areas and cultivations were important in supplying Māori with weaving resources. This research identifies the presence of harakeke varieties which were considered to be of 'high quality'in apparently natural situations. A large number of varieties used for weaving were recorded in these 'natural' areas. Cross (1912, pp.14-16) also discussed swamp harakeke in terms of variety, based on morphological and floristic characteristics. Although her interest in harakeke was primarily botanical, she listed Māori variety names where they coincided with her own variety classifications, and also recorded some of these highly prized fibre varieties as naturally occurring in swamps. This concurs with the evidence discussed in this chapter. Certainly one might expect that most cultivated varieties would have originated as plants in natural populations.

There is inconsistency in the cultivation records of many observers. Colenso (1880, p.4) recorded that cultivations were not generally visited by strangers, so many of the early recorded observations of cultivations are likely to have occurred by chance. Even so, the fact that early observers recorded food plant cultivations,

but not harakeke, suggests limitations inherent in the observers. It may be that some did not consider harakeke noteworthy. Many early visitors may have failed to recognise that harakeke was a significant *Māori* economic resource. Women's activities are under-reported in the historical literature (see *Chapter 2*) and the lack of information about harakeke cultivation may be linked to this phenomenon. It is likely that other reports of harakeke cultivation may emerge in future, as many documents relating to Māori are currently in private collections.

Archaeological evidence for harakeke cultivation also appears sparse. Archaeological records of pā sites do not list harakeke plantations or cultivations (see, for example, McCulloch & Trotter, 1984; Gumbley, 2000; Walton, 2000; Jones & Tanner, 2002). Walton (2000) analysed data from Taranaki and Whanganui regions in terms of resource use, settlement patterns and change. Although pā are very prominent in the archaeological landscape of some parts of Taranaki and Whanganui, no evidence of harakeke cultivation or use was presented. Likewise Gumbley (2000) has recorded pits, terraces, depressions and even a tōtara tree notably associated with pā, but, once again, there is no mention of harakeke. An archaeological survey of southern Hawke's Bay by air (Jones & Tanner, 2002) also failed to report harakeke plantations, if indeed any were sought. It should be noted, however, that the fact that this area is mostly pasture means that cattle damage may have resulted in the disappearance of harakeke. Guthrie-Smith (1969, p.75) explored old pā on his land in Hawke's Bay in the late 19th century. In so doing, he noted evidence of kumara plantations, peach groves (*Prunus persica*), and even clumps of mint (*Nepeta cataria*) near the sites of old *kāinga*, but he did not refer to harakeke.

Harakeke cultivations have not been noted near *pā* sites in archaeological records held by the National File keeper, Department of Conservation, although cultivation records for plants such as karaka (*Corynocarpus laevigatus*) trees do exist. Other file keepers of archaeological records in Waikato and Taranaki were also unable to provide any details of *pā harakeke* although one *pā harakeke*, situated at an archaeological site south of Awakino, was recalled by the Waikato file keeper (O.Wilkes, pers. comm. 28.9.04). However, Walton (2000, p.6) noted that many activities leave few traces in the archaeological record; it seems likely

that harakeke cultivation and use is one of these[92]. Unfortunately, because harakeke is eaten and trampled by cattle, the transformation of many areas to farmland may have destroyed supporting evidence from archaeological sites. It is highly probable, then, that there *were* harakeke sites that could have been recorded. Knowledge of these sites could be of great value in determining further patterns of dispersal, with resulting landscape changes. Wharariki, for example, has been sighted on Patuha pā site in Egmont National Park (Clarkson, 1986 p.15), well outside its naturally occurring distribution, and is also recorded in the historical literature as imported by iwi in southern Taranaki (Buck, 1923). This confirms that varieties were transferred from areas where they were established to other districts within their potential natural distribution, but to which they had not yet naturally dispersed.

Pākehā interest in the commercial fibre industry certainly affected recognition and recording of other knowledge about harakeke. Early 20th century scientific research on harakeke concentrated almost solely on harakeke varieties which were of interest to commercial millers: Poole (1940), for example, mentioned *ngaro*, *paretaniwha*, *ngutunui*, *korako*, *oue* and *tīhore*, all of which were of commercial interest. As well, the search for, and selection of, certain types of information has complicated understanding of harakeke varieties: although commercial growers and scientists received information from a plethora of sources, both Māori and Pākehā, these sources were often not explicitly recorded, and inconsistencies in variety identification have emerged between, for example, the Department of Agriculture Reports and other sources. It is extremely difficult to reconcile scientific and Māori observations of harakeke varieties in the absence of reliable records.

Current understanding of Māori knowledge and use of harakeke (as well as cultivation practices) is woefully incomplete. Under the circumstances, there is

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[92] There are however a small number of instances where pieces of weaving have been found at pā sites or elsewhere (see, for example, Lander (1992) and Trotter (1987)). As well, Owen Wilkes (pers.comm. 28.9.04) pointed out that harakeke processing tools have been found, as has occurred at T12/985 near Coromandel where 210 shells were recorded.

considerable need for research that involves a combination of techniques, including genetic analyses such as that initiated by McBreen et al. (2003). Such research could be valuable for restoration attempts, which often involve the ecosourcing of seed from local genetic stock and which, therefore, need to be based on an understanding of past distribution patterns.

In spite of the fact that the knowledge and understanding of harakeke that can be derived from 19th and early 20th century records is incomplete, and sometimes contradictory, it is clear that both cultivation and management of natural populations has been more extensive than previously reported, and on a larger scale. Changing variety distributions also indicate that hybridisation of harakeke and wharariki needs to be considered in the light of reported human dispersal of varieties and the genetic relationships of these varieties. The extension of harakeke and wharariki into areas of their natural distribution which had not previously been naturally colonised also raises interesting questions about the structure of ecological communities and successional patterns, and how these may also have changed. Historical Māori harakeke use and management demonstrate the entangled relationship that we have with the environment in which we live, and the potential for changes to our landscape that are often unacknowledged.

Chapter 5

A critical analysis of harakeke management practices in the late 18th – early 20th century literature

Kua tupu te pā harakeke

5.1 Introduction

In this chapter I identify Māori resource management practices for harakeke which emerge from an analysis of the 19th and early 20th century literature. These practices contribute to an hypothesis of active management of harakeke by Māori. Further, I examine these practices in relation to practices identified in the literature on harakeke and weaving from the last 40 years, and in relation to ecological research published by the modern scientific community.

Recent scientific publications have demonstrated increasing collaboration and interest in Māori traditional knowledge of harakeke. For example, Scheele & Walls (1994) included a brief note on traditional planting methods, based on the comments of Ngoi Pewhairangi, an esteemed elder from the East Coast. Other scientific papers on resource management by Māori have used pollen data to analyse evidence on Māori resource use and management, but without specific attention to harakeke (see, for example, Wilmshurst et al., 2004). However, there has to date been no comprehensive examination of historical resource use and management of *harakeke* by Māori.

Publications in the last 40 years relating to Māori use of harakeke have tended to focus primarily on the art of weaving itself (see, for example, Mead, 1968; Hopa, 1971; Yates, 1980; Tamati-Quennell, 1993; van de Klundert, 1996; Pendergrast, 2003). Nonetheless, recent literature indicates a revived interest in traditional Māori management of weaving resources (Puketapu-Hetet, 1989; Scheele & Walls, 1994; Mihinui, 2002; Moeke-Pickering & Kete, 2002). It also draws attention, in relation to traditional resource management by Māori, to a Māori world view in which concepts such as *whakapapa* and *mauri* play an important role. Mihinui (2002), for example, has provided insight into the practices and

responsibilities of *te hunga tiaki* (more widely known as *kaitiaki*) in Te Arawa. Concepts such as *whakapapa* and *kaitiakitanga* are briefly introduced in *Appendix 1*. Although their importance is not discussed in any detail in this chapter, the fact remains that this world view continues to be central to contemporary Māori resource management practices. This is evident in the discussions of contemporary Māori authors (see, for example, Garven, Nepia & Ashwell, 1997 p.24; Roberts et al., 1995; Kawharu, 1998; Mihinui, 2002; Marsden, 2003; Mead, 2003).

Some of these recent texts have been written by expert contemporary weavers whose knowledge is based on oral tradition (see, for example, Puketapu-Hetet, 1989; Mihinui, 2002). As such, they are valuable documents of contemporary beliefs and practices drawn from extended family knowledge passed down through the generations. Traditional ecological knowledge is generally most evident as part of oral tradition, and is therefore represented in these sources. There is also a small but growing number of sources in other media such as videos and sound recordings which refer to harakeke use and management by Māori (see, for example, Schuster, n.d.). All of these sources are of very considerable significance.

In literature about Māori resource management, *rāhui* and *tapu* are frequently discussed as means of restricting access to resources, especially when these are in short supply (see, for example, Best, 1898b; Marsden, 2003 pp.49-50 and 69-70; Kape, 1998; Tau et al., 1990), but these measures may be less applicable to a resource such as harakeke which is generally in plentiful supply. Many publications, in fact, emphasise resources or food products such as fish, shellfish or birdlife (see, for example, Mead, 1984; Hodges, 1994; Hauraki Customary Indicators Report, 1999; Tau et al., 1990; Kawharu, 1998) without consideration of a vital economic plant resource such as harakeke.

With the current resurgence of Māori weaving, many contemporary *pā harakeke*, or cultivated harakeke gardens, are being developed at sites around the country, including schools and marae. It is therefore timely to examine information associated with past Māori management of *pā harakeke*. An investigation of

written historical sources can provide insight into changing traditions of resource management, and thus provide useful information for discussion by contemporary weavers. This chapter analyses information contained in literature from the late 18th to the early 20th century with a view to illuminating historical Māori management techniques.

The information provided in *Chapter 4* indicates that harakeke was cultivated in a large number of districts, ranging from Taranaki (Smith, 1993 pp.17-18; Kelly, 1866) and the Whanganui River (Buck, 1911), to the Urewera (Best, 1898a). What specific practices, then, were developed to manage these harakeke cultivations, and were these practices also used to manage wild harakeke populations? This chapter provides an analysis of harakeke resource management practices presented in late 18th – early 20th century literature. The following questions are therefore critical to the discussion of these analyses of resource management of harakeke:

- What were the main methods of cultivation and management of harakeke by Māori recorded in the historical literature from 1790 to 1930?
- What was the role of fire in historical resource management of harakeke?
- Do any of the recorded methods have wider implications in terms of landscape change?

5.2 Methods

As outlined in *Chapter 2* (see *Section 2.2*) a search and critical review of historical sources comprised the main method of investigation.

5.3 Results

Early references to the management of *pā harakeke* are sparse. In the first half of the 19th century, some Pākehā observers seemed to consider either that *harakeke* had never been cultivated (see, for example, Terry in Bell & Young, 1842, p.25), or alternatively that Māori had forgotten any resource management practices that

had once been known (Bell & Young, 1842 p.12; Brodie, 1845, p.95).[3] Brodie reported that "the cultivation of the flax has of late years been entirely neglected [by Māori]" which suggests a period of inactivity and loss. In a similar vein, Heaphy wrote that "[no] pains have ever yet been taken in its culture; and indeed but little are necessary, so luxuriant is it in its wild state" (Heaphy in Bell & Young, 1842 p.19). Other early writers, such as Lang (1839, pp.59-60), made only superficial observations of Māori weaving, or appeared to have little interest in harakeke (see, for example, Yate 1835, p.31).

Ethnological writing during the later part of the 19th and early 20th centuries which relates to harakeke is heavily weighted towards descriptions of the art and customs of weaving (see, for example, Best, 1898a; Buck, 1923, 1924; Roth, 1979). These ethnographers recorded terminology associated with weaving in great detail, as well as customs associated with the *whare pora*, and names for different items of clothing. Unfortunately, they paid almost no attention to the plant itself. Thus Andersen (1907, pp.322-334) devoted twelve pages to weaving itself and three pages to *all* of the plants used in *raranga* and *whatu*, Buck (1950, pp.302-6 and 144-178) included thirty eight pages on weaving but none on harakeke itself, and Best devoted only two pages to harakeke in *Forest Lore of the Maori* (1942, pp.100-102). In *The Maori,* Best allocated twenty eight pages to desriptions of woven clothing (Best, 1924, pp.503-531) and a single paragraph to harakeke management. The exceptions to this trend are two papers, one by Best (1908), the other by Buck (1911), which provide what are almost certainly the two most valuable historical accounts of harakeke management. Additionally, a number of practices are reported, often fleetingly, in other sources.

The botanical literature on harakeke published in the second half of the 19th century focused on quantifiable measurement or observation that might be relevant to the commercial harakeke industry (Crawford, 1869; Hutton, 1869; Nottidge, 1869; Purchas, 1868; Hutton, 1870; Church, 1873). Generally, Māori ecological knowledge was ignored. As one example, Haultain (1872) examined the growth of harakeke without any reference to Māori knowledge although it is evident that harakeke growth patterns and environmental preferences were observed by Māori (see *Chapter 3*). The emphasis on research for the harakeke

industry continued in the early 20th century. It appears that after the revival of the harakeke industry during this period, and faced with both the need for cultivation and difficulties in insect pest management, the scientific community began to turn towards Māori ecological practices and knowledge as a source of ideas for commercial industry. Scientific writers such as Atkinson (1921a, 1921b, 1921c) incorporated brief accounts of Māori knowledge into papers on the history, cultivation and conservation of harakeke. These seem to rely heavily on the work of Buck (1911) although no source was acknowledged. Although Cross (1912) included some information on Māori varieties into her research, this was largely incidental. Details of resource management of harakeke in both early scientific and ethnographic sources in the 19th and early 20th centuries are sparse, but nonetheless taken with other early records of harakeke management, these sources provide an important resource in relation to the practices used by Māori to manage *pā harakeke*.

5.3.1 Propagation

It is possible to propagate harakeke using two main propagation methods. First, harakeke can be propagated by separating out and planting leaf fans taken from an established harakeke bush; this is often referred to as propagation by root division. Each of these ramets or fans (sometimes also referred to as 'roots' or 'offsets') must have attached root stock or rhizatomous material in order to grow. The second method is propagation of harakeke from seed.

Propagation by root division

Māori use of root propagation to multiply desired varieties is reported in numerous sources (King, 1793; Ross, n.d.; Elder, 1932 p.241[4]; Selwyn, 1847; Kelly, 1866; the Report of the Flax Commissioners, 1870-1871; Williams, n.d.; Best, 1908; Buck, 1911; Atkinson, 1921c). These sources cover much of the country, from Northland to the Eastern districts, Taranaki and the Urewera. Root division therefore appears to have been a well-known common method of propagating harakeke. Nonetheless, a later botanical publication referring to the

experimental harakeke plantations of the Department of Agriculture did not refer to Māori practices at all (Critchfield, 1951)[93].

Propagation by root division of harakeke appears to have been well established before the arrival of Pākehā. Some of the earliest information about Māori cultivation techniques comes from Tuki and Huru, two high ranking Māori kidnapped in 1793 from the Bay of Islands, who were taken to Norfolk Island in the hope that they would be able to help the convicts there extract fibre from harakeke for the growing trade[94]. Philip Gidley King (1793, p.188) described in his journal how, according to Tuki and Huru, "it is Cultivated by seperating [sic] the roots". This method of propagation was still reportedly in common use a century later, as Williams (n.d.) recorded that when Māori discover a *tīhore* plant, they "propagate it by dividing the root stock and . . . plant it in rows near their ordinary habitations." Propagation by root division remains the preferred method of establishing *pā harakeke* today. It appears, therefore, that Māori have been propagating harakeke by root division for at least 200 years, and most likely longer.

As noted in *Chapter 1*, Craig & Stewart (1988) discussed the implications of this mode of asexual reproduction via the production of offshoots or fans, so that a typical plant consists of tens of fans of the same genetic stock. Root propagation seems likely to have been a deliberate choice of technique by Māori, based on its usefulness in multiplying valued harakeke varieties using identical stock. Later research by Critchfield (1951) reported that propagation of fans was also employed by commercial growers to maintain "the qualities of individual varieties".

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[93] This raises the possibility that in the 20th century Māori practice was becoming increasingly separated from mainstream science; an alternative hypothesis might be that the scientific community had absorbed and incorporated Māori ecological knowledge of harakeke under its umbrella.

[94] Norfolk Island harakeke is described as *Phormium tenax*, and no morphological features which are different from the range of *Phormium tenax* in New Zealand have been reported.

Botanists noted that propagation by root division was applied by Māori not only to harakeke but also to other crops. Cheeseman noted that while taro occasionally flowers, Māori regularly multiplied it by root division (Cheeseman in Thomson, 1922 p.485). Distribution data from the Pacific Islands provides evidence that Polynesians had developed techniques to propagate other weaving plants in a similar way to harakeke prior to the colonisation of New Zealand (see for example, Connor, 1983 p.19). This technique was quickly and easily adaptable to a range of plants in Aotearoa.

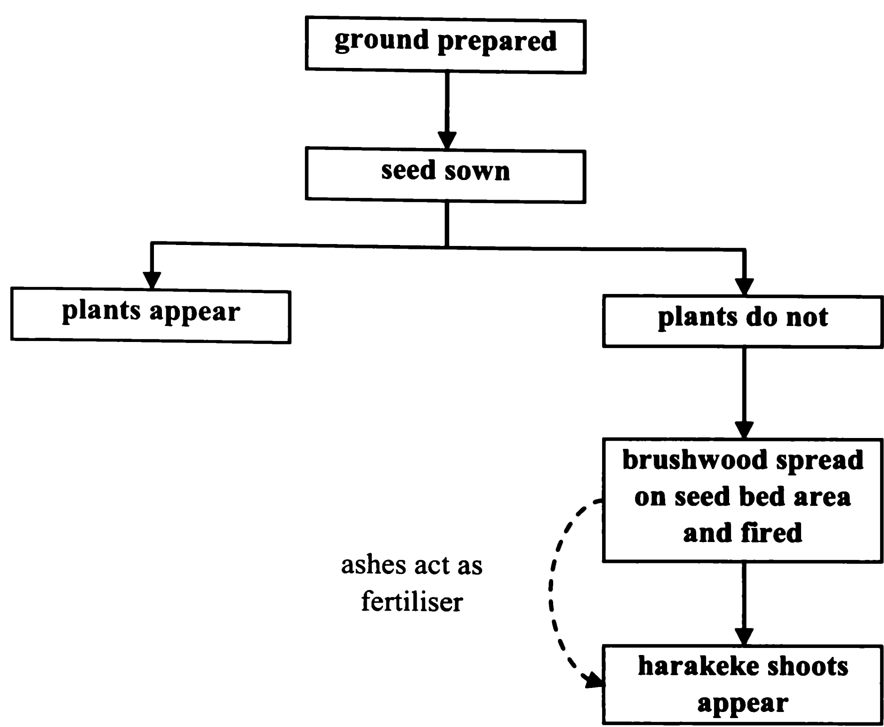
Seed germination

The Report of the Flax Commissioners (1870, p.6) stated categorically that Māori did not grow harakeke from seed, and always transplanted harakeke, and this view was echoed by others (Canterbury Flax Association, 1871; Atkinson, 1921c). This view seems to be widely accepted today, as propagation by seed is not discussed in any later references. Kelly (RFC, 1870 p.9), meanwhile, reported that Māori had tried to propagate from seed unsuccessfully. However, detailed description of Māori seed propagation methods for other plant species such as hue are given by, for example, Colenso (1880), and Makereti (1938, pp.215-216). These writers provide evidence that Māori experimented successfully with different methods of maximising seed germination.

There *is* evidence which refutes the widely held view that Māori did not propagate harakeke by seed. Examination of an early text by Murray (1836, p.13) reveals evidence that they did. He quoted the words of a friend, who wrote to him after consultation with a Māori informant (unfortunately neither the friend nor the Māori informant is named), describing the Māori method of sowing harakeke seeds (summarised in *Figure 5.1*). Murray's description is as follows:

> After preparing the ground and sowing the seed, if they do not quickly see the plants appear, they spread a quantity of brushwood over the land and set fire to it. This being done, the plants soon make their appearance, and a crop is ensured.

Figure 5.1: **The seed germination process described by Murray (1836, p.13)**



This method is similar to other seed propagation methods described much later for kumara by Best (1925, p.188). Best also described a method of growing potatoes called *whakapara*, where potatoes were planted in the bush or scrub (Best, n.d. p.202)[95]. *Whakapara* illustrates the use of fire to ensure new growth at an appropriate time of year. A similar process is also described by Shortland (1856, pp.203-4).

It is, however, currently unclear under what conditions Māori chose to grow harakeke from seed; propagation by root division is likely always to have been, in most contexts, a more effective way of propagating this valuable weaving resource. As Murray (1836, p.15) noted (with regard to cultivating harakeke in Scotland): "The difficulty of obtaining mature seeds appears to be a subject of

[95] The scrub was cut down and the larger trees had their branches cut off. The potatoes grew up through the scrub, which was burned after the potato flowers had appeared. The potato plants would be burned but then come up vigorously. He noted that this method was used to provide very early potatoes which then allow a second growth of potatoes to spring up after the frosts.

little or no regret, from the great facility with which plants may be cultivated by offsets." That is, propagation of harakeke by root division is much more effective than seed propagation for multiplying desirable varieties at a fast rate. This supports Māori preferential use of root division to propagate desirable varieties in *pā harakeke*. Some benefits of both forms of propagation are suggested in *Table 5.1*.

Table 5.1: **Potential benefits of different propagation methods**

Fan or offset use from existing bushes	Seed from seed pods planted
Shorter time span from planting to maturity when leaves can be harvested	Genetic variation and therefore potential new varieties
Maintenance of high quality varieties	Fire breaks dormancy; harakeke could be used as a nurse plant for other species
Ease of trading or sharing varieties with other iwi	Transformation of large areas to harakeke cultivations

Propagation from seed encourages genetic diversity and the establishment of different genetic varieties. It is not clear whether this was the purpose behind germination of harakeke from seed, although the identification and use of around 60 harakeke varieties by Māori suggests this might be a valid hypothesis. It was noted by Hector (1889) that seed could not be relied on to reproduce the characters of the plant from which it was gathered, an observation that came well before understanding of Mendelian inheritance and genetic theory. It seems inconceivable that Māori would not have noticed the genetic diversity produced from seed. However, harakeke growth from seed germination is slow, with plants taking approximately 6-8 years to mature. As well, a range of desirable forms might be selected from natural stands, and then grown by root division. Another hypothesis might be that Māori sought to establish large areas of harakeke in

regions with a poor natural distribution, or with a dense human population and high resource usage.

Unfortunately it is not clear from Murray's account what was done to "prepare" the soil prior to sowing the seed. Nor did the Report of the Flax Commissioners record soil preparation in detail, although they too noted that Māori "do not use manure though they prepare the soil with great care" (RFC, 1870 p.7). That Māori did not use manure would be expected given a Māori world view in which bodily functions and *tapu* are linked. The comment on soil preparation, nonetheless, emphasises the importance of soil condition to promote growth and vigour of harakeke. This will be discussed further in relation to the use of fire.

Murray (1836) also noted that "the iodine, or alkaline of the ashes, is no doubt the efficient stimulus in this case". The ashes would act to enrich the soil and create soil conditions more suited to harakeke growth: harakeke thrives in relatively nutrient rich, high pH conditions with good drainage (see, for example, Wardle, 1977; Duncan et al., 1990; Clarkson et al., 2004). Buck (1950, p.89) described a similar process of soil enrichment for kumara, with the return of ashes to the soil after the weeds and brushwood were cleared and burned.

5.3.2 Planting

The development of pā harakeke using rhizatomous fans of different varieties raises the question of planting methods. There are, in fact, a number of 19th and early 20th century sources which describe planting of harakeke. Buck (1911) provided the most succinct record of planting as follows:

> Considerable trouble was taken in the cultivation of flax, each family having their own *pa harakeke* or flax-garden. Suitable ground having been prepared, the roots were planted perhaps in groups of four, slanting outwards from one another. These would all grow up into one large bunch, which was called a *pu harakeke.* The next *pu* would be planted about 8 ft. away. The bunches were arranged in rows of from six to thirty or so. Each row was called a *pa*, a term which was also applied to the whole collection in the phrase *pa harakeke* or *pa muka.* The *pa harakeke*

was carefully weeded, and as the various roots sprouted up earth was banked between the divisions of the bunch.

However, contrasting information is provided by other authors in relation to planting distances. These can be compared in *Table 5.2.*

Table 5.2: **Descriptions of planting distances between *pū harakeke* (bushes) from 19th and early 20th century literature**

Planting description	District	Source	Background or discipline
Roots one foot apart	Northland	King, 1793 p. 188	Māori
Roots one foot apart	Waikato	Ross in Bass, 1993	Possibly Māori practice
Each root to be planted about two yards apart		Brodie, 1845 p. 92	Unknown; context of farming and milling harakeke
Spaces of six feet between plants, and rows six feet apart		Selwyn, 1847	Probably Māori, from the East Coast
Each native flax plant occupies about two square yards of ground; *Tihori* [sic] is set in rows about three feet apart	Unknown	Moore, 1849	Unknown
Spaces of six feet between plants, and rows six feet apart	Probably Taranaki	Kelly, 1866	Reminiscent of Selwyn (1847), as is Kelly's classification of varieties
Six feet between rows and plants		RFC, 1870	Possibly based on commercial flax growers returns
Tāpoto class is planted in rows 20 feet apart	Pourerere, Hawke's Bay	Nairn in the RFC, 1870 p.8	From Māori sources
Wharanui is planted in rows 20 feet apart	Pourerere, Hawke's Bay	Nairn in the RFC, 1870 p.8	From Māori sources
Six feet or eight feet or 10 feet apart.	Possibly Wellington	J T Mitchell, 1905 p.35	Based on his memory of Māori plantings 35 years prior
Each root 10 feet apart and in rows		Raymond, 1905 p.6	Flax milling
Each pū harakeke planted about eight feet from the next	Whanganui River	Buck, 1911	Māori
Plant eight feet apart with four feet between plants		Critchfield, 1951	Scientific community
Young fans should be planted at least two metres apart		Scheele and Walls, 1994 p.7	Unknown

There is also evidence from different parts of the country that harakeke was planted in rows. Crawford, who made a trip up the Whanganui River in 1861, mentioned that at Tangarakau "flax . . . is here planted in rows, dividing garden from garden" (Crawford, 1880 p.108). Evidence from other authors (Selwyn, 1847; Moore, 1849; Kelly, 1866, Heaphy, 1869; Nairn in the RFC, 1870; Buck, 1911) concurs. Best (1908) also reported that long rows of cultivated flax were seen by early settlers.

There is considerable variation in reported distances between harakeke bushes. This variation may relate, in part, to the fact that some authors appear to be describing planting methods whereas others may be describing either planting distances, or the distances between *existing* plants. However, the distances recorded between planted harakeke roots certainly appear to increase over time. There are two likely explanations. First, distances may appear to increase without this being the case because of substantial variation in planting practices, particularly between regions, and the circumstantial reporting of this variation. These regional differences may also have included variation in which varieties were chosen, with bush size depending on the variety and growth conditions (see below for further discussion). Secondly, the commercial harvesting of harakeke for industry may have had a significant impact on planting distances. During the later part of the 19th century, commercial harvesting of harakeke was prevalent in many areas, and non-Māori interest was closely focused on the harakeke industry. Although initially natural stands of harakeke were harvested, by the turn of the 19th century landowners were planting harakeke for planned commercial harvest. Large distances between rows of harakeke allowed tramlines to pass through so the leaves could be carted more easily. It is possible that what has been reported as Māori practice during this period is misrepresented as such, or that Māori planting distances themselves changed in response to industry. Hector (1889, p. xvii) noted that harakeke was in constant use by Māori during the early contact period, and that "a very considerable trade in the article [*Phormium* fibre] existed as early as 1828". This trade increased in the second half of the 19th century, and Māori continued to be involved in the trade as harvesters.

The Flax Commissioners (1870, p.6) noted in their report that "[it] seems to be overlooked that planted flax will not be allowed to grow into large bushes". This suggests that small distances may be appropriate in some contexts. Crozet (1999, p.40[96]) had observed that harakeke bushes he saw planted in Northland were "very small". This, together with the fact that Tuki reported close planting (King, 1793 p.188), lends support to the hypothesis that there was a relationship between planting distance and bush size.

The transplanting of fans to propagate harakeke also requires a decision on the number of fans to place together at any one site. Evidence suggests that the number of fans planted in any one hole probably varied in different areas (*Table 5.3*).

Table 5.3: **Records of the number of rooted harakeke fans placed in one planting hole**

Number of fans (with root attached)	Reported District	Time period	Source
3	Bay of Islands	1793	King, 1793 p.188
2	possibly Tuhoe but not specified	around 1900	Best, 1908
4	Whanganui River	around 1900	Buck, 1911

Planting one fan only in each hole is probably the most common method of planting today, possibly because that is the amount of material able to be supplied by the giver of a desired variety. However, some weavers still prefer to plant two or three fans together. Pendergrast (2000, p.14) noted a "traditional method used by the late Mrs Marara Maihi" where fans were planted singly or in groups of three with the rhizomes pointing outwards. It can be seen here that there appears to have been considerable variation in practice previously. Best additionally recorded that in Tūhoe tradition it was considered unlucky to plant an uneven number of harakeke fans in a hole (Best, 1972 p.1010). The number of suggested fans in Pendergrast differs from Best's record, although Pendergrast's description

[96] From his voyage in 1771-2.

of planting orientation from the East Coast area is similar to that described by Buck (1911) with reference to the Whanganui River area. However, the overall preference for more than one fan may be based on the faster speed of bush development into harvestable material.

The Flax Commissioners (1870, p.7) noted one practical reason for variation in the number of roots planted: "[if] close planting should be adopted, only one root should be planted at one place". Although it is not clear from the context whether this referred to Māori practice, it seems likely that it did. Another explanation relates to the nature of traditional knowledge itself, which is based on experience, and therefore open to change (see, for example, Grenier, 1998).

A large number of authors (see, for example, Selwyn, 1847; Kelly, 1866; Best, 1908; Buck, 1950 p.89; Makereti, 1938 p.191) remarked on the weed-free nature of Māori cultivations. Harakeke cultivations were also reported by Buck (1911) as weed-free, while Best (1924, p.514) noted that Māori "attended to . . . [pā harakeke] by keeping the plants free from surrounding weeds, cutting off dead leaves, etc."

Planting seasonality

Seasonality is mentioned frequently in the 19th and early 20th century literature in relation to resource management by Māori. It is mentioned, for example, with reference to kumara (Best, 1925; Makereti, 1938, p.193), fishing (Makereti, 1938 p.246) and bird harvesting (Best, 1942 p.127; Firth, 1959 p.79). Harakeke planting also appears to have been strongly seasonal. Kelly (1866) reported that the best season for planting is April or May. His indication of seasonality may be based on communication with Bishop Selwyn, as his list of harakeke varieties is strongly suggestive of Selwyn's work (Selwyn, 1847). Best (1908), however, reported that fans were planted out in the fourth month of the Māori year, which corresponds to spring in the western calendar. Firth (1959, p.71) also recorded flax planting as an activity for September, or spring, in his reconstruction of a Māori calendar. In this case, historical reports and modern practice correlate well: transplanting of harakeke fans in autumn or spring is common today. Because seasonality is important for a large variety of activities undertaken by Māori, from

fishing to planting of crops, it is likely that continuation of this practice has been supported by this broad base of traditional knowledge.

A number of planting practices for harakeke were dismissed as involving superstition by Best (1942, pp.102-3). These include practices that involve observation of wind and wind direction:

> When it was planted near a village for daily use, it was highly essential that the planters should note and remember what wind was blowing at the time of planting. When the plants had developed and the leaves were ready for use it was necessary that such leaves be cut during the prevalence of the same wind; if cut at any other time the fibre of the leaves will be found to be of poor quality.

At face value, these practices might seem strange, but there is at least one oral tradition maintained among weavers that suggests the way harakeke is planted in relation to the prevailing winds of the area is important in terms of survival and growth. Winds are often indicators of bad weather, or season, something that can clearly affect the appropriate timing of harvesting, or the growth of the plant itself. Further consideration of the meaning behind these comments may yet illuminate the practices described. As well, although traditional ecological knowledge is largely discussed in relation to western scientific understandings, it cannot be solely restricted to this forum.

5.3.3 Irrigation

Māori irrigation of harakeke was not recorded by Kelly (1866), Best (1908), Buck (1911) and others. However, Crawford (1869) noted that "it is said in the old days of Maori flax cultivation, the plants were irrigated, although always planted on a hillside". This record provides evidence of a significant resource management practice. Cross (1912, p.151) also mentioned irrigation by Māori, but as her writing is remarkably reminiscent of that of Crawford, he is likely to have been the authority for her statement. Frustratingly, Crawford (1869) did not elaborate further on his comment. It therefore remains unclear whether he was referring to watering or ground-based irrigation systems. Nor can we know the

extent of irrigation use from this rather tantalising report. Even so, the fact that Crawford's paper focused on the usefulness of cutting drains to increase growth in commercial harakeke plantations, places his comment in a context of ground-based irrigation of some kind. Other research demonstrates that Māori were well versed in water management techniques, manipulating the water table, irrigating, and building artificial islands to transform the landscape in Hauraki, the Manawatu, the Urewera and, no doubt, other places (Best, 1972 p.85; Park, 1995 pp.52ff.and 189).

The irrigation of harakeke on hillsides reconciles well with what is currently known about environmental parameters for harakeke. Harakeke is frequently described as liking free flowing (rather than stagnant) water which is well oxygenated (see, for example, Hector, 1889; Cross, 1912 p.132; Dobson, 1979; Wardle, 1991 p.310). Elevation may also play an important role in determining the composition of natural communities (Robertson et al., 1991). *Pā harakeke* which were irrigated on hillsides with good drainage would thus be provided with good conditions for growth.

5.3.4 Harvesting practices

Care of the central growing shoot or *rito* and the surrounding *mātua* leaves when harvesting is a recurring theme in the 19th and early 20th century literature (Heaphy, 1869; Hector, 1889 p.9; McGregor in JHR 1905 p.40; Beattie, 1994 p.53). Hector described the cutting of the leaves as follows:

> The general understanding is that in cutting Phormium only the outer leaves should be cut, and that in doing so great care should be taken not to injure the leaves which enclose the centre shoot. With this view the knife should be inserted at the leaf enclosing the centre shoot, and the outside leaves, two or three on each side, cut downwards and slanting outwards; but no leaf should be cut before maturity, as doing this only weakens the plant and makes it liable to go to flower.

Although he did not specifically state that these suggestions are based on Māori practice, this is almost certainly the case. This method of harvesting is shown in *Figure 5.2.*

Figure 5.2: **Illustration of harvesting method described by Hector (1889).**

Extremely careful selection of harakeke leaves for harvesting also related to Māori assessment of fibre quality in the leaves (see, for example, Rees & Graham in the RFC, 1871 p.62). McGregor (1905, p.40) considered that Māori would not harvest immature leaves, as the fibre was less strong. Nonetheless, Best (1908) noted that if young leaves were too numerous, some of these would be cut out while harvesting. This would have created space for the remaining leaves to grow.

Following appropriate harvesting protocols is an essential element of harakeke management for contemporary weavers. Cutting methods are strongly emphasised both in teaching courses for weavers, and in literature on weaving (see, for example, Puketapu-Hetet, 1989 p.3; Pendergrast, 2000, pp.15-16). Harris et al. (2005) observed that in their trials of harakeke growth, the *mātua* leaves offered frost protection to the *rito*, suggesting that Māori harvesting protocols act

to protect the plant. On the other hand, the removal of young leaves as described by Best (1908) is not discussed by contemporary authors although it is the current practice of at least some experienced weavers (see *Chapter 3*). Many novice weavers, however, seem to be unaware of this practice.

Seasonality emerges as an important tenet of harakeke harvesting in the 19th century literature. Unfortunately, however, there is confusion in 19th century sources as to exactly what season is best for harakeke harvesting activities (see *Table 5.4*). Further, a lack of detail limits the usefulness of some references, such as those of Hursthouse (1849) and Stack (1898) who indicated that harvesting was seasonal, as with many other activities, but failed to indicate *which* season was considered best for harvesting.

Table 5.4: **Indications of harvesting reported in 19th and early 20th century**

Season recommended for harvesting	Source
Harvested "just about the time it flowers"	Brodie, 1845 p.92
Fibre tears out more easily in spring/autumn	Field in RFC 1870, p. 24 (from own observation)
Not during summer flowering	RFC, 1870
Stripping fibre [and hence probably harvesting] is best in autumn and winter	RFC, 1871 p.68, Hector, 1889 p.6
Winter the best time for cutting	Andersen, 1907 p.322
Not while flowering in spring and summer	Atkinson, 1921d
Māori "carefully preserve their flax swamps" during winter	RFC, 1870 p.7; Hector, 1889

Brodie (1845, p.92) must be viewed as a suspect source. Brodie's descriptions of other Māori processes (in the same book) such as harakeke stripping are extremely limited and his statements contradictory: he also wrote that harakeke may be cut twice a year (Brodie, 1845 p.94). Nonetheless, Heaphy recorded that harakeke leaves may be cut twice a year (Heaphy, 1869), providing support for the concept of two seasons for cutting. Andersen (1907) is likewise probably a less reliable source than is the Report of the Flax Commissioners who collected

their data much earlier. Spring, summer, and autumn, excluding the flowering period, emerge as the leading harvest periods.

Thus, while 19th century authors stressed the importance of seasonality, the actual details of this traditional knowledge, so far as the 19th century is concerned, appear to have been lost. Even so, many modern weavers harvest for much of the year, depending on need, although Puketapu-Hetet (1989, p.18) recommended summer and autumn as the best times for harvesting. Additionally, she identified specific effects of rain and frost on the ease of weaving processes (Puketapu-Hetet, 1989 p.3) as did Pendergrast (2000, p.15), and seasonal harvesting makes sense within this context. Her recommendations generally accord with the 19th century literature, bearing in mind that expert weavers also remove the flower stalk from valued varieties that they cultivate (see *Section 5.4.5*).

Modern scientific studies have not yet demonstrated any direct relationship between the growth or vigour of harakeke and seasonal harvesting, although Twose (1988, pp.16-17) believed that Māori avoided harvesting in the spring and summer months because "the resulting fibres would be brittle and difficult to strip". Research into plant responses to temperature and other environmental parameters might further illuminate understanding of seasonal patterns of harvesting.

5.3.5 Flowering patterns

A small number of historical records refer to management of the harakeke flower stalk (that is, the peduncle and inflorescence, or *kōrari*). Hector (1889, p.9) recorded a number of practices that 'should be' carried out in relation to the harvesting of harakeke. He did not, however, specifically identify them as Māori. One of these practices was cutting the flower stalk as soon as possible, and then rubbing the cut part with a little earth to prevent "bleeding"[6], or, better still, twisting it off. Buck (1911) also identified the Māori practice of removing the flower stalk. He gave two reasons for this: firstly, that it "exhausts" the plant, and secondly, that there was no chance of cross-fertilisation and propagation by seed. Two further sources (RFC, 1870 p.7; Atkinson, 1921a, 1921b) reported that Māori refrained from cutting harakeke from the time that the flower stalk shoots

until the time that it dies off. Removal of the flower stalk continues to be part of Māori management of highly valued varieties today. Although Cross (1912, p.170) noted that a horticulturalist who is interested in vegetative plants (such as a miller or weaver might be) would cut off all inflorescences to promote more luxuriant leaf growth, she attributed this observation to flax millers and did not discuss this practice with regard to Māori management. Her observation therefore emphasises the separation of Māori and western scientific knowledge which has been a feature of much of the 20th century.

5.3.6 Restrictions on use

Nineteenth and early 20th century literature indicates the monitoring and restricted use of harakeke by Māori (Shortland, 1856 p.209; Best, 1924 p.514; Makereti, 1938 p.204). Shortland (1856, p.209), for example, reported that the *oue* variety was so highly prized by Māori that, "if anyone cuts the leaves from plants belonging to his neighbour, the act is resented as any other case of theft would be." White also reported on the consequences of such action, recording "Ka rahuitia te pa muka ka haere atu te tangata ke ka kukuti ka mate" (White, n.d.)[97].

However, while all of these sources emphasise the restrictions on harakeke use, the principles behind the restrictions are not made explicit. On the other hand, contemporary authors (Kawharu, 1998 p.10 and pp.21-22; Mihinui, 2002) are clear that at least some forms of resource restriction were part of *kaitiakitanga*, the purpose of which was to protect the resource and its abundance.

5.3.7 Excess material after weaving

Expert contemporary weavers consider the return of excess or 'waste' material from the harakeke plant to its base to be a traditional part of the weaving process. Weavers are held to have a responsibility to nurture the plants they use, and as part of this philosophy, to return any excess material from weaving "*hei whāngai i*

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[97] White's own translation was "When the loom is set up if anyone goes and cuts it the [unclear] will die by being bewitched." This does not seem accurate: the reference might be better translated according to the definition of a *pā muka* given by Buck, and is therefore a caution to strangers who might want to harvest the resources of other unrelated groups.

te harakeke"[98] (Mihinui, 2002). This material is seen as compost and further nutrition for the plant (Puketapu-Hetet, 1989 p.3; Mihinui, 2002).

The return of excess weaving material to harakeke plants is poorly documented in the 19th century literature. For example, the practice is not recorded by Best (1908) or Buck (1911). However, in their report to Parliament, the Flax Commissioners recorded their belief that a top dressing of refuse (thoroughly decomposed) would keep down weeds and shelter roots from sun as well as supplying the minerals required by a harakeke plant (RFC, 1870 p.7). This seems remarkably similar to what has been recorded as traditional Māori practice, although, in fact, Māori practice was not mentioned in this context in the report.

One late 19th century source outlined a different approach to the disposal of excess material from harakeke. Guthrie-Smith (1969, p.92) reported the story of Te Otua who, while he was running, "stepped on the spot where the refuse flax of the village was deposited. It was about a couple of feet thick with the butts of the great blades. . . " This story suggests that, in this case at least, excess harakeke material had *not* been deposited back with the plant. In this part of Hawke's Bay in the North Island, there may have been a designated area for such material. The village to which reference is made appears to have been close to the lagoon where a flax swamp was growing, so that the harakeke may not have been highly valued '*muka*' harakeke from cultivation, but a more common variety from the swamp. It does, however, reveal that more than one strategy was used by weavers in the 19th century in relation to disposal of excess material. Park (1995, p.178) likewise documented the burying of harakeke. *Figure 5.3* provides a diagrammatic representation of the two identified possibilities for excess harakeke from the early literature.

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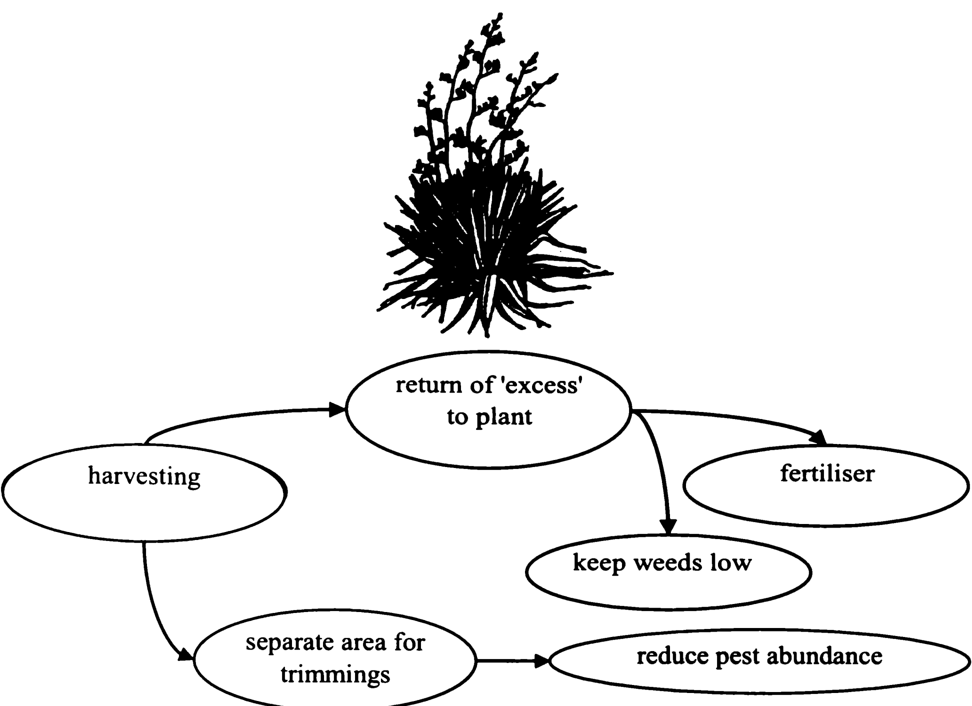
[98] literally, to feed or nourish the harakeke

Figure 5.3: **Management practices for excess harakeke material with possible benefits**



Early views in the scientific community were markedly different, with suggestions that the refuse might be fed to cattle (Purchas, 1868), or burned so that the ash could be used to cleanse the fibre (Church, 1873). It is unlikely that these views would have been promulgated or accepted by Māori. However, some Māori views on the relationship between fire and harakeke are discussed below (*Section 5.4.9*). In later scientific work, Aston (1913), Easterfield et al. (1929) and Rigg & Watson (1945) all agreed that additional material provides a 'compost' which is beneficial for harakeke growth. Aston (1913) trialled the refuse from harakeke as a fertiliser for potatoes and suggested further experimentation with other crops. Easterfield et al. (1929) trialled harakeke itself as a crop, planting the young fans with fertiliser applications (such as phosphate). They found that plants dressed with flax refuse grew markedly better. Phosphate applications also had a marked effect on growth of harakeke roots and leaves (Easterfield et al., 1929; Rigg & Watson, 1945). The practice of returning trimmings to the base of a bush, which continues to this day, can, therefore, be beneficial according to both contemporary Māori weavers and the available scientific literature on favourable soil conditions for harakeke growth.

Nonetheless, contemporary scientific work suggests that returning trimmings directly to harakeke bushes is no longer appropriate as it encourages a growth in insect numbers (Scheele, 1997). It is possible that this was one reason why a different approach was sometimes taken.

5.3.8 Insect pest management and disease

Contemporary weavers frequently observe the notches or weak spots in harakeke leaves from pest predation: this damage is particularly undesirable so far as weavers are concerned because it weakens or discolours the leaf and fibre (*Figure 5.4*). Miller (1930) identified and described these insect pests, as outlined in *Chapter 1:* all are characterised as endemic, and so would have been present prior to European arrival in New Zealand.

Figure 5.4: **Pest damage showing weak spots in the leaf caused by the windower caterpillar (*Orthoclydon praefectata*)**

Control of pests and disease can be addressed in a number of ways. For example, favourable conditions for insects can be reduced, including habitat, cover from predation, preferred temperature or humidity conditions, food source, and so on. Control can also be addressed by directly eliminating pests: for example, burning of harakeke bushes affected by yellow-leaf disease is recommended by modern scientists and plant managers (Scheele, 1997).

References to pests in relation to Māori cultivations are not apparent in 19th century records (Brodie, 1845; Selwyn, 1847; Shortland, 1856; Kelly, 1866; Best, 1908; Buck, 1911; Elder, 1932) although Hector (1889, p.3) did observe the "appearance" of a small caterpillar in several districts. On the other hand, an

increased incidence of insect pests and disease which corresponded with commercial planting of harakeke in the late 19th and early 20th century was reported (Department of Agriculture Report, 1909; Cross, 1912 p.134; Atkinson, 1921e; Miller 1930). Attacks were severe by the 1920s: a large outbreak of yellow leaf disease caused major industry concern (Atkinson, 1921e; Esler, 1978 p.17), while damage from flax moth larvae dramatically increased, apparently because of clearance of their preferred vegetation food source (Thomson, 1922 p.512). It seems likely that these pests would have been reported earlier if they were a major concern: kumara pests were intimately known and reported by Māori (see, for example, Best, 1925 pp.212-214).

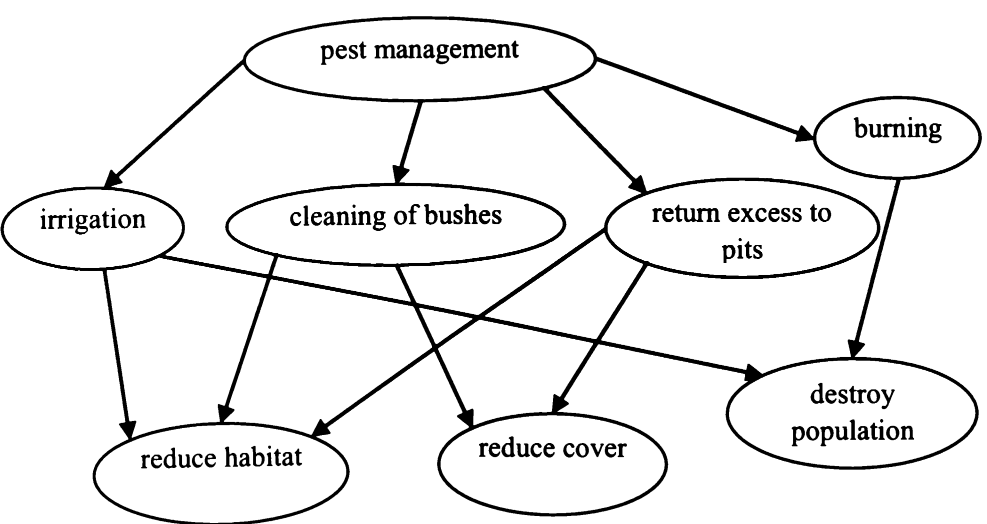
Harakeke habitat changed markedly at the start of the 20th century from its previous natural state to "induced swamps" which were much drier (see, for example, Cockayne, 1967 p.151; Poole, 1946). Commercial millers had exhausted natural stands of harakeke, and drained raupo swamps to create harakeke in great profusion where previously it had only grown around the edge of a raupo swamp (see, for example, Poole, 1946; Poole & Boyce, 1949; Matheson, 2000). Widespread commercial planting of harakeke was also required to maintain the industry. It was believed that harakeke growing on dry ground had better fibre (Hector, 1889 pp.4-5; Cross, 1912 p.170). These monotypic stands, with resulting biodiversity loss, can account for much of the change in pest abundance and distribution (see, for example, Poole & Boyce, 1949).

Periodic flooding of harakeke stands has been recommended to reduce pests and disease (Boyce et al., 1953; Smith, 1957; Esler, 1978 p.17). Boyce et al. observed that rapid increase in yellow-leaf incidence frequently follows drainage of harakeke areas. They found that harakeke could stand water inundation to a depth of three feet for periods up to four weeks in winter and would benefit from the resulting suppression of much weed and insect infestation. Smith (1957) found that the vector insect of yellow-leaf disease in its ground-living nymph form was killed by immersion for longer than 48 hours. Atkinson (1921e) also suggested that yellow-leaf is aggravated by the presence of stagnant water around plants. Furthermore, Matheson (1963) observed that although Moutoa swamp used to be flooded approximately four times a year, flooding was, at that time, negligible,

something that led to difficulties in the growing of harakeke. The lowered water table has meant that the natural swamp harakeke died out and was replanted with another variety that tolerates the drier conditions.

Manipulation of landscape conditions by Māori (including irrigation of *pā harakeke*) may have prevented similar outbreaks. Such methods would certainly ensure that water was well oxygenated rather than stagnant. If the irrigation was ground-based, presumably the water would also assist in the prevention of disease. Furthermore, continued use of naturally occurring 'swamp' harakeke by Māori would also ensure that weavers had access to harakeke which was less likely to suffer disease because of natural flooding. Planting of harakeke in rows interspersed amongst other crops in Māori gardens would also increase natural biodiversity. In *Figure 5.5*, I construct a model of integrated pest management based on data deduced from historical evidence presented in this chapter. Different pest control management methods might be used depending on pest abundance or damage.

Figure 5.5: **A model of integrated pest management based on evidence from written historical sources**



Selection of pest resistant varieties is another method of pest control. Different varieties of harakeke have been reported in the scientific literature as either resistant or vulnerable to insect attack (*Table 5.5*).

Table 5.5: **Harakeke varieties reported as resistant or vulnerable to disease in the early 20th century scientific literature**

Variety	Disease resistant	Vulnerable to disease
Putaiore	Report of the Department of Agriculture, 1911; Cross, 1912 p.136	Report of the Department of Agriculture, 1908
Wharariki	Critchfield, 1951	Cross, 1912
Tīhore	Cross, 1912; Boyce et al., 1953 (yellow-leaf disease)	
Paretaniwha	Report of the Department of Agriculture, 1908 (fungus growth); Cross, 1912	
Korako	Cross, 1912 p.136	
Parekoritawa	Cross, 1912 p.136	
Tutaemanu	Cross, 1912 p.136	
Atiraukawa	Cross, 1912 p.136	
Ngutunui		Report of the Department of Agriculture, 1908
Raumoa		Cross, 1912 p.136
Oue	Report of the Department of Agriculture, 1908 (fungus growth)	
Rauehu		Cross, 1912 p.136

Some varieties are recorded as both disease resistant and vulnerable to disease (see in particular, *putaiore* which was reported as badly affected by disease in 1908, and disease resistant in 1911), suggesting that in some cases conclusions were premature. Although discrepancies between Department of Agriculture nomenclature and that used by Māori seem to have occurred (Scheele & Walls, 1994), all of those varieties classified as resistant are, in fact, varieties used by Māori, including a number of highly valued fibre varieties. The possibility exists that Māori either selected them, or continued to cultivate them, because of their disease resistance.

Critchfield (1951) considered that some varieties of *wharariki* (*Phormium cookianum)* have qualities of disease resistance (and softness of fibre) which have been useful for crossing with harakeke. Recent genetic work (McBreen et al.,

2003) has determined that some harakeke varieties are in fact hybrids of *Phormium tenax* and *cookianum*, as has been previously suggested because of the variable phenotype (Wardle, 1979). Currently, it is not known whether Māori deliberately undertook experimental crosses, or cultivated natural crosses for specific benefits.

Other methods of pest control may also have been used. Buck (1911), for example, recorded that the ground was banked up around the roots or rhizomes, and dried up leaves were carefully removed. Best (1908) similarly reported the removal of old leaves. These practices can be interpreted as active pest management. Another interesting possibility is the use of smoke or fire to destroy pests. Best (n.d., p.21) recorded that when a *māra*, or cultivated garden, was afflicted by insects, a *tōhunga* would both *karakia* and make a fire which burned "a few insects", the combined result being that all the insects were destroyed.

5.3.9 Fire

Burning harakeke has been recommended as an effective solution when pests are abundant (Cross, 1912 pp.136-8; Scheele & Walls, 1994; Hobbs, 1995) but could be considered problematic for contemporary Māori weavers who do not burn excess waste from the plant (see, for example, Orchiston, 1987; Pendergrast, 2000 p.15; Mihinui, 2002). However, while Best (1908) reported that harakeke trimmings were not thrown onto a fire, he added that this restriction applied only to *harakeke muka* (or *harakeke whitau*) varieties, and not to "common varieties" or *harakeke māori*. The differentiation between burning *harakeke muka*, and *harakeke māori*, has become blurred. Large numbers of weavers no longer make this distinction.

Although there is no *direct* evidence in the 19th or early 20th century literature that Māori used fire to either create new areas of harakeke or to enhance existing ones, there *is* evidence that Māori had observed the effects of fire on harakeke growth (Kelly in the RFC, 1870 p.9; *Chapter 3*)[99]. Moreover, Cheeseman (1882)

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[99] Unfortunately some of the comments made by nineteenth century authors are so cryptic as to be uninterpretable. Thus, there is a suggestion in a letter from Field to Hector in 1871 (RFC, 1871)

recorded Māori use of fire to create new clearings, also noting that "[they] generally took precautions that it should not spread further than was absolutely required."[100] If Best (1908) was correct in claiming that common harakeke could be, and was, burned, then this might also allow for the burning of harakeke in its natural form. Many herbaceous species such as harakeke are able to survive fire through resprouting, enhanced flowering and seed germination (Allen, Basher & Comrie, 1996). Dobson (1979) reported that where lowland forest mires (such as kahikatea (*Dacrydium dacrydioides*) forest which had harakeke as part of an under storey) were burned, harakeke was able to colonise through both rhizatomous and seed growth and thus become dominant.

Harakeke distribution also changed dramatically from the time of widespread European arrival in the 19th century. Smith (1957, p.127) noted that felling swamp forest in many places resulted in stands of harakeke on the undrained land. He believed that many of the vast harakeke swamps of the late 19th and early 20th centuries resulted from the felling of these forests as Pākehā settlement extended. Some recent investigations strongly suggest that Māori used fire over large areas of the country to clear forest (see, for example, McGlone, 1989; McGlone et al., 1994 p.146; Wilmshurst et al., 2004), something that could have resulted in harakeke swamp lands increasing in number and size.

5.3.10 Ecological relationships with other species

Specific systemic understandings relating to the seasonality of harakeke and other such phenomena are not apparent in the 19th century literature although they are recorded for other species (see, for example, Dieffenbach, 1843 Vol. II p.123;

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that Māori may have planted harakeke in cleared bush, but this is not stated clearly and is open to different interpretations. He described habitat where harakeke grows, such as in pumice along the border of a swamp. This, he noted "always produces the rankest growth of flax; better even than cleared bush, in which last the plant always seemed to thrive better in places where the Natives had mixed a considerable proportion of sand with the soil, in order to grow kumeras [sic]".

1 Cheeseman wrote in the same paper that, prior to Pākehā settlement, "the repeated burning off, year after year, of large tracts of country, was then a circumstance almost unknown. The Maori rarely wantonly destroyed vegetation. . ." However, recent scientific papers challenge this view of Māori fires (see, for example, McGlone, 1989; McGlone, Anderson & Holdaway, 1994 p.146; Wilmshurst et al., 2004).

Taylor, 1855 p.178). The *tōhunga*, Teone Tikao, who lived on Banks Peninsula at the end of the 19th century, recalled that he had been told of such relationships (Beattie, 1939), including the timing of harakeke flowering in relation to other events. Unfortunately he could not recall any specific details whilst being interviewed by Beattie. Other kinds of ecological relationships are, however, revealed in *whakataukī* (see *Chapter 3*).

5.4 Discussion

Relatively little detail of Māori harakeke management practices is recorded in the literature prior to the 1930s. In part, this appears to be due to the conceptions, and misconceptions, of non-Māori observers, many of whom appeared to believe that harakeke cultivation had either long been abandoned by Māori or had never existed. In fact, in the entire period from the late 18th to the early 20th century, there is very little recorded material about Māori resource management of harakeke. Furthermore, very little information of any kind has been gleaned from South Island historical sources. This makes the little information that *can* be recovered about the management of *pā harakeke* by Māori during this period even more valuable.

In spite of the limitations of the written historical records, they do reveal a number of interesting practices, some of which confirm what has been passed down in oral tradition. For example, themes which emerge from the historical literature are considerations of seasonality, the life cycle of the plant, and suitable conditions for growth. Other recorded practices differ from those practices which are now common. There appears, for example, to be a difference between early planting distances and distances recommended today (see, for example, Scheele & Walls, 1994). Care of bushes included removal of cover for insect pests, while irrigation of *pā harakeke* may have contributed to low pest numbers in some areas (also creating favourable growth conditions). Traditional sites for *pā harakeke* in relation to contour and soil and the use of fire in relation to harakeke are other issues of particular interest which have emerged from this analysis of the early literature.

It remains uncertain how much impact commercial production of muka may have had on traditional Māori methods: on the planting, cutting and resting of harakeke bushes. For example, commercial harvesting clearly differed from traditional harvesting in cutting off all leaves from a bush: it was unselective. In other areas also, the boundaries between early European scientific research and Māori ecological knowledge are not well defined. Thus, we can, for example, only speculate about whether traditional planting distances were influenced by commercial requirements.

What *is* clear is that Māori have planted harakeke in a structured and methodical way for (possibly) several hundred years, and that the maintenance of the *pā harakeke* was carefully managed. It was probably common in many regions for Māori to plant a number of roots together, leaning outwards. These were most likely arranged in rows in *pā harakeke*, which may in turn have bordered other cultivations. Planting of harakeke appears to have occurred preferentially in spring or autumn. Weeding was considered important, as was the care of bushes. Care also appears to have been given to soil preparation, irrigation and aspect of the *pā harakeke*. Some of the management methods revealed here may have led to broad landscape change. As yet, however, there is no firm evidence for this.

These historical reports are of traditional methods which may have evolved over time through Māori experience of changing environmental conditions and ongoing observation and experimentation. Examples of traditional knowledge provided here, therefore, can be considered by contemporary weavers in the light of their own experience of harakeke, the continuing goal being to develop and maintain well cared for and vigorous pā harakeke. In doing so, they will be continuing what is clearly a tradition of active management of *pā harakeke* by Māori.

Chapter 6

Environmental parameters and predictive mapping of harakeke and wharariki

6.1 Introduction

In this chapter, I explore the environmental profile of harakeke and wharariki, and undertake a generalised regression analysis to predict the probability of harakeke occurrence in the northern part of New Zealand in relation to environmental variables. I address the subsidiary questions:

- What are the main environmental parameters predicting harakeke occurrence; and
- Can changes in distribution from the expected occurrence of harakeke be identified?

Patterns of occurrence and diversity are generated through the interaction of biotic and abiotic factors, and understanding the contribution of environmental variables is an essential part of addressing this issue (Leathwick, Burns & Clarkson, 1998). Because plant growth and distribution are controlled by environmental factors such as rainfall, temperature, water supply and demand, and solar radiation, each species will have an 'environmental envelope' which defines where it will potentially occur, and what limits its occurrence. Soil parent material and landforms can also influence the occurrence of species, and can be included in these models (Leathwick, 2001). Increasingly, environmental modelling is used to understand the relationships between both animal and plant distributions and climatic factors (see, for example, Leathwick et al., 1998; Leathwick, 2001; Leathwick & Whitehead, 2001; Hortal, Garcia-Pereira & Garcia-Barros, 2004; Gegout et al., 2005; Rangel & Diniz-Filho, 2005). Moreover, environmental modelling has a wide range of applications, from predicting weed distributions for conservation management (Overton & Lehmann, 2003) to assessing the biodiversity of road networks (Overton et al., 2002).

In *Chapter 1*, I reviewed the scientific literature for relevant information on the ecology of harakeke which can be considered in relation to historical Māori resource use and management practices. Predictive modelling of the spatial distributions of plants can be a powerful tool for exploration of the factors driving observed patterns of distribution (Leathwick, 2001). Quantitative data which extends our knowledge of harakeke in relation to environmental variables can, in turn, be considered in the light of Māori management practices and traditional ecological knowledge. Any form of species management which affects the distribution, prevalence, and/or ecological niche of a plant will in turn modify the landscape.

Predictive models can be useful in a number of ways. For example, information about environmental factors which indicates the environments in which species are most likely to occur can be ascertained, as can factors which limit distribution. This approach can, therefore, be used to predict the environmental range in relation to the establishment or survival of a species. If a species is limited in its distribution, apparently because of one environmental variable, it is then possible to predict what might happen were that variable to change. Thus, for example, one could predict changes in harakeke distribution were temperature or frost patterns to change, or were these factors to be ameliorated by management. Predictive mapping can be derived from the analysis of point data combined with regression tools such as generalised additive models (GAMs; Hastie & Tibshirani, 1990), climate interpolation tools and geographic information systems (GIS).

In this chapter, I analyse current environmental relationships for both *Phormium tenax* (harakeke) and *Phormium cookianum* (wharariki) and create spatial maps of occurrence in relation to environmental variables, the first stage in predicting the potential natural distribution for both *Phormium* species. This preliminary investigation explores what environmental limits appear to exist for these species. Following this initial exploration, regression analysis of *Phormium tenax* in the northern part of New Zealand predicts the probability of harakeke occurrence in relation to different environmental variables, and hence geographical locations. However, although predictive mapping can help us to understand relationships, it

can not predict causatively: the approach is correlative, and further experimentation is required to establish cause-effect relationships. Predictive modelling does not therefore explain *why* the relationship between the predictor variables and the distribution of the species occurs. First, the environmental measurements made are *indirect* assessments of distribution. That is, the vital processes of the organism are mediated by the target environmental variable, so that, for example, temperature or solar radiation determines the rate of photosynthesis which in turn controls growth rate. Secondly, there may be unknown variables such as soil fertility which have not been taken into account. Such variables may have major effects on the survival, dispersal and distribution of a plant. Furthermore, plants pass through different life stages which may be affected differently by a predictor variable. One example of this is the susceptibility of *Phormium* seedlings, but not adult plants, to salt spray in coastal situations (Wilson & Cullen, 1986).

6.2 Methods

6.2.1 Input data

Point data

Compositional data used for the analysis came from two main sources. First, a dataset (presence only) was collated from herbaria data and a small number of records which I collected from the Kāwhia district. Herbaria store plant samples which have been collected throughout New Zealand. All samples are curated and a number of details recorded, such as genus, species, date of collection, place of collection and, possibly, altitude, as well as other details that the collector considers important. Data were obtained from herbaria around the country: Auckland Museum Herbarium (AK), Waikato University Herbarium (WAIK), Forest Research Institute Herbarium (NZFRI) in Rotorua, Te Papa Herbarium in Wellington, the national plant collection at the Allan Herbarium (CCHR), and the University of Otago Herbarium. Of the 418 *Phormium* herbaria and personal records, locations could be ascertained for 141 records of *Phormium cookianum* and 207 of *Phormium tenax*.

Supplementary data was provided from the Landcare Research database (NIVS) which contains records from vegetation surveys (many carried out by the now defunct Forest Service) such as the National Forest and Ecological Surveys of the 1940s-1960s. Six hundred and ninety seven samples of *Phormium tenax* or harakeke and 1953 of *Phormium cookianum* or wharariki were compiled from this source, not all of which could be used. That is, it was impossible to determine accurate locations for some data as not enough information was provided with the original record. In total, 361 harakeke samples and 2026 wharariki samples from all sources were used in the analysis. Raw data is stored on disk at the School of Māori and Pacific Development, University of Waikato to comply with university ethics regulations.

I accepted the species identifications of each source, but have updated nomenclature where appropriate, so that, for example, all *Phormium colensoi* records were updated as *Phormium cookianum*. *Phormium* that was not clearly identified to sub-species level (including a number of hybrids) was excluded from the data set. Specific geographic reference points were converted to New Zealand Map Grid northings and eastings to locate the collection site for each sample in New Zealand, but many elevations were lacking. This problem was overcome by overlaying the geographic locations on to a 25m resolution elevation model fitted by Landcare Research staff to Land Information New Zealand's digital New Zealand Map Series (NZMS) contour data. These locations were then used as a basis for estimating a range of environmental parameters which have previously been shown to be relevant to landscape scale distributions of plants, and particularly to canopy trees (see, for example, Leathwick et al., 1998).

Pseudo-absence points were generated for the GRASP analysis for northern New Zealand (n=1000) (Price & Overton, unpub. software[101]). This provided background data for a binomial analysis based on presence/absence (n=99 for presence). Degrees of freedom for the analysis are hence 1099.

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[101] Further information about this software, which can create a specified number of pseudo-absence points for data sets in accordance with identified parameters, can be accessed from Landcare Research, Hamilton.

Data limitations

There are some limitations on herbarium data. For example, there are frequent biases in the overall pattern of distribution because of the non-random mode of collection. Collectors are more likely to prepare herbarium samples if they are surveying in an area, or if they see rare species which they might not expect to see at a particular site. This includes plants which are living at the limits of their ranges. Furthermore, many samples are taken from roadsides and other areas which have easy access for collectors. Moreover, although herbaria samples provide a record of where a species is found, there is no record of absence, necessitating the generation of pseudo-absence points. The limitations of these points are discussed further on p.194.

One major limitation for this data set is the skewed geographical spread of data for *Phormium tenax* in particular (see *Figure 6.7* for *Phormium tenax* and *Figure 6.12* for *Phormium cookianum*). This limitation has most likely occurred through a lack of complete records from the Allan Herbarium; only recent records have been incorporated into the herbarium database. Many of the earlier records do not have specific locations or grid references listed, and were not available for use. This means that data relating to areas such as the South Island and Taranaki are either minimal or absent altogether. Environmental modelling of harakeke was therefore restricted to the northern region of the North Island, where the most complete data set was available.

6.2.2 Spatial predictors

Environmental data

Environmental estimates for each reference point described both climate and landform (see Overton & Leathwick (2001) for a pictorial representation of these). Climatic variables were estimated using plot elevations and geographic co-ordinates from thin-plate splines fitted to average monthly climate data from meteorological stations (Leathwick & Stephens, 1998). The majority of the climatic information originated from publications previously released by the NZ Meteorological Service and cover the period from 1950 to 1980. Monthly

estimates of temperature, precipitation, solar radiation, and humidity were converted to a reduced set of variables (*Table 6.1*). These describe annual and seasonal temperature, annual and seasonal solar radiation, and soil and atmospheric water deficits (Leathwick & Whitehead, 2001; Leathwick et al., 2002). Some of these variables were chosen to test current ideason environmental tolerance (Wardle, 1991) as well as those suggested in *whakataukī* (*Table 3.3 whakataukī* numbers 2, 8, 14; discussed in *Section 3.5.2*).

Table 6.1: **Environmental variables used to predict distributions for harakeke and wharariki (explanations taken from Leathwick et al., 1998; Leathwick et al., 2002)**

Symbol	Measurement Unit	Derivation
DEFICIT	MPa day	Annual root zone water deficit. An annual integral of root zone water potentials below field capacity, calculated from a process-based daily water balance model (Leathwick, 2000)
GFREE	Days/year	Frost free status of the ground
JUNES	MJ/m/day	Solar radiation (sunshine hours) in June (mid-winter)
MAS	$MJ/m^2/day$	Mean annual solar radiation, derived from an average of daily solar radiation or hours of sunshine.
MAT	°C	Mean annual temperature, derived by averaging the daily minimum and maximum temperatures for each month then taking the overall average of these records.
R2PET	Ratio	Ratio of mean rainfall to potential evapotranspiration in the driest month, indicating the average maximum water deficit. Values were derived by calculating estimates of monthly evaporation using a predictive model (see Leathwick et al., 2002).
RAIN	mm	Rainfall in excess of that required to keep water at field capacity
SSEAS	MJ/m/day	Solar radiation seasonality, i.e., a measure comparing winter and annual solar radiation as in the case of temperature seasonality
TMIN	°C	Minimum temperature. Minimum temperature was taken as the mean minimum temperature of the coldest month.
TSEAS	°C	Temperature seasonality, i.e., a measure of winter harshness calculated as the deviation in winter minimum temperatures for each site from that expected given its annual temperature
VPD	kPa	Vapour pressure deficit i.e., the mean October (spring) air saturation deficit, a strong determinant of evaporative demand

Landform variables

Three landform variables (induration, acidity, and drainage) were derived by overlaying plot coordinates onto the NZLRI spatial database. Landform scales and information for all New Zealand environments can be found in Leathwick et al. (2002). Drainage, induration and AcidP are scales with five classes in each. *Drainage* describes the internal drainage of soils, taking into account soil colour and waterlogging (*Table 6.2*). *Induration* measures the weathering of soil parent material (*Table 6.2*). *AcidP* measures acid soluble phosphorus classes, their definition and extent, and quantifies one aspect of soil fertility (*Table 6.3*).

Table 6.2: **Landform variables, their classes and definitions (explanations taken from Leathwick et al., 2002)**

Landform Variable	Class	Diagnostic criteria
Drainage	1 Very poor	Having an organic horizon with pale colours due to water-logging in the horizon immediately below.
	2 Poor	Having pale colours due to water-logging immediately below the topsoil.
	3 Imperfect	Having pale mottled colours due to water-logging at intermediate depths in the subsoil.
	4 Moderate	Having pale mottled colours due to water-logging at lower depths in the subsoil.
	5 Good (=well)	Lacking significant mottling or pale colours.
Induration	1 Non-indurated	A specimen disaggregates or slakes within one hour when placed in water.
	2 Very weakly indurated	A specimen does not slake in water but can be crushed with the thumb and forefinger when wet.
	3 Weakly indurated	A wet test specimen cannot be crushed with the thumb and finger but fails when subjected to average body weight applied slowly with the foot.
	4 Strongly indurated	A wet test specimen can only be broken when struck a sharp blow with a hammer.
	5 Very strongly indurated	Indurated; cannot be broken when struck a sharp blow with a hammer.

Table 6.3: **Acid soluble Phosphorus classes and their definition (taken from Leathwick et al., 2002)**

Class	Range (mg/100g)
Very low	0-7
Low	7-15
Moderate	15-30
High	30-60
Very high	60-100

Spatial prediction of environment across any landscape requires a digital representation of elevation, usually by means of a set of elevation estimates on a regular grid, that is, a digital elevation model (DEM). The DEM in this study had a 200 m resolution (pixels were 200 m^2) (Leathwick et al., 2002). Monthly estimates were calculated for each grid point and the minimum value selected.

6.2.3 Generalised Regression Analysis (GRASP)

Generalised regression analysis and spatial prediction (GRASP) was used to model harakeke occurrence (harakeke being the response variable) in relation to climatic, landform and other spatial predictor variables for the northern region of New Zealand. GRASP combines the power of advanced statistical and spatial analyses with the advantages of extensive spatial information which is managed in Geographic Information Systems (GIS). First, multiple regression modelling is used to establish relationships between a response variable, such as harakeke occurrence, and a set of spatial predictors (Lehmann, Overton & Leathwick, 2002). The regression relationships are then used to make spatial predictions of the response. The GRASP process requires point measurements of a response (in this case, harakeke occurrence) as well as predictor variables that are statistically important in determining the patterns of the response (Lehmann et al., 2002). GRASP has three key functions (Overton & Lehmann, 2003), which in this project can be described as:

- spatially explicit estimates produced by spatial extrapolations from point data;

- a regional description of harakeke occurrence and factors influencing occurrence; and
- identification of biases in the data that result from *ad hoc* or biased sampling patterns.

For all sample locations, the geographical points from the herbarium data were overlaid on environmental predictors resulting in estimates of environmental predictors for each point. Each measurement was modelled by multiple regression using generalised additive models (GAMs) implemented in S-Plus.

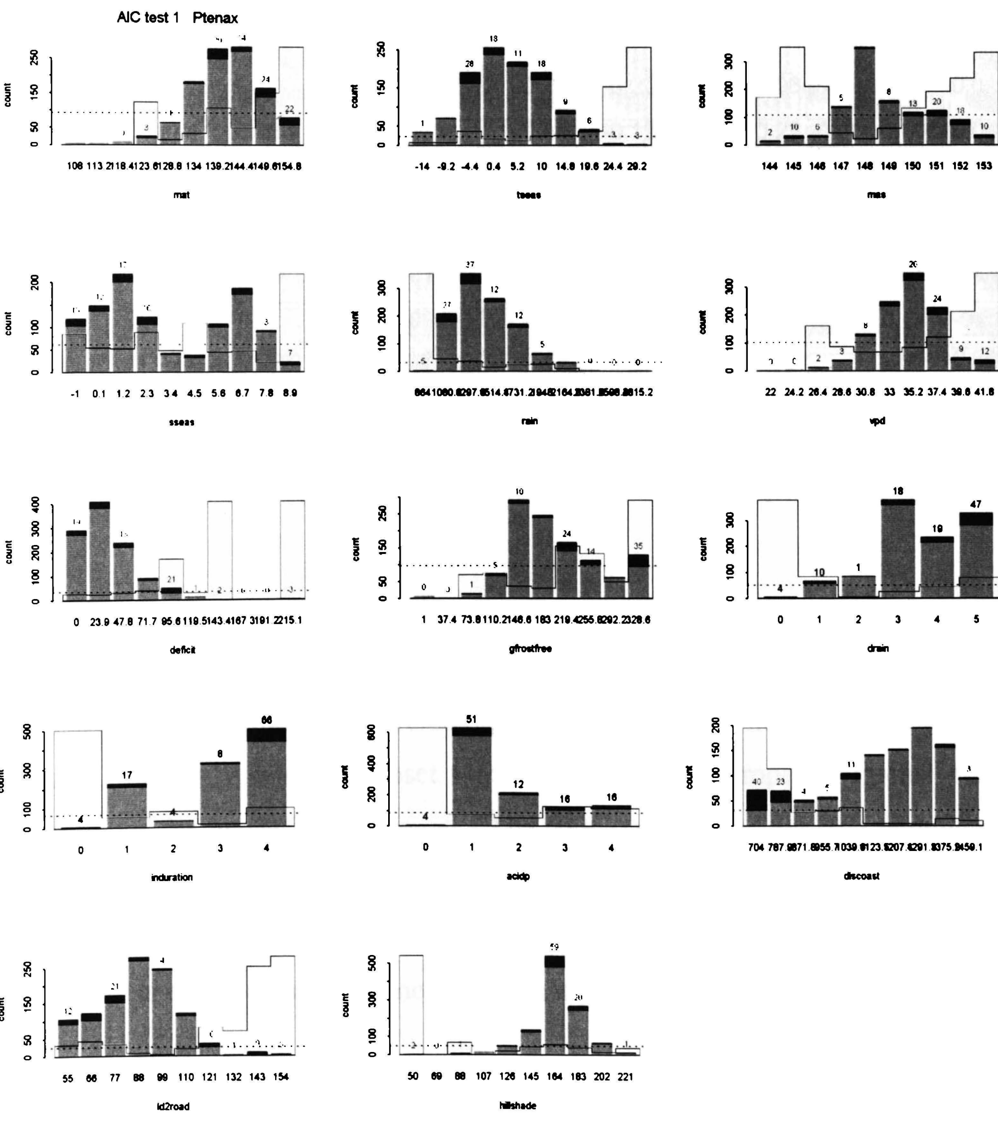
GAMs are a non-parametric extension of generalised linear models, which are themselves a generalisation of the usual linear regression models (classical least squares regression) (Hastie & Tibshirani, 1990). GAMs estimate response curves with a non-parametric smoothing function which is often more appropriate for ecological applications (Lehmann et al., 2002). These smoothers summarise the trend of a response measurement as a function of one or more predictor measurements. They produce an estimate of the trend that is less variable than Y itself, and the non-parametric nature of the smoother means it does not assume a rigid form of the sum of least squares for the dependence of Y on X (Hastie & Tibshirani, 1990). A smoother line can be used to estimate the dependence of the mean of Y on the predictors. In this case, a backwards stepwise procedure was used to fit the model. The regression began with all variables fitted in an initial model, the significance of dropping each variable being tested in turn (the 'drop' contribution). The drop contribution is thus based on the drop in overall deviance if that particular variable is dropped out of a full model that has all the variables present. The 'alone' contribution, on the other hand, is used to consider the amount of deviance which is explained if only that variable is in the model. Graphs showing the relative contributions of the significant explanatory variables in the GAM models are used to display the amount of deviance explained by both the 'drop' contribution and the 'alone' contribution.

Data exploration

First, I mapped presence points for both *Phormium tenax* and *Phormium cookianum* to check their spatial distribution and to identify geographic outliers in

the data, such as those where grid references may have been inaccurately recorded. The environmental space occupied by harakeke was then described using specially designed histograms (*Figure 6.1*).

Figure 6.1: **Histograms of all environmental predictor variables (n=14) showing the sampling distribution of both real and pseudo point data in relation to expected probability of distribution. Entire histogram bars represent the distribution of all points, where darker areas represent the number of harakeke occurrence points. The number is also written at the top of each bar. The plain line is the ratio between presence and absence points and the dashed lines correspond to the overall mean proportion of harakeke occurrence.**



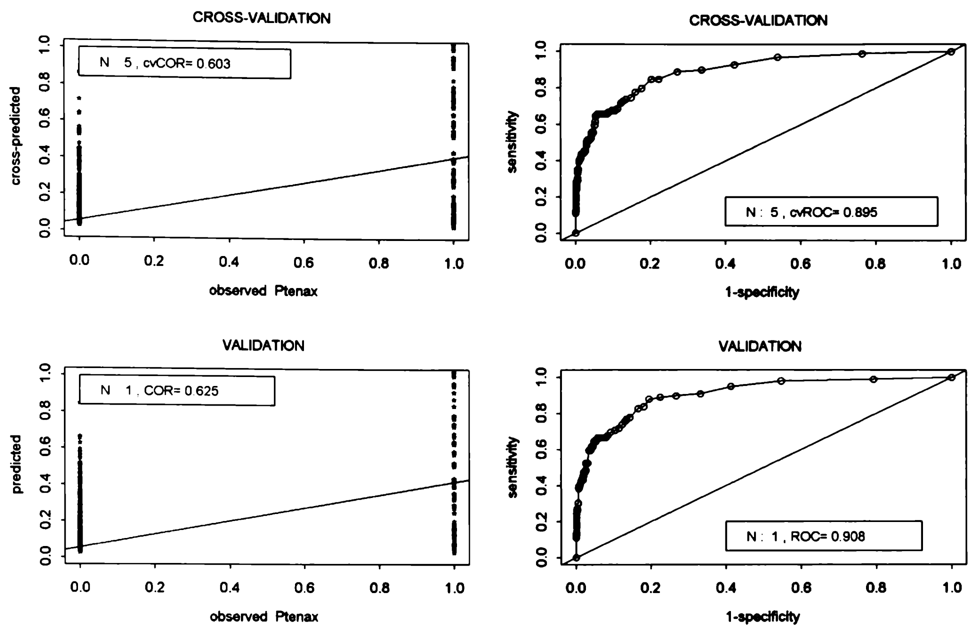
Finally, correlations between the chosen environmental predictors were calculated to allow removal of those that were highly correlated. Correlated predictor variables can impact on estimations of additive surfaces (Lehmann et al., 2002). Correlations of environmental variables were therefore examined (*Figure 6.2*), and a high correlation between R2PET and RAINFALL ($r = 0.96$) resulted in the removal of R2PET from the matrix.

***Figure 6.2:* The correlation matrix of environmental and other predictor variables in the GAM model.**

Model Validation

Two methods were used. First, plots show the observed response values for *Phormium tenax* against the values predicted by the model (*Figure 6.3*). Secondly, randomly selected subset samples of data are compared against other such samples for internal consistency. The ROC test is used for non-parametric binomial GAM models such as this (Fielding & Bell, 1997), and high ROC values indicate good model stability. Both validation and cross- validation of the model (using subsets of the data set) demonstrated a high level of confidence.

***Figure 6.3:* Validation of the GAM model. N= number of samples being compared.**



6.2.4 Study Area

The limitations of the data set required a selective approach to the model, as described in *Section 6.2.1*. For this reason, the model was restricted to northern New Zealand and boundaries drawn from Tīrua Point on the west coast of the North Island to the northern tip of Matakana Island on the east coast. Point data north of this boundary was included in the analysis.

6.3 Results

6.3.1 Mapping point data in relation to environmental variables

Phormium tenax

Table 6.4 summarises the minimum and maximum values for each environmental variable investigated in relation to the reference points obtained for harakeke. Examination of the data in relation to rainfall suggests that rainfall, and the ratio of rainfall to potential evapotranspiration (R2PET), limit harakeke occurrence in some regions of the South Island. Harakeke was found to be present in areas of low to fairly heavy rainfall, but to be absent in extreme rainfall areas. As well,

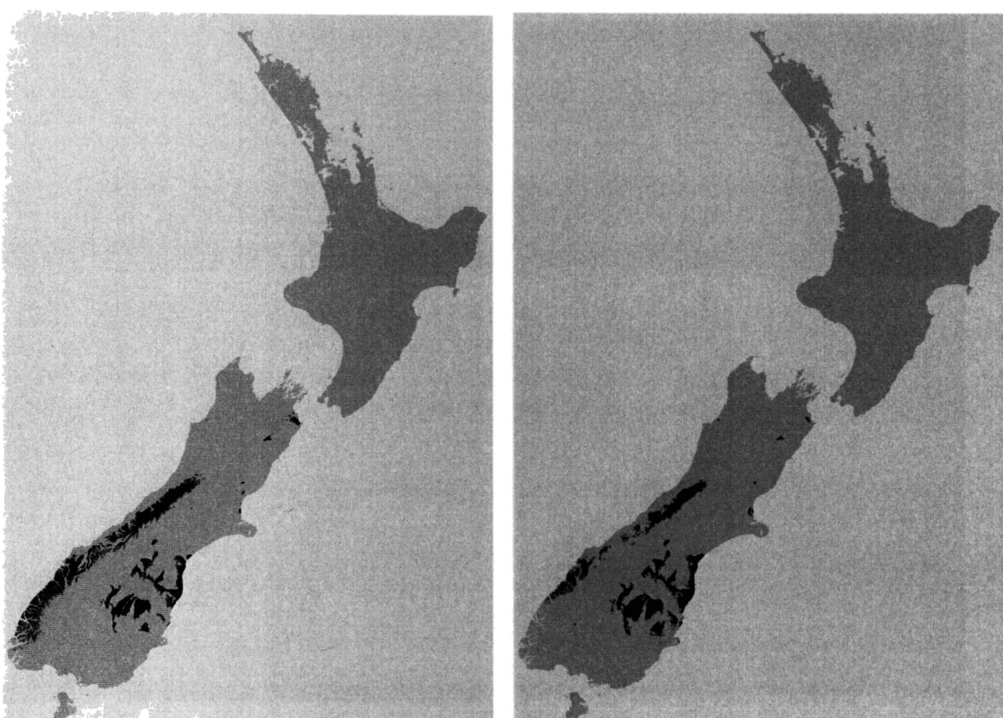
some areas appeared to be too dry for harakeke, such as central Otago and south Canterbury (*Figure 6.4*).

Table 6.4: **Environmental variables, including measurement units, and the minimum and maximum environmental limits recorded from the *Phormium tenax* point data. The mean for each environmental variable, with standard deviation, is also included. Data is from throughout New Zealand**

Environmental variable	Min	Max	Mean	SD
DEFICIT (MPa*days)	0	271	79.4	74.5
GFROSTFREE (Days/year)	1 (81*)	365	227.8	82.5
JUNES (MJ/m/day)	29	71	54	9.6
MAS (MJ/m^2/day)	119	154	146.2	7.5
MAT (°C)	9.1	16.0	13.5	1.7
R2PET (Ratio)	14	162 (111*)	29.6	20
RAIN (mm)	610 (650*)	6025 (4331*)	1443.9	711.3
SSEAS (MJ/m/day)	-13	10	0.23	4.8
TMIN (°C)	-1.7 (-0.3*)	10.1	5.0	2.3
TSEAS (°C)	-1.5	3.4	0.6	0.9
VPD (kPa)	12	65	41	11.8

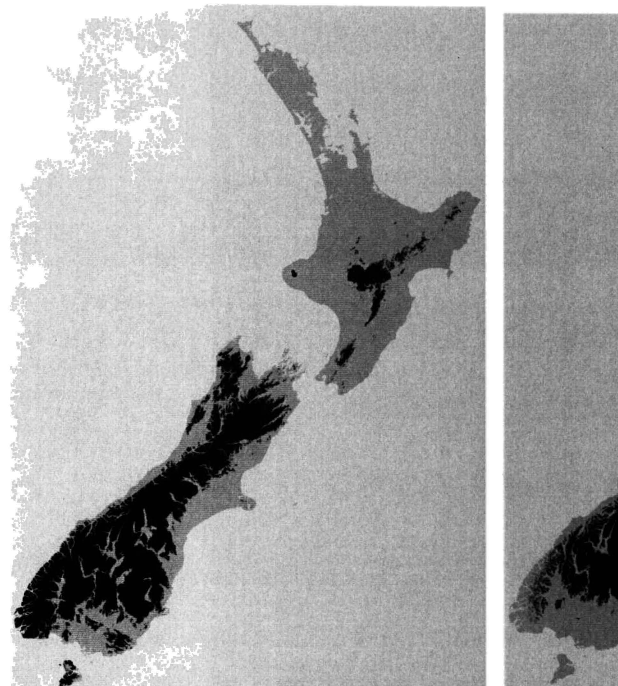
*The next highest or lowest value after that presented in the table

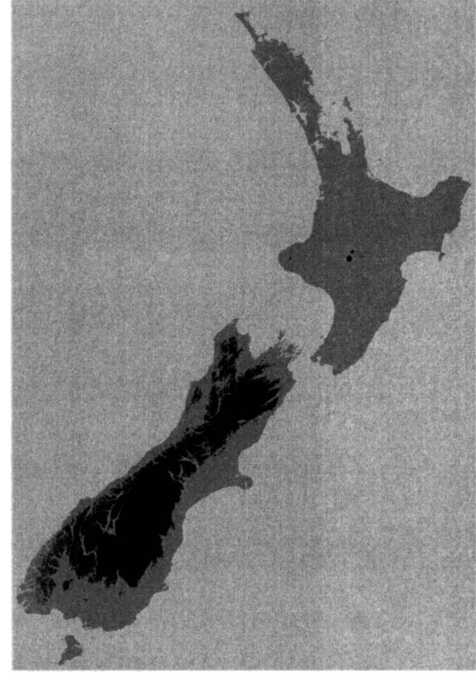
Figure 6.4: **Predictive maps for (a) the ratio of rainfall to potential evapotranspiration (R2PET) and (b) rainfall (RAIN) for harakeke. Dark areas represent regions where harakeke is excluded by these environmental parameters.**



The data suggest that temperature affects the potential distribution of harakeke (*Figure 6.5*). Both minimum and mean temperature may be important in restricting harakeke through the centre of the South Island. On the other hand, solar radiation in mid winter (JUNES) does not appear to be important for most of New Zealand, with only the tip of Fiordland and most of Stewart Island excluded from the 'environmental envelope' for harakeke (*Figure 6.6*). However, this contrasts with the findings of the exhaustive botanical survey on Stewart Island (Wilson, 1987), where harakeke *was* found to be present, illustrating a major flaw in this data set; that is, the lack of point data in the South Island and Stewart Island, which led to the ensuing decision to model an environmental envelope for the northern part of New Zealand only (see *Figure 6.9*).

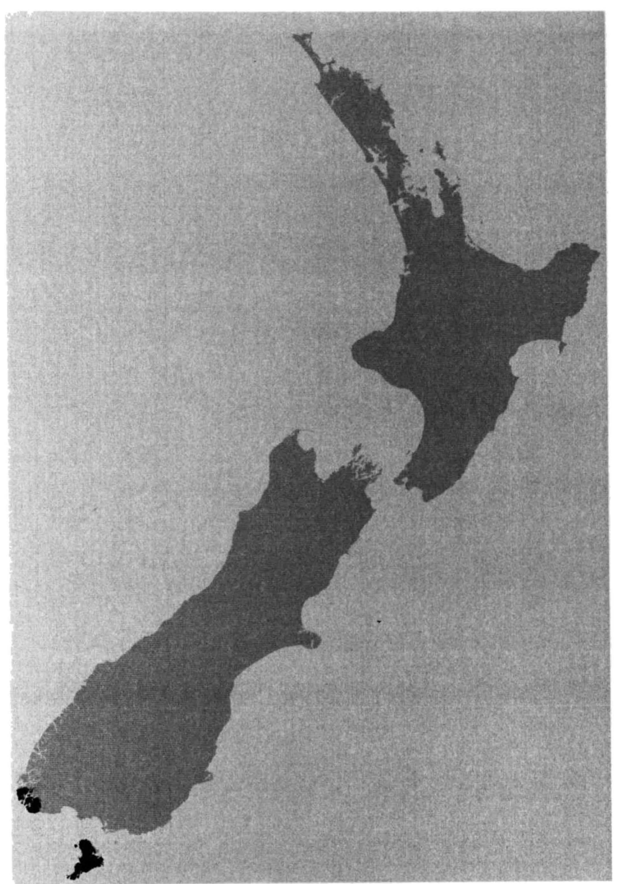
Figure 6.5: **Predictive map of harakeke natural potential distribution in relation to (a) mean annual temperature and (b) minimum annual temperature. Dark areas represent regions where harakeke is excluded by these environmental parameters**





Ground frost as an environmental variable (GFROSTFREE) also demonstrates the uneven spread of point data across a range of conditions and locations. *Table 6.2* shows a large difference between the *lowest* minimum ground frost free days estimated for harakeke occurrence, and the *second lowest* (in brackets). When spatially mapped, the difference that the inclusion or exclusion of this one data point makes to the overall potential natural distribution is highly visible (*Figures 6.7* and *6.8*). The difference is particularly noticeable in the central North Island, Taranaki and Southland.

Figure 6.6: **Potential distribution of harakeke in relation to solar radiation in June (JUNES) showing (a) predictive map for New Zealand and (b) detail of the area excluded by this environmental parameter. Dark areas represent regions where harakeke is excluded by these environmental parameters.**



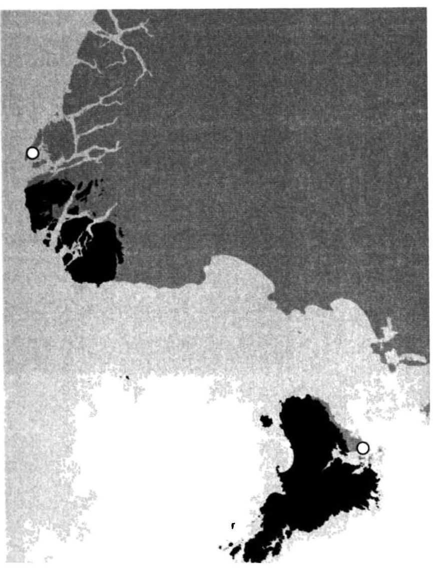


Figure 6.7: **Final predictive map of the potential natural distribution of *Phormium tenax* (harakeke), including all the point data used to determine environmental parameters. Dark areas represent regions where, based on the environmental parameters for this data set, harakeke would not be naturally found.**

Figure 6.8: **Final predictive map of the potential natural distribution of harakeke from the point data, with one point removed from the analysis to demonstrate the uneven spread of data and its effect. Dark areas represent regions where harakeke would not be found, based on the environmental parameters for this data set.**

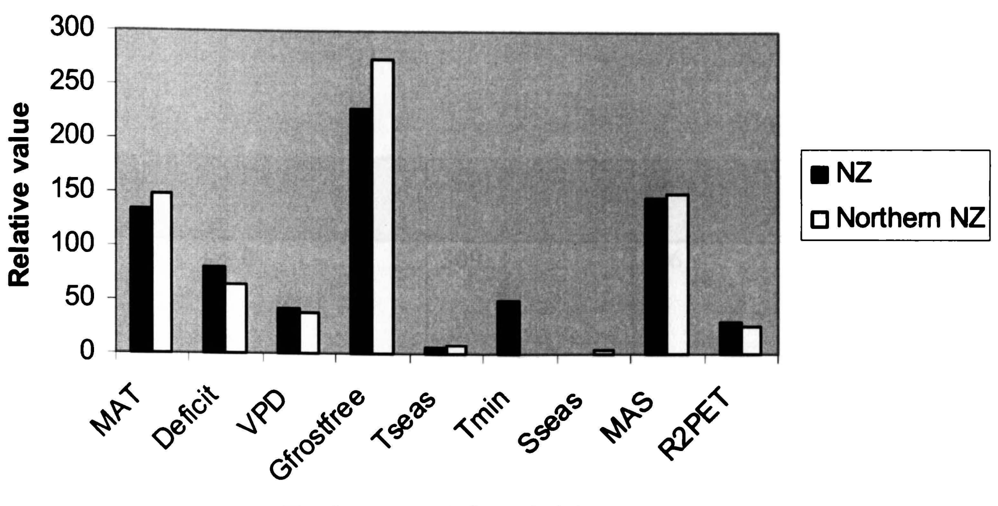
Environmental and landform data for *Phormium tenax* from the northern region of New Zealand are presented in *Table 6.5.* Drainage averaged 3.18 (SD=1.5), induration 3.8 (SD=1.3), and AcidP averaged 3.16 (SD=1.2).

Table 6.5: **Environmental variable data for *Phormium tenax* in the northern region of New Zealand generated from point data (n=99). Minimum and maximum environmental limits, as well as the mean and standard deviation, are recorded for each environmental variable. Measurement units are given in brackets**

Environmental variable	**Min**	**Max**	**Mean**	**SD**
DEFICIT (MPa day)	0	239	63.4	49.5
GFROSTFREE (Days/year)	87	365	273.8	78.7
MAS (MJ/m^2/day)	144	154	150.3	3
MAT (°C)	12.6	16.0	14.8	0.8
R2PET (Ratio)	14	44	25.8	6
RAIN (mm)	864	2256	1447	291.2
SSEAS (MJ/m/day)	0	10	3.6	2.9
TSEAS (°C)	1.1	3.4	0.8	0.9
VPD (kPa)	28	44	37.1	3.4

Differences in environmental parameters for the two sets of harakeke data can be compared in *Figure 6.9.* Values were generally similar, but the differences, such as that for the frost free status of ground (GFROSTFREE), suggest that the broader data set should be treated with caution.

Figure 6.9: **Environmental parameter data for *Phormium tenax* throughout New Zealand, and in northern New Zealand only**



Wharariki

Minimum and maximum parameters for the environmental variables under scrutiny are presented in *Table 6.6*. No environmental limits were observed for wharariki in relation to VPD or ground frost (GFROSTFREE) with this data set. Environmental tolerances for rain, root zone water deficit (DEFICIT), the ratio of rainfall to potential evapotranspiration (R2PET) and mean annual solar radiation (MAS) were also broad, with only small areas of exclusion, such as parts of central Otago (see *Appendix 4* for details). A wide tolerance for minimum temperature and seasonal variability in temperature was also demonstrated.

Table 6.6: **Environmental data for *Phormium cookianum* (wharariki) from throughout New Zealand, generated from point data. Minimum and maximum environmental limits, as well as the mean and standard deviation, are recorded for each environmental variable. Measurement units are given in brackets**

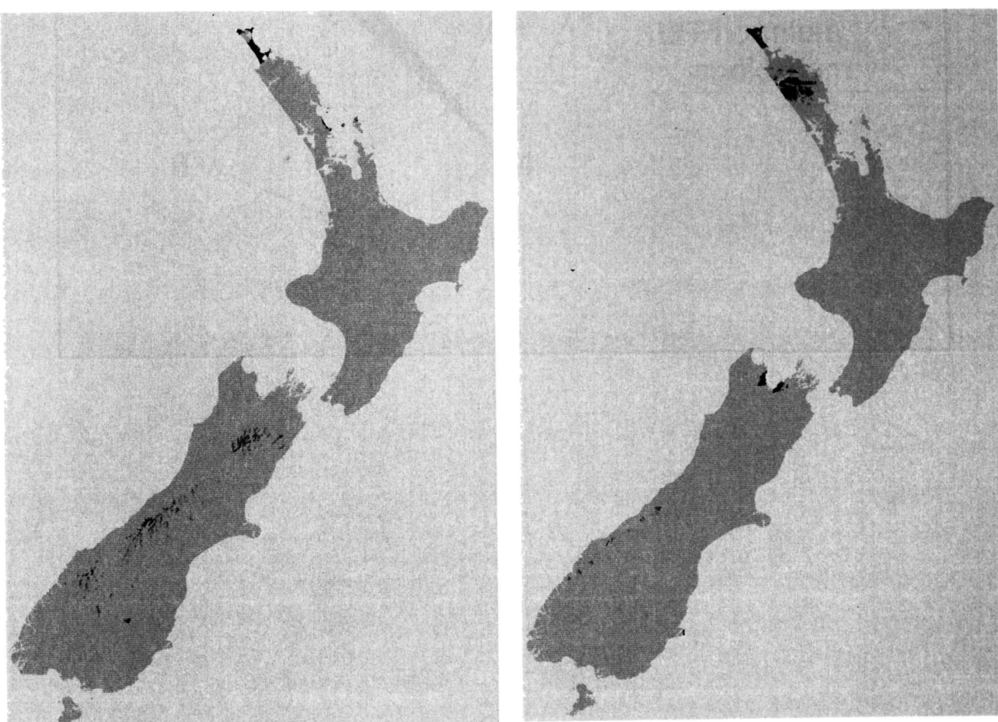
Environmental variable	**Min**	**Max**	**Mean**	**SD**
DEFICIT (MPa*days)	0	309	8.6	28.9
GFROSTFREE (Days/year)	1	365	36.5	66.5
JUNES (MJ/m/day)	27	66	41.5	6.3
MAS (MJ/m^2/day)	117	154	132.7	8.4
MAT (°C)	2.2	15.7	8.0	2.0
R2PET (Ratio)	10	292	118.4	70.3
RAIN (mm)	454	9260	4142.4	2255.5
SSEAS (MJ/m/day)	-13	7	1.1	3.4
TMIN (°C)	-5.0	8.3	-0.9	2.2
TSEAS (°C)	-1.9	4.0	0.3	1.0
VPD (kPa)	0	65	20.9	14.7

Wharariki was indicated as absent from the far north region (as well as areas of the South Island) being limited in this area by seasonal solar radiation (SSEAS), solar radiation in midwinter (JUNES), and minimum annual temperature (MAT) (*Figure 6.10*).

The distinct environmental parameters for *Phormium cookianum* and *Phormium tenax* (northern data set) are illustrated in *Figure 6.11* (using the presence data) for mean annual temperature (MAT), root zone water deficit (DEFICIT), VPD, degree of ground frost (GFROSTFREE), temperature seasonality (TSEAS), solar seasonality (SSEAS), mean annual solar radiation (MAS) and R2PET. Large

differences in the mean rainfall were also evident (4142 mm for wharariki compared to 1447 mm for harakeke), but are not included in *Figure 6.11* for reasons of scale. The means for harakeke and wharariki clearly differ in relation to mean annual temperature, root zone water deficit, and ability to withstand frost. Wharariki could be characterised as more common in a cooler, cloudier environment with higher rainfall levels when compared to harakeke.

Figure 6.10: **Limitations on the potential natural distribution of wharariki in relation to: (a) minimum temperature (TMIN); and (b) seasonal solar radiation (SSEAS). Dark areas represent regions where wharariki is excluded by these environmental parameters. The far north of the North Island is excluded by both environmental variables.**



The final map indicating environmental limits for wharariki (*Figure 6.12*) demonstrates a broader environmental range than that indicated for harakeke (*Figure 6.7*). In total, the potential natural distribution for wharariki covered 92% of the total area of New Zealand, in contrast to harakeke (54%).

Figure 6.11 **Radar diagram demonstrating the distinct environmental envelopes of harakeke and wharariki, using means for eight environmental variables. 1=MAT, 2=DEFICIT, 3=VPD, 4=GFROSTFREE, 5=TSEAS, 6=SSEAS, 7=MAS, 8=R2PET.**

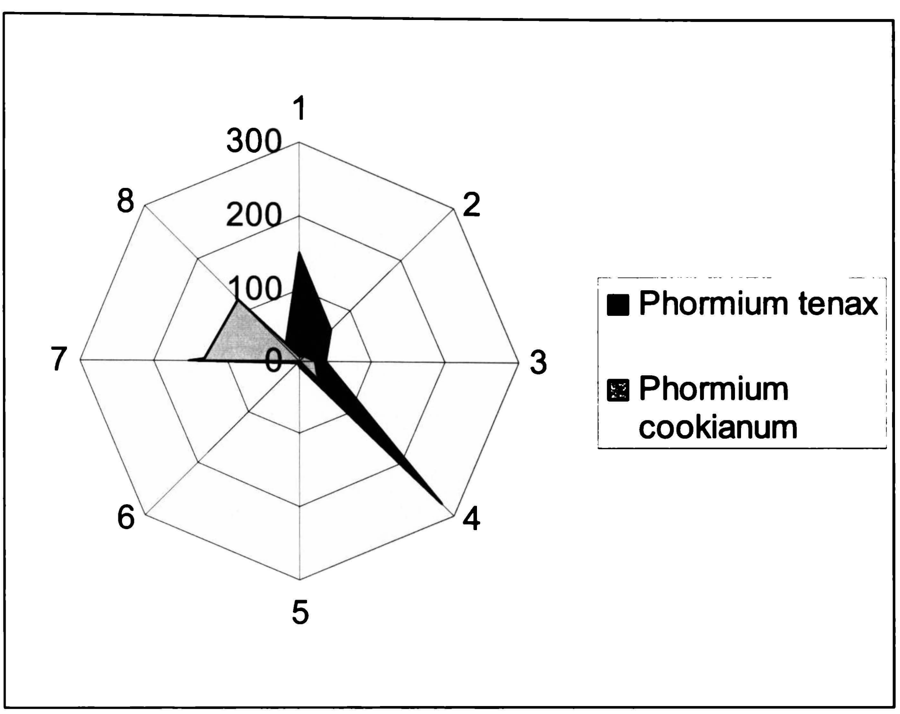


Figure 6.12: **Final predictive map of the potential natural distribution for *Phormium cookianum* (wharariki), including the occurrence point data. Grey areas represent the indicated 'environmental envelope' for wharariki**

6.3.2 GRASP: *Phormium tenax* in northern New Zealand

The final regression model was restricted to the northern region of New Zealand, as stated previously (see *Section 6.2.1*). Two analyses were used to help interpret and understand the regression models. First, plots of response curves resulting from the model were used (*Figure 6.13*), and secondly, graphs of the overall contribution of the variables to the model. The final model contained those environmental variables which contributed significantly: groundfrost (GFROSTFREE), root zone water deficit (DEFICIT), solar seasonality (SSEAS), mean annual solar radiation (MAS), and mean annual temperature (MAT) (*Figure 6.14*). Using the change in residual deviance when dropping each term from the final model as a measure, it was found that ground frost made the highest contribution to the final model. Inspection of the partial response curves also demonstrates the strong negative response of harakeke to ground frost, for example, as an environmental variable (*Figure 6.13*). Mean annual solar radiation was the next most important environmental variable in the model (seen as a strong negative response in *Figure 6.13*), followed by root zone water deficit, mean annual temperature and seasonal solar radiation (*Figure 6.14*). Groundfrost and root zone water deficit made the greatest contributions to the alone model, followed by mean annual temperature and mean annual solar radiation, but seasonal solar radiation was rejected by the model as a non-significant factor.

GRASP is a combination of environmental sampling and the effects of sampling. In this case, sampling distances from roads and from the coast were highly significant. Overall, the model indicates that harakeke is most likely to occur in environments which are near the coast with warm temperatures, little groundfrost annually, and sunny winters. It indicates a broad tolerance of water deficit in the root zone. The predictive map produced from the final regression clearly indicates the influence of the environmental predictors described above (*Figure 6.15*).

Figure 6.13: **Partial response curves of harakeke presence in northern New Zealand for each selected environmental predictor variable. Generalised additive models (GAMs) were used to model the relationship between environmental variables and the occurrence of *Phormium tenax*. These graphs show the partial contribution of each significant explanatory variable (p<0.05).**

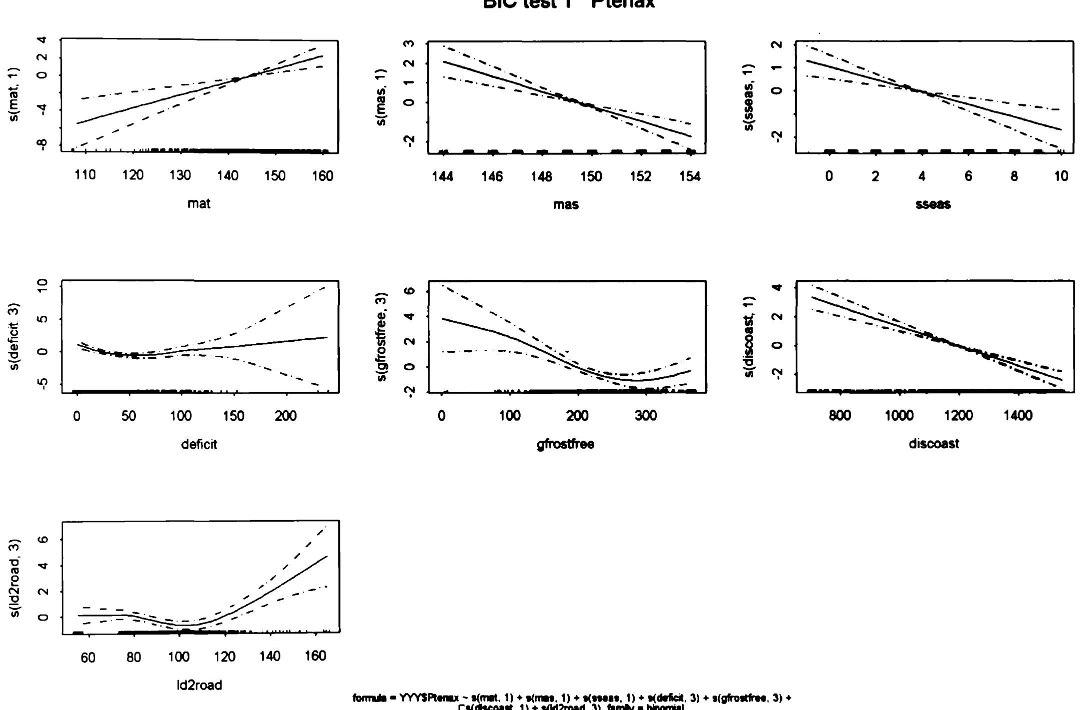


Figure 6.14: **Barplots of the stepwise model showing, for each variable, the amount of deviance explained by the drop contribution to the model (left) and alone contribution (right)**

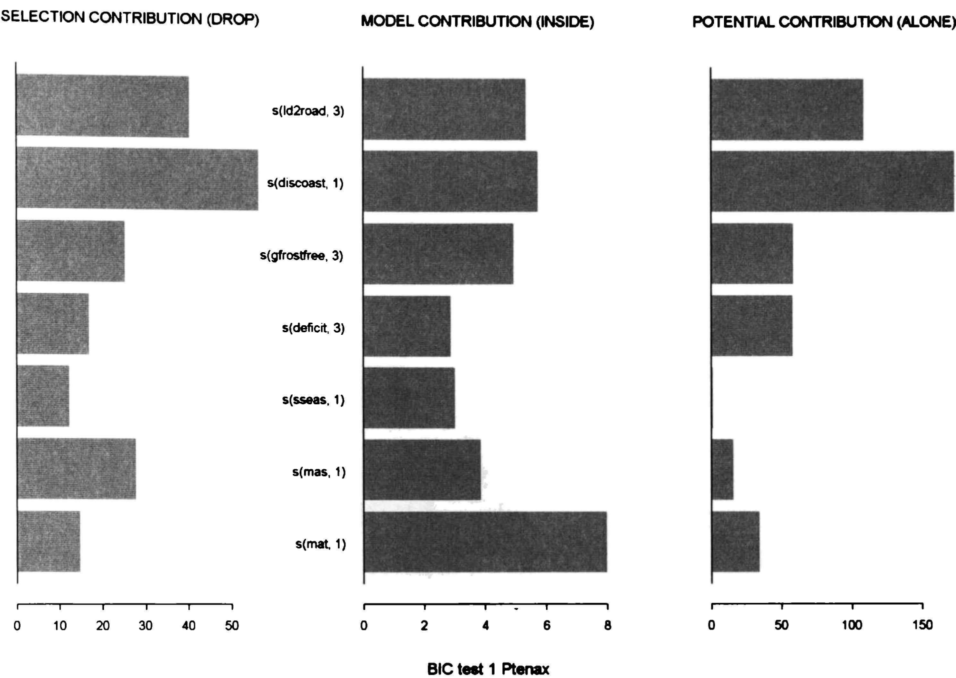
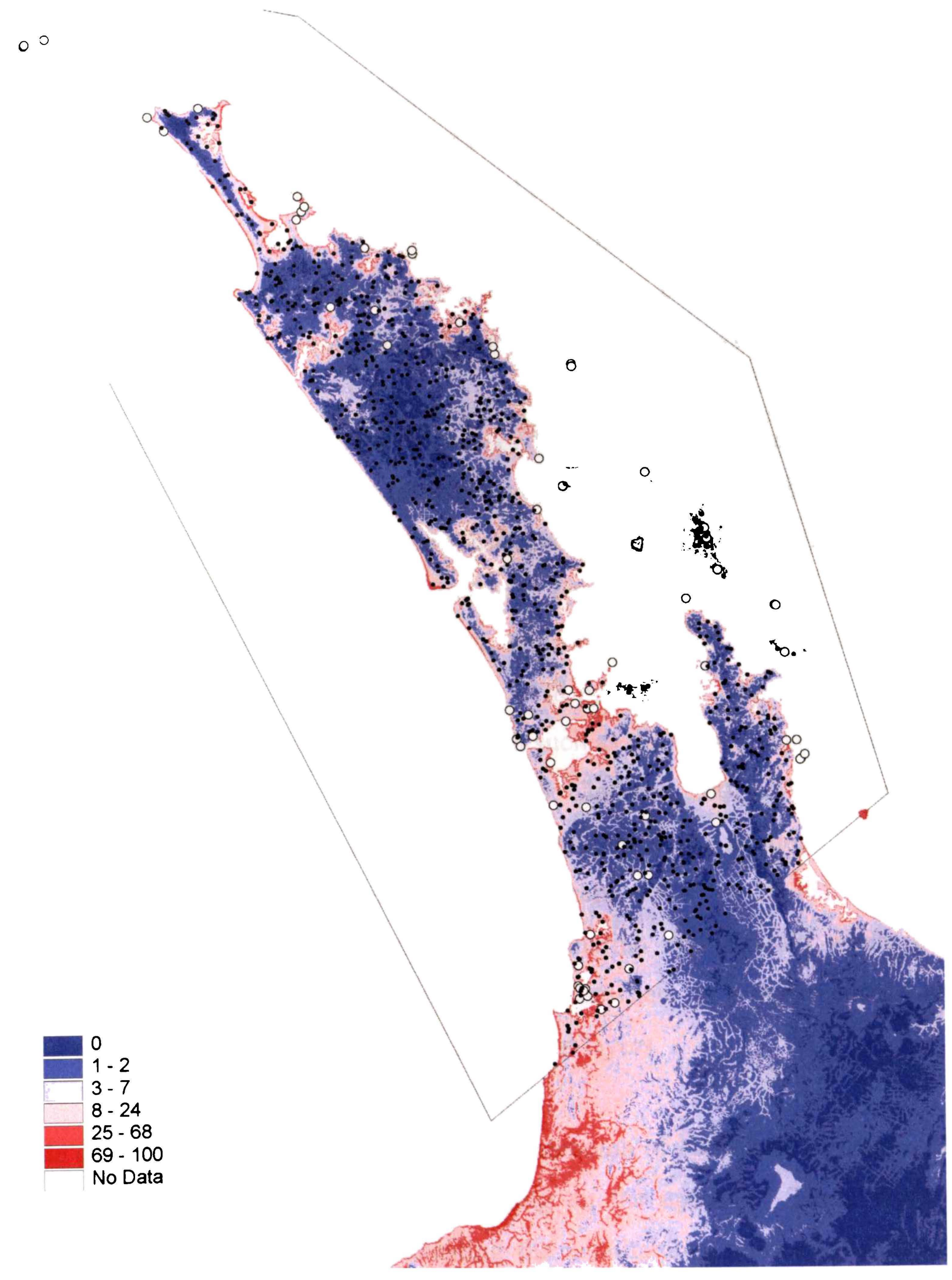


Figure 6.15: **Predictive map of probable harakeke occurrence in the northern region of New Zealand (zero indicates low probability, and 100 high probability of occurrence)**



6.4 Discussion

Harakeke is predicted to have a low occurrence throughout much of the northern area of New Zealand, including Northland and the Waikato. This result can be explained by considering current knowledge of soil fertility and other variables. In Wardle's view, soil fertility is an important factor in predicting harakeke abundance throughout the country (Wardle, 1991).

Harakeke typically dominates fertile lowland swamps along with raupo and *Carex* sedges (Wardle, 1991 p.73). As wetland conditions become more acidic and less fertile over time, however, fertile swamps tend to be succeeded by peat domes and bogs where harakeke is rarely found. Maintenance of harakeke therefore requires maintaining fertility; the burning of peat vegetation in bogs is one method of returning these less fertile wetlands to a previous stage of succession.

Peat forms wherever the substrate is more or less permanently waterlogged and may be either under water or built up as bogs or fens (Davoren, 1978 p.1). These swamp peatlands are widely distributed throughout New Zealand (Wardle, 1991 p.285), including both Northland and Waikato. Peat swamps have been recorded in Northland at Sweetwater, Hikurangi and Waipu, with harakeke being unrecorded in any of these areas (Davoren, 1978 pp.15-25). Similarly, Waikato has extensive peat domes in the Waikato basin such as the Whangamarino fen and Kopuatai peat bog (Wardle, 1991 p.93 and p.285; Clarkson, 2002 p.54): other peat swamps in the Waikato region include Hauraki, Ohinewai, Te Mimiha, Te Hoe o Tainui, Orini, Kainui and Komakarau (Davoren, 1978 pp.26-47). Some *Phormium tenax* has been recorded at Whangamarino and Hauraki where the mineral content of the swamps is higher; but elsewhere it is not recorded as surface vegetation or in plant fragments in the peat layers.

Wardle (1991, p.92) has described the early vegetation of Northland as nearly all warm-temperate forest, with kauri dominating on the uplands. These forests require low fertility soils, again indicating the unsuitability of much of inland Northland for harakeke.

The predictive map suggests that harakeke is most likely to be found in coastal areas of Northland, and other data concur with this finding. Coastal harakeke was an extensive resource prior to the 1840s, particularly in the far north, with flax trading stations operating at Hokianga, the Bay of Islands and Rangaunu during the 1830s (Stokes, 2002 pp.37 and 40). Interviews with expert weavers from Northland (see *Chapter 3*) also indicated that coastal harakeke was an important resource.

Northland has historically had one of the highest Māori densities in New Zealand, being potentially one of the most modified regions in New Zealand. Large numbers of Māori have also settled in Waikato from the time of arrival of the Tainui. Yet this data set does not predict high occurrence of harakeke in either Northland or inland Waikato. Prior to human arrival, temperate forests covered approximately 90% of New Zealand's land area (Masters et al., 1957), so that wetlands and other environments which might include *Phormium* would have formed less than 10% of the natural environment. The proposition therefore is that harakeke was historically of low occurrence in many areas in inland Northland and Waikato, which would in turn strongly encourage active management of the resource, including dispersal. Māori may perhaps have moved harakeke to areas outside of the natural distribution, or used opportunities to increase abundance and ensure availability. Many areas which are currently thought of as 'natural' areas may in fact be the result of earlier (unrecorded) Māori dispersal of harakeke, something that is likely to have taken place because of the importance of this resource. In fact, one research participant mentioned the high number of *pā kōrari* (*pā harakeke*) previously cultivated throughout inland Northland by Māori, providing further support for this hypothesis (see *Chapter 3* for details). Nutrient enrichment of the soil would be one way of achieving this aim.

Historical writing by early visitors, explorers, and botanists suggests that harakeke lacks environmental limits, being ubiquitous across New Zealand in the 19th century (see, for example, Dieffenbach, 1843 Vol. I p.28; Colenso, 1868a, 1868b; Hursthouse, 1849 p.19; Travers, 1868 p.168). Yate (1835, p.14) wrote that the "interior of the country abounds with swamps" and later referred to the supply of

harakeke as "inexhaustible". Succession processes were also remarked upon: Smith (1910, p.433) recorded a commentary from Nelson describing how the site of a flax swamp had previously been occupied by "a forest of mixed timber, which was ultimately destroyed by fire, and a growth of flax [taking] its place." However, although these comments reflect 19th century perceptions of harakeke, particularly during the pioneer period, they do not discount the possibility of harakeke range expansion with earlier Māori settlement across New Zealand.

Many 19th century writers also observed the environmental conditions that harakeke grew in, with observations ranging from drainage to salinity. Lang remarked that "[harakeke] affects moist situations, but is by no means fastidious as to the quality of soil in other respects" (Lang, 1839 p.59) while Bidwill (1952, p.76) noted that on the plains near Matamata, harakeke specimens at least 12 feet high covered many miles, being found in all the moist places which were not actually bog. Dieffenbach commented, when he visited Queen Charlotte's Sound, that harakeke was "everywhere", including on the driest hills, in swamps and by the sea where it was exposed to the salt water (Dieffenbach, 1843 Vol. I p.28). These observations, highly coloured and unmethodical in nature as they are, nevertheless provide some indication of environmental parameters. Harakeke does indeed occur frequently in rainy areas and near the coast, and also has the ability to withstand drought. However, it is more likely to occur in warm temperatures. Temperatures decrease with increasing latitude, so harakeke could be expected to have a low probability of occurrence in the south of New Zealand. Nevertheless, according to the model reported here, it is more likely to occur where solar radiation is less intense, suggesting that its occurrence is not restricted to northern areas. In fact, harakeke is found in Westland, and as far south as Stewart Island (Wardle, 1977; Wilson, 1987). Inland areas often have harder frosts, warmer summer days and lower humidities (Wardle, 1991 p.80). Harris et al. (2005) found that frost badly affected harakeke planted in southern locations. Of the fans that they planted out in these locations, there was a higher incidence of stunted growth and death: the environmental profile presented here concurs with their findings. Proximity to the coast might be expected to be of increasing importance as latitude increases for harakeke, because of the different climatic conditions in coastal areas.

When compared with harakeke, the environmental profile for wharariki indicates that it is able to tolerate a greater number of days with ground frost, lower average temperatures, and a wider range of rainfall conditions, including extreme rainfall. Wardle (1991, p.381) identified a wide range of wharariki habitats, including rock crevices, coastal cliffs, slopes and bluffs, and schist bluffs at all altitudes in the Southern Alps. The broad environmental envelope occupied by wharariki would have assisted successful dispersal to different parts of its potential natural distribution.

Technical issues

The number of reference points, and their location around the country, resulted in bias in relation to the potential natural distribution of harakeke in particular. This problem is illustrated in the harakeke groundfrost data for New Zealand, where a large difference between the minimum reference point, and the next minimum reference point, creates a large change in the predictive map. Including the minimum reference point suggests that harakeke can grow in districts where the minimum number of days free of frost each year is only one; that is, it is extremely frost tolerant. Inclusion of the reference point in the data set leads to a final potential distribution which fits relatively closely with this observation. For example, harakeke has been reported up to 1000m on Mt Taranaki (B. D. Clarkson, pers.comm.) and this apparently concurs with this predictive map. However, if that reference point is removed from the data, the minimum number of frost free days changes to 81 days per year, and the potential final distribution of harakeke in relation to this environmental variable changes dramatically, as does the final predictive map of its potential distribution (*Figure 6.15*). Much of the South Island high country and a large part of Taranaki, for example, are also removed from the potential natural distribution.

The midwinter solar radiation limits (JUNES) may also be unreliable. *Figure 6.6* shows that the natural potential distribution for harakeke in relation to this variable excludes most of Stewart Island. This contrasts with the presence of harakeke described by Wilson (1987) while conducting an extensive botanical survey of the island.

Generalised additive point models such as GRASP are one way of obtaining higher resolution by examining abundance within the environmental envelope. However, the lack of sources which record absence as well as presence, the limited number of reference points for harakeke, and the bias within the data set all combine to suggest that such a regression would be more appropriate with an expanded set of reference points. Methodical recording of species absence from survey data is particularly important if the assumption that no record means absence is to be avoided. This problem is inherent in all herbarium data.

The presence-only nature of the data has clear limitations. Since the absence points are pseudo-absence points only, some may in fact coincide with the actual presence of harakeke. Thus, the probability of harakeke occurrence is likely to be underestimated for the environments they represent (Leathwick, 2000). Thus, for example, in Northland, the central inland area is poorly represented by presence data compared to island and coastal presence point data. Further, because of the lack of genuine absence points, probability values are relative and have no absolute meaning (Leathwick, 2000). Even so, they tend to behave in an ordinal way, so that higher fitted values can be confidently expected to indicate a relatively higher likelihood of occurrence.

In spite of these limitations, the environmental envelopes generated provide an important first step in understanding the environmental limits of both harakeke and wharariki. Harakeke is most likely to be found in northern New Zealand in warm coastal areas with relatively frost-free situations and a low degree of seasonal variation in solar radiation, although skies may be cloudy rather than clear. The data indicate it is drought tolerant, and can withstand a wide range of root zone water conditions. Wharariki, on the other hand, appears to tolerate extreme rainfall, thrive in cooler temperatures, has a R2PET ratio four times that of harakeke, and withstands ground frost well.

The final predictive map for harakeke clearly demonstrates the influence of environmental variables such as ground frost, temperature and solar radiation, and

suggests that harakeke and wharariki both favour different and distinctive ecological niches.

Chapter 7

Discussion and Conclusions

7.1 Introduction and main findings

Different techniques have been employed in this research project to determine (a) the extent and type of active past management of harakeke by Māori, and (b) whether active management has resulted in changes to the New Zealand landscape. In *Chapter 3*, the foundation of the research was laid in interviews with elders that focused on their knowledge of past active management of harakeke, and examination of *whakataukī* in terms of evidence (implicit or explicit) of ecological knowledge of harakeke, and past management patterns. Elders focused on management practices which are important to the sustainable use and autecology of harakeke. These included the importance of appropriate harvesting, 'cleaning' the bush to reduce pest abundance, methods for dealing with waste harakeke after weaving, planting techniques and the specific use of different varieties. These practices were described in relation to both *pā harakeke* cultivations and natural areas. Elders emphasised the importance of natural areas for harvesting, a theme reiterated throughout the research. Discussions with elders also provided links with other areas of the research. For example, references to *pā harakeke* throughout the central Northland area can be considered in relation to the predicted probability of harakeke occurrence (modelled in *Chapter 6*). The *whakataukī* discussed in *Chapter 3* are remarkable for the wealth of ecological information they provide from the oral tradition. Information on ecological processes such as shoot growth, competition, nutrient cycling, germination, habitat specialisation and community relationships is embedded in these *whakataukī*. Information on environmental parameters, such as rain and drought, which may be important to identifying the natural distribution of harakeke is also in evidence. In addition, *whakataukī* provide clues to potential agents of landscape change which have not previously been considered in relation to harakeke use by Māori. One such agent is deliberate firing to encourage harakeke growth.

Critical analysis of historical documents in *Chapters 4* and *5* has provided further insight into past harakeke variety use, the extent of cultivation and dispersal and practices used in management. Understanding the role that harakeke cultivars have played in historical management is complex, not least because of the difficulties of identification. Even so, it is clear that a large number of varieties were extensively used, planted, and dispersed around the North Island. Cultivations were more extensive than has been previously thought, some appearing to cover considerable areas. It seems probable that cultivation of harakeke occurred throughout much of the country. However, the evidence also supports continued use, for a variety of purposes, of naturally occurring harakeke in swamp areas. The development of planting and propagation methods identified in *Chapter 5* clearly demonstrates active management of the harakeke resource by Māori. Planting of vegetative fans is well documented in the 19th and early 20th century literature; it appears that this method of propagating harakeke has been in use for at least several hundred years. However, a critical analysis of written documents also reveals that, contrary to current belief, Māori germinated harakeke from seed. Furthermore, it indicates that fire was used to enhance germination and growth, either from existing seed banks in the soil or from human sowing of seed. The irrigation of *pā harakeke* is also identified.

The environmental parameters identified in *Chapter 6* quantify, for the first time, the kinds of environmental information illustrated in both *whakataukī* and botanical sources, creating an 'environmental envelope' for both harakeke and wharariki. These parameters confirm, for example, that frost can limit harakeke distribution, while also demonstrating its resistance to drought and preference for warm temperatures. The parameters also indicate that wharariki occupies a distinct niche: it appears to be tolerant of a wider range of climatic conditions, with the ability to colonise a greater proportion of the New Zealand landscape. Modelling of harakeke occurrence in the northern region of New Zealand indicates a low probability of occurrence in much of this region. Low soil fertility measurements in much of Northland and Waikato (Davoren, 1978) as well as observations of wetland plant community composition support these findings.

7.2 Limitations of the research

One of the difficulties of historical research is bias in the data (see *Chapter 2*). The critical analysis of historical documents undertaken in *Chapters 4* and *5* reveals such bias and attempts to overcome it. In particular, that bias is evident in the fact that discussion of harakeke was generally related to issues relevant to the industrial extraction of fibre, and to harakeke varieties that were considered to have 'superior' fibre. Even so, these historical sources, when considered critically, reveal a great deal of information which would not otherwise be available.

Interviews with research participants focused on the relevant knowledge of a small number of elders and weavers in two regions of New Zealand. Some of these people were expert weavers, while others were family members whose knowledge, though more fragmented, is also valuable, particularly as it relates to our family tribal area. There is considerable scope to extend this work, including a greater number of research participants from a variety of regions, and focusing more directly on specific issues, including for example, spiritual aspects of management and harakeke genealogy which were not covered here. Valuable information and insight into historical management of harakeke can be gleaned from interviews with weavers and elders. However, understanding the knowledge inherent in oral history can also be complicated when both research participants and interviewer live in a modern world. These interviews have indicated that this is the case.

The quantitative data used to model environmental parameters was limited in its distribution, something that inevitably impacted in a negative way on the findings. As well, the lack of absence data meant that pseudo-absence points had to be created, further complicating the model. However, although this means that the reported environmental parameters must be treated with some caution, enough data is available to present initial findings. A larger georeferenced data set with wider distribution is required for confident prediction of the likelihood of occurrence of harakeke and wharariki in particular areas. Moreover, because environmental parameter data was primarily developed in relation to canopy trees

(see, for example, Leathwick et al., 1998), further research on its application to other plant forms, such as monocotyledons, would be useful.

7.3 Discussion

Human derived landscape change has frequently been described in negative terms. However, it may be more appropriate to acknowledge the development of innovative solutions and management practices that have allowed people to survive and flourish in difficult environments. This research on harakeke ecology and historical Māori management reveals such solutions and management practices. Māori manipulation of wetlands for fishing, horticulture and defence has previously been acknowledged by ecologists (Wardle, 1991; Park, 1995 p.51ff.). The fact that, as this research reveals, Māori have similarly manipulated the environment to ensure maintenance of harakeke resources has not previously been acknowledged. This includes manipulation of the water table to irrigate harakeke cultivations on hillside slopes. Wardle (1991, p.310) has observed that harakeke thrives on river banks and hillside seepages, indicating that the development of similar water table and slope conditions in *pā harakeke* is indeed appropriate for growth.

It is interesting to consider the possibility that some of the tools of landscape change identified in this research, such as the use of fire to germinate seed (see *Chapter 5*), were involved in the creation of large scale harakeke plantations. Certainly, the use of fire to germinate harakeke (either from existing seed banks or after sowing the seed) sheds new light on past harakeke management by Māori. Thus, in environments where harakeke did not commonly occur (as indicated for the northern North Island by the predictive mapping in *Chapter 6*), the need to ensure large scale availability may have led to the use of fire for germination. Although the rapid decline of wetlands since European settlement has been noted by a number of authors (see, for example, Clarkson, 2002 p.49; Park, 2002 p.151), less attention has been paid to the question of wetland creation prior to European settlement, despite recognition of the high regard Māori have for lowland swamps (Park, 2002 p.161).

The possibility of fire use to create swamps is indicated in *whakataukī* (see *Chapter 3*). Wardle (1991, p.287) has described the incidence of fires as increasing after Māori arrival, transforming wooded swamps (such as kahikatea forest which often borders fertile swamps) into herbaceous swamps and increasing sedimentation. However, although ecologists have observed that most harakeke swamps have been induced by clearing the forest and scrub from wet soils, or partly draining deep swamps (Wardle, 1991 p.310), they have not considered the development of harakeke harvesting areas as a possible goal of landscape transformation (see, for example, Anderson, 2002 p.30). Given the essential nature of harakeke as a resource, the *maintenance* of harakeke swamps is another goal which is consistent with the management practices revealed in this research. Kahikatea forests were frequently found in areas subjected to prolonged flooding, and can be succeeded by fertile swamps such as those dominated by *Phormium tenax* (Wardle, 1991 p.129). Charcoals in Waikato peats show that wetlands have always been subject to periodic fire, as their vegetation and even the peat itself are flammable during dry weather (Wardle, 1991 p.287). This flammability provides the opportunity to replace peat vegetation with earlier, more fertile successional stages which include harakeke. Similarly, the establishment of fertile swamps is inhibited by rapid growth of other species (Wardle, 1991 p.287). In *Chapter 3*, it is noted that certain *whakataukī* indicate the clearing of overgrown plants to allow harakeke growth.

The interconnectedness of landscapes is another theme revealed in *whakataukī* in *Chapter 3*. Park (2002, p.162) has emphasised that, because of the small-scale geographic diversity of New Zealand, the premium breeding and feeding zones provided by lowland swamps are (or have been) used by a diversity of bird species, including interior forest birds. Some of the *whakataukī* included in *Chapter 3* comment on harakeke providing habitat for the pītongatonga, and food resources for the kākā and bellbird. Destruction of wetlands therefore has serious ramifications in terms of these community relationships.

Specific management practices used by Māori weavers, and described in both *Chapters 3* and *5*, are consistent with current western ecological knowledge of harakeke. Thus, for example, harvesting methods allow the *mātua* leaves to

continue protecting the young shoot or *rito* from ground frost damage (Harris et al., 2005). Protecting from frost or modifying micro-climatic conditions can extend the ecological range of a plant beyond its natural distribution. Such management practices act to support the potential for larger landscape scale change. Furthermore, the interconnected nature of management practices in maintaining plant health is evident. Thus, alternative methods of disposing of waste harakeke, such as the use of pits for example, reduce pest infestation.

The development of planting and propagation methods (identified in *Chapter 5*) supports the dispersal of plant material (such as fans) for cultivation, as well as the selective use of different varieties. Vegetative propagation allows plant material to be easily reproduced, and easily dispersed. Māori propagation of fans and dispersal of harakeke varieties has previously been identified (Scheele & Walls, 1994; McBreen et al., 2003), but this study enhances current knowledge of past planting regimes through identification of specific planting and management practices. Additionally, it addresses the issue of the extent of dispersal throughout the North Island, both through the identification of dispersal records, and through records of the location of specific varieties. When the extent of cultivation (see *Chapter 4*) is considered, the potential for large-scale landscape change is clear.

Environmental parameters for harakeke and wharariki reveal that these species occupy distinct, but broad ecological niches. Human directed movement of both harakeke and wharariki has taken advantage of these broad parameters to disperse varieties to areas not previously colonised by these plants. In doing so, new genetic material has also moved from one region to another. Although weavers may have removed seedheads from cultivated harakeke to prevent genetic mixing of varieties, genetic mixing will undoubtedly have occurred because many *pā harakeke* have fallen into disuse. Predictive mapping of environmental parameters for harakeke in the northern region of New Zealand allows us to define where the probability of finding harakeke is highest; in doing so, it indicates that what is often considered to be the 'natural' environment may not be nearly as 'natural' as it seems. In that it often occurs in areas of low probability of natural harakeke occurrence, roadside harakeke (found throughout inland Northland) may be indicative of previous human dispersal to create *pā harakeke*.

7.4 Main contributions of the research

One of the strengths of this research is the acknowledgement of Māori ecological knowledge of harakeke, and its integration, in a meaningful way, with quantitative data and western scientific understanding. Too often modern ecological research does not explore the traditional ecological knowledge which precedes it, either because the knowledge is not accessible to the researchers or because they are unaware of its existence. This research emphasises the value of oral tradition and Māori ecological knowledge in relation to western science, including ecological restoration and historical ecology. Integrating different types of knowledge and understanding can lead to more effective decision making.

Clark (1990) has emphasised the fact that managing ecosystems without knowledge of their history may invite future disaster. Although his work was concerned with Australian ecosystems, where fire and climate can have extreme consequences, his views also have relevance for New Zealand. It is important to detect long-term trends and to understand rates and directions of change as well as climatic variability. To predict outcomes of management actions, studies of present-day patterns must be complemented by investigations of past patterns and processes. Even so, the contribution that cultural history can make to our understanding of changes in the New Zealand landscape has been under-estimated or even ignored. An understanding of the importance of harakeke to Māori led to an investigation of its possible management by Māori in the past, an investigation that, in this case, included the identification and analysis of relevant *whakataukī*. This investigation enhances our current understanding of ecosystem processes and community relationships by, for example, identifying the kākā as a pollinator of harakeke. Knowledge of such relationships is important to the return of full ecosystem functioning in currently degraded ecosystems.

For the first time, an attempt has been made to quantify environmental parameters for harakeke and wharariki. Past reconstructions of vegetation have been largely qualitative in nature (see, for example, McGlone, 2002). Botanists have typically surveyed different environments and collated lists of extant species in their attempts to understand ecological communities: to this end, the composition of wetland fragments and other environments (which include harakeke) has been

recorded (see, for example, Bagnall & Ogle, 1981; Duguid, 1990; Robertson et al., 1991; Wardle, 1977). However, the development of a landscape-scale spatial framework can extend our ability to predict the likely biological character of regions in the absence of human activity using quantitative data (Leathwick, 2001). Environmental parameters provide the first step to better understanding the relationship of climatic factors to harakeke distribution, with the potential for further studies which investigate causative factors in the distribution.

7.5 Future areas for research

A number of avenues for future research appear promising. Indications of irrigation in *pā harakeke* are tantalisingly vague in the 19th century literature, yet are important to a full understanding of past Māori management practices. Experiments involving different water and slope regimes would be useful in forming hypotheses in this area. For example, cloned offsets of harakeke could be trialled on a number of sites, with a range of treatments. Measurement of pest damage and harakeke growth could also indicate whether these may have been major determinants of *pā harakeke* irrigation and placement. Similarly, exploration of the effect of different conditions on management practices could provide some indications of why Māori have continued to use and value swamps. For example, the relationship between the return of excess material to the plant and pest damage or abundance could be explored in harakeke on both wet and dry natural sites. It may be that this practice is highly effective at fertilising the plant in wetter sites without any ensuing ramifications for pest abundance.

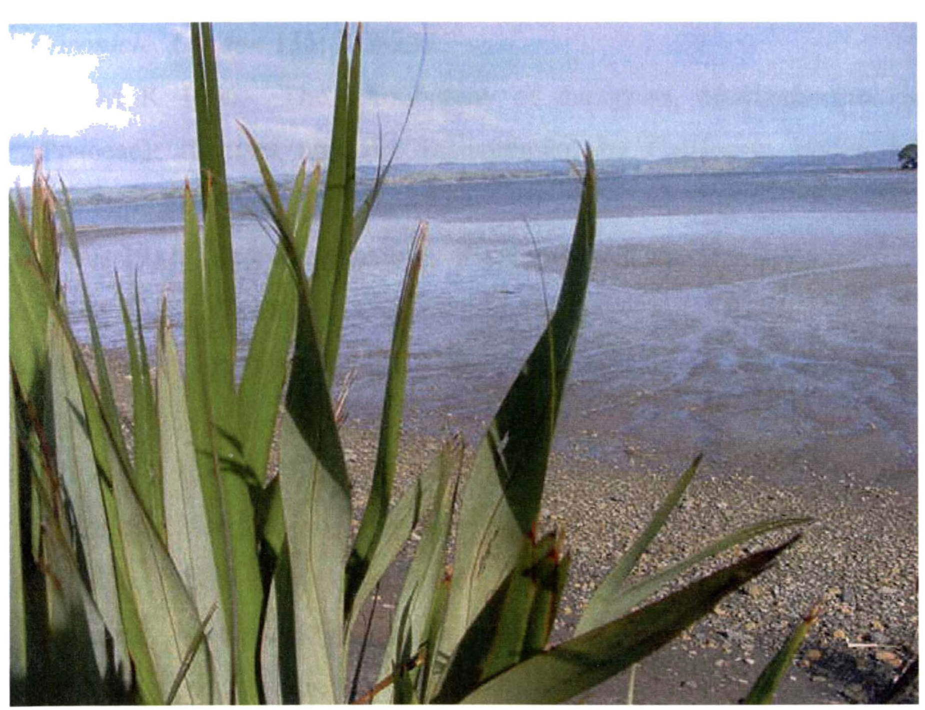
Pollen cores are a useful tool in assessing past harakeke presence (despite difficulties in detecting harakeke pollen). Analysis of harakeke pollen levels may help us to determine whether harakeke swamps succeeded wetland kahikatea forest, and whether these swamps may have been maintained through burning.

Further modelling of an environmental envelope for harakeke and wharariki across the whole New Zealand landscape would lead to better understanding of the ecology of the species. Once environmental envelopes have been established for both species, it should be possible to combine these with other databases to further examine changes in past distributions. From there, other relationships could be explored. Thus, it might be possible to determine whether abundance of

harakeke in relation to different environmental conditions is also linked to the location of pā sites. Leathwick (2000) predicted that the probability of occurrence for pā sites is highest in northern and eastern New Zealand, with a strong increase in probability close to major water bodies. Analysis of harakeke occurrence in relation to pā sites might allow us to quantify the probable relative locations of this essential resource, and the likelihood of cultivation.

7.6 Conclusions

Oral tradition combines with evidence from the 19th and early 20th century literature to support the hypothesis that Māori have managed harakeke extensively throughout much of the country. Evidence of cultivations, coupled with the dispersal of esteemed harakeke varieties throughout the North Island, suggests likely changes in harakeke distribution. Cultivation methods likewise indicate the potential for landscape scale changes. Further research is, however, required to quantify these changes. Even so, it remains the case that understanding Māori knowledge of harakeke, including ecological relationships, management regimes and environmental parameters, has been shown to be important for restoration projects which incorporate cultural history. This research project demonstrates that human history and the biotic environment are more connected than is often acknowledged.



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Glossary of scientific names for biota used in the text

aute	*Broussonetia papyrifera*
bellbird	*Anthornis melanura*
eel	*Anguilla* spp.
fantail	*Rhipidura fuliginosa placabilis*
fernbird	*Bowdleria punctata*
ferret	*Mustela furo*
harakeke	*Phormium tenax*
hue (bottle gourd)	*Lagenaria siceraria*
kahikatea	*Dacrydium dacrydioides*
kākā	*Nestor meridionalis*
karaka	*Corynocarpus laevigatus*
kauri	*Agathis australis*
kereru	*Hemiphaga novaeseelandiae*
kiekie	*Freycinetia banksii* var. *baueriana*
kiore	*Rattus exulans*
kūkū	*Mytilus* spp.
kumara	*Ipomoea batatas*
leaf hopper	*Oliarus atkinsoni*
looping grub	*Orthoclydon praefectata*
mangeao	*Litsea calicaris*
manuka	*Leptospermum scoparium*
mauku	*Asplenium bulbiferum* and *Hymenophylllum* sp.
mint	*Nepeta cataria*
niggerhead	*Carex secta*
notching grub	*Tmetolophota steropastis*
pandanus	*Pandanus* spp.
parakeet	*Cyanoramphus* spp.
peach	*Prunus persica*

pīngao	*Desmoschoenus spiralis*
possum	*Trichosurus vulpecula*
potato	*Solanum tuberosum*
pukatea	*Laurelia novae-zelandiae*
rat, black	*Rattus rattus*
rat, norwegian	*Rattus norvegicus*
raupo	*Typha orientalis*
saddleback	*Philesturnus carunculatus*
silvereye	*Zosterops lateralis novae-seelandiae*
stitchbird	*Notiomystis cincta*
stoat	*Mustela erminea*
tānekaha	*Phyllocladus trichomanoides*
taro	*Colocasia esculenta*
tī (cabbage tree)	*Cordyline australis; Cordyline* spp.
tītī	*Puffinus griseus*
toetoe	*Cortaderia spp.*
tōtara	*Podocarpus totara*
tūī	*Prosthemadera novaeseelandiae*
tūtū	*Coriaria arborea*
wharariki	*Phormium cookianum*

Glossary of Māori words used in the text

NB: brief meanings only are provided here, and the reader should seek other sources for the full meaning of some of the complex ideas embodied in these terms.

apurangi	type of net
atua (ātua plural*)*	god or goddess
atua kaitiaki	spiritual guardians
hapū	sub-tribal group
harakeke māori	ordinary varieties
harakeke muka	harakeke selected for its fibre
harakeke whītau	harakeke selected for its fibre, *whītau* being a dialect word for the fibre
hāro	a method, and class, of harakeke which requires use of a shell to extract the fibre in the harakeke leaf
iwi	tribal group
kāinga	house (s)
kaitaka	fine garment lacking ornamentation on the body of the cloak, perhaps the most prestigious garment prior to the late 19th century
kaitiaki	guardian (s)
kaitiakitanga	system of guardianship of resources
karakia	prayer
karanga	ritual calling by women when a group enters the marae
kaumātua	elders
kaupapa Māori	project, research, or research method which incorporates Māori perspectives and values

kawa	processes and practices by which *tikanga* is applied
kawe	burden carrier, made from plaited harakeke
kete	basket
kete pīpī	baskets made for collecting shellfish
kete kai	food baskets
kete rauroha	receptacle or basket for stars
kono	food baskets
kōrari	flowerstalk of harakeke and wharariki; in Northland, the harakeke plant
kōrero	speak, discuss; speech, discussion
korowai	type of fine garment, with thrums on the body of the cloak
kuia	respected female elder
mana	prestige
manaakitanga	hospitality
manuhiri	visitor (s)
māra	cultivated gardens
marae	traditional gathering place for a hapū or iwi
matarau	type of net
mātua	the two leaves that enclose the central shoot of a harakeke fan
mauri	spiritual essence
muka	fibre extracted from the leaf of *Phormium*
noa	profane; removes tapu
pā	village or settlement
pā harakeke	harakeke cultivations
pā kōrari	harakeke cultivation (northern usage)
pā muka	harakeke cultivation
pā tī	grove or cultivation of tī trees

Pākehā	New Zealanders of European descent
parawai	type of fine garment
pepeha	sayings
piupiu	item of clothing made from harakeke
poiawhiowhio	Musical instrument made from a gourd
pou rāhui	post or other sign to warn of a rāhui
pū harakeke	generally considered to be a harakeke plant, although it also refers to a cultivation in northern usage
puku	belly or stomach
pūrakau	myths
pūreke	rough cloak made of undressed harakeke
rāhui	restricted access to resource
raranga	weaving; sometimes referred to as plaiting. This technique is used to make floor mats and baskets.
ritenga	processes and practices by which *tikanga* is applied
rito	the central shoot of a harakeke fan
tangata whenua	in the context of the marae, the local people
tangi	mourning ceremony
tāniko	decorative border on cloaks, made using a whatu technique
taniwha	supernatural guardian or protector
taonga	treasured possession
tapu	sacred, set apart
te hunga tiaki	kaitiaki, or guardians
teina	younger sibling or relation
tīhore	a class of harakeke where the fibre can be stripped out with the nails of the hand

tikanga	what is correct, right and usual
tōhunga	expert
tuakana	older sibling or relation
tupuna (pl. *tūpuna*)	ancestor
waere (a)	clear away
waiata	song
whaikōrero	formal speaking
whakaheke	type of net
whakapapa	genealogy
whakapara	method of growing plants where scrub is cut down and burned off to aid growth and timing of crops
whakataukī	ancestral saying
whānau	family, extended family
whanaungatanga	connecting through family relationships
whararahi	alternate name for *Phormium cookianum*
whare pora	sacred house of weaving knowledge; weavers reach a level of attainment and understanding rather than entering a physical structure
whare pūrakau	house of learning
whare wānanga	house of learning
whāriki	floor mat
whatu	process of weaving used for clothing and *tāniko*, sometimes called twining as it uses the fingers

Appendix 1

Traditional ecological knowledge: perspectives on a Māori world view

Essential elements of a Māori world view

There has been an increasing number of publications by both Māori and Pākehā writers in the last 20 years that discuss or present philosophical aspects of a traditional Māori world view (see, for example, Orbell, 1985, Puketapu-Hetet, 1989, Barlow, 1991; Marsden & Henare, 1992; Hodges, 1994; Patterson, 1992; Kawharu, 1998; Prime, 1999). Most, if not all, contemporary scholars of Māori have agreed that a traditional Māori world view is, in accordance with the literature on traditional ecological knowledge, holistic, and this "rests on notions of connectedness and interdependence, on the personal and collective, and on the relationship between people and the environment both physical and spiritual" (Cunningham, 1998). Only a brief introduction to some important aspects of a Māori world view is provided here. Readers are encouraged to seek further sources for a fuller understanding.

Whakapapa

Whakapapa is often translated as genealogy. According to a traditional Māori world view, everything in the universe (animate and inanimate), including, for example, plants, birds, rocks, or people, is connected by *whakapapa*. Tau (2001b) has described how, in such a view, all things (from the emotions to flora and fauna) are conceived of as part of an organic system of relationships that can be traced back to Rangi and Papa. Knowledge of *whakapapa* reinforces the spiritual relationship between the *ātua* (gods) and all other forms. Although *whakapapa* is often thought of as a lineal descent, it also encompasses relationships between different branches of a large family. Tāne Mahuta, the *atua* of the forest, had many children (such as the trees and birds) from a number of different wives: *whakapapa* illustrates the links between the siblings (Tioke, 1990). Humans are an integral part of this natural order: Ngāi Tahu writers, for example, believe that

whakapapa binds Ngāi Tahu and other tribes to the mountains, forests and waters, and the life supported by them (Tau et al., 1990). This is echoed by *kaumātua* such as Te Wharehuia Milroy, who called the environment "our extended whānau" (Yates-Smith, 1998 p.289). Furthermore, Tau (2001a) has noted that because the ancestors, through ritual, become part of the landscape, the past remains in front of Māori so that Papatūānuku, for example, lies before us, rather than being part of the distant past.

Whakapapa is vital to Māori sustainable management in the human sphere: genealogical relationships determine not only access to resources and the philosophies relating to their use, but also the responsibilities people have to others (Tau et al., 1990). This is referred to by Roberts et al. (1995) as "reciprocal utilitarianism". This emphasises the social obligations of parents, siblings and other members of the extended family to each other. Kawharu (1998, p.7) has expressed the view that since Māori society is still tribal, the actual management of resources is itself part of the kinship system.

Whakapapa is sometimes now seen in literal terms, sometimes in metaphoric terms in the following way:

> The framework . . . was an arrangement of beliefs underpinned by a paradigm of genealogy. These beliefs were held together by whakapapa, which functioned to maintain the solidarity of the kin group rather than the pursuit of certain and true knowledge (Tau, 2001a).

For Tau, what is important is that "the creation chant and lullabies show how a people attempted to explain", an explanation that came from "the observation of their immediate experiences" (Tau, 2001a). According to this perspective, what is most significant about *whakapapa* is its retention of communal solidarity, kinship and identity.

In discussing *whakapapa*, Royal (1998) has focused on purpose, seeing *whakapapa* as an organic process that can also be seen as a research methodology. Royal has argued that *whakapapa* is a traditional analytical tool used to generate

understanding of, and explanations for, many things in the world of phenomena, including their origins, nature, connections and relationships, descriptions and locations. It is also, according to Royal, a means of extrapolation from existing phenomena in such a way as to predict future phenomena. According to Royal, the central idea of *whakapapa* is that two phenomena come together to give birth to a third phenomenon, so that all phenomena arise from some kind of parental interaction. Thus, *whakapapa* enables people to posit theories about why phenomena occur and have occurred. *Whakapapa* is therefore conceived as being concerned with growth rather than deconstruction. Similarly, Marsden & Henare (1992, pp.13-14) have discussed *whakapapa* in terms of both symbolic and practical functions, describing it as a tool for transmitting knowledge, one that helps delineate the order of processes and the order in which activities should be conducted (p.10).

Importantly, *whakapapa* can be seen as a taxonomic system that describes the relationships of different parts of the environment to one another (Roberts et al., 1995; Haami & Roberts, 2002). It provides knowledge of a Māori world view in terms of relationships (relationships within and between species and relationships among phenomena of different kinds). Marsden & Henare (1992, p.11) give the example of Tāne and his wives, grouping the children from one wife together as the healing trees, and the children from another wife as the building trees, and so on. In doing so, they indicate that *whakapapa* acts as an ecological map that encapsulates important understandings of, for example, specific uses for different varieties of plants and animals, or their different qualities. It may also store detailed environmental knowledge at a micro-level that is important for resource users (see Haami & Roberts (2002) for examples). Understanding the biology of the plants and animals, understanding their relationships with others (including pests), and understanding species groupings in particular habitats all inform the appropriate use and management of plants and animals.

Mauri

Mauri has been described by Marsden & Henare (1992, p.9) as a force that is inherent in all things, that binds and knits them together. As the various elements diversify, *mauri* acts as the bonding element, creating unity in diversity.

Similarly, Kawharu (1998, p.20) has identified *mauri* as "an integral part of all resources and natural phenomena". An understanding of *mauri*, often translated simply as 'essence' or 'life force' (Marsden, 1977 p.147), therefore involves an appreciation of the connections between the natural world and humans. Thus, it is said that when the *mauri* is strong, plants and animals will flourish. The use of *mauri* stones to ensure the health of natural resources is described in Marsden & Henare (1992, p.23) and Kawharu (1998, p.21). Because the resources of the lands, forests, lakes, rivers and sea are seen to emanate from the gods, they are seen as having spiritual as well as physical aspects. Many authors, such as Matunga (1995) and Kawharu (1998, p.15), have said that spiritual and physical realities cannot be considered as separate. Thus, desecration of resources is seen as involving more than destruction in a physical sense. It is also an insult to the spiritual powers that created them (Kawharu, 1998 p.18). This concept of *mauri* extends to everything in the environment that is linked by *whakapapa*.

Writers in the 19th and early 20th centuries, such as Best, also discussed *mauri* (Best, 1942 pp.7-12). He included in his writings, for example, a *karakia* for the *mauri* of the forest "to protect and retain the fertility of the forest, and of all denizens of the forest" as well as explanations from his informants about the use of *mauri* stones. It is unlikely, however, that he fully understood the processes described by his informants. Thus, for example, he referred to *mauri* stones as "a material symbol of that quality [*mauri*]", before noting that "[they] acted really as a shrine or abiding place for the spirit-gods." In spite of the somewhat confused explanations, what is clear is the importance of *mauri* as a concept, and the fact that *mauri* stones played a significant role in the protection and abundance of resources. Thus, Makereti (1938, p.259) noted that "a mauri was always placed in the forest, and this was sometimes a stone placed in the ground. This was supposed to hold the mana of the gods who had charge over all the forest."

Makereti's view of the connection between the *mauri* of the forest and the abundance of flora and fauna reflects a traditional world view. She wrote that:

> If a scarcity of birds in the forest, it was thought that there was something wrong with the mauri, probably because someone had done wrong. A

Tohunga would karakia over it, appealing to the gods to bestow its protection on it again, when it would have its mana restored. The mauri is supposed to have the mana to attract birds to that part of the forest where it is (Makereti 1938, p.269).

Kaitiakitanga

Kaitiakitanga is another central concept identified and discussed in depth by modern writers such as Marsden & Henare (1992), Roberts et al. (1995) and Kawharu (1998). Kawharu (1998, p.266) has noted that two fundamental elements of kaitiakitanga are:

> the protection and enhancement of a spiritual life force (mauri), and the reciprocal ethic between human beings, the natural environment and the atua. Kaitiakitanga is guided by spiritual beliefs emanating from a body of values known as tikanga (lore) and practical experimentation carried out over generations.

Matunga (1995, p.30) has described *kaitiaki* as responsible for protecting the source of the *mauri*; they are the chosen representatives of the *ātua*. He observed that *kaitiaki* take many different forms, such as fantails (*Rhipidura fuliginosa placabilis*), eels (*Anguilla* spp.), and certain plants as well as people. Marsden & Henare (1992, p.18) called the 'ancient ones', the spiritual sons and daughters of Rangi and Papa, the *kaitiaki*, so that, for example, Tāne is guardian of the forest.

Kaitiakitanga is based on *whakapapa*, and 'resources' and 'management' are also key elements (Kawharu, 1998 p.12). The leader of an iwi was, and is, a traditional *kaitiaki* (Firth, 1959 p.108). In this context, therefore, the Māori Kings are *kaitiaki*. Kirkwood (1999, p.88), in a biography of King Koroki writes:

> Koroki embraced the physical and spiritual essence within the environment that surrounded him and that nurtured him and his people. He understood his ancient obligations as kaitiaki and took an active interest in the well-being of the whenua within Waikato. Waikato lived

> with the land and nurtured what was theirs. They were conscious of their responsibilities.

All *kaitiaki* are therefore concerned with spiritual and physical management (Kawharu, 1998 p.12). In specific terms, each whānau or hapū is *kaitiaki* for their ancestral land and seas. Should they fail to carry out their *kaitiakitanga* duties adequately, not only will *mana* be removed, but harm will come to members of the whānau or hapū (see, for example, Hodges, 1994; Kawharu, 1998). Thus, "Koroki and his people took seriously ritual handed down by our tupuna. This ritual ensured their physical and spiritual sustenance and safety. Such activity as rāhui laid over depleted areas of kaimoana or the fisheries or bush retained the relationship with te mauri and ātua of land, water and air" (Kirkwood, 1999 p.88). It should be noted that *kaitiakitanga* and *rangatiratanga* are intimately linked (Marsden & Henare, 1992 pp.23-24; Kawharu, 1998).

Reciprocity is a fundamental element in the exercise of *kaitiakitanga*, and links back to the relationship between *whakapapa* and *kaitiakitanga*. A *kaitiaki*, in protecting a resource in terms of its sustainability, is 'repaying' that resource for what it provides. By undertaking careful administration of a resource, a livelihood would be ensured (Kawharu, 1998 p.14). According to Kawharu (1998 p.10), reciprocity plays an essential role in maintaining relations between humans, the ancestors, the spirit world and the natural environment. A great many concepts are linked into the notion of *kaitiakitanga*:

> Kaitiakitanga . . . contains a corpus of primary beliefs that is moulded with and by each generation for it has an important role in maintaining the social fabric of a kin group. . . . Included within the corpus of beliefs are concepts concerning authority and title over land (rangatiratanga, mana whenua), spiritual beliefs pertaining to sacredness, prohibition, energy and life-force (tapu, rāhui, hihiri and mauri) and social protocols associated with respect, reciprocity and obligation (manaaki, tuku and utu). Such facets of kaitiakitanga direct and set precedent for behaviour and action.

Kape (1998) also discussed *kaitiakitanga* in terms of conservation:

> The importance of the traditional relationship of Māori to the natural world has both human and spiritual elements that generate a sense of duty to nurture the mauri of all things in the natural world and the human communities who depend on it. Therefore, Māori have developed an ethic of conserving resources to ensure their availability for present and future generations.

Concepts such as *kaitiakitanga* are frequently referred to in oral tradition. Many *taniwha* are said to act as *kaitiaki* in different tribal areas, such as those which are said to reside in Kāwhia Harbour, or at the Ngāwhā hot springs (Kawharu, 1998 p.12).

Traditional rituals evoke the spiritual values of *kaitiakitanga* and resource use. *Karakia* (incantation to the gods) is one example of such a ritual. Another is the use of music, and instruments such as the *poiawiowhio*, which is made from the hue (gourd) and was used in rituals involved in opening the fowling season. Māori may consider song as a pathway linking the spiritual and physical realms. The sound of the *poiawhiowhio* can resemble the cooing of the kereru (*Hemiphaga novaeseelandiae*) or other birds (Melbourne, 1993).

Tikanga and *ritenga* therefore embody the values inherent in *kaitiakitanga.* As Hodges (1994, p.4) observed "[The] application of tikanga Māori, through ritenga and kawa is made for the express purpose of preserving the Mauri of all representative species". He also made explicit the link between *mauri* and *kaitiakitanga*, emphasising the fact that the responsibility for preservation of *mauri* (and therefore the conservation of valued resources) is that of the appropriate *kaitiaki.* According to Hodges, the first duty of the *kaitiaki* is to the *taonga.* After that comes responsibility to current and future resource users.

The principle of reciprocity, a principle by which balance is achieved and maintained, underlies and governs every aspect of *tikanga.* Matunga (1995, p.30) noted that "because in everyday life use was made of the environment, there was constant risk of limiting or affecting the mauri. To guard against this a set of rules

governing conduct and behaviour consistent with . . . spiritual tribal (ancestral) beliefs had to be followed". *Tapu* and *rāhui* are the two management principles that recur overwhelmingly in writings about Māori use of natural resources (see, for example, Dacker, 1990; Marsden & Henare, 1992 p.21; Hodges, 1994; Kape, 1998; Kawharu, 1998).

Tapu and Rāhui

Tapu is defined by Marsden (1977, p.148) as "the sacred state or condition in which a person, place or thing is set aside by dedication to the gods and thereby removed from profane use. This tapu is secured by the sanction of the gods and reinforced by endowment with mana." Matunga (1995) similarly introduced the idea of being in the presence of one's *atua* with the effect that a person or object was set aside for restricted use by that *atua*. In a resource management context, the condition of *tapu* is central to restrictions on resource use. Some activities might be prohibited, others tempered by restriction. Examples of this might be a direction not to leave the feathers of snared birds in the forest (as other birds sense danger and leave the area) or the placing of limits on who might enter the forest during the bird-hunting season. Kawharu (1998, p.20) described *tapu* in relation to resource use as "a custom that has primacy in all aspects of socio-economic life by conditioning human relationships with each other and with the environment. It shapes the relevance of *kaitiakitanga* and affirms the importance of applying proper practices."

Beattie (1939, pp.73-74) described some instances of tapu as relayed to him by Teone Taare Tikao, such as the restriction on taking cooked food into some forests while hunting. All of the ethnographers reported in this study devote space to spiritual concepts relating to resource management. The fact that they do in spite of a general belief that such beliefs were superstitious or primitive, emphasises the importance Māori informants placed on these values and beliefs and the central role they played in the management of resources.

Tapu is intrinsically connected to other concepts such as *mana*, or *noa*, concepts which are discussed in detail by, for example, Marsden (1977) and Barlow (1991). Teone Tikao has stressed that concepts such as *mana* and *tapu* have a relationship

with resource use and management (Beattie, 1939 pp.73-74 and 95-97). *Tapu* can be temporary, permanent or seasonal. Specific forms of a temporary state of *tapu* are known as *rāhui*, restricting access to an area or resource. *Rāhui* was defined by Kawharu (1998, p.20) as follows:

> A ritual prohibition, where something becomes tapu or set apart from normal use. It was implemented over an area by a specialist performing an incantation (karakia) asking the presiding spiritual powers to intervene, render it tapu, offer protection and help the resource area to return to normal health. Specifically, the karakia addressed the life principle (mauri) of the resource.

Marsden & Henare (1992, p.21) have referred to *rāhui* simply as a "prohibition or ban instituted to protect resources". In describing the close relationship between tapu and *rāhui*, they noted that the *rāhui* designated the boundaries within which the *tapu* as a ban was imposed (Marsden & Henare, 1992 p.22). A *pou rāhui*, which was generally a post or some other physical sign, warned people of the *rāhui* (Tau et al., 1990). Tau et al. (1990) have emphasised the fact that a *rāhui* signals the active management of a resource.

Mead (1984, pp.126-9), closely following Best (1898b), has identified two main types of *rāhui*: "pollution" *rāhui* (those instigated because of *aituā* or misfortune resulting in death), and "conservation" *rāhui*, used to ensure the sustainability of resources for human use. He noted that they are closely linked (Mead, 1984 p.126). Marsden & Henare (1992, p.21) have, however, cautioned that they should not be confused. Mead (1984, p.129) also identified a third kind of *rāhui*, the "no-trespass" *rāhui* (or *aukati*) which can be regarded as a conservation *rāhui* in some circumstances, although it was frequently used in a political context (Mead, 1984 p.130). Mead noted that conservation *rāhui* seem to have been associated not only with the control of resources for the good of the whole community, but also with the political use of resources. In every case, however, the purpose was to protect the resources from the people and allow them to grow without disturbance (Mead, 1984 p.136). Marsden & Henare (1992, p.21) noted that *rāhui* allowed Māori to develop a form of rotation farming by opening and

closing resource areas for use, hence allowing resources to regenerate and ensuring a constant and steady supply. Over-exploitation of a resource could therefore be avoided.

There are numerous examples of *rāhui* involving resource use. For example, a tree might be preserved for a certain purpose by means of a *rāhui*, or it might be kept for the use of a particular family. Depletion of resources was clearly a serious concern. Thus, for example, the name Rāhui-pōkeka commemorates a well-known *rāhui* placed on the resources of two lakes near Huntly because of over-fishing by local people. Kawharu (1998, p.21) has also noted that *rāhui* may be activated where a particular resource was set aside for a particular purpose: harakeke, pīngao or other weaving resources may have been designated for making a special item such as a cloak.

Further evidence for the importance of *rāhui* in relation to resources can be found in the ethnographic writings of authors such as Elsdon Best and Herries Beattie. For example, Best (1898b) described a conservation *rāhui* as being "for the purpose of protecting the forest products, *i.e.*, berries, birds, &c., or fish, as also sometimes cultivated crops, or fern root, or flax, or places where ochre was obtained." He also referred to the use of *pou rāhui*, noting that even the clothing of a chief might be used as such a sign (Best 1898b). Another example of *rāhui* is that of a grove of tūtū (*Coriaria arborea*) at Ruātoki which was protected by a *rāhui* lest the berries were taken by those not entitled to do so (Best, 1898b). Best (1942, p.132) noted that a *rāhui* was most effective and beneficial when applied to the protection of bird-life during the breeding season.

As might be expected with such an important issue as the wellbeing of resources, there were consequences for breaking *rāhui* or *tapu* (see, for example, Best, 1898b; Mead, 1984 p.134; Dacker, 1990; Hodges, 1994; Kawharu, 1998). Roberts et al. (1995) have noted that:

> Compliance with these rules, based on respect and reciprocity, were enforced primarily by fear of divine retribution, or failing that, by human acts of muru (confiscation of resources). Kaitiaki acting directly or

indirectly through the medium of tohungas or animal guardians were an essential "controlling" component of this complex network of checks and balances whereby relationships within the environmental family were maintained.

Conclusion

A number of related concepts are central to the understanding of a traditional Māori world view. Kevin Prime (1999) of Ngāti Hine has neatly summarised his understanding of a Māori world view as follows:

> If I was asked to give a five word summary of a generic Maori conservation ethic I would say 'respect nature and waste not'. In fact I would go so far as to say that it is not just a Maori conservation ethic but a sensible approach to conservation. In the Maori order of creation, mankind came after trees and sea life. Therefore Maori (mankind) have an obligation to care for their tuakana (elder brothers), i.e. the land and land life, the water and water life, and the sea and sea life . . . The basic Maori philosophy regarding conservation originated from a spiritual respect for Papatuanuku (Mother earth) [and] ... Tane (the God of Forests and Birds). The practical application of this hypothesis was, *no wastage, no hunting for pleasure, no littering, no desecration of tapu, no desecration of waterways, and no over-exploitation of the resources.*

Modern sources which articulate a traditional Māori world view overwhelmingly support sustainable use of environmental resources as a guiding principle. Practical aspects of *kaitiakitanga* have been developed over generations as a result of the consolidation of accumulated experience in the husbandry and use of resources (Kawharu, 1998 p.24). However, during the early years of settlement in New Zealand, *kaitiakitanga* techniques typically reflected management techniques of the Pacific Island homelands (McGlone et al., 1994). Based on analyses of possible extinction rates, apparent exploitation of resources and other indicators of resource use, it has been suggested that the extinction of a number of species as well as large scale environmental changes were caused by Māori practices (see, for example, McGlone, 1989). Kawharu (1998, p.25) has argued that

"kaitiakitanga became a more ordered system of resource management as a result of generations of trial and error, particularly at times of crisis or resource depletion." Because traditional ecological knowledge is characteristically cumulative and experiential, many generations of experimentation may be required to find an appropriate balance.

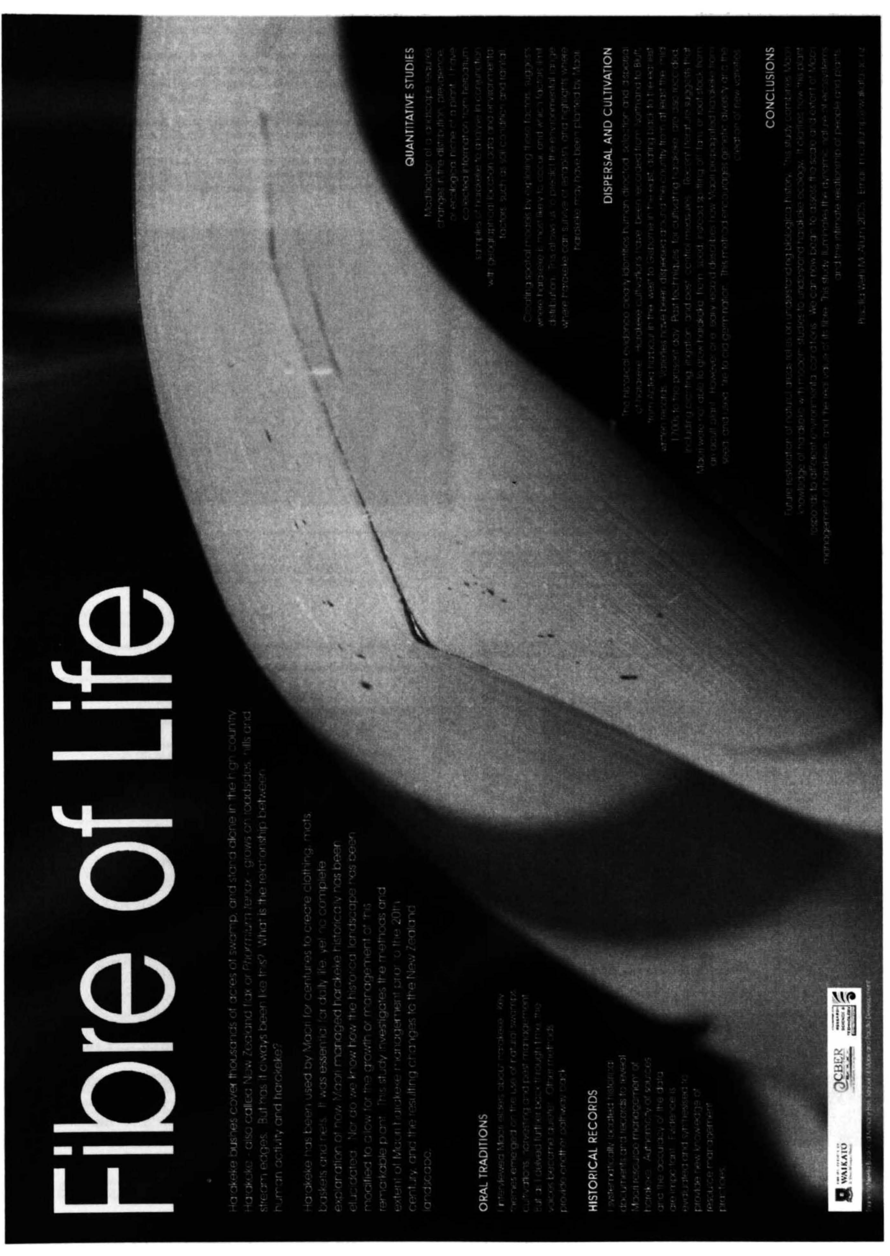
Resource use practices by Māori today may not always reflect a traditional view. Even so, as Bubbles Mihinui (2002, p.33), a respected kuia and weaver from Te Arawa, has observed:

> Management and trusteeship are key principles for Maori communities. Hunga tiaki or managers in applying guardianship are not concerned with simply conservation. . . . Customary management is about resource use, development, protection, conservation and finding a balance between all those things. And fundamental to all of that is the idea of respect and commitment. These are the most important facets of management.

Appendix 2

Communicating with posters

Posters produced to communicate ideas associated with this research project to a lay audience.



'Fibre of Life'. Produced 2005.

Hutia te rito o te harakeke

Understanding harakeke ecology and Mâori historical management

Priscilla McAllum Wehi
School of Mâori and Pacific Development and Department of Biological Sciences, University of Waikato, Private Bag, Hamilton.
Email: mcallump@waikato.ac.nz

The history of harakeke (*Phormium tenax*), or flax, has been entwined with human history since our arrival in New Zealand. It has special value to Mâori weavers, and around 60 varieties have been known to Mâori. Prior to European colonisation, harakeke was essential for survival. It was used to make nets, baskets, mats and clothing.

These days, harakeke is everywhere. But has it always had such a widespread distribution? Was it actively managed by Mâori, and if so, how? My hypotheses investigate these questions, and how the New Zealand landscape has changed.

Scientists generally rely on quantitative data to interpret past biological processes. But multidisciplinary approaches can combine indigenous knowledge and modern ecological methods to provide a deeper understanding of, and context for, past ecological processes. In this research, ancestral sayings, interviews with Mâori elders, historical records, herbarium data and pollen records are being investigated as sources of information.

Te Ahi Wera: Harakeke and fire

Two of these whakatauki refer to the use of fire. So how was fire used in relation to harakeke? Historical records provide one answer. A description of Mâori harakeke planting from 1836 relates:

> *After preparing the ground and sowing the seed, if they do not quickly see the plants appear, they spread a quantity of brushwood over the land and set fire to it. This being done, the plants soon make their appearance, and a crop is ensured.*

Contemporary Mâori weavers use root division to propagate desirable varieties in pâ harakeke. Why would Mâori grow harakeke from seed when it is much easier to propagate harakeke vegetatively by splitting off fans from a mature plant? These contradictions encourage new hypotheses: it could be that Mâori grew harakeke from seed to increase genetic variability and develop new cultivars for use. Or perhaps it was vital to increase the amount of harakeke in districts where it was poorly distributed. The next step is to analyse harakeke pollen data to model ecological succession and reconstruct past distributions of harakeke after fire.

Te Ara Whanaunga: Human Dispersal

Another way of investigating human modification of the landscape is through reconstruction of past dispersal of harakeke by people.

It is clear that highly valued varieties have moved around the North Island through 'channels of friendship'. For example, one variety moved from Waikato to the Urewera, where harakeke was not naturally distributed. Other desirable varieties moved from Kawhia to the Manawatu - an area known for its harakeke abundance in the 19th century! The evidence tells us that Waikato was well known in previous times for the quality of its harakeke. Today, it has only a few remaining harakeke swamps. What has the ecological succession and past harakeke distribution been in this area? The research continues. . .

What does the study tell us?

This research identifies resource management techniques that have been lost from current knowledge, such as the use of fire to propagate harakeke. It demonstrates how human activity has changed the landscape, and will also help us identify how past distributions of harakeke might have interacted with Mâori weaving needs.

This research will show how Indigenous knowledge can give context and meaning to quantitative data such as pollen records. Together with modern ecological data, indigenous knowledge can illuminate past processes of modification to natural areas so we better understand the relationship between people and plants. Recovery and support of traditional knowledge helps strengthen the contemporary relationship between communities and plants, and adds another strand to informed restoration of natural areas.

He puawaitanga no te harakeke
he rito whakaii i ngâ whâruarua.

Table 1. A selection of *whakatauk* which refer to harakeke.

E kore au e ngaro, e kore au e ngaro, he harakeke tongai nui no roto no Mangamuka
I shall not perish for I am like the dried flax plants of Mangamuka. The species survivies through periods of drought.

He puawaitanga nô te harakeke he rito whakaki i ngâ whâruarua.
The flax flowers: new shoots fill the empty gaps.

Ka nui te harakeke, ka ua te ua. e haere ana, ka kiia, ka mate koe I te ua, ka rukuruku Hunâ, ka horahora Pāpakanui.
When the flax plants are plentiful, it is a sign of much rain. The adage warns that signs should be considered and appropriate clothing worn.

Me te wera harakeke, me te ahi tôtara
Like a flax fire and burning totara. The loud cracking noise which accompanies these events was said to resemble the gunfire of Ngapuhi at Toka-a-kuku.

Tūngia te ururua, kia tupu whakaritorito te tupu o te harakeke.
Burn off the overgrowth so that the flax shoots may sprout.

Hutia te rito o te harakeke. Kei hea te komako e ko?
If you pull out the central shoot of the harakeke where will the bellbird sing?
The first two lines of a well known proverb. It also refers to the appropriate thinning of the bush to allow new shoots room to grow.

He Korari, He Korero: The Oral Tradition

Whakatauki, or Mâori ancestral sayings, hold ecological information about harakeke management and ecology which can be called indigenous knowledge. As one example, the relationship between harakeke and kômako, or bellbirds, is identified in the proverb *Hutia te rito o te harakeke.*

Most of these whakatauki date to at least the mid 19th century. Some of these refer to environmental tolerances, and others to resource management practices (Table 1). Modern research has confirmed that harakeke is pollinated by bellbirds and tui, and are vital to the production of viable harakeke seed.

Nga Mihi

Thanks to Nan Awhitu, the Wehi whanau and Neville Black.

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'Hutia te rito o te harakeke'. Produced 2005.

Appendix 3

Māori classification of *Phormium* in 19th century New Zealand

Introduction

Current collaborative research by scientists and Māori weavers relies on understanding knowledge from both traditional and western scientific paradigms in relation to both *Phormium tenax* and *Phormium cookianum* (wharariki). However there are frequently problems of understanding and accessing Māori knowledge. It is generally accepted that varieties of *Phormium tenax* (harakeke) are classified by Māori according to the properties of their fibre (Cross, 1912 p.30; Hopa, 1971; Heenan, 1991 p.6). Despite this, the features of Māori classification have not been elucidated. Recent publications have referred to the confusion surrounding classification of varieties and the difficulty in identifying important cultivars (Orchiston, 1987; Heenan, 1991; Scheele & Walls, 1994). Scheele and Walls (1994), for example, noted that *awanga* in the National Flax Collection is different from that referred to in the Department of Agriculture Reports at the beginning of the 20th century. Heenan (1991, pp. 6-7) considered that these nomenclature problems include name priority, synonymy, and orthography. Unfortunately, accurate identification of traditional harakeke varieties remains elusive because of inconsistent and inadequate cultivar descriptions. Thus, for example, historical descriptions do not match those of some of the plants in the National Collection (Scheele & Walls, 1994).

McBreen et al. (2003) attempted a preliminary analysis of harakeke varieties from the National Collection using genetic techniques but only had limited success in determining variety relationships and provenance. In part, this was due to low levels of genetic variation in commonly studied DNA markers because of the recent nature of species radiation. They found that although some genetic groupings were consistent with morphology, some did not match the groupings expected from their fibre similarities. They were unable to

satisfactorily compare the relationship of genetic information and Māori classification (using fibre quality as a key classification tool).

I investigate whether 19th century representations of Māori classification of *Phormium* can be used to better understand traditional Māori classification of harakeke, and whether they are consistent with current understanding of Māori classification. Secondly, I consider errors and misunderstandings of terminology by these writers. I examine how careful reading of these sources, accompanied by re-analysis of Māori terminology can potentially solve at least some of the current problems of variety identification.

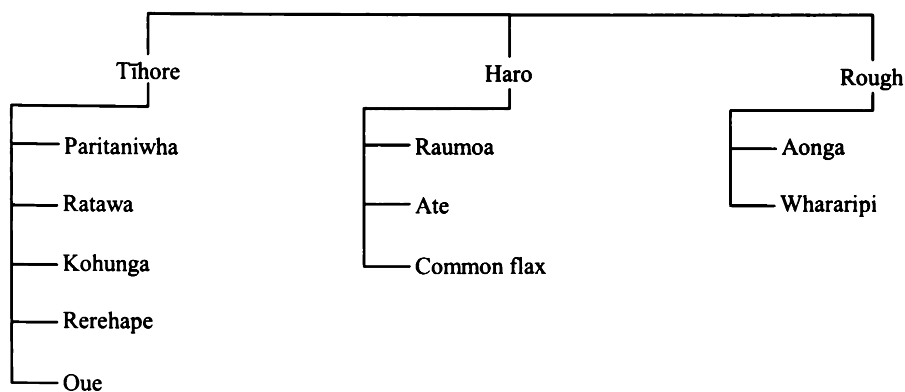
Species nomenclature

Descriptions of New Zealand 'flax' by Māori which are recorded in 19th and early 20th century records can be organised into hierarchies, or levels, of classification. Some attempts by 19th and early 20th century authors to classify 'flax' or harakeke have been summarised in *Figure A3.1*. Common English usage describes both *Phormium tenax* and *Phormium cookianum* as 'flax'. However, Māori separation of the two species into harakeke and wharariki is recorded in a range of districts, by a number of authors (Haultain in the RFC, 1872; Tregear, 1904; *Figure A3.1*). Botanist Thomas Kirk (1870) clearly identified Māori cultivations of wharariki as *Phormim cookianum* in the Waikato and Thames districts.

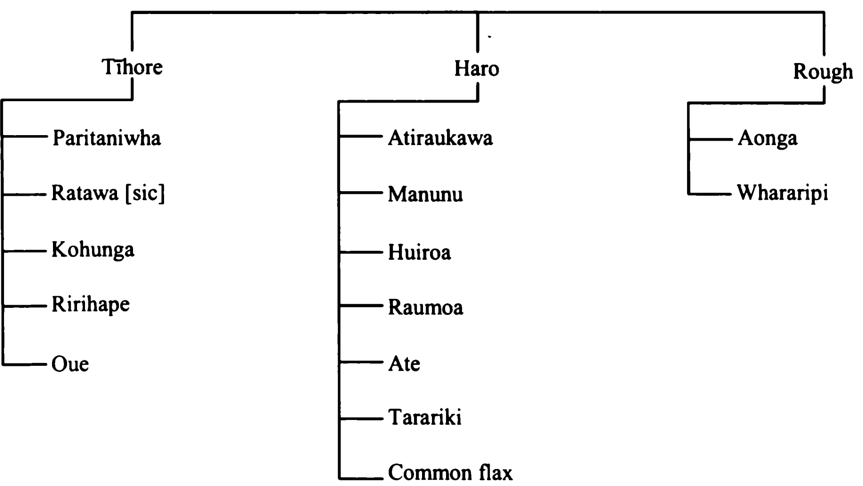
The identification of harakeke and wharariki is only the initial step in a Māori classification system of 'flax': further differentiation of harakeke occurs. Selwyn (1847) provided a description of Māori varieties which centred on traditional Māori garment manufacture (using the fibre inside each harakeke leaf). Thus, harakeke which is stripped for its fibre using the nails of the hand is referred to as *tīhore*, while that stripped with a *kūkū* shell (*Mytilus* spp.), is classified as *hāro*. This term recurs in 19th century records of harakeke (*Figure A3.1*) and is consistent with contemporary knowledge and practice based on the oral tradition.

Figure A3.1: **Classification systems of harakeke based on information provided by Māori informants to non-Māori researchers in the 19th century**

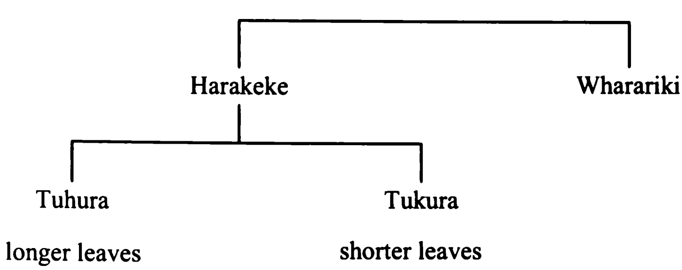
Selwyn (1847)



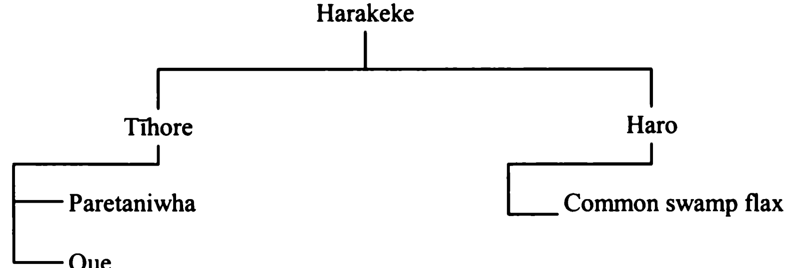
Kelly (1866) (arranged according to the Māori system of manufacturing)



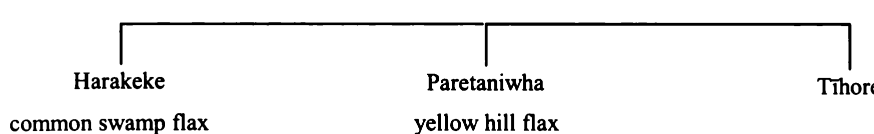
Haultain in Hector (RFC, 1872)



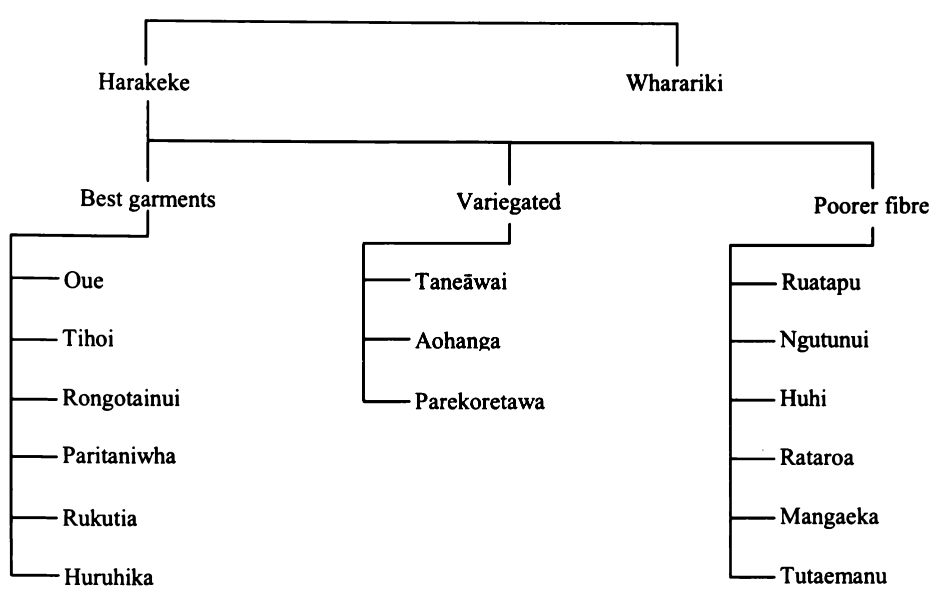
Hector (1889)



Hutton (in Hector, 1889): own classification



Tregear (1904): own classification



Beattie (1994a)

Harakeke Wharariki

Harakeke fibre classes: *Tīhore* and *hāro*

Harakeke fibre is defined as a key element of Māori classification (Hector, 1889 p.3; Williams n.d.). Early authors used both *tīhore* and *hāro* as classification categories, and strongly emphasised harakeke varieties valued for their fibre and hence garment manufacture (Selwyn, 1847; Moore, 1849; Kelly, 1866; Hector 1889). The Flax Commissioners also concluded that *tīhore* is a category rather than a specific variety, in part because of the conflicting descriptions of *tīhore* varieties provided by their sources. Other authoritative writers concurred, some providing examples of varieties which represented these types (Kelly, 1866; Haultain in the RFC, 1872; Williams, n.d.; *Figure A3.1*). Selwyn's and Kelly's classifications are therefore probably closest in form to traditional Māori classification of fibre varieties. However, this emphasis on fibre was not universal. Colenso (1881) claimed that Māori were generally able to differentiate more than 50 varieties by the hue of the leaves alone. Colenso appears to be one of the few Europeans to have made an assessment of variety

number based on longstanding knowledge of Māori culture. This strongly suggests that fine differentiation of leaf colour was another classification marker.

Colenso (1852) and Nairn (RFC, 1870) also recorded alternate terms to describe harakeke which could have been used as classification categories. Colenso (1852) reported *wharanui* (meaning broad leaved) as "common flax" and *wharariki* (narrow leaved) as two of four types he identified in correspondence to the botanist Sir Joseph Hooker, while also noting that *wharanui* was "commonly used for manufacture". Although it is not completely clear whether 'manufacture' indicates only fibre based industry by Māori, or all use by Māori (including plaiting), *wharanui* certainly appears to be more than a variety name. However, Williams (n.d.) added that *tīhore* was a type of *wharanui*, a distinction not made by Colenso. The use of '*whara*' is also recorded in the term *tatua whara*, a term for belts made of harakeke (Best, 1898a). Colenso's later comment that *Phormium* was well known to Māori "by the common names of harakeke, wharanui, wharariki, and tihore - excluding those of the many varieties, as known to them" further supports the use of *wharanui* as some kind of generic term (Colenso, 1891). There is therefore a clear identification of other, morphological, features as a Māori classification tool.

Nairn (RFC, 1870) recorded information about *Phormium* for the Flax Commissioners from Hawke's Bay. He noted four "kinds" of 'flax': *wharanui, wharariki, tāpoto* and *kauhangaroa*. *Tāpoto* will be discussed further below. *Kauhangaroa* does not appear to be a widespread term as it is only mentioned elsewhere by one unnamed Māori informant, from Hawke's Bay, in the 1871 Report of the Flax Commissioners. However, a variety named *kauhangaroa* in the National Flax Collection is variegated, so it is possible that this earlier reference to *kauhangaroa* similarly indicates either a variegated variety or class. Moreover, of the four terms for 'flax' listed by Colenso (1852), one was the variegated *awanga*, suggesting that both Colenso and Nairn appear to have considered variegated harakeke to be a separate category.

Three variegated harakeke varieties are clearly identified in the historical literature: *awanga* (Kelly, 1866; Tregear, 1904; Andersen, 1907 p.325; Best, 1942 p.101), *taneāwai* (Tregear, 1904; Best, 1908) and *parekoritawa* (Hector, 1889; Tregear, 1904; Stowell in Best, n.d., Smith, 1910; Best, 1911 p.146; Buck, 1911). Although some commentators claimed that variegated varieties were probably ornamental (Tregear (1904 p.222; Andersen 1907 p.325), there are enough reports of fibre usage from these harakeke to modify this statement (Buck, 1911 for *parekoritawa*; Best, n.d., p.351 for *awanga*). Nairn (RFC, 1870) also reported that *kauhangaroa* was used for baskets and mats. There are two possibilities, then: first, that Māori have separated variegated harakeke varieties into a classification category because of their appearance, or secondly, that they were included as 'rough' varieties in a classification based on manufacturing usage and fibre (Selwyn, 1847; Kelly, 1866). It is possible, of course, that both forms of categorisation were used, as they need not be mutually exclusive. Categorisation of variegated harakeke on the basis of ornamental appearance, however, again suggests that classification tools other than fibre were important.

Haultain (in Hector, 1889) is the only author who provides a division based on leaf length (*Figure A3.1*). Haultain recorded terminology for long and short leaved harakeke, providing the descriptors *tuhura* and *tukura* respectively. In contrast, Best (1942, p.101) reported *tukura* as a swamp growing type of harakeke, so it is unclear whether this is a descriptor or variety. Buck (n.d.), however, recorded that short leaved wharariki was called *tuparitupari* in the Whanganui River area. It is tempting to conclude that leaf length was also considered. Certainly, longer leaves are used for different purposes than short leaves, and this would have been the case for wharariki. Later attempts to record harakeke classification included other characteristics, but may not have been based on Māori thought. Hutton (in Hector, 1889) used plant height and location. Hutton considered that harakeke (or "common swamp flax") grew to 14 feet tall or more, while the yellow hill flax was between 4 - 6 feet tall. In his 1870 lecture he noted the Māori divisions *tīhore* and *hāro*, but clearly did not view these as a legitimate form of botanical classification (Hutton, 1870).

Tīhore and *tāpoto*

Comments by Williams (n.d.) draw attention to the confusion that still exists in terminology: he stated that *tāpoto*, *tīhore* and *tākirau* were all used as a name for the stronger fibred varieties which alone will stand stripping with the nails, and considered that one or other of these names is in common use in each tribe. Williams thus considers *tāpoto* to be a synonym for *tīhore* rather than a variety name. Moreover, Locke (RFC, 1870) also noted that on the East Coast *tāpoto* or *tākirikau* is sometimes called *tīhore* or *tākiri*, although it appears that he thought it was a variety. On the other hand, Hector apparently concurred with Heaphy's suggestion that *oue* and *tāpoto* were the same variety, thus indicating that *tāpoto* was a variety name (Hector, 1889 p.4). Haultain (RFC, 1870) considered that *tīhore*, *oue* and *tāpoto* were probably the same. The balance of evidence suggests that neither of these authors fully understood Māori terminology.

Williams' report clearly supports *tāpoto* as a classification rather than a variety name, as is the case in modern usage (see, for example, Scheele & Walls, 1994). *Tāpoto* was the last of the four types of *Phormium* described by Colenso (1852) in his memorandum to Hooker (the others being already mentioned elsewhere in this paper). His description of its morphology, as well as the ease of use, is similar to that given by Moore (1849) for *tīhore*. Moreover, *tāpoto* is not listed as a specific variety name by any of the 19th century authors whose work is examined in this research project. Analysis of the geographical origins of these sources allows further amplification (*Figure A3.2*). All sources which list *tāpoto* are based in the East Coast region, bar Opunake (two reports), while *tīhore* was clearly a common term throughout the West Coast.

Figure A3.2:* Geographical distribution of reports citing *tāpoto* and *tīhore

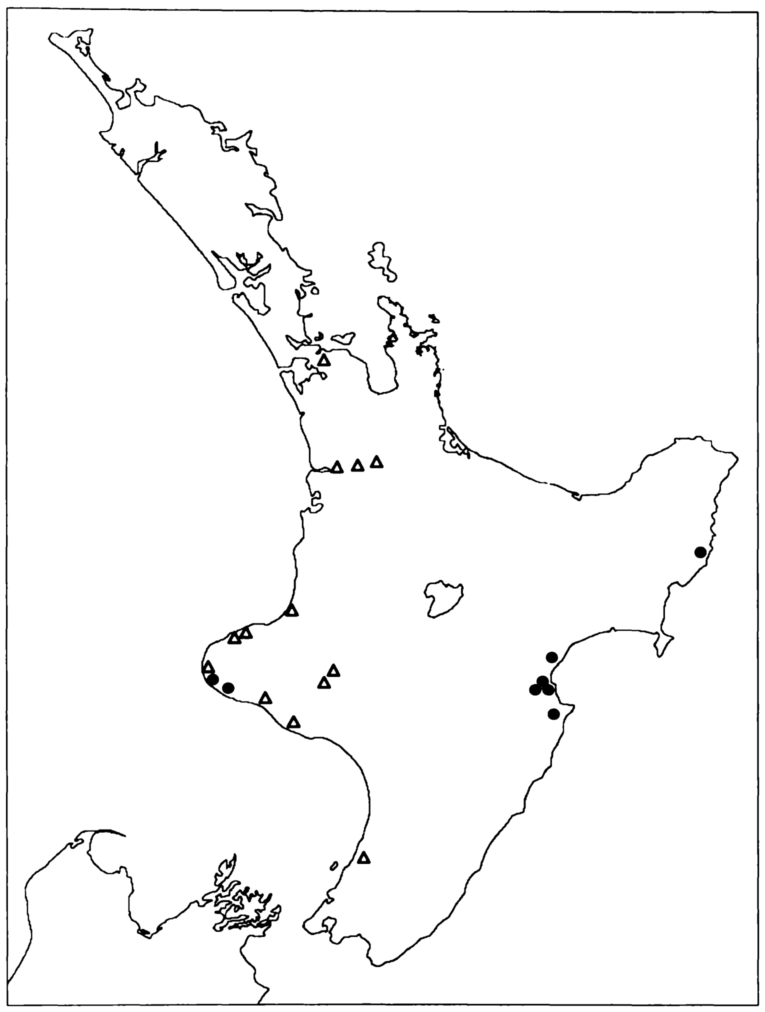
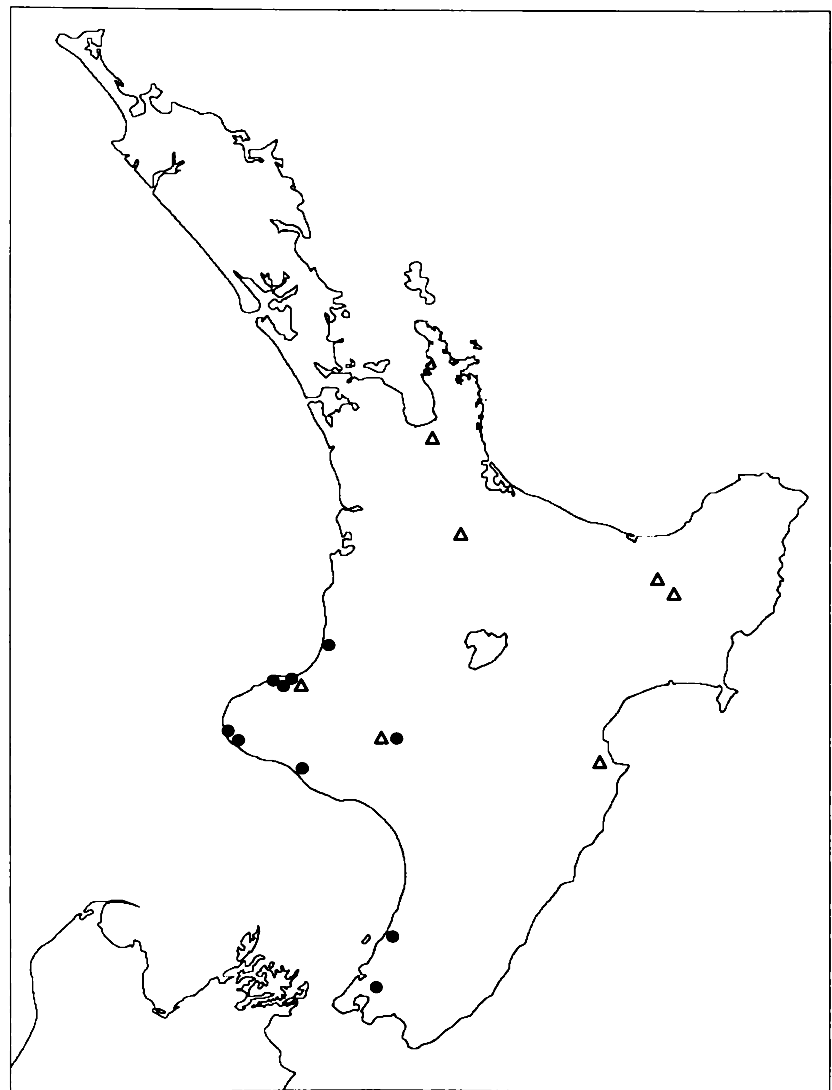


Figure A3.3: **Distribution of historical reports citing tarariki and wharariki**



Wharariki

The classification of wharariki signals another difficulty in understanding Māori classification and use of *Phormium*. Best (1942, p.101) and Buck (n.d.) both identified *tarariki* as a synonym for wharariki (cf. Kelly, 1866). Furthermore, Selwyn (1847) and Kelly (1866) both categorised wharariki as a subgroup of harakeke, whereas other writers classified it separately from harakeke. Moore's (1849) description agrees more closely with as a subgroup of *Phormium tenax* rather than as *Phormium cookianum*: he described it as one of the largest sorts of flax, attaining a great size, and growing by riverbanks or in swamps. Other

reports seem further at odds: Field (1869) recorded wharariki from the Whanganui River as a small variety with broad leaves "of the Tihore species". Kirk (1870) recorded Māori wharariki as *Phormium cookianum* in the upper central North Island. Mapping the records for *tarariki* and wharariki neatly separates these terms by region, with a strong bias towards use of wharariki in the West Coast area in the North Island, and *tarariki* in the East (*Figure A3.3*). Although mapping supports the proposition that these terms are synonyms, this confusion is impossible to resolve without further research; examination of historical specimens such as those provided by Colenso (1852) might illuminate the issue further. The lodging of cultivar specimens might be another method of partially clarifying the issue, at least with regard to regional differences in contemporary identification. However, there may be some regional concordance of historical information in the classification of wharariki. Selwyn's information on harakeke may have come from the East Coast, where Pendergrast has researched weaving over the last 40 years. Kelly, on the other hand, was based in Taranaki, which is in close proximity to the upper Whanganui River where Buck's (1911) report of wharariki as a weaving fibre came from.

Discussion

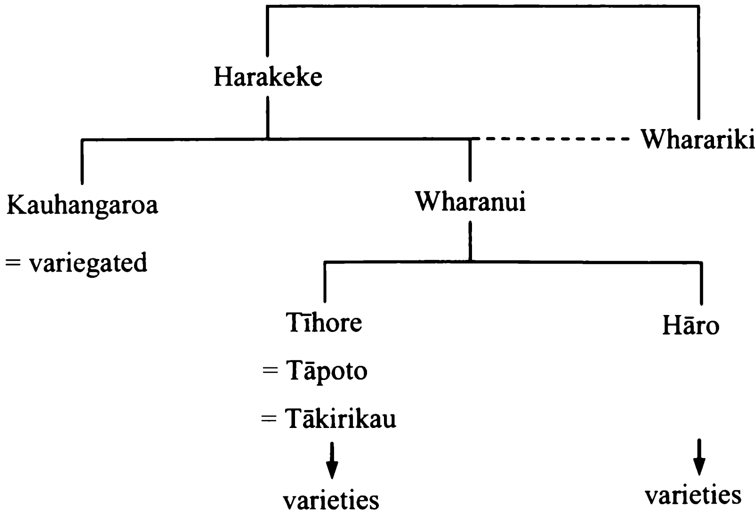
In these records, Māori classification is indeed closely associated with fibre use. The differentiation of harakeke into *tīhore* and *haro* varieties is an important one for weavers and forms the basis for harakeke fibre use by Māori. The Flax Commissioners (1870, p.9) concluded that *tīhore* must be a class name based on conflicting morphological descriptions given to it by different respondents, and other authors are in agreement. These terms also continue to be widely used today to describe the processes used by weavers to extract fibre from different varieties of harakeke.

The value of harakeke as a weaving fibre has been the driving factor in Māori classification of harakeke, and fibre quality appears to be the primary classification tool. It is equally clear, nonetheless, that Māori classifications of harakeke reported in the 19th century and early 20th century literature included other features and terms. Other morphological characteristics such as hue and leaf shape were almost certainly also involved. European preoccupation with fibre for

commercial industry in the 19th century has precluded adequate description and recognition of other classification markers. As yet traditional South Island knowledge of harakeke is unrecorded: further exploration of this area would be valuable. It is possible, for example, that South Island Māori may share terminology with the East Coast of the North Island because of their genealogical links, but it is also possible that harakeke classification evolved to suit different climatic and growing conditions in the south. Māori taxonomy is likely to be both more complete and more sophisticated than currently recognised.

One possible reconstruction of harakeke classification is presented in *Figure A3.4.* It is uncertain what Māori classifications were applied to harakeke used for plaiting, as although Māori used harakeke extensively to plait items such as *whāriki* and baskets, 19th century writers generally did not report evidence of this kind of harakeke. Despite this, wharariki and *kauhangaroa* are two possible terms for harakeke classes based on plaiting.

Figure A3.4: **Reconstruction of possible Māori classifications from representations in the 19th and early 20th century literature**



Examination of specimen nomenclature in the National Flax Collection, when compared with 19th century representations, confuses classification issues further. A number of what may be category names are in fact recorded as variety names in this collection. Thus, *tākirikau* and *tīhore* (as already noted by Scheele & Walls (1994)) appear as names for variety specimens, as do *wharanui*, *tukura*, and

tāpoto. This suggests either a misunderstanding of terminology between the weaver who gifted the variety and the collector, or that knowledge of the specific name had been lost and only the generic category name retained. Hence, a name transfer has occurred. Scheele & Walls (1994) have pointed out that *tukura* was noted by collector Rene Orchiston as a variety which was widely grown under many names, whereas some historical authors referred to 'swamp flax' or 'commoner flax' which might be *tukura* (see, for example, Hector, 1889). It has not been possible to uncover further terminology or classification of these types. This description seems to support the concept of transfer of a class nomenclature onto a variety. The confusion around terminology for 'swamp flax' and short leaved harakeke, however, highlights the issues of understanding and recording terminology accurately.

Scheele & Walls (1994) have pointed out that the *oue* specimen in the collection does not correspond to descriptions of *oue* in the historical records, but rather, that the variety currently listed as *tāpoto* does. This confusion can be solved if we consider *tāpoto* as a generic term which is equivalent to *tīhore*, as described by Williams (n.d.). Williams (n.d.) is a reliable source; he was fluent in Māori. Furthermore, his synonymous use of *tīhore* and *tākiri* is supported by a tribal account of the kidnapping of Tuki and Huru in 1793. When these Māori men were taken to Norfolk Island to pass on their knowledge of harakeke to the convicts there, the island harakeke was found not to be good for weaving. Salmond (1997 p.221) reported their response which clearly identifies *tīhore* as a synonym for *tākirikau*, whilst noting that the harakeke was not *tīhore* (with the result that the flax tow broke in short lengths). *Tīhore*, or *tākiri*, is thus used as a generic term for a particular kind of harakeke. Moreover, *tāpoto* is not clearly identified as a specific variety name by any of the 19th and early 20th century authors whose work was examined. More recent experts in Māori language have also clarified that *muka tāpoto* is "varieties of soft flax which can be used without scraping" (Mead & Grove, 2001 p. 296; *Table 3.3*).

It can be seen in *Figure A3.1* that *oue* was classified as a *tīhore* variety, and according to Williams' report could therefore be considered as a variety of the *tāpoto or tīhore* class (*Figure A3.2*). The use of *tāpoto* as a variety name may

therefore be a more recent or localised change. Rearranging the classification thus removes inconsistencies in descriptions, and makes sense of the observations of Scheele & Walls (1994). The specimen currently listed as *tāpoto* can then be considered as one of the *tāpoto* class, but of the *oue* variety, which is correct according to 19th century classification records. The ramification, however, is that the specimen currently listed as *oue* becomes nameless. It is of course also possible that *oue* is a class not a variety, as claimed by Haultain (RFC, 1870), which would then account for this nomenclature. Scheele & Walls (1994) have described the variety *tāpoto* in the National Flax Collection as a *tīhore* flax which is similar to *tākirikau*, but smaller, and often given the synonym *oue*.

It is impossible to fully resolve the identification of wharariki and harakeke from historical records. Wharariki is commonly distinguished as *Phormium cookianum*. This is often considered to have poor fibre by contemporary weavers, and hence is rarely used. Some authors have, however, indicated that wharariki was previously valued as a weaving fibre in areas such as the Whanganui River (Buck, 1911). As wharariki appears to have been particularly valued for plaiting, it may have been considered as a separate category for this reason. However, some contemporary weavers identify wharariki as a variant of *Phormium tenax* rather than *Phormium cookianum* (Puketapu-Hetet, 1989); *tarariki* is also listed as a separate variety from wharariki in the National Flax Collection. These differences are significant and may arise for several reasons. The differences in classifying wharariki by 19th century authors may reflect both the general categorisation of *Phormium cookianum* as wharariki (and hence its separation from *Phormium tenax* or harakeke), and its use as a weaving fibre by Māori and hence its inclusion as a subcategory of harakeke. Alternatively, it may be classified according to features which have not yet been recognised. From a botanical point of view, Cross (1912) and Wardle (1979) both describe the relationship between harakeke and wharariki as indistinct, with outcrossing leading to hybridisation. It appears at least some varieties are of mixed genetic stock (Cross, 1912; Wardle, 1979). This may account for some of the confusion surrounding what is called 'wharariki', and why it seems to vary between districts. In any case, it is clear that for many varieties their fibre and morphological features lie on a continuum. Moreover, the differences in height and location used

by Hutton (in Hector, 1889) to classify harakeke are probably morphological features determined by soil type or other environmental conditions: Harris et al. (2005) investigated harakeke growth in different environmental conditions and found marked resulting differences.

As Heenan (1991) and others have pointed out, the contemporary confusion about variety names is difficult to resolve. Despite this, clarification is important for future research on harakeke varieties, particularly if we seek to analyse the relationship of genetic data and other classification systems, whether Linnaean or traditional. It is clear that careful reading of 19th and early 20th century sources can suggest errors of current interpretation which partially or fully explain inconsistencies.

Cultural classification systems are tools which are as valid as other systems and illuminate different aspects of knowledge. Cross (1912) concluded that Māori classification of harakeke was much closer to a botanical classification than she had expected: almost all harakeke varieties in each category that she constructed according to botanical classification principles, also fell into the same fibre grade. Māori taxonomy is therefore likely to be both more complete and more sophisticated than currently recognised, taking into account features such as leaf length, width, hue and other variables. Moorfield (2001) has observed that "where there are important aspects of a culture in which fine distinctions are required, a language will develop to cope with these." Certainly fine differences in hue were noted in the use of more than 40 traditional names for stormclouds (Moorfield, 2001), so it could be argued that a similar system would almost certainly be applied to harakeke. Understanding traditional classifications increases our understanding of ecological information and reveals new information about the inherent relationship of humans and plants. Furthermore, because we classify information in different ways, critical information can be identified using multiple classification systems. Traditional classification systems, such as that for harakeke, remain valuable contemporary tools: use of multiple classification systems increases our ecological knowledge and understanding of human-plant relationships.

Appendix 4

Spatial representations of environmental parameters for *Phormium cookianum.* Dark areas represent exclusion zones for the environmental variable being represented.

Figure A4.1: **Rainfall**

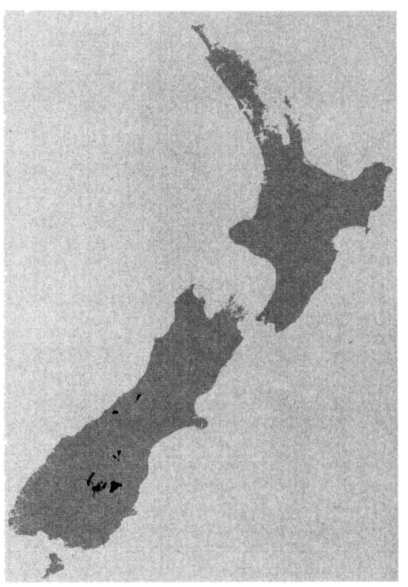


Figure A4.2: **Deficit**

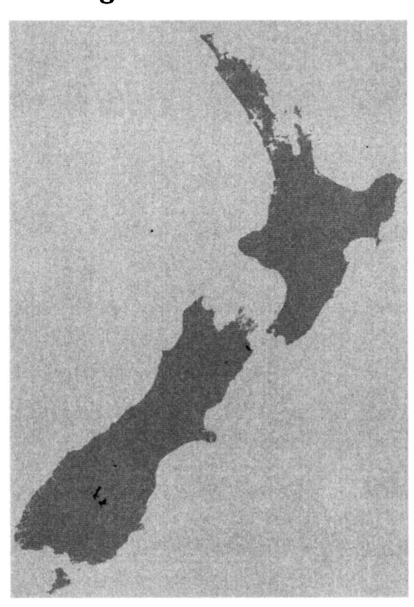


Figure A4.3: **R2PET**

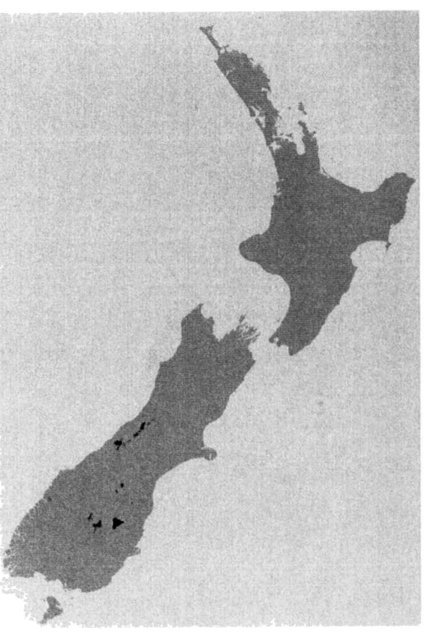


Figure A4.4: **Minimum seasonal temperature**

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