# He Ahuwhenua Taketake
# Indigenous Agroecology

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Edited by Marion Johnson and Chris Perley

NGĀ PAE O TE MĀRAMATANGA

BHU Future Farming Centre

## Contributing authors

### Marion Johnson - Principal Investigator

Marion Johnson is a senior scientist with the Future Farming Centre Lincoln and a Ngā Pae o te Māramatanga Research Fellow.

Marion has a background in sheep and cattle farming, working both at home and abroad.  She then swapped gum boots for a desk and gained a Masters and PhD in Veterinary Parasitology.

Her research grapples with the problems of declining animal health on many farms, believing that healthy stock thrive on healthy feed grown in healthy soils.  She has searched for natural anthelminthics amongst native plants, in consultation with local communities looked for animal health remedies from traditional medicines and worked with local farmers and communities to implement the principles and practices of Agroecology.  Multi-cultural and interdisciplinary projects, natural medicines, Agroecology, shrewd farming within the perceived constraints of regenerative agriculture and finding the best possible local forage options for animal health and productivity are her major research directions.

Future Farming Centre, Lincoln www.bhu.org.nz/future-farming-centre

Email: marion.johnson@bhu.org.nz

### James Ātaria

He uri nō Rongomaiwahine, Ngāti Kahungunu me Ngāti Tūwharetoa ia.

James is currently a Senior Lecturer, Ecology Department and Tūmuaki of Te Mātāpuna – Kaupapa Māori Unit, Agricultural and Life Science Faculty, Lincoln University.  He works as an ecotoxicologist at the Cawthron Institute, Nelson, where he assists with Māori business development.  James is a trustee of the Tuaropaki Trust (an Ahu Whenua Trust that has business interests in the energy and food production, and communication sectors). He is also a co-Deputy Director for Ngā Pae o te Māramatanga-Centre of Māori Research Excellence.

James' scientific research interests lie in the development and application of ecotoxicological tools for the assessment of the biological effects and impacts of legacy and new emerging contaminants on culturally significant species and sites (especially freshwater) in New Zealand. He enjoys conducting his research within multi-disciplinary/multi-organisational programmes that are firmly embedded in Māori culture and process but with strong linkages to end-user organisations. This approach interfaces between science and mātauranga Māori (traditional and contemporary Māori knowledge) and explores mechanisms that promote mutual understanding and equality of uptake in policy and decision making with respect to environmental resource management.

P O Box 84, Lincoln University, Lincoln 7647, Christchurch, New Zealand.

Email: James.Ataria@lincoln.ac.nz

**Olivier Champeau**

Olivier Champeau is an environmental toxicologist at the Cawthron Institute, assessing the impact of pollutants in a range of freshwater, marine and soil organisms. He has experience with biological markers for short term (e.g. oxidative stress) or long term exposure, reflecting further changes at the community/population level (e.g. immunotoxicity and genotoxicity). His worked focused mainly on the impact of heavy metals and emerging contaminants (personal care products, veterinary medicines). He also uses International guidelines and standardised tests for environmental risk assessment helping councils and private companies with their consent.

Email: Olivier.champeau@cawthron.org.nz

**Maui Hudson**

Maui affiliates to Whakatōhea, Ngāruahine and Te Mahurehure and

is currently based at the University of Waikato. He is= an interdisciplinary researcher with experience across a diverse range of research areas including traditional medicine, indigenous research ethics, Māori economic development, Māori health and the interface between indigenous knowledge and science. Maui is also a member of his tribal governing council, the Whakatōhea Māori Trust Board.

Email: maui@waikati.ac.nz

**Samantha Tihoi Jackson**

I am of Ngāti Whātua, Ngāpuhi, Te Roroa, Ngāti Kahu o Whangaroa, Ngāi Takoto, Ngāti Wai and European descent. In 2013, I completed my Master of Arts in Indigenous Development at the University of Otago. I am passionate about Māori and Indigenous youth development and have been fortunate to be a part of many kaupapa that aim to help rangatahi to reach their potential. I was fortunate to research youth programmes for Hokotehi Moriori trust, Rēkohu. I am passionate about all things Māori and enjoyed learning about Indigenous Agroecology through this project where I was a research assistant. I am currently enjoying being apart of 'Hoea te Waka, Piki te Matau', a kaupapa aimed at engaging youth safely in the water. I am a third year medical student at the University of Otago.

**Emma Kearney**

Emma Kearney is a Masters Student in the Marine Department at the University of Otago. Emma's research has focused on the New Zealand scallop *Pecten novaezelandiae* in a customary reserve – Te Whaka ā Te Wera Mātaitai, Rakiura. Her research has aimed to provide the community who locally manage the resource with insight into those factors influencing the recovery of the scallop population. Emma joined the research team through the help of a studentship funded by Ngā Pae o Te Māramatanga and hosted by Marion Johnson. She had a particular interest in understanding the range of perspectives of what constitutes healthy waterways in New Zealand and how land use and policies influence waterway health from technical and traditional perspectives.

**Tony Moore**

Dr. Antoni Moore is a senior lecturer in Geographical Information Science and Deputy Head (Research and Postgraduate) at the National School of Surveying, University of Otago. He is the coordinator of the Otago Applied Science undergraduate and postgraduate degrees in Geographical Information Systems (GIS) and is also secretary of the New Zealand Cartographic Society. He was previously in Otago's Department of Information Science from 2001 to 2008 and before that working as a coastal/marine GIS Analyst at Plymouth Marine Laboratory in the UK. He completed his BSc in Geographical Science (Portsmouth) in 1993, an MSc in GIS (Leicester) in 1994 and his PhD (on the application of spatial artificial intelligence to integrated coastal zone management, Plymouth) in 2001. He currently researches in the areas of geovisualisation, cartography and spatial analysis.

Email: tony.moore@otago.ac.nz

**Chris Perley**

Chris Perley is an associated researcher of Otago's University Centre for Sustainability. Chris has a three decade background in operational management, advisory services, policy, strategy and research covering participatory approaches and strategic frameworks relating to sustainable land management and integrated land use. His expertise extends through agriculture, forestry, economic policy, primary sector strategy, environmental policy and environmental philosophy. He is motivated by the potential of place – environmentally, socially and economically, if and when we get the philosophy right.

Chris has edited NZ J Forestry, is a writer and commentator, and as Manager Land Management in Hawke's Bay Regional Council implemented Integrated Catchment Management approaches to facilitating change and the sharing of a collective vision of place. His work is largely to create a necessary alternative to the mechanical industrial model of land use that currently predominates in Aotearoa-New Zealand. The complex adaptive systems views of indigenous peoples from around the world – including the pre-modern views of Celtic and Germanic traditions – has a major role to play in this shift.

www.chrisperleyblog.wordpress.com

chris@thoughtscapes.co.nz

**Priscilla Wehi**

Cilla is now a researcher and Rutherford Discovery Fellow with the wildlife and ecology management team at Landcare Manaaki Whenua. Her academic background is in zoology, animal ecology and human dimensions of ecology. After her PhD in 2006, she worked as a research officer in the Centre for Biodiversity and Ecology Research (CBER) at the University of Waikato, a FRST postdoctoral fellow in Massey University's Ecology Group then as a researcher at the Centre for Sustainability, where she remains an Associated Researcher.

Cilla's research interests form two main strands. First, human dimensions of conservation, including cultural management of resources, traditional ecological knowledge, links between culture and biodiversity, and urban ecology. Second, Cilla uses stable isotope and nutrient analyses to clarify diet, foraging patterns and ecological niche parameters. Cilla is affiliated with Okapu Marae, Aotea.

Email: WehiP@landcareresearch.co.nz



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# Mihi

Whatungarongaro te tangata, toitū te whenua

I te timatanga ko te kupu, ko te Atua te kupu, nā te Atua anō te kupu i te timatanga. Nāna anō te rangi me te whenua i hanga hei oranga mō te tangata, korōria ki tōna ingoa tapu.

Rere tonu ngā mihi ki ngā tipuna kua haere kei tua o te ārai, nā rātou te whenua i takahia, nā rātou te tangata i arahina, nā rātou hoki te rangi i wheturangitia. Nō reira haere e ngā mate huhua o wā, haere, oti atu.

Huri noa ki a tātou ngā waihotanga o rātou mā. Tēnā tātou. Tēnā hoki tēnei kaupapa rangahau mō ngā mahi ahuwhenua taketake e kawea nei hei oranga whenua-oranga tangata. Me mihi ka tika ki ngā mana, ki ngā pātaka kōrero i pā mai ki tēnei kaupapa hei awhina i ngā kairangahau. Nā koutou te kaupapa i herea ki te whenua, ki te rangi, kia puawai ko te ia o ngā kōrero hei tohu arahi mō ngā uri whakatipu.

## Kōrero Whakarāpopoto – Executive Summary

Agroecology in its simplest terms reconnects ecology to agriculture and to the people that draw their livelihoods from the land. He Ahuwhenua Taketake, Indigenous Agroecology, weaves Māori and Moriori ways of seeing with modern discussions of agroecology to create a land management paradigm that marries their knowledge and worldviews with agroecological principles for Aotearoa New Zealand.

This report illustrates some of the areas of knowledge that are important to agroecology. It also highlights the necessity of farmers, whānau and specialists talking, working and adapting together for a common good.

We begin by introducing the concepts of Agroecology and Indigenous Agroecology framed for Aotearoa New Zealand. Traditional land managements are explored, as is the use of geographical information systems and visualisation to aid discussions of change. Indigenous Agroecology requires a meeting of local culture and science so we discuss the challenges for communities in working with Mātauranga Māori and Science and the problems faced by indigenous communities in retaining the participation of youth. We depend on healthy water ways, healthy livestock and a broad diversity to support our lands and livelihoods, the multiple roles played by native plants in farm systems are enumerated and the problems of pollution and possibilities of bioremediation discussed. Two final chapters illustrate the suggestions for local applications of Ahuwhenua Taketake on our research link farms.

This document is a beginning, making a contribution to the development of an alternative land management paradigm in Aotearoa New Zealand. We hope that it will provide a context for dialogue and change.

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# 1 Agroecology – an Introduction

Marion Johnson

Definitions of Agroecology abound. As the discipline gains traction more definitions and arguments appear, many of them academic. Agroecology is a contested term (Smaje & Rowlatt, 2011), with more research required before we can accept any one definition (Wezel & Soldat, 2009). On one hand it is a scientific discipline, and on the other a movement or agricultural practice that *"has not matured as a scientific discipline"* (Dalgaard, Hutchings, & Porter, 2003), made more complex by the practice of both 'hard' and 'soft' agroecology. Buttel (2003) regards agroecology as a sometimes *"elusive and controversial notion"* but believes that the debate over the application of agroecology is healthy, and that no one discipline should dominate.

One of the first principles of agroecology is, after all, diversity.

Out on the farm, agroecology engages farmers with ecology and agriculture, developing a farming system that nurtures the soil, the plants, and the animals that in turn support farming families, communities and in Aotearoa New Zealand a large sector of the economy (agricultural exports valued at $NZ25.9billion 2011 www.stats.govt.nz). Give farmers the tools, the resources, the support and they will often provide the answers. And as agroecology matures, the political support required to support its continued development is germinating.

## 1.1 What is Agroecology?

*"Agroecology is a discipline that defines, classifies and studies agricultural systems from an ecological and socioeconomic perspective and applies ecological concepts and principles to the design and management of sustainable ecosystems"*

*(Altieri 1995)*

Interestingly when Hanson coined the term *Agroecologist* in 1939, he was discussing the linking of agriculture and ecology as being vital in order to solve the problems faced by agriculture alone. He said we do not need to call people agroecologists just as we do not call people zooecologists - but we do *need* agroecologists. In his view, *"the special contribution of ecology is to ferret out relationships with the environment so that man using this knowledge in conjunction with that obtained from other fields can strive intelligently to secure balance and stabilisation, a goal essential for the attainment of the abundant life and the building of a culture far beyond our present dreams."*

Unfortunately, Hanson's dreams were not realised.

*"Agroecology is deeply rooted in the ecological rationale of traditional small scale agriculture, characterised by diversity of domesticated crop and animals and maintained and enhanced by soil and water diversity."*

*(Altieri 2004)*

Traditional farmers utilised many species and did not have access to short-term quick fix chemicals. They knew their environment and many traditions supported their knowledge. Much of that accumulated experience has been lost but pockets remain and many farmers still have an innate knowledge of their land which, given the opportunity, they can draw upon to adapt farming practices and innovate once again creating stable farming systems.

## 1.2 Participatory Knowledge Systems

It is important to understand how traditional farmers perceive their environment (Altieri, 2002) and how they translate those perceptions into agricultural systems. Not all traditional techniques are applicable in the twenty-first century, but they can after discussion be adapted and spread from farmer to farmer and through knowledgeable extension workers. Farmers should be viewed as experts in their field – their knowledge complementing scientific knowledge – and they should not be viewed as *"beneficiaries of aid"* (De Schutter, 2010). Conventional 'technology transfer' *"breaks down, as it is top down and relies on magic bullets."* Agroecology requires the engagement and knowledge of people and should be adapted to local conditions and to individual farm situations (Altieri et al., 2012). Importantly, although diversity and debate are excellent, the rural practitioners', the extension workers' and the academics' views of agroecology as applied to a locale must mesh.

Agroecology is knowledge intensive and locally situated**.** Although there are a number of overarching principles, the manner in which they are employed varies with the environmental, social and economic situation on each farm. Farmers must participate and local knowledge is vital to the development of agroecological practices in an area (Uphoff, 2012). Farmers in a particular region know how to manage their land with the resources available and are responsive to ecological feedback loops.

The traditional agroecosystems that still survive today have commonalities. Exhibiting high levels of biodiversity and resilience, they are managed carefully, often using age-old technology, for example to prevent erosion or manage water supply. Frequently social institutions govern their management and use (Altieri & Toledo, 2011). The spread of agroecology depends upon knowledge exchange among farmers (Altieri et al., 2012). Locally, it depends upon farmers, their knowledge and access and control over resources, including their land. Agroecology empowers local people (Smaje & Rowlatt, 2011) to manage their land, their environment and their health. Farmers transitioning to agroecology need support, not only because they are striving to change and may be seen as different, but because they have to think differently. Agroecology is not a recipe, there are no quick fixes and a farmer has to respond to and interact with the environment. *"Farmers ask each other what has worked and what hasn't"* (Blesh & Wolf, 2014). (Altieri 2009) reminds us *"agroecological processes require participation and enhancement of farmers ecological literacy,"* and that *"farmers must be involved in a research agenda."*

Currently many decisions about agriculture and agricultural policy are made in cities (Tomich et al., 2011), often by people who have no visceral connection to the land or agroecosystems.

*"You cannot act well in a place until you have understood what nature intended for it"*

*Wendell Berry, quoted in Williams (2001)*

## 1.3 Contrasts with Industrial Agri-Business

Agroecology seeks, using ecological concepts, to maximise the generation of inputs and beneficial processes on farm, providing required nutrients through biological processes (Altieri 1995; Altieri et al., 2012) and to minimise off-farm inputs. Nutrient recycling, enhancing soil organic matter and biota, diversifying species and genes, integrating livestock back into cropping systems and thinking in several dimensions are integral practices. When activities on a farm resemble a closed loop rather than a linear process there are fewer losses and soil and water quality are conserved (Blesh & Wolf, 2014).

This is a major contrast with the industrial agricultural system. Under that system, the lost excesses of pesticides and herbicides, eroded soil and nutrients become pollutants and degrade the ecosystem. However, agribusiness is not liable for the costs, and so society pays the price.

*"Public money is spent in the agricultural sector to encourage the production of commodity crops and yet more money is spent in the health sector to encourage people not to eat them."* (Smaje & Rowlatt, 2011)

### 1.3.2 The Hidden Costs of Industrial Agriculture

Industrial agriculture is not required to clean up, there is *"no self-correcting pressure on the practice because food producers have little incentive"* (Wibbelmann et al., 2013). Meanwhile "the poor" (and not only the poor) *"are driven to practices that amount to ecological suicide"* (Oram, 1998).

Tilman (1999) suggests that it is hard to truly value all the benefits from intact agroecosystems, but makes the point that the technological inputs, designed to replace the degraded functions of natural systems treated industrially, are themselves expensive. Altieri, writing in 2012, quotes the external costs of industrial agriculture as between one and two billion pounds in the UK and thirteen billion pounds in the United States. The global market for the pesticides required to maintain monocultures is in the region of 25 billion US dollars (Altieri & Nicholls, 2012). Fertile, deep soils are a prerequisite for healthy high yielding crops and pastures, but 17% of the vegetated land has been degraded by poor agricultural practices (Tilman, Cassman, Matson, Naylor, & Polasky, 2002).

Squire, Hawes, Valentine, and Young (2015) examined the soil in 70 sites in high yielding agricultural regions of Great Britain. They concluded that there was an association "probably causative" between intensive cropping and soil degradation but that it had not yet been noticed because the region still produced good returns. Cultivation also has a detrimental effect on soils with 40-70% of soil organic matter is lost in the first fifty years (Tilman, 1999). The damage done by cultivation is exacerbated by the addition of pesticides and herbicides. Many of these chemicals become concentrated in the soil solution (Tomich et al., 2011) and are toxic to the beneficial soil biota (Wibbelmann et al., 2013). As the beneficial populations that keep the balance in the soil are damaged, the pest populations can expand. It is unknown how much time is required *"for the functional reestablishment of the predators"* (Tomich et al., 2011). How many have become extinct?

## 1.4 The Effects of Agroecology in Practice: Functional Diversity

As the agroecological farm becomes self-sustaining, losses are minimised, fertility, soil and water are retained on farm and chemicals are not required. De Schutter (2010) describes agroecological processes as a *"fertiliser factory in the field"* through the use of animal manure, green crops and nutrient accumulating species. Agroecological practices encourage the growth and activity of mycorrhiza and other organisms that facilitate nutrient availability and uptake (Wibbelmann et al., 2013). With a diversified planting system, unlike monocultures, there are not enough of a particular species in close proximity for a pest or disease to take hold (Altieri 1995). Additionally, diversity provides habitat for the natural enemies of pests and disease, and encouraging ecological relationships builds healthier plant populations. Domestication of crops and livestock has led to a decreased genetic diversity amongst and within farmed species. Within a wild population genetic diversity is greater (Dempewolf et al., 2014). These populations are vital sources of genetic material for our future, particularly the adaptations that will be required for agroecological systems to adjust to climate change. Small traditional farmers usually grow a number of species and within those species ranges of cultivars that are locally adapted, thus buffering their farms against adversity (Altieri 2009). Many of the varieties have been selected over generations for their response to local conditions. Consumers and retailers demanding a standard product have also influenced the loss of the genetic base of agriculture.

### 1.4.1 Diversity in Space & Time

Diversification is a key principle in agroecology and polycultures whether of different forages, crops or a mixture of shrubs, trees and crops are encouraged. Diversity should occur both temporally and spatially. Crop rotations should include leguminous species and a wide variety of crops and cultivars. The crops chosen are ideally of different heights and preferably intercropped with companion plants that either serve to promote a particular species growth or discourage a particular pest.

Mixed rotations encourage the recoupling of carbon and nitrogen cycles, increase the plant and microbial reservoirs of nutrients and thus reduce losses (Blesh & Wolf, 2014). Well-planned crop rotations can enrich the soil and soil biology and disrupt the lifecycles of pests and plant species that are not wanted in a particular crop (Altieri, Letourneau, & Davis, 1983; Tomich et al., 2011; Altieri et al., 2012). If there is a low host population or a well interspersed host population it is harder for a pest or disease to spread (Altieri & Martin, 1983; Tilman, 1999). Pest control can be achieved through intra-crop and inter-crop biodiversity. Different establishment times and designs can affect predators; growing companion crops, and inter-planting in rows or groups can disrupt pest movements (M. A. Altieri, Schoonhoven, & Doll, 1977).

Some species are toxic to others or toxic to pests and predators, some are repellents (M. Altieri et al., 1983), others attractants. Pest predator habitat may be also be provided by the diverse species alongside the crop. Polycultures have been shown to improve nutrient use efficiency (Cocannouer, 1950; Altieri, 1995) and improve both the yield and resilience of an area of land.

## 1.5 Agroecological Yield & Resilience Benefits

The primary productivity from diverse ecosystems is greater than for a monoculture. In any particular year, one species may struggle while another is likely to do better than usual. Mixtures act as insurance; species richness ensures the resilience of the whole (Tomich et al., 2011).

A plant drawing nutrients from deeper layers will support other nutrient hungry species within the polyculture. Diversity and polycultures imply that there will never be exposed soil as happens in many monocultures. In agroecological systems, cover crops are encouraged as part of a rotation to protect the soil from wind and rain erosion or to enhance pest control (Altieri et al., 2012). The cover crop may be flattened and planted into or grazed off before the next crop is planted. When the canopy is closed in a cropping or pasture situation unwanted species are unable to establish. Mulching and composting using either the cover crop or other vegetation on the farm protects the soil and adds to organic matter.

Trees and shrubs are an integral part of polycultures protecting soil and water, providing shade and shelter, food and firewood, accessing deeper nutrients and storing carbon (Tilman et al., 2002).

The principle of over-yielding (a mixed crop will produce more on a particular area of land than single crops on the same area) means that the overall productivity of a diverse system will always be higher. Tilman (1999) suggests that as the number of species in a given area increases from 1 to 20, total primary productivity increases about 35-70%.

Polycultures that reduce losses from weeds, pests and disease, and make efficient use of water, light and nutrients, may have a yield advantage of 20-60% (Altieri 2004). Industrial agriculture depends on a small number of species and as such is increasingly vulnerable to pests, disease and the effects of climate change (Altieri et al., 2012).

## 1.6 Integrating Livestock within Agroecological Systems

The most stable systems come from the integration of livestock and crop production. Livestock are key to the maintenance of soil fertility with the return of manure to the soil. Many studies have shown the benefits of livestock and cropping systems (Moraine et al., 2014). Agrobiodiversity is enhanced if livestock are kept, particularly if herbaceous forage, fodder shrubs and trees are planted in combination with mixed pastures.

Livestock production systems that rely heavily on grain and other farm imports and disengage stock from the land are not agroecological. The pollution problems associated with livestock are not related to the animals *per se*, but are to do with the way in which they are managed (B. Dumont & Bernues, 2014). Dense populations of animals whether in feedlots or grazed at high stocking rates encourage the spread of disease by the sheer ease of transmission from individual to individual. Drugs are frequently used to control infections but problems of antibiotic resistance and also the leakage of the products of drug metabolism and residual medication to the environment are increasing (Dumont et al., 2013; Tomich et al., 2011). The negative effects on the environment and human health are being recognised (Greathead, 2003). It is highly likely that the gut biota of livestock, damaged by drugs and poor feeding, affect their growth, cognition and performance, as is being shown in human studies (Clemente et al., 2012).

Dumont et al. (2013) developed five principles for sustainable livestock keeping in agroecological practice:

- Recognising the need to decrease inputs;
- Develop management practices to optimise animal health;
- Enhance diversity within animal systems;
- Promote biological diversity in agroecosystems to promote resilience, and;
- Optimise the 'metabolic functioning' of farming systems to decrease pollution.

### 1.6.1 Animal Genetics and Place

Within agroecological thinking, place matters, and it follows that farmers ought to choose animals that are adapted to the local environment. Within selected breeds, they ought to select animals that thrive in that local environment. Unfortunately, much selection of breeding stock has taken place on the strength of controlled experiments where animals are isolated from their environment and only one trait is selected for; this has often proved detrimental to other traits. There is a need to breed for robustness. There should be an internal trade-off between production and adaptation, efficiency of feed utilisation and an ability to survive and reproduce (Dumont et al., 2014).

The principle of local animals adapted to local environments does not preclude new blood being introduced to broaden the gene pool. However, introduced animals should be selected from and bred up to produce a locally adapted, productive strain.

### 1.6.2 Forage Genetics for Selected Animals

Animal health and biodiversity are both served by growing a range of forages including bioactive plants. Genetic diversity within the livestock kept and the forages consumed should be encouraged. Animals that are fed well with a broad diet have robust immune systems, are less likely to succumb to disease and are more likely to achieve their production potential. The increase in biodiversity broadens livestock diet as well as decreasing the amount of external inputs required – particularly if animals are selected that use natural feeds efficiently. Such biodiversity serves to protect soil and water and increases the amount of biomass produced on the farm.

Changes in animal feeding systems, particularly away from cereals (which puts animals in competition with human needs), increases biodiversity, carbon sequestration, and helps lower greenhouse gas emissions (Botreau, et al., 2014; Dumont et al., 2014). As farms move to agroecological management, not only does the range of fodder species increase, but feed nutrient density increases due to the biological management of the soil.

Dumont (2014) has coined the term 'Agroecological animal production systems' that *"aim to handle disturbance not just endure it, to adapt animals to changing feed quality and quantity and select for the digestion of lower quality herbage."* Managing animals in this way reduces competition for land and increases the likelihood that stock can cope with the vicissitudes of climate change and associated changes in the availability and quality of feedstuffs.

Under agroecological animal production systems, pastures should not be monocultural but contain a range of species, preferably legume mixes. Mixed forage systems should also contains herbs and shrubs, preferably densely planted (Altieri, et al., 2012). This type of planting encourages soil stability, provides habitat for pollinators and pest predators and can augment both soil and animal health.

## 1.7 Trees and Woodlands in Agroecological Systems

Growing trees as part of the farm system, as well as protecting the soil can help soil water infiltration and improve fertility. Nutrients are brought up from deep layers, beyond the roots of crops and forages, and deposited as leaf litter, further increasing soil organic matter and feeds soil biology. Trees provide shade and shelter, creating microclimates and buffering temperature fluctuations (Tilman et al., 2002; Wibbelmann et al., 2013). They also provide additional income in the form of timber or fruits. Wolf and Gomes (2015) describe beekeeping projects successfully integrated into agroforestry systems using agroecological principles. By planting a range of species they ensured that the bees were continually supported, honey provided additional income and pollination was ensured for orchards, crops and pastures. Unfortunately, in Aotearoa New Zealand there is a continual tension between pasture production and trees (Williams, 2001) with little understanding of the complementary roles played by each in farm systems.

Increased diversity on farm promotes integration and closing loops, supporting the whole farm ecosystem. Agroecology means *"increasing biological and genetic diversity and regenerating instead of degrading"* (Wibbelmann et al., 2013).

## 1.8 Healthy Agroecosystems, Healthy Culture

Altieri (1983) described the negative impacts and consequences of industrial agriculture as producing ecological diseases, nutrient loss, soil erosion and loss of genetic resources. Gleissman (1998) introduced the concept of agroecology supporting the maintenance of an ecosystem's immunity. He felt the ecosystems 'immune system' was strengthened through the enhancement of functional biodiversity, encouraging natural enemies, recycling biomass and enhancing biological interactions and synergies. By boosting immunity the ecosystem is kept healthy and its regulatory processes functioning as they should. The more diverse an ecosystem the better the regulation of its parts (Koohafkan, et al., 2011).

In a healthy agroecosystem the loss of water and nutrients is minimised and the diversity of species and genetic resources maximised, both above and below the ground. Diversified systems are more efficient in terms of light capture, different layers intercepting light at different points. Water is utilised more efficiently and it is held by a mixture of leaves and roots and a covered soil, rather than running straight off the land. In an agroecological system the performance of the whole is more important than the performance of the individual. As many reductionist researchers have discovered, the whole does not equal the sum of its parts. Uphoff (2012) reminds us that *"biology operates with the nonlinear logic of open systems."* It is impossible to develop a successful agricultural system with a closed mind. A comparison of industrial food systems and agroecological food systems is given in Table 1.

*Table 1. A comparison of industrial and agroecologically based food systems. Modified from (Altieri & Toledo, 2011)*

| **Industrial food Systems** | **Agroecological peasant food systems** |
|---|---|
| Crop and biofuel production for export<br>Food miles substantial | Local, regional, national food production and consumption |
| Less than 20 livestock and crop species | More than 40 livestock species and thousands of edible plants |
| Large scale monocultures | Small scale diversified farming systems |
| High yielding varieties, hybrids, trans genic crops | 1.9 million landraces and local crop varieties |
| Dependent upon oil and agrichemical inputs | Local resources, biodiversity provides support |
| Fertilisers for crop nutrition feeding plant | Plant and animal derived organic matter feeds the soil |
| Top down extension schemes linked to corporate controlled scientific research | Farmer – farmer local innovations socially orientated horizontal exchanges |
| Narrow technological knowledge of parts | Holistic knowledge of nature |
| Exists in simplified degraded natural matrix<br>Discourages conservation | Exist in complex matrix that provides ecological services and encourages biodiversity and wild species conservation |

Pretty et al. (2006) surveyed 286 projects with an agroecological basis in 57 countries in the developing world and found: improvements in water use; a decrease in pesticides; and production increases. A further survey of 40 projects utilising agroecological methodology found an average increase in crop yield of 113% and concomitant decreases in negative impacts such as soil erosion and chemical use (Pretty, Toulmin, & Williams, 2011).

Using agroecological methods changes the way people think about the land. New crops or trees are planted, different rotations are tried, small patches of land become vegetable gardens. Fodder and forage crops are introduced for livestock, cut and cart systems developed, different varieties are trialed so two crops may be harvested where there used to be one.

## 1.9 The Resilience of Agroecological Systems

Altieri, et al. (2012) quote examples of the resilience of agroecological systems. In the Valle del Cauca in Colombia, a farm managed using agroecological principles survived the drought. Although pasture production dropped, the shrubs and trees still produced fodder, and milk production continued. On neighbouring farms animals died from starvation. After Hurricane Mitch in 1998 farmers in Central America who were using agroecological techniques had less damage and less erosion losses; they had 20-40% more topsoil. In Cuba after Hurricane Ike in 2008, production recovered faster on farms run using agroecology.

Across Africa simply by re-introducing nitrogen-fixing trees into cropping systems maize yield was increased (Poschen, 1986). Using agroforestry and agroecology 350ha of land have been rehabilitated to agriculture in Tanzania (de Schutter, 2010). Uphoff (2012) describes the development of the system of rice intensification (SRI) changing the way rice is produced. Changes in management of soil and water increases the root growth of the plants, encourages the soil biota and increases productivity over four-fold with no additional inputs. As SRI is implemented, farmers can then select from their most productive plants and continue to improve their local production.

## 1.10 The Growth of Agroecology

In 1995 Altieri defined agroecology as providing *"the basic ecological principles for how to study, design and manage agroecosystems that are both productive and natural resource conserving and that are also culturally sensitive, socially just and economically viable."* In 2002 he defined agroecology as an holistic study of agroecosystems combining human and environmental elements (Altieri 2002). As the discipline has become more widely accepted, agroecology has become a movement incorporating the social and the geopolitical. A social context is integral to the practical issues of food security. In addition, availability of fair markets, distribution networks and equity have assumed an important role (Altieri, et al., 2012; Dumont et al., 2014).

## 1.11 Greater Production of Food

The production of food is vital, but any system must address poverty and inequality (Koohafkan et al., 2011). Holt-Gimenez, et al. (2012) state that *"enough food is currently produced to feed 10 billion people, but poverty, inequality, degraded land and constant conflict make access difficult or impossible for many."*

The Food and Agriculture Organisation (2011) reports that one third of the food produced by farmers is wasted. It is wasted when stored and transported, it is lost in the field or at harvest or it is simply thrown out (FAO, 2011). This is insupportable when so much land is being degraded by industrial agriculture and thus the base for food production is dwindling. Soils can be rebuilt, areas can be revegetated, but it takes time, knowledge, will and money.

Agriculture has to deliver food, but the detrimental aspects of industrial agriculture are not acknowledged by the market (Smaje & Rowlatt, 2011). It has been argued that the food crisis facing the planet is one of poor distribution and immense wastage, not one of production (Holt-Gimenez et al., 2012). This is true, but it is also a crisis of poor management and planning, as well as the externalisation of costs by agribusiness. It will be further exacerbated by a changing climate. War and conflict disrupt food production for many communities and aid handouts are not the answer. Governments in many parts of the world follow the agendas of leadership or corporate business. The critical issues are secure access to land and natural resources and support for locally-suited production methods coupled with innovation.

## 1.12 The Rights of Farmers

It is essential to ensure the rights of farmers to save their own seed, to exchange seeds (Uphoff, 2012) and not to be forced into using hybrid or genetically-modified seed. It is unacceptable for one generation to challenge the ability of future generations to survive by degrading our natural systems and "*undermining biodiversity*" (Koohafkan et al., 2011).

When we consider changes in the system, we must recognise the role of private interest and businesses. Institutions and their funders also shape the direction of agriculture by choosing particular paradigms over others, and encouraging a short-term focus. Francis (2009) likens many research questions currently asked as "*academic trivial pursuit*" and suggests that new holistic methods are required as research moves forward in both thinking and analysis.

## 1.13 International Support for Agroecology and Food Security

Olivier de Schutter (2010) in his role as Special Rapporteur to the United Nations, supports agroecology. He suggested that the principles be taken up as an option to produce food sustainably, and argued that by using agroecological techniques food production could double. He suggests that past agricultural effort has simply replicated linear industrial processes of input equals output and that agriculture, instead of copying industry, should mimic nature. In his opinion the change to a simplified agriculture has contributed to malnutrition and a move back to a complex, species diverse pattern of farming will provide a diversity of nutrients. This lack of nutrients is not confined to the developing nations. The nutrient density of fruit and vegetables is less than it was previously, with mineral levels falling by 76% between 1940 and 1991 (Wibbelmann et al., 2013).

In 2012 the Special Rapporteur reminded the United Nations that the right to food is a human right recognised under law and that this right should permeate all core activities of the FAO (De Schutter, 2012). As agroecology is increasingly endorsed in international organisations, it gives weight to programmes beginning within countries around the world.

In October 2013 the Committee on World Food Security (CWFS) endorsed the second version of Global Framework for Food Security and Nutrition. Their philosophy is that:

> *"Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life."*

The four pillars of food security are: availability; access; utilisation; and stability. The nutritional dimension is integral to the concept of food security. The framework recognises that:

> *"agroecological practices have proved to be important in improving agricultural sustainability as well as incomes of food producers and their resilience in the face of climate change. …* [And recognises the] *importance of local knowledge in promoting food security, particularly as the latter is influenced by the capacity to manage natural assets and biodiversity and to adapt to the localised impact of climate change"* (Security, 2013).

## 1.14 Agroecology and Science

Agroecology, although espousing traditional methods of agriculture, is not against science or scientific innovations (Anon., 2014), but the science must be genuine and respond to farmers needs. It must be thoroughly thought through, and any risks carefully evaluated. Critics who declare that agroecology is 'subsistence orientated' and cannot be scaled-up (Anon., 2014) are incorrect; the techniques have been applied on a number of farms in Europe and the United States, and the principles apply to all agricultural contexts. However, agroecology is incompatible with industrial paradigms that see the world as reducible to simple mechanics in conflict with Aldo Leopold's maxim, *"The first rule of intelligent tinkering is to keep all the parts."*

Agroecology is a challenge to the deterministic and mechanical industrial paradigm of land use, and it cannot marry genetic modification or sustainable intensification. To do so would

*"… render agroecology a concept devoid of meaning and divorced from the reality of farmers and the environment"* (Altieri & Nicholls, 2012).

## 1.15 Shifting Agroecology into the Mainstream

In February 2015 over 200 delegates met in Mali to discuss the practice of agroecology in their regions and *"to develop joint strategies to promote agroecology and defend it from corporate co-option."* Recognising that as agroecology becomes acknowledged as a successful discipline and a movement, academics, institutions and corporates are attempting to use it for their own purposes, or co-opt it to industrial technologies *"while the existing structures of power remain unchallenged."* Some authors (Koohafkan et al., 2011) suggest that a set of standards for agroecology should be established and monitored. However, should agroecology conform to standards – which are anathema to complex systems? Industrial agriculture has no standards.

If agroecology is to become the norm, then it would best be owned by farmers working together with their communities to implement agroecological principles. A shared appreciation of agroecological principles would regard a good farmer as one who has a diverse, multifunctional system that works with the environment, not against it.

## 1.16 Agroecology is Complex, not Linear

Other authors have complicated the implementation and distinction of agroecology. For example, Botreau et al. (2014) developed an agroecological diagnostic tool identifying the strengths and weaknesses of each farm using multi-criteria evaluations to make recommendations. This is stepping away from farmer-to-farmer interaction and local knowledge. Models and kits can too easily miss the nuances of a particular environment, and they are themselves closely aligned to the idea of universal approaches rather than the often radically different needs of local cultures and environments, the contingency of time and place.

More linear approaches are advocated by Koohafkan et al. (2011), who suggest that agricultural paradigms be designed to respect the limits of local resources. They argue that indicators should be developed in each region that will warn of the approach to a threshold level, beyond which irreversible damage will occur.

This, however, is a linear mindset and gives permission for behaviours that can push the complex system to the edge of the assessed theoretical boundary. That is a dangerous place to be. If agroecology is truly embraced and implemented, such indicators are unnecessary. It is important however, as Koohafkan and colleagues suggest, to monitor and to further understand agroecosystems to be forewarned of change, and adapt appropriate technologies as circumstances change.

Many non-industrial farming paradigms incorporate agroecology methodologies. Conservation Agriculture for example abhors bare soil. Biological Farming encourages soil biota and the use of composts; Organics bans the use of chemicals; Agroforestry incorporates trees and Permaculture encourages a wealth of different species and the clever use of space. These are stepping stones to, and part of, the pattern of a truly connected, supportive, healthy and sustaining agriculture – Agroecology.

## 1.17 Conditions Underpinning Sustainable Agriculture

In 2011, Koohafkan, Altieri and Holt Gimenez developed a series of guiding questions that should be applied when developing an agricultural system that strives to be sustainable and to support local communities. If the system is based on agroecological principles, then the answers will be positive. The fewer positives, the less sustainable the system.

These guiding questions are: Is the system:

1. Reducing poverty?
2. Based on rights and social equity?
3. Reducing social exclusion of women, minorities and indigenous peoples?
4. Protecting access and rights to land, water and other natural resources?
5. Favouring redistribution (rather than concentration) of productive resources?
6. Substantially increase food production and contributing to household food security and improved nutrition?
7. Enhancing water access and availability?
8. Regenerating and conserving soil; increasing or at least maintaining soil fertility?
9. Reducing soil loss/degradation and enhancing soil regeneration and conservation?
10. Maintaining or enhancing organic matter and biological life and biodiversity of the soil?
11. Preventing pest and disease outbreaks?
12. Conserving and encouraging agrobiodiversity?
13. Reducing Green House Gases (GHG)?
14. Increasing income opportunities and employment?
15. Reducing variation in agricultural production under climatic stress?
16. Enhancing farm diversification and resilience?
17. Reducing investment costs and dependence on external inputs?
18. Increasing the effectiveness of farmer organisations?
19. Increasing human capital formation?
20. Contributing to local or regional food sovereignty?

Blesh and Wolf (2014) remind us that, *"transformations to agroecology represent complex farming changes rather than the adoption of discrete techniques."* This statement serves to emphasise the importance of local farmers supporting other local farmers as they strive to rebuild the agroecosystem that supports them, and to shift to a new paradigm other than the one supported by proponents of industrial models. One farmer at a field day Blesh attended stated *"the beauty of having beef cows is that weeds are good,"* another that a failed soy crop could be fed to the pigs so was not lost.

Rather than a recipe, Altieri et al. (2012) presented a set of requirements that should be achieved when considering the sustainable management of agricultural land. If the land is being managed according to agroecological principles, the following conditions in Table 2 will be met.

*Table 2. Defining Agroecological Conditions (Altieri et al., 2012) from Koohafkan et al. 2011)*

| |
|---|
| Is the farm using local and improved crop varieties and livestock breeds, enhancing genetic diversity and adaptation to changing biotic and environmental conditions? |
| Is the farm avoiding the use of agrochemicals and other technologies, for example heavy machinery or transgenic crops that harm the environment and impact human health? |
| Is the use of resources such as water, nutrients and energy efficient, and has the farm reduced the use of external inputs and non-renewables? |
| Are agroecological principles and processes being used to promote nutrient recycling, biological nitrogen fixation, allelopathy and biological control? Is functional biodiversity being encouraged through diversified farming systems? |
| Is the best of traditional and scientific knowledge being used and is innovation welcomed? Are cultural identities, participatory methods and farmer networks recognised? |
| Are efforts being made to reduce the ecological footprint of production, distribution and consumption to minimise pollution, soil damage and Greenhouse Gas emission? |
| Are practices promoted enhancing clean water availability, carbon sequestration and conservation of biodiversity, soil and water? |
| Is there a balance between long-term adaptability and short-term efficiency and an ability to cope with short-term change? |
| Is there improved adaptive capacity and resilience through maintaining agroecosystem diversity so that the farm is responsive to change and to secure key farming functions? |
| Is the farm conserving agricultural heritage supporting social cohesion and a sense of pride to help reduce migration from rural areas? |

## 1.18 The Growing Recognition of Agroecology by Farmers

In a study of the adoption of agricultural practices, Alonge and Martin (1995) suggested a number of reasons why the uptake of agroecological methods might be slow. The primary reasons concerned a lack of information and knowhow, as well as the economic uncertainty associated a new venture.

Other reasons relate to a lack of local knowledge (agroecology principles are general but local in application), access to local breeds and varieties, as well as a lack of support, within farmer networks and from technical support. In addition, uncertainty around land tenure, the influence of governments, agro-exports and industrial agriculture does not encourage uptake, particularly where a farmer was an isolated practitioner.

As agroecology is spreading and becoming a social force, networks are developing both on the ground and at the international level. La Via Campesina (www.viacampesina.org) is an international movement that began in Belgium in 1993. The movement unites 200 million small and medium-size farmers, indigenous people, peasants, women farmers, landless people, agricultural workers and migrants.

La Via Campesina opposes corporate and industrial agricultures, believing they destroy people, livelihoods and the environment. The movement supports small-scale sustainable agriculture knowing that it will produce food for their communities and feed the world in a sustainable, healthy and socially just way. La Via Campesina introduced the concept of food sovereignty at the World Food Summit 1996, defining food sovereignty as the right of peoples to healthy and culturally appropriate food produced through sustainable methods and their right to define their own food and agriculture systems.

Via Campesina ..

*"puts the aspirations, needs and livelihoods of those who produce, distribute and consume food at the heart of food systems and policies rather than the demands of markets and corporations" and it strives to ensure "that the rights to use and manage lands, territories, water, seeds, livestock and biodiversity are in the hands of those who produce food and not of the corporate sector."*

## 1.19 Agroecology in Summary

There is no single defined agroecological method, there cannot be. Agroecological practice is local, but there are principles and questions that can be asked to guide the development of an agroecological approach to agriculture.

The key principle of agroecology is diversification (Altieri et al., 2012), harnessing the complementarities between species for the benefit of the farm. Altieri describes diversity as functioning as an "ecological turntable" activating all the natural processes that sustain productive agroecosystems. In 1983 he suggested that

*"guidelines for designing balanced and well adapted cropping systems may be gleaned from the structural and functional features of the natural or semi natural ecosystem remaining in the area."*

Agroecology demands that we look at every facet from as many angles as possible and derive as many purposes from each component as our current understanding allows; the concept of multi-functionality of landscapes.

Agroecology is a new way of thinking and seeing that moves beyond the mechanical constructs of Modernity. In so doing it can shift us from an 'extractive' and degrading industrial land use model that trades off the environment and cultural values for short-term economic gain, and long-term economic loss. Agroecology shifts us from that failing model to a 'creative' model where multiple-values as well as cultural, environmental and economic resilience can flourish.

*"Agroecology is a way of life and the language of Nature that we learn as her children. It is not a mere set of technologies or production practices. It cannot be implemented the same way in all territories. Rather it is based on principles that, while they may be similar across the diversity of our territories, can and are practiced in many different ways, with each sector contributing their own colours of their local reality and culture, while always respecting Mother Earth and our common, shared values."*

The Nyeleni declaration (2015)
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## References


Alonge, A. J., & Martin, R. 1995. Assessment of the adoption of sustainable agriculture practices: Implications for agricultural education. *Journal of Agricultural Education, 36*(3), 34-42.

Altieri , M. 1995. *Agroecology: The Scientific Basis of Alternative Agriculture* Boulder Colorado US: Westview Press.

Altieri , M. 2002. Agroecology; the science of natural resource management for poor farmers in marginal environments. *Agriculture, Ecosystems and Environment, 93*, 1-24.

Altieri , M. 2004. Linking ecologists and traditional farmers in the search for sustainable agriculture. *Frontiers in Ecology and the Environment, 2*, 35-42.

Altieri , M. 2009. Agroecology,Small Farms and Food Sovereignty. *Monthly Review, 61,* 102-112.

Altieri , M., Bartlett, A. K., Callenius, C., Campeau, C., Elasser, K., Hagerman, P., Ulmer, K. 2012. *Nourishing the world sustainably:scaling up Agroecology* (pp. 47). www.e-alliance.ch: Ecumenical Advocacy Alliance.

Altieri, M., Letourneau, D. K., & Davis, J. R. 1983. Developing Sustainable Agroecosystems. *BioScience, 33*(1), 45-49.

Altieri , M., & Martin, P. B. 1983. A quest for Ecologically Based Pest Management Systems. *Environmental Management, 7*(1), 91-100.

Altieri , M., & Nicholls, C. 2012. Agroecology Scaling up for Food Sovereignty and Resiliency. *Sustainable Agriculture Reviews, 11*, 1-29.

Altieri , M., & Toledo, V. M. 2011. The agroecological revolution in Latin America; rescuing nature, ensuring food sovereigntyand empowering peasants. *The Journal of Peasant Studies, 38*(3), 587-601.

Altieri, M. A. 2002. Agroecology: the science of natural resource management for poor farmers in marginal environments. *Agriculture, Ecosystems & Environment, 93*(1-3), 1.

Altieri, M. A., Schoonhoven, A. V., & Doll, J. D. 1977. The ecological role of weeds in insect pest management systems: A review illustrated with bean (Phaseolus vulgaris L.) cropping systems. . *PANS, 23*(2), 195-205.

Anon. 2014. Building a new agricultural future Supporting agro-ecology for people and the planet *Oxfam issue briefing*.

Blesh, J., & Wolf, S. 2014. Transitions to agroecological farming systems in the Mississippi River Basin:toward an integrated sociological analysis. *Agriculture and Human Values, 31*, 621-635.

Botreau, R., Farruggia, A., Martin, B., Pomies, D., & Dumont, B. 2014. Towards and agroecological assessment of dairy systems:proposal for a set of criteria suited to mountain farming. *Animal, 8*(8), 1349-1360.

Buttel, F. 2003. Envisioning the Future Development of farming in the USA: Agroecology Between Extinction and Multifunctionality. *New Directions in Agroecology Research and Education*, 2014

Clemente, Jose C., Ursell, Luke K., Parfrey, Laura W., & Knight, R. 2012. The Impact of the Gut Microbiota on Human Health: An Integrative View. *Cell, 148*(6), 1258-1270.

Cocannouer, J. A. 1950. *Weeds Guardians of the Soil*. Old Greenwich • Connecticut: The Devin-Adair Company

Dalgaard, T., Hutchings, N. J., & Porter, J. R. 2003. Agroecology, scaling and interdisciplinarity. *Agriculture, Ecosystems & Environment, 100*(1), 39.

De Schutter, O. 2010. *Report submitted by the Special Rapporteur on the right to food*. A/HRC/16/49: United Nations General Assembly Human Rights Council Sixteenth session.

De Schutter, O. 2012. *Report of the Special rapporteur on the right to food*: *addendum*. A/HRC/22/50/Add.3: United nations General Assembly Human Rights council twenty-second session.

Dempewolf, H., Eastwood, R. J., Guarino, L., Khoury, C. K., Müller, J. V., & Toll, J. 2014. Adapting Agriculture to Climate Change: A Global Initiative to Collect, Conserve, and Use Crop Wild Relatives. *Agroecology and Sustainable Food Systems, 38*(4), 369-377. doi: 10.1080/21683565.2013.870629

Dumont, B., & Bernues, A. 2014. Editorial:Agroecology for producing goods and services in sustainable animal farming systems. *Animal, 8*(8), 1201-1203.

Dumont, B., Fortun-Lamothe, L., Jouven, M., Thomas, M., & Tichit, M. 2013. Prospects from agroecology and industrial ecology for animal production in the 21st century. *Animal, 7*(6), 1028–1043.

Dumont, B., Gonzalez-Garcia, E., Thomas, M., Fortun-Lamothe, L., Ducrot, C., Dourmad, J. Y., & Tichit, M. 2014. Forty research issues for the redesign of animal production systems in the 21st century. *Animal, 8*(8), 1382-1393.

FAO. 2011. *Global food losses and food waste – Extent, causes and prevention*. Rome: FAO.

Francis, C. A. 2009. Conventional research on controversial issues: an exercise in futility? *Renewable Agriculture and Food Systems, 25* (Special Issue 01), 3-7.

Gleissman, S. R. 1998. *Agroecology:Ecological processes in sustainable agriculture*. Ann Arbor Press: Michigan.

Greathead, H. 2003. Plants and plant extracts for mproving animal productivity. *Proceedings of the Nutrition Society, 62*, 279-290.

Hanson, H. C. 1939. Ecology in Agriculture. *Ecology, 20*(2), 111-117.

Holt-Gimenez, E., Shattuck, A., Altieri , M., Herren, H., & Gleissman, S. R. 2012. We Already Grow Enough Food for 10 Billion People... and Still Can't End Hunger. *Journal of Sustainable Agriculture, 36*(6), 595-598.

Koohafkan, P., Altieri , M., & Holt-Gimenez, E. 2011. Green Agriculture:foundations for biodiverse, resilient and productive agricultural systems. *International Journal of Sustainability, 10*(1), 61-75.

Moraine, M., Duru, M., Nicholas, P., Leterme, P., & Therond, O. 2014. Farming system design for innovative crop-livestock integration in Europe. *Animal, 8*(8), 1204-1217.

Oram, P. 1998. Moving toward sustainability Building the Agroecological Framework. *Environment: Science and Policy for Sustainable Development, 30*(9), 14-36.

Poschen, P. 1986. An evaluation of the Acacia albida-based agroforestry practices in the Hararghe highlands of Eastern Ethiopia. *Agroforestry Systems, 4*(2), 129-143. doi: 10.1007/bf00141545

Pretty, J., Noble, A., Bossio, D., Dixon, J., Hine, R. E., Penning de Vries, P., & Morison, J. I. L. 2006. Resource conserving agriculture increases yields in developing countries. *Environment, Science and Technology, 40*, 1114-1119.

Pretty, J., Toulmin, C., & Williams, S. 2011. Sustainable Intensification in African Agriculture. *International Journal of Agricultural Sustainability, 9*(1), 5-24.

Security., C. o. W. F. 2013. *Global Strategic Framework for Food Security & Nutrition* (GSF).

Smaje, C., & Rowlatt, C. 2011. *Key policies for Agroecology in the UK* (pp. 29). agroecology-appg.org: The All Party Parliamentary Group on Agroecology.

Squire, G. R., Hawes, C., Valentine, T. A., & Young, M. W. 2015. Degradation of soil function varies with trajectory of agricultural intensification. *Agriculture,Ecosystems and Environment, 202*, 160-167.

Tilman, D. 1999. Global Environmental impacts of agricultural expansion:The need for sustainable and efficient practices. Paper presented at the *Plants and Population: Is there time?*, Irvine California.

Tilman, D., Cassman, K. G., Matson, P. A., Naylor, R., & Polasky, S. 2002. Agricultural sustainability and intensive production practices. *Nature, 418*(6898), 671-677.

Tomich, T. P., Brodt, S., Ferris, H., Galt, R., Horwarth, W. R., Kebreab, E., Yang, L. 2011. Agroecology:A review from a Global-Change Perspective. *The Annual review of Environment and Resources, 36*, 193-222.

Uphoff, N. 2012. Supporting food security in the 21st century through resource-conserving increases in agricultural production. *Agriculture and Food Security, 1*(18), 1-12.

Wezel, A., & Soldat, V. 2009. A quantative and qualitative historical analysis of the scientific discipline of agroecology. *International Journal of Agricultural Sustainability, 7*(1), 3-18.

Wibbelmann, M., Schmutz, U., Wright, J., Udall, D., Rayns, F., Kneafsey, M., Lennartson, M. 2013. Mainstreaming Agroecology: Implications for Global Food and Farming Systems. *Centre for Agroecology and Food Security Discussion Paper*. Coventry: Centre for Agroecolohy and Food Security.

Williams, M. 2001. Back to the Future-Pastoral land use in forest land-sustainability challenges for the 21st century. Paper presented at the *International Grasslands Congress*, Brazil.

Wolf, L. F., & Gomes, J. C. C. 2015. Beekeeping and Agroecological Systems for Endogenous Sustainable Development. *Agroecology and Sustainable Food Systems, 39*(4), 416-435.

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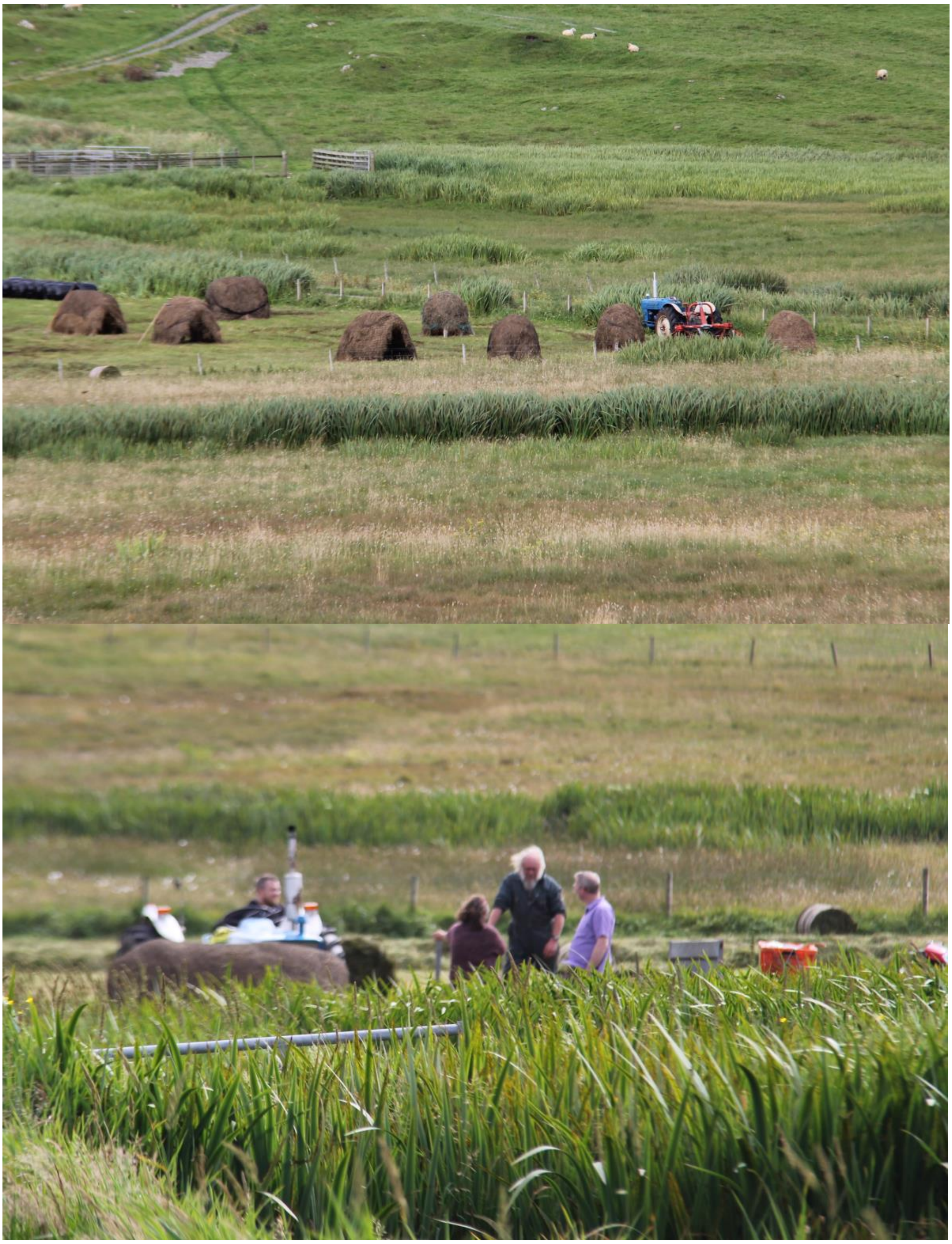

*Community haymaking: Ibster Shetland*

# 2 He Ahuwhenua Taketake: Indigenous Agroecology in Aotearoa New Zealand

Marion Johnson

## 2.1 Working within the Principles of Agroecology

The discipline of Agroecology provides direction, ideas and tools for farmers and those associated with the land. They can farm though valuing ecological principles, working with nature not against it. But agroecology is more than land management, as the land is more than soil and crops. People live on the land and people are fed from the land. Agroecology supports those relationships and encourages health, justice and equity. There is no universal recipe for agroecology; it is situated locally, and land management draws on deep experience and networks, driven by practitioners and those with connections to the earth, not corporations or industry.

In February 2015 the participants at an agroecology congress in Mali declared:

> *"Agroecology is a way of life and the language of Nature that we learn as her children. It is not a mere set of technologies or production practices. It cannot be implemented the same way in all territories. Rather it is based on principles that, while they may be similar across the diversity of our territories, can and are practiced in many different ways, with each sector contributing their own colours of their local reality and culture, while always respecting Mother Earth and our common, shared values."*

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Fred Provenza (2008) explored the ideas of being locally adapted (and asked the question who cares anyway?) as an extension of his work on herbivores and food choices in rangeland management.

> *"… from soils and plants to herbivores and people we will learn once again what it is to be locally adapted… we will of necessity nurture relationships among soil, water, plants, herbivores and people in ways that sustain the production, health and wellbeing of ecosystems and make farming profitable and enjoyable."*

It is not desirable to simply return to an old pattern of practice that is no longer appropriate for this time and place. Agroecology embraces the old principles of care for land and community, local adaptation and knowledge through networks, but knowledge is not a static thing; knowledge involves learning, and the wisdom to know what new learning is relevant given agroecological principles. Even when the practices of old are deeply relevant, it is not always possible to simply return to the old local ways, as Provenza (2008) explains.

*"George emphasises the value of local knowledge, once lost it is difficult to regain He describes peoples attempts to recreate the 'old sheep cycle' " they were crazy, once knowledge is gone you can't get it back just like that, they didn't even have a dog that knew anything…they were looking for trouble and they found it"….*

*" lack of adaptation from dogs and sheep and people ensured they never moved out of the valley and into the mountain, let alone recreated the old sheep cycle."*

## 2.2 Lessons from Indigenous Communities

Miguel Altieri commented that many indigenous peoples had their own agroecologies (Altieri 2009). Gari (2001) used the phrase Indigenous agroecology *"to emphasise the wholeness and connectedness of the Pastaza peoples practices,"* which are socially, culturally and ecologically interwoven. The indigenous peoples of Pastaza province in Amazonia cultivate 30-50 different species of plants that function as food and medicine. For each species, they grow a range of cultivars. Although they clear patches of forest for their crops, they replant it steadily with forest species so that when cropping ceases the forest can regenerate. They, *"conserve, use, cultivate, manage and exchange biodiversity as a fundamental component of their lifestyle"* understanding that they are working within a slowly cycling functional system, a radically different paradigm from the one that sees land merely as 'resources' measured in dollars. It is a deeply embedded way of being which recognises connection and dynamism.

Many farmers in Bhutan still practice older agricultural approaches but new laws can obstruct their methods. Now they spend much of the summer camping in their fields to scare away the wild pigs that may no longer legally be hunted. No other methods of control or porcine discouragement have been introduced to help the farmers.

*Figure 1: Farming in Bhutan: 1a, Huts from which to discourage pigs, 1b, Traditional ploughing*

There is a great weight of expectation upon many indigenous peoples to suddenly provide answers to environmental problems. This is difficult when many communities have been disconnected from the land for several generations. Agroecology provides a link back to culture and with it the possibility of reviving many traditional practices and connections.

## 2.3 He Ahuwhenua Taketake: Indigenous Agroecology, Aotearoa New Zealand

In Aotearoa New Zealand agroecology has a rich history to draw upon. Indigenous Agroecology is an ethic of farm stewardship that is being developed based on the traditional and contemporary experience of Māori and Moriori agricultural practitioners invoking the principle of Kaitiakitanga or guardianship. Indigenous Agroecology brings a 'ki uta ki tai' (from the mountains to the sea) approach, highlighting the inter-relationship between land and water, acknowledging Papatūānuku (earth mother) and Ranginui (sky father) and our relationship with all living things.

Diversity is central to the restoration of the land and the implementation of agroecological methods. Thus, native plants are central to our concept of Indigenous Agroecology, benefiting land, water and communities as illustrated in Figure 2.

Although there is a growing understanding of the importance of ecosystems and the contribution made by their components in supporting our lives, the enhancement of indigenous biodiversity on productive lands is more likely to succeed if it is done in partnership with agriculture and is understood to bestow benefits.

By managing the land appropriately, respecting the ability of the soils, water, flora and fauna to generate and regenerate, we can produce healthy food and enough to feed everyone. By drawing on the knowledge of our older cultures, we can relearn how to respect the land and by drawing on modern science we can solve problems *within the context of agroecology*.

There is a constant conflict between the short-term expedience of industrial ideas, which may create long-term harm to principles of community, Kaitiakitanga, and local knowledge and learnings. Before we apply our new techniques and ideas, we must discuss how they fit into agroecological principles at the community level. We must, above all, be willing to adapt and change quickly, neither clinging to rigid agendas, nor being tempted by industry-driven income streams with actions detrimental to the earth and to peoples' future.

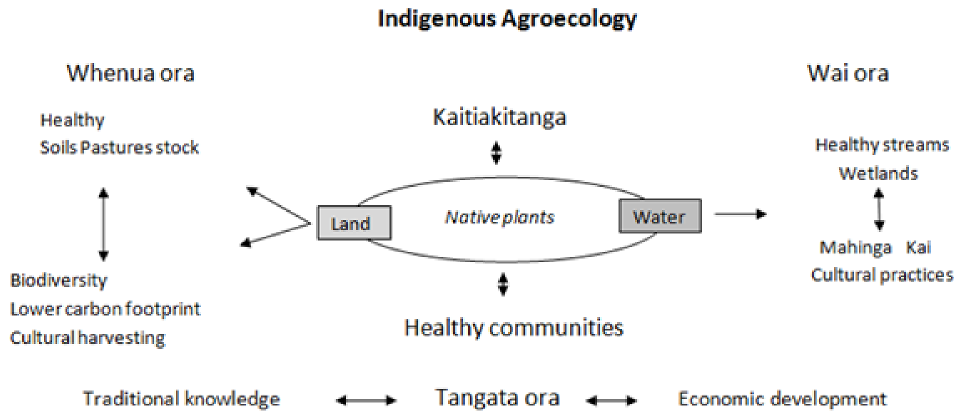


*Figure 2: Native species have a central role in the concept of Indigenous Agroecology*

The Indigenous Agroecology project has taken the first steps in developing an ethic for land management in Aotearoa New Zealand. By working with research link farms the team tried to ground their thoughts and investigations and to develop ideas that grew from the aspirations and knowledge of the local people yet drew on modern techniques to aid decisions around land management. Only a portion of the agroecology paradigm has been addressed thus far. We have looked at the Māori and Moriori concepts of land management, the management of waterways and the land, ensuring safety with respect to mahinga kai or food gathering. We studied the history of the farms and looked at alternative ways of encouraging and supporting the diversity of species on farm through animal health, diversity of food and production and ecosystems.

Although the concepts of Indigenous Agroecology draw on traditional knowledge, science and technology have much to contribute to the successful agroecological operation. We have mapped all the research link farms using Geographic Information Systems (GIS) and have examined the meeting of science and traditional knowledge.

### 2.3.1 Support for Indigenous Agroecology

Three trusts kindly agreed to work with the Indigenous Agroecology concept.

Te kete Wairewa manage Te Kaio farm on behalf of Wairewa, a people of Horomaka Banks Peninsula in Te Waipounamu South Island New Zealand. The second mainland farm Taiporutu, on the Mahia Peninsula in the North Island is managed by the Taiporutu trust. The third farm, Henga is on Rēkohu (Chatham Island) is managed by Hokotehi Moriori trust (Figure 3).

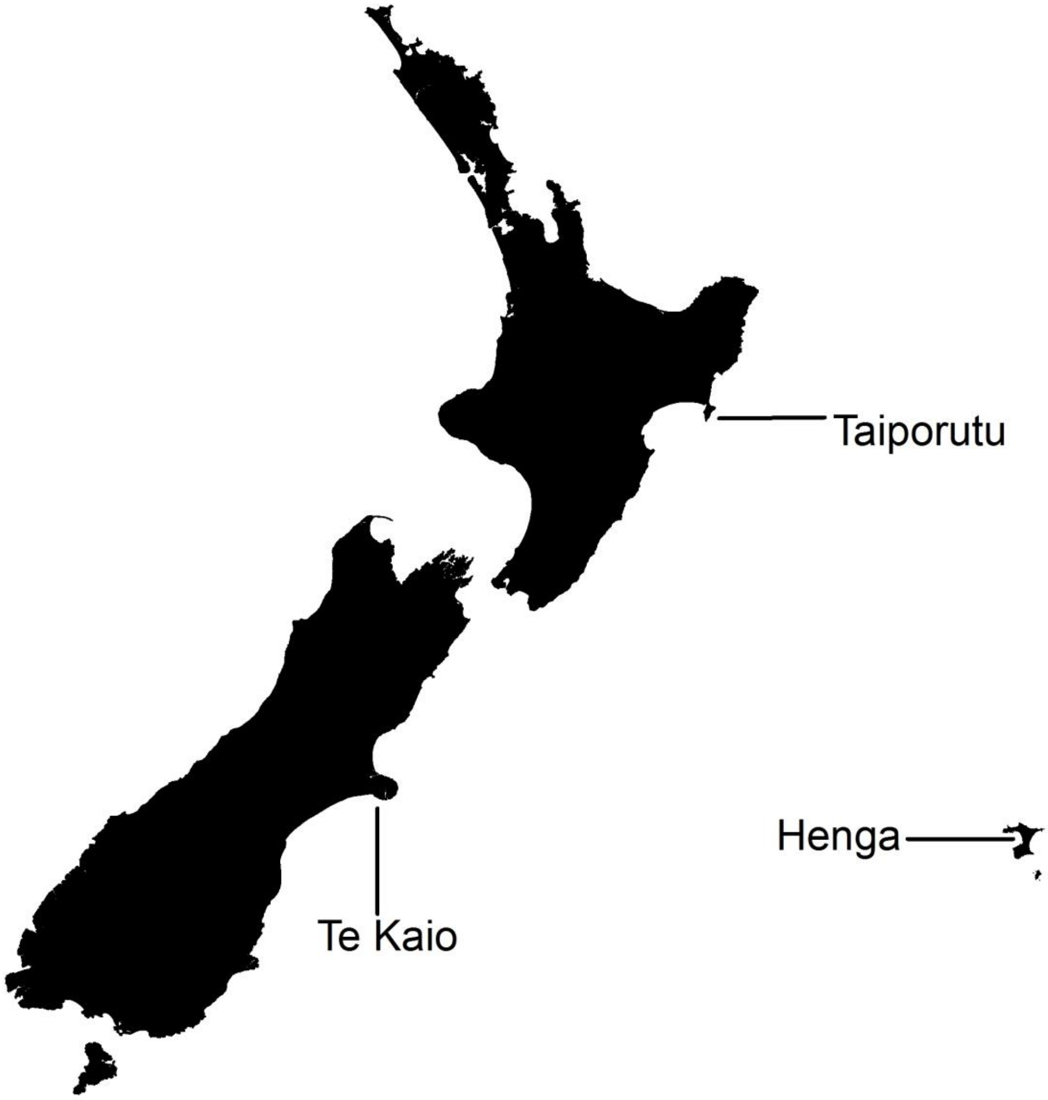


*Figure 3: Location of research link farms*

We have developed concept agroecological plans for Henga and Te Kaio and addressed the cultural significance of Taiporutu through bioremediation of significant spring sites. All the farms have to provide a return and support their peoples. Large economic returns are not always possible on small land areas, but regenerated land managed for health and in accordance with the aspirations of its owners can support its people culturally and spiritually, and produce an income, as well as food and medicines for the community.

## References

Altieri , M. 2009. Agroecology,Small Farms and Food Sovereignty. In *Monthly Review* (New York), pp. 102-112.

Gari, J.A., 2001. Biodiversity and Indigenous Agroecology in Amazonia:The indigenous peoples of Pastaza. *Etnoecologica* 5, 21-37.

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Special thanks to Tremane Barr who began the project and gave us our title He Ahuwhenua Taketake. Unfortunately due to ill health Tremane had to reduce his work commitments and withdraw from the project. He is thankfully recovered.

Taking up the hangi: Kopinga marae Rēkohu

# 3 Māori Land

Samantha Tihoi Jackson

Māori land management, use and ownership is complex and this has changed over time in New Zealand due to a number of influences. This chapter will be split into three major sections; Māori worldview, an historic approach to land management and Māori land use today. To understand Māori land use and ownership today it is useful to first understand the history of Māori land use in New Zealand. This begins first with understanding a Māori conception of land, values and concepts of care.

## 3.1 Māori worldview

Māori views of land and care find origin in pūrākau or creation narratives. While each tribal area has its own narrative there are common themes between tribes. According to some tribal areas[1], the world began in a dark void. There were two primordial parents, Ranginui (Sky Father) and Papatūānuku (Earth Mother), who were locked in a tight embrace. Through the embrace, the parents had seventy children. Tired of living in darkness, some of the children plotted to separate their parents. Shirres (1997, p. 16) recalls a mōteatea (chant) that captures the incident:

> *"Tokorima i pai kia wehea, kotahi i aroha - koia ena kupu, te po, te po, te ao, te ao, te kimihanga, te hahaunga, i te kore, i te kore. Ko ta ratou rapunga whakaaro hoki, mo o ratou matua kia tupu ai te tangata."*

> *"Five agreed that they (the parents) should be separated, one felt compassion for them. Therefore those words, the night, the night, the day, the day, the seeking, the searching, from the nothing, from the nothing this was their searching out for ideas for what to do about their parents, so that the human race could grow."*

Those who agreed to separate their parents trialled various methods. Tūmatauenga (the God of war) cut the arms of his parents and Tāwhirimātea (the God of the winds) blew winds of rage, both unsuccessful attempts for the parents to relinquish their embrace. Finally, Tāne (the God of man and forest and birds) thrust himself between his parents. Tāne wedged his feet onto his father and his hands onto his mother and with a powerful upward drive he propelled his parents apart, Ranginui skyward and

[1] Including the tribes of Northland through which I have whakapapa (genealogical) links to.

Papatūānuku to the earth below. This central act of separation is attributed to the origin of all life, light, knowledge and being for tangata whenua.  Following the separation Ranginui and Papatūānuku and their sons remain constantly present as the Sky Father and the Earth Mother and guardians of various domains including the oceans (Tangaroa), winds (Tāwhirimātea) and so on (Marsden, 2003a, 2003c).

## 3.2 Tangata whenua

A second pūrākau, or narrative explains the origin of man whereby Tāne was in search of a partner in order for the human race to grow. Tāne fashioned a woman from the earth named Hineahuone, and breathed life into her. From their union all human kind descends.

These stories of origin position Māori as tangata whenua, literally people of the land. Because Māori are descendants of the land there are responsibilities to maintain the prestige of the land in a way that will last for generations. Ngāpuhi scholar Māori Marsden (2003c, p. 45) explains the important connection that Māori have with the land:

> *"Whenua was the term for the Natural Earth. It was also the term for 'after-birth' –placenta. This use of the term 'whenua' served as a constant reminder that we are born out of the womb of the primeval mother."*

The whenua nurtures us, physically, emotionally and philosophically. The whenua also nurtures other animals and plants, cementing our place in a woven order of being.  Marsden (2003b, p. 68) continues:

> *"the streams of water are her arteries, bringing the life giving waters for her to imbibe and share with her offspring. Those same streams act as alimentary canals and help in the disposal of waste. Because of this fundamental relationship, between a person and their world governed by cosmogonic processes, a person is junior to the natural world and can learn from it."*

Similarly, Mika (2012, p. 1086) writes:

> *"Māori believe that the self is part of the environment, and hence the self's uptake of anything- emotion, feeling, cognition, even physical attribute- is dependent on the interplay of whakapapa with the natural world. The deep links that Māori have with the natural world- seen and unseen- permeate outwards to include those who are*

*deceased and those who are yet to come, as well as past and future impacts on the environment."*

It is no wonder Māori have throughout history worked closely with the land and have politically tried to maintain rights to access landscape throughout time.

## 3.3 Take whenua: Principles of land rights

Within Māori worldview, the relationship with the land was ordered, and Māori gained rights through various means and mechanisms. According to Meredith (2012b) Major Rāpata Wahawaha, a Ngāti Porou leader, outlined some 28 variations of take whenua (principles of land rights) in a letter to the ethnographer Elsdon Best in the 1890s. At the core of these principles is the concept of ahikā, or ahi kā roa (the long burning fires of occupation). It was and is of importance for individuals within family groups to maintain their access rights through occupation of their ancestral areas. The following section provides a short description of the four major themes as outlined by Te Ara Encyclopaedia:

### 3.3.1 Take tuku: Transfers of land for a purpose

Take tuku refers to the transfer of land for the temporary access to a resource, or resources. According to Meredith (2012a) "anthropologist Raymond Firth wrote that 'the cession of land to another tribe seems to have been regarded as one of the most valuable of gifts, to be made only on occasions of great significance.'"

Meredith (2012a) further explains that Ngāti Kahungunu leader Īhāia Hūtana gave four examples of tuku whenua (the transfer of land):

1. He ngakinga-a-mate [payment for a death],
2. He pa-kuha [betrothal],
3. He kai-haukai [a return feast],
4. He whanaunga i tono kainga mahinga kai ranei [a relative has requested a house or an area for cultivating food].

### 3.3.2 Tāpae toto: Non-permanent transfers of land

Meredith (2012a) states that *"transfers of land were not always permanent. They were commonly accompanied by specific conditions, such as a requirement to supply food or other resources to a chief, or an expectation of support in times of conflict. Often a public ceremony recorded the grant."* There are many tribal examples of land being gifted during times of war under the concept of manaakitanga (hospitality).

### 3.3.3 Whenua kite hou: Discovery

Meredith (2012a) conjectures that *"the people who first discovered an area held general rights over it – known as whenua kite hou (newly discovered land)."* Ancestral rights and whakapapa were generally imbued in the landscape through the naming of particular features in the landscape – many of these names are carried through to present times. This act of naming a portion of land after part of their body, in order to reserve it for their future use, *"or for gifting or allocation to other was known as taunaha whenua or tapatapa whenua"* (Meredith, 2012a).

### 3.3.4 Take tīpunu: Ancestral rights

Many original placenames hold clues about the original inhabitants of particular areas, tell stories of the original ancestors and are a site through which Māori claim relationship with a landscape. This process is operationalised in modern times through the recital of pepeha. Hakopa (2011, p. 4) writes:

> *"Pepeha describes features of the land clothed with names given to the region by ancestors who inherited the region. Inherent in each name is a sacred corpus of oral traditions that describe the deeds of the ancestors, imbue the land with character and shape the identity of the local iwi or tribe as a separate and unique people of Aotearoa, New Zealand; behind each name is a story."*

This notion of pepeha, ancestral connection, is linked to take tupuna (ancestral rights). Take tīpunu are also linked closely to the concept of ahikāroa and burning fires of occupation. Ancestral rights to land were held by descendants who occupied and cultivated the land and these rights were expressed through whakapapa and naming.

### 3.3.5 Take raupatu: Conquest of new territory

Raupatu refers to the conquering of a new territory, displacement of original habitants and therefore gaining access to the resources of that territory. However, because of the importance of ancestral title and ahikāroa, take raupatu was generally thought to be less secure means of gaining land rights. The initial inhabitants may remain on, or near the lands and may challenge to re-establish themselves on the land. For outsiders seeking conquest, rights could be gained through marriage, where children would gain full ancestral rights to the land.

With the above arrangements, values and cultural forms of organization in mind it is clear to see that Māori land rights were complex, communal, resource-based and dependant upon a complex array of factors including genealogy, status, occupation and relationships. Boundaries were not rigid as they are today and the distribution of resources within a particular landscape involved the wellbeing of the collective.

### 3.3.6 Conclusion – take tuku

An understanding of Māori land is informed by a Māori worldview, their creation narratives, in addition to a specific set of principles such as take whenua, taka tuku, tāpae toto, whenua kite hou and take raupatu.  The following section will examine different waka (canoe) traditions and in particular the kūmara and hue in relation to important Māori food sources. This will provide a framework through which to understand early forms of Māori agriculture, which foods were used.

## 3.4 Kūmara and Hue

Māori have rich ocean traditions including the arrival to Aotearoa from Te Moananui-a-Kiwa (Pacific Ocean).  Some of the food that was on board the waka of these early journeys survived the change in temperature from the warmer climates of the Pacific to the cooler Aotearoa climates.  According to Best (1941, p. 354), Māori introduced four foods to Aotearoa *"the sweet potato, the yam, the taro, and the gourd."*

### 3.4.1 Kūmara

The kūmara was a particularly prized possession and many waka hold different stories about how the kūmara arrived here in Aotearoa. There are numerous accounts about the arrival of kūmara in Aotearoa; this becomes increasingly important because there was an agricultural shift towards potatoes with the arrival of European crops and technologies.

### 3.4.2 Waka Voyaging

There are several waka voyaging stories that describe how some of the traditional crops and food were brought to Aotearoa (see http://www.teara.govt.nz/en/canoe-traditions/page-1 for further information).  I will describe two such stories of the waka of Māhuhu-ki-te-rangi and the Arai-te-uru.

### 3.4.3 Māhuhu-ki-te-rangi (Māhuhu)

Māhuhu, also known as Māhuhu-ki-te-rangi and Māhuhu-nui-o-te-Rangi, is the ancestral canoe of Ngāti Whātua. Rongomai (referred to above) has been described as its captain.[2] Keene (1975, p. 44) writes:

> *"In company with the great Matatua came the Māhuhu-ki-te-rangi, whose captain was Rongomai and its tohunga, Whakatau-ariki. This was the canoes that brought the ancestors of Ngatiwhatua who eventually claimed the lands of the Kaipara and those as far South as Tamaki."*

Taonui (1996) further describes Māhuhu-ki-te-rangi as the *"most important canoe for the Ngāti Whātua tribes occupying the Kaipara region between the Hokianga Harbour and Tāmaki* [Auckland]*."* Taonui (1996) continues, the waka came from:

> *"Waerota, Waeroti and Mata-te-rā, after a feud over food resources. The canoe's cargo included several new types of food, including uwhi (yam), kūmara (sweet potato) and taro, another starchy tuber."*

The Māhuhu explored various places in Aotearoa including Whangaroa, Tākou and Whangaruru with other accounts saying the waka went on to explore the Bay of Plenty and East Coast before returning northward to Pārengarenga. From here it rounded North Cape and sailed down the West coast of Northland.

Because of the extensive travel around northern parts of Aotearoa, Māhuhu-ki-te-rangi appears in many tribal traditions (Taonui, 1996, p. 59). A map of exploration sites of the Māhuhu waka can be seen below.

[2] There is contention both as to who was the captain of Māhuhu and where its landing places were.


*Figure 1: Exploration sites of Māhuhu waka. Adapted from "Canoe Traditions" by Taonui, 1996, in Bateman (Ed.),* Te Ara Māori Peoples of New Zealand: Ngā iwi o Aotearoa *p. 60.*

### 3.4.4 Ārai-te-uru

There is a well-known kōrero in the South about the Ārai-te-uru waka. The crew of the waka carried the kūmara and on its journey further south the waka was ravaged by a wild storm. The crew and the cargo on board were washed to shore. The crew became immortalised into the mountain and hill ranges around East Otago and the food baskets and kūmara were petrified as the large rounded rocks on the beach at Moeraki.

Beyond the myriad of tribal accounts, Elsdon Best collected and published much information about the cultivation of the kūmara, the times of planting by the moon, the karakia and practices associated with its cultivation and harvest, and the implements used for cultivation as well as the numerous names and varieties (Best, 1941).

### 3.4.5 Hue

The gourd had many uses traditionally, including being used as carrier vessels. However, because of the climate gourds were not widely available in New Zealand. Best notes (1934, p. 178) "In the South Island, and in some parts of the North Island, the gourd-plant did not flourish, hence seaweed and bark vessels were much used".

Early voyagers in these seas speak of the extremely neat manner in which the Māori kept his cultivated lands (Best, 1941). Of such seen on the East Coast, Banks wrote: *"their plantations were now hardly finished, but so well was the ground tilled that I have seldom seen land better broken up…Each distinct patch was fenced in, generally with reeds placed close by one another, so that a mouse could scarcely creep through"* (Best, pp. 28-29).

### 3.4.6 Conclusion – Kūmara and Hue

The waka traditions show a rich history of connection to some of the main food types eaten by Māori, two of which, were the kūmara and hue. The following section will look briefly at Māori agricultural practice over time and how it has changed, within the way that Māori have managed land.

## 3.5 Introduction of European Food Plants

New European crops were introduced and according to Best (1931, p. 18) *"had quite an important effect on Māori life and activities."* The potato for example was easier to grow and cultivate than the kūmara. *"It was the coming of the potato that struck fern-root off the daily bill of fare of the Māori"* (Best, 1931, p. 19). The potato affected Māori in a number of ways including: a change in the daily tasks of food gathering; fishing; birding and collecting wild vegetables.

Some of the early narratives of the introduction of European foods suggest that in the far north potato, pigs, fowls, wheat, peas, and rice were given in 1769 to Māori, however it is not clear by whom (Best, 1931).

*"In 1772 Marion du Fresne planted potatoes in the north, and Roux's Journal shows us that wheat, maize, potatoes, and various kinds of nuts were planted, and grew well. The maize and wheat were not, according to later evidence, retained and utilised. Crozet mentions having planted, on Motuaro isle at the Bay of Islands, "all sorts of vegetables, stones and the pips of our fruits, wheat, millet, maize, and, in fact, every variety of grain which I*

*had brought from the Cape of Good Hope; everything succeeded admirably" (Best, 1931, p. 19).*

Further, according to Best (1931, p. 20) in the far north the natives are said to have grown two crops of potatoes in the year not very long after they had acquired them. In certain districts further south, the Māori employed a peculiar method in order to obtain a very early crop of potatoes. This method is termed *whakapara* by the Tuhoe natives, and *whakaota* at Taupō. The seed tubers are planted about June in scrubland or light bush. The bush is then felled and burned off in the spring, the fire destroying the haulm that has grown up through it. The growth is protected from frost by the brush and branches, and, after the burning, the potato-growth springs up again.

Wheat was also an introduced food supply eaten by Māori and sold to European traders.

Best (1931, p. 21) aptly concludes that the

> *"Polynesian folk have apparently been agriculturists for untold centuries. They brought from hidden lands beyond far horizons the genius and instincts of soil-tilling man. They carried with them on their deep-ocean voyages their economic plants and often their few domestic animals. They cultivated such plants wherever they settled if it was possible to do so, in some cases at the expense of much toil and trouble, as in certain parts of New Zealand. Their agricultural tools were primitive in the extreme, but the system of universal service enabled them to perform the necessary tasks with despatch, and the racial genius for detail resulted in extreme regularity and neatness in their cultivation-grounds."*

Best (1931, pp. 21-22) describes the importance of worldview, practice, beliefs and tikanga connected to agriculture. Furthermore, an importance was placed on the connection to Matariki and food stores:

> *"When spring came it was then that Mahuru (personified form of Spring) sent the cuckoo hither to call the Māori folk to the annual task of the husbandman. When the wharauroa, the far-travelled one, was heard crying "Koia! Koia! Koia!" the Māori seized his ko and, in company with all members of his family group, went forth to obey the behest of Mahuru, before Hine-raumati, the Summer Maid, appeared. Ere long the ground was cleaned and the mara was koia, or planted. When Whanui, the low-hung star of Vega, was seen above the*

*horizon for the first time, ere dawn appeared, the Māori knew that it was time to prepare his store-pits and lift his crops. When, after those crops were stored, he saw Matariki, the Pleiades, appear in like manner, he knew that a new year had arrived."*

Matariki continues to be celebrated by Māori today.

"In far-off lands that lie beyond the curve of the earth, the ancestors of the Māori dwelt in the remote past. In the realm of Irihia that gives on the gleaming sunset they cultivated the "small seed" termed *ari* and *vari,* possibly the rice of western nomenclature.  In Rongo they saw the moon-god of agriculture of Babylonia, and in Pani a popular Ceres who gave birth to the prized food-product in water, even as it germinates in these days, but who was apparently transferred to the *kūmara* in later times. The ancient symbols of fertility, the phallus and the crescent moon, were carried far across wide seas and are yet in evidence in this land of Aotearoa. At Easter Island a crescent-shaped stone symbolised fertility, even as did the crescent-symbol at the head of the *ko,* the Māori digging-tool—a symbol that betrays its origin in its two names—*whakamarama* and *whakaaurei* (Best, 1931, p. 22).

According to Whaanga (2012, p. 49)

*"The earliest European accounts of Māori gardens were those of William Monkhouse, surgeon on the Endeavour. In October 1769, he wrote of extensive gardens at Anaura Bay which he estimated to be a hundred acres in extent: The ground is completely cleared of all weeds – the mold broke with as much care as that of our best gardens.*

As European crops were introduced, because of the ease in which they could be grown they were quickly adopted and spread from area to area. According to Hargreaves (1959, p. 64)

"By mid-century wheat, maize and potatoes were the favourites and had become the staple diet of the Māori, while vegetables such as cabbages, onions, carrots, turnips, marrows, beans; fruit such as apples, peaches, quinces, cherries and grapes; and other crops like oats, barley, water melons and tobacco were grown success fully. Tobacco was grown primarily for home consumption although it occasionally appeared on the Auckland and other markets under the name of raurau."

These early accounts of Māori-European contact are important because Māori agricultural practices before European introduced foods were very labour intensive. Māori used a number of grubbing tools including the kō and the timo[3].

### 3.5.1 Commercial Production

It is clear that as European settlers arrived, with introduced food crops Māori began to adapt their agricultural practices. This adoption of foreign food crops such as potatoes was very successful. According to Durie (in Whaanga, 2012, pp. 56-57)

The Waikato, Bay of Plenty and Poverty Bay capitalised upon the traditional Māori skills in gardening to make the 1840s to 1860s a golden age in Māori agriculture and economic growth. The feats of Māori farming in the early days of European settlement have not always received the historical recognition they deserve. Certainly the advances made have never been repeated in Māori history. While today Māori farmers are predominantly pastoralists, Māori agriculturalists were then in the business of growing crops and it was as croppers that they made a tremendous impact on the early New Zealand scene.

In the late 1850s the Māori people of the Bay of Plenty, Taupō and Rotorua districts had more than 9000 acres of wheat, potatoes, maize and kūmara under cultivation and there are reports of similar developments throughout the Poverty Bay, East Coast and Waikato areas. At that time the Māori people also built and operated several flourmills.

In 1857, one observer recorded 43 small coastal vessels averaging 20 tons each as belonging to the Bay of Plenty Māori, while at the Port of Auckland in 1858, 53 small vessels were registered as being in native ownership and the annual total of canoes entering the harbour was more than 1,700. ....but it must be noted that success was easier for the Māori people last century. They owned most of the good land then, they farmed communally, and they had no labour costs.

Whaanga (2012, p 56) explains that:

By the time of the establishment of the Native Land Court in 1862, the New Zealand Wars had already begun. These conflicts were to lead to the confiscation of vast areas of the best croppable land,

[3] See 1.14.11

and the destruction of the economic base of Māori throughout the country. The agency to effect the transfer of Māori lands into the hands of Pākehā settlers was the Native Land Court.

To obtain a Crown Grant to their ancestral land, it was necessary for our ancestors to give evidence attesting to their rights to various areas. Prime amongst the rights to land were those of take tipuna and ahikāroa. A critical part of proving ahikāroa, the long occupation of the land, was knowing where its resources were, how to use, capture or grow them, and when the resources could be harvested.

### 3.5.2 Introduction of Crops

According to numerous scholars, the major crops introduced were the white potato and wheat, and limited livestock, notably the pig, by early European explorers in the late 1700s (Best, 1925; Grey, 1994; Lambert, 2008). *"More systematic introductions occurred under the direction of Reverend Samuel Marsden"* (Lambert, 2011, p. 2) with Māori adopting the new crops, livestock, technologies, and activities onto their own land.

> *"The growth and spread of these new farming methods through Māori society was remarkable…European settlers observed - and benefitted from - the establishment of Māori commercial ventures (Hargreaves, 1959, 1960, 1963; Petrie, 2006). Māori leaders who emerged, or cemented their status in their relations to the visiting early traders, in this period were those who recognised and pursued particular innovations, notably muskets and potatoes (R. D. Crosby, 1999), or including particular "activities" or concepts such as Christianity, literacy, trade and commerce (Salmond, 1997, 2000). Ultimately the economic success of Māori, and its exclusivity through land-ownership, was a key cause of the brutal military colonisation that was to dominate the 1860s (Belich, 1996; King, 2003) and lead to the precipitous decline of Māori society and its highly productive agriculture"* (Lambert, 2011, p. 3).

#### *3.5.2.1 Potatoes, Pigs and Peas*

Kingi (2012a) notes:

> *"when Captain James Cook arrived in New Zealand in 1769 he gave (or traded) cabbage, turnips and potatoes to Ngāti Porou in Ūawa (Tolaga Bay). In the same year the French explorer Jean François Marie de Surville brought wheat, rice and peas to Doubtless Bay. Four*

*years later, on Cook's second voyage in 1773, he visited Ūawa again and dropped off pigs and potatoes. From 1803, Māori were reported trading in potatoes, pigs, maize and other foodstuffs."*

#### 3.5.2.2 The Plough and Christianity

The event of early European settlement meant Māori gained access to new technologies and were able to extend their tools beyond the use of kō and timo (digging and grubbing instruments), meaning they could work larger areas of land (Kingi, 2012a).

*"In 1814 the missionary Samuel Marsden introduced horses and cattle. Missionary John Butler introduced the plough in 1820. These new domesticated animals and iron tools eased the workload for land preparation. Māori who travelled overseas could learn about different farming methods. When Ngāpuhi leader Ruatara returned from overseas he took an active role in the adoption of European farming methods within his tribe"* (Kingi, 2012a).

#### 3.5.2.3 Wheat Growing and Shipping

*"The rise of Māori agriculture was rapid between 1830 and the 1850s. Most of the coastal shipping in the North Island was under Māori ownership, and Māori grew a large proportion of the food sold locally and exported to Australia. By the 1850s wheat growing had become widespread throughout the North Island and Māori were building dam- or water-operated flourmills throughout the country. Between 1846 and 1860, 37 flour mills were built for Māori owners in the Auckland province alone"* (Kingi, 2012a).

#### 3.5.2.4 Reliance on Māori

*"Expanding Māori agriculture in the mid-1800s played its part in the emergence of New Zealand as a leading agricultural nation. New Zealand's population of European settlers began to increase rapidly during this period. Initially settlers, unfamiliar with local soils and climate, were reliant on Māori for food supplies. In 1842 Bishop G. A. Selwyn noted that Nelson settlers were completely dependent on the local tribe for food. The success of Māori as agriculturalists at this time was noted"* (Kingi, 2012a).

With an increasing number of Europeans arriving in Aotearoa, they were interested in finding land to settle. Often Māori chiefs would allow European settlement in exchange for goods. From the chief's perspective, this was under the provision of 'manaakitanga' or hosting and hospitality, however, from European eyes, these early transactions meant granting absolute ownership.

In pre-treaty times all types of agreements were made upon land.

*"Alienation of Māori land began before British sovereignty was proclaimed over New Zealand in 1840. Missionary organisations, private settlers and New South Wales land speculators all entered into various kinds of land transactions with Māori. For example, the Te Rarawa chief Nōpera Pana-kareao arranged with the Church Missionary Society for 1,000 acres (405 hectares) to be set aside at Kaitāia for the mission. There were numerous similar arrangements wherever missions were located"*

*(Boast, 2012b).*

*"Commercial arrangements made land available for cutting timber or building wharves and jetties. Some Pākehā settlers, whalers and businessmen married to Māori women arranged with local chiefs to set land aside for their families. There were also many speculator transactions. New South Wales businessmen made all kinds of deals with Māori, probably in the hope of obtaining equitable (or 'weak') interests which could be converted into 'strong' legal or Crown-granted interests after British sovereignty was proclaimed"* (Boast, 2012b).

Boast (2012a) explained the meeting of different worldviews:

*Māori land tenure includes complex overlapping rights over both land and sea, with a number of methods of acquiring title. English common law recognises indigenous customary titles through aboriginal title, which means that customary tenures survive until the new sovereign power extinguishes them lawfully.*

In New Zealand, it was unclear to British residents whether the crown gaining governorship over New Zealand conferred all rights and full legal ownership over the land. However, the practice of the New Zealand government was that Māori title extended over the whole country, and had to be extinguished – usually by purchase – before it could be granted to new settlers.

Because of Māori relationship to and understanding of land rights (as discussed above) Māori believed the loaning or gifting of land did not extinguish their ahikā and rights to land. Māori saw an opportunity in attracting aspects of European culture (for example, Māori had already benefitted from taking on new crops and trade).

### 3.5.3 Māori View of 'Sales'

Boast (2012b) explains that "New Zealand was still governed by Māori customary law, and Māori would have viewed transactions within the framework of their own culture and expectations. They may have seen many deals as a part of entering into reciprocal or shared relationships – not really 'sales' as the term is understood today. Some chiefs allowed Europeans to settle on a piece of land in exchange for goods, but did not see this as granting them absolute ownership – they saw it as a transfer of particular rights which remained subject to Māori rights to the land".

Lambert (2011, p. 3) writes, *"European settlers observed – and benefitted from – the establishment of Māori commercial ventures* (Hargreaves, 1959, 1960, 1963; Petrie, 2006). *Māori leaders who emerged, or cemented their status, in this period were those who recognised and pursued particular innovations, notably muskets and potatoes* (Crosby, 1999)*, or including particular 'activities' or concepts such as Christianity, literacy, trade and commerce* (Salmond, 1997, 2000)."

This led to increasing tension in Aotearoa with Māori maintain exclusive land ownership and proving to cultivate a successful colonisation, what followed is described by Lambert (2011, p. 3) as *"a brutal military colonisation that was to dominate the 1860s* (Belich, 1996; King, 2003) *and led to the precipitous decline of Māori society and its highly productive agriculture."*

This period can be defined as a systemised alienation of Māori land ownership and rights, which gives context to Māori society today. It was the arrival of the Europeans, the apparent lawlessness of European subjects that would provide impetus for Māori to enter into a formal arrangement with Europeans. This lead to the drafting and signing of Te Tiriti o Waitangi, to try and create rules, however, this further added to confusion about views toward land. Below is a table of the legislative history of land ownership in New Zealand throughout history as reproduced from the Auckland University Library.

## 3.6 Te Tiriti o Waitangi and Treaty of Waitangi

Te Tiriti o Waitangi/Treaty of Waitangi was signed on 6 February 1840. It was a treaty of cessation between the Chiefs of the Māori tribes of New Zealand and the Queen of England (Orange, 1987). There are significant discrepancies with both texts as neither is a direct translation of the other (Ross, 2001). There are three main articles and the second article of both versions is of particular relevance to this report. The second article of Te Tiriti states "te tino rangatiratanga o ō rātou wenua ō rātou kāinga me ō rātou taonga katoa". The second article has a variation of meanings for example: "the full possession of their lands, their homes and all their possessions" (Ngata, 1963, p. 7); "the unqualified exercise of their chieftainship over their lands, villages and all their treasures" (Kawharu, 1989, p. 321) and; "their paramount and ultimate power and authority over their lands, their villages and all their treasured possessions" (Mutu, 2010, p. 25).

The second article of the Treaty states:

> *"Her Majesty the Queen of England confirms and guarantees to the Chiefs and Tribes of New Zealand and to the respective families and individuals thereof the full exclusive and undisturbed possession of their Lands and Estates Forests Fisheries and other properties which they may collectively or individually possess so long as it is their wish and desire to retain the same in their possession."*

## 3.7 Historical Land ownership

The rapid change in Māori land ownership can best be seen in the following timeline reproduced from the Auckland Library.

*Table 1: Change in Māori land ownership from 1840 – 1993.*

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|---|---|
| 1840 | **Treaty of Waitangi** signed by 500 rangatira around New Zealand. Article 1 gives the kāwanatanga of New Zealand to the British Government. Article 2 confirms the "tino rangatiratanga" of the chiefs and hapu and all the people of New Zealand over their lands and villages, but gives the queen or her representatives the buying of those pieces that they might wish to sell. Article 3 as a quid pro quo, allows the people of New Zealand exactly the same tikanga (rights, privileges, customs) as the people of England. |
| 1844 -1846 | Governor Fitzroy waives Crown pre-emption in favour of direct purchases. Much Auckland city land purchased under this system. |
| 1850 | Large scale Government purchasing continues especially in Northland, Wairarapa, Hawke's Bay and Manawatu.<br>**1857** Māori King crowned. Further sales of land in Waikato and Taranaki halted. Would be sellers face severe sanctions.<br>**1859** Government attempt to purchase land at Waitara, Taranaki from a minor chief encounters armed resistance. |

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| 1860 | **1860-1863** War in North Taranaki<br><br>**1862 Native Lands Act** sets up Court to adjudicate on ownership but remains a dead letter.<br><br>**1863 New Zealand Settlements Act** Districts in arms against the Government to be confiscated. Queenites and neutrals may apply to a Compensation Court to have their interests returned. Large areas were taken in the Waikato, Tauranga, Whakatane/Opotiki and Taranaki and smaller areas in Gisborne, Wairoa and Hawke's Bay.<br><br>**1865 Native Lands Act** Any Māori owner can apply for title. Survey generally required before investigation can begin. Judge and two Māori assessors to agree. Ownership to vest in either a hapu or in no more than 10 owners. Provisions for Māori jury as an alternative. Hapu title and jury used in less than 10 cases. Direct leases and sales now valid of land passed through Court. Higher prices but more litigation. Government retains right to advance money before cases are heard and Government purchasing continues to dominate the market. Conveyances of individual shares to be before a Judge or a JP.<br><br>**1866 Amendment** requiring any restrictions against sale or lease to be noted on every title.<br><br>**1867 Native Lands Act** Names of any other owners must now be endorsed on the back of the title. Those named on the front (10 or fewer) can lease but not sell. Most blocks brought into Court continue to be awarded to less than 10 named rangatira.<br><br>**1867** Four Māori seats created in settler-dominated Parliament.<br><br>**1869** Native Lands Act Amendment Act? Alienation by a minority of owners not lawful. Majority of owners (by value) may apply for a partition. |
| 1870 | **1870 Native Lands Frauds Prevention Act** Trust Commissioners appointed to ensure sufficient land retained for alienators support.<br><br>**1873 Native Land Act** All owners must now be registered on a Memorial of Ownership with presumed equal rights unless a further hearing determines otherwise. Block cannot be sold or leased without consent of every owner. Majority of owners may apply to partition out interests of sellers. Undivided interests protected against action to recover debt. Judge or magistrate and interpreter must certify deeds of alienation. Reserves of at least 50 acres per head must be retained. Individual owners |

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| | continue to sell shares. Buyers can partition out proportion of interests acquired. |
| 1880 | **1881 Native Lands Frauds Prevention Act** All sales of shares must be approved by Trust Commissioners. Sellers must prove they retain sufficient land to support them (More than 50 acres per head depending on land quality).<br><br>**1882 Native Land Division Act** Pakehas who have bought up individual shares in the past can apply for a partition of their interests.<br><br>**1882 Crown and Native Lands Rating Act** All land within 5 miles of a highway to be subject to rates. Government to pay for Māori owned blocks and charge it as a lien against the land.<br><br>**1882 Native Reserves Act** Native Land Court can remove restrictions on application of owners if they still have sufficient land.<br><br>**1883 Native Land Laws Amendment Act** Unlawful for private buyers to negotiate until 40 days after title awarded.<br><br>**1884 Native land Alienation Restriction Act** Private lease and purchase prohibited on 4 million acres near route of the main trunk railway line in King Country and upper Wanganui.<br><br>**1885** 1,107,727 acres sold since 1873 for 326,965 pounds.<br><br>**1886 Native Land Act** Elected block committees may sell to Crown or sell and lease through a Government appointed Commissioner. Little land is affected. Other private dealing outlawed but uncompleted purchases, if registered within 3 months, can proceed.<br><br>**1886 Native Equitable Owners Act** Owners left out of titles under earlier legislation (10 owner rule 1865-1867 or in other cases where those on the title were really trustees for the whole hapu can apply to have their names added.<br><br>1886 Native Land Court Act A consolidation.<br><br>**1888 Native Land Act** Repeals 1886 Act and reinstitutes free trade.<br><br>**1888 Native Land Court Act** 1886 Amendment Act Extends completion of purchase provisions.<br><br>**1888** Native Lands Frauds Prevention Act 1881 Amendment Act No sales of lands except those owned by less than 20 people. Commissioner to approve sales with regard to sufficiency of remaining land. |

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| | **1889 Native Land Frauds Prevention Act** Amendment Act Trust Commissioners also required to examine fairness of price. Removes requirement to subdivide. |
| 1890 | **1891 Native Lands Commission** (Rees, Carroll and MacKay) reports on effects of introducing private sales and recommends resumption of Crown preemption.<br>**1892-1894 Validation Court** set up to decide equitably on complicated cases of uncompleted purchases of individual shares.<br>**1893 Amendment Act** allows Government to initiate title investigations.<br>**1894 Native Land Court Act** Major consolidation. General resumption of Crown preemption. Amendments in 1895 and 1896 allow exemptions for small blocks with 1 or 2 owners subject to confirmation by the Native Land Court. Provisions for incorporation of owners and committees of management. Native Appellate Court created. |
| 1900 | **1900 Māori Lands Administration Act** Seven regional Māori Land Councils set up to manage surplus lands. Separate category of papakāinga lands to be inalienable. Papatupu block committees appointed by Councils to investigate title to large areas remaining outside the Court system in Northland and the East Coast. Provisions for Councils to take over management of some categories of land. Sales by majority of owners or by incorporations require consent of Council and a papakāinga certificate from each owner re sufficiency of remaining land interests.<br>**1902 Land Titles Protection Act** Titles over 10 years old may not be contested without special permission from the Government.<br>**1902 Māori Land Laws Amendment Act** Hapu and whānau can obtain papakāinga certificates.<br>**1904 Native Land Rating Act** Customary land remains exempt but Minister can require a title investigation.<br>**1905 Māori Land Settlement Act** Māori Land Councils become appointed Land Boards with a brief to sell or develop unutilised lands. Compulsory vesting of surplus lands in Taitokerau and Tairawhiti – voluntary elsewhere. Private leases allowed subject to consent of boards.<br>**1907-1909 Stout-Ngata Commission of Inquiry** |

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| | investigates remaining blocks with a view to determining which should be sold and which should remain in Māori hands.<br><br>**1907 Native Land Settlement Act** Māori Land Boards must sell 50% of surplus lands vested in them and lease 50%. Provisions for Boards to lend money to Māori farmers.<br><br>**1909 Native Land Act** Major consolidation of 69 existing Acts. Generally reintroduces private dealing in Māori land with provisions for decisions on sales and leases to be made by a majority of shares at meetings of owners. Powers to vest land in Māori Land Boards limited to noxious weeds and unpaid rates. |
| 1910 | **1913 Native Land Amendment Act** Māori Land Boards and Native Land Court amalgamated. Crown may purchase individual interests. Minister may apply for title investigation and partition.<br><br>**1914-1920** Last big blocks of land under customary title investigated by Native Land Court. |
| 1920 | **1921 Native Land Amendment and Native Land Claims Adjustment Act** Provides for consolidation of scattered interests and exchanges with the Crown.<br><br>**1924 Native Land Rating Act** Native Land to be rated the same as other land.<br><br>**1927 Native Land Amendment and Native Land Claims Adjustment Act** Unpaid rates written off.<br><br>**1928 Native Land Amendment and Native Land Claims Adjustment Act** Māori Land Boards to administer and develop on behalf of owners.<br><br>**1928 Sim Commission** investigates confiscations.<br><br>**1929 Native Land Amendment and Native Land Claims Adjustment Act** Provides for large-scale development schemes. |
| 1930 | Āpirana Ngata continues large-scale depression era schemes to develop unproductive Māori land using unemployed Māori labour.<br><br>Government schemes to promote consolidation of uneconomic interests in different blocks of land to create viable farming units.<br><br>**1931 Native Land Court Act Consolidation** |

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| | **1936 Native Land Amendment Act:** Crown land can be included in development schemes. 1938 Social welfare policies of Labour government provide substantial pensions, child benefits, cheap housing in rural areas. |
| 1940 | Large-scale Māori migration to cities and towns begins during war years.<br>**1944 Ngāi Tahu Claim Settlement Act** "Final settlement" over Crown purchases in 1848. Ngai Tahu Trust Board.<br>**1944 Taranaki Māori Claims Settlement Act** "Final settlement" of claims over 1863 confiscation. Taranaki Māori Trust Board.<br>**1946 Waikato-Maniapoto Māori Claims Settlement Act** "Final settlement" of confiscation claims. Tainui Māori Trust Board. |
| 1950 | **1950 Māori Purposes Act** Provides for compulsory improvements clauses (at 75% of value in leases.<br>**1952 Māori Land Amendment Act** Abolishes Māori Land Boards.<br>**1953 Māori Affairs Act** Mainly a consolidation. Provisions for "conversion" of uneconomic shares (value less than 25 pounds) in multiply owned land by sale to other owners or the Government are strongly resisted.<br>Government policy and full employment encourages burgeoning Māori population move to cities. |
| 1960 | **1967 Māori Affairs Amendment Act** Conversion level raised to 50 pounds.<br>**1967 Māori Purposes Act** Quorum of owners at meeting for sale raised to 10 or 25% by person or value.<br>Majority of Māori population is now based in urban centres. |
| 1970 | Māori activists challenge Government policy and race relations record.<br>**1974 Māori Affairs Amendment Act** Māori-owned general land can be returned to status of Māori Land. Quorum for alienation raised to 75%. Conversion of uneconomic shares repealed.<br>**1975 Treaty of Waitangi Act** Waitangi Tribunal set up to investigate current breaches of rights provided under the Treaty of Waitangi. |

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|---|---|
| | 1977 Town and Country Planning Act 1978 Occupation of Bastion Point, Auckland. |
| 1980 | **1985 Treaty of Waitangi Amendment Act** Jurisdiction of Waitangi Tribunal extended back to 1840.<br><br>**1986 State-owned Enterprises Act** Protects existing Māori claims to Crown assets being transferred to SOEs.<br><br>**1988 Treaty of Waitangi (State Enterprises) Act** Protects possible future Māori claims to assets of SOEs, including those subsequently sold to third parties.<br>**1989 Crown Forests Assets Act** Ground rents on forest lands where cutting rights have been sold to be paid to Crown Forestry Rental Trust and subsequently divided between Māori claimants and Crown according to recommendations of the Waitangi Tribunal. Interest to fund claimants research. |
| 1990 | **1991 Resource Management Act** Strong emphasis on Māori cultural issues, especially wahi tapu. Applications for resource consents must be sent to iwi authorities. Relation of Māoris to ancestral lands must be taken into account.<br>Claims to Waitangi Tribunal pour in from all parts of New Zealand. Tribunal begins to group claims for regional hearings.<br><br>**1993 Te Ture Whenua Māori Act** To promote retention of land in Māori ownership. Provides for various types of trust management and preferred classes of alienees in cases of sale. Māori Land Court to determine appropriate representatives for Māori groups.<br><br>**1998** Ngai Tahu claims to the South Island settled for $170 million and acknowledgement of residual ownership rights over various reserves. |

http://www.library.auckland.ac.nz/subject-guides/Māori/guides/Māori-land-timeline.html#top

Māori lost land to the Crown and private owners through a wide variety of methods. The dominant acquirer, by purchase or otherwise, was the Crown, even after the first Native Lands Acts were passed in 1862 and 1865, setting up the Native Land Court to investigate Māori land titles. According to Whaanga (2012, p. 147) "between 1870 and 1900 the Crown had acquired 7,582,705 acres, more than what was estimated to remain to Māori".

## 3.8 Land confiscation

Kingi explains (2012b) *"the confiscation of Māori land following wars between some Māori tribes and the government targeted* *prime agricultural lands, particularly in Taranaki, Waikato and the Bay of Plenty."*

Further, Boast (2015) states *"for most of the period from 1840 to 1865 land acquisition from Māori operated under the doctrine of Crown pre-emption – only the Crown could extinguish Māori customary title to their lands. Private individuals could not buy land directly from Māori. This was standard practice in all British colonies, and in New Zealand was set out in Article Two of the Treaty of Waitangi and in section two of the Land Claims Ordinance 1841."*

Furthermore, Boast (2015) outlines that *"some historians have noted that the pre-emption rule allowed the government to buy land cheaply from Māori and then on-sell it to settlers at a higher price, with the profits supporting the costs of immigration by British settlers. But probably pre-emption was introduced simply because it was standard practice. It was also intended, at least in part, to protect Māori from private European purchasers."*

### 3.8.1 Purchase under Pre-emption

*"In this period about two-thirds of the entire land area of New Zealand was 'bought' from Māori, using deeds of sale. Māori would sign a deed (essentially a formal sale contract), usually written in both English and Māori. This would record that a certain area had been purchased by the Crown in exchange for a cash payment and the right to retain certain reserves or access to resources such as fish. Some of these deeds related to huge areas, sometimes thousands of square kilometres – while others were for small blocks of just a few hectares"* (Boast, 2015).

*"Using this method the government acquired virtually the whole South Island and substantial areas in the North Island, especially close to Auckland and Wellington. The land was then transferred to the various provincial governments, for sale and grant to private settlers. Ngāi Tahu of the South Island lost their very large landed estate to the Crown by a sequence of deeds between 1844 and 1864. Other important deed purchases were in the northern South Island, Porirua, parts of Hawke's Bay, the Rangitīkei region, Auckland and Northland"* (Boast, 2015).

### 3.8.2 Implications of Selling Land

*"Crown policy on these purchases was set by the colonial governors, especially George Grey and Thomas Gore Browne. The head of the Native Land Purchase Office was Donald McLean. He persuaded many chiefs to sell land to the government at low*

*prices by arguing that Māori would gain economic advantage from British settlement"* (Boast, 2015).

*"Māori who sold land to the government usually did so on the basis that they would retain certain areas where the people could continue to live. The deeds were not always clear as to the size and location of these reserves, and many turned out to be very small, inaccessible, and insufficient to support local Māori. This was particularly the case with the Ngāi Tahu deeds, where the government's failure to set aside adequate reserves created a long-standing grievance, which was not resolved until the Ngāi Tahu claim settlement in 1998"* (Boast, 2015).

### 3.8.3 Individualisation

Legislation surrounding Māori land ownership had a direct impact on Māori agriculture. According to Kingi (2012b) *"the Native Lands Act 1862 was passed to individualise and register Māori land in a form that was recognisable under English common law – so that it could be readily traded."*

This was in direct contrast to the communally based traditional land tenure. The individualisation of land also led to the fragmentation both of land title and communities. Communal claim to land through ahikā was dismissed through individuals gaining the right to be named as owners of land blocks. As the generations continued, more people were named as owners of the land, which slowly fragmented and diluted the power for Māori to communally develop lands.

Māori were in search of ways of holding on to land and rights to develop and manage land. Lambert (2011, p. 3) notes:

*"within Māori farming we see politico-legislative responses such as that by a group of Māori landowners on the East Coast in the 1870s who vested their lands in a trust managed by Māori leader, Wi Pere and a Pākehā lawyer and politician, William Rees. This attempt led to the establishment of the New Zealand Native Land Settlement Co. Ltd. to capitalise Māori development strategies, the capital primarily coming from Pākehā* (MacKay, 1949). *Although this trust eventually went bankrupt, provoking its own legislative remedy, it illustrated Māori were open to accessing the commercial innovations of Europeans in the development of their lands."*

Māori began seeking for a means to come together under a single unitary organisation which become possible under the 1984 Native Land Act, however, this did not gain wide spread traction. 1929 proved to be significant in Māori land history *"with the* *introduction of the Māori Land Development Scheme by Ngāti Porou leader and cabinet minister Sir Āpirana Ngata"* (Kingi, 2012b).

According to Lambert (2011, p. 3): *"Ngata had been working for many years to improve the position of Māori, not least through increasing the productivity of their land* (Tuuta, 1996)*, and he vigorously pursued economic development through such organisations as the Union of Ngāti Porou Farmers"* (Walker, 2001).

Ngata was well positioned to assert his influence because not only was he Ngāti Porou, experienced in farming of the East Coast, but he was also well versed in European law. Lambert (2011, p. 3) continues: *"When Ngata was promoted to Minister of Native Affairs in 1928 he secured government funding for Māori landowners to develop their own farms, and the Native Land Claims Adjustment Act of 1929 allowed him to advance finance towards 'agricultural pursuits' and 'efforts of industry and self-help' for Māori"* (Walker, 2001, p. 235).

Further, agricultural and trades colleges were established in New Zealand and Australia and Māori became skilled in agriculture. However, according to Lambert (2011, p. 4) *"while the number of incorporations continued to grow, the co-operative spirit evident in their establishment had declined."* By this time the extent of European influence in New Zealand had extended beyond the pursuit of land and many other laws were put in place to assert European culture in Aotearoa. Therefore, many Māori had drifted to urban centres in search of opportunity, as a result, *"there was a corresponding decline in Māori farmers, from 9,773 in 1951, to 9,676 in 1956, falling to 9,141 in 1961"* (Butterworth, 1967, p. 34; Lambert, 2011, p. 4). Further, incorporations had become very complex and moved from a communal model to a capitalist model where there was paid labour, management and administrations. In this way, corporations come to resemble businesses, *"taking on many of the practices of private companies"* (2011, p. 4). Furthermore, *"the overall trend was for non-Māori, non-traditional social practices to become more and more prevalent in managing Māori land. It is this history of daily, seasonal and generational struggle that is woven through Te Ahuwhenua"* (2011, p. 4).

> *"In the Māori Affairs Act 1953 the main land management structures established were the section 438 trust, and the Māori land incorporation. Under Te Ture Whenua Māori Act, 1993, section 438 trusts became ahuwhenua trusts, while Māori incorporations remained unchanged"* (Kingi, 2012b).

## 3.9 Māori Land Today

The purpose of this section is to look at how Māori land use and management has changed in a modern context.

### 3.9.1 Māori Land Trusts and Incorporations

According to Kingi (2012b) around 1.5 million hectares of land in New Zealand is Māori land (around 5% of New Zealand's total land area). Of this, 750,187 hectares (or 49.5% of Māori land) is administered by ahuwhenua (Māori farming) trusts, and 207,157 hectares (or 13.7% of Māori land) is administered by Māori incorporations. Almost all of the incorporations, and a significant proportion of the ahuwhenua trusts, have an interest in agriculture. It is clear that Māori relationship to the land and interest in the land remains the same. Some tribes, such as Ngai Tahu have even begun to invest in Māori agricultural programmes to promote this as a viable employment option in the future.

Kingi further notes, the majority of these organisations are reliant on land-based sectors including agriculture, horticulture and forestry. In 2007 it was estimated that the asset value of these organisations was around $3.2 billion. This figure does not include the assets of Māori who privately own farms or forests" (Kingi, 2012b).

### 3.9.2 Individual Farmers

In terms of the remaining land, Kingi (2012b) notes:

> *"almost 300,000 hectares or 20% of Māori land is not administered by trusts or incorporations. Landowners who wish to live and work on ancestral land are required under legislation to gain the approval of a majority of the owners. This approval is formalised through the Māori Land Court in the form of a lease. Where the number of owners is small, an agreement can be gained relatively easily. However, owners can number in the hundreds or thousands, hence the predominance of trusts and incorporations"* (Kingi, 2012b).

### 3.9.3 Land Utilisation

In 1997 survey of 633 Māori incorporations and trusts showed how most Māori land is being used in an agricultural context and thus, agriculture remains a primary source of income for Māori. According to the survey, *"1.21 million hectares of Māori land were being used for agriculture (80% of all Māori land), 0.267 million hectares were in forestry (18%) and the balance of approximately*

*28,000 hectares was in urban property investments"* (Kingi, 2012b).

### 3.9.4 Effect on the Economy

Due to the significant amount of Māori utilising Māori land for agriculture, Māori contributions to New Zealand's farming economy are significant. According to Kingi *"in 2003 it was estimated that the annual agricultural and forestry production from Māori communally owned land assets was approximately $750 million per annum, around 5% of the total. In the early 2000s more than 15% of the country's sheep and beef exports came from Māori farming interests, and Māori owned around $100 million worth of shares in the huge dairy company Fonterra. Māori were farming 720,000 hectares in 2003 – mainly in sheep, beef and dairy"* (Kingi, 2012b).

### 3.9.5 Ahuwhenua Trusts and Māori Incorporations

As mentioned above, the two major structures developed to manage Māori interests in land were ahuwhenua trusts and Māori incorporations. Kingi notes, *"in 2008 there were 129 Māori incorporations and 5,201 ahuwhenua trusts which together administered around two-thirds of Māori land"* (Kingi, 2012c).

In terms of the benefits of each structure, *"ahuwhenua trusts are popular because land owners retain their interests as owners. With incorporations, owners become shareholders who receive dividends on their shareholding. More recent legislation allows ahuwhenua trusts to conduct themselves in a more commercial manner if owners wish, and to amend the trust order accordingly"* (Kingi, 2012c).

### 3.9.6 Corporate Farmers

There is also a proportion of Māori who utilise their land in corporate structures. Kingi notes:

> *"the majority of Māori land is administered by trustees or management committees, unlike the broader New Zealand agricultural sector, which is dominated by owner-operator family farms. Much of Māori agricultural production is carried out by the corporate farmer – landowners do not work on farms but employ others to run them"*
>
> (Kingi, 2012c).

"Māori agriculture has unique problems relating to ownership, governance and access to capital"

(Kingi, 2012c).

### 3.9.7 Ownership

It is in the issues of ownership of land in the modern context that Māori agriculture today becomes complicated. Kingi notes:

*"the majority of Māori landowners are absentee owners. The physical separation of the owners from their ancestral lands has major effects on the organisations that administer and control the lands"*

(Kingi, 2012c).

Kingi continues:

*"Most Māori landowners will never occupy the land they collectively own, nor obtain a livelihood from it."*

This point is important as in the earlier sections of this chapter it is clear that ownership and sovereignty of Māori land plays a crucial role in identity. Kingi notes:

*"land provides owners with their tūrangawaewae (their place to stand, or sense of belonging). Because such land is precious, owners are often conservative and risk-averse, particularly when there is a chance that land might be placed at risk of being lost. Landowners believe that organisations should place as much importance on their social and cultural objectives as on maintaining commercial viability"*

(Kingi, 2012c).

### 3.9.8 Access to Capital

New Zealand's socio-political landscape also makes it difficult for Māori landowners to access capital to develop their land in the ways they would like. Kingi explains; *"A conservative, debt-averse approach is often driven by owners' demands. Because of the complexity of multiple land ownership, lenders are often unwilling to lend with Māori land as security. If managers do not have extensive business experience, it can be harder to get finance to develop land"* (Kingi, 2012c).

### 3.9.9 Company solutions

*"Recently, the Māori Land Court has more actively promoted the use of the company structure, under the Companies Act 1993, as*

*a way to separate land ownership from business activities. A company structure can allow the separation of commercial objectives from social and cultural ones, and provide a mechanism for internal checks on performance. The commercial goals of a company can be clearly laid down and management can be assessed. Electing a board of directors – none of whom necessarily need to be owners and who are chosen primarily for their commercial ability – improves lines of accountability"* (Kingi, 2012c).

### 3.9.10 Ngāti Porou Sheep Farming

*"From around 1900, Āpirana Ngata became deeply interested in sheep farming on the East Coast, as he took over Ahikōuka station, and managed three other stations. Ngāti Porou leaders like Rāpata Wahawaha and Mōkena Kōhere had successfully farmed sheep on open country in the late 1800s, but it became apparent that for sheep farming to be successful a more structured approach was needed"* (Kingi, 2015).

*"At around that time Ngāti Porou farmers formed a Union of Ngāti Porou Farmers. Ngata capitalised on this, educating Ngāti Porou about contemporary farming methods, including fencing, stock rotation and sowing grass. Ngata's friend Samuel Williams, founder of Te Aute College, provided finance for Ngāti Porou farmers. Sheep farming underwent a transformation in the Waiapu valley, with Āpirana Ngata leading the way. Sheep numbers increased from 52,786 in 1900, to 65,619 in 1905, to 132,356 in 1909. By 1927 sheep numbers were estimated at 500,000"* (Kingi, 2015). This would prove to be a good source of income for Ngāti Porou farmers and this initiative generated many jobs.

### 3.9.11 Ahuwhenua Trophy

Āpirana Ngata instigated the Māori Farmer of the Year awards in 1932. The winner of the awards received the Ahuwhenua Trophy, presented in 1932 by the governor general, Lord Bledisloe. Over time the difficulty in judging between dairying and sheep farming became clear, and in 1954 Lord Bledisloe presented an additional trophy for sheep farming. Māori women won trophies for sheep farming in 1952 and dairy farming in 1954 (Kingi, 2015).

### 3.9.12 Ngāti Porou Dairying

In 1923 Āpirana Ngata began looking for suitable land for dairy farming on the East Coast. Ngata worked hard to change the Ngāti Porou farmers from sheep farming to dairying. Money was borrowed from the Native Trustee and used to build a dairy factory, buy cows, build milking sheds and launch the Ngāti Porou Dairy Company. By 1925/26 the Ruatōria factory produced around 60 tonnes of butter. In the 1931/32 season production climbed to almost 460 tonnes. However, Kingi notes it did not thrive after the Second World War and closed in 1954 (Kingi, 2015).

### 3.9.13 Large Incorporations

In a modern economic context, a number of Māori incorporations are carrying out large-scale farming. According to Kingi (2015):

- Parininihi Ki Waitōtara Incorporation, based in Taranaki, has 13 dairy farms and milks 8,000 cows on 2,500 hectares of productive farmland. In 2008 the incorporation had a $50 million farming interest in Taranaki, and collected rents from 20,000 hectares of perpetual lease.
- The Ātihau-Whanganui Incorporation was formed in 1970 to manage 40,873 hectares of land. In the early 2000s it managed 10 stations and one dairy farm on behalf of its 7,072 shareholders. One of its stations, Pah Hill, a 1,900-hectare sheep and beef farm, supported 20,800 stock units.
- Wairarapa Moana Incorporation owned assets of almost $90 million in the early 2000s, a large part being forestry and farming operations. They managed 4,200 hectares of farmland, comprising 12 dairy units and 1,325 hectares of sheep and beef farms. Dairy farms employed sharemilkers to milk around 7,200 cows, producing over 2.3 million kilograms of milk solids annually.
- The Puketapu 3A Trust owns the Moerangi station with 3,877 hectares, 2,150 hectares of which are effective farming land. In 2008 Moerangi carried 13,200 sheep, about 1,200 cattle, nearly 2,000 deer and 500 goats.

### 3.9.14 Māori Land Today – Conclusion

Today the complex questions remain: can Māori still hold onto sovereignty of land in a shared model; what do sustainable farming and practices look like, and how can these values can be shared throughout the entire population to ensure that Māori and Europeans alike are respecting and looking after landscapes for generations to come?

## References


Best, E. *Māori agriculture*. Wellington: A.R. Shearer.

Best, E. 1931. Māori agriculture. Cultivated food-plants of the Māori and native methods of agriculture. *The Journal of the Polynesian Society, 40*(1(157)), 1-22.

Best, E. 1934. *The Māori as he was: A brief account of life as it was in Pre-European days.* Wellington: Dominion Museum.

Best, E. 1941. *The Māori* (Vol. 2). Wellington: Polynesian Society.

Boast, R. 2012a, 22 September 2012. Te tango whenua - Māori land alienation - Land tenure and alienation. *Te Ara - The Encyclopedia of New Zealand.* Retrieved from http://www.teara.govt.nz/en/te-tango-whenua-Māori -land-alienation/page-1

Boast, R. 2012b, 22 September 2012. Te tango whenua - Māori land alienation - Pre-Treaty transactions. *Te Ara - The Encyclopedia of New Zealand.* Retrieved from http://www.teara.govt.nz/en/te-tango-whenua-Māori -land-alienation/page-2

Boast, R. 2015, 8 April 2015. Te tango whenua - Māori land alienation - Crown pre-emption. *Te Ara - The Encyclopedia of New Zealand.* Retrieved from http://www.teara.govt.nz/en/te-tango-whenua-Māori -land-alienation/page-3

Hakopa, H. 2011. *Spatial information technology and the geography of narratives.* (Doctor of Philosophy), University of Otago.

Hargreaves, R. P. 1959. The Māori agriculture of the Auckland Province in the Mid-Nineteenth Century. *The Journal of the Polynesian Society, 68*(2), 61-79.

Kawharu, I. H. (1989). Appendix. Translation of Māori text by I.H. Kawharu. In I. H. Kawharu (Ed.), *Waitangi: Māori and Pākehā perspectives of the Treaty of Waitangi* (pp. 319-321). Auckland: Oxford University Press.

Keene, F. M. M. 1975. *Tai Tokerau*. Whangarei: Unknown.

Kingi, T. 2012a, 22 September 2012. Ahuwhenua - Māori land and agriculture - Changes to Māori agriculture. *Te Ara - The Encyclopedia of New Zealand.* Retrieved from http://www.teara.govt.nz/en/ahuwhenua-Māori -land-and-agriculture/page-1

Kingi, T. 2012b, 22 September 2012. Ahuwhenua - Māori land and agriculture - Land ownership and Māori agriculture. *Te Ara - The Encyclopedia of New Zealand.* Retrieved from http://www.teara.govt.nz/en/ahuwhenua-Māori -land-and-agriculture/page-2

Kingi, T. 2012c, 22 September 2012. Ahuwhenua - Māori land and agriculture - Trusts and incorporations. *Te Ara - The Encyclopedia of New Zealand.* Retrieved from http://www.teara.govt.nz/en/ahuwhenua-Māori -land-and-agriculture/page-3

Kingi, T. 2015, 8 September 2015. Ahuwhenua - Māori land and agriculture - Incorporations and ahuwhenua. *Te Ara - The Encyclopedia of New Zealand.* Retrieved from http://www.teara.govt.nz/en/ahuwhenua-Māori -land-and-agriculture/page-4

Lambert, S. 2011. Te ahuwhenua and the 'Sons of the Soil': A history of the Māori-Farmer-of-the Year award. *MAI Review* (1-13).

Marsden, M. 2003a. God, man and universe: A Māori view. In T. A. C. Royal (Ed.), *The woven universe: Selected writings of Rev. Māori Marsden* (pp. 2-23). Otaki, New Zealand: Estate of Rev. Māori Marsden.

Marsden, M. 2003b. Kaitiakitanga. A definitive introduction to the holistic worldview of the Māori. In T. A. C. Royal (Ed.), *The woven universe: Selected writings of Rev. Māori Marsden* (pp. 54-72). Otaki, New Zealand: Estate of Rev. Māori Marsden.

Marsden, M. 2003c. The natural world and natural resources. Māori value systems and perspectives. In T. A. C. Royal (Ed.), *The woven universe: Selected writings of Rev. Māori Marsden* (pp. 24-53). Otaki, New Zealand: Estate of Rev. Māori Marsden.

Meredith, P. 2012a, 22 Sept 2012. Take whenua - Māori land tenure - Gift and occupation. *Te Ara - the Encyclopedia of New Zealand.* Retrieved from http://www.TeAra.govt.nz/en/take-whenua-Māori -land-tenure/page-4

Meredith, P. 2012b, 22 Sept 2012. Take whenua - Māori land tenure - Take whenua - principles of land-use rights. *Te Ara - the Encyclopedia of New Zealand.* Retrieved from http://www.TeAra.govt.nz/en/take-whenua-Māori -land-tenure/page-2

Mika, C. T. H. 2012. Overcoming 'Being' in favour of knowledge: The fixing effect of 'mātauranga'. *Educational Philosophy & Theory, 44*(10), 1080-1092. doi:http://dx.doi.org/10.1111/j.1469-5812.2011.00771.x

Mutu, M. 2010. Constitutional intentions: The Treaty of Waitangi texts. In M. Mulholland & V. Tawhai (Eds.), *Weeping waters. The Treaty of Waitangi and constitutional change* (pp. 13-40). Wellington: Huia Publishers.

Ngata, A. 1963. *The Treaty of Waitangi: An explanation. Te Tiriti o Waitangi: He whakamarama.* New Zealand Texts Collection. Christchurch.

Orange, C. 1987. *The Treaty of Waitangi*. Wellington: Bridget Williams Books Limited.

Ross, R. 2001. Te Tiriti o Waitangi. Texts and translations. In J. Binney (Ed.), *The shaping of history: Essays from the New Zealand Journal of History* (pp. 90-113). Wellington: Bridget Williams Books.

Shirres, M. 1997. *Te tangata: The human person*. Auckland: Accent.

Taonui, R. 1996. Canoe Traditions. In Bateman (Ed.), *Te Ara Māori Peoples of New Zealand: Ngā iwi o Aotearoa*. Auckland, NZ: David Bateman Ltd.

Whaanga, M. 2012. *Rata, the effect of Māori Land Law on Ahikāroa.* (Doctor of Philosophy), University of Waikato, Waikato.

# 4

# The Challenge for Communities in working with Mātauranga Māori and Science in Aotearoa-New Zealand

Maui Hudson, Dr Mere Roberts, Murray Hemi

## 4.1 Introduction

Research activities can advance the incorporation of indigenous knowledge into mainstream research, development and education and accelerate processes for its innovation, whether that is in collaboration with western science or through endogenous processes of creativity. Projects, including this one on Indigenous Agroecology, are part of a lengthy tradition in New Zealand of attempting to bridge the cultural divide between its minority indigenous Māori people and the majority colonists of European descent.

A particular focus of this work is to explore ways in which both traditional and emerging forms of indigenous knowledge can be advanced alongside western science through dialogue and collaboration with practitioners. Most University and research centres follow the philosophy and methodology of western science in the production of knowledge, whether that is in the form of teaching curricula, technology or scientific products and solutions. The marginalisation of traditional knowledge, practices and beliefs as well as inequalities in access to education has resulted in the alienation today of many Māori from their own cultural traditions and the philosophy and practices of western science.

This cultural malaise may be reflected in the comparative absence of western-trained scientists who are Māori and who are raised in their own knowledge tradition. During the 1980s however, the New Zealand Government (the "Crown") responded to increasing political activism and pressure from Māori to incorporate the Māori knowledge into scientific research and development. Similar initiatives were also undertaken to develop and incorporate indigenous knowledge into teaching and learning curricula, a process enhanced by the development of immersion schools and Māori Studies departments within Universities. The establishment of Whare Wānanga (tribal universities) in the 1989 has also contributed to the revitalisation of Māori knowledge and capacity building in communities. Ngā Pae o te Māramatanga , a Māori Centre of Research Excellence, has been particularly active in recent times and in addition to funding endogenous research projects surpassed their goal of completing 500 PhD's in 5 years (Nga Pae o te Māramatanga , 2008). This activity is spread across a range of institutions and a range of disciplines and has contributed significantly to the increase in general Māori scholarship that is revitalising and strengthening the Māori knowledge base. The major government research funds have developed streams that allow space for Māori knowledge to be included within research. Initially framed around a Treaty of Waitangi principle promoting participation of Māori in research, the overarching policy framework now focuses on unlocking the innovation potential of Māori knowledge, resources and people (MoRST, 2005). The outcome of these activities has been an increase in research that supports the aims of endogenous development and capacity building.

This chapter describes some of these cross-cultural developments, past and present, in Aotearoa (New Zealand).

## 4.2 Migratory Roots

The indigenous people of New Zealand are the Māori, whose ancestors migrated from Polynesia. Anthropologists and geneticists have traced their migration westwards from south-east Asia, possibly Taiwan into the Pacific where the Polynesian culture originated in the islands encompassing Tonga and Samoa (Friedlaender et al., 2008). As skilled navigators, they continued to move east reaching Tahiti, the Marquesas, Hawaii and Easter Island. The modern consensus is that they also reached South America where they acquired the sweet potato (kūmara). In a last great voyage of discovery, this food crop along with other plants and animals travelled southwest with the ancestors, making landfall in Aotearoa/New Zealand between 800-- 1000 years ago (Irwin, 2006). Traditional stories refer to many different founding waka (canoes) arriving in Aotearoa (the land of the long white cloud), now known as New Zealand. In addition to material goods they brought with them a rich intellectual heritage notably in the form of a cosmology linking all things in a network of relationships with each other and the gods. Movement from a tropical to a temperate climate necessitated adaptation and invention, and through this process, a well-developed knowledge of their new found environment evolved into what is known today as mātauranga Māori (Māori knowledge).

## 4.3 Experiences of Dialogue between Indigenous Knowledge and Science in Aotearoa-New Zealand

### 4.3.1 Colonial Era Dialogue

The history of engagement between 'science' and 'indigenous' knowledge can be summarised as a five and a half century history of colonial encounters between what Stuart Hall (1992, 1998) refers to as 'The West' and the native peoples of the world. Those encounters are of modern memory in the history of the world and represent a larger set of stories about the development of what we might now call science and what we might now call indigenous knowledge. The New Zealand story resonates with other British colonial experiences but as a late 18th and 19th Century 'discovery' and then colony, New Zealand's British administrators, missionaries and settlers had an arguably stronger sense of their scientific, intellectual potential than might have been the case with earlier forays into the New World that focused more on searching for El Dorado or seeking military conquest. Early missionaries and pre-ethnographers of the Māori world (for example Henry Williams, Edward Tregear, James Cowan, Percy Smith, Elsdon Best) were interested in what Māori knew, about the reasons behind their beliefs and about their views of knowledge itself. Early settlers were much more conscious of establishing universities and schools even before they arrived in New Zealand and learned societies once they had arrived. There was an established literature about Māori beliefs, cosmologies, lore and accounts of histories by the turn of the 19th century. None of this necessarily means that scientists and Māori were engaged in meaningful dialogue about knowledge but it does mean that New Zealand settlers had a determination and consciousness about science.

Māori were also seen as proactive in their engagement with new technologies most notably literacy, the musket, and the use of metal tools. They engaged in trade with Australia and in the production and transport by sea of marketable goods such as food, flour and flax. In the 19th century these new approaches were incorporated into a Māori world in which Māori still retained political dominance. While this situation changed radically and rapidly in the latter half of the 19th century with increasing settler dominance there are still many examples to be found of Māori willingness to engage with new knowledge and scholarship when given the opportunities. The best examples include the achievements of individuals such as Te Rangihiroa Sir Peter Buck who trained as an anthropologist, taught at Yale University and helped establish the Bishop Museum in Hawaii; and Sir Āpirana Ngata who saw opportunities in the new knowledge of the Pākehā but who was also confident in asserting that Māori had knowledge to contribute to the world.

### 4.3.2 Current Dialogue

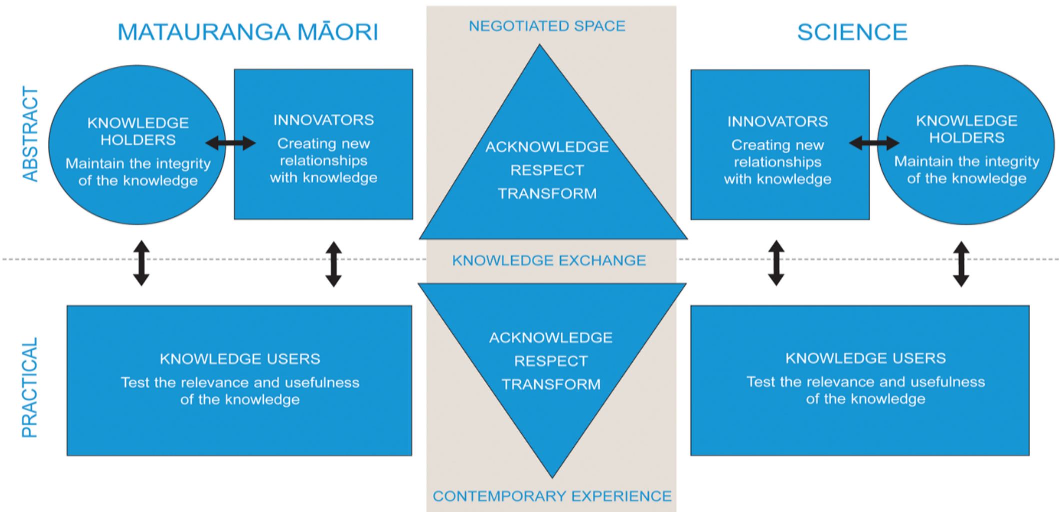
In the late 20th century scientific knowledge has undergone rapid technological advances. Knowledge has become the key commodity of the 21st Century that will drive economies and be the basis upon which societies, globally, will derive their wellbeing. (United Kingdom Department of Trade and Industry 1998; NZIER, 2002; Durie, 2003). Indigenous communities represent an interesting intersection in the knowledge economy discourse. In the 20th century indigenous communities occupied the margins of the economy in terms of their socio-economic positions in countries such as New Zealand. This is despite their significant contribution to the establishment of New Zealand in terms of the building of infrastructure, engagement in World Wars, and participation in the primary industries. In the 21st Century however cultural difference and access to other, previously subjugated, knowledge resources position indigenous communities in a unique way to grasp new opportunities for development. To do this indigenous communities need confidence in their own knowledge systems and identity, capacity and motivation to engage with institutions and society and a purpose for engagement that does not compromise their own cultural aspirations. In New Zealand, Māori have been well poised for this engagement due to significant advances in capacity development, renewed cultural confidence, settlement of historic grievances that have provided cash reparations and statutory protections to tribal entities, and a shift away from a colonised mentality.

Māori engagement with science has increased over the past decade as more Māori become scientists and Māori communities become more involved in decision-making processes that require science input. A review of engagement around science and biotechnology highlighted two types of approaches (Joseph et al., 2008). Firstly, projects exploring Māori views and critiqued the impact of science on Māori values (Cram et al., 2002; Roberts and Fairweather, 2004; Roberts et al., 2004, Te Momo, 2006), and secondly, projects that discussed processes of engagement ( Harmsworth, 2001; Cram et al., 2002; Wilcox et al., 2008, Bishara et al., 2010). The Te Hau Mihi Ata project built on this previous work by seeking to create mechanisms to enhance capacity and capability to engage respectfully, to dialogue constructively and to innovate at the interface of mātauranga Māori and science (Smith et al., 2013). Interaction across knowledge systems can create opportunities for knowledge exchange, support engagement in technological development and contribute towards a more equitable social transformation. The goal of the Te Hau Mihi Ata project was to identify and describe both the process of cross-cultural knowledge exchange and develop tools required to facilitate the interaction.

## 4.4 The Negotiated Space Interfacing Worldviews

The "negotiated space" is a conceptual model (Hudson et al, 2010) to understand the interface between different worldviews and knowledge systems and facilitate productive dialogue (fig 1). The core idea underpinning a negotiated space is that constructive interaction between different knowledge systems requires agreement (by a process of negotiation between the two protagonists) on the nature of a space (both physical and conceptual) and the purpose for dialogue. This model builds on the 'Ethical Space' (Ermine et al 2004, Ermine 2007) which suggested the interaction is guided by establishing ethical parameters for the space within which the dialogue occurs. It is often necessary to advocate for and negotiate space within each knowledge system before dialogue and exchange can be contemplated as each side will have proponents with a vested interest in maintaining the status quo. The interface is negotiated purposefully to facilitate knowledge exchange and mediate appropriation.

*Figure 1: The Negotiated Space*




Central to the negotiated space is the need to uphold the integrity of each cultural knowledge system (through the rebuilding and revitalisation of paradigms as separate coherent knowledge systems) while fostering an environment that supports critical self-reflection, openness to innovation and a willingness to adapt or change. This requires an understanding that each knowledge system has a dynamic relationship between the knowledge users, the knowledge holders and the innovators and that each system interprets phenomena differently, according to different rules, assumptions and internal logic.

Pivotal to the model is the somewhat paradoxical requirement that any knowledge system is both coherent and incomplete. Effective dialogue requires an open door to critical reflection on both knowledge and relationship. Critical reflection is both based in practice and shapes practice. Just as there are multiple forms of knowledge, the various forms of critique, criticism and reflection with and between differing traditions should be encouraged to enable adaptation and generate new possibilities (Turnbull, 2005). The negotiated space acts as an intermediate stage in the process of encountering, understanding and then incorporating new knowledge into a worldview. This is a space where reality is suspended long enough to allow a creative and unlimited dialogue to ensue, where new cultural knowledge and ideas are created. This, perhaps, contrasts with previous experiences of dialogue, between communities where each has sought to preserve the inherent value of its own knowledge system while critically exposing the limitations of the 'other'. This type of engagement is even more challenging when situated within the context of colonisation. Here the questioning of knowledge is often a challenge to the validity or authority of the indigenous community and leads to a style of dialogue that emphasises difference and separation. The failure to recognise value in alternative or indigenous values or engage in dialogue that is firstly generative rather than critical has prevented quality engagement and dialogue on knowledge with mainstream systems. Equally, the lack of understanding around the processes, methods and generation of theory in the context of indigenous knowledge confuses discussions about the relationship with the content of science and the scientific method.

## 4.5 Approaches to theory building in indigenous ways of knowing and sciences

The resilience of a cultural knowledge system is dependent on its ability to respond to challenge and change, and to adapt and explain new phenomena in a way that retains a sense of resonance and coherence with the existing philosophies and psychologies (Hudson et al., 2010a). For indigenous communities the process of colonisation served to invalidate or exclude their own local knowledge from the power structures of the newly colonised society. This has impacted directly on the ability of these communities to engage in the production of new indigenous knowledge. For indigenous communities the process of restoring dignity and self-confidence requires the reclamation by the community of its own knowledge base. The ability to grow, nurture, claim, articulate and privilege one's own knowledge base is a prerequisite for powerful engagement with others' knowledge (Smith, 1999). It is a distinct but important precursor to effective dialogue particularly in the context of dialogue between a marginalised community and another more privileged worldview.

### 4.5.1 Kaupapa Māori

A leading example in the social sciences called Kaupapa Māori, draws upon post-colonisation political, historical and social realities as well as traditional epistemology (Smith, 1997). Kaupapa Māori has been an important strategy in New Zealand whereby Māori community members have sought to reclaim, regenerate, revitalise, remember, and re-imagine their cultural understandings and self-confidence (Smith, 1997; Smith, 1999; Pihama et al., 2004). A central component of Kaupapa Māori is the strategy of positing mātauranga Māori as unquestionably valid and legitimate. However, one of the unintended consequences of protecting mātauranga Māori from external critique has been a corresponding restriction on the opportunities for internal critique by Māori of their own knowledge. Not being open to reflection and critique in the face of social change undermines the ability of a knowledge system to maintain relevance, coherence and usefulness in a changing environment. Through our project we had the opportunity to work with holders of indigenous knowledge who shared some insights into how knowledge is conceptualised and acquired.

### 4.5.2 Endogenous Māori Knowledge

Another aim of Te Hau Mihi Ata was to address the absence of research theories and processes grounded in and arising solely from endogenous Māori knowledge, and the concept outlined above points the way to what is possible by drawing upon traditional teachings and processes. Royal (2008) has written extensively about the epistemology of Māori knowledge (mātauranga) and refers to elements that contribute the development of mātauranga: worldview (aronga); purpose (kaupapa); action (tikanga); guidance (tohu); and leadership (whakahaere).

Knowledge is both a pre-cursor and product of research and learning (wānanga). However, the authenticity of the product is dependent on whether its creation has been guided by the identified elements, and informed by a desire to contribute to Māori aspirations (aroha). Tau (1999) suggests the way forward is the pursuit of Māori knowledge grounded in Māori epistemology, achievable only by the teaching of Māori knowledge in wānanga (Māori places of learning) and in the Māori language (te reo Māori). Elsewhere in the Pacific, Meyer (2003) has identified three components considered essential in the creation of new endogenous Hawaiian knowledge; history, intention and function. History's role, she says, is to remind us of the continuity of our own consciousness; central to intention or purpose is 'right action' - the need to identify the culturally appropriate purpose of knowledge before engaging in its creation. Function is closely related to intention or purpose and must therefore provide a beneficial outcome for Hawaiian society.

Few if any examples exist and are employed in the social or natural sciences. However, kaupapa Māori has provided a new approach to theory building aimed at providing a 'best practice' framework for researchers undertaking research with (not 'on') Māori or on topics of importance to Māori. This has led to the development of indigenous inspired frameworks across a range of disciplines including education (Smith, 1997), research (Smith, 1999; Jones et al., 2007) and ethics (Hudson et al., 2010b).

Several other "hybrid" frameworks combining both endogenous and exogenous knowledge have also been developed in the natural science area which combines scientific methodologies along with Māori environmental knowledge and cultural values to create tools for monitoring the environment and evaluating the health of natural resources (Tipa & Tierney, 2003; King et al., 2007; Morgan, 2006; Lyver et al., 2008; Tipa 2010).

The negotiated space model visualises this endeavour in two ways:

(a) An internal process conducted within a 'closed' or endogenous system which draws exclusively on traditional teachings uncontaminated by externally generated input as suggested by Royal and Tau; and
(b) An open engagement with external input which is then selectively adopted, adapted and contextualised so as to be accepted as new, but culturally appropriate and useful knowledge exemplified by the work of Tipa, King, Lyver and Morgan.

Both processes are necessary for the development of a vibrant indigenous knowledge system. A continuing challenge in New Zealand is that most teaching of Māori knowledge occurs through institutions that don't have access to the deeper levels of knowledge and understanding known to traditional knowledge practitioners. Therefore, collaborative exchanges are limited by the expertise of the participants and the nature of their dialogue.

## 4.6 Correlation between indigenous knowledge and scientific concepts

During the 1960s and 70s cross-cultural comparisons of disparate knowledge and technologies were a prominent feature of Science Technology and Society studies within Universities in Europe, America and Australia. Sociologists of science such as Emile Durkheim, Bruno Latour, Paulo Freire and Ernst von Glaserfield, challenged what they perceived as the doctrine of universalism and positivism promoted by western science.

Work by other scholars (e.g. Agrawal, 1995; Aikenhead, 1996; 2011; Cobern, 1994; Okere et al., 2005; Turnbull, 1993; Thagard, 2008; and Watson-Verran, 1995) in North America, Africa, Australia and elsewhere provided critiques of science as well as valuable insights into the nature of other systems of scientific thought and understanding. Seminal conferences in this area include:

- "Understanding the Natural World: science cross-culturally considered " (Amherst, Massachusetts 1991);
- panels on "Ethnoscience" and "Non-Western approaches to Science and Technology" held as part of the 4S/EASST conference (Gottenburg, 1992);
- the "Science of Pacific Island Peoples" conference (Suva, Fiji 1992);
- the "Working disparate knowledge systems together" workshop (Geelong, Australia, 1994) and
- the "Science, Technology, Education and Ethnicity" conference (Wellington, New Zealand).

### 4.6.1 Māori Education

Māori educationalists, scientists and traditional knowledge holders participated in the three last conferences, and contributed not only papers but insisted on a reversal of the usual privileging of non-indigenous presenters (Watson-Verran & Turnbull, 1994).

Important educational initiatives also resulted from these intellectual challenges. Following a bicultural presentation at the Science of Pacific Island Peoples conference (Haami, 1994; Roberts, 1994a) the Director of the Centre for Pacific Studies requested the development of a bicultural Stage I paper subsequently called Indigenous Knowledge and Western Science: perspectives from the Pacific.

Several of the 27 recommendations passed at the conference several in particular formed the basis for the paper including:

- That indigenous peoples should be encouraged to tell their own stories;
- That Universities should confer appropriate recognition on indigenous knowledge holders with specialist knowledge; and
- That Universities promote the legitimisation of indigenous knowledge and pedagogy in science to stand alongside western curricula and pedagogy (Morrison et al., Vol. 1: 5-9, 1994).

Some of the epistemological and pedagogical issues encountered in the development and presentation of this course have been outlined by Roberts (1994b). A major problem was and still is the lack of appropriate and readily available resources for students in Aotearoa of cross-cultural comparisons of their own indigenous with western knowledge systems. Contributions in this area have been made by Roberts (1996); Roberts and Wills (1998); Roberts and Haami (1999), Roberts et al. (2004) and Harris & Mercier (2006).

Another significant contribution at this time was the development of a science curriculum in the Māori language by McKinley and Waiti (1996). This was a straightforward translation of the mainstream science curriculum, which provided opportunities for students being taught through Māori immersion schools to access science teachings. However, there continues to be an absence of a more comprehensive science vocabulary that more truly reflects an endogenous understanding of the world. Opportunities to further explore the connections between Māori knowledge and science have been delayed by the protective claim made by Māori over the cultural and intellectual property relating to indigenous flora and fauna. The Waitangi Tribunal finally released a report into the claim some 20 years after the initial filing (Waitangi Tribunal, 2011).

There is a range of opportunities for endogenous research in Aotearoa-New Zealand and progress has been made in developing indigenous research projects that truly reflect a spirit of collaboration between the indigenous and scientific.

Current examples of research supported by the Māori Centre of Research Excellence include:

- The Commercial Feasibility of using Mātauranga Māori-Based Fish Traps to Eliminate By-catch,

- Triangulating on the Mechanism for the Lunar Clock:
- Insights from the Māramataka (Māori lunar calendar) and Science,
- Kanakana Harvest Mātauranga:
- Potential Tools to Monitor Population Trends on the Waikawa River,
- Exploring a Māori Classificatory System of Flora and Fauna within Tainui Waka, and
- The development of an Indigenous Agroecology (2012) and the exploration of ecologically and culturally Sustainable Farm Practice (2010).

## 4.7 The Status of Indigenous Research in New Zealand and Strategic Directions for the Future

The context for the incorporation and innovation of indigenous knowledge alongside scientific knowledge within a so-called developed country differs from that of a developing nation. Our developed status has removed most people from environments where indigenous knowledge is actively practiced and/or just a part of daily activities. Our society is predominantly western and our struggle has been to (re)integrate indigenous values, knowledge and understanding into this context. The struggle for recognition and acceptance as indigenous people, as traditional owners of the land and guardians of the environment has been going on over 160 years. This political advocacy is central to the many improvements that have been made and continue to be negotiated including access to resources and research to support Māori aspirations for development.

### 4.7.1 Negotiation and Exchange

Negotiation and exchange are central to social relationships and there are many traditional and contemporary examples and frameworks to draw upon. One of the first major frameworks developed to provide a 'negotiated space' for cross cultural dialogue and exchange in Aotearoa/New Zealand took place in 1840 at a place called Waitangi in the Bay of Islands. The purpose for coming together at this place was to sign a Treaty between two parties: representatives of the British Crown (Queen Victoria) led by William Hobson, and the chiefs of local tribes. While negotiations did not take place on an equal playing field, they represented an attempt to establish some mutually agreed ground rules for the development of a multi-cultural society in New Zealand.

Intentional or not, the Māori translation of the English version of the Treaty was ambiguous in its explanation concerning the proposed transfer of sovereignty by Māori to the British Crown. And not – as Māori had previously been led to believe when they signed a Declaration of Independence in 1835 – to provide for an independent Māori nation under the protection of the British Crown (Orange, 1987). Cross-cultural differences in language and meaning resulted in two versions of the Treaty, which not surprisingly resulted in a tumultuous relationship. The Treaty of Waitangi, which promised so much, was soon ignored by the settlers and the Government of New Zealand. However, with the passing of the Treaty of Waitangi Act, and the creation of the Waitangi Tribunal in 1975, its role in providing a framework for dialogue and exchange re-emerged. Several acts of Parliament now incorporate a 'Treaty clause', which requires that the principles of the Treaty be given effect; among them the principle of equal partnership; of acting in good faith, and the necessity for consultation.

Although the treaty is one of the major defining influences on how Māori engage in cross-cultural collaborations, Māori have also been inspired by negotiations on the international front. Negotiations include the *Mataatua Declaration on Cultural and Intellectual Property Rights* (Commission on Human Rights 1993), the *UN Permanent Forum on Indigenous Issues* and the *Declaration of the Rights of Indigenous Peoples* (United Nations, 2007).

## 4.8 Capabilities, Autonomy and Empowerment

The concepts, ideas and arguments drawn from traditional, treaty, indigenous, contemporary and scientific discourse continue to influence our lives and shape the spaces where we negotiate our futures. Two of the major themes emerging from the analysis of our own efforts at cross-cultural dialogue aimed at revitalising and innovating knowledge are:

- The importance of developing capabilities across both indigenous knowledge and science, and
- The connection between knowledge exchange and self-autonomy.

In New Zealand, as Māori and tribal organisations become more involved in policy development and decision-making processes the requirements to include and/or take account of indigenous knowledge within research projects increases.

Māori need to continue developing expert capabilities in both science and indigenous knowledge. People with dual capabilities are also needed to act as facilitators and concept translators to aid the dialogue and discussions within communities.  However, there is an inherent tension for Māori communities in supporting the 'coloniser' to better understand indigenous knowledge.  While it might allow for the sharing of ideas, this doesn't necessarily translate to more local control over their development.

This is where the question of self-autonomy or tino rangatiratanga and the right to make your own decisions becomes important. Māori continue to advocate for self-autonomy and as the level of participation and control increases it is apparent that they make decisions based on whatever information is relevant to the context, regardless of whether it is traditional, indigenous, endogenous or scientific.

The revitalisation and empowerment of indigenous knowledge can only occur with the revitalisation and empowerment of indigenous communities and by ensuring that the cultural diversity of the world not only survives, but flourishes.

## References

Arun Agarwal, A. 1995. "Dismantling the Divide between Indigenous and Scientific Knowledge," *Development and Change* 26: 413-39. Blackwell, Oxford

Aikenhead, G.S. 1996. Science education: border crossings into the subculture of science. *Studies in Science Education* 27:1 – 52

Aikenhead, G., & Mitchell, H. 2011. *Bridging Cultures: Indigenous and Scientific Ways of Knowing Nature.* Pearson Education: Don Mills, Canada.

Best, E. 1929. Fishing methods and devices of the Māori: Dominion Museum, Bulletin 12.

Bishara, I., Ahuriri-Driscoll, A., Hudson, M., & Hepi, M. 2010. Mātauranga Māori & Biosecurity Research: Integration, Engagement & Partnership. *Report to MAF Biosecurity Operational Research*. June 2010.

Cobern, W.W. 1994. World view, culture and science education. *Science Education International* 5(4): 5-8

Commission on Human Rights, Sub-Commission of Prevention of Discrimination and Protection of Minorities Working Group on Indigenous Populations. 1993. *The Mataatua Declaration on Cultural and Intellectual Property Rights of Indigenous Peoples*. First International Conference on the Cultural & Intellectual Property Rights of Indigenous Peoples. Whakatane, 12-18 June 1993 Aotearoa, New Zealand.

Cram, F., Pihama, L., & Phillip- Barbara, G. 2000. *Mäori and genetic engineering*. Indigenous Research Institute. International Research Institute for Mäori and Indigenous Education.

Cram, F., Henare, M., Hunt, T., Mauger, J., Pahiri, D., Pitama, S., & Tuuta, C. 2002. *Māori and Science: Three Case Studies.* Indigenous Research Institute. Auckland

Durie, M. (2003). *Ngā Kāhui Pou: Launching Māori Futures.* Wellington, New Zealand: Huia Publishers.

Ermine, W., Sinclair, R., Jeffery, B. 2004. *The Ethics of Research involving Indigenous Peoples*. Report of the Indigenous Peoples' Health Research Centre to the Interagency Advisory Panel on Research Ethics. Retrieved on 14th October 2011 from http://www.iphrc.ca/assets/Documents/ethics_review_iphrc.pdf

Ermine, W. 2007. The Ethical Space of Engagement. *Indigenous Law Journal*. Vol 6(1), pg 193-203.

Friedlaender JS, Friedlaender FR, Reed FA, Kidd KK, Kidd JR, et al. 2008 The genetic structure of Pacific Islanders. *PLoS Genet* 4(1): e19.

Haami. B. 1994. The kiore rat in Aotearoa" a Māori perspective. Pp 65 – 76 in Morrison, J., Geraghty, P.& Crowl, L. *Science of Pacific Island Peoples* Vol. 3. Fauna, Flora, Food and Medicine. University of the South Pacific, Suva, Fiji.

Harding, S. 1998. *Is Science Multicultural?* Bloomington: Indiana University Press.

Hall, S. 1992. The West and the Rest: Discourse and Power. In *Formations of Modernity*, eds S Hall, B Gielben. Cambridge, Polity Press, Open University, pp276-320.

Hall, S. 1996 "When was 'the post-colonial'? Thinking at the limit," in *The Post-Colonial Question: Common Skies, Divided Horizons*, eds. Iain Chambers and Lidia Curti (London: Routledge, 242-60, pp. 247, 250.

Harmsworth, G. 2001. *A Collaborative Research Model for Working With Māori.* Landcare Research Contract Report: LC 2001/119. LandCare Research: Hamilton, N.Z.

Harris, P & Mercier, O. 2006. Te Ara Putaiao o Ngā tupuna, o Ngā mokopuna: science education and research. In *State of the Māori Nation: twenty first century issues in Aotearoa*. Edited by Malcolm Mulholland. Reed Books, Auckland, NZ.

Hepi, M., Foote, J., Marino, M., Rogers, M., & Taimona, H. 2007. Ko wai koe, or who are you? Issues of trust in cross cultural collaborative research*. Kōtuitui: New Zealand Journal of Social Sciences Online* 2: 37–53.

Hudson, M., Roberts, M., Smith, L.T., Hemi, M., & Tiakiwai, S. 2010a. Dialogue as a method for evolving mātauranga Māori: Perspectives on the use of embryos in research. *Alternative: Intl. J. of Indigenous Scholarship*. Pg 54-65.

Hudson, M., Milne, M., Reynolds, P., Russell, K., & Smith, B. 2010b. *Te Ara Tika Guidelines for Māori Research Ethics: A framework for researchers and ethics committee members*. Health Research Council, Auckland.

Irwin, G. 2006. Voyaging and Settlement. Chapt. 3 in Howe K.R. (ed). *Vaka Moana: voyages of the ancestors. The discovery and settlement of the Pacific*. Bateman.

Jones, R., Crengle, S., & McCreanor, T. 2006. How tikanga guides and protects the research process: insights from the Hauora Tāne project. *Social Policy Journal of New Zealand* 29: 60-77.

Joseph, R., Hudson, M., Hemi, M., & Tiakiwai, SJ. 2008. *Te hau mihi ata: mätauranga Mäori & science – Literature review on the interface between mätauranga Mäori & science*. University of Waikato: Hamilton.

King, D.N.T., Goff, J., & Skipper, A. 2007. Māori environmental knowledge and natural hazards in Aotearoa-New Zealand. *Journal of the Royal Society of New Zealand* 37(2):59–73.

Lyver, P.O.B., Taputu, T.M., Kutia, S.T., & Tahi, B. 2008. Tūhoe tuawhenua mātauranga of kererū (*Hemiphaga novaseelandiae novaseelandiae*) in Te Urewera. *New Zealand Journal of Ecology 32(1):* 7-17.

McKinley E. and Waiti, P. 1996. *Pūtaiao i roto te Marautanga o Aotearoa*. Ministry of Education. Learning Media, Wellington.

Meyer, Manu 2003. Ho'oulu: *Our Time of Becoming Hawaiian Epistemology and Early Writings*. Honolulu: Ai Pohaku Press.

Ministry of Research Science & Technology. 2005. *Vision Mātauranga: Unlocking the Innovation Potential of Māori Knowledge, Resources and People.* Ministry of Research, Science and Technology. Wellington, NZ.

Mitias, M. H., & Al- Jasmi, A. 2004. Intercultural dialogue. *Dialogue and Universalism*, *3–4*, 143–161.

Morgan, K. 2006. Decision-support tools and the indigenous paradigm. *Proceedings of the Institution of Civil Engineers Engineering Sustainability* 159 December 2006 Issue ES4: 169–177.

Morrison, J., Geraghty, P. and Crowl, L. 1994. *Science of Pacific Island Peoples. Vols. 1 – 4*. Institute of Pacific Island Studies, University of the South Pacific, Suva, Fiji.

Ngā Pae o te Māramatanga. 2008. *Annual Report 2008* retrieved from http://www.maramatanga.co.nz/about/annual-reports

Ngā Pae o te Māramatanga. 2010. *Annual Report 2010* retrieved from http://www.maramatanga.co.nz/about/annual-reports

New Zealand Institute of Economic Research. 2002. *Māori and Innovation: A contribution to Māori development report*. NZIER, Wellington, NZ.

Okere, T., Njoku, C., & Devish, R. 2005. All knowledge is first of all local knowledge: An introduction. *Africa Development*, *3*,1–19.

Oliver, W.H. 1991. Claims to the Waitangi Tribunal. Department of Justice, Wellington.

Orange, C. 1990. *The Treaty of Waitangi*. Allen and Unwin, Wellington.

Pihama, L., Cram, F., & Walker, S. 2002. Creating methodological space: a literature review of Kaupapa Māori research. *Canadian Journal of Native Education* 26(1): 30-43.

Roberts, M. 1994 (a). A Pākehā view of the kiore rat. Pp 125 – 141 in Morrison, J., Geraghty, P.& Crowl, L. *Science of Pacific Island peoples Vol. 3*. Fauna, Flora, Food and Medicine. University of the South Pacific, Suva, Fiji.

Roberts, M. 1994 (b). Can and how should disparate knowledge systems be worked together? A case study from Aotearoa/New Zealand. Paper presented at the "*Working disparate knowledge systems together*" conference, Deakin University, Australia, Nov. 26-27, 1994. ISSN No. 1325/2747.

Roberts, M. 1996. Indigenous knowledge and western science: perspectives from the Pacific. Pp. 59 -75 in Hodson, D. (ed.) *Science and technology education and ethnicity: an Aotearoa/New Zealand perspective*. Royal Society of New Zealand Miscellaneous series 50. Wellington, New Zealand.

Roberts M, and Wills, P. 1998. Understanding Māori epistemology -a scientific perspective. Pp. 43-77 in Wautischer H. (Ed.): *Essays in the philosophy of anthropology*. Avebury.

Roberts, M. and Haami, B. 1999. Science and other knowledge systems; coming of age in the new millennium. *Pacific World.* 54:16-22

Roberts, M., & Fairweather, J. R. 2004. *South Island Mäori perceptions of biotechnology.* Christchurch,NZ: Lincoln University, Agricultural and Economics Research Unit.

Roberts R.M., Haami B., Benton R., Satterfield T., Finucane M.L and Henare M. 2004. Whakapapa as a mental construct of Mäori, and its implications for genetic engineering. *The Contemporary Pacific* 16 (1): 1- 28.

Royal, C. (2009). Te Ngākau: *He Wānanga i te Mātauranga*. Mauriora-ki-te-Ao, Living Universe Ltd.

Sherratt, T. 1994. Report on the *Working Disparate Knowledge Systems Together* Seminar/Workshop, 26-7 November, 1994, Deakin University, Geelong, Victoria, Australia. HASN No. 34, March 1995 ISSN 0811-4757. *Edited and published by Tim Sherratt (Tim.Sherratt@asap.unimelb.edu.au) for ASAP.*

Smith, G. H. 1997. *The Development of Kaupapa Māori: Theory and Praxis*. Unpublished PhD thesis. Auckland University: Auckland, N.Z.

Smith, L.T. 1999. *Decolonising Methodologies: Research and Indigenous Peoples*. University of Otago Press: Dunedin.

Smith, L., Hemi, M., Hudson, M., Roberts, M., Tiakiwai, S., & Baker, M. 2013. *Dialogue at the Cultural Interface*. A report for Te Hau Mihi Ata: Mātauranga Māori, Science & Biotechnology. University of Waikato, Hamilton.

Stewart, G. M. 2007. *Kaupapa Māori Science*. Ph.D Thesis in Education, Education Department, University of Waikato, Hamilton.

Tau, T.M. 1999. 'Mätauranga Mäori as an Epistemology', *Te Pouhere Kōrero Journal*, vol 1(1), pp 10–23.

Te Momo, F. 2005. Exposing diversity: uncovering common scientific values between biotechnology, indigenous knowledge and western knowledge. *International Journal on Technology, Knowledge and Society* 1(6).

Te Momo, O. H. F. 2006. Socially and culturally sustainable biotechnology in Aotearoa/New Zealand. A report on the social, cultural and religious/spiritual dimensions of biotechnology for Mäori from 2003 to 2006. Auckland: Massey University.

Thagard, P. 2008. Conceptual change in the history of science: Life, mind, and disease. In S. Vosniadou (Ed.), *International handbook of research on conceptual change* (pp. 374–387). London: Routledge.

Tipa, G., and Tierney, L. 2003. *A Cultural Health Index for Streams and Waterways: Indicators for Recognising and Expressing Cultural Values*. Ministry for the Environment Technical Paper 75.

Tipa, G. 2010. Cultural opportunity assessments: introducing a framework for assessing the suitability of stream flow from a cultural perspective. Pp. 155-173 in Selby, S., Moore, P. Mulholland, M. *Māori and the environment*: Kaitiaki. Wellington, Huia.

Turnbull, D. 1993. Local Knowledge and Comparative Scientific Traditions, *Knowledge and Policy 6*, nos. 3&4: 29-54.

Turnbull, D. & Verran, H. 1994. *Working disparate knowledge systems together.* Sciences in Society Working papers Second series No. 15. Deakin University, Australia. ISSN No. 1325/2747

Turnbull, D. 2005. Comparing knowledge traditions: Working with multiplicity, sustaining criticism and avoiding 'epistemic charity'. In: *Proceeding of the Indigenous Knowledges Conference: Reconciling Academic Priorities with Indigenous Realities*. June 22–25 (pp. 169–178). Wellington: Victoria University.

United Kingdom Department of Trade and Industry, Secretary of State for Trade and Industry, 1998 *Our Competitive Future: Building the Knowledge Economy*, Vol. Cm 4176. London.

United Nations, 2007. *United Nations Declaration on the Rights of Indigenous Peoples*. Retrieved from http://www.un.org/esa/socdev/unpfii/en/drip.html on October 14th 2011.

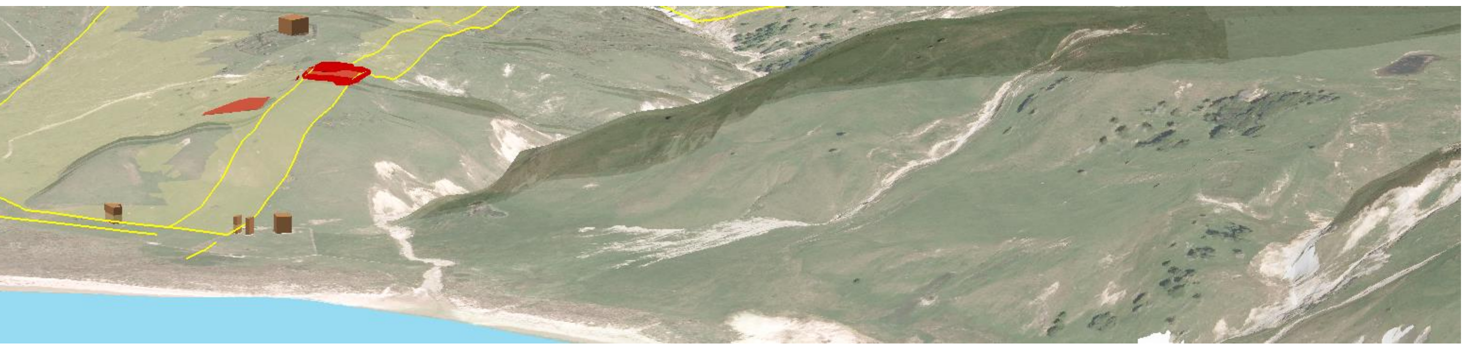
Waitangi Tribunal. 2011. *Ko Aotearoa Tēnei: a report into the claims concerning New Zealand law and policy affecting Māori culture and identity*. Te taumata tuatahi. (Waitangi Tribunal report. Wellington New Zealand: Legislation Direct.

Watson-Verran, H. & Turnbull, D. 1995. Science and Other Indigenous Knowledge Systems, pp. 115-39 in Jasanoff, S., Markle, G., Petersen, J. and Pinch, T. (eds.) *Handbook of Science and Technology Studies.* Thousand Oaks, CA: Sage, 1995.

Wilcox, P.L., Charity, J.A., Moke-Delaney, P., Roberts, M.R., Tauwhare, S., Tipene-Matua, B., Kereama-Royal, I. 2008. A values-based framework for cross-cultural dialogue between scientists and Māori. *Journal of the Royal Society of New Zealand*. 38(3) p215-227.

# 5 Farm Mapping and Geographical Information Systems

Antoni Moore



## 5.1 Introduction

To support the agroecology research and community initiatives for the NPM project it is essential to obtain a robust spatial inventory of the three case study farms at Banks Peninsula (Te Kaio), Mahia Peninsula (Taiporutu) and Chatham Islands (Henga). Authoritative maps therefore need to exist as a baseline for the scientific and community work to follow. These maps would contain the on-farm infrastructure (buildings, roads, tracks, fences etc.) as well as other features of cultural significance (e.g. pa sites). These features should be situated on an elevation surface of high quality. The maps would be compiled and designed using a Geographical Information System (GIS).

This section reports on mapping work at all three farms. An initial survey of the geographic data existing for these farms revealed availability of freely available resources (i.e. LINZ Topo50 data which provides 20 metre contours, coastline, rivers and streams, roads and tracks) but at too coarse a scale to adequately map at the farm scale. Therefore, topographical surveys were undertaken and photogrammetric mapping commissioned to source high resolution, high quality spatial data.

The data management and mapping were carried out using Esri ArcGIS 10.x and Manifold GIS software.

## 5.2 Te Kaio Farm, Banks Peninsula

A topographic survey of Te Kaio (at the time, Te Putahi) was completed in 2011 by then School of Surveying Professional Practice Fellow Phil Rhodes, supported by two Bachelor of Surveying students (Tim Hastings and Riki Cambridge).

### 5.2.1 Description of data

The collected data were in the form of point, polyline and polygon Computer Aided Design (CAD) file format (dwg and dxf). The CAD data were collected in a Transverse Mercator projection system, Geographic Coordinate System GCS_NZGD_2000_Mount_Pleasant_Circuit. These CAD files were converted into GIS format files. These are feature classes, stored in an ArcGIS geodatabase.

The main reason for using a geodatabase is to enable logical storage, manipulation and query, and facilitate analysis and visualisation (mapping) of the spatial data collected. This data forms a baseline for subsequent biological and chemical measurements for agroecology research as well as spatial analysis projects, determining the planting of rongoā and visitor access infrastructure.

The feature classes extracted from the CAD data into the geodatabase consist of:

- Buildings (polygon) (dwellings and farm function)
- Contours (line) (2 metre) represent lines of equal height or isolines
- Spot heights (point) are point estimates of height
- Roads (line)
- Powerlines (line) (cable or wires to transmit power to the farm)
- Poles (point) for overhead powerlines located in the farm
- Tracks (line) (minor footpaths located within the farm boundaries)
- Banks (line) describe any breaks in slope across the farm.
- Breaklines (line) describe any significant change in the slope of the ground
- Waterways (line) (little narrow ditches normally leading to the sea)
- Tree shelter belt (line) is the demarcated trees being used on the farm as wind shelter
- Fences (line) are a barrier used to enclose and demarcate the farm area.

These are all vector data (point, line, polygon) collected and once in the geodatabase, did not require any further processing, with one exception. The contours were interpolated to produce a continuous elevation surface, a spatial dataset of raster format (1m). This subsequently enabled the production of derived outputs for analysis, such as slope, aspect and hillshade layers.

This dataset was supplemented by an orthophotograph of the farm bought from New Zealand Aerial Mapping, and layers from Environment Canterbury's database, including slope, land use capability, soil PH, chemical limitation to plant growth, erosion type and severity.

Finally, there are other data associated with the project that would be desirable but proved difficult to source, such as the soil condition, soil classification and vegetation.

### 5.2.2 Overview Maps

A subset of the data described above is featured in the following overview maps:

- A 2D topographic map (Figure 5.1) featuring collected data, both processed (the raster relief layer of the ground surface) and as captured (a selection of contours, roads and tracks, breaks of slope, buildings, fences, powerlines and tree shelter belts)
- A 2D orthophoto of the farm (source: NZAM) (Figure 5.2)
- A 3D view of the farm from the south east (Figure 5.3)

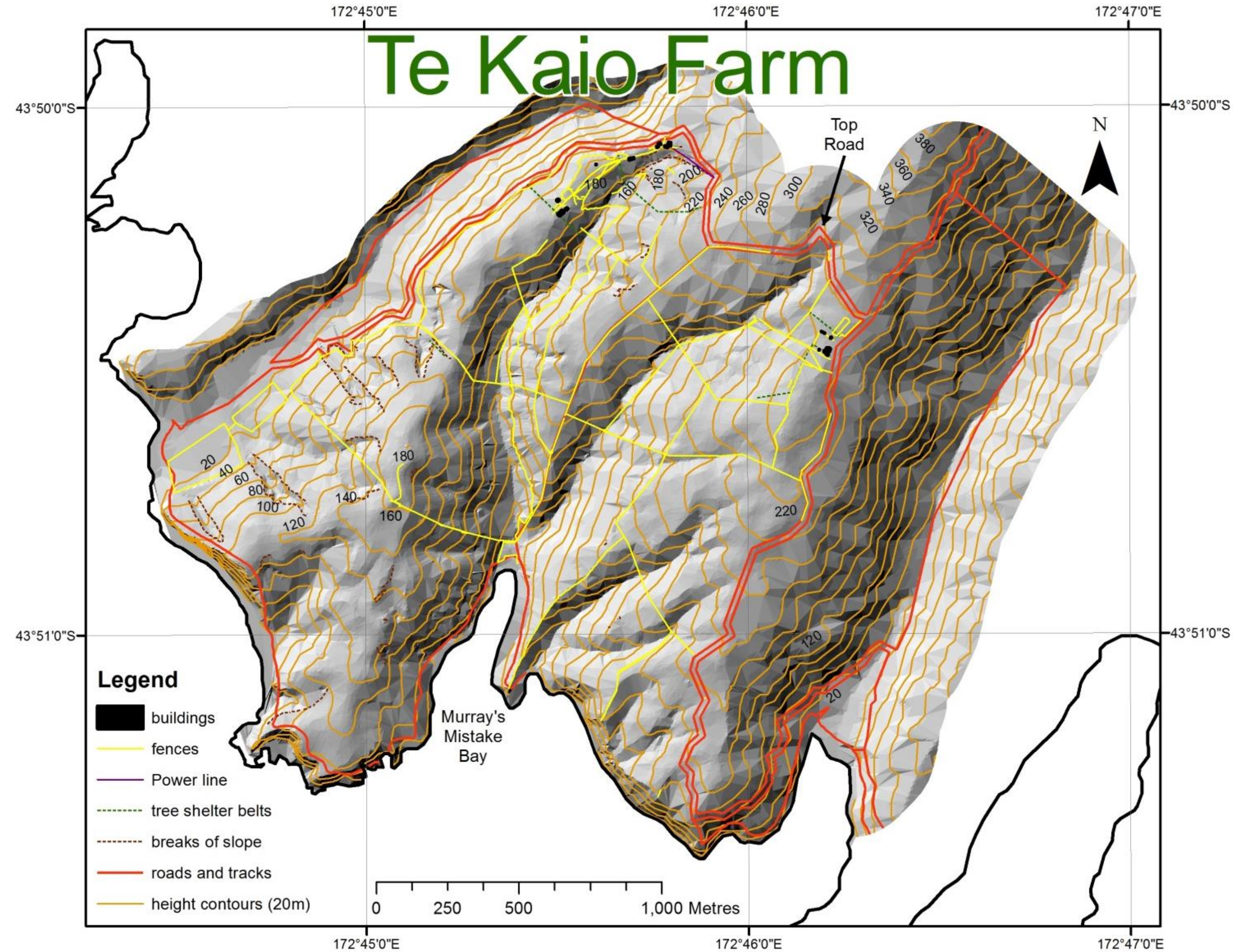



*Figure 5.1: Context Map of Te Kaio farm*


*Figure 5.2: Orthophoto Map of Te Kaio farm*

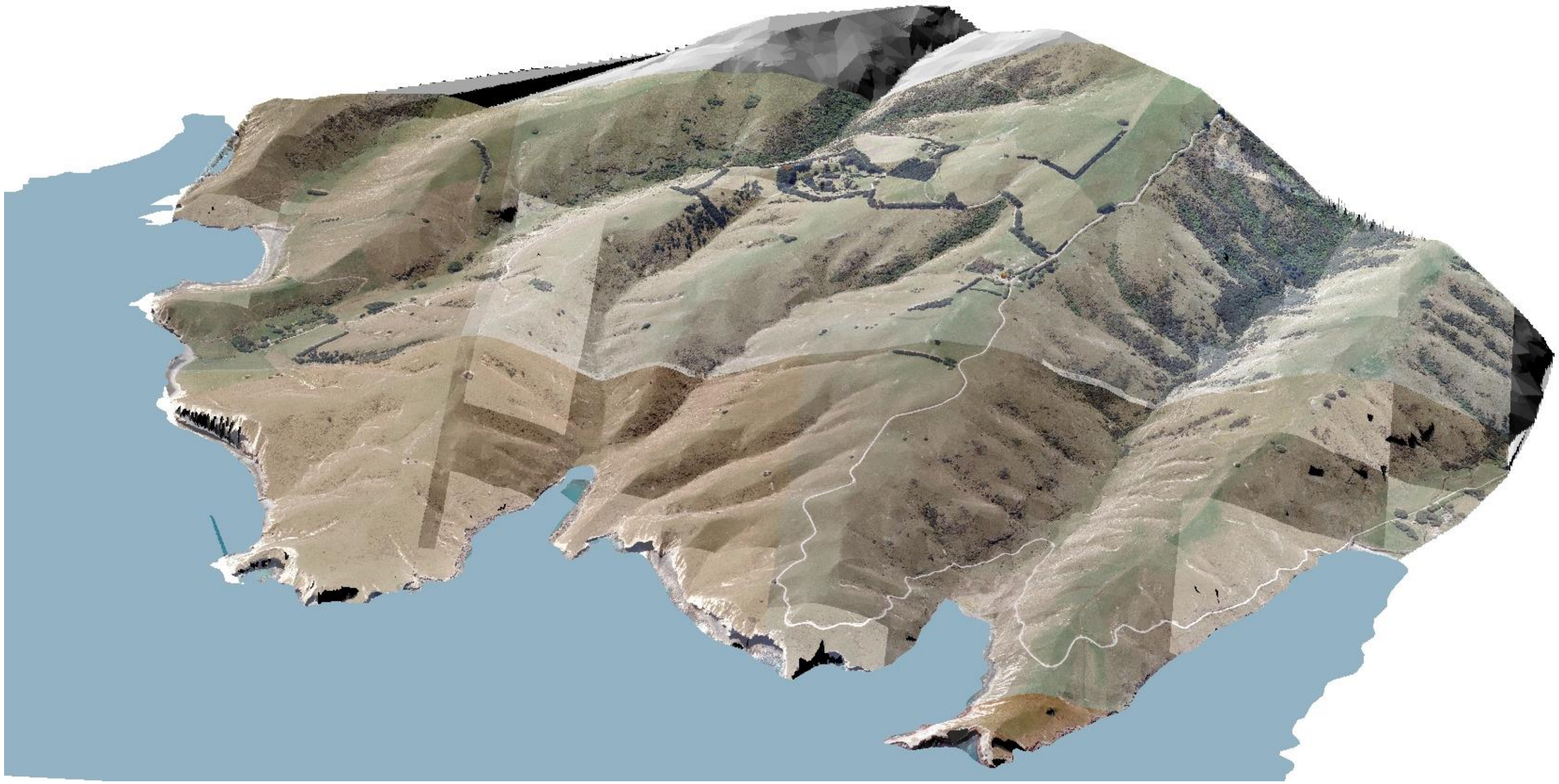


*Figure 5.3: 3D Map of Te Kaio farm, viewed from the South East*

## 5.3 Taiporutu Farm, Mahia Peninsula

A topographic survey was completed in June 2014 by two Bachelor of Surveying students of the time (Mariana Pagan and Sam Mogford), supervised by School of Surveying Professional Practice Fellow Richard Hemi.

### 5.3.1 Description of data

The collected data were received in the form of points in a Comma Separated Variable (CSV) format. The data were collected using the national map projection and coordinate system: New Zealand Transverse Mercator 2000. A single session with the surveyors clarified further what the points signified, whether they should remain as point features, or be turned into line or polygon features. Once the CSV files had been reformatted to reflect the real-world features they represented, they were imported into ArcGIS as feature classes in a geodatabase.

In addition to the kinds of infrastructural features such as those collected at Te Kaio (boundaries, buildings, fences etc.), the surveyors were directed by Desna Whaanga-Schollum of Taiporutu to capture spatial data of on-farm features of cultural significance (e.g. pa sites, potential midden sites). This formed part of a complementary cultural mapping of the farm.

The feature classes extracted from the CSV data into the geodatabase consist of the following infrastructural and natural data:

- Fences (line)
- Boundary Pegs (point)
- Culverts (point)
- Old Posts (point)
- Power Poles (point)
- Trees (point) (mostly Ti Kōuka – cabbage trees, but including karaka and nikau)
- 3m from Bush Line (line)
- 3m from Erosion Line (line) (equivalent to banks and breaklines in the Te Kaio dataset)
- 1m from Erosion Line (line)
- Wetland (polygon)
- Streams (line)
- Springs (point).

In addition, the following cultural data was mapped:

- Pa sites (polygon)
- Potential midden sites (point)
- Pits (polygon) (usually within a pa site)
- Pit bottoms (line)
- Pit drains (line)
- Boulders (point).

These are all vector data (point, line, polygon), and once collected and in the geodatabase, did not require any further processing.

This dataset was supplemented by an orthophotograph of the farm bought from New Zealand Aerial Mapping. New Zealand Aerial Mapping was also commissioned to digitise, through photogrammetry, contours and other features from photography. The derived datasets were received as Esri ArcGIS shapefiles (a common GIS exchange format) and were imported into a geodatabase as feature classes. This geodatabase consists of:

- Buildings (polygon)
- Contours (line) (2 metre) represent lines of equal height or isolines.
- Farm boundary (line)
- Fences (line)
- Roads (line)
- Tracks (line)
- Streams (line)
- Ponds (polygon)
- Exotic bush (polygon)
- Native bush (polygon).

These are all vector data (point, line, polygon), and once collected and in the geodatabase, with one exception, did not require any further processing. The contours were interpolated to produce a continuous elevation surface, a spatial dataset of raster format (1m). This subsequently enabled the production of derived outputs for analysis, such as slope, aspect and hillshade layers.

### 5.3.2 Overview Maps

A subset of the data described above is featured in the following overview maps:

- A 2D topographic map (Figure 5.4) featuring collected data, both processed (the raster relief layer of the ground surface) and as captured (boundary, roads and tracks and other infrastructural features; bush, trees, streams, wetlands and other natural features; pa sites, pits, midden sites and other cultural features). The data was augmented by LINZ Topo 50 data (surface derived from 20 metre contours, roads, streams) outside the farm area

- A 2D orthophoto of the farm (source: NZAM) (Figure 5.5)
- A 3D view of the farm from the north east with boundary and cultural features (Figure 5.6)

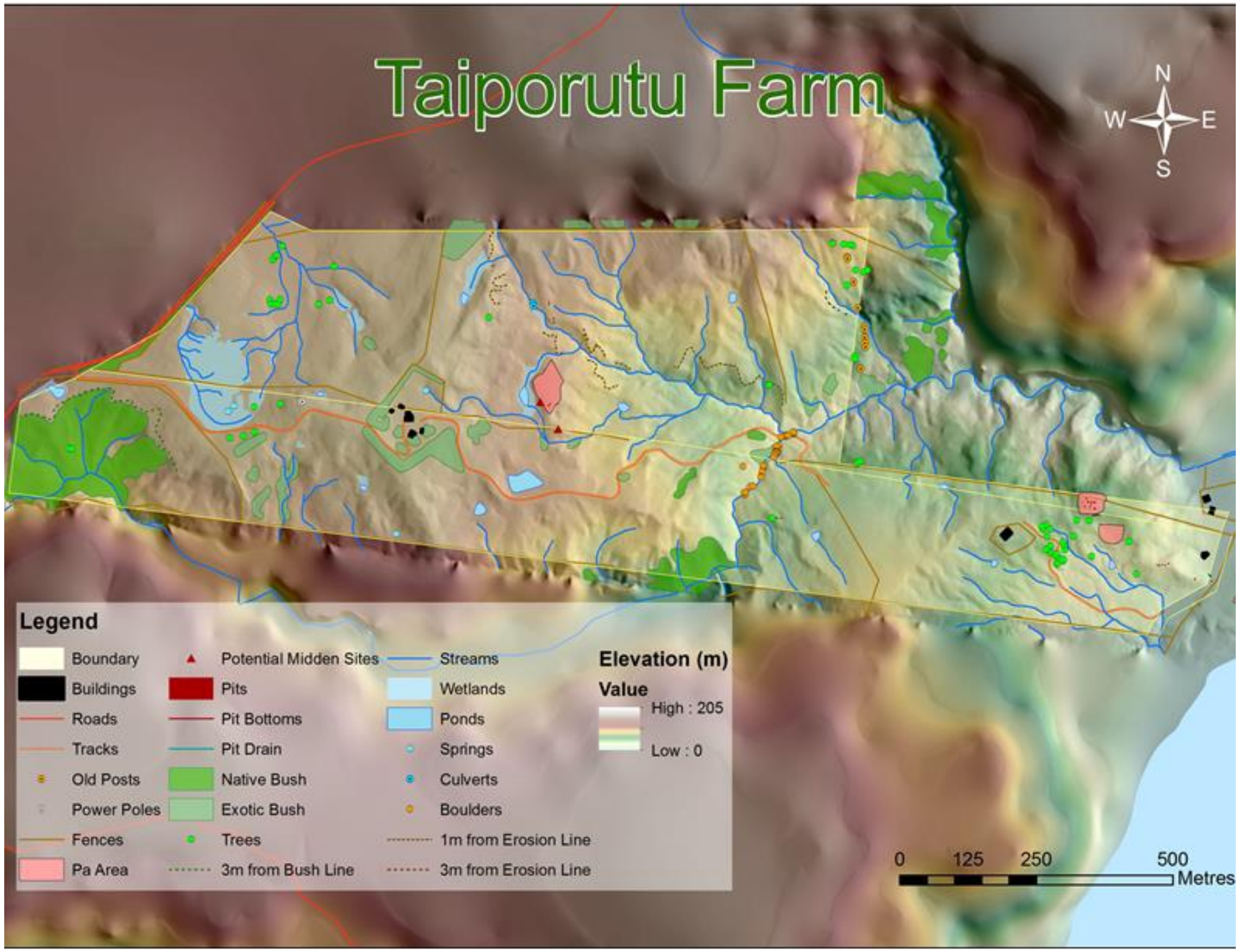



*Figure 5.4: Context Map of Taiporutu farm*

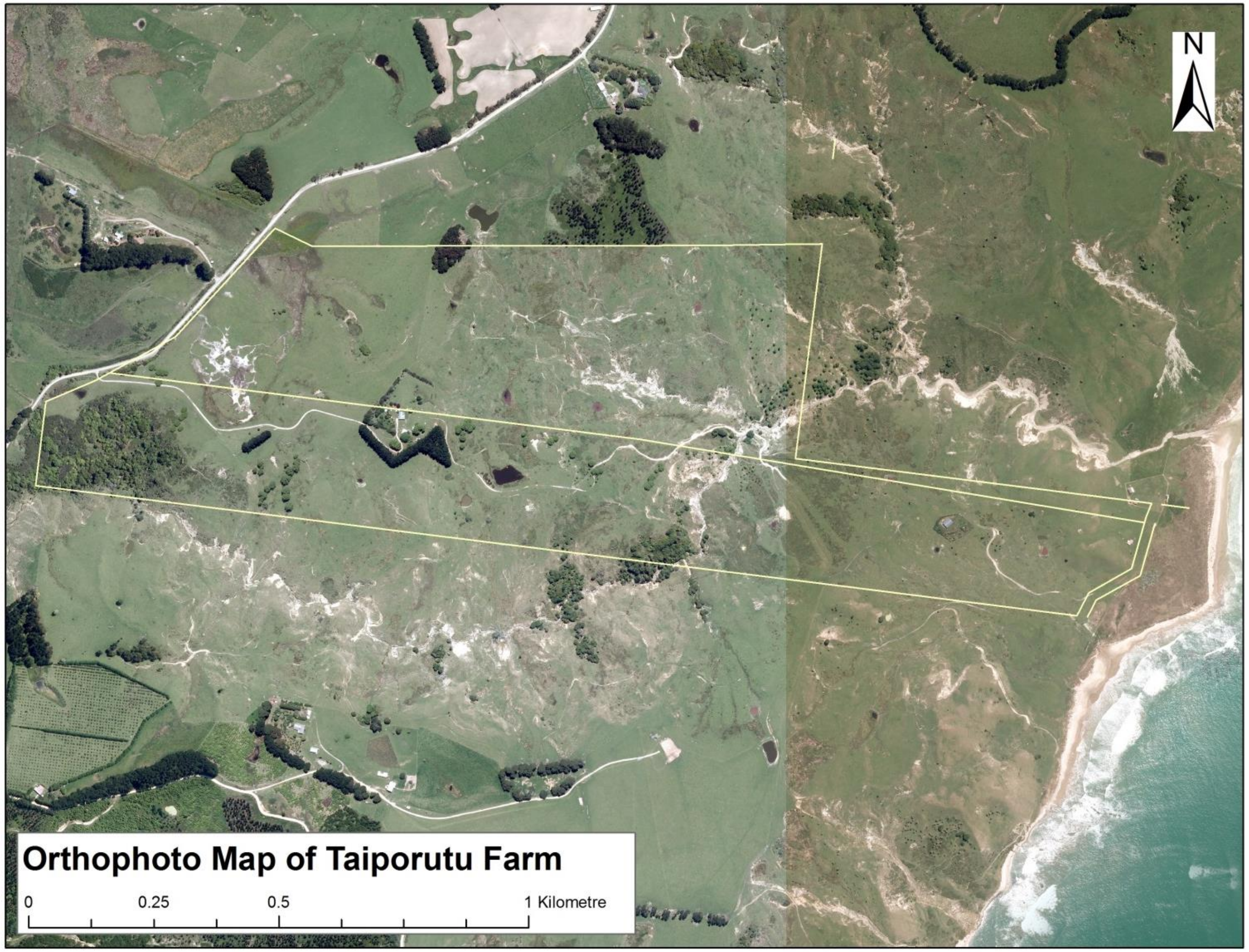



*Figure 5.5: Orthophoto Map of Taiporutu farm*

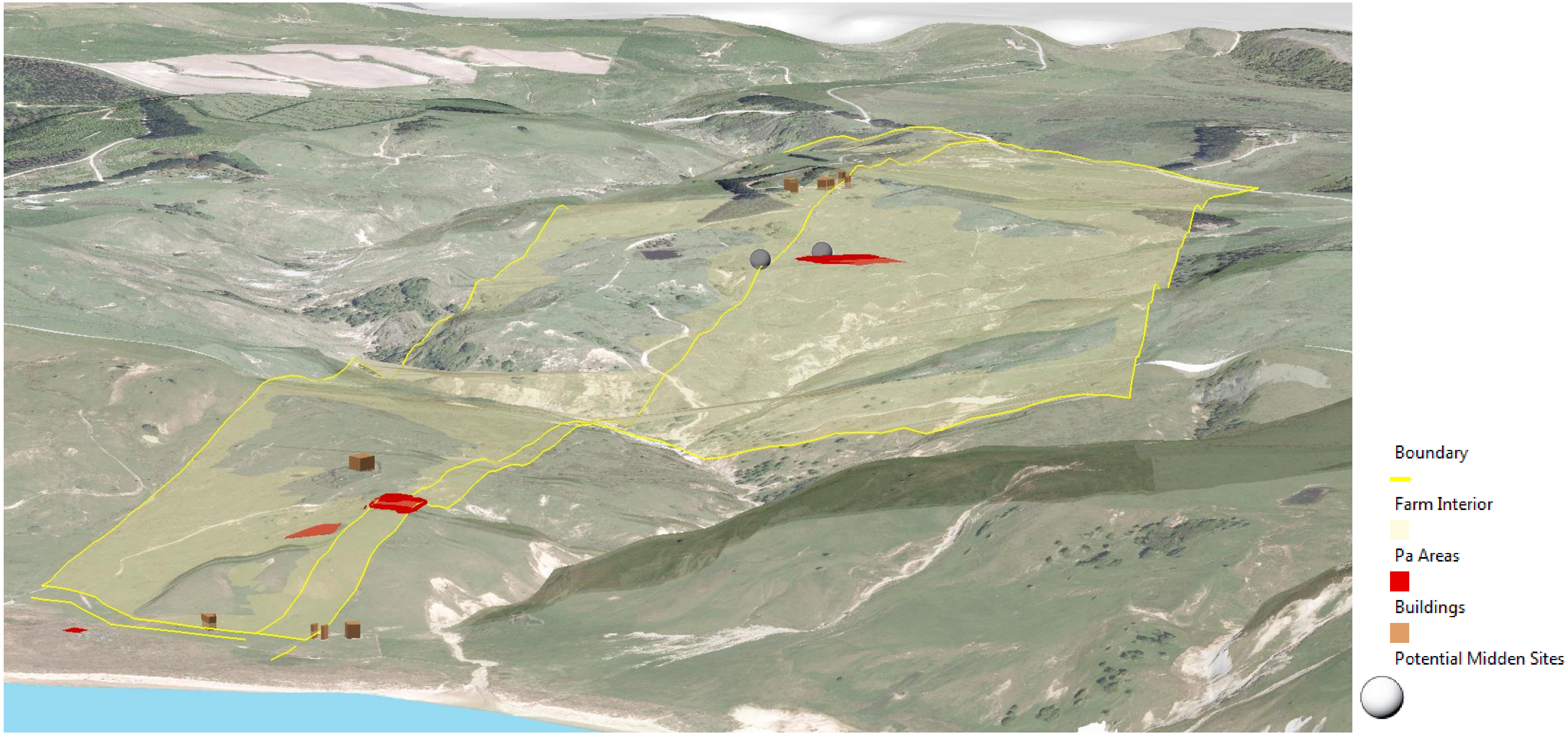



*Figure 5.6: 3D View of Taiporutu from the north east, created from elevation (interpolated from NZAM and LINZ Topo 50 contours), orthophoto, boundary, building, pa and potential midden site spatial data*

## 5.4 Henga Farm, Rēkohu (Chatham Islands)

A Remotely-Piloted Aircraft System (RPAS) survey backed up by a ground control and ground feature land survey was completed in November 2015 by Neill Glover (Geo & Spatial Information Systems Ltd) and Mike McConachie (Master of Applied Science in GIS student at Otago University).

### 5.4.1 Description of data

The main products of the aerial survey of the farm were a high resolution stitched orthophotograph and a dense cloud of 3D terrain points.

The photography was performed from a Phantom II Vision Plus drone with an integrated camera (14 megapixels; 140 degree field of view). The drone was flying at 370 – 400 feet, generating orthoimagery of 5 – 7 cm resolution.

23-26 blocks out of 30 planned blocks were flown (as wind conditions allowed), with each block or flight having 150 – 300 photos. The sorties were subject to below 15km/h wind velocity for optimal flying and photo stability. 30km/h was the absolute upper limit under which the drone could fly.

AgiSoft photogrammetric software was used to stitch the photos within a block together. To enable this, there was approximately 80% aerial overlap between photos in a flight line or block and 50% overlap between flight lines. The software automatically identified tie points for the stitching process.

As well as a stitched photoset, a Digital Elevation Model (DEM) in the form of a dense 3D point cloud was also produced. From this, a 3D mesh was created with an overlain texture. From this, a cellular DEM was generated with resolution to match the imagery. Contours were created from this and used to orthorectify each photo block, before stitching the blocks together.

The final stage within AgiSoft is exporting the data then importing into ArcGIS, for compatibility with data of the other two farms.

On the ground, a Trimble R8 was used to provide ground control points as well as vector data for the following on-ground features, to be stored in geodatabase feature class format in NZGD 2000 Chatham Islands Transverse Mercator 2000 projection:

- Fences (line and point [for posts])
- Power Poles (point)
- Gates (point)
- Cattle yards (polygon)

- Swamps (polygon)
- Water Reticulation (polygon and line)
- Water Storage (polygon)
- Water troughs (point)
- Hazards (polygon)
- Buildings (polygon)
- Roads (line)
- Contours (line).

These are all vector data (point, line, polygon) extracted, and did not require any further processing.

This dataset was supplemented by a 30cm orthophotograph of the farm to fill in areas not covered by the drone.

### 5.4.2 Overview Maps

A subset of the data described above is featured in the following overview maps:

- A 2D topographic map (Figure 5.7) featuring collected data (fencelines and posts, buildings, roads, hazard areas, swamp areas and water reticulation, storage and trough features).
- A 2D orthophoto of the farm (Figure 5.8)
- A 2D contour map of the farm to indicate its topography (Figure 5.9)

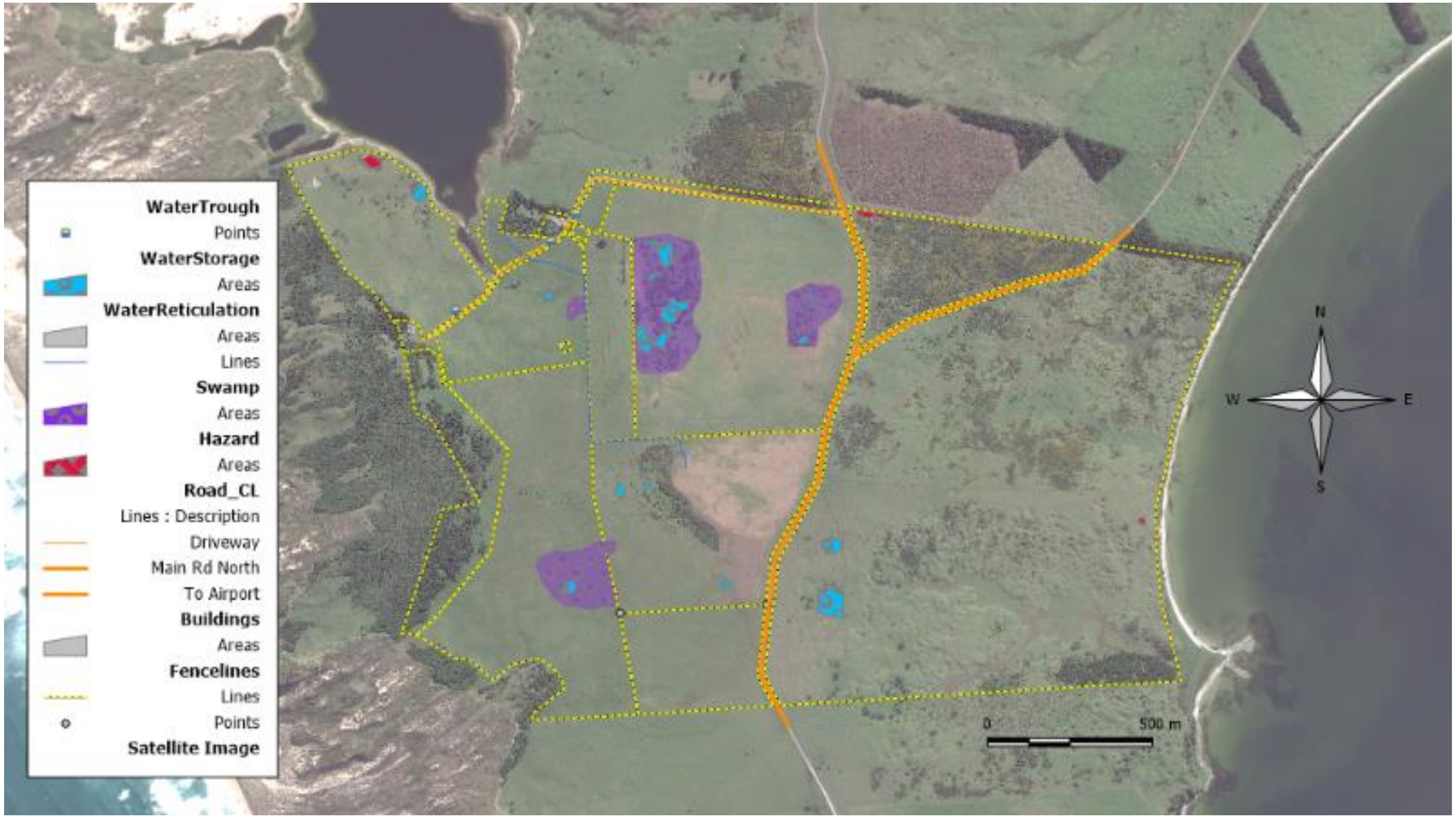



*Figure 5.7: Context Map of Henga farm (Neill Glover, Geo & Spatial Information Systems Ltd.)*

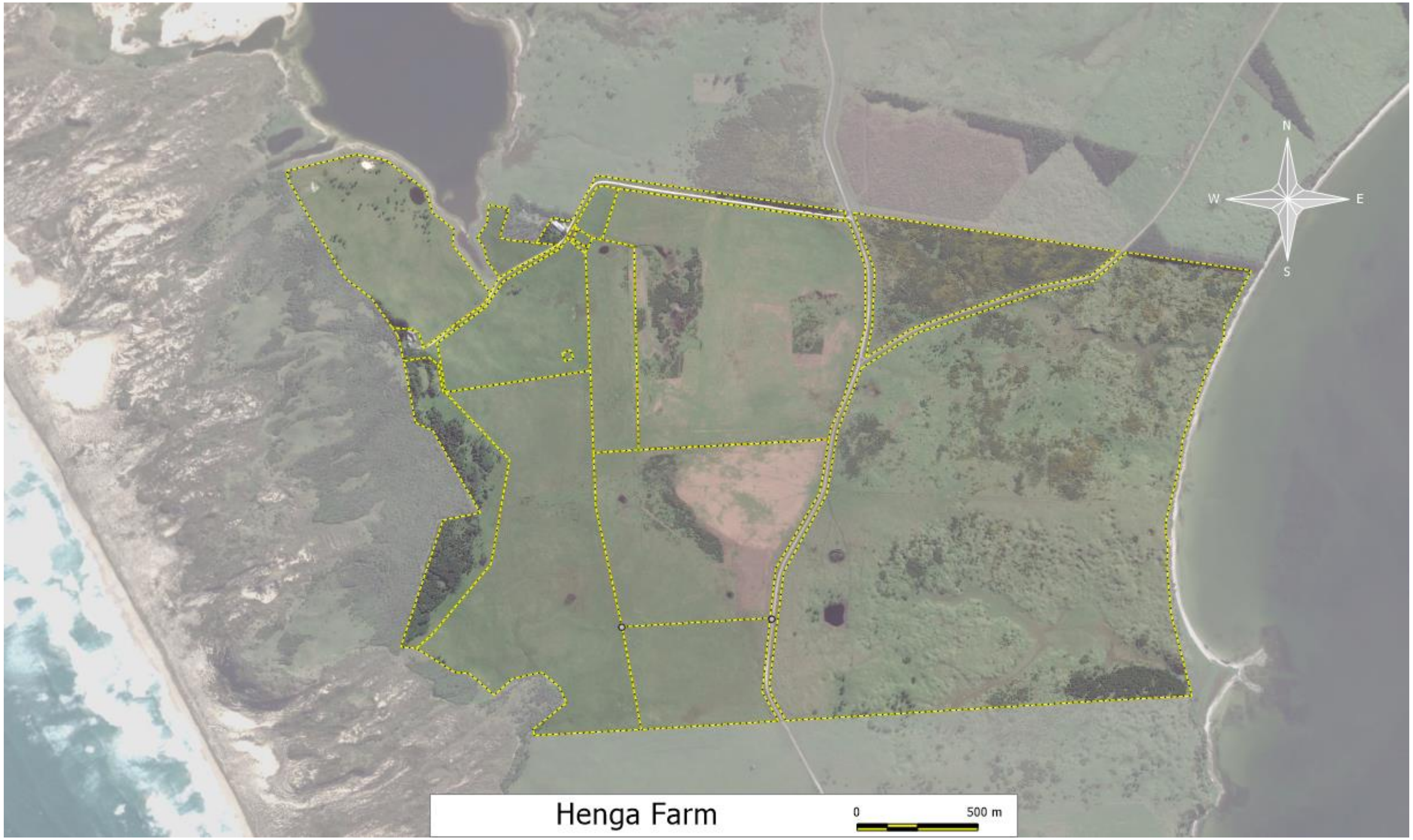



*Figure 5.8: Orthophoto Map of Henga farm (Neill Glover, Geo & Spatial Information Systems Ltd.)*

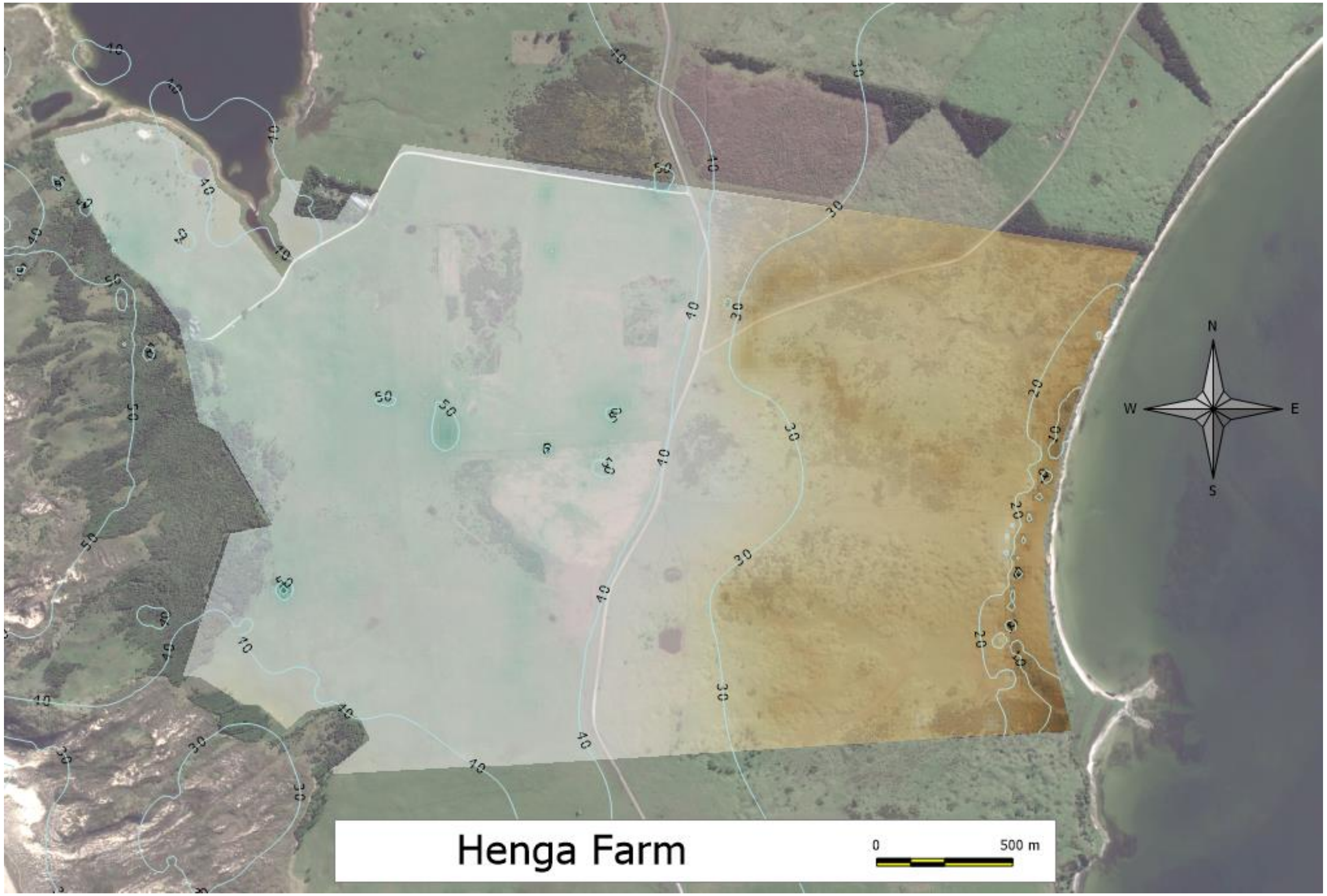



*Figure 5.9: Contour Map of Henga (10m interval) (Neill Glover, Geo & Spatial Information Systems Ltd.)*

## 5.5 Summary

This is an account of surveying and mapping using GIS, in support of the Indigenous Agroecology project. Three farms were featured; Te Kaio on Banks Peninsula, Taiporutu on Mahia and Henga in the Chatham Islands. A mixture of natural (e.g. terrain), infrastructural (e.g. buildings) and cultural (e.g. pa sites) data was collected, derived or collated. The purpose of this data is to provide a baseline for the other scientific and community activities and to form a complement to other cultural mapping practices. The next stages will involve the further exploration of how scientific and cultural mapping can unite for an enhanced capturing of farm geography and history.

## Glossary & Acronyms

Computer Aided Design (CAD): Digital design process used in engineering, generating 2D and 3D data on buildings, other built structures, and terrain

Digital Elevation Model (DEM): Digital spatial data of the ground surface, normally in raster form.

Geodatabase: The ArcGIS spatial database, containing feature classes

Geographical Information System (GIS): An information system for the storage, analysis and visualisation of spatial data.

Global Positioning System (GPS): A system of satellites orbiting the Earth that can be used to pinpoint position on the Earth's surface through a receiver.

Interpolation: Estimating values in between locations of known and measured values (e.g. estimating the heights between contour lines in order to create a continuous surface)

Land Information New Zealand (LINZ): New Zealand's national mapping agency

Orthophotograph: A photograph that has been corrected for camera distortions and terrain effects so that it can be used like a map

Photogrammetry: Making 2D and 3D measurements from photographs

Projection: Transformation from 3D globe (or more accurately, mathematical ellipsoid) to 2D flat map.

Raster: A format of spatial data where continuous attributes (e.g. terrain heights) are stored in cells forming a gridded tessellation

Remotely-Piloted Aircraft System (RPAS): A remotely controlled aerial device carrying sensors (normally a camera) to collect data of the ground surface (also called Unmanned Aerial Vehicles - UAVs - or drones)

Topographical survey: Accurate and precise spatial data collection using GPS receivers or total stations

Vector: A format of spatial data where discrete objects (e.g. roads, buildings) are stored as coordinate-based points, lines and polygons

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Neill Glover, Mike McConachie

*Photo credit:* *Desna Whaanga-Schollum*

# 6

# Agroecology and Farm Restoration: informed by Ecology and History

Priscilla Wehi

## Mihi

He mihi nui ki ngā tangata kua hāpaitia te kaupapa nei.  Ki a koe, Poua John, ngā mihi nui.  Ki a Ted hoki, rātou ko Iaean and Theo, kia ora rā mō tō koutou manaakitanga.

## 6.1 Introduction

Biodiversity losses under industrial agriculture reduce the ability for tangata whenua to express their cultural practices. Although there is a growing understanding of habitats and their components, enhancement of indigenous biodiversity on productive lands is more likely to succeed if it is done in partnership with agriculture and is understood to bestow benefits (Indigenous Agroecology NPM 2012).

Community members are concerned at the loss of mahinga kai arising from poor management of farm waterways. They are also concerned that conventional farming is currently largely insensitive to environmental, cultural and social concerns. The loss of biodiversity has severely limited the ability for tangata whenua to participate in many cultural practices (Indigenous Agroecology NPM 2012).

This research seeks to identify culturally significant native plants and animals, and mātauranga Māori that can help restore the resilience and mauri of the land and water to provide for communities economic and cultural wellbeing.

## 6.2 Research aims and objectives

If land is to be restored to create a functioning agricultural ecosystem then some understanding is required as to historical land cover, management, resource provision and use. Identification of taonga species that are or have been important in Ngāi Tahu tikanga and ecology, particular to the farms and iwi that reside there, means that these species can be used to assess land restoration, and the success of an integrated farming framework that has core Māori values. We therefore focus on indigenous perspectives on biodiversity, recollections of land use and management, and identifying sites of historical significance. This report specifically contributes towards a picture of historical use for the case study farm at Te Kaio by examining some of the past resource use patterns on Horomaka (Banks Peninsula).

In addition, it contributes information on two plant species that are culturally important in two other communities, at Mahia Peninsula (Taipōrutu Farm) and Rēkohu (Chatham Islands). The information in total can be drawn upon by whānau and hapū to select culturally appropriate indicator species for each farm, and to provide ideas on restoration planting if the farm is to be managed in the future within an indigenous agroecology framework.

## 6.3 Research Methodology

The methods of historical ecology can include searches of land records and archives, and discussions with owners and communities. Two main strands of information were collated during this part of the research: first, information from oral sources, primarily in the form of interviews, and secondly from written archives, including historical accounts and English and Māori language newspapers (niupepa Māori) from the 19th and 20th centuries.

Participants for this study were carefully selected by members of the hapū at Wairewa and Te Rūnanga o Ngāi Tahu. Local and traditional knowledge and history is not distributed evenly in a community, and there are usually a small number of locally recognised experts in a given area of expertise (Whaanga et al. 2012). The depth of knowledge that is offered to a research project does not therefore rely on a large sample size. The two participants interviewed here were both men aged over 70 years, and their kōrero were central to the research. They were asked about the history of the land on Horomaka, and specifically in the region of Te Kaio, and about human relationships with the land.

Elders John Panirau and Ted Hutchinson discussed growing up in the Horomaka region, and experiences that reflected their knowledge of the history of Te Kaio and the surrounding bays. Ted is the descendant of an early Pākehā farming family, and still farms the family land.

The second participant, John Panirau, is a poua originally from the Chatham Islands who grew up at Wairewa in the 1940s and 1950s and remained living and working on the peninsula for many years. Although he does not belong to the local hapū by descent, there are strong whāngai relationships that have existed since childhood. He later married into the hapū, and was instructed by some of the prominent leaders of the hapū in some of the history of the Peninsula.

The applied research for this project has centred on three farms, Te Kaio (now owned by Te Putahi Trust, Wairewa, Horomaka), Taipōrutu Farm (Mahia Peninsula), and a Hokotehi farm on Rēkohu. However, in this part of the research, the focus is on Te Kaio Farm. This focus was complemented by a broad search on two plant species that are culturally significant on Horomaka, as well as on both Mahia Peninsula and on Rēkohu, tī (*Cordyline australis*) and karaka (*Corynocarpus laevigatus*).

Oral Māori traditions have not specifically been examined for this research project, but history recorded in waiata and kōrero could be accessed in future. Environmental information is retained in waiata and other oral traditions relevant to the farm communities.

## 6.4 Farm partnerships: Te Kaio

European settlement on Horomaka was based on disputed sales of land title, in many cases beginning with the Canterbury Settlement of 1850. The long history of dispossession, and Ngāi Tahu response, is recorded elsewhere (see for example Evison 2006). Although Ngāi Tahu land purchases were disputed throughout the second half of the 19th century and beyond, European settlers bought and received title for land blocks across the peninsula, and settled to farm. The Wright family began farming at Ikoraki on the south side of Horomaka, when Ikoraki was purchased by James Wright in 1914, after the break-up of the large Kinloch estate in 1906 (Ogilvie 2010). James Wright established an orchard there, and in 1917 an 18.9 ha bushed reserve. His son Albert Wright worked the property in turn, but later transferred to a house higher up Magnet Bay Valley. In 1924 Ikoraki was taken over by the Hutchinsons, descendants of Hugh Buchanan who had previously farmed the Kinloch estate. Ted Hutchinson remains farming there. Jim Wright, however, continued to farm the family property until his death in 2006. In his will, Jim Wright gifted the 449 ha farm block to the Wairewa rūnanga, based at Little River. Te Kaio is now an integral part of the Wairewa rūnanga's vision for an integrated mahinga kai cultural park.

## 6.5 Horomaka flora and fauna

Horomaka is an eroded volcanic landscape with a high point of 669 m on the east coast of the south Island (Wood and Pawson, 2008). Before human arrival around 1000 years BP it was forested from the summit to the coast (Wilson, guide to the route). At higher altitudes above 600m the forest was dominated by species such as thin-barked tōtara (*Podocarpus hallii*), broadleaf (*Griselinia*) and pepperwood (*Pseudowintera colorata*), as well as tī (*Cordyline*) and native cedar (*Libocedrus bidwillii*). Forest on the alluvial valley floors consisted of podocarps such as kahikatea (*Dacrycarpus dacrydioides*), lowland tōtara (*Podocarpus totara*) and mātai (*Prumnopitys taxifolia*), whereas hill slopes were heavily wooded with tree ferns, shrubs and vines. Coastal gullies were warm, with species such as nikau (*Rhopalostylis sapida*), akeake (*Dodonaea viscosa*), and kawakawa (*Macropiper excelsum*) that reach their southern limit here, as does tītoki (*Alectryon excelsus*), while other species that might be expected to occur here (e.g. *Cordyline banksii*) do not (Laing, 1919; Laing & Wall, 1924; Wilson, 1992). Nonetheless, some of Laing's records seem incomplete or doubtful: pīngao (*Ficinia spiralis*) is not recorded from the peninsula by Laing, and another important species, *Cordyline indivisa* was reported as present but uncommon above 1800 feet on Purau Line, Akaroa Summit Rd by Laing (1919). A proliferation of birds existed within this forest environment, including moa, kererū, kaka, tūī, makomako or bellbird and owls. It is also estimated that at least four species of moa were found on the peninsula (Ogilvie 2010).

## 6.6 Human influences

Māori arrival on the peninsula has been estimated at around 1300 AD, using radiocarbon dating of moa-hunting sites (Challis, 1995). Between the time of Māori arrival and European arrival, it is estimated that around one third of the forest was removed (Figure 1), particularly on the headlands and the tops which were now covered with native tussocks (Ogilvie, 2010). Petrie (1963) suggests that around 120,000 acres, or half the area of the peninsula was still forested in 1840 when organised European settlement began. In the space of the fifty years between 1840 and 1890, however, forest clearance accelerated dramatically, and virtually all the forest was cleared during this period, including old growth podocarps (Laing, 1919; Wood & Pawson, 2008). For example, 600,000 feet of sawn timber was transported from Akaroa to Lyttleton in 1857 (Lowndes, 2002), and 26 sawmills were established prior to 1880 (Wood & Pawson, 2008). Fire also destroyed many thousands of acres on the peninsula, and it was estimated that more than 30,000 acres of forest were lost to fire in the 1860s (Wood & Pawson 2008 – 30). Where forest was destroyed, the ngaio (or kaio in Ngāi Tahu dialect; *Myoporum laetum*) was still sometimes found (Baughan et al., 1914).

European settlement and clearing of the forest brought a range of exotic mammals and plants to the Peninsula: the first cattle were brought to the peninsula in 1839 (Lowndes, 2002, p.11), possums were liberated on the peninsula in 1865, and feral goats also began to be seen (Ogilvie 2010). Wild pigs were numerous on the peninsula for many years also. Cocksfoot (*Dactylis glomerata*), a hardy strain of pasture grass, was first imported from England in 1852, and growing the seed became a major industry in itself, with up to 100,000 sacks of seed exported p.a. in good years, through to the end of WWII, although less so after the 1920s. Agents of decline therefore include clearance for cultivation, tussock fires, drought, sheep, cattle, rabbits and hares (Laing, 1919). Only 12 native forest birds are now present on the peninsula, including kererū and tūī. Current estimates of forest cover are around 15% of the peninsula, or 15,000 ha (Primdahl & Swaffield in Wood & Pawson, 2008), and reforestation has been occurring at locations as diverse as Te Oka Bay and the Kaituna Valley.

Wetland areas were similarly rich in bird species, with native ducks, swan, geese, pukeko, waders and harrier hawks present. However, wetland areas have also been extensively damaged by deforestation and previous farming practices, resulting in increased sediment and nutrient input into the lakes (e.g. Woodward & Shulmeister, 2005), and their extent and quality thus reduced. Sand dunes are few on the peninsula, so few sand plants were noted by European botanists and explorers. Pīngao, however, is a highly valued plant for weaving, and is prolific on Kaitorete Spit. It is also found at Te Kaio farm (see below). Coastal scrub was characterised by species such as *Olearia forsteri*, akeake and kawakawa, while kānuka (*Kunzea ericoides*) and mānuka (*Leptospermum scoparium*) might also come down to the water's edge (Laing, 1919).

On the coast, fish, shellfish, penguins, gulls, terns, petrels, southern fur seals, and dolphins were abundant, and humpback and southern right whales migrated up the peninsula coastline (Dawbin, 1956). Whaling began in New Zealand in 1792, but sperm whaling was the main objective until right whaling commenced in the 1820s. Humpback whaling appears to have begun slightly later (Dawbin, 1956). Whales caught were mostly right whales, which came closer inshore than humpbacks (Dawbin, 1956), although humpbacks were also occasionally seen, and the main whaling season was from May-August (Tremewan, 1989).

The South Pacific was the world's main whaling ground in the late 1830s and early 1840s, and Horomaka was part of this activity. Whaling bases were situated in the bays close to Te Kaio, at Peraki (1837-43), Ikoraki (1840-1876) and Oashore (1840-c.1850; Ogilvie, 2010). Early reports indicate that whales were less numerous than previously by around 1845, and whaling has not recovered as an industry on Horomaka, despite some talk of doing so. It is not thought that Māori have a tradition of actively hunting whale; rather, the bones and carcasses of washed up whales were utilised. Certainly, a great deal of whalebone has been used in taonga found at Te Kaio in archaeological research (Challis, 1995). Sealing was also an important industry; in 1806 more than 60,000 seal skins from the east coast were sent to Sydney. Muttonbirds have also been a resource for Māori on Horomaka, and still nest on the coast in some parts of the peninsula.

The history of Te Kaio farm echoes the story of enormous environmental change that has occurred since human settlement (Figure 1). Poua John Panirau recalls much of the vegetation at Te Kaio in the 1940s and 1950s as *"mānuka and tī kōuka with a lot of short stubby bushes"* as well as pine like small trees. In addition, there were other large trees such as macrocarpa (*Cupressus macrocarpa*) that were used as powerlines at that time.

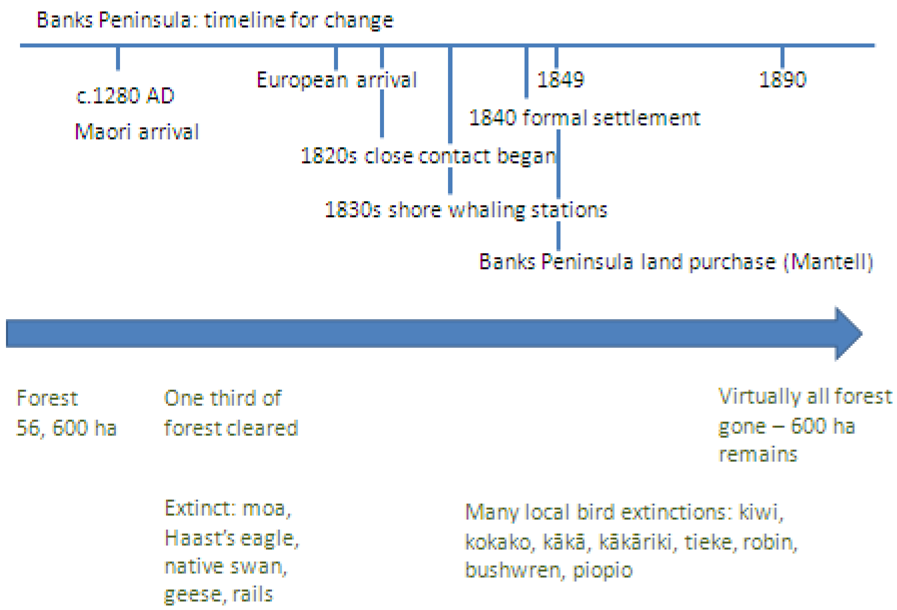


*Figure 1: Outline of environmental and historical change on Horomaka from c. 1280 AD until 1900.*

## 6.7 Te Kaio history

Māori have occupied the site that is now known locally as Te Kaio (Tumbledown Bay in the archaeological literature) over a long time period. In 1910 Frederick Anson wrote:

> *"it must have been at one time a populous native settlement, to judge by the quantities of skulls, skeletons, and other bones of human beings, pigs, fish, which are (or were) exposed to view whenever a dry nor-wester blows away the drafting sand."*

Many implements, as well as bones, have been found during archaeological searches at this site. For example, adzes flaked out of local basalt have been found at Te Kaio (Allingham, 1988). Stone items found here, however, are mostly derived from greywacke beach cobbles. Sub-circular flakes or spalls made from greywacke are found on sites associated with moa-hunting, and were probably used as knives for cutting or scraping meat or wood. Sawn greenstone has also been found at Te Kaio (Allingham, 1988, NZ7654, NZ7745, sixteenth century), as have North Island-sourced obsidian artifacts. Food remains include shellfish, seal, dog, rat, tuatara, four species of moa, swan, giant rail, shag penguin, kiwi, kaka, parakeet, tūī, pigeon, kōkako and several other bird species.

Poua John Panirau also notes that:

*"Te Kaio was a burial ground . . . apparently the burials are guardians either Waitaha or Ngāti Mamoe ancestry or both and they were there to ensure that our natural kai in the bay remained plentiful. . . I discovered later that there are ancestors buried all along the southern coast of the Peninsula either as guardians or because of some tragedy in the past."*

Intriguing unconfirmed accounts of resources that are no longer associated with Horomaka also exist. Radiocarbon dating of moa bone collagen from Te Kaio indicates that moa hunting was widespread and relatively intensive in the $14^{th}$ and $15^{th}$ centuries, and may have continued on a smaller and more localised scale through the sixteenth century before their extinction (Challis, 1995). Oral history also indicates that moa may have survived longer on Horomaka than elsewhere; John Panirau says that:

*"According to the Poua who spoke to me, moa were "farmed" in Te Kaio. They were apparently brought in especially and although allowed to roam freely were easily kept in the narrow valley because of the steep hillsides."*

In the Menzies family history, centred around Menzies Bay on the far side of the Peninsula from Te Kaio, Menzies (p. 141) noted that:

*"The Māoris say long ago these downs [tussock land downs] were the favourite feeding ground of many moas; that they lived on berries in the bush; that they laid two eggs at a time, that they were hunted by them. . . They tried to domesticate them, but did not succeed in doing it."*

He also recounted a story of killing moa using red-hot stones from the fire.

Bones of tuatara, no longer present on mainland New Zealand, have also been distinguished in middens from Te Kaio, as well as two other sites in Canterbury. While it is unlikely or impossible for some of these species to be restored, they nonetheless form part of the story of Te Kaio.

Marine resources were certainly used by local Māori in past times, and many of these continue to be gathered today. Poua John Panirau recalls:

*"Because the water in the bay [at Te Kaio] is so shallow, even at high tide, it is easy to gather pāua (from the eastern side of the bay) and crayfish from the western side. I remember gathering lots of pāua in my young days but was never lucky enough to get any crayfish from this bay. But both pāua and crayfish seem to be on the move all the time and not always in the same location on every visit. . . I remember seeing some kaio plants (sea tulips) but they weren't as big or as plentiful as those I experienced in Wainui and Akaroa harbour."*

Whakaraupo (Lyttleton harbour) was known for its sand shark or pioke, which cannot now be caught (Ogilvie, 2010). John Panirau has noted that Maherua bay, past Te Kaio and Te Oka, was used extensively for catching shark and hapuka. As well, the creek and raupō swamp abounded with eels (John Panirau, unpub. ms.). Poua John has described how the name Te Putahi could refer to small tufts of grass growing out from the cliffs; he has placed Te Putahi on a cliff face, on the map he has redrawn for his manuscript. He adds however:

*"It was also mentioned that huge eels populated the area and that the name could be Te Putakitaki but this is probably going too far. The old people also referred to an old yarn about a taniwha being somewhere in the area that was known as a pūtangitangi (Putakitaki = Ngati Mamoe/ Ngai Tahu dialect). A Putangitangi is a large eel. . . There were certainly plenty of eels in Maherua, the main bay next to Te Putahi. . . Putaki can also mean to be lost."*

Challis suggests that whales were likely a regular item in the diet, because of the use of whalebone for a variety of taonga found at Te Kaio (see Figure 2 for a distribution of marine resources in relation to South Island archaeological sites). The bones of young kekeno (fur seal) have also been found at Te Kaio. Fish bones, as might be expected, were also found in the middens at Te Kaio; Maka, or barracouta, was dominant. Oral histories from Horomaka similarly indicate barracouta was an important resource. A distinctive Canterbury type of fish hook, with two-piece bait hook points, a rounded cross section, substantial internal barb, and well developed lashing grooves and lashing surface, and usually made from moa bone is well represented at Te Kaio.

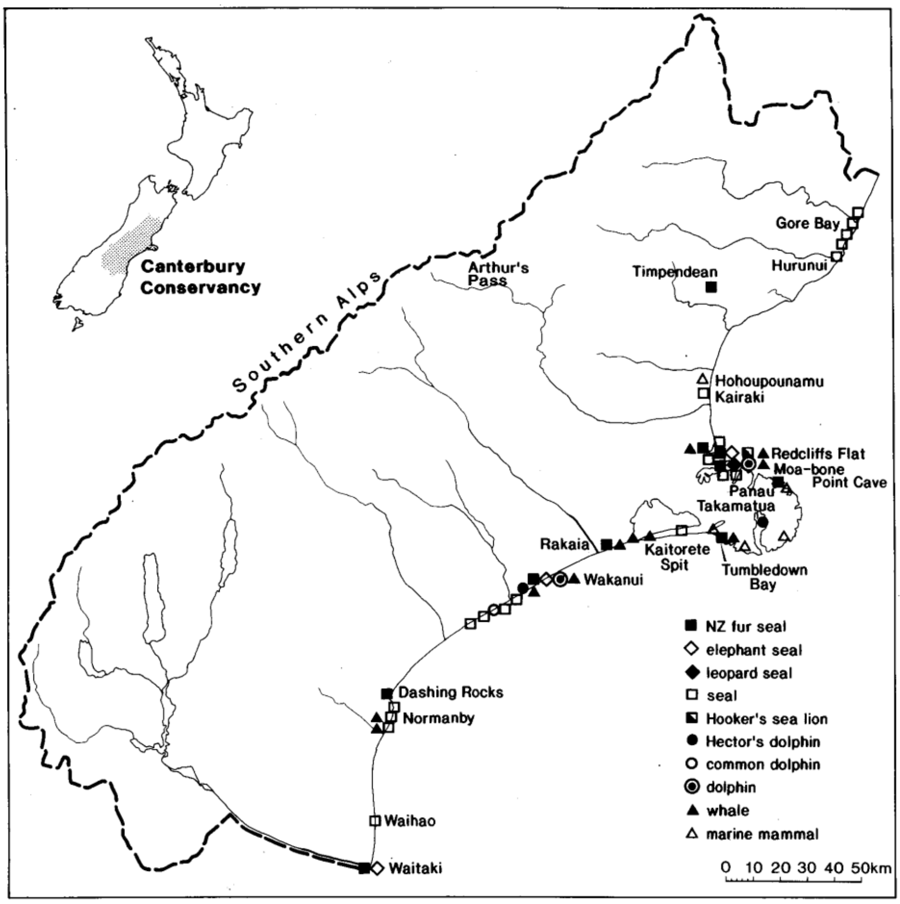


*Figure 2: Distribution of identified marine mammal bones from a range of archaeological sites, and probably associated with human settlements (Taken from Challis 1995).*

Names again from the local area indicate both mahinga kai sites and history. For example, Te Karoro is the headland separating Te Kaio from Te Oka Bay, presumably referring to the shags that were previously an important food source. Poua John Panirau recalls that:

*"The tall stone rock pillar out off the western head of the Te Kaio bay was known as Te Karoro . . .but it can't be easily seen from Te Kaio beach. There are two such pillars, or there were two at one time; the other stone pillar stands at the eastern head of the bay and can easily be seen by the beach. I haven't been out to Te Kaio for a few years and the recent earthquakes might have damaged them. A similar stone sentinel stands on the Sumner*

*seafront, it is known as Rapanui, and it was damaged in the recent earthquakes."*

He thought that Te Karoro might be a sea bird guardian. Poua John went on to recall the story he was told about two taniwha that frequented Te Kaio, and who captured a niece of Tangaroa from there. However, Tangaroa caught them, and berated them before turning them into pillars of stone (John Panirau, full story in his ms.).

Of other resources, pīngao (or pīkao) from Te Kaio is well known to weavers, in part because of its length. John Panirau has noted that:

*"Before the visit by Te Rauparaha to the Peninsula, Te Kaio was frequented by many Māori food-gathering parties. Women also visited because of the pīngao (pīkao) that grows in the sand dunes. The women said it was special (whatever that means) and different to the pīngao gathered along Kaitorete Spit."*

The continued existence of pīngao in these dunes is also a testament to the strong connection between Jim Wright and the local Wairewa rūnanga. Jim erected a fence after discussion with the rūnanga, to support the rūnanga's goal of protecting these plants from motorbike and other damage. This shared goal was perhaps instrumental in his eventual gift of the farm back to the rūnanga.

## 6.8 Resource Management

Williams (2012) emphasises an important point in the management of resources. First, the abundance and quality of the resources available to a tribal group directly determined their mana, welfare and future. He then goes on to say:

*"The actual management of resources operates within a context, and the context is as significant as the actions taken. Furthermore, the whole of the context needs to be regarded."*

Thus, European arrival and notions of land ownership created an entirely new and challenging context for Māori.

Early European visitors to New Zealand recorded horticultural areas in use by Māori during the late 18$^{th}$ and 19$^{th}$ centuries (e.g. Best 1925), but they also failed to recognise some cultivation regimes (e.g. for harakeke *Phormium tenax*, see Wehi, 2006). In Canterbury, Beattie (1945, pp.117-8) records how one managed site was disregarded: one of his informants told him that:

*"The name of the Styx River [in Christchurch] was Pu-harakeke-nui . . . and I had a reserve there on which great flax grew, and it was a special delight to me, but when I visited it next I found the white man had cut down all my beautiful flax. I felt like weeping."*

It is likely that Māori horticulture (and other resource management) began soon after the arrival of Polynesians in New Zealand (Leach, 1987), and early gardening sites have been dated to before 1300 AD (Leach & Leach, 1979; Trotter & McCulloch, 1997). Moreover, as Furey (2006) points out, the Polynesians brought long established traditions and techniques for growing staple food crops with them. Resource management therefore included husbandry around the growth and the harvest of important resources, as well as their preparation, distribution and storage (Williams, 2012). As such, husbandry includes habitat enhancement, improvements to the quality of stock such as selective breeding, and limitations on harvest. Harakeke (*Phormium tenax*) is probably the most well known example of Māori selection for specific purposes, but other known examples include both tī and karaka (Garven et al., 1997; Williams, 2005; Stowe, 2003).

In many parts of New Zealand, Māori sustained a mixed economy based on gardening, gathering and fishing (Furey, 2006). This was certainly true in the South Island, and on Horomaka. Horomaka was among the southernmost sites of kūmara (*Ipomoea batatas*) cultivation in New Zealand (Beattie, 1990), largely because kūmara failed to flourish in the cooler temperate southern climate despite extensive Māori horticultural expertise and soil modification (Yen, 1961). Nonetheless, kūmara gardens have been identified on the southernmost side of the peninsula (Okuora Farm approximately 1 km from Waikakahi in the Birdlings Flat area, Challis, 1995; Jacomb, 2000; Basset et al., 2004).

The rich natural resources of southern Horomaka allowed Māori to diversify and kūmara gardening was only one of many sources of food. A number of vegetable food plants were also predominant in southern Māori diet. These include kāuru (from tī), waitutu (from tutu, *Coriaria arborea*), and berries such as kotukutuku (*Fuchsia excorticata*) (see, for example, Tikao n.d.). As well, Te Waihora (Lake Ellesmere) and Te Wairewa (Lake Forsyth) were rich food baskets for South Island Māori, and Beattie (1945, p.117) considered that at least four "forts" were situated on the southern edge of Waihora. Horomaka, with its varied coastline, provided a wide array of marine resources.

Priorities in land management under regimes that aim to restore land functioning and valued ecosystems, and that incorporates both cultural and ecological goals, includes planting to reduce erosion, reduce nutrient run-off, and reduce livestock access to waterways (Tau et al., 1990). Nutrient pollution effects render coastal shellfish beds unusable and unfit for recreational use, and affect the life in freshwater streams. The abundance and health of freshwater kōura or crayfish (*Paranephrops* species), whitebait, and other freshwater life can therefore be used as an indicator of freshwater and coastal water quality, particularly previous herbicide use or topdressing chemicals may have entered creeks and berms. Topdressing of cocksfoot grass crops was reported as heavy before WWII (John Panirau, pers. comm.). Stream quality could be improved by creating new habitat or enhancing existing habitat, thereby facilitating freshwater seeding (Williams, 2012). As well, habitat improvement and enhancement was undertaken.

*"Water and associated resources confirm life to man and thereby form a basis for his identification, his belonging, his mana"* (Tau et al. 1990). Using indicators of ecosystem health from freshwater and marine ecosystems, as well as terrestrial ecosystems, is therefore appropriate on farms using indigenous agroecology principles. Kakahi or freshwater mussels (*Hyridella menziesii*) occur in lakes and rivers throughout Canterbury and are widely recorded in archaeological deposits (Challis, 1995). Freshwater kōura that had previously been harvested on Horomaka (John Panirau, pers. comm.; see below), along with whitebait, are likely to have been more widespread in the past. All of these could be used as indicators of ecosystem health.

The evidence indicates that species and ecosystems that are valued highly by Māori may differ from those that resonate with Pākehā. For example, a Ngāi Tahu kōrero that celebrates Waihora alludes to tuna, lamprey, inanga, and mohoao, as well as pīngao (Anon. 2008). Similarly, the meeting house at Taumutu, near Kaitorete Spit celebrates aua (herring), pātiki and tuna. In a restoration project under the auspices of indigenous agroecology, the use of culturally important indicator species is appropriate: one such example could be the freshwater kōura or crayfish as mentioned above. As part of the protected natural areas programme (that assesses ecological fragments) on the Peninsula, Hugh Wilson noted that freshwater crayfish might be expected in the lower stretches of streams. However, he did not observe it, and nor did he find any records of it on the peninsula (Wilson 1992). In contrast, Poua John Panirau recalled that the old people extensively discussed the freshwater crayfish, had harvested it as a delicacy, and that he had also seen kōura in two streams on the peninsula some years ago, with one of these being a stream near Te Oka, not far from Te Kaio.

## 6.9 Gifting and Exchange of Resources, Manaakitanga

The importance of resources can be partially inferred by examining trading and gifting patterns (e.g. Shortland, 1851, p.224; Salmond & Stirling, 1980). Williams (2012) discusses kaihaukai, which he describes as:

> *"the ritual distribution of surplus by exchanging specialty foods from one area to another, usually both obligatory and reciprocal."*

Kaihaukai was a form of feasting, and at the same time a means of distributing, from district to district, the significant and disparate surpluses that occurred. Kaihaukai were therefore an important part of Māori life both before and after European arrival. While an extensive analysis is beyond the scope of this project, some patterns in gifting and resource use are nonetheless apparent from a survey of 19th and 20th century newspapers, which report on important community events on Horomaka. When the reports are considered in the light of Māori practices and values, it is evident that kaihaukai continued to be practiced even when European foods replaced traditional Māori resources (see below).

It is clear that important community events were attended by large contingents from other Ngāi Tahu communities, such as those at Wairewa, Koukourata, and Rapaki on Horomaka, and from other kainga in the South Island such as Tuahiwi. In addition, other communities from further afield were often represented including Rēkohu and North Island iwi. Strong links existed between these communities that are evident in whakapapa and history, and that have been described elsewhere (e.g. Tau, 2003, 2011). Many of these linkages were maintained through gifting and other expressions of manaakitanga (literally, caring for a person's wellbeing or mana). Patterns of manaakitanga between local communities were confirmed by Poua John Panirau. He recalled, for example, that while he was a young man growing up at Wairewa, the people of Rāpaki very often shared rewena with their relations at Wairewa, who reciprocated with tuna (JP pers. comm. 2013).

During the 19th century, there was regular bartering in tītī, dried fish, kererū, kūmara and greenstone. Southern Māori told Beattie (1920) that although kūmara did not flourish further south than Horomaka, the system of kaihaukai allowed the exchange of items such as tītī for kūmara from Canterbury, or even taro and hue from the North Island. In addition, there were more localised circles of reciprocity.

Niupepa Māori and English language newspapers such as the Akaroa Mail recorded the continued expression of Māori values such as manaakitanga. These values were clearly evident at tangi, hall openings and other important occasions in the life of the community.

The reference to karaka kernels at tangi from various newspaper sources confirms the esteem in which karaka was held. Traditionally, foods that uphold the mana of the local hapū and whānau are prepared at a tangihanga, and for this reason, many traditional foods appear on these menus when they may be long gone from less prestigious meals.

More generally, a wealth of evidence indicates that karaka was a desirable food. Hay (1915, p.13) described the process of steeping karaka that he observed on Horomaka in the mid 19th century as follows:

*"maize and karaka berries they steeped in semi-stagnant water (by damming up a slowly-running stream) for three weeks. It was then withdrawn, black-looking, and emitting a vile stench, and, when dry, ground into a kind of flour between stones. Rotten potatoes, which they collected when digging, were treated in the same fashion."*

Both this report, and the recollections of Poua John Panirau provide evidence that the steeping process was used for a range of resources, from karaka through to pāua, in contrast to modern usage where the steeping process is essentially limited to the production of kānga pirau.

Archaeological evidence indicates that groves of karaka trees were deliberately planted throughout the country, including Horomaka. For example, the recorded distribution of the trees is associated with coastal archaeological sites (M36/67, N36/9, 14, 72, 77; site record forms; Challis, 1995). This contrasts with the early 20th century view of Laing (1919) who reported that karaka occurred in lowland forest on Horomaka between Port Levy and Akaroa. As the evidence was re-assessed however, the view of botanists began to change also: Wilson (1992) asserted that karaka was almost certainly naturalised on the peninsula, as it only occurred around known Māori sites (Wilson, 1992). Nonetheless, both Laing and Wilson recognised its importance to Māori. Laing (1919) wrote that:

*"At one time a few scattered specimens probably existed along the coast from Dampier's Bay, Lyttleton, to long Lookout Point. It has been suggested by J.B.A. [J. B. Armstrong] that it is an escape*

*from cultivation; but there is nothing in its distribution at Long Lookout Point, the only place where it now occurs, to suggest this. It there extends to a distance of a mile and a half inland from the beach, and has been comparatively abundant over this area. It is said that a grove existing at Macintosh bay was felled by the owner in order to discourage the Māori s from visiting the place. One plant in Aylmer's Valley, Akaroa, found by Miss Fyfe!"*

Menzies (1980, p. 138-9) further recalled that there was a large plantation of karaka trees at one time on the beach. Māori claimed the right of coming to collect the fruit, *"of which they were very fond. Those plantations of karaka trees were considered of great value by the Māori s".* However, he also noted that because the landowner did not want local Māori on his land, he cut down the plantation, and thus removed the source of his "anguish." Fine groves of karaka were also recorded from Little Okains Bay (Hay 1915).

## 6.10 Restoration of Tī and Karaka within the Landscape

Three partnerships with indigenous landowners fall within the scope of the Indigenous Agroecology project. The first of these is with the trustees and managers of Te Kaio Farm; the second centres on Moriori owned farms at Hokotehi on Rēkohu, also known as Wharekauri and the Chatham Islands, and the third centres on Taiporutu Farm on the Mahia Peninsula on the eastern coast of the North Island of New Zealand. With regard to the other partnerships, a different approach has been taken. First, much of the complex and unique history of Rēkohu has previously been described in personal accounts, government investigations and systematic, comprehensive historical research (for example, Holmes 1993; Waitangi Tribunal 1993; King 2000). Second, the desire of local whānau at Mahia to record their own cultural landscapes emerged and strengthened during discussions between the local whānau and the research team. This strength of commitment to historical ecology research that will underpin restoration of the farming landscape therefore facilitated a new approach by the research team. In the historical ecology part of the Indigenous Agroecology project, only issues relevant to Te Kaio Farm have been described here. Our focus in relation to the other partnerships has shifted to consider the restoration of two culturally important species, tī kōuka (*Cordyline australis*) and karaka (*Corynocarpus laevigatus*) within the broader farming landscapes of Mahia and Horomaka, and to explore how agricultural systems and restoration ecology can together improve the realisation of whānau and hapū aspirations with regard to these culturally important species. In this part of the project, we focus on a synthesis of culture and ecology for these species.

### 6.11 Tī kōuka, Whanake (*Cordyline australis*)

Tī is an iconic species within the landscape, dotting the crests along the Summit Road of Horomaka (Baughan et al., 1914). Its many uses are outlined in Williams and Chrisp (1992). In particular, the leaves were durable and useful for weavers, it was used in rongoā and the stems and rhizomes were nutritious foods.

In the South Island in particular, the cooked root of the tī, known as kāuru, was a vital component of the pre-European diet and as such tī rhizomes was heavily harvested, as were tī stems (Tikao n.d.; Beattie, 1920). The archaeology of cooking tī, for example by examining the tī ovens, has been studied in detail by Fankhauser (1986), and specific adzes associated with sugar extraction from kāuru and tī harvesting have been identified from archaeological sites in Canterbury (Duff, 1976; Challis, 1995). Elsewhere, Williams (2005) and Simpson (2000) have discussed kāuru in the southern Māori economy, from both emic and etic perspectives, and the resource potential of tī is also quite clear in the late 19th century writings about kāuru by leading Banks Peninsula elder Teone Taare Tikao (Tikao n.d.). Māori writers were also aware of its importance both on the New Zealand mainland and in the Chathams (e.g. Polack, 1840; Servant, 1979; Hamilton, 1903). For example, Anon (1848) sums up Māori use of tī from an early outsider's perspective as follows, although he or she somewhat confuses the forms of tī, and fails to indicate the general importance of kāuru:

*"there are several varieties of this tree, all of which have long tap roots, which the natives cook; they have then a bitter sweet taste; the early Missionaries brewed excellent beer from them; the tender shoots are also eaten, and, although rather bitter, make a wholesome dish; the Toi dracedra also has a large tap root, which is likewise eaten; the Kōuka is another variety which may be used in a similar way."*

Nonetheless, the preparation of kāuru on Banks Peninsula was recalled by 19th century Pākehā settler James Hay (1915, p.15):

*"In the "forties" the Māori s had a method of extracting sugar from young cabbage trees, which, I fear, is now lost. They began operations by digging a hole 8ft. long, 4ft. wide, and from 5ft. to 6ft. deep. A layer of stones was placed in the bottom, and on them an enormous fire was built. When this had burned down the*

*young cabbage tree was stripped and laid on the stones. Water was then poured over them, and all was quickly covered over with earth and left for many days. Beyond this I do not know what other process was adopted, but it seemed to me that the pith of the tree had the sugar encrusted in it. The Māoris carried it with them in this fibrous form. They chewed it when on a journey, spitting out the fibre when they had exhausted the sugar from it."*

To maintain this resource, tī was managed in a number of ways. Tree cropping (as well as the orcharding of karaka trees) was likely to have been a significant horticultural practice in pre-European times (Challis, 1995; Williams, 2005). Beattie also records information about the planting of rhizome pieces to ensure propagation of the tī. Williams (2005) discusses other management practices associated with tī, including restrictions on harvesting locations, karakia, and replanting of tops as well as root tips (also see Tikao n.d.).

The attractiveness of tī in restoration plantings therefore has a strong Māori context, in addition to being iconic to a wider section of New Zealand society (see Simpson 2000 for a discussion of this). Some of the many qualities of tī are frequently alluded to in traditional forms of literature within Māori culture such as whakataukī. Tī can be associated with spiritual qualities, and in many places around the country, old tī trees can be seen planted in burial grounds. Its regenerative abilities are identified in the whakataukī:

*Ehara i te ti e wana ake*

*It is not a tī tree that it should grow again, or regain life (Best 1977 p.87)*

*E kore e rite ki te ti, ka tapahia tona tinana, ka tipu ake Ngā huri*

*Not like the ti tree which when it is chopped down, produces new shoots*

*(Grove and Mead 1989, p.25)*

A number of iwi also have stories about tī walking within the landscape (Simpson 2000), emphasising the links between tī and landscape, and the metaphysical and physical realms. Poua John Panirau has recounted a Ngāi Tahu account of walking trees on Horomaka in his manuscript.

Māori also used Tī as indicator species. As one example, the timing and abundance of flowering was used to determine the time to gather kina (Simpson, 2000). A detailed whakapapa for tī, that describes some of the intricate knowledge Māori have retained around this genus, is presented by Hohepa Delamere in Simpson (2000, pp. 115-123).

Nonetheless, the single tī that are often seen standing in farm paddocks are at risk of trampling, being eaten by stock, and not being able to regenerate (Simpson, 2000). If tī are to be considered within the wider context of agroecology, and as a vital component of farm restoration, the principles of whānau planting (where associated species are planted in clusters), streamside restoration, and the use of fruit and seeds from parent plants to grow new tī all need to be considered. It is said that tī was also frequently planted in groves to attract kererū (Williams 2005); the planting of groves thus functions to enhance the wider ecosystem by encouraging seed dispersal and maintaining the health of bird life.

## 6.12 Karaka (*Corynocarpus laevitagus*)

Karaka is an indigenous species that has also been described in oral tradition as being transported on the Aotea canoe (Mead & Grove, 1989; Te Rangi Hiroa, 1949). That Māori prized it as a food was evident to early Pākehā; Anon (1848) described karaka as follows:

> *"this beautiful Laurel produces a fruit about twice the size of a large Acorn, of an orange colour, having somewhat the flavour of an apricot, but by far too strong to be agreeable; the kernel is as large as an Acorn; until it has been cooked and steeped in a running stream for a fortnight it is very poisonous; after it has undergone this process it is much prized as an article of food by the natives."*

Māori management practices include practices such as whānau planting to maximise optimal conditions for the plants by planting associated species in clusters. Some species were also planted in groves. Karaka groves remain a feature of the landscape at Mahia, and on Rēkohu. Although on Horomaka karaka groves have currently only been described from the northern side of the peninsula, it could be possible to find warm sites at Te Kaio Farm that might support karaka. Groves would certainly recall the manaakitanga and kaihaukai principles of Ngāi Tahu that are so clearly observed in reports from the 19th century.

The restoration of karaka groves could also reflect the desirable qualities previously identified by Māori. If new plants were raised from the varieties previously planted and treasured by Māori, including descendants of ancestral trees currently on farms, the selected qualities of those trees, including fruit size (Stowe, 2003), would be retained by the generations to come.

## 6.13 Māori values in land management

A range of Māori values have been expressed as important in terms of land and resource management (for example, Munn et al., 1994; Awatere, 2003; Whangapirita et al., 2003; Reid, 2005; Morgan, 2006; Jollands & Harmsworth, 2007). A summary of these studies by Rotarangi (2011) highlighted values such as:

- Taonga tuku iho, which she interpreted to mean that the land and knowledge of the land is a treasure to be respected and handed on to future generations;
- Rangatiratanga, whereby Māori must be able to use their land to pursue their own goals and objectives, and
- Tūrangawaewae, whereby the land provides a place of standing and identity.


*Figure 3: Important cultural harvests on Horomaka prior to the 20th century*

Key values expressed by Māori participants in two North Island case studies undertaken by Rotarangi (2011) included:

- Land retention;
- Kaitiakitanga;

- Maintenance of tikanga;
- Whānaungatanga, and
- Protection of wāhi tapu; as well as
- A desire for the land
    - To sustain the people,
    - For the land to be left in a better condition than before, and
    - To maintain the wairua of the land.

By exploring historical narratives, we gain a better understanding of how socio-ecological systems have worked through history, and in the present. Rotarangi (2011) identifies resilience pivots for landowners that include the ecology of the area (land use and land use impact), and culture (values and history). By examining human-environment relationships with these resilience pivots in mind, essential components of restoration within a Māori-centred agroecology framework are more clearly identifiable.
Other work has focused specifically on Ngāi Tahu kaitiakitanga (e.g. Williams, 2005, 2012), and Ngāi Tahu relationships with the environment and resource values are identified in Ngāi Tahu resource management plans (Garven et al., 1997; Tau et al. 1990). These writers confirm rangatiratanga as an underlying principle, and similarly, that mahinga kai values cannot be divorced from such a discussion.

It is quite clear that 19th century Ngāi Tahu had not relinquished a sense of rangatiratanga over the land at Horomaka. Extensive evidence has been presented to the Waitangi Tribunal that asserts rangatiratanga, and discussed elsewhere (e.g. Tau et al., 1990, Williams 2005). Here, it is simply noted, as one example, that Pākehā settler James Hay (1915), whose family was settled on the Peninsula, reported that in 1843-4 Māori were "insistent" in asking for rent from settlers such as his father, and this did not change until after the measles epidemic in 1848-9 when he estimated that around half the population died.

Many have argued that a substantial body of evidence supports sustainability as a guiding principle in Māori resource use and management. Williams (2005) noted that:

*"In traditional Kai Tahu society, the act of harvesting one day would often shape the pattern of abundance and spatial distribution found on the morrow, consistent with [a] definition of sustainability."*

He also offers an interesting example of kelp harvesting. Southern Māori have harvested kelp to create pōhā, used in muttonbirding and for other purposes, for many generations. In this case, when pōhā makers returned to a region of kelp that had not been harvested for many years, it no longer had the qualities sought by the pōhā makers. In their view, maintaining the harvest would have ensured the desired qualities remained (Williams, 2005). Similarly, weavers harvest flax bushes to ensure the future health of the plant (e.g. Scheele, 1998, 2005).

The indigenous agroecology research project aims to reflect these sustainability principles, and to combine native and exotic ecologies in a way that will reflect the new "forest transition" of Horomaka (Wood & Pawson, 2008) and other farming areas. Kaitiaki may wish to consider future plantings that reflect previous traditional harvests in some way, to enable new echoes of identity to emanate through the landscape. With Māori principles and resource practices at the forefront, animals and plants that resonate with cultural values can return to the greater landscape of the Peninsula, and reflect the gifting and kaihaukai principles of the many people who have called Horomaka home.

## 6.14 Conclusion

From this project, four potential, non-mutually exclusive approaches have been identified that could recognise layers of cultural history in agroecology:

1. Restoration of cultural landscapes through e.g. planting of karaka, ngaio or tī groves, pīngao, tōtara and other native species, using seed from locally sourced and valued plants that have the features previously valued by local hapū e.g. large fruit size, long leaf length, resilience in local climatic conditions. This restoration could also include creating vegetation corridors for culturally valued birds such as kererū to flock and move across the landscape, and protection for existing plants that are at risk of stock or other damage.
2. Planting and care of non-native species that reference cultural history e.g. plum and other fruit trees that have been valued in the community.
3. Planting specifically for rongoā and stock health and/or human health.
4. Farming stock, restoration planting and/or other actions to reflect traditional principles such as kaihaukai and manaakitanga e.g. through stocking or planting so that surpluses can be shared amongst and between communities.

## References


Allan, H.H. 1982. *Flora of New Zealand, Vol. 1*. Manaaki Whenua Press, Lincoln.

Allingham, B.J. 1988. *Preliminary report on salvage excavations at Tumbledown Bay, Banks Peninsula*. NZHPT permit 1987/9. B. Allingham, Seacliff.

Anon 1848. A leaf from the natural history of New Zealand. *New Zealand Journal* 25 March 1848.

Anson, F.A. 1910. *The Piraki Log*. Diary of George Hempleman. Oxford University Press, London.

Baughan, B.E., Cockayne, L., Speight, R. 1914. *Summit Rd: its scenery, botany and geology*. Smith and Anthony Christchurch. Facsimile edition Kiwi Publishers 1995, Christchurch.

Beattie, H. 1920. Nature of the southern Māori . *Transactions of the New Zealand Institute* xx: 53-77.

Beattie, H. 1945. *Māori Place-names of Canterbury including one thousand hitherto unpublished names collected from Māori sources.* Otago Daily times and Witness Newspapers, Dunedin.

Beattie, H. (1990). *Teone Taare Tikao. Tikao talks to Harries Beattie*. Auckland, New Zealand: Penguin Books.

Best, E. 1925. *Māori agriculture. The cultivated food plants of the natives of New Zealand, with some account of Native methods of Agriculture, its rituals and origin myths*, New Zealand Dominion Museum Bulletin 9. Whitcombe and Tombs, Wellington, New Zealand.

Best, E. 1977. *Forest lore of the Māori* . Wellington: Government Printer

Challis, A. 1995. *Ka Pakihi Whakatekateka o Waitaha: The archaeology of Canterbury in Māori times*, Science and Research Series No. 89. Wellington, New Zealand: New Zealand Department of Conservation.

Dawbin, W.H. 1956. The migrations of humpback whales which pass the New Zealand coast. *Transactions of the Royal Society of New Zealand*. 84: 147-196.

Duff, R. 1976. Māori history of Alford forest district. *In* W Vance, *Bush, Bullocks and Boulders: Story of Upper Ashburton,* pp.

1-12. Alford Forest Bushside Springbum District Centenary Committee, Ashburton.

Evison, H. 2006. *The Ngai Tahu Deeds: a window on New Zealand history*. Canterbury University Press, Christchurch.

Fankhauser, B. 1986. *Archeometric studies of Cordyline (ti) based on ethnobotanical and archeological research.* Unpublished PhD thesis, University of Otago, Dunedin.

Furey, L. 2006. *Māori gardening An archeological perspective*. Department of Conservation, Wellington.

Garven, P., Nepia, M. & Ashwell, H. 1997. *Te Whakatau Kaupapa o Murihiku*.Aoraki Press, Wellington.

Hamilton, A. 1903. Moriori carving on the trunks of karka-trees. *Transcations of the NZ Institute* 36: 11-13

Hay, J. 1915. *Reminiscences of Earliest Canterbury. New ed*. 1995. The Christchurch Press Co., Christchurch.

Jacomb, C. 2000. *Panau—the archaeology of a Banks Peninsula Māori village*, Bulletin No. 9. Christchurch, New Zealand: Canterbury Museum.

Jollands, N. & Harmsworth, G. 2007. Participation of indigenous groups in sustainable development monitoring: Rationale and examples from New Zealand. *Ecological Economics, 62*, 716-726.

Laing, R.M. 1919. The vegetation of Banks Peninsula, with a list of species (flowering-plants and ferns). *Transactions of the New Zealand Institute* 51: 355-408.

Laing, R.M. & Wall, A. 1924. The vegetation of Banks Peninsula: Supplement 1. *Transactions of the New Zealand Institute* 55: 438-444.

Leach, B.F. & Leach, H.M. 1979. Prehistoric communities in eastern Palliser Bay. In H. Leach & F. Leach (Eds.), *Prehistoric man in Palliser Bay* (pp. 251–272), National Museum Bulletin 21. Wellington, New Zealand: National Museum of New Zealand.

Leach, H. 1987. The land, the provider. In J. Wilson (Ed.), *From the beginning: The archaeology of the Māori* (pp. 85–94). Penguin Books in association with the New Zealand Historic Places Trust, Auckland, New Zealand.

Lowndes, S. 2002. *Akaroa Hormaka Banks Peninsula Lyttleton*. Portmanteau Print, Christchurch.

Menzies, I.H. 1980. *The story of Menzies Bay*. Pisces Print.

Morgan, T.K.K.B. 2006. *Decision-support tools and the indigenous paradigm*: Institute of Civil Engineers.

Ogilvie, G. 2010. *Banks Peninsula: Cradle of Canterbury*. Revised edition, Phillips and King, Christchurch.

Petrie, L.M. 1963. *From Bush to Cocksfoot: An Essay on the Destruction of Banks Peninsulas' Forests*. Unpublished M.Sc. thesis, University of Canterbury, New Zealand.

Polack, J.S. 1840. *Manners and customs of the New Zealanders*. Madden and Co., London.

Reid, J. 2005. *He Whenua Whakatipu: a draft sustainable development framework for Ngai Tahu landholders*. ARGOS Working Paper No. 4.

Rotarangi, S. 2011. *Planted forests on ancestral land: the experiences and resilience of Māori land owners*. Unpublished PhD thesis, University of Otago, Dunedin.

Salmond, A. 1975. *Hui: a study of Maoir ceremonial gatherings*. AH & AW Reed, Auckland.

Scheele S 1998. Insect pests and diseases of harakeke. Manaaki Whenua Press, Lincoln.

Scheele, S. 2005 (revised ed.). *Harakeke- the Rene Orchiston collection*. Manaaki Whenua Press, Lincoln.

Servant, L.C. 1979. *Customs and habits of the New Zealanders*. Reed, Wellington.

Shortland, E. 1851. *The southern districts of New Zealand*. Longman, Brown, Green and Longmans, London.

Shortland, E. 1854. *Traditions and superstitions of the New Zealanders, with illustrations of their manners and customs*. Longman, Brown, Green and Longmans, London.

Stowe, C.J. 2003. *The Ecology and Ethnobotany of Karaka (Corynocarpus laevitagus)*. MSc thesis, University of Otago, Dunedin.

Tau, T.M. 2003. Ngā *pikituroa o Ngai Tahu [The oral traditions of Ngai Tahu].* Otago University Press, Dunedin. 335 pp.

Tau, R.T.M. 2011. *I whānau au i Kaiapoi: The Story of Natanahira Waruwarutu as told by Thomas Green*. Otago University Press, Dunedin. 112pp.

Tau, T.M. & Anderson, A. (eds.) 2008. *Ngai Tahu: a migration history: the Carrington text*. Bridget Williams Books, Christchurch.

Tau, T.M., Goodall, A., Palmer, D., & Tau, R, 1990. *Te Whakatau Kaupapa; Ngai Tahu resource* management strategy for the Canterbury region. Aoraki Press, Wellington.

Taylor, W.A. 1952. *Lore and history of the South Island Māori* . Bascands, Christchurch, New Zealand.

Tikao, T.T. n.d., but before 1870. *Mahinga Kauru*, ms. papers 1187, folder 208. Wellington: Alexander Turnbull Library.

Te Rangi Hiroa 1949. The Coming of the Māori . Whitcombe and Tombs, Dunedin.

Tremewan, P. 1989. *Kai Tahu Land Sales to Captain Langlois and the Nanto-Bordelaise Company on Banks Peninsula.* Vol 3 of Wai 27 (the Ngāi Tahu Claim).

Trotter, M. & McCulloch, B. 1997 (editors, revised ed.). *Digging up the Past: New Zealand's archaeological history*. Penguin books, Auckland.

Wehi, P.M. 2006. Unpublished PhD thesis, University of Waikato, Hamilton.

Whaanga, H., Roa, T., Seed-Pihama, J., Papa, W., Thompson, K. & Haereroa, B. 2012. *Exploring a Māori classificatory system of flora and fauna.* Final report for Ngā Pae o te Māramatanga. SMPD: Hamilton, University of Waikato.

Williams, H.W. 1957. 6th edition, *Dictionary of the Māori Language*. Government Printer, Wellington.

Williams, J. 2005. *E Pakihi hakinga a kai. An examination of pre-contact resource management practice in Southern Te Wäi Pounamu* Unpublished PhD thesis, University of Otago, Dunedin.

Williams, J. 2012. Ngāi Tahu kaitiakitanga. MAI Journal 2012: 89-102.

Williams, J. & Chrisp, T. 1992. *Tii rākau. Māori perspectives on the cabbage tree*. Māori Studies Research Unit, Victoria University of Wellington.

Wilson, H.D. 1992. *Banks ecological region: Port Hills, Herbert and Akaroa ecological districts, Protected Natural Areas Programme, Survey Report No 21*. Christchurch, New Zealand: Canterbury Conservancy.

Wood, V. & Pawson, E. 2008. The Banks Peninsula forests and Akaroa cocksfoot: explaining a New Zealand forest transition. *Environment and History* 14: 449-468.

Woodward, C.S. & Shulmeister, J. 2005. A Holocene record of human induced and natural environmental change from Lake Forsyth (Te Wairewa), *New Zealand. Journal of Paleolimnology* 34: 481-501.

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

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# 7 Rēkohu: Investigating future pathways for Moriori Youth

Samantha Tihoi Jackson

Hokotehi Moriori Trust

## 7.1 Ko Matangi Ao

*Ka Pou a Rangitokona*
*Tongia tenga rehu Tawake moetahuna*
*Koi tenga mokopu o Rongomaiwhenua o Rongomaitere*
*Koi tama wainuku*
*Koi tama waiorangi*
*Koi tama ruruhau o Pāpātuanuku*

*Tahia te ihinga mai o te Ra*
*Tahia koi tama Rehua-Tane*
*Moe tahi koe i runga*
*Tahia te nui Tahia te roa*
*Werohia te ata*
(Hokotehi Moriori Trust, 2011)

The above karaki (prayer) describes the creation of the world from a Moriori perspective. The karaki is carved into the central post of Kōpinga Marae (Moriori place of gathering) at Rēkohu and is a reminder of the Moriori story of belonging. What follows is a brief account of 'Ko Matangi ao', the dawn of existence from a Moriori perspective as recorded by Alexander Shand (an early recorder of Moriori history) in 1895 (see Shand, 1895).
According to Moriori traditions, the world began with Rangi (the heavens) and Papa (the earth), who were joined in darkness. Within the darkness, the spirit Rangitokona arose to solicit Rangi and Papa to separate. Rangi and Papa refused, so Rangitokona propped them apart by pushing Rangi up with ten pillars; one above the other. This story is captured in the chant that was recited by Rangitokona during the separation:

> *Rangitokona prop up the heaven, Rangitokona prop up the morning. The pillar stands in the baldness of heaven, in the bare part of heaven. The pillar stands, the pillar – the pillar stands, the pillar of heaven (Davis and Solomon, 2012).*

The separation of Rangi and Papa allowed light to enter the world for the first time and thus, the world came into being. Following the separation, Rangitokona heaped up the soil of Papa, to make the first man named Tū, Rangitokona describes:

> *"…heap it in the waving of the tree, heap it in the pattern of the tree, heap it in the finishing of the tree, heap it, it grows; heap it, it lives; the heaven lives, e! Stem heaped*

*up, stem heaped up, let the heaven stand which lives"*
*(see Davis and Solomon, 2012).*

Tū descended from Rongo, Tane, Tangaroa and others (a grouping known as 'Te whānau o te rangi' or 'heaven born'). In Moriori genealogies, the heaven born ancestors (which spanned 30 generations) are distinct from human born. A second group of ancestors (which spanned 26 generations) came next, finally Te Ao-mārama (the world of light) was born and he begat Rongomaiwhenua, the ancestor from which all Moriori descend.

The purpose of this research is to investigate ways of reconnecting Moriori (indigenous people of Rēkohu) youth to their distinct cultural identity as embedded in the landscape of Rēkohu. This project is focused around the following key areas:

- Draw attention to various strands and layers of Moriori history, to provide a context through which one can understand indigenous reconnection;
- Examine Rēkohu, the significant sites, the people and the realities of living in a small island community;
- Investigate literature on indigenous youth reconnection;
- Provide examples of positive youth programmes that currently exist in Aotearoa/New Zealand and investigate current youth initiatives on Rēkohu;
- Investigate indigenous youth and the Internet; and
- Provide recommendations for potential youth programmes and considerations the Hokotehi Moriori Trust may need to make when considering establishing a youth programme on the island.

Information for this project was gathered through literature searching, informal interviews during a weeklong visit to Rēkohu, observations during the same visit and reflections on my own participation and involvement in indigenous youth initiatives in mainland New Zealand. A major limitation of this project includes not interviewing any Moriori youth during my time on Rēkohu. This is largely due to the fact that the majority of high-school aged youth from Rēkohu are educated on mainland New Zealand.

## 7.2 Rooted in the Life-world of Moriori

I have begun this text with a Moriori story of creation so that both myself as writer and you as readers can be in some way rooted in the life-world of Moriori, a complex of people-place, whose needs and stories are central to every element of this research project.

The Palestinian-American scholar Edward Said (2003) challenges researchers to be mindful of the complexities when researching an 'other':

> *"There is a difference between knowledge of other peoples and other times that is the result of understanding, compassion, careful study and analysis for their own sakes, and on the other hand knowledge – if that is what it is – that is part of an overall campaign of self affirmation, belligerency and outright war. There is, after all, a profound difference between the will to understand for purposes of co-existence and humanistic enlargement of horizons, and the will to dominate for the purposes of control and external domination" (Said, 2003, p xiv).*

It is difficult to fully know the life world of another, regardless of how many similarities there are in culture. An important consideration I have had to make throughout this research project is to let the Moriori and Rēkohu voices and manuscripts speak for themselves. As a researcher, I am of Māori (Ngāti Whātua, Ngāpuhi) and European descent. I was first introduced to Moriori culture when I attended the 'Me Rongo Peace Congress' at Kōpinga marae on Rēkohu in 2011 (see Hokotehi Moriori Trust, 2011 for more information). My initial purpose of attending was to share some preliminary results of my Master of Arts in Indigenous Development thesis. My connection to Rēkohu has been maintained through a 'friends of Rēkohu group', which is based in Dunedin, New Zealand. The largely informal function of the friends of Rēkohu group is to meet with like-minded people (many who attended the congress) who have a working relationship to the people of Rēkohu. It is the culmination of my visit to Rēkohu, the connections formed through the friends of Rēkohu working group, my university studies in indigenous development (within my own tribal community) and passion for indigenous youth development that has led me to write this project. I announce the place from which I write because as an indigenous person who is neither Moriori nor a resident of Rēkohu there are potential limitations in the ways in which I can see and understand this project. In this vein, consultation at every step of the research process becomes paramount so that an authenticity is maintained throughout this work.

## 7.3 Towards an understanding of Moriori

The following provides a context for Moriori youth connection by drawing upon worldview, genealogical and historical threads as a means of understanding Moriori. It is important to gain an insight into who the Moriori people are, what are key aspects of their culture and why would there be a need for (re)connection to Rēkohu.

The Moriori are the indigenous peoples of Rēkohu (Chatham) and Rangihaute (Pitt), islands of the Chatham Island group that lie approximately 760km South East of mainland New Zealand. According to the 2013 census, 600 people are resident on the Chatham Islands. Of the 600 residents, 336 identified as Māori (Davis and Solomon, 2012). In Aotearoa New Zealand 738 people identified Moriori as their iwi or tribal grouping. The following sections will examine some of the history and genealogy of the Moriori people.

### 7.3.1 Migration Traditions

Moriori posit two separate voyaging traditions. The first is the waka of Kahu (sometimes called Tāne, sometimes called Ko ro waka a Kahu), which has two accounts. One account proposes Kahu came to Rēkohu with forty people on board and landed first was at Kaingaroa Harbour where he planted his fern-root (eruhe) at a place named Tangariro. He also brought with him, Kikokiko a god that he secreted at Rangikapua as well as the kūmara, which he planted on the island, but it would not grow. The date of this arrival is during the time of Kahuti and Te Akaroroa (Davis and Solomon, 2012; Shand, 1895). On his arrival, the island was floating (kauteretere) and he was responsible for joining together some places of the islands, while separating others. A second tradition posits Kahu first arrived at Tuku and journeyed around the cliff faces of the island to various coasts before sailing from Whangaroa to Waitangi and planting his kūmara at Okahu, Monoutu (again where the kūmara would not grow). A karaki 'ka Tai-a-Kahu' captures a tale of Kahu returning to Aropawa and Hawai'ki (Shand, 1895).

A second set of canoes that arrived on Rēkohu were those of Rangihoua and Rangimata. The arrival of the canoes appears to be a consequence of a set of quarrels most notably a lovers' fight, which occurred in Hawaiki between the Rauru and Wheteina tribes and led to the death of a woman from the Rauru tribe (Shand, 1895). During various cycles of payback, the Rangihoua and Rangimata canoes were built and put to sea. However, the Rangihoua was not properly completed before the launch. The canoe was wrecked on landing and many of the crew died on the voyage. The Rangimata landed safely on the North East coast of Rēkohu, and the crew planted Kōpi (karaka) berries at Wairarapa.

They stopped at several points around the island and talked to the inhabitants (who are described as 'no ro hunu ake' (sprung from the earth) the Hamata people. The Hamata explained that their sealskin garments were much warmer than the migrants' clothes (Davis and Solomon, 2012). The Rangimata was finally wrecked at Te Awapātiki, but the remaining crew went to other parts of the islands and lived there peacefully.

Later, it is said that Moe (a descendant of Rauru) captained the Oropuke canoe to Rēkohu. Moe was a child when the former waka left, during the time of war. It is here that 'Ko Matangi Ao' is said to finish, and Hokorongo tiringi (hearing of the ears) begins (Shand, 1895). Before leaving, Moe went to see his grandfather Horopapa, who warned his grandson, on leaving, that on reaching "ta ika" (the land) they were to cease "manslaying" and should live peaceably. They did live peaceably, until provoked by one of the Rangimata people, named Hangarua, who commenced the old troubles by killing a person Henga-mai-tawhiti, and ate part of him. Moe and his brothers then killed Hangarua, thus the fighting and man-eating began again. It is said that the conflict ended when Moe and his people were burnt in their huts at night. In other accounts Moe returned to Hawai'ki, and yet another story says the Oropuke canoe was wrecked on the cliffs of Rēkohu (Shand, 1895).

Initially it was thought Moriori descend from Melanesia, however, in more recent times it has been suggested that Moriori are a part of the wider Polynesian family. The canoe traditions are important because they give an insight into important aspects of Moriori culture that are still maintained today. These aspects include living peaceably and the centrality of the Kōpi tree.

### 7.3.2 Genealogy

A second way to garner more information about where Moriori come from is by looking at genealogy. As mentioned in the opening karaki, Rongomaiwhenua is the name of the ancestor from which all Moriori descend. According to some traditions Rongomaiwhenua is the demarcation point between 'god-like' and human ancestors in the Moriori genealogy of the origins of the world. Rongomaiwhenua (Shand 1895, pp 44-45) (land god, 'peace to the land', 'song of the land') had a brother, Rongomaitere (ocean god) who according to tradition travelled to New Zealand providing sailing directions for the return journey by later generations. Rongomaiwhenua has been described as 'no te whenua ake' by Tamahiwaki (Shand, 1895), and 'no ro hunu ake' 'sprung by the earth' (Davis and Solomon, 2012). This ancestor is important because he shows the intimate and innate relationship Moriori have with their land and natural environment from a creation perspective.

### 7.3.3 Nunukuwhenua

A prominent ancestor of note today is Nunukuwhenua. During the time of fighting and murder on Rēkohu, Nunuku, was responsible for outlawing murder and the eating of human flesh. It was said that in the case of quarrels, once first blood was shed, the strife was to end. He proclaimed to those fighting enemies, "From now and forever, never again let there be war as this day has seen!" This covenant, known as Nunuku's Law, was accompanied by Nunuku's Curse "May your bowels rot the day you disobey."

A ceremony was established and handed down generationally, whereby a person would place their weapons on the tūahu (sacred altar) and in doing so enter into a tohinga (sacred covenant) with the gods. The covenant was an acknowledgement that the power over life and death was removed from human hands and placed into the hands of the gods alone. The peace covenant would be reaffirmed in a ceremony where the old weapons on the tūahu would be removed and handed to the child, whereby the practice and custom was explained to the child. By replacing the weapon back on the tūahu the child would renew the covenant for the next generation and completing the tohinga ceremony (Hokotehi Moriori Trust, 2011).

This covenant was reaffirmed at a large gathering of Moriori at Te Awapatiki in early 1836, to decide what response they would make to the invasion of their island home in 1835. While the young men urged resistance, the elders, Tapata and Torea insisted that the people hold fast to the teachings of Nunuku (Davis and Solomon, 2012). As they said, the covenant was a spiritual pact entered into with their gods. To break that covenant would represent a betrayal of their gods and a loss of mana for them as a people. Instead, they offered peace, friendship and sharing of the Island's resources, as was their custom. This covenant has been renewed during recent times, notably at the 2005 opening of Kōpinga Marae and during the 2011 Me Rongo Peace congress (Hokotehi Moriori Trust, 2011).

## 7.4 Arrival of Europeans

In 1791, a British ship, HMS Chatham, was blown off-course after leaving Dusky Sound on a voyage to Tahiti and landed on Rēkohu. Its Captain, Lt. Broughton, planted a British flag; claiming the island in the name of King George III, renaming Rēkohu, Chatham

Island. During this visit, in a misunderstanding with the ship's crew, a Moriori named Tamakaroro was shot and killed by the men from HMS Chatham while defending his fishing nets (Solomon, 2005; Solomon & Thorpe, 2012; Waitangi Tribunal Report, 2001). This was the first act of killing Moriori had experienced since the introduction of Nunuku's covenant. There is currently a memorial plaque at Kaingaroa that reads:

*Memorial to Torotoro*

*"Moriori resident of Rangikapua who was shot and killed by Lieut. Broughton's men of "Chatham" on 29th November 1791 while defending his fishing gear on the beach below this point."*

The first arrival of British led to whaling and sealing and introduction of measles, influenza, and venereal disease, which caused the Moriori population to plummet. By the 1830s, the seal rookeries had been virtually wiped out. King wrote that *"This catastrophe deprived the Moriori of their major source of winter clothing, a major source of food, and the presence of an animal that had figured intimately in their mythology and religious ritual"* (Waitangi Tribunal Report, 2001, p 36).

This was the beginning of an onslaught of cultural change.

## 7.5 Arrival of Māori

Later, in November 1835, two Māori tribes (Ngāti Mutunga and Ngāti Tama) arrived at Rēkohu from Port Nicholson (Wellington) on a commandeered English sailing ship and set out to conquer the Moriori. Approximately 900 Māori arrived in two trips and landed on Rēkohu with guns. These Māori tribes named the main island Wharekauri, after a locality on the North coast of the island (Solomon & Thorpe, 2012; Waitangi Tribunal Report, 2001). In response to the initial attacks, Moriori men gathered at their traditional tribal meeting place near the outlet of the large lagoon on the main island, Te Whānga, to debate their response. This gathering, of as many as 1,000 people, is where Moriori decided to hold fast to their pacifism – a sacred covenant between the gods and their ancestors. It is said that many of the younger men disagreed to holding fast to Pacifism, however, for the elders, it was important to adhere to the covenant. In the events that followed, some 230 Moriori were killed in the initial slaughter and the rest were enslaved. Some were taken to New Zealand and traded into slavery, while others were taken by force by Ngāti Mutunga to the Auckland Islands (King cited in Waitangi Tribunal Report, 2001, p 56). The Moriori population plummeted from

1,663 people in 1835 to only 101 by 1862; the death of 1,562 Moriori in 27 years as a combined result of European disease, Māori invasion and neglect on the part of the New Zealand government.

Moriori who were enslaved were housed in inadequate whare, poorly fed, forced to undertake extreme labour, brutalised, made to respond to everyone's bidding (including even Māori children), and, for a time, killed at whim. Moriori were forbidden to marry or to have children. In 1862, Moriori elders made a plea to the Government for relief, listing the names of 226 killed and 1,366 who, they wrote, had died of "despair". But the Government did not respond. Slavery officially ceased in 1863, almost a quarter century after it was abolished on mainland New Zealand (Blank, 2007; Waitangi Tribunal Report, 2001, p 63).

It is historically important to note that the Māori invaders originated in Waikato but had been driven out and went south in search of arms, where they were then under threat from Ngāti Toa (Waitangi Tribunal Report, 2001, section 1.1). During this time, the government was involved in land confiscation in the Taranaki region. Many of the Māori who were based in Rēkohu returned to Taranaki in a bid to hold onto their land, but the Governor did not want Māori from Rēkohu in Taranaki. The Rēkohu Māori went to the Compensation Court but were denied lands due to them being at Rēkohu in 1840. Later, the Native Land Court sat on Rēkohu and awarded 97% of the land of the main island of Rēkohu and later all of the outer islands to the Taranaki Māori. It is believed the judge (who sat in on the Taranaki case) was heavily influenced by a Ngāti Mutunga leader who was also a Native Land Court assessor and would go on to become the major land owner in Rēkohu. The grounds for the land being awarded were conquest, but for Moriori, there was no such conquest but simply a blatant disregard for Nunuku's law and their sacred peace covenant. At the time the land was awarded, the majority of the Rēkohu Māori were still in Taranaki fighting land confiscation there. Ngāti Tama did not return, and Ngāti Mutunga returned six years after the Court's decision to take up land ownership on Rēkohu.

## 7.6 'The last of the Moriori'

Tommy Solomon was renowned as an expert famer from Rēkohu. Regarded as the last 'full-blooded' Moriori, when he died on Rēkohu in 1933, it was thought that the Moriori had died with him. In fact, Tommy Solomon had a number of descendants, many of whom would play a crucial role in the revival of Moriori culture.

The Waitangi Tribunal Report (2001) offers a timeline, which I have amended for the purposes of this project:

- 1950s – Bully Solomon bought his family back to Rēkohu and openly asserted his Moriori identity
- 1960s – Crayfishing boom years. More Moriori returned to take part and protest the plundering of ancestral seas
- 1970s – Moriori protest over removal of dendroglyphs for preservation in mainland museums without consultation
- 1983 – Solomon family reunion Temuka
- 1986 – Tommy Solomon statue unveiled.

## 7.7 Rēkohu Today

Today, Rēkohu is alive with many of the past injustices and historical grievances, which largely remain unresolved. Moriori are in a state of cultural revitalisation and there are several key sites of celebration, which act as cornerstones of this cultural revival. These sites include but are not limited to Kōpinga Marae, Hapupu and MEG (Moriori Ethnobotanic Garden).

The interests of Moriori are managed formally by the 'Hokotehi Moriori Trust' (HMT). HMT was established and registered as a charitable trust in 2001. Before 2001, Moriori were represented by two tribal organisations: Tchakat Henu Trust and Te Iwi Moriori. These merged to form Hokotehi Moriori Trust (HMT).

### 7.7.1 The Centrality of the Kōpi Tree.

The Kōpi (Karaka in Māori) tree is significant to Moriori and the uniqueness of Moriori can perhaps be found in the rākau momori, or dendroglyphs, inimitable carved incisions in the skin of Kōpi trees. The dendroglyphs have been the subject of much research and perhaps hold the key to an understanding of Moriori past.

The Kōpi trees were significant to every aspect of Moriori life. The berry was a staple food source, the highly poisonous nut, once treated, was a staple carbohydrate source and the trees were used for gathering and as shelter. Christina Jefferson (1955), whose interests were in the dendroglyphs or rākau momori, speaks of the initial arrival of Lt. Broughton and his crew into the Chathams. Broughton and his men appear to have observed the way in which Kōpi groves were used to live in:

Broughton (6, [p. 23] p. 84) says, *"The woods in some spots had the appearance of being cleared and in several places between the hills, smoke was observed."* Again [p. 23] p. 87, *"The woods* *afforded a delightful shade and being clear of undergrowth, were in many cases formed into arbours by bending the trees when young and enclosing them round with smaller trees. These appear to have been slept in very lately"* (Jefferson, 1955, p 372).

Different members of the community discussed bending the young kōpi branches to make shelter while we were at Rēkohu. Jefferson (1955, p 373) also reports that Johnstone's journal (13, [p. 27] p. 505) says, … *"whilst we were free from molestation [we] examined the skirts of the wood, where we found no other signs of habitation, than a small circle of clear ground sometimes fenced in by a simple palisade. In the centre of the circle was the mark of a fireplace and a great number of fish shells lay about particularly the earshell. This had no other covering than the growing branches of the trees."*

Klinac et al. (2009) also explore other the uses of the kōpi tree:

*"There are reports of karaka leaves being used as wound dressings and the wood being used for paddles, in addition to the nuts themselves being used as a food source. They were especially valuable because they could be stored and eaten throughout the winter, when other food supplies may have been in short supply, especially for the elderly."*

The toxicity of the kōpi nut is widely known; the result of poisoning can be lethal. For this reason, care was needed in preparing the nut for consuming. Klinac et al (2009, pp 4-5) note:

*"The poison present in the fruit had to be carefully soaked out in fresh or salt water over a period of several days or weeks…Standard treatment seems to have involved collection of the nuts, either from the ground or from the tree; removal of the berry flesh, possibly after soaking/shaking in specially woven bags or trampling; cooking the karaka nuts in their shells in an umu (or boiling spring) before soaking them in water to leach out any remaining toxins; then removing the shell and eating the nut."*

It is important to mention Klinac et al (2009) acknowledge the detailed methods of removing toxicity are not well known. Once the poison was removed the nuts could be kept for a long time, which proved to be an important food source in Rēkohu, where other food crops such as the kūmara are not readily available.

Klinac et al (2009, p 17) also moot other ideas about the Kōpi trees and the circular groves in which they are found in on Rēkohu:

*"In the Chatham Islands, where karaka have long been especially important, an ancient grove of fruiting karaka trees exist, planted*

*in a circle with a single, separate tree at the centre. It would be interesting to know if this central tree had been deliberately planted to act as a pollinator for the others in order to ensure good yields."*

Further, they question whether the dendroglyphs are in fact indicative of techniques to promote a better yield from the trees.

Now, there are very few kōpi groves and far less rākau momori than there were in the past. While on Rēkohu we learned that part of the reason there are far less kōpi groves is there was a period of time on Rēkohu, where if a person was interested in farming they were expected to clear all trees of the land each year in order to keep their lease. Within this context, no care was taken as to whether the trees on the land contained rākau momori or not. Though, according to (Klinac et al, 2009 p 34) kōpi trees can promote animal health:

*"On one dairy farm at least (Norm Johnson, Taranaki) the planting of karaka trees has been actively encouraged and the karaka nuts and leaves are collected and deliberately fed to stock….especially to any sick animals and calves. The stock seem to rapidly gain a taste for karaka nuts and actively seek them out, with no ill effects. There seems to be no problem with toxins in the milk and, indeed, the milk quality from this particular farm has been widely praised over many years."*

The use of the Kōpi tree in farming and animal health was also spoken about during our time at Rēkohu.

Amidst all of the uncertainty around the Kōpi tree, what remains clear is an understanding of the Kōpi tree; its origins, their arrangements and the purpose of the carvings can provide a gateway to understanding Moriori people and culture. It is perhaps the culmination of these factors that led to the establishment of the Moriori Ethnobotanic Garden (MEG) near Henga Lodge in which 2000 kōpi trees will be planted to memorialise and symbolise the Moriori who lost their lives during the invasions. The garden and its adjacent nursery are a site of cultural aspiration and hope in Rēkohu, propagating plants for projects throughout the island. MEG was officially opened in 2011, and the purpose of the garden is to provide a site of reflection for Moriori and visitors to the island.

Currently, the rākau momori are in danger of disappearing as the trees age and others appear to be diseased. This has led to HMT along with DOC and experts from Te Papa and The University of Otago to work collaboratively in recording the important information held on the trees, taking those ageing trees out and back to the marae for restoration work. There have been efforts undertaken to hold on to the integrity of the rākau momori in the form of laser scanning. More recently, a carving wānanga has been held for Moriori to rekindle an old skill. These scanned images are present in the marae and one serves as the HMT emblem.

### 7.7.2 Rēkohu Today: Conclusion

What is clear when investigating the history and people of Rēkohu is there are a number of important threads which have come to define how Moriori culture is both lived and understood on Rēkohu. Some of these threads include, but are not limited to a respect and understanding of Kōpi trees (this is expressed in the Moriori Ethnobotanic Garden); Kōpinga marae, a place of gathering, debate, celebration and shared practice; Nunuku's law and the peace covenant, adhering to and upholding one of the longest standing indigenous peace traditions. Secondly, understanding Moriori culture is complex as an outsider because of the many facets of Moriori worldview and because of the many social, historical and physical grievances that have taken place in the past. Some of these grievances are still apparent today and are still a barrier to Moriori living as Moriori. Third, there is a large number of Moriori who live away from Rēkohu, so the question of 'for who' is a youth programme for is very relevant. These considerations will frame the ways in which we can come to understand the realities of living on a remote island community.

## 7.8 Living on Rēkohu

During our visit to Rēkohu many challenges were presented and discussed regarding the high cost of living in a remote island community. Before visiting Rēkohu, I had not realised the enormity of these barriers and therefore, many of the youth programmes that were discussed while there did not take these barriers into consideration. What I present here is information around the cost of living as recorded in the 2014 "Wharekauri, Rēkohu, Chatham Islands Health and Social Needs" report prepared for the Ministry of Health by Litmus Ltd (Litmus Ltd, 2014). The purpose of presenting this information is to outline the complexity of establishing programmes in a small island community. I will briefly look at employment opportunities followed by the cost of living with regards to food, electricity and housing. Finally I will focus specifically on the youth of Rēkohu and look at what opportunities there are currently for youth.

### 7.8.1 Employment

The Health and Social Needs report states that *"employment on Rēkohu is high, within the following key industries; fishing, farming and tourism"* (Litmus Ltd, 2014, p 28).

### 7.8.2 Fishing

The fishing industry contributes nearly 60% of the income of Rēkohu and employs about 33% of the adult working population. Fishing and agriculture contributes around $200 million a year to the New Zealand economy (Lawrie and Powell, 2012). There are currently three seafood-processing units on Rēkohu, which have high running costs largely due to the price of electricity. The fishing industry is managed by a quota system, which limits catch sizes and access to the fishery. Local individuals, organisations and iwi hold the quotas, in part and the balance is held offshore.

While on Rēkohu I engaged in a number of semi-formal discussions with locals (from a range of backgrounds and heritages) about aspirations for the residents of Rēkohu as a whole. During these discussions the idea was raised of the benefit of having a single seafood processing unit on Rēkohu. A single factory would dramatically decrease consumption of electricity and thus the costs of production providing an economic benefit for the island. There were reservations however regarding the current social fabric on the island and whether it would be possible to have different groups of people "work together" for such a cause. The development of aquaculture was also discussed. The University of Otago has a newly established major in Aquaculture and Fisheries under the Bachelor of Applied Science where students are able to learn more about these resources and their significance in Aotearoa. Perhaps there is room for establishing a relationship between HMT and the co-ordinators of the Aquaculture and Fisheries major should this continue to be an aspiration for HMT and their members.

### 7.8.3 Farming

Farm production is the second biggest contributor to the Rēkohu economy. Agriculture production is limited, due to poor soil quality. Sheep and cattle are grazed (Lawrie and Powell, 2012, Litmus Ltd, 2014) and sent to the mainland for slaughter. Because of the high cost of freight and the stress that it placed on the animals during transportation to the mainland, animals tend to lose weight and are worth less money by the time they arrive in New Zealand. Whānau tend to work their own farms meaning there are few employment opportunities for non-whānau members. There was a time when there was a meat processing plant on Rēkohu and some people expressed aspirations to re-establish a meat processing plant again, with cost being the biggest barrier. Discussion ranged around ensuring the good health of livestock on the island to export high quality produce with a "Chatham Island" or "Rēkohu" brand attracting a premium. The Rēkohu brand would be marketed with traceability from "Paddock-to-Plate". This conversation links directly to the work of my supervisor Dr Marion Johnson in relation to animal health and rongoā species in farming.

### 7.8.4 Tourism

With approximately 1500 visitors a year, tourism is a growing industry in Rēkohu. For example, Pukekohe travel offers 8 day tourism packages for approximately $4000 per person. These packages include fishing, daily-guided tours, flights and accommodation at the Chatham's Hotel. While tourism is seen by many as a means to boost the local economy and employment, there are a number of important considerations with regard to both the environment and local cultures.

Two potential future eco-tourism initiatives that were discussed during our time on Rēkohu included a 'Rēkohu bound' type experience (similar to Outward Bound, or Aoraki Bound) and a paddock/forage to plate style food experience at Henga Lodge. All initiatives need to consider taonga Moriori and cultural norms. A recent study on Aoraki Bound completed by Kendall Stevenson (2013, p 134) put forward the following recommendations: it is important to follow up people once they have taken part in the programme and also maintaining the authenticity of the stories and landscape being shared (in the context of increased popularity) is an important cultural consideration to be made.

While employment levels are high on Rēkohu, the question remains whether the existing employment pathways match the aspirations of young people who live, or aspire to live on Rēkohu. This question needs to be explored further in future research.

### 7.8.5 Transport to Rēkohu

There are two primary ways of getting to Rēkohu. One is a flight via Air Chathams and the second via Chatham Islands Shipping.

#### *7.8.5.1 Air Chathams*

According to Litmus Ltd. (2014, p 30) the cheapest return fare for an adult is $754 and the most expensive $1230. For children, the cost ranges from $542 to $874. Air Chathams is the only airline that flies to Rēkohu and operates flights from Wellington, Christchurch and Auckland. Flights to Wellington are the most frequent; there are three flights per week in summer and two per week in winter. The flight time is around 90 minutes. For some families living off the island, this cost of getting to Rēkohu is a barrier to people visiting the island. The history of invasions, not knowing whānau, not having accommodation and not being able to afford tourist prices compounds the problem.

#### *7.8.5.2 Chatham Islands Shipping*

Alternatively, people can use Chatham Islands Shipping, which offers 12 berths (four cabins). A ship tends to leave every 10 to 12 days. The trip takes approximately two days between Napier and Waitangi (on Rēkohu). The cost including meals and bedding for the 40 hour voyage is $300 plus GST for an adult and $150 plus GST for a child less than 15 years who must be accompanied (Litmus Ltd. 2014, p 30).

For Rangihaute (Pitt Island) residents, there is the additional cost of travelling to Rēkohu by plane or boat. Flights are irregular and on demand basis. The cost to charter a plane for the 20 minute journey from Rangihaute to Rēkohu is $450, and the cost to charter a boat (travel time approximately 1-2 hours) is estimated at $1500 plus GST.

### 7.8.6 Cost of Living

One of the major barriers to bringing youth back to Rēkohu is the high cost of living on Rēkohu compared to mainland New Zealand. The cost of living is primarily driven by freight. This section will present examples of higher cost of living:

### 7.8.6.1 Food


*Figure 1: Comparative grocery prices – Chatham Island vs Wellington on 10 June 2013 Litmus Ltd. (2014, p 29)*

There are two stores in Waitangi, the main settlement in Rēkohu. These general stores are forced to mark prices up to account for high freight costs.

### 7.8.6.2 Shipping freight costs to Chatham Island

A ten to twelve day shipping service from mainland New Zealand carries produce and general cargo to and from Waitangi. Freight is charged at whichever is greatest, weight or volume. The minimum charge is twenty dollars. Some families opt to buy groceries three to four times a year from Aotearoa (at a lower price), but need to take into consideration the cost of freight and buying groceries in bulk. During our visit it was recommended that we bring our own fresh fruit and vegetables to the island for the duration of our stay.

Some members of the community have personal vegetable gardens on Rēkohu. With a moderate climate, growing seasons were reported to be longer than on the mainland. One of the people we spoke with shared stories from the past where each family on Rēkohu had their own house cow and therefore access to fresh milk. If a family did not have access to a particular food, it was common for food to be traded within the community. In contemporary times, there are a number of regulations that prevent the community from living in such a manner. An example of the impact of these regulations played out while we were visiting. While we were at Rēkohu, the 'Chatham Islands food festival" was on and there was discourse around the festival no longer being a 'wild food' festival of local kai because of health and safety regulations. Much of the food that was sold in the many stalls was brought over from the mainland, including the seafood.

#### *7.8.6.3 Transport costs on the island*

According to the report, the cost of petrol and diesel is 25% more expensive than in Wellington (23.5% and 25.8% respectively) and there is currently no public transport service. The road taxes on Rēkohu are much higher than mainland New Zealand and many of the roads are gravel and harsh on cars which makes vehicle maintenance very high. There are a limited number of rental cars available for visitors to the island to use during their stay

#### *7.8.6.4 Electricity*

Electricity was one of the main costs discussed during our visit to Rēkohu. The price per unit is 88 cents compared to 35 cents from a provider in Wellington. The price of power in Chatham Island is therefore 150% higher than Wellington.

We observed during our stay that many of the homes in Rēkohu have solar panels, however, the cost of freight for the items is expensive and the mark up is expensive. A further issue is, the more people who opt for solar power, the higher the cost of electricity becomes for those who are still 'on the grid'. The high cost of electricity is one of the largest issues for the factory owners who use a large amount of electricity to run their businesses.

### 7.8.7 Housing

Rēkohu has a lack of housing and there are many reasons for this. Housing New Zealand does not have any rental housing on the Islands. Consequently, there is a lack of affordable rentals for those on low income, particularly for residents of Rēkohu. There is some rental housing on Rēkohu attached to employment such as the Chatham Islands Enterprise Trust, Chatham Islands Council, Downers, and the Ministry of Education. Existing residents have barriers to maintaining healthy homes due to cost of power and freighting costs for any materials which might be shipped to the island such as insulation or heat pumps.

The issue of housing on Rēkohu has been recognised as a national issue and the Government in the 2014 budget announced funding of $16 million dollars over four years targeted at the repair and the improvement of housing on Rēkohu.

The lack of rental accommodation provides a kind of social barrier for young persons wanting to live on the island. It is likely they will need to remain at home as there are not many flatting options available for young people to live with those of their own age.

If a person has not been raised on the island or does not know family who live there, there are two marae on the island; Kōpinga (Moriori) and Whakamaharatanga (Ngāti Mutunga). These can be venues for whānau to stay when they visit the island.

### 7.8.8 Rangatahi specific services and costs

As there are no high schools on Rēkohu, most teenagers opt to leave Rēkohu to pursue their high school education. The Ministry of Education pays for the cost of transport from Rēkohu to the mainland and back each school holidays and offers a boarding grant of $2700. It will cost the families an extra $10-12,000 per year to send their teenagers to boarding school. Some parents/caregivers opt to move to the mainland during the high school years. There are currently no youth specific services on Rēkohu (such as community programmes, or rangatahi development programmes).

### 7.8.9 Hokotehi Youth Mentors

There is currently a Hokotehi Youth Mentors programme that is run by Hokotehi Moriori Trust. The programme is a resource for young people who come from Rēkohu. According to the current Mentors book:

*"A mentor is a trusted friend or colleague who is willing to provide guidance and support on a long-term, on-going basis. The aim is to provide constructive support to develop character and capabilities of young people."*

Once matched, Mentors and Mentees are able to discuss appropriate ways of contact which is generally via social media or online. Not all of the mentors are of Moriori descent, nor do they all live on or come from Rēkohu. The purpose of the programme is to provide a space and opportunities for like minds to meet and to help young Moriori grow. It was discussed that this programme was established out of a need and desire to support rangatahi on Rēkohu, however, the programme has not been picked up by many of the Moriori youth. Follow up with families as to why this programme is not being picked up is necessary in understanding what kinds of youth initiatives are relevant and meaningful for the HMT and their youth.

### 7.8.10 Conclusion: Living on Rēkohu

The purpose of this section has been to provide a context through which one can be introduced to the Moriori of Rēkohu and some of the factors which need to be taken into consideration when thinking about establishing youth programmes on Rēkohu. These factors include the social and historical context of the groups living on the island, the current status of these different groups, and the challenges that groups on Rēkohu are faced with when considering bringing youth back to Rēkohu to engage with programmes. The major physical challenges include the high cost of living, lack of appropriate housing and no current programmes targeted at youth on the island. It is likely there are other challenges specific to Moriori regarding their desire or comfort in reconnecting with Rēkohu, if a connection has previously been ruptured. The next section will look at other indigenous youth programmes before I look specifically at opportunities for engagement in the final section.

## 7.9 Youth Initiatives

During the initial stages of research of this project, my intention was to research existing successful youth programmes and use these to inform a model for a successful programme on Rēkohu. However, I found that a number of the international youth initiatives were focused on evaluation of programmes that were deficit focused. For example, there is a raft of literature on indigenous youth and alcoholism, abuse, negative education and health statistics and language loss and the programmes which have been set up to stop the impacts of these negative things. Conversely, the literature focused on positive programmes set up purely for youth aspirations, is scarce. This finding indicated there is a gap in the literature around strength based understandings of indigenous youth programmes and thus, the section presented here is an informal overview of different indigenous and Māori initiatives that are currently in place in New Zealand. For the most part, I have some involvement in or knowledge of each of these initiatives and therefore feel comfortable writing about these initiatives. These initiatives were shown to the HMT as potential models for discussion for an appropriate youth initiative.

## 7.10 International Initiatives

### 7.10.1 Voyaging Canoes

Across the Pacific, the voyaging canoe is said to represent genealogy. Many Polynesian cultures trace their origins to particular canoes, which provide insight into a person's ancestry through the narratives and names associated with the canoes. The art of voyaging and traditional navigation is currently in a state of revival. In recent times, the ancient art of wayfinding was nearly extinct until one of its last keepers, master navigator Mau Piailug from Micronesia, on the island of Sattawal, chose to teach the Hawai'ians who had built Hōkūle'a, a voyaging canoe based on old drawings and plans of traditional canoes. Papa Mau (as he was known by many) then mentored Nainoa Thompson, who became the first Hawaiian and Polynesian since the 14th century to practice wayfinding on long-distance ocean voyages. In 1976, Mau helped to guide the Hōkūle`a across 2,500 miles on her first voyage from Hawai'i to Tahiti using only traditional navigation techniques. Her voyages have inspired an extraordinary cultural revival and renewal of pride that continues to empower and inspire future leadership. Currently Hōkūle'a and Hikianalia are embarking on a worldwide voyage 'Mālama Honua' with the purpose of addressing global sustainability and environmental issues[4].

The Pacific Voyagers Trust are responsible for a fleet of several open ocean sailing canoes from throughout the Pacific who have embarked on various sailing journeys between islands and across the Pacific Ocean. The kaupapa involves voyaging to strengthen indigenous ties with the sea, renewing a commitment to healthy ecosystems for future generations. Many Polynesian and Pacific Islands have voyaging canoes that are used for deep-sea ocean voyaging, transport of food and other necessary items between islands and shipping containers. Aotearoa New Zealand is the home of at least four voyaging canoes; Te Aurere, Te Matau a Māui, Haunui, Ngāhiraka mai Tawhiti.

In 2014, the Ngāti Kahungunu waka hourua Te Matau a Māui sailed from Ahuriri to Rēkohu in the hope to establish a long term sustainable relationship with the Moriori of Rēkohu[5]. Te Matau a Māui are currently working towards starting rangatahi initiatives in the Kahungunu area and have expressed an interest in working with Rēkohu. A further voyaging canoe, Haunui, skippered by

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[4] See http://www.hokulea.com/follow-the-voyage/ for more information on Mālama Honua

[5] See http://www.Māori television.com/mi/purongo/a-rohe/kua-hono-te-waka-hourua-Māori -o-te-matau-maui-ki-nga-iwi-moriori, http://www.nzherald.co.nz/hawkes-bay-today/photos/news/image.cfm?c_id=1503455&gal_cid=1503455&gallery_id=142420#14810878 and http://www.nzherald.co.nz/hawkes-bay-today/news/article.cfm?c_id=1503462&objectid=11242223 for media on the voyage.

Hoturoa Barclay-Kerr under Te Toki Voyaging Trust has also expressed a desire to establish links to karaka (Kōpi) voyaging with Rēkohu and the Moriori people.

These initiatives could provide Moriori youth with the opportunity to understand the voyaging traditions of their past, while visiting the specific areas pertaining to their history and to learn practical skills like team work, knot tying and working together.

## 7.11 National Māori Youth Initiatives

### 7.11.1 Tuia (rangatahi Māori, under the age of 25)

Tuia (Tuia te here tangata) is a Māori youth development programme with an intentional, long term, intergenerational focus on building and developing the leadership capacity of rangatahi Māori in communities throughout New Zealand (Hastings District Council, 2011). Tuia is founded on the idea that many young Māori have a commitment to their whānau, hapū and iwi and as such provide a lot of volunteer service within their home communities. Tuia believes that with the right support and guidance these young Māori will become drivers of social change.

Tuia began as a Mayor's task force initiative where participating regions select a young Māori person from their region who the Mayor will develop a one-on-one relationship with. Participants meet with their Mayor on a regular basis both formally and informally. The mentoring relationship is often reciprocal and can provide both parties with an insight into the generational challenges that face communities today.

Further, each rangatahi is expected to undertake 100 community-service hours providing the young person with the opportunity to share, develop, practice and demonstrate their leadership. The selected rangatahi also attend four national wānanga throughout New Zealand where they have the opportunity to network with the other rangatahi who are undertaking the Tuia programme in different regions. This is a chance to consolidate what they have learned, meet inspiring Māori leaders, and visit different rohe and also an opportunity to meet other young people with a heart for their communities. Tuia is effectively run 'by rangatahi, for rangatahi' and at the end of each year participants are given the ownership to determine the direction of the kaupapa for the future and any further expressions that might 'pop up'. Such expressions include the 'Tuia Tour' a one-year haerenga around New Zealand where a group of 9 rangatahi were taken to all of the major kaupapa Māori events to connect with each other, different iwi, people, stories and places[6].

Because of the size of Rēkohu and the number of rangatehi Moriori, a model like Tuia would necessarily look very different if it were to work for rangatehi Moriori. However, elements such as the community service aspects and connection people to people, people to place could be important values to take forward into any youth initiative.

### 7.11.2 Te RārangaTira (Māori aged 20-35)

Te RārangaTira is a kaupapa that is focused on connecting young Māori who have a love and desire for Māori culture and people[7]. The kaupapa is premised on the simple belief of *"when you bring good people together, good things happen."* Participants are gathered from throughout New Zealand to engage in a series of wānanga with the purpose of connecting people to one another, to different rohe and to strengthen relationships and capacity. Currently, Te RārangaTira participants engage in four wānanga a year and the process has a strong focus on personal development. Te RārangaTira is currently funded by Te Aho Tūroa, a branch of the Enviroschools foundation, who in turn are funded by the Ministry of Environment.

### 7.11.3 Tribal Specific Youth Development Programmes

#### *7.11.3.1 Aoraki Bound*

*"Ekea kā tiritiri o te moana…Ascend to the heights of your aspirations"*

Aoraki Bound is a cultural and personal development programme combining Ngāi Tahu cultural knowledge with the expertise and reputation of Outward Bound in a 20-day journey-based course that builds leadership, cultural awareness and personal development[8]. Aoraki Bound students spend 8 days at the

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[6] See https://www.facebook.com/tuiatour2013 and http://foundation.vodafone.co.nz/what-we-fund/world-of-difference/haimona-waititi/ for more information about Tuia

[7] https://www.facebook.com/TeRarangaTira

[8] For more information see http://ngaitahu.iwi.nz/whanau/aoraki-bound/about-aoraki-bound/

Outward Bound camp at Anakiwa, Queen Charlotte Sound and 12 days on a hīkoi (journey) from Anakiwa to the base of Aoraki Mt Cook. Aoraki Bound was established in the context of cultural and language revitalisation as specific to Ngāi Tahu.

According to Ngāi Tahu traditions, Aoraki was the eldest son of Rangi (the Sky) and Papatūānuku (the Earth). Aoraki and his three brothers brought the great waka, Te Waka o Aoraki, down from the heavens, but it became stranded and overturned tipping the brothers into the water. The brothers climbed upon the upturned canoe awaiting rescue, but instead were turned into stone becoming Ka Tiritiri o te Moana (the Southern Alps) with Aoraki forming its highest peak (Te Rūnanga o Ngai Tahu, 2014a).

Aoraki Bound was created as a relationship between an existing personal development programme Outward Bound and Te Rūnanga o Ngāi Tahu. Participants have a chance to learn and engage in Ngāi Tahu language, culture, marae, customs and song.

An Aoraki Bound initiative has been mentioned already in this internship, and could provide a steady platform for young Moriori to visit sites of significance, learn particular mahinga kai (food gathering) skills, narratives and meet other Moriori youth. Cost of the programme and bringing the participants to the island (if any are coming from the mainland) are important considerations that need to be made.

#### *7.11.3.2 Manawa Hou[9] (Ngai Tahu rangatahi in years 11, 12 and 13.)*

Manawa Hou is a four-day 'your space in our place' hīkoi. This hīkoi has been modelled on the bus trips that were run by Ngāi Tahu Development Corp in the early 1990s (Te Rūnanga o Ngai Tahu, 2014b). Manawa Hou involves taking a group of rangatahi on a 'hīkoi' around various rohe and marae in the Kāi Tahu takiwā, with an emphasis on whānaukatanga (relationship building) and Kāi Tahutanga (Ngai Tahu cultural identity). The purpose of Manawa Hou is to connect Kai Tahu rangatahi and develop culturally competent and connected leaders. Rangatahi are given the chance to spend time with current young Ngāi Tahu leaders and learn stories, language, song and traditions specific to Ngāi Tahu and the areas in which the wānanga are immersed.

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[9] See http://ngaitahu.iwi.nz/whanau/manawa-hou/

Manawa Hou is a long-term programme with the vision of eventually having four per year in different rohe (areas). It is also part of a larger Capability Strategy, which involves three integrated programmes: Manawa Hou, Manawa Tītī and Manawa Nui.

### 7.11.4 Regional Based Programmes (Not tribal specific, not national).

#### *7.11.4.1 Te Kura Maurea (high school aged, Māori focused, for all rangatahi)*

Te Kura Maurea (TKM) is a youth programme based in Christchurch[10]. TKM aims to take high-school aged rangatahi to different marae in the Ngāi Tahu rohe to learn different histories and stories embedded in the local landscape. Each TKM wānanga is based on a different Atua Māori (Māori God) and rangatahi have the chance to learn the knowledge associated with the specific atua (for example, Tangaroa is the Atua of the ocean and rangatahi undertake whakapapa activities, mahinga kai (traditional food gathering practices), waka ama and other related activities).

Te Kura Maurea was born out of a challenge laid out by a Kaumatua at a tangihanga (funeral) in Christchurch following the death of a young person through "huffing". The kaumatua exclaimed that if there were more positive initiatives in the Christchurch region, youth would have better avenues to spend their time.

#### *7.11.4.2 Te Taitimu Trust (6-16, all rangatahi)*

Te Taitimu Trust is a Māori non-profit organisation based in Hastings. Te Taitimu aims to engage the hearts and minds of rangatahi by motivating them to become rangatira for the future through engagement with Tangaroa[11]. TTT has a formal relationship with water safety New Zealand and each year holds a large wānanga, which has in the past hosted up to 150 youth aged 6-16. The activities at past wānanga have included water safety, stand up paddle boarding, surf lifesaving, kapa haka, karakia, slam poetry and more. Throughout the year, Te Taitimu runs

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[10] For further information see https://www.facebook.com/TeKuraMaurea
[11] For more information see https://www.facebook.com/tetaitimu

smaller wānanga focussed on providing opportunities for at risk youth to broaden their horizons.

Te Taitimu also holds a number of smaller wānanga throughout the year with selected groups of rangatahi. The purpose of these smaller wānanga is to engage the rangatahi and ground them in their communities and identity as Māori. Much of Te Taitimu's focus is around early prevention of recognised negative pathways for youth.

### 7.11.5 Conclusion: National Māori Youth Initiatives

Each of these programmes that I have briefly mentioned in this section focus on youth development, but each have different platforms through which they explore and express youth development. Further consultation is required to understand which (if any) parts of each programme could be used as a model to mould a programme that is unique and specific to the needs and aspirations of Moriori people, their culture, place and youth. What is common to all of these programmes is they are based on a face-to-face connection within a particular landscape, therefore, if they were to be replicated or trialled on Rēkohu they would likely include engaging with other Moriori people, face-to-face on Rēkohu. This leaves room for asking about virtual interactions and whether this is a potential avenue to begin to engage Moriori youth.

## 7.12 Indigenous people and the Internet

In the technological era, more research is being conducted around indigenous peoples' use of social networking sites and the Internet (see O'Carroll 2013). In particular, research is centred about the cultural implications of the Internet with an emphasis on social networking sites. These sites can be used as tools for cultural preservation through language learning, sharing narratives and events and issues significant to Māori and indigenous peoples. Examples of successful indigenous online campaigns include "Idle no More" which has over 130,000 'likes' on Facebook.

In a New Zealand context, 86% of Māori are using the Internet (Smith, 2011). With increased access to broadband connections in remote areas, internet in the home is becoming almost commonplace and smart phones continue to extend internet use (Smith et al., 2011). In this context of high internet access, a high number of young users and a high Moriori diaspora the question of the appropriateness of online engagement with Moriori youth is worth investigating.

## 7.13 Moriori Diaspora

Seven hundred and thirty eight people identified as Moriori in the 2013 census. The census figures should be balanced against the HMT member register that has 1500 registered Moriori adults and children, and growing. Of the 945 who identified as Moriori in 2006, 498 were living in the Canterbury, Auckland, Wellington and Southland regions. Table 1 provides a breakdown of residence by province. The majority of Moriori live away from Rēkohu (see Davis and Solomon, 2012).

*Table 1: The distribution of Moriori residence, by province, in Aotearoa New Zealand 2006.*

| Location | Number of Moriori declared as resident |
|---|---|
| **Canterbury** | 192 |
| **Auckland** | 129 |
| **Wellington** | 93 |
| **Southland** | 84 |

Because of the large Moriori diaspora and the economic barriers to physically connecting to the island a digital connection might be an appropriate avenue through which Moriori youth (in particular the diaspora) engage with Rēkohu and Moriori stories, song and language.

### 7.13.1 Virtual Marae – Aotearoa

Currently, there are two major platforms through which Māori in Aotearoa can access marae in a virtual space. This virtualising of marae enables a greater access and connection for those living outside of their tribal areas (O'Carroll, 2013).

The website www.Naumaiplace.com offers an online central hub where marae are registered as part of its database and are enabled to connect to other marae around the country, and globally to their people. New technology combined with a unique system and processes enables Naumaiplace to bridge gaps and return significant benefits to local marae thus impacting positively on Iwi Māori and the community as a whole.

Over 900 marae located within Aotearoa have registered as part of this database, which features contact information for each marae. Marae are able to fully register with the site (at a cost) enabling them to construct a website (embedded within naumaiplace.com) with the potential functions of a registration page, upcoming events, photo gallery, marae bookings calendar and secure login-access pages.

Māori maps (www.Māori maps.com) is a more recently developed and similar website that provides the geographic locations of the many tribal marae throughout Aotearoa. The website enables the viewing of marae taonga and provides information: *"Māori Maps is a gateway to the Māori world of marae. It aims to take visitors to the gateway of marae around Aotearoa New Zealand."* The website features over 750 marae and is being updated regularly with more marae and information. For Paul Tapsell, Māori Maps grew from a concern over marae usage in today's society, in that some Māori were not returning their dead to the haukāinga and were instead keeping them at home to conduct the tangihanga rituals. He states that the marae is of utmost importance, particularly when conducting tangihanga rituals:

> *"It gives expression and context and frames our whakapapa [descent] as Māori , which is accountable back to a landscape in which our ancestors are buried. If we do not farewell our dead on their ancestral marae, there goes the last bastion of being Māori"* (Tahana, 2012 in O'Carroll 2013)

The second phase of Māori Maps will be centred on a 'beyond the gate' concept, which will allow marae and iwi to add more information to their page for whānau safe viewing. In some respects, this may be similar to that of the paid version of the naumaiplace.com platform.

### 7.13.2 Kōpinga Marae - A Virtual Space.

Kōpinga marae is located close to the main township of Waitangi and was central to cultural revitalization efforts for Moriori on Rēkohu. Construction on Kōpinga began in 1997 and the building was opened on 21st January 2005 in a ceremony attended by over 1,000 people. Dignitaries included Te Arikinui Dame Te Atārangikāhu, Tumu Te Heuheu, and the Prime Minister Rt. Hon. Helen Clark. During the opening ceremony the ancestral covenant of peace was renewed by all the timiriki Moriori (children) attending the event.

The marae was built to re-establish a central base on Rēkohu in which Moriori could meet, celebrate, and debate in a shared space. The name 'Kōpinga' is derived from the name for a grove of kōpi (karaka) trees. Traditionally Moriori gathered in the kōpi groves for events and the celebration of family and tribal rituals and events. The kōpi groves are also home to the living tree carvings (rākau momori) that reflect ancestral images. The marae was named to reflect the significance of the kōpi in traditional Moriori communities. Hokomenetai is the name for the main whare. Hokomenetai means: "to gather together in peace" (See Hokotehi Moriori Trust, FAQ for all information pertaining to Kōpinga). The marae complex is built in a unique pentagon structure, inspired by the basalt columns found on the north western coast of Rēkohu, where Moriori gathered to make adzes and other stone tools. From above, the main complex resembles a hopo (albatross) with wings outstretched, a significant taonga specifies and symbol for Moriori. Further, the shape also reflects the typical stance of many of the rākau momori – carved human figures with arms open in welcome (Hokotehi Moriori Trust).

Inside Hokomenetai is a central pou, Ka Pou a Rangitokona, named after the Moriori ancestor who propped up the heavens. The pou was carved using laser routing techniques and features the names of all of the people known to have been alive at the time of the Ngāti Mutunga/Ngāti Tama invasion in 1835. The pou carvings also include replicas of rākau momori and symbols from Rēkohu landscapes such as rimurapa (kelp), seals, and hopo. The pou stands on a stone tūahu kōrero. During rituals of encounter guests are invited to stand around the tūahu kōrero and offer on taonga, gifts and thoughts of peace to the ancestors.

The marae features several carvings that are reflections of traditional Moriori images as well as Rēkohu landscapes. Images include the hopo, seals, eels, and rākau momori, as well as an intricately carved map of Rēkohu and Rangihaute (Pitt Island) that depicts the four elements in the Chatham's community – Moriori, Māori, Pākehā and Pitt Islanders.

The two large carvings on the outside of the building represent two Moriori ancestors, Rongomaiwhenua (at the front of the house) and Rongomaitere (on the north-facing side). These were carved by Mana Cracknell. Rongomaiwhenua is holding a tupuare – a Moriori wooden staff, reflecting Nunuku's law which decreed that *"men could fight 'til first blood was drawn and then fighting was to cease."* Nunuku's law has covenant has been reaffirmed during important events at the marae, and remains a significant part of the legacy of Moriori today.

There is a large pentagonal stone outside the front entrance of Kōpinga. This is one of the mauri stones for the marae.

### 7.13.3 Conclusion: Moriori Diaspora

With the large Moriori diaspora in mind, the rich cultural knowledge that is being collected on Rēkohu (for example through the carving scanning projects, the library which is being set up) perhaps there is a space to investigate an online forum through which Moriori youth can connect with one another and with their culture. Utilising the concept of digital marae as an example, such a site may include a member from the descendant community connecting to the Kopinga marae via a website and being able to access different areas of the island through visiting the different carved pou. Such areas might include Hapupu, the basalt columns, MEG and other sites of significance including the well-documented middens. This would provide an opportunity for the Moriori youth to engage in aspects of their landscape and culture, at a low cost and from a distance. There could also be forums or online spaces for the youth to connect with one another, find out more about their ancestors and ancestry, the specific taonga of the area and more. Once this initial connection is made (albeit virtually) to the people and place, perhaps face-to-face programmes could be established to help continue support and develop the growth of Moriori youth.

## 7.14 Future Recommendations

2015 marked ten years from the opening of Kōpinga marae, and HMT hope to host ten events throughout the coming year. Perhaps there is space to host an event specific for Moriori youth depending on what they are trying to achieve for their people, why they are trying to achieve it and further, space to launch a website based on the virtual marae concept if it is deemed important.

Further research needs to be conducted around the usefulness of and piloting a rangatahi programme on Rēkohu. One of the major limitations of this study is that I did not speak to any rangatahi during this research and the sources that I reviewed also note this as a limitation in their research. The youth voice is therefore largely missing.

Secondly, this research requires implementation and evaluation of any programme to ensure that it is meaningful and contributes to the long-term sustainability and visions of the HMT and the people they represent.

## 7.15 Conclusions

There have been several key findings in this research internship, all which highlight the need for future research both in the area of indigenous youth programmes and those specific to Moriori. It is important to cast a historical and genealogical lens on the Moriori people of Rēkohu, so that one can come to understand where they have come from, where they are and thus, where they might move as a people.

There are several key aspects to the Moriori culture that remain strong today, and these are focused around (but not limited to) Kōpinga marae, MEG, HMT and Nunuku's law. There are also people with huge knowledge of the landscape and the food of the area. For this reason, these sites or aspect of culture seem key to engaging Moriori youth in their culture and in relationships with one another. There is a small but passionate group of people working within HMT dedicated to looking after the interests of Moriori now and in the future and it has been a privilege to work alongside these people for the duration of this project.

Other key findings include learning that much of the international literature around indigenous youth reconnection is deficit-modelled and focused on 'fixing problems' rather than empowering and engaging indigenous youth. One could suggest various reasons for this skew in literature including where research funding is being focused, and questions of whose eyes are evaluating the programmes (and the youth) and what are the focal points for each project. This has highlighted the specific need for future research in this area, in particular research that focuses on cultural aspiration and understanding. Further, many of the existing successful youth programmes in Aotearoa cannot be replicated on Rēkohu for various reasons including population, Moriori diaspora, costs of living on Rēkohu and size of the island. Initiatives around an Aoraki Bound concept and eco-tourism are worth further investigation.

Lastly, I am reminded of the name 'Rēkohu' and its meaning, 'to look at the sun through misted skies' – while there may be many challenges which lay ahead, some unforeseen, the sun will always shine beyond the misted skies – such is the strength of the Moriori people and the future which awaits.

## References


Davis, D., Solomon, M. 2012. *Moriori: Origins of the Moriori People.*

Hastings District Council 2011. *Tuia Prospectus*.

Hokotehi Moriori Trust. *Kōpinga Marae FAQ*.

Hokotehi Moriori Trust, 2011. Me Rongo Peace Congress 2011 Proceedings. In: *Me Rongo Peace Congress: Peace, Sustainability and Respect for the Sacred, Rēkohu*.

Jefferson, C., 1955. The Dendroglyphs of the Chatham Islands. *Journal of the Polynesian Society* 64, 367-441.

Klinac, D., Benton, R.A., Rentoul, S. 2009. Karaka Nuts: A "New" *NZ Nutcrop*, p. 85.

Lawrie, C., Powell, J., 2012. *Discover the Chatham Islands: First to see the sun*. Deerubbin Press, Australia.

Litmus Ltd 2014. *Wharekauri, Rēkohu, Chatham Islands Health and Social Needs Report* (Wellington, Ministry of Health.).

O'Carroll, A.D. 2013. *Kanohi ki te kanohi - a thing of the past? An examination of Māori use of social networking sites and the implications for Māori culture and society* (Massey University).

Said, E., 2003. *Orientalism: Western conceptions of the orient*.

Shand, A., 1895. The Moriori people of the Chatham Islands: their traditions and history. *The Journal of the Polynesian Society* 4, 33-46.

Smith, P., Gibson, A., Crothers, C., Billot, J., & Bell, A. 2011. *World Internet Project New Zealand The Internet in New Zealand 2011* (Auckland: Institute of Culture, Discourse & Communication, AUT University).

Stevenson, K. 2013. *Māori Leadership within Recreation Management. A case study of Aoraki Bound*. (Dunedin, University of Otago).

Te Rūnanga o Ngai Tahu 2014a. Aoraki Bound.

Te Rūnanga o Ngai Tahu 2014b. Manawa Hou.

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Rēkohu means to look at the sun through misted skies. Perhaps my greatest realisation throughout this internship is that the concept behind the name Rēkohu can be thought of as a metaphor for ones acquisition of knowledge and of the sometimes difficult pathways people face when trying to create a more positive, vibrant future. To me, the sun symbolises the reaches of knowledge and the potential and promise of a bright future. In the context of this internship, the misted clouds might be thought of as the barriers to youth reconnection, the historical context in which Moriori find themselves and the difficulties that can come with living on a small island community. However, like Rēkohu, a bright future both lies beyond and pierces through the misted clouds – but it requires vision and courage to see promise beyond barriers. I have come to understand that the members of the HMT who I worked with, the many committed people of Rēkohu who I have had the privilege of meeting throughout this process and my supervisor Dr Marion Johnson, have both the commitment and the vision to see the sun beyond mist. For that gift, I am humbled and I thank you all for the many ways in which you have supported me. To Māui and Susan, nā kōura anō te kuaha i whakatuwhera, nā reira, nei rā te mihi aroha ki a kōura tahi. Anō nei ki a John, Tom, Sylvia koutou katoa o HMT, tēnei te mihi manahou ki a koutou i tō koutou kaha tautoko i a māua, i tēnei kaupapa hoki.

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KOPINGA MARAE

# 8 Native Plants for Animal Health

Marion Johnson

## 8.1 Healthy Land: Healthy Animals

The flora of Aotearoa New Zealand comprises 6,698 indigenous species, 2,418 are vascular plants (www.nzpcn.org.nz). Eighty percent of our indigenous flora is endemic occurring nowhere else in the world (Brooker et al., 1989) and yet the levels of biodiversity on our productive landscapes, our farmlands, are decreasing. It is time, in the words of Morgan Williams *"to halt the degradation of an ancient Gondwanan treasure chest of unique species"* (Williams, 2001). Wandering feral stock can be blamed for the loss of diversity in many of our bush areas for example (Zotov et al., 1938; Wardle et al., 1971; Wardle et al., 2001; Forsyth et al., 2002) but the blame for the loss of diversity on farmland sits squarely on the shoulders of the land managers. When they were introduced, stock ate out their favourite plants as they moved into new areas for example (Hunt, 1866; Stark, 1979; Peden, 2011) and the devastation has continued unabated. The pressure for intensification at all costs and the concept that production must be based on a limited number of highly (and questionably) selected pasture species propped up with nitrogen has sickened our land and our animals.

With the increasing awareness of the impact of many livestock rearing practices on land and water, the notion of planting on farm to protect waterways is becoming accepted and in fact a requirement. For example, the sustainable dairying water accord (www.Dairynz.co.nz) has been developed to help dairy farmers reach water quality targets. Our plants however have far more to contribute to our farms than languishing in riparian strips. Our flora should be taking centre stage and supporting the health of our soils, pastures and livestock, and associated flora and fauna.

Māori have long acknowledged the importance of plants (rongoā rākau) to health, not only to personal health but to the health of the land. Rongoā or traditional medicine is a holistic process incorporating the state of the body (tinana), the mind (hinengaro), the spirit (wairua), family connections (whānau) and whenua – the land. Mark and Lyons (2010) record a healer stating that unless the land to which a person is connected is healed that person will not be well. Durie (1985) reminds us ..

*"land is a symbol of continuity with those who have passed on to the spiritual world and respect for the land augments ones spiritual strength."*

The sense of knowing, respecting and caring for the land that nurtures us is all pervasive. Māori wisdom acknowledges our kinship with all species, in fact *"the trees and birds and all living creatures of the forest are tuakana (senior) to us"* (McGowan, 2009) and Durie reminds us that a truly healthy individual has all their connections in balance. The health of the land is no different there are many connections between the microbiota of the soils, the plants, the stock, the water and the air, these are largely ignored and wantonly disrupted by industrial, intensive land management.

The focus of this chapter is on animal health and using plants to promote animal health, but the information should not be read and compartmentalised. The processes of self-medication in animals, ethnoveterinary knowledge and non-allopathic veterinary practices are holistic and demand that ..

.. the environment is considered as a whole: healthy soils; healthy feed; clean water; clean air and respectful management will all contribute to healthy animals.

## 8.2 Ethnoveterinary Studies

McCorkle (1986) defined ethnoveterinary research and development as *"systematic research and development which takes as its principle subject or major departure point folk knowledge and belief, practices, technology and resources, social organisation and so forth pertaining to any aspects of animal health among species raised or managed by human beings."*

The definition addresses ecology and society, it addresses the whole gamut of medicinal beliefs, it encompasses agroecology and above all it underlines the importance of holistic thinking for the promotion of animal health. McCorkle emphasises the importance of first-hand investigation and real-world study when researching ethnoveterinary practices and of understanding the peoples and cultures *"magico-religious practice and idiom embody practical veterinary and management acumen."* All too frequently local knowledge has been decried and ignored, the seemingly illogical actually is perfectly logical, such as keeping stock 'out of evil winds'; many livestock diseases can be transmitted aerially (McCorkle, 1986).

Spirituality is integral to the practice of ethnoveterinary medicine and although it is often ignored and ridiculed by agri-business and researchers, it is this spiritual element that helps to safeguard the environment (Mathias, 2004) and secures animal husbandry in a locality. Sometimes knowledge is not passed on because there is no spiritual network and the knowledge is too heavy (Pa Ropata pers. comm.). The skills and practices, knowledge and beliefs about animal health that are passed down through the generations are the basis for the practice of ethnoveterinary medicine today (Akerreta et al., 2010; Piluzza et al., 2015).

Evelyn Mathias points out, ethnoveterinary practices have been developed by farmers in their local regions for their local breeds. Stockmen know when their animals are sick and they know where the best pastures are and where the plants grow that have alleviated ailments for eons. Certainly some treatments may be ineffective, particularly if they cannot be used within a complete treatment protocol. For example, the animal may be dosed but it cannot be moved to new grazing. Some treatments may be dangerous, especially if not fully understood and particularly as there is rarely a standard dose. If someone who understands the animal and the plants being used is applying the treatment, then the vagaries of dose can be compensated for through stockmanship and botanical expertise.

Extreme care must be taken when listening to and translating ethnoveterinary knowledge. Local words may be used to describe symptoms that may apply to several diseases (Dold and Cocks, 2001). Sometimes the causative agent is not described (Gabalebatse et al., 2013), leading to an incorrect allopathic veterinary identification. In some cultures, and when describing some diseases, ethnoveterinary knowledge can be more detailed. For example, in Nigeria herders know some ticks cause illness in cattle and they identify the species of tick according to whether it causes illness or not. In Kenya, East Coast fever is described according to four manifestations (Schillhorn van Veen, 1997) .

Unfortunately many allopathic veterinary drugs are unscrupulously produced and sold often without instructions and at high prices by people who are not qualified to dispense them.(Mathias, 2007). These drugs are frequently ineffective, have unexpected side effects and contribute to worldwide problems of resistance. Ethnoveterinary preparations are local and if used in conjunction with local practitioners, holistic management and prevention strategies, are effective.

Schillhorn van Veen (1997) reminds us that traditional animal health care is unregulated and as such is open to abuse. This may be so, but if animal health remains in a local context and does not become part of the global marketplace then fraud is less likely. If we keep holistic animal health within an agroecological paradigm, contributing not only to the health of livestock but also of the farm and community then it can only evolve with the community and not with outside agencies such as pharmaceutical companies and other profit centred entities.

### 8.2.1 The Decline in Local Ethnoveterinary Knowledge

Increasing numbers of ethnoveterinary investigations are being published as the realisation grows amongst farmers, communities and researchers that the knowledge of how to treat animals on farm is disappearing with the death of the older generation, along with the plants they used.

Some of the reasons given as to the disappearance of ethnoveterinary practices are as follows.

1. There is a ***loss of knowledge often held by older people*** (Akerreta et al., 2010; Kidane et al., 2014; Nabukenya et al., 2014; Piluzza et al., 2015). This knowledge is not recorded so is not easily accessible. Working with Banswara communities in India, Yadav and Rajput (2015) noted that the people had *"a rich storehouse of ethno-knowledge for animal care but did not keep any records of practices."*
2. ***Knowledge is not freely shared,*** it is held by some people (Nabukenya et al., 2014) and frequently kept secret (Yadav and Rajput, 2015). Githiori et al. (2005) found that amongst pastoralists in Kenya, knowledge was freely shared and belonged to the community. There were however still specialists with a deeper knowledge. By contrast, in the agropastoral communities in Kenya ethnoveterinary knowledge was guarded and the preserve of the few.
3. The ***growing scarcity of some plants*** or difficulty accessing one plant required in a mixture (Mathias, 2001; Gabalebatse et al., 2013; Nabukenya et al., 2014). An interviewee in Nabukenya's study of ethnopharmocological practices in Uganda stated *"we only use chips of roots from big trees so we do not completely destroy the source, most of these plants are rare and many people use the same tree, thus we do not encourage the use of roots in traditional medicine."* Interestingly, Akerreta et al. (2010) report that the bulb or root is used less often than the aerial parts of the plants by practitioners in the Navarra Spain. Aerial parts, such as flowers and leafy portions are most commonly used in Switzerland (Disler et al., 2014).
4. ***Social and technological changes*** meant that people moved away, literally and figuratively from traditional

medicines (Gabalebatse et al., 2013). The ravages of war on a community and proximity to town led to a lessening of use and loss of knowledge in Uganda (Nabukenya et al., 2014). However, the shift to cities need not isolate people from their ethnoveterinary traditions. Goraya et al. (2013) found that more than 60 plants were used in ethnoveterinary treatments for donkeys, mules and horses in the peri-urban areas of Pakistan.

5. ***Doses not qualified or standardised and wide variations in treatment durations and amounts*** are given (Mathias, 2001; Nabukenya et al., 2014). Lans et al. (2007) addressed the problem of verification through a ranking system. Firstly, the plant that is offered as a remedy was correctly identified and then the literature searched for any analysis of compounds that have been isolated from it. The remedy was then given a ranking from 1 (no information supports its use) through to 4 (folk knowledge, phytochemical and pharmacological data supports its use). Although helpful, the ranking system makes assumptions; for example if there is no pharmacological data, it could be that the plant has simply not been investigated. A related plant being used gives a greater level of confidence in the ranking system, but often plants in the same genus do not have the same actions. Ethnoveterinary medicine is by necessity local, using local plants in local conditions. As remedies are shared and used, validation is inherent. Treatment has to be flexible as plant allelochemicals change with time and space.
6. ***Traditional culture is often regarded as inferior***. This was found with participants in a study in Navarre, Spain (Akerreta et al., 2010), a similar attitude to young farmers in a study in South Africa (Dold and Cocks, 2001). This sense of cultural inferiority was not universal; those in the Ari and Maale tribal districts of Ethiopia believe herbal medicines more efficacious than allopathic medicines (Kidane et al., 2014). Duck farmers in Tamil Nadu embrace ethnoveterinary practices, managing and treating their ducks using indigenous practices, and used the ducks themselves as biological pest control (Gajendran and Karthickeyan, 2011).

Ethnoveterinary health care, based upon veterinary Ayurvedic medicine (Mrugayurveda) is actively promoted in India. The Foundation for the Revitalisation of Local Health Traditions, in association with Institute of Transdisciplinary Health Sciences and Technology is working to record and assess traditional practices across India http (www.frlht.org). The team at the

Foundation has developed a rapid assessment tool in which the treatment is documented, researched and evaluated. The treatment is then promoted, training given and plants established (Santhanakrishnan et al., 2008). To date the safety and efficacy of 353 formulations have been evaluated (B. Nair personal communication).

There is an increasing literature on the assessment of traditional remedies and plants for parasite infections. In the drive to find a new wonder drug, many of these plants are assessed out of context; they are often used in short-term controlled experiments that bear no resemblance to the holistic treatment in the field. Often laboratory animals are used as models, a plant that has been grown out of context and the target parasite is often not specified (Githiori et al., 2005). The species of parasite is important, anthelminthic plants are not a replacement drug and frequently affect only particular species. When lambs grazed Sulla (*Hedysarum coronarium*) faecal egg output was reduced in those infected with *Haemonchus contortus* but less so in lambs infected with *Trichostrongylus colubriformis* (Rahmann and Seip, 2007). Many plants are rejected as ineffective when, if they were used in a holistic treatment system accompanied by management changes, they may well prove to be efficacious. *In vitro* experiments may provide clues as to future drugs to be developed by the pharmaceutical companies but do not provide the grounds to reject indigenous ethnoveterinary knowledge that is being taken out of context.

Human traditional treatments and animal treatments may overlap (Mathias, 2004; McCorkle, 1986), or the same plants may be used independently. For example, both chimpanzees and humans utilise *Veronia amygdalina* for intestinal discomforts associated with endoparasites (Huffman, 2003). In a survey of Mediterranean animal health remedies, Pieroni et al. (2006) noted that nearly half the remedies had a similar indication in folk medicine. In a nationwide survey of rongoā practitioners in Aotearoa New Zealand, 26% of respondents indicated that they also treated animals (Boulton).

## 8.3 Self Medication

Given the opportunity can animals choose their diets to optimise their health?

Plants contain a huge range of allelochemicals, the plant secondary metabolites, so named because they did not appear to early researchers to have a primary function in plant life. Secondary compounds exert an allelopathic action on other plants and animals (Fujii). They are classified according to their chemistry (Swain, 1977), plant allelochemicals include phenolics (which include the tannins), alkaloids and terpenes, all of which have some immune associated function (Provenza and Villalba, 2010) and some effect on pathogens (Hart, 2005; Rogosic et al., 2012). Allelochemicals are frequently associated with bitterness, part of their function being to act a feeding deterrent and thus protect the plant. The difference between a medicative plant secondary metabolite and a deadly one is usually the dose (Rogosic et al., 2012). There are frequently two flushes of allelochemicals; one associated with plant damage, the other associated with the plant healing (Pa Ropata pers. comm.).

The possibilities of animals medicating themselves were raised by researchers observing chimpanzees in Mahale in Tanzania (Huffman and Seifu, 1989). They noticed that chimpanzees that appeared ill chose to eat *Veronia amygdalina* or bitterleaf, further study elucidated that the parasite loadings of the chimpanzees dropped after ingestion. Krief et al. (2005) present a series of studies in which chimpanzees which were known to be ill, selected plants which were not normally part of their diet and recovered. They also note that chimpanzees eat a wide range of foodstuffs, selecting from 35 species.

Animals can sense illness and can select species to alleviate illness. Given the opportunity, they can maintain health (Villalba and Provenza, 2001; Hart, 2005; Engel, 2007) Villalba and Landau (2012) present data from several experiments supporting the suggestion that animals can sense that they are infected with parasites. They suggest that animals may be sensitive to increased protein, mineral or vitamin requirements, and/or there is a mechanism warning them that has not yet been elucidated by researchers and then the infected animal chooses appropriate foods to alleviate the symptoms and/or disease.

Engel (2007) suggests that there are at least three mechanisms of self-medication: changing diet; changing behaviours in response to an illness; and acting on positive feedback. In other words recognising a plant that they have eaten is making them feel better. It is possible for an animal to self medicate in a number of ways. They may ingest a particular plant or plant part, absorb the allelochemicals through the skin or the mucous membranes. Some species may apply a remedy directly to the skin. For example, Kodiak bears chew *Ligustum* species roots and then spit the chewed root onto their paws before working the mixture into their coats. Birds frequently use ‘proximity self medication' lining their nests with plants that have insecticidal properties (Clayton and Wolfe, 1993).

Hart suggests that those animals that were predisposed to eat a broad diet including medical plants had a greater likelihood of survival. Engel suggests among domestic species when animals were selected for breeding on appearance and performance, the ones that were the fittest were probably the self-medicators.

Plant choices need to be studied in the context of the behaviour and physiology of the animal. Short-term experiments may not reflect an animal's innate ability to choose its diet as it may not require the compounds being offered in the experiment at the time and rarely are the feeds tested for the levels of allelochemicals which vary between plants, localities and seasons.

Provenza and Villalba have investigated feed choices and the role of allelochemicals in a series of experiments in which show the change of intake in response to physiology and health status for example (Provenza, 1995; Provenza et al., 2000; Provenza et al., 2003; Villalba et al., 2006). Nutritional wisdom guides animals as to the quantities of allelochemicals that they require in their diet at a given time to maintain their health. Schulkin, quoted in Villalba's 2007 paper, suggests that all animals have an ancient biological knowledge. Livestock are therefore driven to maintain an internal steady or homeostatic state. They will do this by altering their intakes of feed stuffs, balancing energy and protein requirements with allelochemicals needs, and behaviours thereby remaining fit and well with a selective advantage (Villalba, 2007).

The anatomy and physiology of livestock affects their choice of diet, for example the grazing/browsing behaviour of goats differs from cattle and the constituents of the saliva of deer differs from that of sheep and cattle allowing them to choose a diet higher in tannins (Austin et al., 1989; Rochfort et al., 2008). As both nutritional and therapeutic requirements influence an animal's feed choice – and it may be difficult to define the difference (Pieroni et al., 2006) – perhaps for livestock we should regard food as medicine and medicine as food.

Plant secondary compounds often taste bitter (Engel, 2007). Hart (2005) and Villalba (2007) observe that bitter plants are often avoided by healthy animals but are sought out when they are ill, presumably due to a physiological change and an alteration in tolerance. Engel illustrates the supposition by quoting an experiment where mice with malarial parasites chose to drink bitter chloroquine treated water rather than pure water. She also quotes a number of examples of wild animals ingesting bioactive species only when required. For example, monkeys with higher parasite loadings in South America eat figs; Brazilian red and gold-maned wolves infected with kidney worm eat wolf's fruit. Rhinos in South East Asia combat dysentery by eating high tannin species.

Bitterness has deliberately been bred out of many of our pasture species. Plants naturally have varying levels of allelochemicals, the activity of which can be influenced by other species eaten at the same time, how often they are eaten and the animals' physiology. Livestock may eat a toxic plant but will regulate the effects of the toxins by eating other species to balance the diet and control the toxicity (Burritt and Provenza, 2000; Provenza et al., 2003; Shaw et al., 2006b). There is, however, a metabolic cost to detoxifying allelochemicals (Shaw et al., 2006b) so the intake of nutrients will have to allow for those costs, however beneficial the plant secondary metabolite. The total intake of toxins can be increased if those allelochemicals can be detoxified using different metabolic pathways (Kimball and Nolte, 2004). In experiments, Villalba et al. (2006) showed that, given the opportunity, sheep would choose their diets, the amount of nutritious feed influencing their intake of allelochemicals. They also note that if animals only ever eat their favourite foods they do not learn to mix their diets and conversely if animals are forced to eat a range of foods they learn to choose foods to mitigate any toxicity problems caused by other food choices (Shaw et al., 2006a; Villalba et al., 2004). Can domestic animals actually sense the levels of bioactives in a plant?

Hart (2005) divided self-medicating behaviours into therapeutic-species ingested during the course of a disease and prophylactic-preventative ingestion of species either on a continual basis or during high risk periods. Chimpanzees in Mahale were observed to eat certain species prophylactically and therapeutically, with consumption increasing during the rainy season (Huffman et al., 1997). Observations of local Mamber goats and Damascus goats in Israel suggest that Damascus goats include *Pistacia lentiscus* in their diet – a tannin-containing shrub with anthelminthic properties – on a continuous basis, whereas healthy Mamber goats only browsed when challenged by parasites (Amit et al., 2013).

### 8.3.1 Self-medication: The New Zealand Context

As our pastures have changed, so have the livestock in our care. Have livestock lost the ability to self-medicate? Provenza's and Villalba's work (quoted above) would indicate that this is not so and observations by shepherds and herders would suggest that stock will, given the opportunity, eat a wide variety of species. An axiom from old New Zealand shepherds was that if an animal is sick "turn it out on the long acre" or the roadside verge in which a plethora of species grew, sadly now frequently sprayed out. Goats in Israel have been observed to eat the tanniferous shrub *Pistacia lentiscus* in preference to other species when nematode challenges are high. This observation was tested in an indoor trial in which infected goats clearly increased their intakes compared to uninfected goats (Amit et al., 2013).

There is debate as to whether animals can learn to self-medicate without prior teaching by their mothers. Socialisation experiments showed that lambs and their mothers had higher intakes than lambs alone demonstrating the value of being taught whilst at foot (Sanga et al., 2011). In discussion of the requirement for learning Sanga quotes Kummar and Goodall (1985) who suggest that *"many animals respond to environmental stressors by creating a new behaviour or using an existing behaviour in a novel context."* Amongst primates, Huffman (quoted in Sanga) observes that new behaviours arise when a group is faced with a challenge that it cannot solve with its current suite of behaviours. Provenza argues that young animals develop preferences for feedstuffs whilst at foot and that these experiences remain with them for life. Their subsequent foraging behaviour, preferences for feeds and ability to mix different feedstuffs (higher allelochemicals and different nutritional qualities) are all influenced by experience (Provenza et al., 2003; Manteca et al., 2008; Provenza, 2008).

Geophagy or soil/clay eating is another form of self-medication. A local New Zealand farmer undertaking faecal egg counts to monitor parasite burdens in his lambs observed that just before the parasite levels reached the point at which he would have to dose his lambs with anthelminthics the lambs nibbled at the clay banks. He now simply watches his lambs and treats them when clay ingestion begins.

*"It will take time for our stock to explore mixed pastures and learn once again to use nature's pharmacopeia and to regulate their intakes of potentially toxic allelochemicals we need to shepherd them carefully as they do."*

(Engel, 2007)

## 8.4 Native Plants for Animal Health in Aotearoa New Zealand

Kaputī kōrero, relaxed discussions with whānau whenua, were undertaken to document some of the knowledge and ideas about natural animal health and treatments in livestock.

All the people with whom natural animal health was discussed stated that for an animal to be healthy it must have a mixed diet. Observations were made that the healthiest animals were often those that had access to the bush. In fairness, observations were also made on the amount of damage that could be done by stock in the bush. One farmer pointed out that his stock always had access to a mixed "weedy" diet and when they went into the bush did little damage, simply selecting what they needed and only minimally trampling the undergrowth. Another had fenced his paddocks and stock trimmed all the branches that overhung the fence.

Many non-native plants are offered to stock, giving them a broader diet and promoting health. One farmer used to grow comfrey for his cows as well as crops of carrots, chou moellier, turnips and swede. Kale grew wild on the farm and was relished by the cattle. He did mention that back in the day if you thought an animal was suffering you simply shot it. They tried to make onions available as they were known to promote stock health, also garlic but it was often hard to get in quantity. Another farmer stated that he had healthy cattle yet only had *"three species of grass and a load of weeds."* He did, however, also offer a variety of legumes and his cattle could access the bush for browse. Herbs such as kawakawa (*Piper excelsum*), nasturtium (*Tropaeolum majus*), feverfew (*Tanacetum parthenium*) and garlic (*Allium sativum*) are placed in the water troughs.

One of the key points of difference to many industrial farms that was mentioned was having a smaller farm and knowing your animals, many of them individually. One farmer noted the connections between the life experiences of cattle and production, comparing his herd, which he knew well to others locally that did not achieve the same growth rates in their young stock.

Traditionally medicine used what the land provides. Whether treating animals, or giving them the opportunity to self-medicate, native plants are a good starting point. Pa Ropata states that *"the role of any healing plant is to heal the land and that if we don't heal the land we will never know health – the first patient is the ngahere* [native bush]." He also emphasises that any plants being used to treat animals (or humans) must come from a healthy area and a good rongoā patch should have a mixture of species. A list of native species used to treat animals is given below. The species are listed by Latin name so that none of the local names are privileged. If no source is given, the information was conveyed verbally.

*Table 1: Native species used to treat animals*

| |
|---|
| ***Acaena anserinifolia*** Piripiri, Hutiwai, Kaikaiārure, Piriwhetau, Biddybid: An infusion given for scour in calves (Brooker et al., 1987; Macdonald, 1974). Highly palatable. |
| ***Carmichaelia sp***. Maukoro. Eaten by cattle at certain times of the year. |
| ***Clematis forsteri*** Pikiarero, Smaller clematis. Sap used on chafed fetlocks in horses (Brooker et al., 1987) |
| ***Clematis paniculata*** Puawānanga, Pikiarero, Bush clematis. Sap used on chafed fetlocks (Riley, 1994; Williams, 2008) |
| ***Coprosma grandifolia*** Manono, Kanono, large leaved coprosma. Juice of plant applied to wounds, seals up and keeps flies away (Riley, 1994). Palatable to stock and feral goats |
| ***Coprosma robusta*** Karamu. Used for healing wounds ripped pig dogs (Riley, 1994). Palatable to cattle |
| ***Coriaria arborea*** Tutu. Poultice or decoction of tutu leaves used for sprains, cuts swollen legs in horses (Riley, 1994; Williams, 2008) and other stock. **Toxic** to all livestock. |
| ***Corynocarpus laevigatus Kōpi***, Karaka. Give to cattle when they are not well. |
| ***Cyathea medullaris*** Mamaku, black tree fern. Used to treat wounds, saddle sores on horses. Hairy outer skin scraped off inner frond, slimy tissue applied to wound. Applied as poultice raw or boiled (Adams, 1945; Brooker et al., 1987; Riley, 1994) |

| |
|---|
| ***Dacrydium cupressinum*** Rimu, Red pine. Rimu bark boiled with rata and applied to gall sores on horses. Rimu bark boiled with kauri applied to sore backs (Riley, 1994). |
| ***Dysoxylum spectabile*** Kohekohe. Enables the liver to function better. |
| ***Gaultheria antipoda*** Pāpapa, Korupuka, Tāwiniwini, Tūmingi Snowberry. Healing cuts in horses poultices or decoction (Brooker et al., 1987; Riley, 1994). Avoided by deer and goats (Forsyth et al., 2002) but eaten by chamois (Christie, 1964). |
| ***Haloragis erecta*** Toatoa, shrubby haloragis. Leaves given to sick horses (Riley, 1994). Palatable to cattle. |
| ***Hebe salicifolia, H. stricta*** Koromiko, Korohiko, Kōkōmuka, Korokio, Hebe. Used for scour in cattle and sheep (Riley, 1994). Horses and cattle (Neil, 1889) leaves eaten or chopped up and given with feed. Palatable to cattle. |
| ***Laurelia novae-zelandiae*** Pukatea. Used to treat pain. |
| ***Melicytus ramiflorus*** Māhoe Cow leaf. May be effective for use with retained cleansings. |
| ***Metrosideros fulgens*** Aka, Akakura, Puatawhiwhi, Torotoro, Red flowering rata. Used to heal dogs ripped up by pigs the sap from the vine blown directly onto the wound (Riley, 1994). |
| ***Metrosideros robusta*** Rata, Northern rata. Bark boiled with rimu and applied to gall sores on horses. Bark boiled with Kauri and applied to sore backs (Riley, 1994). |
| ***Myoporum laetum*** Ngaio, Kaio. Leaves bruised and warmed to release oils effective drawing pack for wounds (Macdonald, 1974; Riley, 1994). Leaves used as poultice (Williams, 2008) leaves crushed and used as sheep dip (Brooker et al., 1987; Macdonald, 1974). **Toxic** causing deaths in cattle and sheep liver damage in sheep (Brooker et al., 1987) |
| ***Pelargonium inodorum*** Kōpata, Kapurangi, Kurakura, Pōrewarewa, Scentless geranium. Geranium leaves used as poultice treat sores on horses backs (Riley, 1994). |
| ***Piper excelsum*** Kawakawa. Excellent for treating fleas and ticks. A good tonic. Helps waste elimination through the kidneys. Pain killing. |

***Pittosporum eugenioides*** Tarata. Lemon wood. Leaves made into paste and applied to raw skin due to saddle sores (Riley, 1994).

***Plagianthus divaricatus*** Runa Makaka Marsh ribbonwood. Boil and dose lukewarm for worms horses and cattle. Also applied hot to mane and back (Riley, 1994).

***Phormium tenax*** Harakeke. Flax. Used as an anthelminthic. Treats ringworm in calves, the gel being applied to the affected area. Eaten at certain times of the year by cattle. Palatable to deer, goats and cattle (Litherland et al., 2008).

***Ripogonum scandens*** Kareao, Pirita, Supplejack. Used for wounded pig dogs. Sap expressed directly into wound (Macdonald, 1974; Riley, 1994). Highly palatable to cattle (Timmins, 2002). Fruit eaten by feral pigs (Thomson and Challies, 1988), feral goats (Mitchell et al., 1987) and deer (Nugent and Challies, 1988).

***Rubus cissoides*** Tarāmoa, Tātarāmoa. Bush lawyer. Decoction given for scour in stock (Riley, 1994). Eaten by deer and goats but not preferred (Forsyth et al., 2002).

***Schefflera digitata*** Pate. Seven finger. Anti fungal. Crush and squeeze out the juice and drop onto ring worm.

***Solanum aviculare Solanum laciniatum*** Poroporo. Leaves used to treat sheep scab (Riley, 1994). Mixed with lard and rubbed on as a salve. The unripe berries are **poisonous** to sheep and cattle (Parton and Bruere, 2002) and may have been the cause of abortion in cattle on Banks peninsula (Hutton, 1996).

There are a large number of native plants that are palatable; many with human Rongoā uses. Other native species are simply listed by observers as “sometimes preferred.” It is reasonable to presume that these may be the species that are used for self-medication. Species that are preferentially grazed/browsed and in some cases have nearly disappeared, are identified below.

*Table 2: Native Species that are Preferentially Grazed/Browsed*

| |
|---|
| ***Aciphylla colensoi, Aciphylla squarrosa*** Taramea, Papaī, Kūwao Speargrass, Spaniard. Young plants have tender leaves that are highly palatable to stock (Riley, 1994). |
| ***Gingidia montana*** Kohepiro, Koheriki. Māori anise. Sheep love it. Survives in unreachable places (Macdonald, 1974; Stark, 1979). |
| ***Hedycarya arborea*** Porokaiwhiri, Pigeonwood. Grazed by sheep and cattle (Smale et al., 2008). Highly palatable to cattle (Timmins, 2002) but not yet threatened. |
| ***Lepidium oleraceum*** Nau. Cook's scurvy grass. Enjoyed by cattle and sheep (Brooker et al., 1987; Macdonald, 1974; Riley, 1994) The New Zealand Plant Conservation network classify Nau as nationally endangered. |
| ***Poa billardierei*** Pouaka, Hinarepe, sand tussock. Eaten by cattle sheep horses and classified by the NZPCN as at risk and declining. |

Forsyth et al. (2005) examined the rumens from 24 deer. Broadleaf (*Griselina littoralis),* scarlet mistletoe *(Peraxilla colensoi)* and kamahi (*Weinmania racemosa)* were the most abundant species found. They recorded that the deer had eaten 44 species from 38 genera. In 2002 they had analysed the rumen contents of large numbers of feral deer and goats from this analysis developed a list of preferred plants (Forsyth et al., 2002):

*Aristotelia serrata, Cordyline australis, Cordyline indivisa, Fuchsia excortica, Griselinia littoralis, Melicytus lanceolatus, Melicytus ramiflorus, Pseudopanax arboreus, Pseudopanax colensoi, Pseudopanax crassifolius, Raukaua edgerleyi, Schefflera digitata, Weinmannia racemosa, Coprosma lucida, Geniostoma rupestre, Coprosma grandifolia, C. tenuifolia, Ripogonum scandens, Asplenium flaccidum, Microsorum pustulatum.*

When Husheer et al. (2003) studied the effects of deer on beech forests, they noted that the following species were preferred:

*Carpodetus serratus, Coprosma tenuifolia, Weinmannia racemosa, Griselina littoralis, Coprosma microcarpa, Nothofagus menziesii, Nothofagus fusca, Nothofagus solandri, Coprosma pseudocuneata, Coprosma linariifolia.*

A study of the preferred diet of deer in the Murchison mountains identified the following species (Tanentzap et al., 2009):

*Aristotelia fruticosa, Aristotelia serrate, Astelia petriei, Celmisia holosericea, Celmisia verbascifolia, Chionochloa pallens, Chionochloa rigida, Coprosma ciliate, Coprosma colensoi, Coprosma cuneata, Coprosma pseudocuneata, Coprosma rhamnoides, Coprosma rigida, Dolichoglottis lyallii, Dolichoglottis scorzoneroides, Hoheria glabrata, Pseudopanax colensoi, Ranunculus lyallii.*

Studies of the preferred intakes of cattle and sheep are not as common as those of deer and goats but would be very useful. The intakes of deer and goats provide a guide but we must be cogniscant of the different morphological and physiological characteristics of each individual species.

When offering livestock a range of native plants in their diet some plants will be eaten for the nutrition they provide, contributing to the health of the animal; others would be chosen for their allelochemical content and others to balance the diet. We can use observations of livestock feed choices and knowledge of rongoā to develop an ethnoveterinary paradigm for Aotearoa New Zealand.

## 8.5 Conclusion

By aligning our farming methods to agroecology, carrying sensible stock numbers and increasing the biodiversity of our farms we will provide livestock with a wide range of plants to select their diet from and maintain their health. If we don't worry about calculating safe dosages and trust the animals instincts they will adjust their intakes to the levels of allelochemicals present at a particular time in a plant. Using whole plants in situ to promote animal health means a synergy and a safe guard is built in. Livestock will be able to ingest species prophylactically, reducing the likelihood of infection, or therapeutically to combat an infection. If we provide them with a good environment, shade, shelter, clean water and mixed nutritional options they will be healthy, happy and productive.

## References

Adams, O., 1945. *Māori Medicinal Plants*. Auckland Botanical Society Bulletins 2.

Akerreta, s., Calvo, M.I., Cavero, R.Y., 2010. Ethnoveterinary knowledge in Navarra (Iberian peninsula). Journal of *Ethnopharmacology* 130, 369-378.

Amit, M., Cohen, I., Marcovics, A., Muklada, H., Glassr, T.A., Ungar, E.D., Landau, S.Y., 2013. Self-medication with tannin rich browse in goats infected with gastrointestinal nematodes. *Vet Parasitol* 198, 305-311.

Austin, P.J., Suchar, L.A., Robbins, C.T., Hagerman, A.E., 1989. Tannin binding proteins in saliva of deer and their absence in saliva of sheep and cattle. *Journal of Chemical Ecology* 15, 1335-1347.

Boulton, A., Ahuriri-Driscoll, A., Stewart, A., Hudson, M., Pirikahu, Tatauranga, G. Unpublished. *Rongoā Māori Survey study. In Supporting Traditional Rongoā Practice in Contemporary Health Care Settings* (HRC 11/439)

Brooker, S., Cambie, R., Cooper, R., 1987. *New Zealand Medicinal Plants, 2 Edition*. Reed Books, Auckland New Zealand, 268 p.

Brooker, S., Cambie, R., Cooper, R., 1989. Economic native plants of New Zealand. *Economic Botany* 43, 79-106.

Burritt, E.A., Provenza, F.D., 2000. Role of toxins in Intake of Varied Diets by Sheep. *Journal of Chemical Ecology* 26, 1991-2005.

Christie, A.H.C., 1964. A note on the chamois in New Zealand. *Proceedings of the New Zealand Ecological Society* 11, 32-36.

Clayton, D.H., Wolfe, N.D., 1993. The adaptive significance of self-medication. *Trends in Ecology & Evolution* 8, 60-63.

Disler, M., Ivemeyer, S., Hamburger, M., Vogl, C.R., Tesic, A., Klarer, F.m., B., Walkenhorst, M., 2014. Ethnoveterinary herbal remedies used by farmers in four north-eastern Swiss cantons ( St Gallen, Thurgau,Appenzell Innerrhoden and Apenzell Ausserrhofen). *Journal of Ethnobiology and Ethnomedicine* 10, 22 pages.

Dold, A.P., Cocks, M.L., 2001. Traditional veterinary medicine in the Alice district of the Eastern Cape Province,South Africa. *South African Journal of Science* 97, 375-379.

Durie, M.H., 1985. A Māori perspective of health. Social Science & *Medicine* 20, 483-486.

Engel, C., 2007. Zoopharmacognosy, In:  Wynn, S., Fougere, B. (Eds.) *Veterinary Herbal Medicine*. MOSBY Elsevier, Missouri, pp. 7-15.

Forsyth, D.M., Coomes, D.A., Nugent, G., Hall, G.M.J., 2002. Diet and diet preferences of introduced ungulates (Order: Artiodactyla) in New Zealand. *New Zeal J Zool* 29, 323 - 343.

Forsyth, D.M., Richardson, S.J., Menchenton, K., 2005. Foliar fibre predicts diet selection by invasive Red Deer *Cervus elaphus scoticus* in a temperate New Zealand forest. *Functional Ecology* 19, 495-504.

Fujii, Y. *Overview of research on Allelochemicals* (http://www.niaes.affrc.go.jp/marco/marco2009/english/W3-01_Fujii_Yoshiharu.pdf).

Gabalebatse, M., Ngwenya, B., Teketay, D., Kolawole, O.D., 2013. Ethno-veterinary practices amongst livestock farmers in Ngamiland district Botswana. *African Journal of Traditional Comlementary Medicine* 10, 490-502.

Gajendran, K., Karthickeyan, S.M.K., 2011. Indigenous technical knowledge in duck production in Tamil Nadu. *Indian Journal of Traditional Knowledge* 10, 307-310.

Githiori, J.B., Hoglund, J., Waller, P.J., 2005. Ethnoveterinary plant preparations as livestock dewormers: practices, popular beliefs, pitfalls and prospects for the future. *Animal Health Research Reviews* 6, 91-103.

Goraya, K., Iqbal, Z., Sajid, M.S., Muhammad, G., ul Ain, Q., Saleem, M., 2013. Diversity of flora used for cure of equine diseases in selected peri-urban areas of Punjab, Pakistan. *Journal of Ethnobiology and Ethnomedicine* 9, 19 pages.

Hart, B.L., 2005. The evolution of herbal medicine:behavioural perspectives. *Animal Behaviour* 70, 975-989.

Huffman, M., A., 2003. Animal self-medication and ethno-medicine: exploration and exploitation of the medicinal properties of plants. *The Proceedings of the Nutrition Society* 62, 371-381.

Huffman, M., Gotoh, S., Turner, L., Hamai, M., Yoshida, K., 1997. Seasonal trends in intestinal nematode infection and medicinal plant use among chimpanzees in the Mahale Mountains, Tanzania. *Primates* 38, 111-125.

Huffman, M., Seifu, M., 1989. Observations on the illness and consumption of a possibly medicinal plant, by a wild chimpanzee in the Mahale Mountains National Park, Tanzania. *Primates* 30, 51-63.

Hunt, F., 1866. *Twenty five years experience in New Zealand and the Chatham Islands: an Autobiography*. William Lyon, Wellington New Zealand, 64 p.

Husheer, S., Coomes, D., Robertson, A., 2003. Long-term influences of introduced deer on the composition and structure of New Zealand *Nothofagus* forests. *Forest Ecology and Management* 181, 99-117.

Hutton, J.B., 1996. Plant poisoning in New Zealand. *Surveillance* 23, 18-21.

Kidane, B., van der Maesen, L.G.J., van Andel, T., Asfaw, Z., 2014. Ethnoveterinary medicinal plants used by Maale and Ari ethnic communities in southern Ethiopia. Journal of *Ethnopharmacology* 153, 274-282.

Kimball, B.A., Nolte, D.A., 2004. Herbivore experience with plant defense compounds influences acquisition of new flavor aversions. *Applied Animal Behaviour Science* 91, 17-34.

Krief, S., Hladik, C.M., Haxaire, C., 2005. Ethnomedicinal and bioactive properties of plants ingested by wild chimpanzees in Uganda. *Journal of Ethnopharmacology* 101, 1-15.

Lans, C., Turner, N., Khan, T., Brauer, G., Boepple, W., 2007. Ethnoveterinary medicines used for ruminants in British Colombia Canada. *Journal of Ethnobiology and Ethnomedicine* 3, 22 pages.

Litherland, A.J., Deighton, D.L., Leathwick, D.M., 2008. An evaluation of anthelmintic properties, assessed using faecal nematode egg counts, of New Zealand native flax (Phormium tenax). *New Zeal Vet J* 56, 339-342.

Macdonald, C., 1974. *Medicines of the Māori .* William Collins New Zealand Ltd., Auckland New Zealand, 142 p.

Manteca, X., Villalba, J., Atwood, S., Provenza, F., 2008. Is dietary choice important to animal welfare? Journal of *Veterinary Behaviour* 2, 229-239.

Mark, G.T., Lyons, A.C., 2010. Māori healers' views on wellbeing: The importance of mind, body, spirit, family and land. *Social Science & Medicine* 70, 1756-1764.

Mathias, E. 2001. *Introducing ethnoveterinary medicine* (www.ethnovetweb.com, Etnoveterinary network), p. article.

Mathias, E., 2004. *Ethnoveterinary medicine: harnessing its potential.* Veterinary Bulletin 74, 27N-37N.

Mathias, E., 2007. Ethnoveterinary medicine in the era of evidence-based medicine: Mumbo-jumbo, or a valuable resource? *The Veterinary Journal* 173, 241-242.

McCorkle, C.M., 1986. An introduction to ethnoveterinary research and development. *Journal of Ethnobiology* 6, 129-149.

McGowan, R., 2009. *Rongoā Māori* . Robert McGowan, Tauranga New Zealand, 62 p.

Mitchell, R.J., Fordham, R.A., John, A., 1987. The annual diet of feral goats (Capra hircus L.) in lowland rimu-rata-kamahi forest on eastern Mount Taranaki (Mt Egmont). *New Zealand Journal of Zoology*, 14, 179-192.

Nabukenya, I., Rubaire-Akiiki, C., Olila, D., Ikwap, K., Hoglund, J., 2014. Ethnopharmacological practices by livestock farmers in Uganda: Survey experiences from Mpigi and Gulu districts. *Journal of Ethnobiology and Ethnomedicine* 10, 9.

Neil, J.F., 1889. *The New Zealand Family herb doctor: a book on the botanic eclectic system of medicine, containing the latest discoveries in medicine and surgery for the cure of disease.* Mills, Dick & Co., Printers and Lithographers, The Octagon., Dunedin.

Nugent, G., Challies, C.N., 1988. Diet and food preferences of white-tailed deer in north-eastern Stewart Island. *New Zealand Journal of Ecology* 11, 61-71.

Parton, K., Bruere, A.N., 2002. Plant poisoning of livestock in New Zealand. *New Zeal Vet J* 50, 22-27.

Peden, R., 2011. *Making sheep country Mt Peel Station and the transformation of the tussock lands*. Auckland University Press, Auckland New Zealand, 280 p.

Pieroni, A., Elena giusti, M., de Pasquale, C., Lenzarini, C., Censorii, E., Reyes Gonzales-tejero, M., Patrica Sanchez-rojas, C., M Ramiro-Gutierrez, J., Skoula, M., Johnson, C., Sarpaki, A., Della, A., Paraskeva-Hadijchambi, D., El-Jorhi, S., El-Demerdash, M., El-Zayat, M., Al-Shahaby, O., Houmani, Z., Scherazed, M., 2006. Circum-Mederterranean cultural heritage and medicinal plant uses in traditional animal healthcare: a field survey in eight selected areas within the RUBIA project. *Journal of Ethnobiology and Ethnomedicine* 2.

Piluzza, G., Virdis, S., Serralutzu, F., Bullitta, S., 2015. Uses of plants, animal and mineral substances in Mediterranean ethno-veterinary practices for the care of small ruminants. *Journal of Ethnopharmacology* 168, 87-99.

Provenza, F.D., 1995. Post ingestive feedback as an elementary determinat of food preference and intake in ruminants. *Journal of Range Management* 48, 2-17.

Provenza, F.D., 2008. What does it mean to be locally adapted and who cares anyway? *Journal of Animal Science* 86(E. Suppl.), :E271-E284.

Provenza, F.D., Burritt, E.A., Perevolotsky, A., Silanikove, N., 2000. Self regulation of intake of polyethylene glycol by sheep fed diets varying in tannin concentrations. *Journal of Animal Science* 78, 1206-1212.

Provenza, F.D., Villalba, J.J., 2010. The role of natural plant products in modulating the immune system: An adaptable approach for combating disease in grazing animals. *Small Ruminant Research* 89, 131-139.

Provenza, F.D., Villalba, J.J., Dziba, L.E., Atwood, S.B., Banner, R.E., 2003. Linking herbivore experience, varied diets, and plant biochemical diversity. *Small Ruminant Research* 49, 257-274.

Rahmann, G., Seip, H., 2007. Bioactive forage and phytotherapy to cure and control endo-parasite diseases in sheep and goat farming systems - a review of current scientific knowledge. *Landbauforschung Volkenrode* 57, 285-295.

Riley, M., 1994. *Māori Healing and Herbal New Zealand Ethnobotanical Source book, 3 Edition*. Viking Sevenseas N.Z.Ltd, Paraparaumu New Zealand, 528 p.

Rochfort, S., Parker, A.J., Dunshea, F.R., 2008. Plant bioactives for ruminant health and productivity. *Phytochemistry* 69, 299-322.

Rogosic, J., Saric, T., Pfister, J.A., Barina, M. 2012. Importance of plants with medicinal properties in herbivore diets. In

*Animal farming and Environmental interactions in the Mediterrranean region*, al, C.e., ed. (Wageningen Academic Publishers).

Sanga, U., Provenza, F.D., Villalba, J.J., 2011. Transmission of self-medicative behaviour from mother to offspring in sheep. *Animal Behaviour* 82, 219-227.

Santhanakrishnan, R., Hafeel, A., Hariramurthi, B.A., Unnikrishnan, P.M., 2008. Documentation and participatory rapid assessment of ethnoveterinary practices. *Indian Journal of Traditional Knowledge* 7, 360-364.

Schillhorn van Veen, T.W., 1997. Sense or nonsense? Traditional methods of animal parasitic disease control. *Vet Parasitol* 71, 177-194.

Shaw, R., Villalba, J., Provenza, F., 2006a. Resource Availability and Quality Influence Patterns of Diet Mixing by Sheep. *Journal of Chemical Ecology* 32, 1267-1278.

Shaw, R.A., Villalba, J.J., Provenza, F.D., 2006b. Influence of stock density and rate and temporal patterns of forage allocation on the diet mixing behaviour of sheep grazing sagebrush steppe. *Applied Animal Behaviour Science* 100, 207-218.

Smale, M.C., Dodd, M.B., Burns, B.R., Power, I.L., , 2008. Long-term impacts of grazing on indigenous forest remnants on North Island hill country, New Zealand. *New Zealand Journal of Ecology* 32, 57-66.

Stark, R., 1979. *Māori Herbal Remedies: Described, Identified, Illustrated*. Viking Sevenseas, Paraparaumu New Zealand, 116 p.

Swain, T., 1977. Secondary Compounds as Protective Agents. *Annual Review of Plant Physiology* 28, 479-501.

Tanentzap, A.J., Burrows, L.E., Lee, W.G., Nugent, G., Maxwell, J.M., Coomes, D.A., 2009. Landscape-level vegetation recovery from herbivory: progress after four decades of invasive red deer control. *Journal of Applied Ecology* 46, 1064-1072.

Thomson, C., Challies, C.N., 1988. Diet of feral pigs in the podocarp-tawa forests of the Urewera Ranges. *New Zealand Journal of Ecology* 11, 73-78,.

Timmins, S.M., 2002. Impact of cattle on conservation land licensed for grazing in South Westland, New Zealand. *New Zealand Journal of Ecology* 26, 107-120.

Villalba, J.J., Landau, S.Y., 2012. Host behaviour, environment and ability to self medicate. *Small Ruminant Research* 103, 50-59.

Villalba, J.J., Provenza, F.D., 2001. Preference for Polyethylene glycol by sheep fed a quebracho tannin diet. Journalof *Animal Science* 79, 2066-2074.

Villalba, J.J., Provenza, F.D., Goudong, 2004. Experience influences diet mixing by herbivores:implications for plant biochemical diversity. *Oikos* 107, 100-109.

Villalba, J.J., Provenza, F.D., Shaw, R., 2006. Sheep self-medicate when challenged with illness-inducing foods. *Animal Behaviour* 71, 1131-1139.

Villalba, J.J.P., F.D . , 2007. Self-medication and homeostatic behaviour in herbivores: learning about the benifits of nature's pharmacy. *Animal* 1, 1360-1370.

Wardle, D.A., Barker, G.M., Yeates, G.W., Bonner, K.I., Ghani, A., 2001. Introduced browsing mammals in New Zealand natural forests: above ground and below ground consequences. *Ecological Monographs* 71, 587-614.

Wardle, J., Hayward, J., Herbert, J., 1971. Influence of ungulates on the forests and scrublands of South Westland. *New Zealand Journal of Forestry Science* 3, 3-36.

Williams, M., 2001. Back to the Future-Pastoral land use in forest land-sustainability challenges for the 21st century. In: *International Grasslands Congress*, Brazil.

Williams, P.M.E., 2008. *Te Rongoā  Māori .* Penguin, North Shore New Zealand, 79 p.

Yadav, M.L., Rajput, D.S., 2015. Ethno-veterinary practices by tribals of Banswara district of Rajasthan. *Indian Journal of Natural Products and Resources* 6, 237-240.

Zotov, V.D., Elder, N.L., Beddie, A.D., Sainsbury, G.O.K., Hodgson, E.A., 1938. An outline of the vegetation and flora of the Tararua mountains. *Transactions of the Royal Society of New Zealand*, 259-324.

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# 9 Land and Riparian Management Perspectives

Emma Kearney

(Source Steve Reekie Flickr)

Land use and policies in New Zealand influence the health of waterways in a number of ways; the land rules the streams.

This chapter identifies what changes to the natural environment can impact the surrounding waterways, and what indicators (technical and traditional) are used to determine their health.

Riparian management techniques are discussed as a means of providing positive and limiting negative land use effects on waterways, with particular regard for indigenous plants for both their environmental benefits and traditional uses.

## 9.1 The State of New Zealand's Waterways

Waterways include rivers, wetlands, streams, estuaries and lakes.

Waterways are essential to ecosystem functioning; redistributing waters from their source and linking key ecological processes. Many key natural functions of the environment such as the replenishment of groundwater and the maintenance of freshwater ecosystems depend on healthy waterways. Waterways also play a key role in human recreation and commerce. The productivity and the recreational, cultural and spiritual values of freshwater have a key role in shaping New Zealand's identity.

*Figure 1: 1a, Healthy back country river NZ- recreational fishing left (source NZ Fly Fishing Guides) and 1b, Kayaking on Matakitaki river (Source Zak Shaw Rivers.org)*

The water quality of New Zealand waterways, in general, is declining due, particularly in association with land use practices (Collier et al., 1995, Allan et al., 1997).

*Figure 2: 2a, Rivers in urban (left) and 2b, rural contexts (right) (Source Te Ara)*

There is an intimate relationship between a waterway and its catchment area. Waterways have to cope with natural changes in the environment; erosion, nutrient variations, floods and droughts all alter the flow and health of waterways. Changes in waterways and the land use in the catchment can have chronic long lasting impacts on stream communities and structure.

Catchment development in all but the most unmodified parts of New Zealand has led to the deterioration in the quality of waterways, with waters in developed catchments almost always being of the poorest quality (Feeney et al., 2010). The clearing of indigenous vegetation in the conversion of lands to agriculture, farming, forestry and urbanisation has dramatically altered waterway catchment areas (Quinn et al., 1992; Collier et al., 1995; Allan et al., 1997; Elliot et al., 2004; Monaghan et al., 2007; Howard-Williams & Pickmere, 2010; Hughes et al., 2012). The development of dams, abstraction and diversion of water, and the introduction of exotic plants and animals to regions have all altered the habitat, character and hydrology of waters.

Deterioration of New Zealand's waterways continues where land use and farm practices intensify (MacLeod & Moller, 2006; Wilcock et al., 2006; Monaghan et al., 2007). Especially at risk to changes are shallow lakes and estuaries where sediments and nutrients tend to accumulate (Ryan, 1991; Feeney et al., 2010).

## 9.2 History of New Zealand's Land Use and Management

New Zealand has seen dramatic changes in land use with waves of colonisation and the development of natural resources.

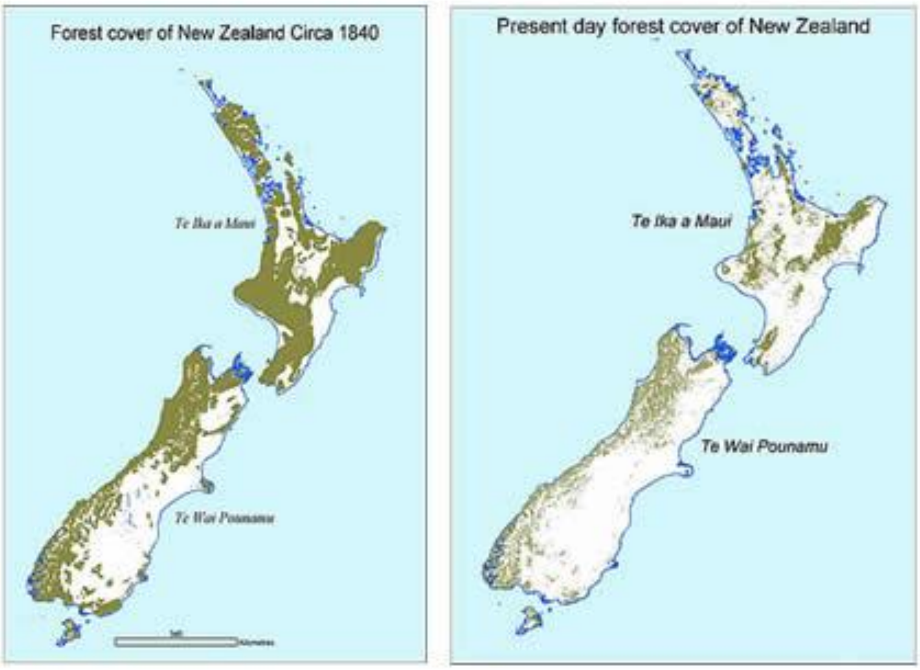


*Figure 3: Changes in New Zealand's forest cover from 1840 to today (Source Ministry for the Environment)*

Colonial 'extensification' increased the area of pastoral land once in woodland, wetland or tall indigenous herbaceous systems (tussock, etc.). The advent of fertilisers, chemicals, fencing and post-war mechanisation led to an 'intensification' of energy inputs into the system and a reduction in the ability of the system to assimilate hydrological effects. This largely technology-based intensification led to a further increase in clearance for pasture. Combined, both extensification and intensification of land is continuing to degrade our waterways, as is urban infrastructural development.

### 9.2.1 Key Events in New Zealand's Land Use & Management

A number of key events were particularly consequential to the health of New Zealand's waterways. These include:

- 1300AD: Polynesian settlers began clearing land for agriculture using fire;
- 1840 – 1870: The major wave of European settlement & development resulting in rapid and dramatic modification with large areas burnt for grazing and the introduction of sheep, and subsequently cattle;
- 1863: Land confiscation and Māori Land Wars leading to further European settlement and development;
- 1877: Land Act providing for forest reserves;
- 1882: Refrigeration and the development of the meat trade affecting development;
- 1884: River Boards Act established the management of New Zealand's waterways (focused on urban flood control);
- 1892: Department of Agriculture established to develop a dairy export industry and control potential agricultural issues; diseases, etc.;
- 1902: Mechanised milking
- 1920: Early intensification of farming with development of fertilisers and plant and animal breeding enhancements;
- 1920-1970: The amount of land in pasture stabilised, stocking units' increase 150%, meat and dairy production doubles, wool tripled, and land use diversified with the establishment of deer, goats, horticulture and agroforestry;
- 1930: Hill country erosion is recognised as an issue resulting from the removal of forests, leading to;
- 1941: Soil Conservation and Rivers Control Act for the conservation of soil resources, the prevention of damage by erosion and protection from flood damage;
- 1945: Agricultural Development Committee, with post-WWII technology leading to aerial topdressing in full swing by 1949;
- 1967: Water and Soil Conservation Act promotes: respect of natural water; the conservation, allocation, use & quality of natural water; soil conservation to reduce flood and erosion damage; the control of multiple uses of natural water; land drainage; to ensure that the needs of industry and community are met;
- 1978: Fertiliser subsidies to encourage use of fertiliser and lime;

- 1980 – 1990s: Later intensification phase with conversion of sheep & beef to dairy, with rapid expansion of use of nitrogenous fertilisers from the Motonui Urea plant.
- 1989: Local government reforms devolve responsibilities for water & soil regional councils, followed by;
- 1991: Resource Management Act to promote the sustainable management of natural and physical resources

## 9.3 Changes in the Environment

### 9.3.1 Floods & Droughts

The effects of floods and droughts are exacerbated by land use practices, particularly as such practices impact on forest cover, wetland loss, reduction in soil functions such as infiltration and water holding capacity, and changes in the morphology of waterways.

Figure 4: 4a Northland waterfall in flood following heavy rain (left) (Source: TVNZ), 4b, Purerua Peninsula, Bay of Islands following a summer drought in Northland (right)

Healthily permeable soils are able to infiltrate water in the majority of rainfall events. Occasional saturation leads to overland flow and surface flooding (Ministry for the Environment, 2001). Healthy landscapes also include the ability to buffer flows, detain water and allow dispersal within flood plains, within wetland complexes and within long meandering and morphologically complex river systems.

The effects of flooding includes in-stream habitat disturbance ranging from intermediate scale disturbance essential for healthy waterways (especially within braided systems) to detrimental, siltation, channel change and bank erosion.

The effect of drought is exacerbated by a reduction in soil function within a catchment landscape, particularly reduced soil water holding capacity (WHC) due to loss of soil quantity and organic matter (OM), and reduced infiltration due to compacted soils, hydrophobicity and reduction in soil quality and OM.

Drought is also exacerbated by high evapotranspiration associated with hot dry winds and the reduction in pasture and woodland covers whose presence retains a moist air layer and thereby reduces the osmotic gradient between moist soil and hot dry air.

Droughts reduce in-stream values through the reduction in permanent flows, and the frequency of flows above an ecological minimum.

The loss of water capture and water holding functions in landscapes effectively sets up a 'hard plate' landscape rather than a 'sponge' landscape. The effect is to exacerbate the extremes of both floods and droughts under whatever rainfall pattern.

### 9.3.2 Rural Land Use

*Figure 5: 5a, Rakaia River flood plain (left), 5b, Variable farm intensification in Canterbury (right) (source Te Ara)*

Farming practices and the intensification of farming has the ability to play a large role in long-term changes to New Zealand's waterways. Like urbanisation, changes in the environment tend to limit the ability for indigenous species to persist, with a range of factors leading to a loss in diversity of the aquatic community.

The qualitative factors that reduce waterway values are also the very factors that provide value to rural land users in the form of functioning natural 'capital' whose loss involves a reduction in the economic potential of land, and increased costs to replace these values with artificial inputs. Losses that are generally detrimental to waterways and beneficial to farming include: soil material; organic matter in the form of topsoil and faeces; fertility associated with both as well as urine and fertiliser runoff; and some land-based chemicals.

*Figure 6: a & b Cattle grazing riverbanks (left) (Source David Hallet, Fairfax NZ) (right) (Source Nelson Mail)*

### *9.3.2.1 Nutrient Effects*

Chemical and fertiliser applications can result in high loss either over or through the soil where soil nutrient loads are high or concentrated (cattle urine spots), soils are over-saturated, application practices are poor, and where homogenisation of land exacerbates loss of nutrients through the reduction in the effectiveness of such landscape structures as wetland swale systems and riparian structures.

Excess biological and nutrient enrichment – in particular nitrogen and phosphorous – leads to increased aquatic plant growth, oxygen depletion, pH variability, changes in plant species quality and food-chain effects, as well as direct biotoxicity.

### *9.3.2.2 Drainage & Morphological Change Effects*

Drainage and direct engineering works directly affect the hydrological function of landscapes and waterways. Land drainage, while making more land suitable for production with less frequency of flooding, also lowers water tables and increase surface runoff, and reduces the effectiveness of riparian areas. This can exacerbate drought and shift the flooding problem to somewhere else in the lower catchment.

Increasing drainage reduces retention of water in the landscape, which in turn exacerbates the run off of contaminants and the loss of soil, nutrients and chemicals from the land.

Morphological changes such as straightening streams and making their structure more homogeneous (from a meandering stream to a ditch, or from a diversely-edged pond to a simple structure) increases the potential for damaging higher-velocity floods and reduces indigenous and introduced biodiversity.

### *9.3.2.3 Irrigation Effects*

Irrigation is directly associated with the energy intensification of land, with more fertiliser and other chemicals applied as gross production increases. It is also associated with direct abstraction of water from waterways and groundwater resulting in reductions in flows below ecological minimums. Over-irrigation can result in saturation of soils, accelerating overland flow.

*Figure 7: Irrigation in the Mackenzie Country (Source Te Ara)*

### *9.3.2.4 Riparian and Wetland Vegetation Effects*

Riparian and wetland systems provide multiple ecological, social and economic functions. Their removal in pursuit of a single function of pasture production creates adverse long term effects to the farm agro-ecosystem.

Hydrological effects of reducing overland flow and increasing water holding reduces both drought and flood intensity. These structures are also key to reducing nutrient contaminants and sedimentation of waterways. Removing woodland and wetland vegetation associations has a direct impact on both terrestrial and aquatic biodiversity, as well as on a reduction of the shelter, shade, erosion-reduction and reduced evapotranspiration functions of riparian margins.

These areas can also provide management opportunities that are not realised by their removal or simplification. The edges of these systems provide opportunity for fodder systems, for health and productivity benefits. Their benefit to clean water troughed out from direct stock access has major benefits for stock health and productivity.


*Figure 8: Cattle drinking from trough in farmland in Akaroa*

#### *9.3.2.5 Increases in Stocking Rates*

Increases in the density of stock results in greater discharges from soil and animals (Nguyen et al., 1998; MacLeod & Moller, 2006). Where stocking rates are especially high, where soil is seasonally or locally wet, and particularly where soils have a high clay content, then soil compaction as a result of stock treading can be severe. Compaction from excessive grazing leads to reduced infiltration rates of soils, increased runoff and accelerated erosion (Agouridis et al., 2005). These effects in turn affect in-stream habitat and biological activity, as well as microbial contamination.

Stock access to waterways leads to bank erosion and the direct input of effluent and nutrients, as well as detrimental effects on edge vegetation and morphological diversity.

## 9.4 Policy Governing the Use of Freshwater Resources in New Zealand

### 9.4.1 Resource Management Act 1991

Land management and riparian management to provide for in-stream values and Mahinga Kai require a legislative framework. The Resource Management Act provides that framework for the sustainable management of New Zealand’s resources and values.

Sections of The RMA specifically relating to freshwater management require the recognition and provision for:

- Section 6a: the preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development;

- 6b: the protection of outstanding natural features and landscapes from inappropriate subdivision, use and development
- 6c: the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna;
- 6d: the maintenance and enhancement of public access to and along the coastal marine area, lakes, and rivers;
- 6e: the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga;
- 6f: the protection of historic heritage from inappropriate subdivision, use, and development, and;
- 6g: the protection of protected customary rights

Of particular relevance to the stewardship of waterways, councils are required to have particular regard to:

- Section 7a: Kaitiakitanga; the ethic of stewardship;
- 7b: The efficient use and development of natural and physical resources;
- 7c: The maintenance and enhancement of amenity values;
- 7d: Intrinsic values of ecosystems;
- 7f: Maintenance and enhancement of the quality of the environment;
- 7h: Protection of the habitat of trout and salmon;
- 7i: Effects of climate changes; and
- 7j: The benefits to be derived from the use and development of renewable energy.

Having regard for the principles of the Treaty of Waitangi when carrying out its functions is specifically references in Section 8 of the Act.  The responsibilities of individuals is detailed in Section 17: *Every person has a duty to avoid, remedy, or mitigate any adverse effect on the environment arising from an activity carried on by or on behalf of the person.*

### 9.4.2 The National Policy Statement for Freshwater Management (NPSFM)

The NPSFM for 2014 provides a National Objectives Framework to clarify the objectives and policies set by the government. Structured around the Resource Management Act (1991), the NPSFM aims to *"direct local government to manage water in an integrated and sustainable way, while providing for economic growth within set water quality and quantity limits."*

The NPSFM acknowledges that the quality, health, availability and economic value of New Zealand's freshwaters are under threat and at risk of being permanently altered by the environmental changes associated with climate change.

Changes in the NPSFM were developed to address a number of concerns:

- Deteriorating water quality;
- Cases of water demand outstripping supply;
- The need to balance interest and values in water where such values were competing
- The interests of iwi/Māori in fresh water
- The need for more robust information on quality, contamination and availability.

NPSFM water quality objectives are to safeguard:

A) Life supporting capacity, ecosystem processes and indigenous species including their associated ecosystems of fresh water and;

B) The health of people and communities.

The overall quality of freshwater within a region is maintained or improved while:

A) Protecting the significant values of outstanding freshwater bodies;

B) Protecting the significant values of wetlands; and

C) Improving the quality of fresh water in water bodies that have been degraded by human activities to the point of being over allocated

Amendments to the 2011 NPSFM came into effect in August 2014. These appointed bottom line standards for toxicity levels, providing councils with numerical and descriptive frameworks by which to set policies, plans and rules.

### 9.4.3 Regional Water Allocation

The government recognises that management of the resource must reflect the catchment-level variation between freshwater bodies and different demands on the resource across regions; this includes managing land use and development activities that affect fresh water.

The Ministry for the Environment policy for management of waterways requires regional councils to set limits on the allocation and management of freshwater quality and quantity within the region's confines.

As of 2006 there were close to 20,000 consented water takes in New Zealand – the majority of which were from ground waters (66%). 29% of consented take were for river water. 78% of total water used was allocated for irrigation.

The extraction of water for stock is non-consented as it falls within the criteria for permitted activity.

Canterbury (55%) and Otago (18%) are the largest allocators of regional water resources.  Water allocation has increased by about 50% since 1990.

### 9.4.4 Monitoring Programmes

Currently more than 800 sites throughout New Zealand's rivers and streams are monitored for dissolved oxygen, temperature, pH, clarity, turbidity, nutrients and bacteria by NIWA and regional councils (Ministry for the Environment, 2009). Waters are sampled at both reference sites – generally at the source of the water network where quality is typically good, as well as sites in lower catchments, likely to be influenced by human activities.

### 9.4.5 Polices to Mitigate Land Use Effects on Waterways

Under the RMA each regional council manages the discharges of wastes from the land to the water. This is a consented process to minimise the allowable toxins to water.

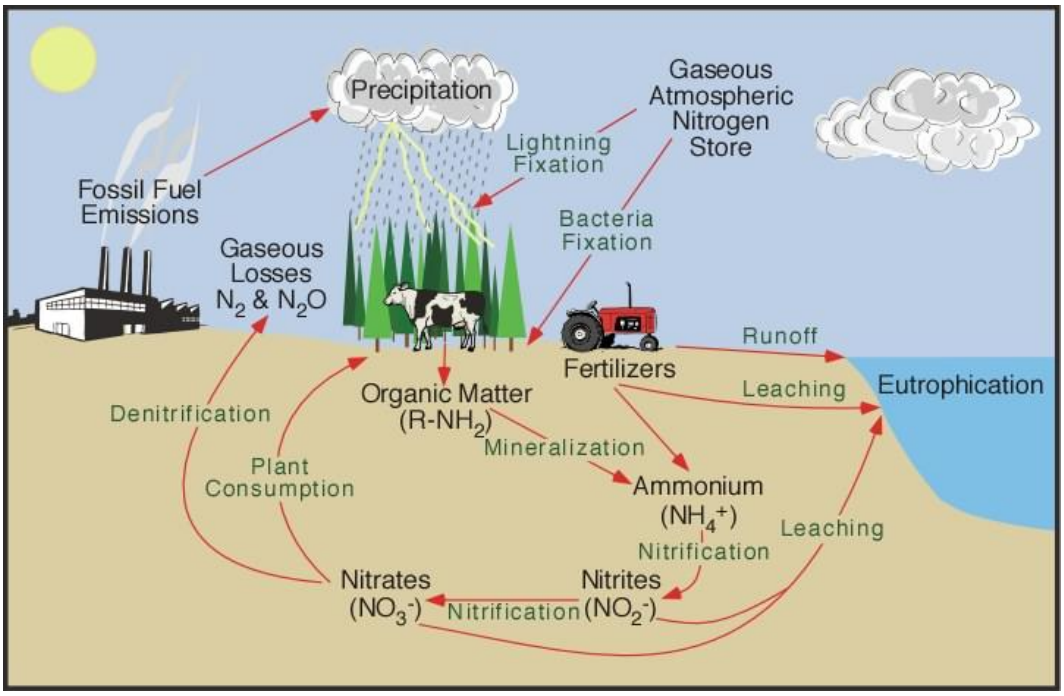


*Figure 9: Nitrogen Cycle (Source M. Pidwirny, Physical Geography)*

### *9.4.5.1 Point source discharges*

Historic issues with water management saw the direct discharge of waste and treated sewage from urban, rural and industrial properties into waterways. Referred to as point source discharges, these became considerably unpopular due to the measurable and visible direct negative impact they caused to the waterway. The stricter regulation of point source discharges in waterways has seen an improvement in quality.

### *9.4.5.2 Non-point source (diffuse) discharges*

Non-point source discharges play considerable role in reducing the health of the waterways. In intensive dairy farms, non-point source runoff to water may represent 90% of the problem, with the point source discharges from the dairy shed and effluent systems accounting for around 10%.

Nutrients, sediments and chemicals sourced from farming practices flow overland or through sub-surface pathways to waterways. Identification and regulation of diffuse discharges is more difficult than point source due to the diversity and irregularity in sources and soils and the inability to directly quantify the rates of discharge from each farm.

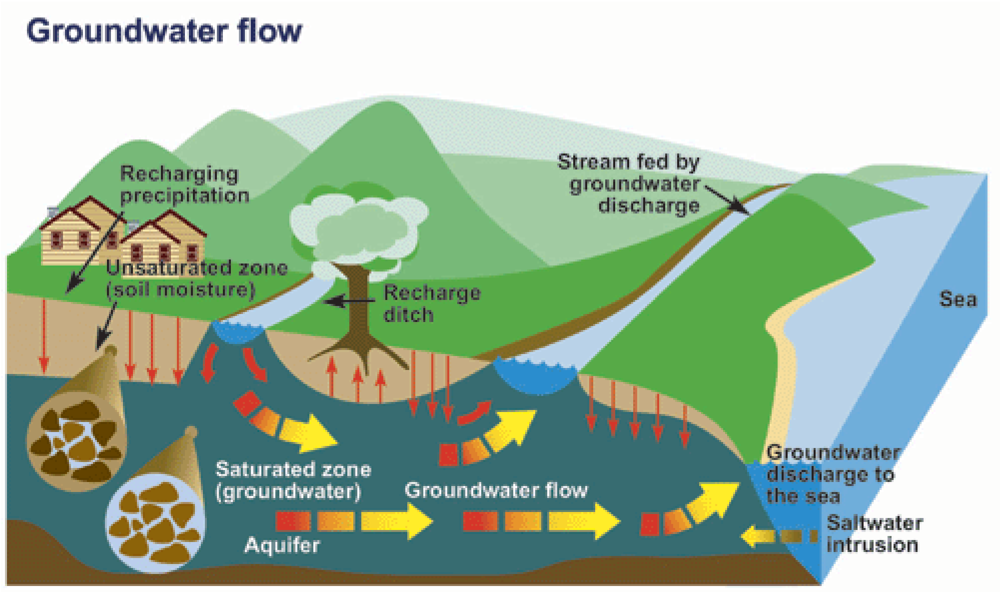


*Figure 10: Diagram of flow of water to groundwater (Source Environment Canada)*

The most effective means of mitigating and avoiding non-point discharges is through agroecological land use practices relating to nutrient management, soil health, pasture composition & management, stock management, and with the strategic use of mixed woodlands, tall herbaceous leys (including riparian) and wetlands.

The challenge is to motivate and empower land users to choose these site-specific options, the solution to which is social programmes.

### 9.4.6 Riparian Management

Riparian management relates to land use activities on the margins of waterways to effect a number of multiple functions including to improve the water quality of waterways. Riparian margins are important sites for putting agroecological principles into practice. Riparian zones play a key role in regulating the inputs from catchments to the waterways (see Riparian Management 10.6 for more details).

Regional councils have best practice guides for Riparian Management specific to each region and particular sites. Councils also work directly with land users and catchment communities toward multiple goals relating to waterways. An Integrated Catchment Management (ICM) process is one approach to the motivation and empowerment of individuals and catchment communities.

Riparian management is not statutory and the implementation of schemes is self-motivated. Since 2011, the National Policy Statement for Freshwater Management has allowed for any expenditure on plantings for the purposes of riparian planting that mitigate the detrimental effects of land use on a watercourse to be tax deductible. Limited funding is available from some councils through grants; however the majority of costs and maintenance of private riparian management scheme are to be met by the landowner.

### 9.4.7 Government Projects and Partnerships

The New Zealand Government funds programmes aimed at restoring waterways. There is a diversity of projects and partnerships in action. Projects currently in progress include:

- Lake Taupō water quality protection programme;
- Rotorua lakes restoration action programme;
- Dairying and Clean Streams Accord: targeting water quality through a government/industry partnership – since replaced by Sustainable Dairying Water Accord between all dairy companies.

#### *9.4.7.1 Funded projects for fresh water clean up*

Further projects are focused on:

- *Te Waihora/Lake Ellesmere*: The restoration and rejuvenation of mauri and the ecosystem health of Te Waihora;
- *Manawatu River*: To restore the health of the river by improving water quality, enhance habitats for indigenous fish species and involve the community in restoration activities;
- *Wairarapa Moana*: To restore the wetland habitat around the edge of Lake Wairarapa and Lake Onoke (collectively known as Wairarapa Moana);
- *Wainono Lagoon*: To improve water quality in Wainono Lagoon and minimise further contamination of the lagoon by reducing sediment inflows. The project will also help restore an important and culturally significant resource for mahinga kai (customary food and resource gathering);
- *Waituna Lagoon*: To restore the water quality of the Waituna Lagoon to a level sufficient to maintain a healthy seagrass dominated ecosystem;

- *Lake Brunner*: To improve the water quality of Lake Brunner through community environmental projects and farm environmental planning;
- *Lake Horowhenua*: To improve the health of the lake through reduction of sediment and nutrient input. The aim is to make the lake fit for recreational purposes, a better habitat for indigenous fish and improve public accessibility to the lake.

## 9.5 Māori & Traditional Ecological Values

Within traditional Māori beliefs, the health of a river considers all aspects of its functioning; the systems that it supports, and the river itself. Water is a source of mana and spiritual sustenance; intricately linked to and reflective of the well being of Tangata Whenua. Māori believe that the health of the waterway should be the priority and not an after thought in management.

Steeped in tradition, Māori identify their local river when explaining the location of their homelands. Māori dispute that the current management system appropriately prioritises the health and well-being or the mauri of the water and waterway. There is a belief throughout Māoridom that freshwater in their Rohe is over-allocated and that the current allocation of New Zealand's freshwater resources are unsustainable (Durette et al., 2009).

### 9.5.1 Traditional Māori Water Health Classification

The importance of water to Māori is evidenced in their classification of the health of water (adapted from www.telford.ac.nz):

- ***Waiora*** is water in its purest form. It is the source of life and well-being.
- ***Waimāori*** is water used for drinking and from where food is gathered. Contamination alters the spiritual health of the water and affects the mana of those who use it.
- ***Waikino*** are waters that are considered dangerous; referring to the nature of flow or the levels of contaminants; both which may cause health problems.
- ***Waimate*** are waters that have lost their purity through contamination, which can cause misfortune to all living things.

Traditionally, Māori would dedicate certain regions of a waterway for specific activities to maintain the integrity of the waiora. Cleaning, bathing and disposal of wastes would take place downstream of regions where water was collected for cooking or drinking to ensure that people were not exposed to waste waters.

Dependence of Māori on the waterways for essential life functions has changed with development, modernisation and changes in land use. Māori, however, still hold a deep spiritual connection with the waterway and many Māori communities still remain intricately connected to waterways associated with their history.

Māori beliefs identify the people of the land as the kaitiakitanga or protectors of their hearth. It is believed the health of people is directly associated with the land and waters they are surrounded by, as traditionally it was these natural aspects that supported daily functioning and provided food etc.

Industrialisation and the introduction and expansion of domestic animals and crops has led to some forms of toxicity that traditional monitoring is unable to detect. The principles and practices by which Māori judge the health of the system vary from those technical approaches used in resource management.

### 9.5.2 Māori Health Indicators

Prior to land development, kaumatua would judge the health of the system on its physical integrity. Signs of a healthy system would include the ability to safely drink the water, the presence of Ika (fish), and water flow.

*Figure 11: 11a, Banded Kokopu (left) and 11b, Inanga (right) indigenous freshwater fish sensitive to changes in natural environment conditions (Source DOC)*

Modern Māori indicators of health are based on the physical value of the environment. With the development in the ability to measure the physical bounds of waterway health, traditional techniques for determining the health of waterways have been enhanced.

Tipa & Tierney (2006) developed a list of indicators to be used to guide management regimes focused on assessing the health of waterways using traditional assessments of health.

*Table 1: Māori indicators of waterway health (Tipa & Tierney, 2006)*

| | |
|---|---|
| Macroinvertebrate communities | Clarity |
| Temperature | Riparian condition |
| Periphyton | Indigenous fish occurrence |
| Dissolved oxygen | Ammonia |
| Place names | Unpleasant odours |
| Greasiness of water | Presence of riffles/white water |
| Sound of winds in riparian vegetation | Sound of birds present |
| Sound of flood flows | Flow in river visible |
| Smell | Sediment on/not on the riverbed |
| Continuity of vegetation | Willow infestation |
| Unnatural growths | Changes to the river mouth |
| Foams, oils and other human pollution | The stomp test |
| Flood flows | Abundance and diversity of birdlife |
| Presence or absence of stock in the riparian margin and waterway | |
| Unnatural sedimentation in channels | |
| Loss of aquatic vegetation in the marine environment | |
| Changes to the extent of the tidal influence | |
| Presence or absence of activities in the headwaters | |

### 9.5.3 The Cultural Health Index

The Cultural Health Index for Streams and waterways (CHI) is a tool developed by Ngāi Tahu, and supported by the Ministry for the Environment, Te Rūnanga o Ngāi Tahu, and Ngāti Kahungunu. Its purpose is to facilitate the monitoring of waterways by Māori (Tipa & Tierney, 2006).

The CHI was developed by Ngāi Tahu to allow iwi/hapu to assess the cultural health of a catchment or stream in their region so that they are able to prioritise areas of stream management.

The CHI scores three aspects of the waterway:

1. ***Site status*** is used in determining whether the region is of significance to tangata whenua and identifies:
   a. whether site is significant to Tangata whenua;
   b. whether it will be significant to Tangata whenua in the future.
2. ***Mahinga kai*** assesses the value of the site in terms of its ability to support kai species:
   a. Whether there are kai species present and the productive capacity of the site;
   b. Comparison of structure of the site today and the mahinga kai sourced from the site in the past;
   c. Physical and legal access of tangata whenua to the resources;
   d. Whether tangata whenua will return to the site in the future as they did in the past.
3. ***Cultural Stream Health*** provides an indication of the health of the stream of river through the quantification of the following criteria, which are averaged to produce a final stream health score:
   a. Catchment land use;
   b. Riparian vegetation- indigenous or exotic?
   c. Use of the riparian margin;
   d. Riverbed condition/sediment;
   e. Channel modification;
   f. Flow and habitat variety;
   g. Water clarity;
   h. Water quality.

### 9.5.4 State of the Takiwā

State of the Takiwā is an *"environmental monitoring and reporting process that integrates Mātauranga Māori and western science and takes into account tangata whenua values"* (TRoNT 2001). It is an on-line tool designed to bring together information that can be accessed in a database. The State of the Takiwā's objective is to provide robust and defensible data that can be used to manage environmental resources in the Ngāi Tahu rohe (Pauling et al., 2007).

State of the Takiwā, utilises data developed from CHI and SHMAK assessments to record information on:

- Site and environmental conditions;
- Overall health state of the site;
- Levels of modification;
- Suitability for harvesting mahinga kai;
- Access issues in relation to site;
- Presence, abundance and diversity of taonga bird, plant and fish species as well as other culturally significant resources;
- Willingness to return to site for harvesting mahinga kai, and;
- CHI for specific monitoring of stream health at a site.

### 9.5.5 Current Tikanga Issues

A number of issues face Māori and traditional interests.

The future availability of water to support Māori and traditional interests remains uncertain. There is particular concern that the allocation of water for community and small businesses, and the integrity of those enterprises, is threatened by the ability of large industry players to better context for water rights (Durette et al., 2009).

The insecurity of future water supply and the quality of that water, favours a short-term focus on land management and the highest economic return. This shifts current management away from prioritising the health of the water and waterways. This shift to a short term and narrow money focus is strongly linked to the degradation of the long-term functions of our lands, water, community and, eventually, the economy that relies on social and environmental function.

There is currently a limited ability for iwi to collect mahinga kai, and the capacity of waterways to sustain future generations is an obvious concern.

Many large-scale projects such as dams and industrial practices (including industrial land use) can have negative consequences for local environments, without the promise of benefits to cultural or economic well-beings.

## 9.6 Riparian Management

Riparian zones are the lands alongside waterways (Parkyn & Davies-Colley, 2003). Riparian regions interact with the overland flow of water into waterways and are zones for water overflow during floods (Parkyn, 2004). Prior to the development of lands for farming, agriculture and forestry, water would flow through forests, swale systems, wetland complexes and natural riparian zones before entering waterways.

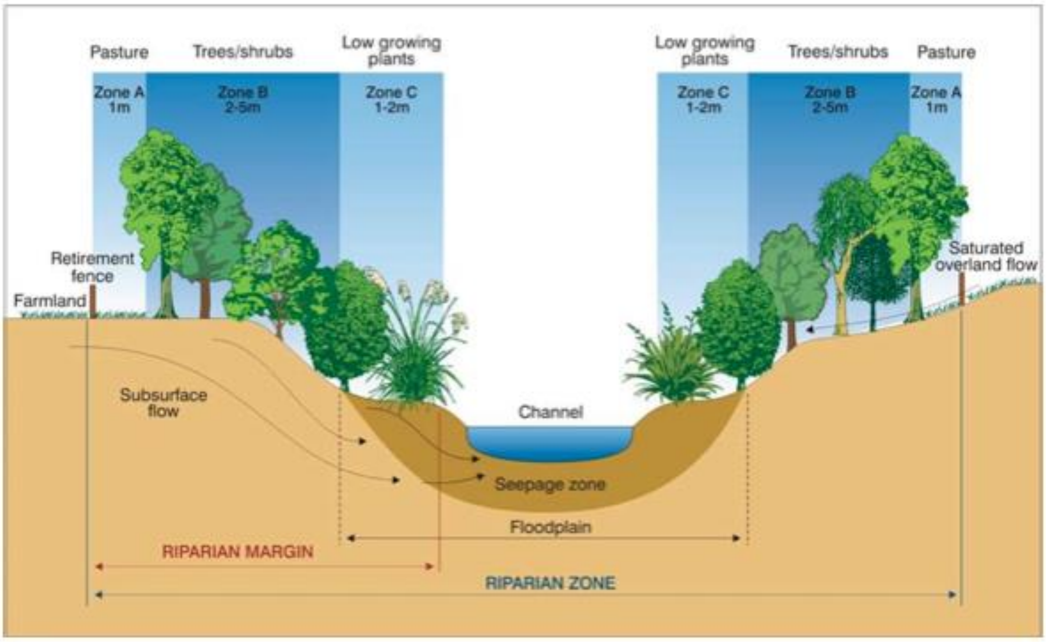


*Figure 12: Riparian Plant schematic showing plant uses along a waterway channel (Source TRC)*

Riparian zones utilise the natural physical and biological processes of plant life and soils to treat, breakdown or alter contaminants derived from the land; mitigating the effects land use has on waterways.

The role riparian zones play in maintaining aquatic health depends on geographic location, groundwater input, riparian width, adjacent soil quality and land use and the composition and density of plants within the zone. Riparian management is not a panacea approach to water quality. Other land use designs and practices – including nutrient management, improvement in the hydrological functioning of soils, residual and compositional pasture management, the restoration of within-paddock wetlands, and stock exclusion – are major contributing factors to in-stream values.

Variability in waterway health reflects wider catchment factors. Implementing the same management technique across streams or waterways can have variable outcomes due to the differences in catchments (Parkyn et al., 2003; Feeney et al., 2010)

Diversity in the environment and the demands of land use calls for diversification in management strategies (Belsky et al., 1999). Riparian management aims to buffer rivers and streams from the adverse impacts associated with land development.

### 9.6.1 The Ecological Function of Riparian Management

*Figure 13: 13a, Riparian plants along a stream (left) (Source Canterbury University) 13b, Riparian strip resembling indigenous bush in a farm context (right) (Source NIWA)*

The benefits of riparian zones when part of a whole-of-landscape approach, include (adapted from Quinn et al., 1992; Collier et al., 1995a).

- *Hydrological and morphological benefits*: buffering of bank erosion; buffering localised changes in morphology; buffering flood flows;
- *Water quality benefits*: maintaining water clarity, the denitrification and detoxification of flows; the reduced inputs of energy, soil, contaminants, pesticides and microbes;
- *Biological benefits*: Provide in-stream food supply and habitat; terrestrial habitat, dispersal corridors, reduction in fine sediment, the encouragement of beneficial biota, shading and temperature regulation, maintaining food webs,
- *Meteorological benefits*: contributing to microclimates;
- *Carbon balance benefits*;
- *Farm and social benefits*: riparian zones are important agroecological sites for improving shelter, shade, fodder

options, stock stress and health; economic options related to woodlands and tall herbaceous leys; habitat and nutrition for beneficial birds and insects; reducing the loss of high value soil, organic matter and nutrients from the land, improving stock control; and providing beauty, recreation and kai.

### 9.6.2 Riparian Vegetation

*Figure 14: Riparian plants straddling a Taranaki River (Source Taranaki Regional Council)*

The ability of plants to assist in assimilating runoff depends on the width, slope gradient, surface roughness and soil permeability of the riparian region. The longer water stays in a local land and water system, the longer biological and physiochemical processes have to act on the nutrients present.

Roots retain nutrients that are bound to sediments. Roots can enhance the uptake of nutrients by increasing their residence time in the system, allowing for uptake or breakdown of soluble nutrients by vegetation and microbes (Rutherford et al., 1997a; Bunn et al., 1999).

Riparian vegetation can maintain the integrity of stream banks and influence the morphology of streams. Grass and plant roots act to prevent stream erosion playing a role in maintaining stream channel width (Davies-Colley et al., 2000).

Vegetation offers habitat for insects and birds, especially where there is a year round nutrient function and the habitat diversity to foster all life stages of stream insects to recruitment to reproductive age so that populations are maintained and enhanced, as well as the habitat, shade and nutrition for in-stream fauna (Collier et al., 1995; Rutherford et al., 1997; Parkyn et al., 2003; Ballantine & Davies-Colley, 2010)

### 9.6.3 The Foci of Riparian Management

#### *9.6.3.1 Wetlands*

Wetlands occur where the water table sits at or near the land surface. Wetlands are key hydrological, ecological and agroecological systems that provide habitat for a diversity of wetland species, as well as providing multiple beneficial functions to the environment, culture and land use economic enterprises.

*Figure 15: Wetland with patches of harakeke (Phormium tenax) (Source Landcare Research)*

Wetlands play a key role in regulating runoff, removing nutrients, providing carbon to the environment and increasing habitat diversity. Slower flow rates allow sediments to settle (Collier et al., 1995; Revsbech et al., 2005; Seibert et al., 2009; Dosskey et al., 2010b) while wetland plants filter nutrients (Collier et al., 1995; Howard-Williams & Pickmere, 2010). These functions are why wetlands are referred to as "the kidneys of the landscape." Their effect is to create cleaner and more regulated water flows.

Wetlands reduce flood damage (Collier et al., 1995; Howard-Williams & Pickmere, 2010) by their ability to hold water as potential energy near the top of catchments, avoiding the release of destructive kinetic energy in lower catchment areas. They reduce stream bank erosion (Collier et al., 1995; Howard-Williams & Pickmere, 2010), provide habitat for fish breeding (Collier et al., 1995; Howard-Williams & Pickmere, 2010), and are often major sites for recharge of groundwater (Collier et al., 1995; Howard-Williams & Pickmere, 2010).

Wetlands support 47 species of rush (DOC), 72 species of Indigenous sedge, 8 of 27 indigenous fish species, as well as birdlife.

### *9.6.3.2 Agricultural Landscapes/grass*

Riparian areas can consist of a range of vegetation types; woodlands, wetlands and tall herbaceous leys.

*Figure 16: Fenced off pasture along a stream edge (Source Gretchen Robertson, Te Ara)*

Intensively grazed sites, especially where water access is limited, require fencing to avoid stock damage, and stock losses.

Tall herbaceous ley riparian zones encourage the deposition and filtration of nutrients and sediments prior to access to stream (Parkyn & Davies-Colley, 2003; Agouridis et al., 2005). When fenced, they prevent stock access to waterways, limiting sedimentation and direct addition of nutrients and wastes (Quinn et al., 1992; Parkyn et al., 2003; Parkyn, 2004).

Infiltration rates are greater under trees than under grass due to the greater porosity related to larger roots, and the build up of mulch under trees. However, lower infiltration rates are less of a problem where the wider paddock environment has healthy soils and pastures where water holding and infiltration functions are strong. In effect, paddocks with high ecological health have riparian functions extending far beyond the waterway margin.

Fencing of all waterways may neither be viable nor necessary in hill and high country areas where stock densities are low (Collier et al., 1995). Fenced ley areas will usually follow ecological succession to woody species, including indigenous, depending on what seed sources and specific site conditions.

### *9.6.3.3. Pasture Management and Streams: Rotational Use*

Waterway health can be enhanced by pasture management practices. Leaving higher residual grazing covers is one. This reduces risks of compaction, and the healthy plants that result tend to enhance soil organic matter, water infiltration and water holding capacity. This reduces overland runoff of water, which is particularly associated with erosion and the loss of soil, organic matter and nutrients.

Rotationally grazed paddocks have lower turbidity and faecal coliforms in contrast to continuously grazed streams (Sovell et al., 2000; Parkyn et al., 2003; Allan, 2004). The resting of pasture and waterways allows both to recover,

The practice of rotational grazing with high residual covers can be particularly effective where stocking densities are low or in back-country where fencing may not be viable (Nguyen et al., 1998). Grazing also increases the harvest of nutrients from the lower sites adjacent to waterways. This is a useful nutrient transfer function within a farm landscape. It is also the reason that some farmer harvest hay from within large fenced riparian areas.

Periodic harvest of riparian vegetation also enhances the rate of nutrient uptake by plants within riparian areas. Generally the greatest nutrient uptake occurs when vegetation is growing vigorously after harvest and before subsequent seeding maturity (Ericsson, 1994).

Rotating grazing with periodic resting may allow for an enhanced recovery of soil microbes (Dosskey et al., 2010).

### *9.6.3.4 Forestry Production Trees*

*Figure 17: Mature Pine trees alongside the Tongariro River (Source Tongariro River NZ)*

A common practice in forestry is to leave a strip of unharvested production trees beside the stream behind which the surrounding area is harvested (Boothroyd et al., 2004). This is more for reasons of practical realities than by design.

Forests have more extensive root systems than herbaceous plants, and produce more carbon at greater depths in the soil profile (Fennessy & Cronk, 1997; Parkyn et al., 2005; Dosskey et al., 2010b). Nitrogen removal in shallow groundwater is greater in forests compared to herbaceous plants owing to faster plant assimilation and slower mineralisation from litter in forest (Dosskey et al., 2010).

Trees are also great shade providers, reducing water temperatures, affecting primary productivity (Rutherford et al., 1997) as well as reducing periphyton growth and influencing the composition of the macroinvertebrate community (Quinn et al., 1992)

Woody plants are also better at stabilising high, steep banks from mass failure (Langer et al., 2008). The larger, stronger, and deeper roots of trees act as a reinforcing of the bank soil 'shear strength', effectively binding the surface soil to the bank.

Trees also contribute large woody debris (>100mm diameter) to waterways. This can be beneficial in situations where the amount of debris is the result of intermediate levels of disturbance. This creates morphological diversity, which generates more ecological niches, which provides more sites suited to a wider range of species diversity. The presence of large woody debris creates roughness that reduces stream erosive power (channeled kinetic energy is held in check). Woody debris creates debris dams whose effect is to increase dispersal of water onto upland valleys.

This localised upland flooding is often seen as detrimental, but is significant in retaining and depositing soil (Langer et al., 2008). The opposite effect – the gulching out of these most productive valley soils – is evidenced around the world where wetlands, woodlands and riparian areas have been cleared for pasture.

The holding of debris and spreading of waters in the uplands also provides mitigation for the effects of lower altitude floods by delaying its arrival, reducing its energy, debris content and peak intensity.

However, where forests are harvested: on too large a scale; without riparian buffers or the maintenance of majority forest cover within a catchment; as well as within steep areas where high intensity rainfall events occur; then the generation of large woody debris can be of a level where major infrastructural damage occurs and stream flows are impacted (Broadmeadow & Nisbet, 2004).

Forests with limited shrub or herbaceous understory can have high sediment movements (Sovell et al., 2000; Weigel et al., 2000; Broadmeadow & Nisbet, 2004). This is partly associated with the conversion of pastoral stream morphology (with steeper banks and narrower channels) converting over time to a forest stream morphology (with less steep banks and wider channels).

## 9.7 Realising the Positive and Avoiding the Negative

The effects of land use can be mitigated or avoided, and the potential of terrestrial and aquatic ecosystems better realised, by the agroecological redesign of our landscapes, including establishment of well-designed riparian systems in association with other land use practices and structures.

That potential relates not just to the hydrology and in-stream values of the waterways and the landscape within which they are embedded, but to benefits to land management and to cultural values such as recreation, social connection and mahinga kai.

The path is not to simplify our landscapes, but to create complexity in both structure and composition. Structural diversity among patches across the landscape – woodland, wetland, pastoral systems, riparian, mixed systems – and compositional diversity within each patch.

Riparian areas and wetlands, the connectors between land and water – whether constituted by herbaceous plants, woody plants or mixtures – can provide a canvass for creating such multiple benefits.

*Figure 18: Riparian plant schemes of varying width alongside a stream (Source TRC)*

## References


Agouridis, C. T., Workman, S. R., Warner, R. C., & Jennings, G. D. 2005. Livestock Grazing Management Impacts On Stream Water Quality: A Review. *Journal of the American Water Resources Association*, 591–606.

Allan, J. D. 2004. Landscapes And Riverscapes: The Influence of Land Use on Stream Ecosystems. *Annual Review of Ecology, Evolution and Systematics*, *35*, 257–284.

Allan, J. D., Erickson, D. L., & Fay, J. 1997. The influence of catchment land use on stream integrity across multiple spatial scales. *Freshwater Biology*, *37*, 149–161.

Ballantine, D.j. & Davies-Colley, R.J. 2010. Water Quality Trends at NRWQN Sites for the Period 1989-2007. National Institute of Water & Atmosphere Research, Hamilton New Zealand, p. 44.

Belsky, A.J. Matzke, A. & Uselman, S. 1999. Survey of Livestock Influences on Stream and Riparian Ecosystems in the Western United States. Journal of Soil and Water Conservation 54(1): 419-431.

Boothroyd, I. K. ., Quinn, J. M., Langer, E. . (Lisa), Costley, K. J., & Steward, G. 2004. Riparian buffers mitigate effects of pine plantation logging on New Zealand streams. *Forest Ecology and Management*, *194*(1-3), 199–213.

Broadmeadow, S., & Nisbet, T. R. 2004. The effects of riparian forest management on the freshwater environment: a literature review of best management practice. *Hydrology and Earth System Sciences*, *8*(3), 286–305.

Bunn, S. E., Davies, P. M., & Mosisch, T. D. 1999. Ecosystem measures of river health and their response to riparian and catchment degradation. *Freshwater Biology*, *41*(2), 333–345.

Collier, K. J., Cooper, A. B., Davies-Colley, R. J., Rutherford, J. C., Smith, C. M., & Williamson, R. B. 1995. *Managing Riparian Zones: A contribution to protecting New Zealand's rivers and streams Volume 1: Concepts* (Vol. 1). Wellington, New Zealand.

Dosskey, M.G., Vidon, P., Gurwick, N.P., Allan, C.J., Duval, T.P. & Lowrance, R. 2010. The Role of Riparian Vegetation in Protecting and Improving Chemical Water Quality In

Streams. *Journal of the American Water Resources Association* 1-18

Durette, M., Nesus, G., & Barcham, M. 2009. *Māori Perspectives on Water Allocation*.

Elliot, S., Jowett, Surren, A., & Richardson, J. 2004. *A guide for assessing effects of urbanisation on flow-related stream habitat*.

Ericsson, T. 1994. Nutrient dynamics and requirements of forest crops. *New Zealand Journal of Forestry Science*, *24*(2/3), 133–168.

Feeney, C., Allen, W., Lees, A., & Drury, M. 2010. *Integrated Catchment Management– a review of literature and practice*.

Fennessy, M. S., & Cronk, J. K. 1997. The effectiveness and restoration potential of riparian ecotones for the management of nonpoint source pollution, particularly nitrate. *Critical Reviews in Environmental Science and Technology*, *27*(4), 285–317.

Howard-Williams, C., & Pickmere, S. 2010. *Thirty years of stream protection*. Wellington.

Hughes, A. O., Quinn, J. M., & Mckergow, L. A. 2012. Land use influences on suspended sediment yields and event sediment dynamics within two headwater catchments, Waikato, New Zealand. *New Zealand Journal of Marine and Freshwater Research*, *46*(3), 315–333.

Langer, E. R. (Lisa), Steward, G. A., & Kimberley, M. O. 2008. Vegetation structure, composition and effect of pine plantation harvesting on riparian buffers in New Zealand. *Forest Ecology and Management*, *256*, 949–957.

MacLeod, C. J., & Moller, H. 2006. Intensification and diversification of New Zealand agriculture since 1960: An evaluation of current indicators of land use change. *Agriculture, Ecosystems & Environment*, *115*(1-4), 201–218.

Ministry for the Environment. 2001. *Managing Waterways on Farms A guide to sustainable water and riparian management in rural New Zealand*.

Ministry for the Environment. 2009. Our Rivers: Trends in water quality. *Ministry for the Environment*.

Monaghan, R. M., Wilcock, R. J., Smith, L. C., & Tikkisetty, B. 2007. Linkages between land management activities and water quality in an intensively farmed catchment in southern New Zealand. *Agriculture, Ecosystems and Environment*, *118*, 211–222.

Nguyen, M. L., Sheath, G. W., Smith, C. M., & Cooper, A. B. 1998. Impact of cattle treading on hill land: 2. Soil physical properties and contaminant runoff. *New Zealand Journal of Agricultural Research*, *41*, 279–290.

Parkyn, S. 2004. *Review of Riparian Buffer Zone Effectiveness*. Wellington, New Zealand.

Parkyn, S., & Davies-colley, R. 2003. Riparian management: how well are we doing? *Water & Atmosphere*, *11*(4), 18–20.

Parkyn, S. M., Davies-Colley, R. J., Cooper, a. B., & Stroud, M. J. 2005. Predictions of stream nutrient and sediment yield changes following restoration of forested riparian buffers. *Ecological Engineering*, *24*(5), 551–558.

Parkyn, S. M., Davies-Colley, R. J., Halliday, N. J., Costley, K. J., & Croker, G. F. 2003. Planted Riparian Buffer Zones in New Zealand: Do They Live Up to Expectations? *Restoration Ecology*, *11*(4), 436–447.

Pauling, C., Lenihan, T., Rupene, M., Tirikatene-Nash, N. & Couch, R. 2007. State of the Takiwā Te Ahauatanga o Te Ihutai Cultural Health Assessment of the Acvon-Heathcote Estuary

Quinn, J. M., Williamson, R. B., Smith, R. K., & Vickers, M. L. 1992. Effects of riparian grazing and channelisation on streams in Southland, New Zealand. 2. Benthic invertebrates. *New Zealand Journal of Marine and Freshwater Research*, *26*(2), 259–273.

Revsbech, N. P., Jacobsen, J. P., & Nielsen, L. P. 2005. Nitrogen transformations in microenvironments of river beds and riparian zones. *Ecological Engineering*, *24*(5), 447–455.

Rutherford, J. C., Davies-Colley, R. J., Quinn, J. M., Stroud, M. J., & Cooper, A. B. 1997. *Stream Shade: Towards a Restoration Strategy Stream Shade : Towards a Restoration Strategy Department of Conservation*.

Ryan, P. A. 1991. Environmental effects of sediment on New Zealand streams: A review. *New Zealand Journal of Marine and Freshwater Research*, *25(2)*, 207–221.

Seibert, J., Grabs, T., Köhler, S., Laudon, H., Winterdahl, M., & Bishop, K. 2009. Technical Note: Linking soil – and stream-water chemistry based on a riparian flow-concentration integration model. *Hydrology and Earth System Sciences Discussions*, *6*(4), 5603–5629.

Sovell, L. A., Vondracek, B., Frost, J. A., & Mumford, K. G. 2000. Impacts of Rotational Grazing and Riparian Buffers on Physicochemical and Biological Characteristics of Southeastern Minnesota, USA, Streams. *Environmental*, *26*(6), 629–641.

Tipa, G., & Teirney, L. 2006. *A Cultural Health Index for Streams and Waterways : A tool for nationwide use*.

Weigel, B. M., Lyons, J., Paine, L. K., Dodson, S. I., & Undersander, D. J. 2000. Using Stream Macroinvertebrates to Compare Riparian Land Use Practices on Cattle Farms in Southwestern Wisconsin. *Journal of Freshwater Ecology*, *15*(1), 93–106.

Wilcock, R. J., Monaghan, R. M., Quinn, J. M., Campbell, M., Thorrold, B. S., Duncan, M. J., … Betteridge, K. 2006. Land‐use impacts and water quality targets in the intensive dairying catchment of the Toenepi Stream, New Zealand. *New Zealand Journal of Marine and Freshwater Research*, *40*, 123–140.


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# 10 Microbial remediation assessments using native plants and risk assessment of drench chemicals using the algal toxicity test

Olivier Champeau
Jamie Ataria

*www.wooden-hoofblock.com/fr*

The New Zealand landscape has been dramatically modified by the increasing proportion of agricultural land, along with an acceleration in intensified farming methods, over the past 40 years (MacLeod & Moller, 2006). In 2011, permanent pastures represented 41.1% of land use in agricultural farming. Primary exports provided a net worth of 6.9% to New Zealand GDP in 2011. Between 1994 and 2013, the herd size (cows per farm) increased by 114% (Scarsbrook & Melland, 2015). The scale and intensity of dairy farming has for example, placed pressures on freshwater quality and water flows. The number of dairy cattle (including bobby calves) increased 30%, to about 6.7 million stock from 2002 to 2014 (Ministry for the Environment & Statistics New Zealand 2015). From 1997 to 2000, dairy farms produced an estimated annual average of approximately 960 million cubic metres of effluent water, of which an average of 59% went to surface water (Flemmer & Flemmer, 2008).

## 10.1 Contamination of Waterways

The contamination of waterways, with pathogens and veterinary products from livestock originating at point-sources or from diffuse farmyard and agricultural inputs, can pose a significant threat to aquatic ecosystems and potable water supplies. Pathogens in livestock waste are of most concern to public health, as the rumen and digestive tract of agricultural livestock are hosts to a rich diversity of microflora that can act as a reservoir for pathogenic micro-organisms (Rasmussen et al. 1993). Faecal microbes, like the intestinal bacteria *Escherichia coli*, are deposited onto pasturelands where they are adsorbed to the surface of soil particles and amongst the ground's porous structure (Oliver et al. 2005). During rainfall events, these microbes can be mobilised in surface runoff and carried into waterways. In addition to pathogens, chemicals such as veterinary products given to animals either orally or in pour-on formulations (Boxall et al., 2002; Boxall et al., 2003b; Kreuzig et al., 2005) can be conveyed into waterways. However, the risk to the aquatic community or to human health can often be substantially reduced by appropriate mitigation measures (Kreuger & Nilsson, 2001). Riparian buffer strips not only stop stock from accessing waterways, they also entrap microbes from the wastes of cattle and other animals carried in surface runoff down-slope towards water bodies (Collins et al., 2007).

## 10.2 Organic mulch as a filter for waterways

Organic mulch can be used in the pathway of run-off as a filter and mediator to complement buffer strips (Lu et al. 2007). Mānuka (*Leptospermum scoparium*), kānuka (*Kunzea ericoides*) and kawakawa (*Piper excelsum*) (Figure 1) were selected for this study to determine the efficacy of mulch to reduce the pathogen load in water spiked with dairy effluent (cow dung).

*Figure 1: The native plants used in experiments: 1a, mānuka, 1b, kānuka and 1c kawakawa (source unknown)*

Mānuka, kānuka and kawakawa are endemic to New Zealand. Mānuka and kānuka leaves contain oils that have well-characterised antiseptic and antimicrobial properties with unique pathways of action and have broad spectrum action (Porter & Wilkins, 1999; Maddocks-Jennings et al., 2005). Of most interest are β-triketones that are believed to confer significant antimicrobial properties. Further research has demonstrated that there are significant geographical variations affecting the composition of these oils (Maddocks-Jennings et al., 2005). Mānuka and kānuka oils from plants from different sites can differ widely in composition and have been be separated into different groups (Figure 2) by the presence and levels of distinctive components (Perry et al., 1997b; Perry et al., 1997a; Porter & Wilkins, 1999; Douglas et al., 2004). Māori have long used Kawakawa for treating many health problems and injuries (Brooker et al., 1998).

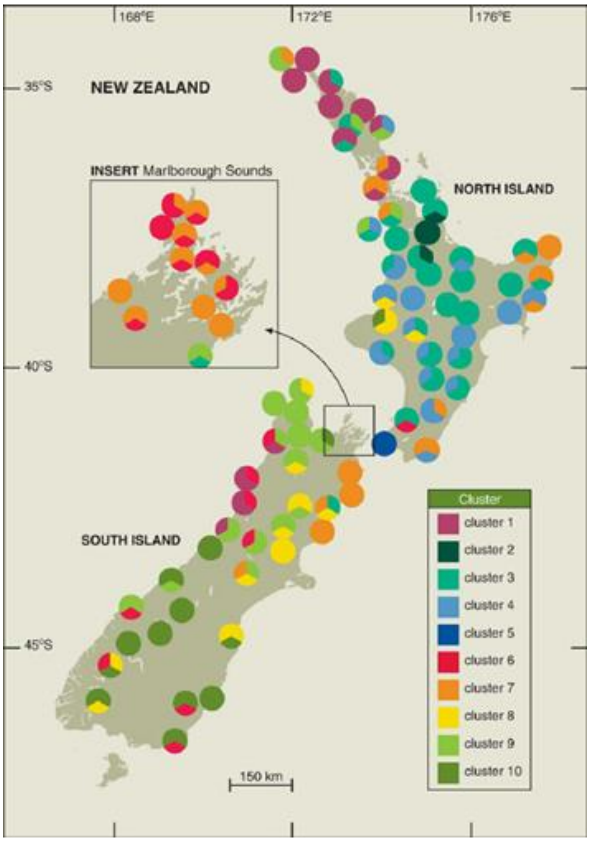



*Figure 2: Groups (clusters) of mānuka depending on their essential oil composition (Douglas et al. 2004)*

Trials were carried out in the laboratory and on site to determine whether mulch derived from these plant materials could be used to construct permeable barriers, specifically to mitigate pasture runoff containing microbial contaminant plumes. The on-site studies were carried out for two Māori-owned farms; Te Kaio farm, Banks Peninsula, South Island and Taiporutu farm, Mahia Peninsula, North Island. The two field sites provide geographical variation for soil type, temperature and rainfall. The impacts of veterinary products (drenches) were assessed using green microalgae as surrogate species for the freshwater aquatic flora.

## 10.3 Laboratory experiments – Plant Material

### 10.3.1 Microbial remediation

#### *10.3.1.1 Plant extracts*

Plant extracts of distal leafy (branches and leaves) material collected from Delaware Bay, Nelson (41°10’48”S, 173°25’54”E) were made by blending the plant material with deionised water at 1:4 ratio. Water was chosen as a solvent to more closely represent conditions present in soil when herbage decomposes

(Prosser et al. 2014). The extract was diluted in deionised water: 50 µL of extract was serially diluted to 200 µL in one well of a 96-well microtitre plate to obtain final extract concentrations of 25%; 12.5%; 6.25%; 3.13%; 1.56%; 0.78%; 0.39%; 0.20%; 0.10%; 0.05%; 0.02% and 0.01%.

#### *10.3.1.2 Antibacterial Activity*

The antibacterial activity of the mānuka extract was tested using an established spectrophotometric bioassay based on a technique used to assess microbial sensitivity to mānuka honey (Patton et al. 2006).

The intestinal bacteria *Escherichia coli* 916 (New Zealand Reference Culture Collection 916, American Type Culture Collection 25922) was used to test the antibacterial activity. *E coli* were grown in a LB broth at 30°C for 24 hours in the presence of one of the 12 extract concentrations. The optical density (595 nm) of each well was read hourly over 24 hours to calculate the bacterial growth curve.

The data were normalised by subtracting the optical density (OD) value at the beginning of the experiment from all subsequent values. Growth curves were then obtained by averaging the replicate wells at each time point and subtracting the respective extract control wells. This was to account for any absorbance caused by the presence of extracts which emitted colour at the same wavelength. Extinction curves were obtained by plotting the total growth at the endpoint of the assay, calculated as a percentage of control (Patton et al. 2006), against the concentration of mānuka extract in the well.

#### *10.3.1.3 Mulch*

The on-site experiments using mulch were designed to determine the bactericidal potential of native plant material, by assessing the reduction of *E.coli* numbers in cow effluent passing through a native plant mulch. Three plant mulches, mānuka, kānuka and kawakawa; fresh (within a week) or aged (three months after mulching) were tested with cow effluent.

Cow dung was collected fresh and a volume of about 500 mL was diluted in 5 L of distilled water. The mix was then filtered with a 20 µm size mesh to remove bulk particles and stirred for three days at 30°C to increase the number of bacteria to mimic an effluent.

The distal leafy branches of mānuka and kānuka, collected from the Marlborough Sounds (41°07′11″S, 173°44′43″S), and kawakawa from Nelson (41 16 22″S, 173°17′ 48″E), were mulched.

A total of 30 g of mulched material and soil (from Te Kaio Farm) were put in 2.5 L food grade plastic bottles (polyethylene terephthalate–PET). 100 mL of the prepared effluent were poured on top of the mulch. Whatman Filter paper #1 was fitted into the lid to allow only the liquid phase to go through (Figure 3). Taps for draining the percolate were inserted into the bottle tops and the whole assembly inverted and placed into pre-drilled holes in a sheet of ply board. Two controls with only soil ("Soil") or with no soil and no mulched material ("Effluent") were also tested. Each treatment was run in quadruplicate (n=4). The experiments were carried out at 18°C.

The aged plant material was used for a pour-though experiment to mimic a storm event, with the effluent poured onto each treatment and collected immediately. Percolates from other treatments were collected after three days.

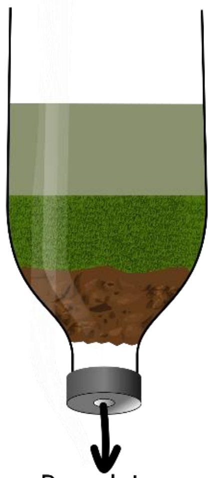



*Figure 3: Laboratory lysimeter system and setup with soil, mulched material and effluent (O. Champeau)*

Effluent collected at the beginning of the experiment and the percolates were sampled in sterile containers and immediately sent to the Cawthron microbiology laboratory for determination of *E.coli* number (using the Colilert ® method (ISO 2012)). Colilert® is a commercially available enzyme-substrate liquid-broth medium (IDEXX Laboratories, Inc., Westbrook, Maine) that allows the detection of total *E. coli* by giving the most-probable number (MPN). The MPN method is facilitated by use of the Quanti-Tray®, a specially designed incubation tray.

### *10.3.1.5 Results*

The growth of bacteria was reduced by the mānuka (distal branch) extract (0.02% concentration) for the 20 first hours (Figure 4). Extracts with concentrations from 0.02% and upwards had a similar effect on bacterial growth, which differed from the 0.01% concentration extract. After 14h, where the growth peaked for the 0.01% concentration extract, the effective concentration inhibiting the growth by 50% (IC50) with its related 95% confidence interval was estimated at 0.5 (0.002–0.288)%.

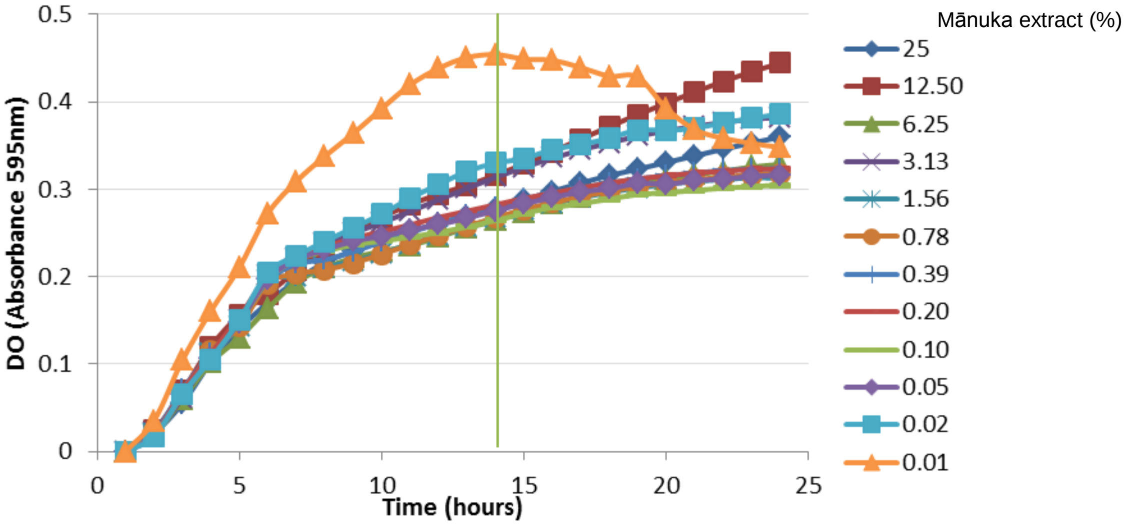



*Figure 4: Escherichia coli growth in contact with different concentrations (%) of mānuka extracts*

The initial number of *E.coli* in the plant material mulch was assessed by pouring in distilled water and immediately analysing the percolate. At the beginning of the experiment *E.coli* numbers in all treatments were below the lower limit of detection (

Table 1). The cow effluent was then applied. Percolates were recovered within one hour and immediately analysed. No significant decrease in number of *E.coli* was observed (Figure 5). The percolates from the same cow effluent, left for three days in contact with the aged mulch, showed a higher density of *E.coli* in the treatments, at the upper limit of detection (2×108 MPN/100 mL) (Figure 6). The control with effluent only had a similar number of *E.coli* after three days compared to the beginning of the experiment.

*Table 1: Number of E.coli in distilled water percolate poured through mulch of aged material prior to the addition of effluent*

| | **Number of *E.coli* (MPN/100mL)** |
|---|---|
| **Mānuka** | < 10 |
| **Kawakawa** | < 10 |
| **Soil** | < 10 |
| **Kānuka** | < 10 |
| **Distilled water** | < 10 |

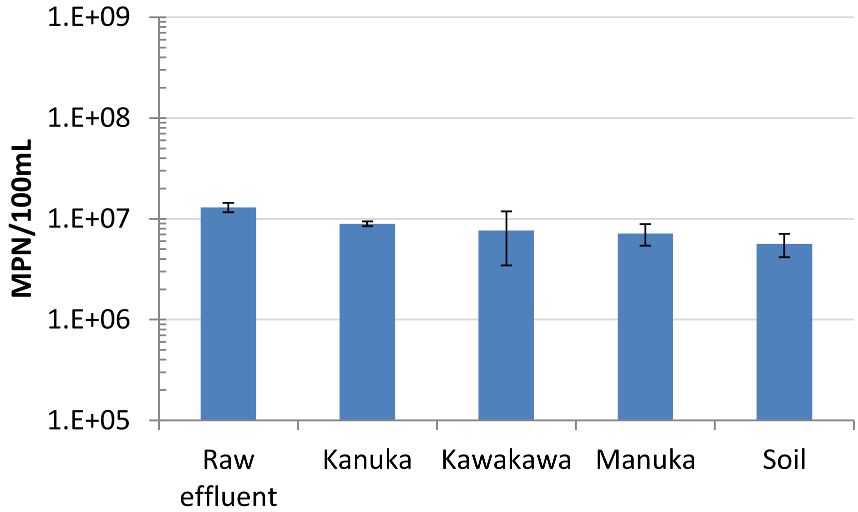



*Figure 5: Number of E.coli (MPN/100 mL) in effluent percolates from a pour through aged mulch*

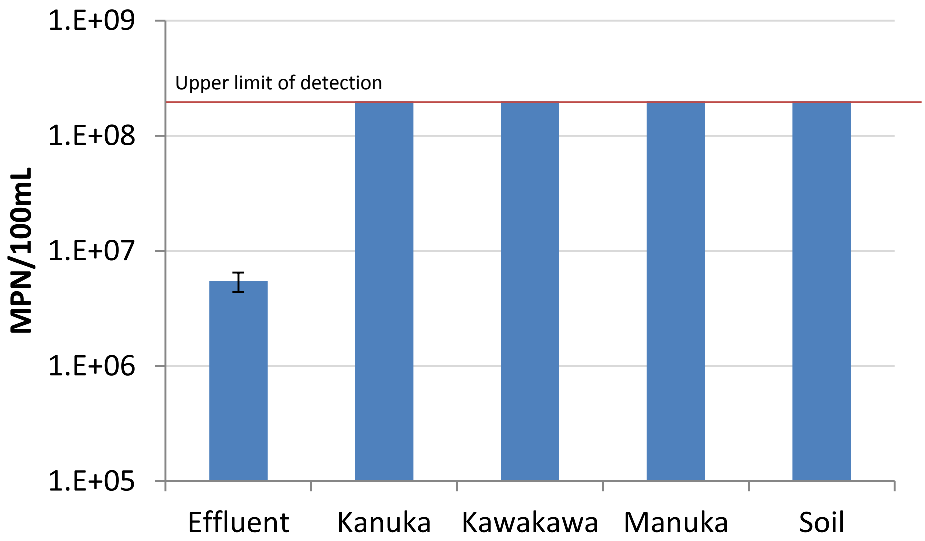



*Figure 6: Number of E.coli (MPN/100 mL) in effluent percolates after a 3 day contact with aged mulch*

### 10.3.2 Fresh mulch

Distilled water was poured through the fresh mulch and percolates immediately collected to determine the level of bacteria naturally occurring in the tested material (Table 2). Levels of *E.coli* were low except in the treatment with kawakawa (3100 MPN/100 mL). This high level may be due to the area where it was collected – a dusty tourist walkway where animals were also present.

After three days in contact with the mulch (Figure 7), the level of bacteria significantly increased in the treatments with mulched kānuka and mānuka, reaching the upper limit of detection (2×108 MPN/100 mL). There was no significant difference in the number of *E.coli* between the two controls (effluent and soil only) and the treatment with the mulch of kawakawa.

*Table 2   Number of E.coli in distilled water percolate poured through mulch of fresh material prior to the addition of effluent.*

| | **Number of *E.coli* (MPN/100 mL)** |
|---|---|
| **Mānuka** | 840 |
| **Kawakawa** | 3,100 |
| **Kānuka** | 100 |
| **Distilled water** | < 10 |

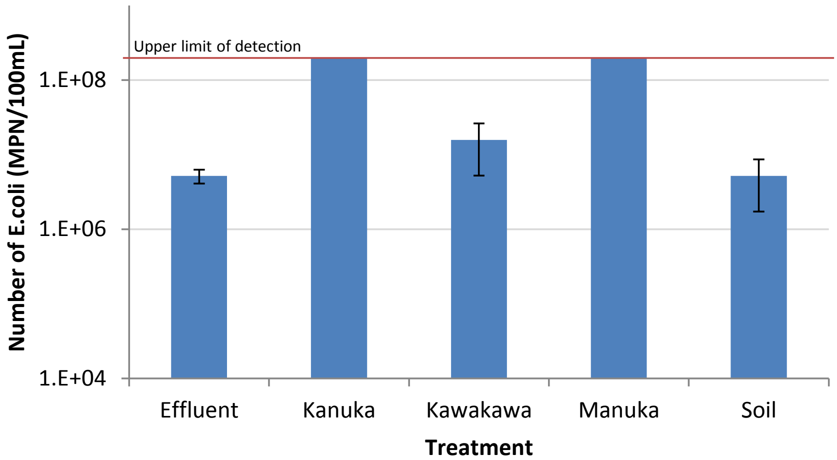



*Figure 7:   Number of E.coli (MPN/100 mL) in effluent percolates after a 3 days contact with mulch of freshly collected material.*

### 10.3.3 Discussion

Oil extracted from mānuka has been found to have antibacterial and antifungal activities on Gram-positive bacteria and dermatophytes (Christoph et al. 2000; Douglas et al. 2001). Recently, an extract from leaves of trees grown in a nursery demonstrated antimicrobial activity on Gram-negative bacteria (*E.coli*) (Prosser et al. 2014).

In this study, the extracts from mānuka distal branches and leaves exhibited bactericidal effects at concentrations as low as 0.02%. However, in the laboratory experiments, the mulched plant materials used had a stimulating effect on the bacterial growth. For the aged mulch, the compounds having an antimicrobial property may have degraded before the experiment was carried out. Any bactericidal effect from the compounds in the leaves may either remain trapped in the cells or be small in relation to the high number of bacteria in the applied effluent and the improved growth conditions. This may be the result of mulched material providing nutrients, or by increasing the surface area for bacterial growth. Furthermore, the mulch that included woody plant material may have diluted the bactericidal properties if they are only present in the leaves. Mulch may not be an appropriate management tool to avoid bacterial contamination of waterways.

## 10.4 Lab Experiments: Drenches and Active Ingredients

Anthelmintics are administered as 'drenches' to farm animals to rid them of internal parasites. In some cases not all of the active components of drenches are completely metabolised by the treated animals, or they are metabolised at different rates (Beynon, 2012). Therefore, unmetabolised parent compounds are excreted directly or indirectly into the environment along with the metabolites (Boxall et al., 2002; Boxall et al., 2003b; Kreuzig et al., 2005) and inevitably are carried by surface runoff and via groundwater into waterways.

Algae are ubiquitous in aquatic ecosystems and serve as food for aquatic animals. Because of their ecological importance and sensitivity too many substances, especially herbicides and metals, algae are often used in toxicity testing as surrogate freshwater test species for aquatic plant and fish communities. Based on existing toxicity studies, algal growth inhibition correlates well with fish lethality (Carlsson et al., 2013).

Algae can also be used to assess the effect of chemicals over several generations (Staveley & Smrchek 2005). The freshwater and marine green microalgae *Pseudokirchneriella subcapitata* and *Dunaliella tertiolecta* were used here as standard species for the toxicity assessment of drenches and their active ingredients. A marine and a freshwater test species were considered appropriate in this study, given the coastal location of the farms that were involved in this research.

Five drench samples: Exodus®, Matrix® (Merial), Combination Sheep® (Seneca Holding Ltd), Scanda® and Systamex ®(Coopers), were collected from Te Kaio farm and three of their active ingredients (albendazole, ivermectin and levamisole) were tested for their potential impact on algal growth.

Albendazole has a broad spectrum of gastrointestinal anthelminthic activity and is used widely in livestock (Martin 1985). Given orally, albendazole is partially metabolised in the gut or in the body of animals, the remainder of the absorbed drug is excreted unchanged in faeces and urine. The main bioactive metabolite, albendazole-sulphoxide, an effective anthelmintic, is also excreted to the environment (Daniel-Mwambete et al. 2004).

Ivermectin is a broad-spectrum antiparasitic drug that was introduced for the control of ectoparasites and endoparasites of sheep and cattle. The main entry into the environment is through direct input from pasture animals and through the application of manure to agricultural land. The parasiticide undergoes moderate metabolism but a significant portion of the parent compound (about 45%) is excreted, mainly in faeces, depending on the treated animal and the route of administration (Halley et al. 1989; Herd et al. 1996).

Levamisole is an anthelmintic belonging to a class of synthetic imidazothiazole derivatives. Levamisole was found in surface waters in higher concentrations (up to 39.43 ng/L) and frequencies (54.5% of sites) than nine other anthelmintics tested in a Spanish river (Zrnčić et al. 2014).

### 10.4.1 Methods

Stock cultures of the freshwater *Pseudokirchneriella subcapitata* and the marine *Dunaliella tertiolecta* green microalgae were grown in OECD standard medium and J/H1 medium at 25°C and 20°C respectively (ASTM 2004), under constant cool white light (approximately 50 and 200 μmol photons m-2.s-1, respectively) and constant shaking. Sterile transfers ensured all algae used were at optimal growth phase.

Microalgae standard 96-hour static toxicity tests (ASTM 2004) were used to establish the toxicity of the test chemicals. Four replicates of each concentration of each chemical were tested. The test conditions are summarised in Table 3. Each drench formulation (Table 4) was dissolved in sterile double-distilled water at the concentration of 0.1, 0.32, 1, 3.2, 10, 32, 100, 320 and 1000 mg/L.

*Table 3: Summary of the test conditions for the two green microalgae bioassay.*

| Test organism | ***Pseudokirchneriella subcapitata*** | ***Dunaliella tertiolecta*** |
|---|---|---|
| **Source** | CSIRO CS-327 | CSIRO CS-175 |
| **Growth medium** | ASTM E1218-04 | |
| **Test type** | Static | |
| **Temperature** | 24 ± 2°C | 20 ± 2°C |
| **Salinity** | - | 33 ± 1 PSU |
| **Light intensity** | 50 µmol/m2/sec | 200 µmol/m2/sec |
| **Photoperiod** | Continuous | |
| **Test chamber** | 96-wells round-bottom microplate | |
| **Dilution water** | Type I water12 | Artificial seawater |
| **Test solution volume** | 190 µL per well | 200 µL per well |
| **Age of test organism** | 5 d old in exponential growth phase | |
| **No. test organisms / test chamber** | 7.1 ×103 ± 3.1×103 cells/mL | 11 ×103 ± 1.8×103 cells/mL |
| **No. replicate / sample** | n = 5 for samples and n = 10 for controls | |
| **Test chamber aeration** | None | |
| **Observation** | Algal cell concentration after 96-h | |
| **Endpoint** | Growth inhibition (IC50) (cell count) | |
| **Test acceptability criteria (in controls)** | Growth > 16 fold, Coefficient of variation < 20% | |
| **Reference toxicant sensitivity IC50-96h (95% CI) (mg Cu2+/L)** | 0.038 (0.028–0.052) | 0.178 (0.154–0.204 ) |

[12] ASTM 2006. D1193-06 (2011) - Standard specification for reagent water. West Conshohocken, PA, ASTM International. Pp. 6.

*Table 4: Composition of the test drenches. (Se: selenium, Co: cobalt, Cu: copper, Zn: zinc, I: iodine).*

| Drench | Application on animals | Active ingredients | Density (g/mL) |
|---|---|---|---|
| **Exodus** | oral | moxidectin (1 g/L), Se (0.5 g/L) | 1.0144 |
| **Matrix** | oral | ivermectin (1 g/L), levamisole HCl (40 g/L), oxfendazole (22.7 g/L), praziquantel (18.8 g/L), Se (0.5 g/L), Co (2.2 g/L) | 0.8507 |
| **Scanda** | oral | oxfendazole (45.3 g/L), levamisole HCl (80 g/L) | 0.9937 |
| **Combination** | oral | albendazole (25 g/L), levamisole HCl (37.5 g/L), praziquantel (18.8 g/L), Se (0.5 g/L), Co (0.2 g/L), Cu (2 g/L), Zn (0.6 g/L), I (1 g/L) | 0.8543 |
| **Systamex** | pour-on | oxfendazole (90.6 g/L) | 1.0279 |

The marine algae *Dunaliella tertiolecta* was used to test drench active ingredients after a decrease in sensitivity over time was observed in the culture of the freshwater algae *P.subcapitata,* preventing comparison between assays. Three selected active ingredients (albendazole, ivermectin and levamisole) found in drench were tested alone for their toxicity toward algae growth.

Stock solutions of albendazole (ALB) and ivermectin (IV) were prepared in dimethyl sulfoxide (DMSO). Levamisole hydrochloride (LV) did not require a solvent so was added directly to working media. From each of these stock solutions, nine dilutions of each chemical (0.1, 0.32, 1, 3.2, 10, 32, 100, 316 and 1000 mg/L) were made in the working media.

Following 96 hours of incubation, the samples were fixed using Lugols iodine and stored in the dark before sample enumeration. To count the cells, the MultiSizer4 Coulter Counter® particle counter was used with the measuring threshold 4.5-10 µm.

ANOVA (STATISTICA 12 software (StatSoft, Tulsa, USA)) was used to assess significant treatment effects. When effect of treatment was significant ($P < 0.05$), a Dunnett test was carried out to detect significant differences with the control. When detected, dose response relationships were analysed using R software (R Core Team 2014). Data were fitted to a Weibull model and the median inhibitory concentration (IC50) values calculated for treatments that demonstrated a significant dose-response relationship using the drc package (Ritz & Streibig 2005).

### 10.4.2 Results

All five drenches reduced algal growth (Figure 8).

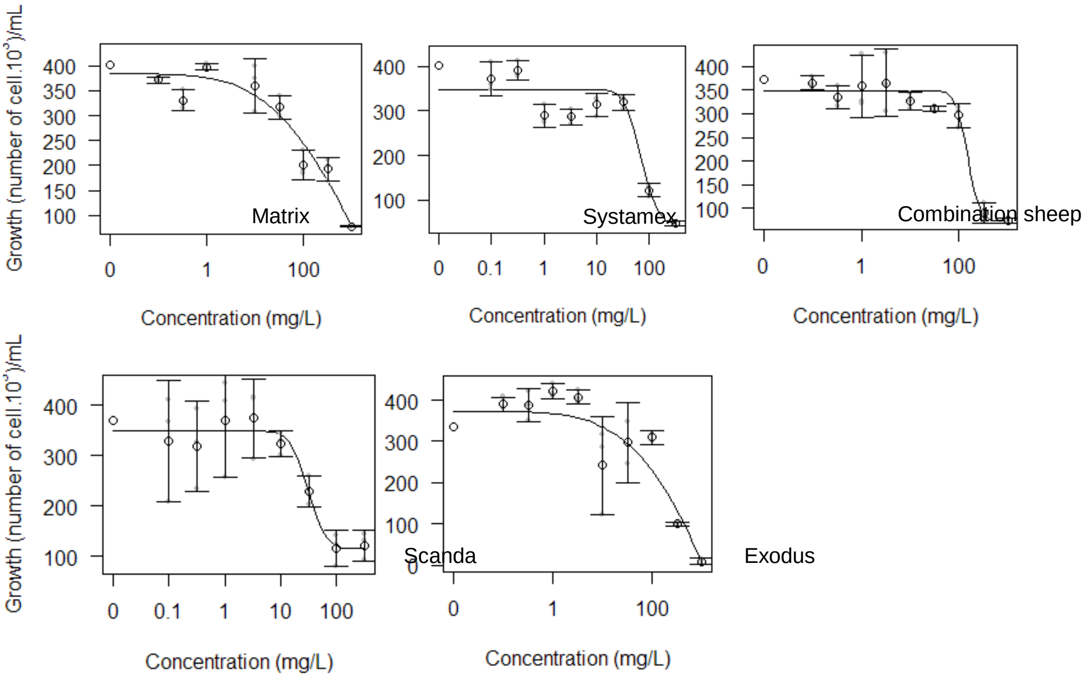



*Figure 8: Freshwater algae growth response (average with standard deviation and fitted model) when exposed to different concentrations of the drenches.*

Algal growth was significantly more affected by Systamex and Scanda compared to Matrix, Exodus and Combination Sheep (Table 5).

*Table 5. Median inhibiting concentrations (IC50) with related 95% confidence intervals (95%CI) of the drench tested*

| Drench | IC50 (mg/L) | 95% CI |
|---|---|---|
| **Matrix** | 197.5 | 138.7 – 275.3 |
| **Systamex** | 77.8 | 58 – 103.2 |
| **Combination** | 208.7 | 157.0 – 279.4 |
| **Scanda** | 70.4 | 36.7 – 133.8 |
| **Exodus** | 193.8 | 131 – 260.3 |

Marine Algae: the counts of algal cells (treated with albendazole and ivermectin) on the Coulter Counter® were confounded by precipitation, leading to counts that were higher for higher concentrations (Figure 9); therefore, no IC50 for these compounds was determined

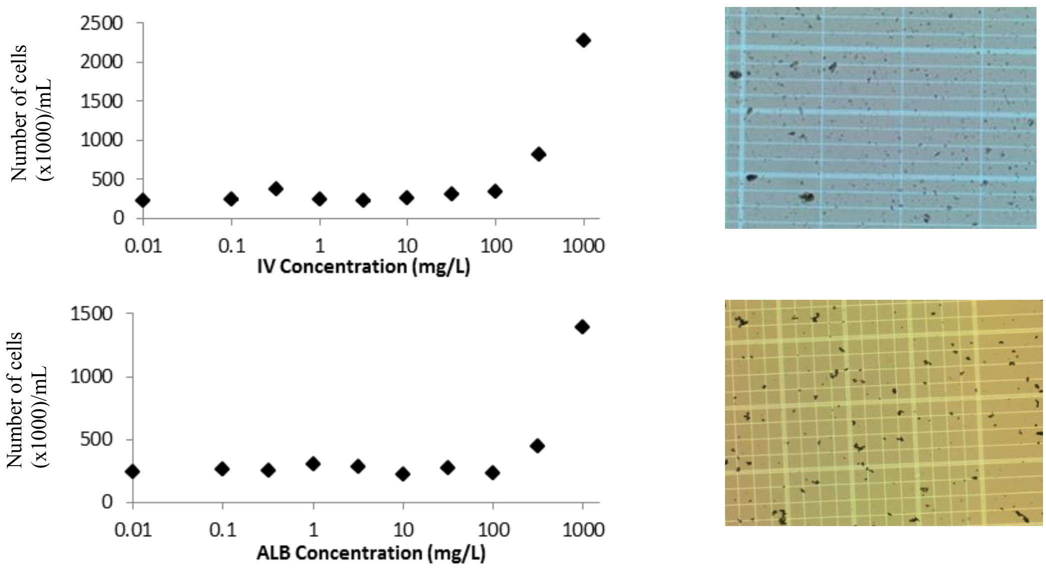



*Figure 9: The average of number of marine algae for different concentrations of ivermectin (IV) and albendazole (ALB) and their appearance under microscope.*

However, the impact of levamisole on algal growth could be shown (Figure 10). The no-effect concentrations and the lowest observed effective concentrations (NOEC and LOEC) are 0.1 and 0.32 mg/L ($P < 0.05$) respectively and the derived 96h IC50 with the related 95% confidence interval is 0.258 (0.176-0.340) mg/L.

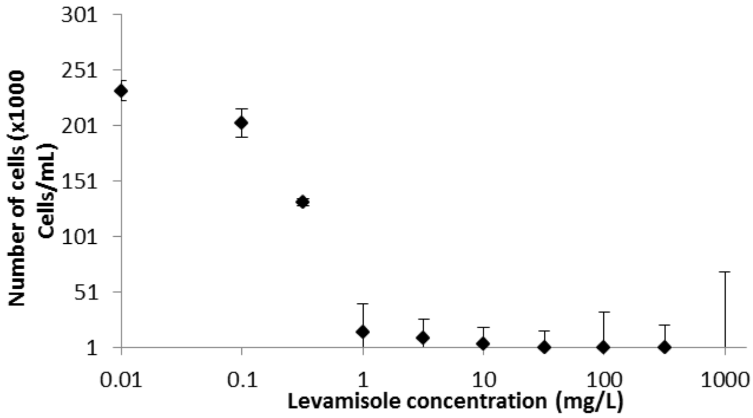



*Figure 10: Average and standard deviation of number of marine algae in the tested concentrations of levamisole*

Drenches containing levamisole (Scanda and Combination) were less toxic to the freshwater green microalgae with a 96-h IC50 of 70.4 and 208.7 mg/L, respectively than the active ingredient alone (96-h IC50 of 0.285 mg/L).

### 10.4.3 Discussion

All tested drenches (Exodus, Matrix, Scanda, Combination and Systamex) caused a growth inhibition in the population of the freshwater microalgae. However, their toxicity is considered “negligible” according to (GESAMP 2002) with a NOEC > 1 mg/L. The active ingredient ivermectin was found to have an IC50 > 4 mg/L with LOEC 1.25 mg/L and NOEC 0.391 mg/L for the freshwater algae *Pseudokirchneriella subcapitata* which was less sensitive than the water flea *Daphnia magna* (LC50-48h 5.7 ng/L) (Garric et al., 2007). Ingredients in formulation (e.g., adjuvants like surfactants, wetting agents and penetrants) can interact to change the toxicity of each active ingredient (Tsui & Chu, 2003).

## 10.5 Field experiments – Te Kaio

Te Kaio farm is situated on Banks Peninsula in Canterbury; the trial site was located in the valley above Magnet Bay.

Mānuka and kānuka used in this experiment were collected from Nelson (Delaware Bay and Happy Valley, respectively) in December 2012, as very few populations were available in Canterbury (van Epenhuijsen et al., 2000).

Lysimeters were deployed at Te Kaio farm on 4 February 2013 (Figure 11). Three sites were selected along a 20 m section of stream. Lysimeters were lined with Whatman Filter paper #1. A soil layer (1–2 cm) was packed into the lysimeter and left to 'equilibrate' through one rain period (to flush through minerals and elements released from the disturbed soil). A 1 kg sample of soil was collected and sent to Cawthron Institute to measure soil moisture content at the time of sampling and water holding capacity.


*Figure 11: Location of the 3 sets of lysimeters on Te Kaio farm*

Fresh cow dung was collected at the site and mixed with spring water to a 1:1 ratio. The diluted dung was then poured into the lysimeter to form an even 'cake' (Figure 12).

Four treatments were set up in triplicate and consisted of:

- Soil only with 10 mL distilled water (control)
- Soil with 10 mL cow effluent
- Mānuka mulch added to soil with 10 mL cow effluent
- Kānuka mulch added to soil with 10 mL cow effluent.

To assess the soil biological activity around the lysimeters, bait lamina sticks were used to measure soil invertebrate numbers and soil micro-organism activities. Bait lamina are made from a mixture of cellulose, bran flakes and bentonite fixed into the holes of small PVC sticks. Normally these are left out for a minimum of four weeks during which time soil invertebrates and microorganisms (if present) will degrade the mixture in the holes.

The number of affected holes provides an estimate of biological activity.

For this experiment 16 bait lamina sticks were placed at each of the three sites around the lysimeters – 48 in total. One stick was used as a control. It was pushed into the soil and pulled back out to check that handling was not affecting the sticks.

The lysimeters and bait lamina sticks were then left in the field under natural conditions until the next rainfall. The lysimeters were checked again after the first rain on 18 March 2013. Percolates were collected in sterile jars and sent to the Cawthron microbiology laboratory to determine the number of *E.coli* using the Colilert® method as previously described.

*Figure 12: Lysimeters deployed at Te Kaio Farm loaded with cattle effluent (top left), lysimeters deployed along the stream (lower), and a view of the farm catchment (top right) (O. Champeau)*

### 10.5.1 Te Kaio Farm Results

When the lysimeters were put in place, the soil moisture content was 7%. However, after they were set up there was no rain for two weeks (Figure 13).

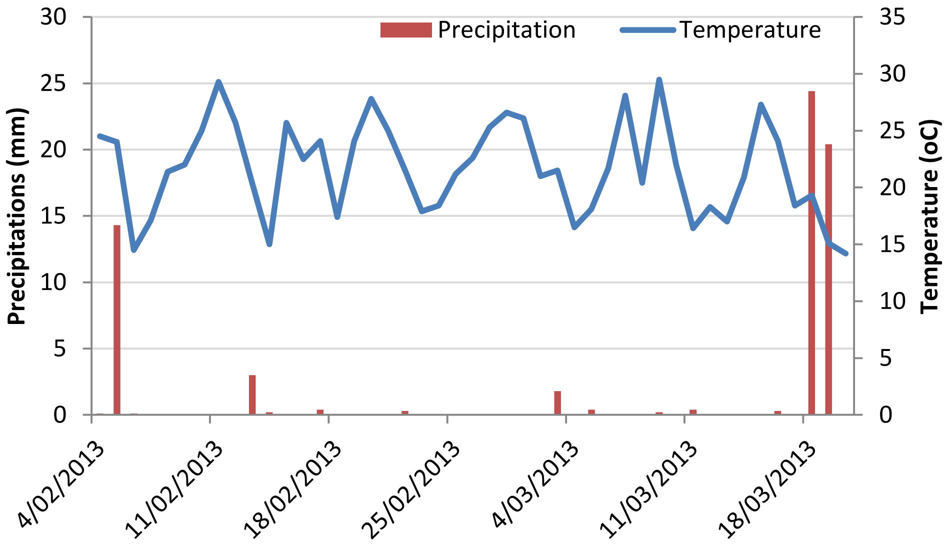



*Figure 13: Precipitation at Magnet Bay and temperature at Akaroa (Banks Peninsula) during the experiment.*

Full exposure to the sun and high summer temperatures effectively dried the cow dung and soil in the lysimeters. The exceptional drought affecting New Zealand at the time also affected Te Kaio farm, with no significant rain falling in months. At the end of the sampling period, rainfall did occur but the percolate would not have been representative of normal biological activity near the surface of the soil, which would have been significantly affected by the drought conditions. The dry surface soil also prevented any normal biological activity occurring near the surface where the bait lamina sticks were located.

No difference occurred between the treatments and the effluent (Figure 14). *E. coli* was however still detected after the cow dung was left in the sun for 42 days, supporting previous research indicating a strong resilience of the bacteria to drought conditions (Polikanov et al., 2012; Gomez et al., 2014).

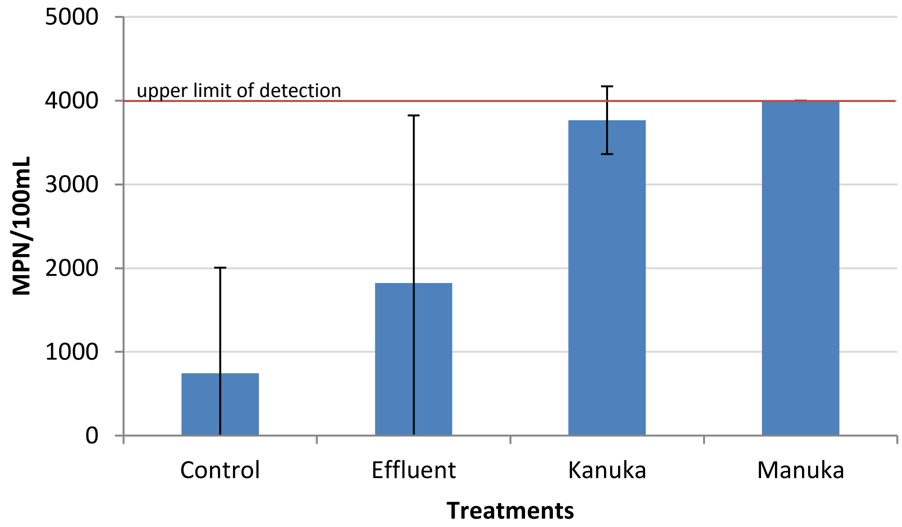



*Figure 14: Number of E.coli (MPN/100mL) in effluent percolate at Te Kaio.*

## 10.6 Field Experiments – Taiporutu

Taiporutu farm is located on the Mahia Peninsula in Hawkes Bay.

On 24 June 2013, an experiment was set up with lysimeters at 3 locations along the farm stream to assess cow effluent remediation on Taiporutu farm. Weather parameters were recorded during the experiment (Table 6).

*Table 6. Weather conditions during field exposure (23rd to 26th of May 2013) (Weather station: Mahia Aws, lat: -39.118, long: 177.96, 136 m)*

| Date | Rain (mm) | Temp. (max –min) | Rad (MJ/m2) |
|---|---|---|---|
| **23 May** | 1.2 | 16.6 – 9.3 | 7.3 |
| **24 May** | 0.2 | 12.9 – 8.8 | 8.27 |
| **25 May** | 13.6 | 13.9 – 6.8 | 4.68 |
| **26 May** | 0 | 19.7 – 10.5 | 10.25 |

Soil cores were sampled at a depth of about 10 cm to determine the moisture content and water holding capacity at the lysimeter locations shown in (Figure 15). The soil temperature was 12.2°C.


*Figure 15: Taiporutu collection site of mānuka and kānuka (left). Location of the three lysimeter sites (red pins) along the stream (middle). Application of cattle effluent to the lysimeter (top right) and lysimeter charged with soil and a top layer of mulch (bottom right) (O. Champeau)*

The lysimeters were lined with Whatman Filter paper #1 and filled with 60 g of soil with roots removed. Distilled water was added to stabilise the soil for 24 hours. Mānuka and kānuka were collected on site (Figure) and mulched using a paua mincer (minced foliage and distal branches). The mulch was assigned randomly to the lysimeters, three per treatment.

Fresh cow dung was collected; diluted 100 fold (weight/volume) and stirred until homogenous. After the 24 hours of soil stabilisation, the treatments were applied to the lysimeters, consisting of either 20 g of loosely packed mānuka or kānuka, along with 40 g of cow effluent or enough spring water as an equivalent of 10 mm rain, for negative controls.

The rainfall after the start of the experiment allowed the termination of the assay 24 hours later (Table 6). Percolate from each lysimeter was collected in a sterile container and kept cold (on ice) until microbial analysis 20 hours later. Stream parameters were collected for a more complete record (Table 7).

*Table 7: Stream water parameters on the 26/6/13 (high turbidity after rain)*

| **Parameters** | **pH** | **DO** | **NO3-** | **NO2-** | **NH3** | **GH** | **KH** |
|---|---|---|---|---|---|---|---|
| **Values (ppm)** | 7.82 | 10.4 | <20 | 0 | 0.5 | 180 | 80-120 |

### 10.6.1 Taiporutu Farm Results

The soil characteristics from the three sites (Table 8) were slightly different whether the soil was sampled near trees, on the riverbank or further away.

*Table 8: Soil characteristics at the Taiporutu farm test site*

| Location | Moisture content | Water holding capacity |
|---|---|---|
| **LYS 1** | 40% | 79% |
| **LYS 2** | 28% | 65% |
| **LYS 3** | 37% | 50% |

The negative control (soil only) had a very small number of *E.coli* (203 ± 105 MPN/100 mL), while the positive control (effluent only) had the highest number at the upper limit of detection (>4×103 MPN/mL). The number of bacteria in the treatments with kānuka and mānuka were significantly different from the number of bacteria in the effluent (Figure 16).

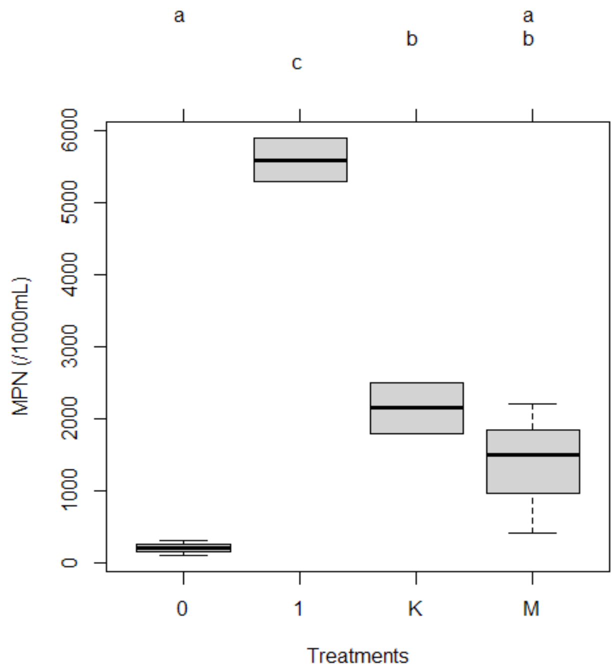



*Figure 16: Mean of the most probable number (MPN) of bacteria for 100mL in the treatments with associated SE and SD. Different letters indicate a statistical difference (P<0.05). (0: soil only, 1: effluent only, K: kānuka, M: mānuka)*

### 10.6.2 Taiporutu Farm Discussion

The National Objectives Framework 13 for freshwater systems identifies values and related attributes to be managed; these include levels of *E.coli* (Ministry for the Environment 2014). From an indigenous perspective, this framework incorporates the consideration of tangata whenua values, consistent with the Mana Atua Mana Tangata Framework 14.

Oils extracted from mānuka and kānuka have well-proven, demonstrable anti-microbial activity. However, the laboratory lysimeter experiments conducted in this research using mulched leafy plant material were inconclusive in demonstrating this activity, because the number of bacteria increased regardless of

[13] http://www.mfe.govt.nz/publications/fresh-water/freshwater-reform-2013-and-beyond/5-national-objectives-framework
[14] http://www.mfe.govt.nz/publications/fresh-water/freshwater-reform-2013-and-beyond/appendix-mana-atua-mana-tangata-framework

the plant treatment. The density of bacteria applied in the effluent may have been too high, or conversely, there was insufficient mulch, so that any bactericidal effect was masked. Only the on-site experiment at Taiporutu showed a lower bacterial level in percolates with mānuka and kānuka mulch treatments compared to the level for raw effluent alone. The observed result could be due to either the combination of; (a) a lower density of bacteria, than that employed in the laboratory experiments; (b) the antibacterial effects of the oils was greater, or there was greater adsorption of the bacteria on the mulched plant material at Taiporutu. The trees used for the experiment were from different locations (Nelson/Marlborough Sounds and Te Mahia Peninsula). Previous research has measured geographical differences resulting in different chemotypes (Douglas et al. 2004), and subsequently exhibiting varying antibacterial activities. However, other bacteria (*Clostridium perfringins*, *Campylobacter jejuni*) were about 40 times more sensitive to mānuka extracts than *E.coli* (Prosser et al. 2014). The evidence from our acute exposure experiments suggests that mānuka and kānuka mulch incorporated into an engineered gabion would be ineffective at reducing microbial densities, and quite possibly could work counter to this objective.

In the production of commercial mānuka active products and the extracts used in this study the plant material is mechanically and/or thermally degraded releasing the antimicrobial compounds from the plant cells. Mechanical and thermal action does not occur during the natural decomposition process.

The increasing use of mānuka for land restoration initiatives, especially plantings around sensitive water bodies, will physically exclude stock from sensitive riparian regions.

Animal drench chemicals may have an impact on fresh water quality, depending on the water catchment, number of animals dosed and excretion rate. Amongst the commercial products tested, ivermectin and levamisole are on the list of veterinary medicines that have a high potential of entering the environment (Boxall et al. 2003a).

Under the environmentally relevant conditions of normal stocking rates, drench adsorption to soil and sediment particles and the dilution effect encountered in water bodies the impacts of the drenches on the freshwater green microalgae seen in this research are unlikely to occur.

## References

ASTM 2004. E1218-04 2012. *Standard guide for conducting static toxicity tests with microalgae*. West Conshohocken, PA, ASTM International. Pp. 14.

Athy ER, Keiffer CH, Stevens MH 2006. Effects of mulch on seedlings and soil on a closed landfill. *Restoration Ecology* 14(2): 233-241.

Beynon SA 2012. Potential environmental consequences of administration of anthelmintics to sheep. *Veterinary Parasitology* 189(1): 113-124.

Boxall AB, Kolpin DW, Halling-Sorensen B, Tolls J 2003a. Are veterinary medicines causing environmental risks? *Environmental Science & Technology* 37(15): 286A-294A.

Boxall ABA, Kolpin DW, Halling-Sørensen B, Tolls J 2003b. Peer Reviewed: Are veterinary medicines causing environmental risks? *Environmental Science & Technology* 37(15): 286A-294A.

Boxall ABA, Fogg L, Blackwell PA, Kay P, Pemberton EJ 2002. *Review of veterinary medicines in the environment* - R&D Technical Report P6-012/8/TR 233 p.

Brooker SG, Cambie RC, Coope RC 1998. N*ew Zealand Medicinal Plant*s. Auckland, Reed Publishing NZ Ltd.

Carlsson G, Patring J, Kreuger J, Norrgren L, Oskarsson A 2013. Toxicity of 15 veterinary pharmaceuticals in zebrafish (Danio rerio) embryos. *Aquatic Toxicology* 126(0): 30-41.

Christoph F, Kaulfers PM, Stahl-Biskup E 2000. A comparative study of the in vitro antimicrobial activity of tea tree oils s.l. with special reference to the activity of beta-triketones. *Planta Med* 66(6): 556-60.

Collins R, McLeod M, Hedley M, Donnison A, Close M, Hanly J, Horne D, Ross C, Davies-Colley R, Bagshaw C and others 2007. Best management practices to mitigate faecal contamination by livestock of New Zealand waters. *New Zealand Journal of Agricultural Research* 50(2): 267-278.

Daniel-Mwambete K, Torrado S, Cuesta-Bandera C, Ponce-Gordo F, Torrado JJ 2004. The effect of solubilization on the oral bioavailability of three benzimidazole carbamate drugs. *International Journal of Pharmaceutics* 272(1–2): 29-36.

Douglas M, Anderson R, van Klink J, Perry N, Smallfield B 2001. *Defining North Island mānuka chemotype resource - a survey report*. Crop & Food Research report No. 447. New

Zealand Institute for Crop and Food Research Limited. 13 p.

Douglas MH, van Klink JW, Smallfield BM, Perry NB, Anderson RE, Johnstone P, Weavers RT 2004. Essential oils from New Zealand mānuka : triketone and other chemotypes of Leptospermum scoparium. *Phytochemistry* 65(9): 1255-1264.

Flemmer CL, Flemmer RC 2008. Water effluent from New Zealand dairy farms from 1997 to 2000. *New Zealand Journal of Agricultural Research* 51(2): 181-189.

Garric J, Vollat B, Duis K, Péry A, Junker T, Ramil M, Fink G, Ternes TA 2007. Effects of the parasiticide ivermectin on the cladoceran Daphnia magna and the green alga Pseudokirchneriella subcapitata. *Chemosphere* 69(6): 903-910.

GESAMP 2002. R*evised GESAMP Hazard Evaluation Procedure for Chemical Substances Carried by Ships*. Rep. Stud. GESAMP No. 64. (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). 126 p.

Gomez Gomez JM, Medina J, Hochberg D, Mateo-Marti E, Martinez-Frias J, Rull F 2014. Drying bacterial biosaline patterns capable of vital reanimation upon rehydration: novel hibernating biomineralogical life formations. *Astrobiology* 14(7): 589-602.

Halley BA, Jacob TA, Lu AYH 1989. The environmental impact of the use of ivermectin: environmental effects and fate. *Chemosphere* 18(7): 1543-1563.

Herd RP, Sams RA, Ashcraft SM 1996. Persistence of ivermectin in plasma and faeces following treatment of cows with ivermectin sustained-release, pour-on or injectable formulations. *International Journal for Parasitology* 26(10): 1087-1093.

ISO 2012. 9308-2 -- Water quality -- Enumeration of Escherichia coli and coliform bacteria -- Part 2: Most probable number method. *Water quality*. Pp. 45.

Kreuger J, Nilsson E 2001. Catchment scale risk-mitigation experiences - key issues for reducing pesticide transport to surface waters. *BCPC Symposium Proceedings: Pesticide behaviour in soil and water* (78): 319-324.

Kreuzig R, Holtge S, Brunotte J, Berenzen N, Wogram J, Schulz R 2005. Test-plot studies on runoff of sulfonamides from manured soils after sprinkler irrigation. *Environ Toxicol Chem* 24(4): 777-81.

Lu X, Wilson JT, Shen H, Henry BM, Kampbell DH 2007. Remediation of TCE-contaminated groundwater by a permeable reactive barrier filled with plant mulch (Biowall). *Journal of Environmental Science and Health, Part A* 43(1): 24-35.

MacLeod CJ, Moller H 2006. Intensification and diversification of New Zealand agriculture since 1960: An evaluation of current indicators of land use change. *Agriculture, Ecosystems & Environment* 115(1–4): 201-218.

Maddocks-Jennings W, Wilkinson JM, Shillington D, Cavanagh H 2005. A fresh look at mānuka and kānuka essential oils from New Zealand. *International Journal of Aromatherapy* 15(3): 141-146.

Martin P 1985. Nematode control schemes and anthelmintic resistance. In: Anderson N, Waller P ed. *Resistance in Nematodes to Anthelmintic Drugs*, CSIRO Division of Animal Health, Glebe. Pp. 29-40.

Ministry for the Environment 2014. *National Objectives Framework. 2014 amendment to the National Policy Statement for Freshwater Management.* Wellington, New Zealand.

Ministry for the Environment, Statistics New Zealand 2015. *New Zealand's Environmental Reporting Series: Environment Aotearoa 2015.*

Oliver DM, Clegg CD, Haygarth PM, Heathwaite AL 2005. *Assessing the potential for pathogen transfer from grassland soils to surface waters. Advances in Agronomy*, Academic Press. Pp. 125-180.

Patton T, Barrett J, Brennan J, Moran N 2006. Use of a spectrophotometric bioassay for determination of microbial sensitivity to mānuka honey. *Journal of Microbiological Methods* 64(1): 84-95.

Perry NB, VanKlink JW, Brennan NJ, Harris W, Anderson RE, Douglas MH, Smallfield BM 1997a. Essential oils from New Zealand mānuka and kānuka: Chemotaxonomy of Kunzea. Phytochemistry 45(8): 1605-1612.

Perry NB, Brennan NJ, Van Klink JW, Harris W, Douglas MH, McGimpsey JA, Smallfield BM, Anderson RE 1997b. Essential oils from New Zealand mānuka and kānuka: *Chemotaxonomy of Leptospermum*. Phytochemistry 44(8): 1485-1494.

Polikanov YS, Blaha GM, Steitz TA 2012. How hibernation factors RMF, HPF, and YfiA turn off protein synthesis. *Science* 336(6083): 915-918.

Porter NG, Wilkins AL 1999. Chemical, physical and antimicrobial properties of essential oils of Leptospermum scoparium and Kunzea ericoides. *Phytochemistry* 50: 407-415.

Prosser JA, Anderson CWN, Horswell J, Speir TW 2014. Can mānuka (Leptospermum scoparium) antimicrobial properties be utilised in the remediation of pathogen contaminated land? *Soil Biology and Biochemistry* 75(0): 167-174.

R Core Team 2014. R: *A language and environment for statistical computing*. Vienna, Austria. R Foundation for Statistical Computing. http://www.R-project.org/.

Rasmussen MA, Cray WC, Casey TA, Whipp SC 1993. Rumen contents as a reservoir of enterohemorrhagic Escherichia coli. *FEMS Microbiology Letter* 114: 79-84.

Ritz C, Streibig JC 2005. Bioassays analysis using R. *Journal of Statistical Software* 12(5): 1-22.

Scarsbrook MR, Melland AR 2015. Dairying and water-quality issues in Australia and New Zealand. *Animal Production Science* 55(7): 856-868.

Staveley JP, Smrchek JC 2005. Algal toxicity test. In: Blaise C, Férad J-F ed. *Small scale freshwater toxicity investigations*, Springer. Pp. 181-203.

Tsui MTK, Chu LM 2003. Aquatic toxicity of glyphosate-based formulations: comparison between different organisms and the effects of environmental factors. *Chemosphere* 52(7): 1189-1197.

van Epenhuijsen K, Henderson RC, Carpenter A, Burge GK 2000. The rise and fall of mānuka blight scale: a review of the distribution of Eriococcus orariensis (Hemiptera: Eriococcidae) in New Zealand. *New Zealand Entomologist* 23: 67-70.

Zrnčić M, Gros M, Babić S, Kaštelan-Macan M, Barcelo D, Petrović M 2014. Analysis of anthelmintics in surface water by ultra high performance liquid chromatography coupled to quadrupole linear ion trap tandem mass spectrometry. *Chemosphere* 99: 224-232.

## Glossary and Acronyms

| | |
|---|---|
| °C | Degree Celsius |
| µL | Microliter (10-6 L) |
| µm | Micrometer (10-6 m) |
| µmol | Micromole (10-6 mol) |
| ALB | Albendazole |
| ASTM | American Society for Testing and Materials |
| CI | Confidence interval |
| cm | Centimetre |
| Co | Cobalt |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| Cu | Copper |
| DMSO | Dimethyl sulphoxide |
| DO | Dissolved oxygen |
| E.coli | Escherichia coli |
| EC50 | Effective concentration |
| g | Gram |
| GESAMP | Group of Experts on Scientific Aspects of Marine Environmental Protection |
| GH | General water hardness |
| h | Hour |
| I | Iodine |
| IC50 | Inhibitory concentration of 50% of the population |
| ISO | International Organization for Standardization |
| IV | Ivermectin |
| KH | Water hardness (calcium carbonate concentration) |
| L | Litre |
| LOEC | Lowest observed effect concentration |
| LV | Levamisole |
| m | Metre |

| | |
|---|---|
| mJ/cm2 | Radiance (light) |
| mL | Millilitre (10-3 L) |
| Mm | Millimetre |
| MPN | Most probable number |
| n | Number of replicate |
| ng | Nanogramme (10-9 g) |
| NH3 | Ammonia |
| NO2- | Nitrite |
| NO3- | Nitrate |
| NOEC | No observed effect concentration |
| OD | Optical density -> to replace by absorbance |
| OECD | Organisation for Economic Co-operation and Development |
| P | Probability |
| pH | Potential hydrogen |
| PSU | Practical salinity unit (equivalent to g/kg or ‰) |
| s | Second |
| SD | Standard deviation |
| Se | Selenium |
| SE | Standard error |
| Zn | Zinc |

| | |
|---|---|
| Absorbance | Ratio of incident to transmitted light through a material |
| Anthelmintic or Anthelminthic | Drugs that expel worms (helminths) from the body by either stunning or killing them. They may also be called vermifuges (stunning) or vermicides (killing) |
| Bait lamina | Plastic sticks with holes filed with cellulose-bait to measure the biological activity of soil |
| Chemotypes | Species with chemically distinct entities |
| Deioinised/distilled water | Water that has had all of its mineral ions removed |
| Dermatophytes | Fungi requiring keratin for growth. They can cause superficial infections of the skin, hair and nails |
| Distal | Located away from the point of attachment (extremity) |
| Ectoparasite | Parasite living on the outside of another organism |
| ECx-t | Effective Concentration is the generic term for a concentration of substance or material that is estimated to cause some defined effect on a proportion (x%) of the test organisms after a defined period of exposure (t). This kind of endpoint allows the classification and the comparison of the toxic potency or intensity of different chemicals. More terms can be derived to describe specific effects (e.g. lethality, inhibition). |
| LCx-t | LCx-t (Lethal Concentration) is the concentration of substance or material that is estimated to be lethal to a proportion (x%) of the test organisms after a defined period of exposure (t). This is an acute toxicity indicator. |

| | |
|---|---|
| ICx-t | ICx-t (Inhibitory Concentration) is the concentration of substance or material that is estimated to have an inhibitory effect (e.g. growth, mobility) on a proportion (x%) of the test organisms after a defined period of exposure (t). This is a chronic toxicity indicator. |
| Endoparasite | Parasite living within another organism |
| Enzyme | Compounds produced by living organisms that biochemically precipitate a process of event (catalyst) |
| Faeces | Bodily waste matter derived from ingested food and the secretions of the intestines and discharged through the anus |
| Gram-negative | Group of bacteria that do not retain the crystal violet stain used in the Gram staining method. They are generally more resistant against antibiotics and antibodies. |
| LOEC | Lowest Observed Effect Concentration is the lowest concentration of a test substance or material that is observed to have a statistically significant adverse effect on the test organisms for a defined time of exposure and under the test conditions, relative to the control. |
| Lugol iodine | Solution of elemental iodine and potassium iodine used as a fixative for microalgae |
| Lysimeter | Cylindrical measuring device used to measure the amount of water released by the plants. They are used in this study as cylindrical sieves. |
| Microalgae | Microscopic algae ranging from a few to hundreds of micrometer |
| Microplate | See: microtiter plate |
| Microtiter plate | or microplate, is a flat plate with multiple "wells" used as small test tubes |

| | |
|---|---|
| NOEC | No Observed Effect Concentration is the highest concentration of a test substance or material that is observed not to have a statistically significant adverse effect on the test organisms for a defined time of exposure and under the test conditions, relative to the control. |
| Percolate | Liquid that has passed through a porous material |
| Spectrophotometric | Related to the use of the spectrophotometer, an instrument for producing or recording a spectrum and measuring the photometric intensity of a selected light wavelength. |
| Type I water | See deionised/distilled water |

## Acknowledgments

The authors wish to thank Fenella Deans (University of Auckland School of Biological Sciences Summer Scholarship) for carrying out for the laboratory experiments with the marine green microalgae and Ch'nee Akuhata (Lincoln University Māori Summer Scholarship and NPM Summer Scholarship) for carrying out the field study at Te Kaio farm.

# 11 Realising the Potential of Redesigning Landscapes for Native Systems

Chris Perley

*"Seeing comes before words. It is seeing that establishes our place in the surrounding world."*

John Berger (1990)

## 11.1 Seeing Place as a Factory, or as Our Home

It begins with how we see. If we are taught to see land as a thing, a production unit, a set of 'resources' defined by simple numbers and dollars, then we blind ourselves to the potential of a place and the multiple values and meanings it can hold. In the industrial model – as still taught in many of our universities – agri-'culture' removes much of the culture and replaces it with the simplest of agronomy – how much of this one thing can we produce on this whole factory farm?

We are told that the industrial factory view is 'efficient'. It is not. Such an approach loses productivity (output per limiting input – I/O), fails to realise the potential of place, is environmentally degrading and therefore socially and economically degrading and results in a further colonisation and extraction of common wealth from both the farm and the region. Those who benefit are the buyers, and the more and more absent industrial owners.

### 11.1.1 A Question of Belonging

*"We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect."*

Aldo Leopold (1949)

There is no question that the way of seeing the world encompassed by the more mechanical so-called 'Modern' Western model reduces the complexity of land, history, meaning and culture to very small parts, and then treats each part in complete isolation from any understanding of the greater whole, including their own inherent belonging to a place. Wisdom is lost in pursuit of the clever imaginings of the technocrats examining their single disconnected patch.

Indigenous ways of seeing and belonging – of connecting whānau and land with history and purpose – is very much part of our necessary future direction. They take a connected systems view, not a reductive mechanical view.

This sense of belonging – to land, community and history – is a common thread throughout the world.

*"No Highlander ever once thought of himself as an individual. Amongst these people, even the meanest mind was in a manner enlarged by association, by anticipation and by retrospect. In the most minute, as well as the most serious concerns, he felt himself one of the many connected together by ties the most lasting and endearing. He considered himself merely with reference to those that had gone before, and those who were to come after him; to these immortals who lived in deathless song and heroic narrative; and to these distinguished beings who were born to be heirs of their fame, and to whom their honours, and perhaps, their virtues, were to be transmitted."*

Anne Grant (1811)

### 11.1.2 The Economic Consequences of an Industrial View

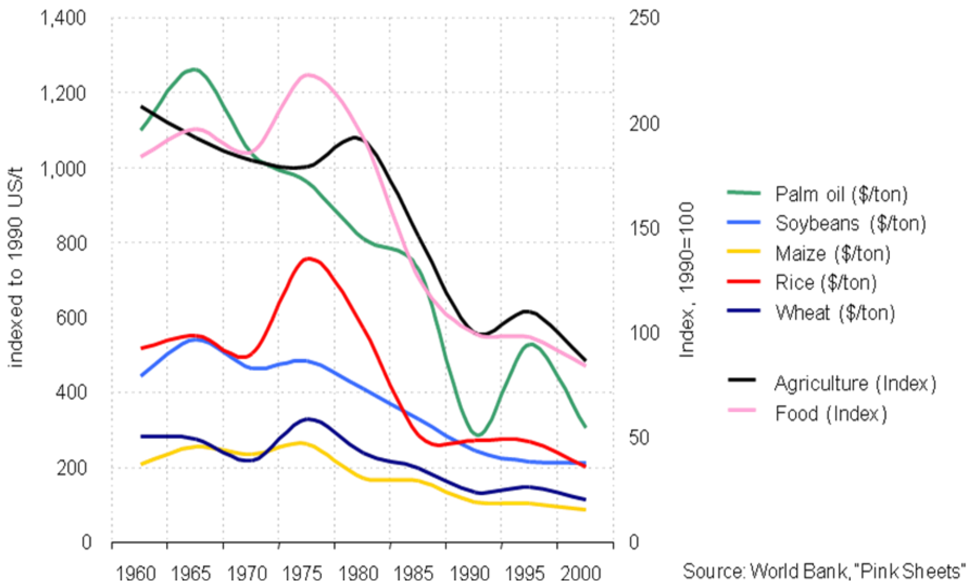



*Figure 1: World Agricultural Commodity real price decline (World Bank)*

Critically, the industrial model loses the 'market position' of what is produced from the land because it disconnects the quality of the goods we produce from our land from the story of that land. Without the story as a point of difference for customers – safe, quality food from a caring community who live within a healthy environment – we end up with no adjectives, only nouns. It is not 'Auntie's home-grown beef'; the adjectives are removed and it becomes simply 'beef'. That puts the 'factory' squarely in the 'price-taking' commodity box where the strong buyer sets the price. And when that is the case, as it has been for most farmers since commodity trade began, then every efficiency gain is bargained away by the strong buyer (see Figure 1).

“Efficiency” through cost-cutting economies of scale has resulted neither in a more prosperous, more socially vibrant, nor in a better environment.

We are ‘seeing’ land in the wrong way. Those that do see in the right way are the people who are deeply embedded in the land, and see it as much more than a technocratic machine. They see the potential in place-based solution, diversity, building landscape and social connection and integration, in cultural belonging, in knowledge held locally as well as from the advice of ‘professionals’, and in participation and dialogue.

That is the agroecological approach to land management.

## 11.2 Asking the Right Questions of the Land

When people are trapped in the industrial mindset, they do not see outside their own goldfish bowl. And they do not think to ask questions such as:

- Is there a better ecosystem – a woodland, a wetland – for this piece of land?
- Should I integrate shelter and shade into the system?
- Could I use fenced edges between pastures and wetland/woodland patches as opportunities for improving our soils, water, pasture and especially stock health through access to diverse species?
- Should I sell and process in such a way that the story of this land and what we harvest from it is told?
- Would the stock benefit from a healthier diet including browse and pasture species?
- Could I improve my economics, my environment and the beauty and functionality of this place by treating the margins between land and water with woodland, wetland and tall pasture systems?
- Should I improve my soils to infiltrate water, hold water and access water, rather than having it run-off overland taking all our nutrients, organic matter and soil with it?
- Isn’t a healthy stream an indicator of the health of the land, clean, cool, none of our soil washed into it, nutrients held in the land, flowing long and with extended reaches because the land is a sponge?

- Could I improve the economics by not focusing on ever-higher gross-production as recommended by those who want to sell me more off-farm chemical energy inputs, or buy more of our ever-cheaper outputs? Who does that suit in the long-term?
- Wouldn't a strongly functioning soil, and a farmscape of patterned diversity (among and within patches), provide more free gifts, and less reliance on finite off-farm inputs? Isn't the loss of soil, nutrients and ecological functions – such as pollination and the holding of water – actually increasing my reliance on buying evermore inputs, some of them finite and unsustainable?

Rather than create value and layers of positives in our landscape, why do we extract or destroy the values that are there, in pursuit of a single narrow end.

## 11.3 How Landscapes Work?

Landscapes are integrated systems made up of parts and wholes. Like the god Janus, landscape elements and patches are wholes as well as parts within a landscape, and they look and influence both ways – from the landscape to the patch, from the patch to the landscape; from the species to the patch, from the patch to the species. Patches of woodlands, individual trees and shrubs, wetlands, pasturelands and croplands all connect to, and influence, each other.

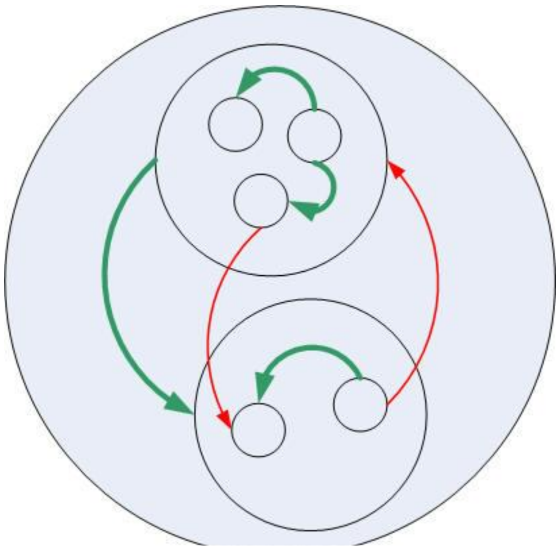


**Figure 2: Parts & Wholes: Functioning between and within patches in the landscape**

It follows that well designed landscape polycultures that maximise the potential for beneficial connection such that synergies occur – where the sum of the parts is considerably greater than the whole – is the essence of agroecological thinking.

A key is diversity: a polycultural farmscape with many different patches located in sensible areas, and within these patches polycultural composition that enhances desired functions, including economic functions.

### 11.3.1 The Wetland Example: A Keystone

For example, a wetland is a patch that provides multiple functions and connections across space and time. They are particularly valuable for water cleansing ("the kidneys of the landscape"), water detention, flood and drought mitigation, biodiversity in terms of useful insects and birds, mahinga kai and recreational values.

Removing direct access by stock, these functions are enhanced, and by so doing, stock losses are prevented, a cost saving. If a wetland is fenced then the edge can be very useful; an area where particular native plants beneficial for stock diet and health can be grown. Particular species and mixes of species can provide diversifying economic returns, such as timber and honey, or key functions such as spring nitrogen boost for kererū. Shelter is another key contribution by a healthy farm system to the prevention of stock losses.

If water is troughed out from wetlands, then the clean water can increase animal health because of the avoidance of ingestion of faecal coliforms, thereby both increasing the productivity of the animal and reducing animal health costs. The net effect is greater profit and a lower dependency on off-farm expenditure and energy. In this example of stock health and profitable performance, the enhancement is even greater when augmented by a diverse range of browse from woodland and wetland edge, from healthy soils, and from a mix of pasture species. The more wetlands within a farm system, then the more effective is the mitigation of flood and drought, and the more enhancement of water quality, biodiversity, water holding capacity, groundwater recharge, irrigation potential and recreational values. These benefits extend beyond the farm to the wider connected landscape – downstream, upstream, and across to other patches in other catchments.

This example of the wetland does not cover the full range of functions; we could easily add children's play, aesthetics, firewood, etc. It is an illustration of how one particular patch or element (an individual tree or tussock can have major value within a given context) can positively affect other values through a ripple effect.

Where the connections are major across environmental, social and economic domains, then a particular element in the landscape can be considered a '*keystone*'.

Other keystones with major positive effects across and within a farmscape system include:

- Soil biology enhancing water, fertility and detoxification functions;
- Woodlands (including individual trees and shrubs) enhancing erosion, water quality, shelter, shade, browse, biodiversity, animal stress, etc.
- Tall grasslands and herbaceous leys.

Many of the compositional elements within each of these systems involve species indigenous to Aotearoa New Zealand.

Each gives value to the neighbour. No patch is an island, entire unto itself. The integration includes between people and land, between animals and land, and between economics and land.

To think that we can reduce and analyse these complexities and remain wise, is perhaps the defining problem of our age.

### 11.3.2 Thinking in Functional Landscapes

If we are taught to only consider one patch – an agronomic crop for instance – and then to not consider the connections (e.g. the effect of monocultural herbage on stock health, or that species' effect on soil organic matter when combined with very low levels of residual grazing), then the effect is two-fold:

- We fail to see the problems that can result from thinking within the box, and;
- We fail to see, and therefore not realise, the potential there is within the farmscape.

It follows that in order to prevent problems, and to generate lasting potentials, the redesign of the structural farmscape system is required. This is a fundamentally different thought process to what predominates currently where a symptom of a dysfunction in the system – for example stock death, or a disease – is to rely on symptom-focused technologies that make no attempt to understand the deeper ultimate causes.

And so the solution to animal death caused by open access to a wetland is to continually try to drain the wetland at sometimes great expense, even in some cases where half the cost of a cattle beast in fencing could save the loss of two cattle a year. A disease that may have its root cause in poor diet is treated with a drug, rather than by fixing the diet. This wider report has considerable data on what dietary potentials there are within our farmscapes.

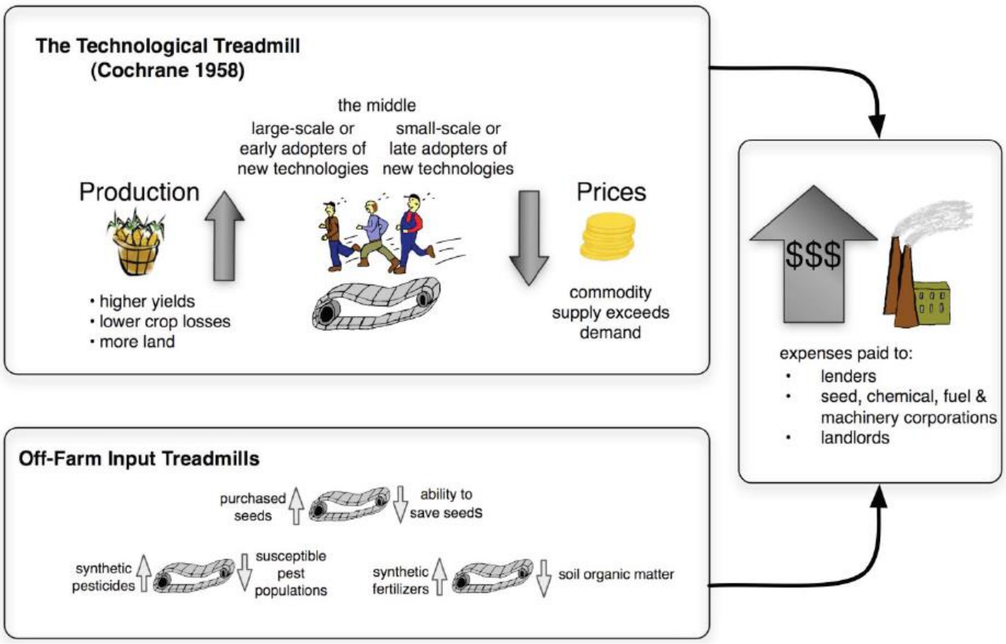
## 11.4 Looking beyond Gross Factory Production

One of the barriers to realising the potential of our farmscapes is the particular metrics being used. An increase in gross production is the call in our industrial land use era. It accelerated after World War II with the advances in the machinery and chemical industries.

That focus on gross production continued after Britain – our major market – joined the European Union in 1973. It continued through the subsidies of the early 1980s, and then through the rise in the production of urea that replaced free nitrogen from legumes. The result has been a rapid energy intensification, the replacement of mixed farming systems with more industrial continuous cropping farms, and a dairy expansion at the cost of our environment and eventually the profitability of those same farmers.

There are other economic metrics of relevance to the future of farming. They include:

- Profitability: it is not true that increasing production increases profit, unless you are throughput processor looking to maximise capacity. It is false for farming. There is an optimum production level somewhat below the possible maximum.
- Risk and Resilience to Uncertainty: the risks associated with increasing production have lead to what Willard Cochrane referred to as the 'technology treadmill' (Levins & Cochrane 1996), where continued production dropped



prices, marginalised particularly family farms, with the technical solution being not to think differently about our landscapes and market models, but to demand the greater subsidy, to amalgamate, to reduce labour and conditions, to demand the right to pollute the people's common – our swimming streams – and to demand even more technology aimed at producing even more. Risk is further exacerbated by the reduction in the number of products produced from the farm, creating further vulnerability, as well as the loss of opportunities – be they new social enterprises (hunting pheasants, homestays, horse trekking) or products.

- Market Position: the position as a price-taker in a market is destined to have any 'efficiency' gain taken by the buyer. This is Aotearoa New Zealand's agribusiness position, and industrial farming is maintaining the trend.
- Dependency on off-farm inputs: Some farms have now lost so many of their functions – water holding, soil depth and quality, healthy flora – that they are now effectively junkies to more inputs to make up for what has been degraded.

## 11.5 Realising the Potential of Place

Landscapes vary across space and time. The industrial views fight against this rather than embrace it. Agroecology does the opposite.

Pastoral production varies between paddocks within a farm up to 100% +/- the mean, with the same variation within paddocks (Dr Gordon Cossens pers. Comm.). Cropping operators have noticed the same variation (Dan Bloomer, pers. Comm.).

Overlaying that variation, are variations in costs. A Pareto 80:20 rule applies to many costs assumed to be spread evenly over the 'factory' uniformity. However, many of these overhead costs are concentrated in a proportion of the farm where stock losses, weed control costs, negative returns to fertiliser, mustering costs, and other problems cluster. The response of some farmers was to convert such problem areas in pasture to another land cover: to a woodland, or to a fenced wetland. This was in the face of considerable resistance from 'industrial 'maximise production' thinking.

What these farmers realised was that the low production areas – less than three stock units per hectare – correlated with the high costs areas. They realised that simply by walking away and leaving it to regenerate as land's preferred habitat (woodland or wetland for instance), they were achieving an economic positive.

### 11.5.1 Principles of Realising Potential

A number of principles can be used when evaluating how to achieve the spatial potential of a farmscape. These include:

- ***Recognising 'Terroir'*** – the qualitative difference for a particular patch, such as a mix of soil, water balance and microclimate – a good forest site, mānuka, wetland, water meadow, etc. Of particular importance is to ask about whether a particular site is *low productive and high cost* – with added costs from environmental soil and water degradation – or a *high production and low cost site*. This is more 'efficient' than forcing low production, high cost areas into yet more narrow gross production, at ever greater expense, and ever greater degradation.
- ***Build connection and value between patches***. This may include the hydrological flows from land to waterway, or through the water system, or it may involve shelter, habitat, or browse for multiple purposes.
- ***Add many things to every patch to build multiple functions*** that benefit environment, cultural and economic value as diverse as fertility, stock health, water function, soil conservation, aesthetics, resilience to droughts, reducing evapotranspiration loss, and new markets.
- ***Create layers of function within a patch or landscape*** to maximise the benefits both within a patch (e.g. a range of species suited to drought or anthelmintic properties, or both; or species and practices that benefit organic matter, water infiltration and percolation rather than detrimental overland flow). A line of trees along specific areas of a contour can stop overland flow, as well as providing browse, shade, timber and beauty.
- ***Create social connection to a place, and enrich the meaning of what it is to belong***; to harvest with others with gratitude, to create memory, to build an ethos of belonging and mutual caring: the earth for us, and we for the earth.

**Papatūānuku (Earth Mother)**

*We are stroking, caressing the spine*
*of the land*
*We are massaging the ricked back*
*Of the land*
*With our sore but ever-loving feet:*
*Hell, she loves it!*
*Squirming, the land wriggles*
*In delight*
*We love her*

*Hone Tuwhare*

Agroecology is not just a new technology; it is a way of seeing with roots in our sense of belonging to these lands. It offers the very real potential to enhance synergies between culture, nature and economy, getting us off the treadmill.

## References


Berger, J. 1990. *Ways of Seeing*. Penguin, London UK

Grant, A. 1811. *Essays on the superstitions of the Highlanders of Scotland,* Longman, Hurst et al., London

Leopold, A. 1949. *A Sand County Almanac and Sketches from Here to There*. Oxford University Press, London

Levins, R.A. and W. W. Cochrane 1996 The Treadmill Revisited. *Land Economics* 72 (4): 550-553

## Acknowledgments

Thank you Marion for keeping the flame of agroecology lit: for the sense that those of us who can see the potential in our lands; for us to belong, for our environment to be healthy, and for our farmers and rural communities to thrive.

We will get there someday, and there will be a point where they say “but we all know that now.”

*Photo: Bud Jones, Eketahuna*

# 12 Te Kaio, Agroecology, Agroforestry and Tourism

Marion Johnson

The trustees of Te Kaio farm have kindly supported the Indigenous Agroecology project since its inception. The determination to begin this work came from discussions in the kitchen at Te Kaio and the lament that watercress was no longer fit to eat in the creeks of Aotearoa New Zealand and the land was slipping away. I trust that we are opening the door to change. Thank you Te Kaio and Wairewa.

## 12.1 Te Kaio farm

Te Kaio is a 449 ha sheep and beef farm located in the Southern Bays of Horomaka (Banks Peninsula). Te Kaio, traditionally a sheep and beef farm since its establishment by the Wright family in the 1900s, was gifted to Wairewa by Jim Wright on his death in 2006. Jim believed in Wairewa's vision of "ki uta ki tai" – from the mountains to the sea – whole ecosystem management and felt that the land would be well cared for in their hands.

Wairewa is one of the five Ngāi Tahu Papatipu Rūnanga situated on Horomaka and is home to the hapū of Ngāti Irakehu and Ngāti Makō. The Wairewa marae is on the outskirts of Little River in the Okana valley. The takiwā of Wairewa centres on Te Roto o Wairewa/Lake Forsyth and the catchment of the lake, hills and coast to the adjoining takiwā of Koukourārata Rūnanga, Onuku Rūnanga, Ngāti Wheke and Taumutu Rūnanga.

Te Kaio rising from sea level to a height of 260 m currently carries 800 mixed breed ewes and 60 cattle. Stock numbers are being increased by selecting the best replacements from each year's crop of young stock. The farm has some internal sub division; some improved pastures and has had little fertiliser application. Te Kaio is in a reasonable rainfall area, although it does suffer from occasional summer drought. There are two serviceable houses and numerous sheds and yards in varying states of repair.

The farm is managed by the Te Kaio Trust, the trustees being charged with the preservation/conservation of the land for future generations. Ideally, the farm should provide a source of sustenance (meat, vegetables and fruit) and cultural opportunities; for example the finding of food (the practice of Mahinga kai) and practice of traditional medicines (Rongoā) for future generations. "*The vision is to protect the whenua* [land], *koiora kanorau* [biodiversity]*, wai māori* [freshwater] *and wai moana* [sea] *of Papatūānuku* [mother earth] *ki uta ki tai* [from the mountains to the sea]" (Robin Wybrow pers. comm.).

Te Kaio is a diverse environment; there are stands of regenerating bush and very badly eroded slopes. The farm is bounded by two creeks that are largely protected by bush and has two major and two smaller internal waterways. Where the farmland meets the sea there are two large bays on the boundaries (Magnet to the west and Tumbledown to the east) and one within the farm (Murray's Mistake). Otherwise, the land falls steeply to the sea with a number of eroding cliffs. A mapping and land stability classification exercise conducted in 2012 by Roger May of Tomorrow's Forests identified that 302ha of the farm were unstable or moderately stable, leaving 154ha available for use. If only the unstable land was removed from agricultural use, the farm would be left with 218ha.

If we farm with the principles of agroecology then we must look after the land, the water and the soils. We must also provide food and resource to the Wairewa whānau (families) so the farm must function to provide income to sustain its existence and to feed its people. To safeguard the soils areas of the farm must be retired and other areas planted. The choice of plantings can be guided by the trustees' objectives of providing opportunities for cultural expression, particularly with respect to mahinga kai and rongoā.

*"Our first patient must be the land itself; if we can heal the land we will have healed ourselves. We can go to the bush for something else now. We can go there to hear the land crying, sighing wind through balding trees, deprived of the song of the birds that once lived there. How can we claim to be so environmentally friendly when we have takahi-ed, tarnished, such a beautiful land."*

Pa Ropata

A farm and its associated agroecosystem is part of the larger landscape. Te Kaio is situated in the southern Bays of Horomaka/Banks Peninsula as shown in Figure 1.

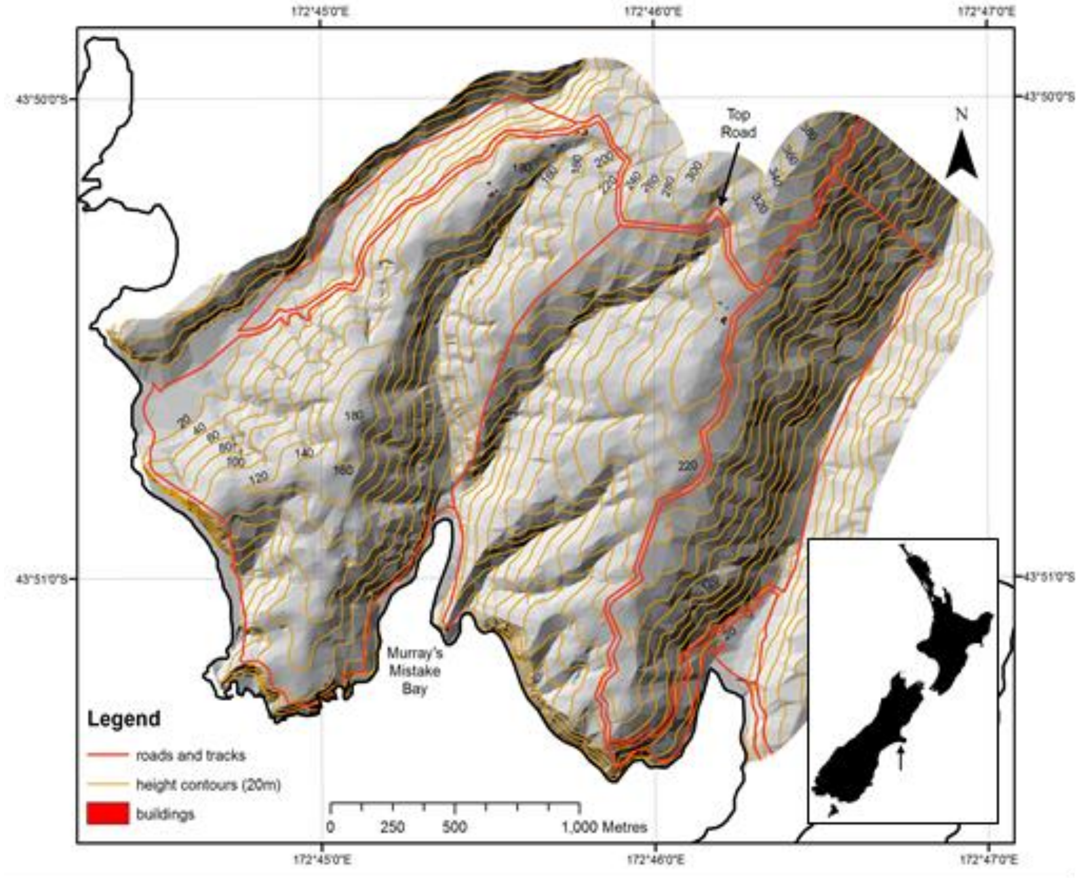



*Figure 1: Location of Te Kaio farm on Horomaka Banks Peninsula.*

## 12.2 Horomaka Banks Peninsula

The peninsula was formed over six million years ago after violent volcanic eruptions (Weaver et al., 1985 quoted in Wilson, 2009) and covers an area of approximately 1000 square kilometres rising steadily from sea level to the summit of Mt Herbert. The soils are derived from bedrock and loess and are moderately to very fertile (Dorsey, 1988 quoted in Wiser & Buxton, 2009). A mixed forest of hardwoods and podocarps clothed the peninsula before the arrival of Māori approximately 700 years ago augmented by a profusion of shrubs and vines, herbs, tree ferns, ground ferns mosses, liverworts and lichens (Burrows, 1994). About a third of the forest was burned before the 1850 as evidenced by the kānuka stands, indicative of forest clearance by fire around many Māori settlements in the late 1800s (Burrows, 1994).

Europeans arrived in the mid-1800s, and by 1920 less than 1% of the original forest remained (Wilson, 2002). The Europeans extracted timber and then established crops and pastures. However, over time many of the new pastures have been difficult to sustain, reversion has occurred and stock numbers have been reduced. A report by Boffa Miskell Ltd (Anon., 2007) estimates that livestock numbers were reduced by a quarter between 1980 and 1990. Although there are pockets of native bush, plantation, scrub, wetland and tussock, pasture comprising exotic grasses, *Poa* and *Festuca* spp and *Chionochloa rigida* is still the most common vegetation type on the Peninsula. The introduction of exotic predators and herbivores futher contributed to the decline of local forests. Herbivores browse on palatable plants, particularly targeting the most favourable species as they germinate. Rodents and possums eat the seeds further hampering regeneration. Frugivorous birds are responsible for much seed dispersal and these are actively preyed upon by mustelids, cats and rats (Burrows, 1994). The forest remnants on the peninsula are refuge for native flora and fauna including bellbird/korimako, wood pigeon/kererū, silvereye, pūkeko, fantail/pīwakawaka, tomtit/miromiro, grey warbler/riroriro, rifleman/tītitipounamu, and brown creeper/pīpipi (www.doc.govt.nz).

## 12.3 Agroecology on Te Kaio

Agroecology – which integrates ecological, social and agricultural aspects of land management – provides an excellent framework for the management of Te Kaio with a particular focus on Mahinga kai, working the food or other resources that were utilised for survival.

*"Once the moa became extinct then peoples had to truly think about survival. The concept of working the food was driven out of necessity, adaptability and an approach to the environment. People became observers and these observations were passed down in oral traditions – for example collecting foods at certain times of the year, rituals about processing and storage, for example, kūmara pits, drying in the wind, salting and storing in kelp bags. For Ngai Tahu it meant being nomadic as they followed food sources."*

*(Robin Wybrow)*

Mahinga kai is a cornerstone of culture, and an abundance of food is important for the survival of the people and for manaakitanga or hospitality. Te Kaio (Tumbledown Bay) and Makara (Magnet Bay) are significant sites of early settlement and important with respect to Mahinga kai.

To help plan the conversion of the farm to an agroecosystem reflecting Indigenous agroecology, the farmland has been divided into eight classes.

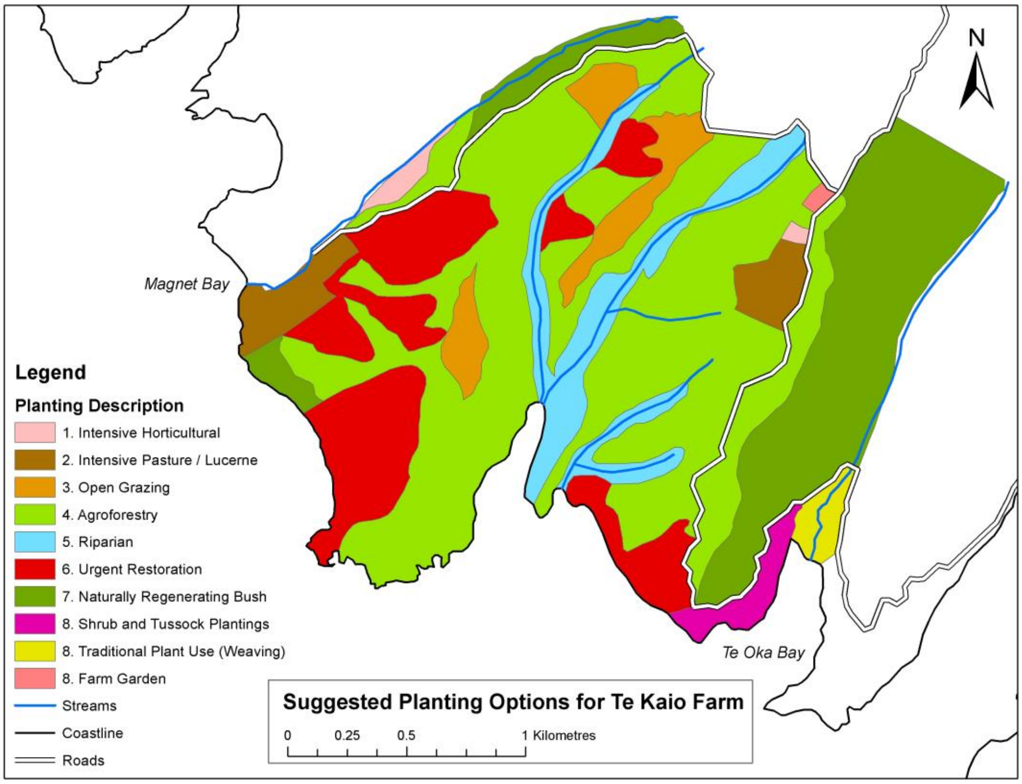



*Figure 2: Map of Te Kaio showing the division of the farm into different management classes*

### 12.3.1 Intensive Horticultural

There is a block of superb soil (approximately 4ha) on the western boundary adjacent to Magnet Bay Creek. This soil was identified by Gianni Principe, a horticulturalist previously employed on Te Kaio as an excellent area in which to grow vegetables. The focus could be on Māori vegetables and crops that would support whānau. Surplus could be sold to local eateries such as the cafes and restaurants from Little River to Akaroa. Kūmara (*Ipomoea batatas*), kamokamo (*Cucurbita pepo*) and Taewa Māori potatoes such as tutaekuri and kararo are likely starting crops. Previously there have been issues with psyllid damage on crops at Te Kaio (Principe pers. comm.). Dr Charles Merfield at the Future Farming Centre, is in the second year of trialing a netting system which successfully prevents the psyllid reaching crops (www.bhu.org.nz/future-farming-centre.). Other crops that could be grown might include silver beet, salad greens, kales and cabbages. The choice of crops should reflect the needs of Wairewa whānau and the opportunities for sales.

### 12.3.2 Intensive Pasture

The two paddocks adjoining Magnet Bay have always been known as excellent lucerne paddocks (Ted Hutchinson pers. comm.).

These paddocks should be used again for lucerne or other mixed cereal/grass crops that can be hayed or baled for stock through the winter.  The crops should be rotated and cover crops used where necessary.  The other intensive paddock is to the south of the main farmhouse.  Again, this could be cropped or sown in highly productive grasses.  It could be used to grow medicinal plants that stock could be rotated through when required or to trial health boosting species such as sainfoin.

### 12.3.3 Open Grazing

The areas identified in Figure 2 as Open Grazing are areas of stable land largely along ridge tops.  Shelter will be provided by the agroforestry plantings and browse bars, planted on the agroforestry side of the fence lines.  The pastures should be planted in productive deep rooting grasses, (summer dry resistant) with clovers, plantain, chicory and other suitable herbs.  This will provide good pasture for flushing ewes and growing on lambs and calves.

*Figure 3: Cattle grazing on the ridge tops Te Kaio*

### 12.3.4 Agroforestry

These paddocks are on steeper slopes running into gullies that require some level of protection.

On most farms, many of the areas indicated as moderately stable or even unstable are in pasture and grazed regularly.  Even if they are recognised as erosion-prone or actively eroding, they may be utilised frequently because of the stocking level and feed requirements at certain times of the year.  Very rarely do land managers take a long-term view and the steadily decreasing productivity of these areas is not acknowledged. After a slip has occurred it is estimated that, over 20 years, pasture production on the site will recover to 70-80% of the pre-slip level where rainfall is not limiting, but there will not be a full recovery (Lambert, et al., 1984). Once the futility of applying pressure to highly erosion prone areas has been recognised, discussion can turn to planting regimes. When trees and shrubs have become established they can be browsed and stock can graze under them. The planting spacing between trees and shrubs should be dictated by the species chosen.

Rongoā species should be integral to the planting plan, to be accessed by Wairewa whānau for the treatment of themselves and livestock. A list of possible Rongoā plantings may be found at the end of the chapter. Species that should also be planted that are of particular significance to Wairewa include: tōtara; species that may be harvested realising a good return; and species that encourage the fauna that the whānau wish to have present. Trees and shrubs that will establish well in the various microclimates must be used and some thought should be given to species that are declining on Banks Peninsula; for examples see Wilson, 2009. The gullies should be thickly planted with shrubs that will help to hold the soil and can be lightly grazed and contribute to ethnoveterinary practices for example Banks Peninsula Koromiko (*Hebe strictissima),* Pāpapa, Snowberry (*Gaultheria antipoda*) and Coprosmas.

*Figure 4: 4a, Pāpapa Snowberry, 4b, Banks peninsula Koromiko. Photographs New Zealand Plant Conservation Network*

The spacing of the trees should be dictated by species, use, ground conditions and their effect on the views from the farm tracks. The pastures should comprise deeply rooting productive and drought-resistant grasses and herbs. Species that may be harvested for kai should also be encouraged in this area. Despite their frequent designation as such, these species are not 'weeds';

for example, puha (*Sonchus* spp.), Hua-inanga (*Chenopodium album*) and native plantains (Roskruge, 2012).

Plantings in the Agroforestry section that borders the horticultural area could have an emphasis on fruit trees including apples, plums, tamarillos, lemons and grapefruit. Karaka trees (*Corynocarpus laevigatus*), which were often associated with pa sites (Burrows, 1994), could be planted in a grove amongst the fruiting trees. The area could be bordered with feijoas and berry bushes forming shelter hedges. Any excess fruit from the trees can be fed to the pigs.

There are sections along the cliff tops that should be planted, these areas are not suitable for tree growth and could usefully provide nurseries for a range of tussocks and small shrubs that are able to cope with sea and salt. Two areas on the steeper cliff areas near Magnet Bay and Tumbledown should be left to regenerate but could usefully be planted with hebes.

#### 12.3.5 Riparian planting

There are four creek systems associated with Te Kaio, two on the boundary and two internally. There is increasing pressure on farmers to keep stock out of natural water and Environment Canterbury in their environmental planning guides specifically requires stock to be excluded from waterways. Tumbledown Creek, on the eastern boundary, flows through the block of regenerating bush from which stock will be excluded so no additional fencing or planting will be required.

Magnet Bay Creek (the western boundary) flows through reserve until it reaches the Te Kaio boundary. The upper section of the creek on Te Kaio is surrounded by regenerating bush. The creek then runs through some land designated for agroforestry, so a short section of riparian fencing will be required. The creek flows through the horticultural block and through the native species block to the sea. The riparian border in the horticultural land need not be fenced. A natural border of larger native grasses, fruiting shrubs and berry bushes could be planted to protect the stream bank and intercept any overland flows. Furthermore, the spread of korare species commonly eaten as greens could be encouraged; for example Puha, sow thistle (*Sonchus* spp), Hua-inanga, fat hen (*Chenopodium album*), Tūtae-Kōau, New Zealand celery (*Apium prostratum*) Hāria , native cabbage (*Brassica oleracea*) and Tohetaka, native dandelion (*Taraxacum magellanicum*) ( Roskruge 2012). Stock will be excluded from the beach access and associated native species so no additional fencing or planting is required. The riparian margin in the agroforestry block might reflect the planting on the land (largely fruit trees) and be planted in native fruiting shrubs such as fuchsia (*Fuchsia excortica*), kaka beak (*Cilianthus puniceus*), karamu (*Coprosma robusta*), Putaputaweta/Marble leaf (*Carpodetus serratus*), green coprosma (*Coprosma virescens*), rohutu (*Lophomyrtus obcordata*) and mikimiki (*Coprosma propinqua, C. rubra* or *C. wallii*). These shrubs will also provide food sources for native birds (Cunningham, 2012).

Two creeks flow from the upper boundary of the farm to Murray's Mistake Bay, joining before reaching the bay itself. The lower end of the creeks at the junction and confluence with the sea is marshy area that could successfully be restored to a vital wetland. Bacteria and fungi growing in wetlands absorb and break down nitrogen and other compounds recycling nutrients. Wetland plants help clean the water and trap silt and the wetland itself provides food for fish, invertebrates, birds and people. Many plants species can be harvested from wetlands to provide kai (food) rongoā (medicine) and materials for weaving and building. Plants to consider within wetland plantings include: the rushes *Juncus gregiflorus* in particular provides cover for nesting birds; sedges (*Carex* spp.) and ferns. Other wetland options are Mingi mingi (*Coprosma propinqua*), other coprosma species, Ti kōuka (*Cordyline australis*), Kahikatea (*Dacrycarpus dacrydioides)* and Rīrīwaka (*Bolboschoenus fluviatilis*).

Both creeks should be fenced and planted along their length. This is an ideal opportunity to plant rongoā rākau or plants used for traditional medicine. The plants can be specifically for human use or for both livestock and humans.

#### *12.3.5.1 Browsing Fenced Margins for Stock Health*

*".. it is commonly known that cows require 96 species to be healthy."*

The source of the quote has been lost over time but the essence rings true. Livestock do better on a broad diet and many old pastures were a mixture of species (Turner, 1951; Foster, 1988) surrounded by hedges that could be browsed. The concept of zoopharmacognosy (self-medication) amongst animals has had a renaissance driven by Huffman's observations of the chimpanzees in Mahale National Park in Tanzania. Chimpanzees that were ill were observed to choose plants that were not a normal part of their diet and having ingested the plants, they were observed to be healthier and to have lower parasite counts in their faeces (Huffman & Seifu, 1989; Clayton & Wolfe, 1993; Huffman, 2003). The literature surrounding the effectiveness of traditional plant remedies and the ability of farmed animals to treat themselves is also growing, for example in Africa (Githiori, Hoglund, Waller, &

Baker, 2004), South America (Lans & Brown, 1998), India (Sharma & Singh, 1989), Europe (Pieroni, Howard, Volpato, & Santoro, 2004) and the United States (Villalba, Provenza, & Shaw, 2006).

Given the opportunity, farmed animals will browse a range of vegetation. Unfortunately, the narrative in New Zealand of ingestion of native vegetation by farmed stock usually pertains to the damage caused by farmed or feral animals (Nugent, Fraser, & Sweetapple, 2001; Forsyth, Coomes, Nugent, & Hall, 2002). Animals on Te Kaio are displaying instinctive knowledge and patterns, for example, the cattle utilise cattle Maukoro (*Carmichaelia* sp.) at various times of the year (Robin Wybrow pers. comm.) and clearly relish Harakeke (flax).

*Figure 5: Harakeke and Maukoro chewed by cattle*

Plantings should approach the fence lines in the case of taller shrubs and trees so that they can be browsed with the forbs and herbs being planted along the inside of the fence so that growth can be accessed but the heart of the plant is protected. Sheep can be used to tidy Rongoā plantings and keep growth down, but cattle should not be given access. Rongoā practitioners adhere to cultural practice, tikanga, handed down over generations, which upholds the integrity of Rongoā harvesting and maintains the resource in good heart (Gallagher, 2009; McGowan, 2009). The respect for the plants and harvesting is just as applicable to managing stock as to human harvesters.

The Eastern branch of the Murray's Mistake Creek is partially vegetated in the steeper less accessible areas. Species already growing include kawakawa (*Piper excelsum*), Māhoe (*Melicytus ramiflorus*), tītoki (*Alectryon excelsus*), kānuka (*Kunzea ericoides*), tōtara (*Podocarpus hallii*), small-leaved milk tree (*Streblus heterophyllus*), a number of coprosmas (for example *C. rotundifolia*, and *C. crassifolia*), ferns such as shield fern (*Polystichum neozelandicum* subsp. *Zerophyllum*), Hookers spleenwort (*Asplenium hookerianum*) and vines, for example *Parsonsia heterophylla (*New Zealand Jasmine). These areas should be left to regenerate and augmented with Rongoā species.

In the absence of expert advice, it is difficult to know where to plant species; in which pockets of the farm will they grow well? To address this need, a programme was developed using GIS-based multi-criteria analysis of terrain and proximity and local botanical knowledge input to indicate optimal areas of growth for traditional medicinal plants (Moore et al., 2015). Seven species were modeled in the initial programme, tōtara (*Podocarpus tōtara*), harakeke (*Phormium tenax*), māpou/matipo (*Myrsine australis*), kawakawa (*Piper excelsum*), Ti kōuka (*Cordyline australis*), mānuka (*Leptospermum scoparium*) and kahikatea (*Dacrycarpus dacrydioides*). The resulting map shows where the seven species may be successfully planted on Te Kaio (Figure 6).

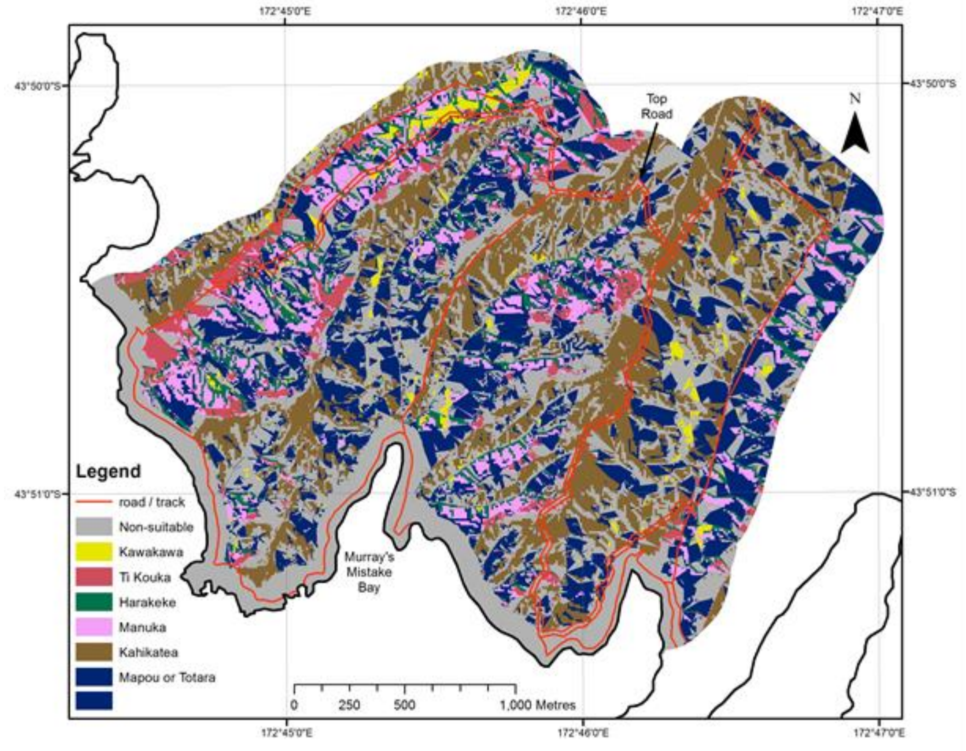



*Figure 6: Map showing where seven Rongoā species might be grown on Te Kaio*

If Rongoā species are routinely planted on farms, not only will the land and stock benefit but communities have the opportunity to practice Rongoā, to pass on the knowledge and to train practitioners in the art of harvesting, preparing and administering Rongoā rākau.

### 12.3.6 Temporarily Retired Areas

These are the badly eroded and actively eroding areas of the farm. They should be fenced off, stock permanently excluded and planted in pioneer soil-healing species such as tree lucerne (*Chamaecytisus palmensis*) and matagouri (*Discaria toumatou*), both nitrogen fixing species and both feed and habitat providers for birds. A number of bird attractant species should be interplanted such as wineberry (*Aristotelia serrata*), kaikōmako (*Pennantia corymbosa*) and māhoe (*Melicytus ramiflorus*).

As birds are encouraged into the areas (kererū love to feed on tree lucerne), seed from other food sources will naturally be deposited. The tree lucerne will die back after a period of about 10 years and then the naturally sown plants should be augmented with flowering species to promote bird life and honey production. The tree lucerne can be gently harvested for fodder if necessary in times of shortage.

*Figure 6: An area of Te Kaio that could be temporarily retired*

### 12.3.7 Naturally Regenerating Bush

The two east-facing ridges on the boundaries of the farm (Magnet Bay Creek and Tumbledown Creek) have large areas of bush remaining on them. These areas should be fenced and left to regenerate. Supplementary planting would speed regeneration, but with increasing bird populations and exclusion of grazers, seedlings will germinate and grow. This process has been successfully demonstrated at Hinewai on Banks Peninsula (Wilson, 2002). The naturally regenerating areas can be regarded as insurance policies and utilised for very short periods as feed banks for times of drought and for emergency shelter and feed in bad weather.

### 12.3.8 Conservation Areas

Conservation areas surround public access to Magnet and Tumbledown bays**.** There is a small car park for the public on the approach to Magnet Bay, from here surfers walk to the beach. At present, there are no facilities available for public use. A small changing shed and composting toilet could be provided, the design either blending into the rocky wood strewn environment or a raupō or driftwood covered hut would stand out as an artwork. The beach is frequented by many birds and seals so the environment should not be disturbed unduly and the hut/toilet should be set well back, an outdoor freshwater shower would be welcomed by surfers.

The approaches to the bay should be planted in shoreline species, especially those that are sensitive to grazing; for example Nau/Cook's scurvy grass (*Lepidium oleraceum)*, rauhuia, native linen (*Linum monogynum*), NZ spinach (*Tetragonia implexicoma*) toetoe (*Austroderia richardii* ), pīngao (*Ficinia spiralis*), Festuca novae-zelandiae (*Ficinia nodosa*), sea rush (*Juncus kraussii var. australiensis*), sand coprosma (*Coprosma acerosa)*, *Coprosma crassifolia, Coprosma propinqua Coprosma robusta,* korokio (*Corokia cotoneaster),* koromiko (*Hebe salicifolia)*, Shrubby toroaro (*Muehlenbeckia astonii*), golden cottonwood (*Ozothamnus leptophylla*), and salt marsh ribbonwood (*Plagianthus divaricatus).*

A mātaitai or prohibition is in place along the coast line of Magnet Bay. This prevents commercial exploitation of the kai moana or seafood and ensures its conservation for local people. A mātaitai recognises a traditional fishing ground and the relationship tangata whenua (the people of the land) have with it and provides for customary management and food gathering, but does not exclude anyone from the area.

Visitors to Te Kaio, Tumbledown Bay will park on the side of the road and access the beach via a stile crossing a small area of land on which there are isolated plantings of Harakeke New Zealand flax and Ngaio (*Myoporum laetum*). Visitors then pass through small sand dunes down to the beach. Ideally the sand dunes should be stabilised with extensive plantings of pīngao (*Ficinia spiralis*). Animals should be excluded from this area, so it is an ideal place to supplement the plantings of ngaio as this plant is toxic to stock. The ngaio, or kaio in the southern dialect, was once plentiful in this area and reflected in the name Te Kaio Bay. The balance of the space could be planted with weaving species, providing a resource for Wairewa whānau and a point of interest for tourists. Species would include a range of cultivars of New Zealand flax (*Phormium tenax*), Ti kōuka cabbage tree (*Cordyline australis*) and perhaps raupō (*Typha orientalis*) to stabilise the meanders in the creek.

## 12.4 Stock

The farm should remain as a sheep and beef farm, the breeds currently on the farm suit the environment and will benefit from the broader diet, shelter and shade engendered by the plantings. Stock will largely be run to the west of the Te Oka road as to the right there is only a strip of summer grazing and emergency bush grazing. There are already yards and sheds on the farm that are used to handle animals but these are on the other side of the Murrays Mistake creeks. It might be useful to construct a small set of sheep yards near the main farmhouse or to invest in some portable yards so that small jobs can be easily done without moving the flock across the farm. If the tourism option is not to be considered the yards across from the farmhouse could be repaired.

Work has been done on the water supply, but once the riparian planting and new fencing is complete the requirement for any further troughs should be assessed.

## 12.5 Soils

There is no detailed soils information for Te Kaio. The Landcare soil mapping project S map on line (www.smap.landcareresearch.co.nz) has no data as yet. The old New Zealand soils map (sheet 9) provides a general classification of soil type as a yellow grey earth Takahe – kiwi 15gH. The soils of New Zealand were reclassified in 1980 and within this classification Te Kaio soils are Fragic pallic PX (soils.landcareresearch.co.nz). Soil tests should be conducted, particularly with respect to the soil microfauna and a programme set in place to improve the soil biology. The use of local kelp as a fertiliser could be investigated.

## 12.6 Other Works

Beehives should be established on Te Kaio to take advantage of the abundant flowering that will occur as the plantings establish. There will be opportunity for specialist native honeys and mānuka and/or kānuka honey.

The suggested plan for Te Kaio will require considerable expenditure and will not initially produce a large income. A stringent pest control programme should be implemented with the planting programme to ensure the survival of the trees and shrubs. The farm will sustain the whānau into the future and as the plantings and horticulture ventures mature and the land recovers more surpluses will be generated. Tourism may provide an alternative income stream in the interim.

## 12.7 The Tourism Potential for Te Kaio.

Surfers and beach goers already travel along the Te Kaio boundary. The farm given its coastal position has superb views and the potential to develop several income generating prospects. Utilising the existing buildings, gardens and land the farm could offer visitors a number of experiences from walking trails, interaction with the garden and animals, and heritage information.

There is an old dairy shed and woolshed near Jim's house. These sheds could easily be renovated and converted to a small museum telling the history of Te Kaio from the time tribes passed through collecting kai to the present day. Tribal histories and archaeological evidence indicate that the land of Te Kaio has been occupied from the period of the moa hunters onwards, middens and artefacts have been found on the farm (Anon.). There are a number of old agricultural implements around the farm which could be collected and displayed. There is ample room for visitors to park and the shed is easily reached from the proposed walking track.

The old woolshed opposite the main farmhouse could be transformed into a small café, and visitor centre. The woolshed is adjacent to the Te Oka Bay road, access is easy and parking is available. The story of Wairewa whānau and the farm, of Te roto o Wairewa and the efforts to restore tuna (eels) could be told here through interactive displays.

*Figure 7: An example of a Māra kai demonstration at Hamilton Botanical gardens*

In addition to drinks and café food, plants and produce from the farm garden could be sold. The produce could be displayed with its story and suggested recipes. Visitors could walk across the road from the café to the farm garden, an exemplification of māra kai, Māori gardening.

The garden should be fenced with a palisade and include a Pātaka, storehouse and display of traditional gardening tools such as kō a digging stick, timo a grubbing tool and ketu, smaller hand tool (Talbot). The farm garden should provide vegetables, herbs and soft fruit for the whānau and the café. The garden will remind people that when the first European settlers came to Wairewa they found gardens at Little River growing Indian corn, potatoes and many vegetables. There are numerous small sheds adjacent to the farm garden these can be used to house chickens (free range) and a couple of kune kune pigs. The farm will provide most of the feed for these animals and they will be an additional point of interest for visitors. A short walk from the garden brings the visitor to a superb viewpoint, looking out across the farm to Kaitorete spit, a narrow neck of land separating Te Waihora, Lake Ellesmere from the ocean.

*Figure 8: The view across the farm to Kaitorete spit.*

The trustees have had preliminary discussions with other landowners as to the feasibility of a Southern bays track, similar to the very popular Banks Peninsula track (www.bankstrack.co.nz). The planning, negotiations and building of a multi property track is likely to be a lengthy process. In the interim, a track could be constructed on Te Kaio to cater for walkers. As part of the Post graduate diploma in surveying Jeremiah Gbolagun developed a proposal for a track from the boundary of the farm down to Murray's Mistake beach and back up to the farm boundary. The proposed track is shown in Figure 9.

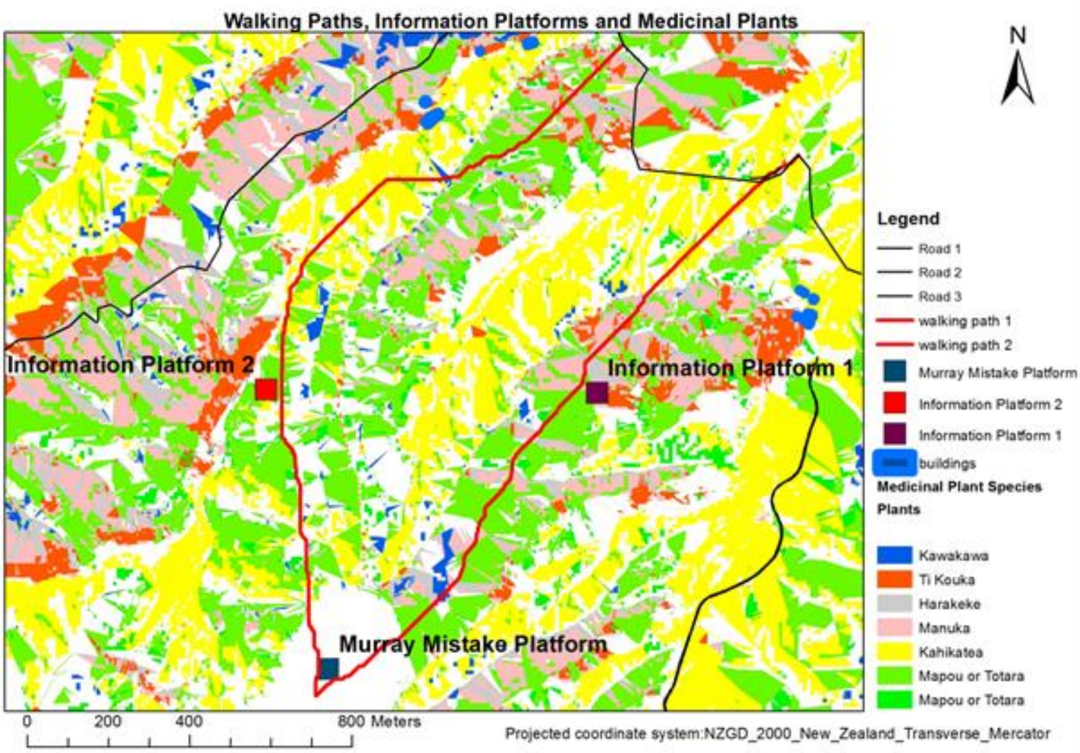



*Figure 9: Proposed walking tracks and information platforms. Map courtesy of Jeremiah Gbolagun*

Walkers leaving the farm boundary would descend to the private beach following the eastern arm of the creek. The path passes above regenerating bush and alongside developing agroforestry blocks, which are being planted with trees and shrubs that will provide traditional food, medicine, dyes, oils and bark. The path descends to the creek and crosses to the eastern bank. The bridge at the crossing point could be crafted locally reflecting traditional stories. Where the bridge crosses the creek there is a large open area that could be planted in tōtara, much of the peninsula was once clothed in tōtara and old tōtara fence posts can still be found on Te Kaio. The plantings would reflect the natural history of the farm and provide a valuable resource in the future, tōtara for traditional carving and for sale. Stock will also use this bridge to cross from one side of the farm to the other so an alternative rope bridge might also be provided for the adventurous.

The path now passes through large areas of riparian planting which is protecting the waterway. The riparian margins here are planted with rongoā rākau (plants that are used for traditional medicine). Members of the community can harvest these plants, keeping traditional knowledge alive and livestock can access them for self-medication. The path passes above rocky hollows in which a number of native species have survived, including small areas of kawakawa. As the path approaches Murray's Mistake beach it passes through the restored wetland area overlooked by a number of local artworks. At Murrays Mistake there is a small memorial cairn to those aboard the ship that was wrecked when the captain put in there many years ago thinking he was going to Oashore whale fishery (Jacobsen, 1914). Leaving the beach, the path ascends the ridge through more agroforestry plantings with stunning views out cross the farm to the sea. As the walker nears the farm boundary once again the path drops down to the creek passing through further rongoā riparian plantings and passing an old lime (*Tilia* sp.) tree often frequented by kererū.

## 12.8 Is it Agroecology?

Altieri et al. (2012) presented a set of questions that should be asked as the management of a farm moves towards agroecological management. Considering the questions will guide the trustees in their decisions.

*Table 1: A Guide to Agroecological Practice*

| |
|---|
| Is the farm using local and improved crop varieties and livestock breeds, enhancing genetic diversity and adaptation to changing biotic and environmental conditions? |
| Is the farm avoiding the use of agrochemicals and other technologies for example heavy machinery or transgenic crops that harm the environment and impact human health? |
| Is the use of resources such as water, nutrients and energy efficient and has the farm reduced the use of external inputs and non-renewables. |
| Are agroecological principles and processes being used to promote nutrient recycling, biological nitrogen fixation, allelopathy and biological control? Is functional biodiversity being encouraged through diversified farming systems? |
| Is the best of traditional and scientific knowledge being used and is innovation welcomed? Are cultural identities, participatory methods and farmer networks recognised? |
| Are efforts being made to reduce the ecological footprint of production, distribution and consumption to minimise pollution, soil damage and Greenhouse Gas emission? |
| Are practices promoted enhancing clean water availability, carbon sequestration and conservation of biodiversity, soil and water? |
| Is there a balance between long-term adaptability and short-term efficiency and an ability to cope with short-term change? |

| |
|---|
| Is there improved adaptive capacity and resilience through maintaining agroecosystem diversity so that the farm is responsive to change and to secure key farming functions? |
| Is the farm conserving agricultural heritage supporting social cohesion and a sense of pride to help reduce migration from rural areas? |

Table 2 lists the questions proposed by Koohafkan, et al. (2011) to evaluate whether a developing agricultural system is likely to be sustainable and to support local communities.  If the system is based on agroecological principles, the answers will be positive. The fewer positives, the less sustainable the system.  The answers have been suggested by the author for Te Kaio but will benefit from consultation with Wairewa whānau whenua.

*Table 2: Evaluating the sustainability and local community support of a farming system for the proposed development on Te Kaio farm*

| **Is the development a sustainable one?** | **Te Kaio** |
|---|---|
| Reduce poverty? | Yes, food is provided for Wairewa whānau in need and income is generated from the farm for Wairewa |
| Based on rights and social equity? | The farm belongs to Wairewa and is managed by the trustees for the benefit of the whānau whenua |
| Reduce social exclusion women, minorities indigenous peoples? | The farm is owned by people indigenous to the area.  Employment would be provided that would include women and opportunities would be provided for youth. The specific plantings encourage the resumption of traditional skills and provide the raw materials for cultural revitalisation |
| Protect access and rights to land, water and other natural resources? | The mātaitai on the coast protects the traditional fishing grounds.  The proposed management incorporating extensive planting will protect the water and heal the land |

| Is the development a sustainable one? | Te Kaio |
|---|---|
| Enhance water access and availability? | The riparian plantings and wetland restoration will help conserve and clean all the water flowing through Te Kaio |
| Regenerate and conserve soil, increase or at least maintain soil fertility? | Removing the badly or actively eroding areas from grazing and planting them will begin to regenerate the land. Managing the other areas according to the land capability will conserve the soils. Managing the entire farm according to agroecological principles will regenerate the soils |
| Reduce soil loss/ degradation and enhance soil regeneration and conservation? | Riparian and agroforestry plantings will reduce soil degradation and aid in its conservation. On the more intensively managed areas the suggested use of cover crops and deep rooting species will protect the soil and increase organic matter. The encouragement of soil biota will help regenerate it |
| Maintain or enhance organic matter and biological life and biodiversity of the soil? | All the plantings will support the agroecosystem and encourage nutrient cycling. By maintaining soil cover and a diversity of species, including livestock the biology of the soil will be protected and enhanced |
| Prevent pest and disease outbreaks? | As there will be no monocultures and plentiful mixed species plantings the likelihood of pest and disease are reduced. There will be opportunity for companion planting and other non-chemical control methods in the horticultural and māra kai areas. As the livestock will have a broader diet and access to plants for self-medication including anthelminthic plants they will be healthier. The stocking rate will be maintained at a level easily supported by the farm so there will be no undue stress on stock |

| Is the development a sustainable one? | Te Kaio |
|---|---|
| Conserve and encourage agrobiodiversity? | The planting of a variety of native and non-native species will conserve and encourage agrobiodiversity. As the water becomes cleaner, the wetland restored and the forestry established there will be more habitat for fauna to re-establish |
| Reduce GHG? | The plantings and non-intensive husbandry of the land will increase carbon sequestration and decrease greenhouse gas production |
| Increase income opportunities and employment? | The farm already employs a manager and a stockman. Further staff will be needed for the required fencing and planting. The plantings need to be maintained and predators controlled. There will be opportunities for employment in the horticultural unit and the farm garden. If the tourism options are taken up there will be employment in the café and on the tracks |
| Reduce variation in agricultural production under climatic stress? | The farm contains a number of microclimates that can be utilised for different crops, shifting to cope with climatic variation. The pastures should be planted with diverse deep rooting species to encourage persistence. As the proposed management system is diverse and includes traditional food sources the farm will be resilient |
| Enhance farm diversification and resilience? | The proposed land classification, plantings and alternative income streams will promote resilience |
| Reduce investment costs and dependence on external inputs? | The investment in infrastructure will be high but once the farm is developed and running there will be little investment required and few external inputs |
| Increase degree and effectiveness of farmer organisations? | The farm should stand as an example of how land can be managed upholding kaitiakitanga, the principles of rongoā and indigenous agroecology |

| Is the development a sustainable one? | Te Kaio |
|---|---|
| Increase human capital formation? | The changes in management will create employment opportunities. Importantly with the accessibility of plants, materials and restored bush and wetlands young people will be able to rekindle their culture and learn traditional ways |
| Contribute to local or regional food sovereignty? | The farm will provide food and resources for Wairewa and the wider community |

## 12.9 Conclusion: The Potential of Te Kaio

Te Kaio farm could be developed in a number of ways. It could become organic or the trustees could simply manage the land with minimal input and returns. Alternatively, the farm could be an exemplar of indigenous agroecology principles. As the farm developed it would answer all of Altieri and colleagues questions with an affirmative.

## References


Altieri , M., Bartlett, A. K., Callenius, C., Campeau, C., Elasser, K., Hagerman, P., . . . Ulmer, K. 2012. *Nourishing the world sustainably:scaling up Agroecology* (pp. 47). [www.e-alliance.ch:](http://www.e-alliance.ch) Ecumenical Advocacy Alliance.

Anon. 2015. *Te Kaio Bay - Tumbledown Bay Retrieved* 28/7/15,

Anon. 2007. *Banks Peninsula Landscape Study*: Boffa Miskell.

Burrows, C. J. 1994. Fruit, seeds birds and the forests of Banks Peninsula. *New Zealand Natural Sciences, 21*, 87-108.

Clayton, D. H., & Wolfe, N. D. 1993. The adaptive significance of self-medication. *Trends in Ecology & Evolution, 8*(2), 60-63. doi: 10.1016/0169-5347(93)90160-q

Cunningham, S. 2012. *Establishment and enhancement of native biodiversity on Te Putahi farm, Banks Peninsula, Christchurch* (pp. 53): University of Otago.

Forsyth, D. M., Coomes, D. A., Nugent, G., & Hall, G. M. J. 2002. Diet and diet preferences of introduced ungulates (Order: Artiodactyla) in New Zealand. *New Zealand Journal of Zoology, 29*(4), 323 - 343.

Foster, L. 1988. Herbs in Pastures. Development Research in Britain, 1850–1984. *Biological Agriculture & Horticulture: An International Journal for Sustainable Production Systems, 5*(2), 97-133.

Gallagher, K. (Writer). 2009. *Earthwhisperers Papatūānuku*. WickCandle Film.

Githiori, J. B., Hoglund, J., Waller, P. J., & Baker, R. L. 2004. Evaluation of anthelmintic properties of some plants used as livestock dewormers against Haemonchus contortus infections in sheep. *Parasitology, 129*(Pt 2), 245-253.

Huffman, M. 2003. Animal self-medication and ethno-medicine: exploration and exploitation of the medicinal properties of plants. *The Proceedings of the Nutrition Society, 62*(2), 371-381.

Huffman, M., & Seifu, M. 1989. Observations on the illness and consumption of a possibly medicinal plant, by a wild chimpanzee in the Mahale Mountains National Park, Tanzania. *Primates, 30*(1), 51-63. doi: 10.1007/bf02381210

Jacobsen, H. C. 1914. Tales of Banks Peninsula Outside the harbour. *Akaora Mail*.

Johnson, M. 2012. *Adapting the principles of Te Rongoā into ecologically and culturally sustainable farm practice* (pp. 21). http://www.maramatanga.ac.nz/sites/default/files/10%20RF%2032%20Final%20Contract%20report%20for%20web.pdf: Ngā Pae o te Māramatanga .

Koohafkan, P., Altieri , M., & Holt-Gimenez, E. 2011. Green Agriculture:foundations for biodiverse, resilient and productive agricultural systems. *International Journal of Sustainability, 10*(1), 61-75.

Lambert, M. G., Trustrum, N. A., & Costall, D. 1984. Effect of soil slip erosion on seasonally dry Wairarapa hill pastures. *New Zealand Journal of Agricultural Research, 27*(1), 57-64.

Lans, C., & Brown, G. 1998. Ethnoveterinary medicines used for ruminants in Trinidad and Tobago. *Preventive Veterinary Medicine, 35*(3), 149-163. doi: 10.1016/s0167-5877(98)00066-x

McGowan, R. 2009. *Rongoā Māori A practical guide to traditional Māori Medicine*. Tauranga New Zealand: Rob McGowan.

Moore, A., Johnson, M., Lord, J., Coutts, S., Pagan, M., Gbolagun, J., & Hall, G. B. 2015. Applying spatial analysis to the agroecology-led management of an indigenous farm in New Zealand. *Ecological Informatics*.

Nugent, G., Fraser, W., & Sweetapple, P. 2001. Top down or bottom up? Comparing the impacts of introduced arboreal possums and 'terrestrial' ruminants on native forests in New Zealand. *Biological Conservation, 99*(1), 65-79.

Pieroni, A., Howard, P., Volpato, G., & Santoro, R. F. 2004. Natural Remedies and Nutraceuticals Used in Ethnoveterinary Practices in Inland Southern Italy. *Veterinary Research Communications, 28*(1), 55-80.

Roskruge, N. 2012. *Tahua-Roa food for your visitors Korare Māori green vegetables Their history and tips on their use.* Palmerston North, New Zealand: Institute of Natural Resources, Massey University.

Sharma, P. K., & Singh, V. 1989. Ethnobotanical studies in NorthWest AND Trans-Himalaya. V. Ethno-veterinary medicinal plants used in Jammu and Kashmir, India. *Journal of Ethnopharmacology, 27*(1–2), 63-70. doi: 10.1016/0378-8741(89)90078-0

Talbot, L. *Grow your own kai*. Whanganui, New Zealand: Te Atawhai o te Ao Independent Māori Institute for Environment and Health.

Turner, N. 1951. *Fertility Farming*. London: Faber and Faber.

Villalba, J. J., Provenza, F. D., & Shaw, R. 2006. Sheep self-medicate when challenged with illness-inducing foods. *Animal Behaviour, 71*(5), 1131-1139. doi: 10.1016/j.anbehav.2005.09.012

Wilson, H. 2002. *Hinewai: The Journal of a New Zealand naturalist*. Christchurch New Zealand: Shoal Bay Press.

Wilson, H. 2009. Natural History of Banks Peninsula. Christchurch, New Zealand: Canterbury University Press.

Wiser, S. K., & Buxton, R. P. 2009. Montane outcrop vegetation of Banks Peninsula, South Island, New Zealand. *New Zealand Ecological Society, 33*(2), 164-176.

## Appendix 1.

Some suggested Rongoā species that could be planted on Te Kaio adapted from Johnson 2012.

| Scientific name | Māori or common name | Action | Growth form |
|---|---|---|---|
| *Acaena anserinifolia* | Piripiri, Biddybid | Tonic | Herbaceous |
| *Alectryon excelsus* | Tītoki, New Zealand Ash | Chest TB | Tree/shrub |
| *Amygdalus persica* | Pītiti ,Peach | Tonic | Tree/shrub |
| *Apium prostratum* | Tūtae kōau, wild celery | Tonic | Herbaceous |
| *Aristotelia serrata* | Makomako, Wine berry | Tonic | Tree/shrub |
| *Barbarea vulgaris* | Toi ,Winter cress | Tonic | Herbaceous |
| *Brassica campestris* | Nanī, Keha Māori turnip | Tonic | Herbaceous |
| *Brassica oleracea* | Kāpeti Māori cabbage | Tonic | Herbaceous |
| *Brassica rapa* | Pōhata, Wild turnip | Tonic | Herbaceous |
| *Calystegia sepium, C. Soldanella* | Pōhue, Pōhuehue, Pōpōhue, Panahi, Rauparaha Bindweed | Lactation, Scour | Climber |
| *Cardamine debilis* | Panapana, NZ bitter cress | Tonic, Scour | Herbaceous |
| *Chenopodium album* | Huainanga, Huainga Fat-hen, | Tonic, Antiparasitic | Herbaceous |
| *Coprosma acerosa* | Tātaraheke, Tarakupenga Sand coprosma | Tonic | Tree/shrub |
| *Coprosma robusta* | Karamū | Tonic | Tree/shrub |
| *Cordyline australis* | Tī kōuka, Cabbage tree | Tonic, Scour Lactation | Tree/shrub |
| *Corynocarpus laevigatus* | Karaka | Wounds | Tree/shrub |
| *Cortaderia spp.* | Toetoe Haumatangi | Scour, Styptic Antiparasitic | Herbaceous |

| Scientific name | Māori or common name | Action | Growth form |
|---|---|---|---|
| *Dacrycarpus dacrydioides* | Kahikatea, White pine | Tonic, | Tree/shrub |
| *Elaeocarpus hookerianus* | Pōkākā White hinau | Tonic, Scour | Tree/shrub |
| *Eucalyptus globulus* | Purukamu, Blue gum | Scour, Chest, Wounds | Tree/shrub |
| *Gaultheria antipoda* | Pāpapa, Korupuka, Snowberry | Lactation | Tree/shrub |
| *Geum urbanum* | Kopata Common avens, Herb Bennett | Scour | Herbaceous |
| *Geranium microphyllum* | Namunamu Small leaved geranium native cranesbill | Chest, TB | Herbaceous |
| *Gnaphalium keriense, G. luteo-album* | Puatea, Pukatea Cudweed | Scour | Herbaceous |
| *Hebe strictissima* | Koromiko Banks peninsula koromiko | Tonic, Scour, Wounds | Tree/shrub |
| *Hierochloe redolens* | Kāretu, Scented, Holy grass | Fungicide | Herbaceous |
| *Hoheria populnea, H. angustifolia* | Hōhere Lacebark<br>Houhi Narrow leaved lacebark | Chest | Tree/shrub |
| *Kunzea ericoides* | Kānuka | Scour | Tree/shrub |
| *Lepidium oleraceum* | Nau, Heketara, Cooks scurvy grass | Tonic | Herbaceous |
| *Nasturtium officianale* | Kōwhitiwhiti, Wātakirihi, Watercress | Tonic | Herbaceous |
| *Pelargonium inodorum* | Kopata, scentless pelargonium | Scour | Herbaceous |
| *Phormium tenax* | Harakeke, NZ flax | Tonic, Fungicide, Antiparasitic, Styptic | Herbaceous |
| *Pittosporum eugenioides* | Tarata Lemonwood | Chest, Wounds | Tree/shrub |

| Scientific name | Māori or common name | Action | Growth form |
|---|---|---|---|
| *Plantago spp.* | Kopakopa, Pārerarera Plantain | Tonic | Herbaceous |
| *Pneumatopteris pennigera* | Piupiu feather fern, Pakau, gully fern | Antiparasitic | Fern |
| *Podocarpus totara* | Tōtara | Tonic, Wounds (splints) | Tree/shrub |
| *Prumnopitys ferruginea* | Miro | Styptic, Antiparasitic, Wounds | Tree/shrub |
| *Pseudopanax edgerleyi* | Raukawa | Antiparasitic | Tree/shrub |
| *Ripogonum scandens* | Kareao, Supplejack | Tonic, Antiparasitic, Wounds | Climber |
| *Rorippa palustris* | Hanea, Ponui, Marsh cress | Tonic | Herbaceous |
| *Rubus cissoides* | Tarāmoa, tātarāmoa Bush lawyer | Scour, Antiparasitic, Chest | Climber |
| *Salix babylonica* | Whiro ,Weeping willow | Tonic | Tree/shrub |
| *Schefflera digitata* | Patē Seven finger | Fungicide | Tree/Shrub |
| *Sonchus olearus* | Puha, sow thistle | Tonic, Wounds | Herbaceous |
| *Taraxacum magellanicum* | Tohetaka, Tohetake, NZ dandelion | Tonic | Herbaceous |

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# 13 Henga and the Moriori Ethnobotanical Garden: Agroecology and Ethnobiology

Marion Johnson

Hokotehi Moriori trust kindly invited us to Rēkohu, Henga farm and the Moriori Ethnobotanical Garden (MEG) several times over a period from 2011 to 2015. We were introduced to Moriori life and history, and the ecology of a unique island. Being from outside we have tried to develop an Indigenous Agroecology plan for Henga and MEG, but are aware that our insights are limited.

## 13.1 Rēkohu

600 people live on two of the 11 islands that comprise the Chathams (Figure 1). The islands, 860km due east of Christchurch in the southern ocean are windy and misty, hence the Moriori name for Chatham Island – Rēkohu. Rēkohu (Wharekauri or Chatham) comprises 90,000 hectares (not including the area of the lagoon Te Whanga). Rangihaute, or Pitt island, some 6000 hectares (DoC, 1999). The primary economic activities on Rēkohu are fishing, farming and tourism, fishing providing the greatest returns to the local economy.

The Chatham Islands Enterprise Trust (CIET) is charged with providing "*key infrastructure facilities and services to promote economic and social development in a cost effective and sustainable manner in accordance with the trust deed*" (www.chathams.co.nz/index.php/enterprise-trust).

One of the objectives of the deed is "*to promote farming and the farming industry in the Chatham Islands in the interests of the community of the present and future inhabitants of the Chatham Islands and to facilitate improvement of island farming practice and assist with projects such as sustainable farming on a reactive and supportive basis.*"


*Figure 1. Rēkohu (Chatham Island) in relation to New Zealand*

*(Map Chatham Islands Council)*

The Chatham Islands group has 902 vascular plant taxa, of these 42 taxa are endemic, occurring only on the islands. There is one monotypic genus (only one species in the genus), the Chatham Island Forget-me-not (*Myosotidium hortensia*) (de Lange et al., 2011; NZPCN). The islands have the highest level of plant endemism in Aotearoa New Zealand. There is one wetland shrub community and two coastal mixed broadleaf forests; one dominated by Kōpi (*Corynocarpus laevigatus*), the other by akeake (*Olearia traversiorum*). One lizard, numerous invertebrates and 16 birds are also endemic to the islands (1999). A checklist of the vascular plants of the Chatham islands has been published by the Department of Conservation (de Lange et al., 2011).

*Figure 2: Chatham Island forget me not (Myosotidium hortensia). Flower photograph credit Peter de Lange*

## 13.2 Moriori

Moriori are Tchakat Henu (people of the land/tangata whenua) travelling from eastern Polynesia some 800-1000 years ago, settling on Rēkohu and Rangihaute islands between 1000 and 800 years ago (King, 1989; Solomon and Thorpe, 2012). Moriori trace their ancestry to the founding ancestor, Rongomaiwhenua. The early Moriori forbade killing and cannibalism and committed to living in peace, following a code known as Nunuku's law. In 1791, the brig Chatham arrived at Kaingaroa to be followed by sealers, whalers and Māori invaders.

For a fuller description of the Moriori tradition and history of Rēkohu see Sam Jackson's Chapter 7, this report. Moriori have been described as itinerant on the islands, dependent upon the sea with no horticultural traditions but this view is being challenged (Solomon and Thorpe, 2012). Prior to the invasion there were over 1600 Moriori on the island. By 1862, 101 people remained (Solomon and Thorpe, 2012). Following recognition of the existence of Moriori and a revival of culture, people have returned to the island and/or reclaimed their history. In the 2013 census 738 people identified as Moriori (www.stats.govt.nz). Collaboration with the author Michael King led to the publication of *Moriori: A People Rediscovered* in which the history of Moriori is made available and accessible to all. As a people today, Moriori are represented by Hokotehi Moriori Trust, established in 2001. The trust is committed to the development of a *"commercial, cultural, language and resource base for Moriori"* and is the imi authority for Moriori in negotiations with the crown.

## 13.3 Land and Marae

Moriori are one of major landowners on Rēkohu. In 1997, five hectares of land was bought at Awatea on which Kopinga marae was built. The marae officially opened in January 2005 provides a place for Moriori to meet *"celebrate and just be together"* (www.moriori.co.nz). The marae is also a tribute to and acknowledgement of the sacrifices made by earlier Moriori in holding to the commitment of Peace. Their names are inscribed on the central pou. Kaingaroa station (3320 ha) was purchased by the trust in 2004, Henga (400 ha) in 2005. Kaingaroa station surrounds the J. M. Barker Hapupu National Historic Reserve in which there are a number of rākau momori, Moriori dendroglyphs. The Hokotehi Moriori Trust is working with the Department of Conservation to conserve and protect as many carvings as possible.

*Figure 3: Kopinga marae*

## 13.4 Farming on Rēkohu

Livestock were introduced to the islands in 1841 (Madden and Healy, 1959). David Holmes recalls that 50 Saxony merinos were imported in 1840, the progeny of which spread around the island. Fredrick Hunt brought further sheep to Rangihaute in the 1840s (Hunt, 1866) and Engst and Baucke brought 50 sheep back from Sydney and a number of cattle beasts. Sixty Romney rams arrived in 1870; giving rise to the Chatham Island Romney, a big clean sheep. The Lincoln, to give greater wool weights, and English Leicester were then imported. In the last century

Shropshires, Cheviots, Polled Dorsets, South Downs, South Suffolks, Border Leicesters, Coopworths, Perendales and Texel have all been imported. The original cattle brought onto the island were probably Longhorns and Red Devons. Herefords are recorded as running at Wharekauri station in 1900 and Shorthorns at Kaingaroa in 1923. Many of the cattle ran wild or were grazed on the clears (Holmes, 1993). Today Herefords and Black polls (Angus) predominate. The first Jersey bull arrived in 1918 and there were herds of milking Shorthorns by 1924. At one time, butter was exported from the Chathams and a cheese factory operated. Livestock have to be shipped to and from the Chathams and this has always provided a hurdle for farmers as there are large costs involved (Dalton, 2014). David Holmes gives vivid descriptions of animals being swung aboard ships and photographs in Waitangi museum provide graphic descriptions (Figure 4).

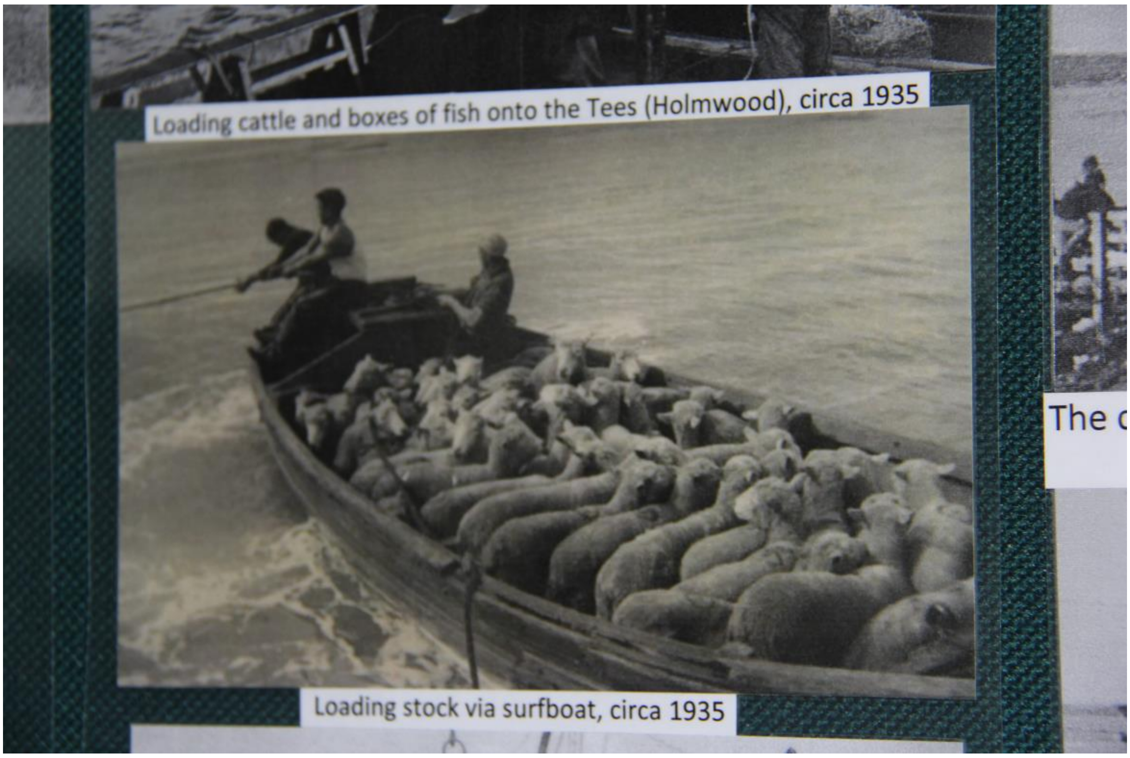


*Figure 4: Loading sheep photograph Waitangi museum*

As the ships and the accommodation for livestock changed, losses in transit increased yet farmers still paid transport on dead sheep. Many cull ewes were just killed on the island and the carcasses dumped on the beach (Holmes, 1993). Today stock is freighted to Timaru and then agisted before being sent to the works or moved on as stores but there are still large costs involved. In 1968, the Department of Agriculture sent Lindsay Galloway to the Chathams to assess farming and set some goals to raise production.

Working together the farmers raised lambing percentages and calving rates, and achieved greater killing-out percentages and improved wool weights. The introduction of new breeds and lines led to improvements in wool quality and training elevated wool handling skills. The Chatham Island Shearing and Wool handling championships began at this time and are still contested (Dalton, 2014). Beef and Lamb have recently held workshops on the islands.

With livestock and settlers came many new plants. Kirk listed 28 introduced species by 1873, and by 1959 there were 153. Cockayne (1902) suggests that the large numbers of sheep that were grazing on the islands may actually have helped prevent the establishment of many introduced species but acknowledges the havoc wrought on the native vegetation by the introduction of cows, sheep, horses and pigs. Introduced species have arrived on the islands as accidental introductions with livestock, seed, machinery and building materials. Other species have been deliberate introductions for food and medicine and more recently as garden ornamentals (de Lange et al., 2011).

Potatoes probably arrived on the Chathams in the 1820s with the sealing gangs from Tasmania (Holmes, 1993), becoming an important crop on the islands. Fredrick Hunt traded potatoes and vegetables with the whaling ships and there was a large export trade until 1860. Potato blight struck in 1903 and many stored potatoes rotted; ending the trade (Holmes, 1993). Fruit and vegetables grew well upon the island (Cockayne, 1902) and most families had a house cow (Holmes, 1993).

## 13.5 The Moriori Ethnobotanical Garden (MEG)

The 12-hectare garden adjacent to Henga scenic reserve was fenced off from Henga farm in 2011. The garden serves as a living memorial to the Moriori way of life before the arrival of other peoples and the subsequent changes in society. Gardens are quiet spaces; MEG is a place of reconnection and reflection upon Nunuku’s covenant of peace and Moriori ethics. An ethnobotanical garden links people to the plants that support and nurture them, it provides a window into the past and is a pathway to the present. Ethnobotanical gardens are not solely about food plants; many species support life providing materials for housing, making fire, weaving, fishing or boat building. Today the distinctive endemic and indigenous plants of Rēkohu are valued throughout the world and could be conserved and displayed in the garden. MEG could provide a refuge for many species. During the planning discussions it was envisaged that the garden would become a resource for teaching and research, providing education and opportunity for Moriori whilst reconnecting them to their past. Living on an island meant that resources had to be carefully husbanded, lessons that are equally relevant today. In 2016, a carving wānanga will be held in which participants will relearn the art of engraving the Kōpi tree using young trees in MEG. The trees currently growing in the garden are Kōpi (*Corynocarpus laevigatus*), karamu (*Coprosma chathamica*) and matipo (*Myrsine chathamica*). Originally, it was planned to plant 2000 Kōpi to represent Moriori before the invasion but the forest is regenerating fast with hundreds of young Kōpi growing on the forest floor. Within MEG, there are also limestone bluffs on which numerous endemics could find refuge, as well as wetlands and a large pond. The pond supports a healthy population of watercress (*Nasturtium officinale*), which is likely to be pollutant free and already supports islanders.

The garden would benefit from shelter on the boundaries. Planting has begun using Chatham Island akeake (*Olearia traversiorum*), traditionally used for firewood and building, the bark being used to line the walls of whare. Toetoe (*Cortaderia turbaria*) was used to thatch the whare roof.

*Figure 5: MEG (clockwise) Kōpi regenerating, the garden, planting Kōpi Me Rongo 2011*

## 13.6 Kopi

The Kōpi is revered by Moriori. It has been used for food, shelter, gatherings and is deeply intertwined with cultural beliefs. A ceremony was held to ensure the future fruitfulness of the Kōpi (Riley, 1994) and many of the older trees - 200-600 years old (Solomon and Thorpe, 2012) – bear unique carvings known as Rākau Momori, memorials to ancestors and events. Numbers of the older trees are dying, some have been removed to preserve the carvings and others are being protected in situ by the erection of windbreaks and imposition of rahui to lighten the visitor load on their environment. The Kōpi kernels made a significant contribution to the diet; they were first baked in an earth oven then placed in baskets. The baskets were put in water and stamped upon to get rid of the outer pulp of the fruit. The kernels were then steeped in water for no less than three weeks (Shand, 1894).

*Figure 6: Rākau Momori*

For Moriori it is vital to retain knowledge of the tree for example, how to prepare the berries so that they become a nontoxic food source; how to carve the trunks; how to use Kōpi for medicine. Kōpi also provide the spiritual connection to the ancestors who have passed.

## 13.7 Henga farm

The lagoon borders Henga farm on the east and MEG and the Henga Scenic reserve on the west. At 400 ha, the farm is not currently considered economic if managed as conventional sheep and beef farm (Whatman pers. comm.).

*Figure 7: Henga farm and MEG. MEG is outlined in the darker yellow.*

According to the latest stock reconciliation, 2040 stock units are run; 656 ewes and hoggets, 270 cows and other cattle, four rams and 42 calves. The sheep are Romney with a Texel being used as a terminal sire. The cattle are largely Herefords with a small number of Red Devons, which were bought with the farm. The farm has had little fertiliser applied, some superphosphate, sulphate of ammonia and lime on the improved pastures. Approximately 25 hectares have been sown in ryegrass (*Lolium perenne*) and clover (*Trifolium repens*) with some cocksfoot (*Dactylis glomerata*) and timothy (*Phleum pratense*).

*Figure 8: Henga: Red Devon cattle and sheep*

A large part of Henga farm is under gorse. It could be sprayed and cleared at enormous expense, but then continual pressure would have to be applied to retain clear pastures. Ideologically and financially, the application of toxic herbicide is difficult. The paddocks on the west side of the farm close to Henga Lodge and those alongside MEG, are clear and have good clover and grass content, ideal for lamb fattening and growing on young stock.

## 13.8 Agroecology Henga and MEG

Agroecology emphasises the importance of connection to the land. Henga and MEG provide this, supporting both the physical and spiritual aspects of Moriori life.

**"***Me Rongo"* is a Moriori term meaning "in peace." It is used as both a salutation and affirmation. The word "rongo" also embodies other vital ingredients for peaceful living, as rongo means "to listen." Me Rongo implies that in order to be in peace, one must also listen, and listen deeply and respectfully. This listening is not just amongst people, but also incorporates *"a deeper listening to the rhythms and sounds of the living systems of which we are a part"* (www.merongo.com).

In 2011, the inaugural Me Rongo Congress for Peace, Sustainability and Respect for the Sacred was held at Kopinga marae. After the gathering, the Me Rongo declaration was ratified honouring Moriori traditions of peace. The declaration is given below. The management of Henga and MEG should be guided by the spirit of me rongo, listening to the land and the ancestors, regenerating the land and managing for peace and future generations.

**Me Rongo declaration 2011** (www.merongo.com)

We believe that the creation of a meaningful and lasting, intergenerational practice of mindfulness is essential for establishing a culture of peace and non-violence. When you have hope for future generations, peace prevails.

We are convinced that the Moriori message of peace is something to be proud of and is worthy of sharing with the rest of the world, as an unbroken commitment over countless generations to peacekeeping, and as a beacon of hope. Moriori history on Rēkohu demonstrates that it is possible to consciously and successfully change from a culture that accepted occasional warfare and killing to one of peace and the outlawing of killing.

Our collective experience shows that in order for individuals, communities and states to recover from acts of violence or aggression, a process for meaningful reconciliation needs to occur. The destructive consequences otherwise are intergenerational.

Our experience also shows that adoption of and adherence to values of peace and non-violence is not simply an option – it is a necessity - in a world of increasingly fragility. This also acknowledges that peace is not simply absence of violence. Peace is contingent on the presence of justice, and the respect for and freedom of identity in our hearts, homes, communities, and across the Earth.

We are further convinced that there is a deep connection amongst notions of peace, ecological resilience, and reverence for human dignity, ritual practices and sacred places: thus the connections at Me Rongo between "peace, sustainability and respect for the sacred".

We believe that creative people and cultures in our communities have the capacity to shine a light on truths and the potential for healing through the arts. Artists, poets, writers, musicians and those with the capacity of insight should be valued and respected accordingly. Me Rongo has recognised this by incorporating the work of artists and their teachings as a protective cloak for this Congress.

We further believe that the year 2011 marks a time of great hope. Global awakening, and demonstrations of civil societies have shown the hunger for lives of freedom, without fear, want and discrimination – a birth right for all citizens of this planet.

We are aware that this planet is in need of multiple, effective mechanisms for achieving peaceful, non-violent conflict resolution and accordingly, propose solutions that have arisen from Me Rongo.

This declaration is based on an awareness that the establishment of a culture of peace and non-violence is not an end in itself.

Peace is a condition that needs to be constantly worked on.  The values stated in this declaration are a step in the larger process of achieving a world without violence.

Two further points have direct bearing on how Henga and MEG might be developed.

**Protect and respect our sacred spaces and places**.  These places have the capacity to heal and restore the human spirit, as well as natural processes.  In order to care for these places and values we must hold dear to and safeguard traditional practices of reverence.

**Protect and respect for Indigenous rights, values and teachings**.  Most indigenous communities have traditions of deep connection with the Earth and its rhythms and systems.  Ensuring that these are valued alongside other knowledge systems is critical for the survival of Earth.

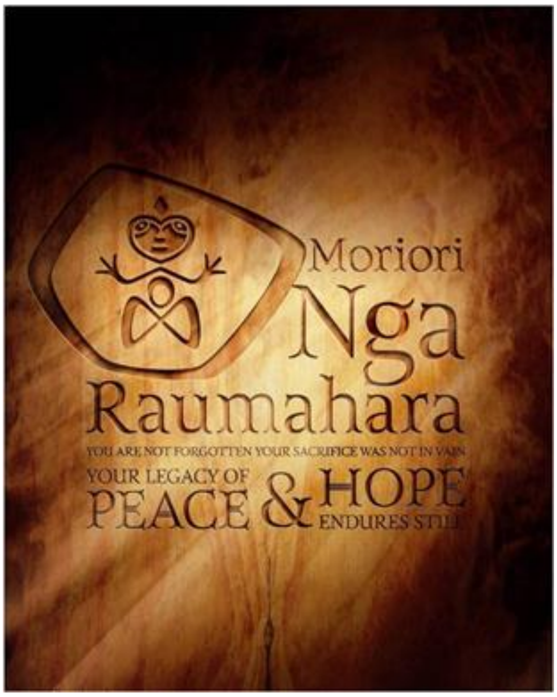


*Figure 9:	Moriori Memorial honouring the continuation of peace and hope*

The other major agroecology emphasis is on managing the land within the context of its location, locally adapted breeds and pastures, encouraging healthy soils and healthy stock, community involvement and support.  The use of external inputs is discouraged, where possible, so that farms become more resilient and able to feed their communities and adapt in the face of change.

It is important that Henga and MEG complement each other.  The species for the plantings on Henga can be grown in the MEG nursery.  Henga provides shelter and a working window for MEG. Some species such as aruhe/bracken (*Pteridium esculentum*), which was an important food source, are best contained within MEG.  Other species such as Kōpi could be grown within MEG to commemorate an earlier way of life, and as a crop on Henga to support Moriori today.  The focus of the properties should be broad, providing sustenance, education, science, research and a connection to the land, both physically and spiritually.  If the properties are managed in the spirit of Me rongo, then the health of the land plants and people will increase.

*Figure 10:  Nursery at MEG managed by Sylvia Eyles, Planting akeake Sylvia and Sam MEG 2014*

Some initial MEG plantings to commemorate and demonstrate early life in Rēkohu might include food plants such as Kōpi, Aruhe (*Pteridium esculentum*), Kakaha (*Astelia chathamica*) and Nikau (*Rhopalostylis sapida*) (Shand, 1894).  The Nikau on Rēkohu are unusual in that they have larger fruits, thicker hairs on the fronds and a distinct juvenile stage (NZPCN).  Rushes (wi) were also used for food (Shand, 1894) and could be planted in the wetter areas.  Plants used for building included Chatham Island Toetoe (*Austroderia turbaria*), whose roots were also used as medicine, and Chatham Island akeake.  Harakeke (*Phormium tenax*), Kakaha and Nikau provided fibre. The Chathams' harakeke, also known as *Phormium* 'Chathams', is a more robust plant than the mainland flaxes.  The leaves have a lower fibre content, and there is a yellow and red edge on younger leaves (Cockayne, 1902; Greenwood, 1992).

Tuna/eel were caught using baskets (Shand, 1894). The flooring of sea-going rafts was made using the stalks of the flax (Shand, 1894).  Fire was made by rubbing a Māhoe (*Melicytus chathamicus*) stick into a grooved section of Rautini (*Brachyglottis huntii*) (Shand, 1894).

A short publication on Chatham Islands plants (NZPCN) stresses the importance of *Coprosma chathamica* as a canopy tree co-associating with matipo (*Myrsine chathamica*) and swamp akeake (*Olearia telmatica*). *C. chathamica* should be planted in MEG. *Hebe barkeri* and *Hebe chathamica* are both endemic and at risk from browsing by stock and possums, as are the iconic Chatham Islands Forget-me-not *(Myosotidium hortensia*) and giant sow thistle (*Sonchus grandifolia*). The smaller sow thistle *Sonchus kirkii* is also endemic and no longer common.

The islands have been isolated for more than 80 million years so there are differences between many species that are indigenous to the Chathams and the Aotearoa New Zealand mainland. The plants of Rēkohu have had to adapt to wind, sea and mist. The trees have larger and fleshier leaves and more coloured flowers and the forbs are large and fleshy leaved (Greenwood, 1992).

Plantings in MEG and on Henga can celebrate the adaptations that species have made to survive in the island environment. Further examples include *Hebe barkeri,* an endemic, and the largest hebe in the genus and *Olearia traversiorum* which is the largest tree daisy (Anon., 2005). It is thought that isolated specimens of *Hebe barkeri* do not set viable seed so it is vital to plant them in groupings, away from browsing, to ensure the survival of the species (Anon., 2011). Thirty orchid taxa have been confirmed on the islands from three habitats (Molloy, 2002). Ideally, those that suit the habitats available in MEG could be planted there.

Introduced plants such as the cabbage tree and the potato have become integral to the Moriori way of life and as such, these should be included in MEG. Introduced indigenous plants that have become naturalised can hybridise with their Chatham relatives, thereby resulting in the loss of endemic Chatham Islands stock (de Lange et al., 2011) through being out-competed in their home range. It is important that plantings of Chatham Islands endemics are grown in MEG and on Henga.

## 13.9 Henga farm

It is difficult to run older Romneys and cattle on the lagoon block and other gorse-infested paddocks. There is a lack of suitable feed and as these paddocks also have dips, hollows and gullies constant vigilance in required for stock safety. Labour is also an issue for Henga. The farm manager Cheryl Carr is based at Kaingaroa station, at least an hour’s drive away. Rather than increasing stocking conventionally with an increased workload and an almost impossible gorse clearance task, the farm could be managed less intensively, generating a broader range of products that require clearly defined periods of labour.

Rather than try to eradicate the gorse by chemical means, it will be better to plant trees and shrubs amongst it and allow them to grow up and shade out the gorse. Eradication/reduction of gorse has been successfully managed in this manner at Hinewai on the Banks peninsula (Wilson, 2002). However, Hinewai is a reserve, not a working farm. In the spirit of trying to conserve as much endemic and indigenous Chatham Island flora as possible, under planting the gorse is sensible, but some income should be generated.

Pitt Island sheep could be an alternative, these are rugged animals well used to foraging for themselves. There is a good market for feral/wild sheep meat, Pitt island sheep being prized for "sweet and lean'' meat (Rudge, 1983), and they would attract a premium. When sheep were introduced to the islands, they ranged unconfined. Numbers were missed in musters and became feral (Whitaker). The sheep on Pitt are likely descended from the original Saxony merinos. There may still be a small flock of feral Chatham Island sheep, which, if they could be found, could provide the progeny suitable for an extensive operation on Henga. There are already marketing channels to restaurants for Chatham Island fish. High-end chefs would also readily seek healthy, unusual Pitt Island sheep meat.

### 13.6.1 Diet of Sheep on Pitt Island

Rudge (1983) analysed the rumen contents of feral and domestic sheep on Pitt Island and found that the feral sheep had eaten more woody material; in particular Hoho (*Pseudopanax chathamicus)*, Kawakawa (*Piper excelsum*), Chatham Island Māhoe (*Hymenanthera* now *Melicytus chathamicus*), Chatham Island karamu (*Coprosma Chathamica*) and supplejack (*Ripognum scandens*). These species were growing up through a covering of bramble and regenerating a forest cover. Both domestic and feral rumens contained grasses. Those recorded by Rudge as being available on Pitt Island included sweet vernal (*Anthoxanthum odoratum*), fog (*Holcus lanatus*) and barley grass (*Hordeum murinum*), not regarded as improved species. The sheep also browsed sedges, fern carex, biddybid (*Acaena anserinifolia*) and shore dock (*Rumex neglectus*).

Table 1 lists species eaten by feral and domestic sheep on Pitt Island. The rumens of domestic sheep contained much larger quantities of clover. Feral sheep will thrive on an unimproved pasture/shrub/forest complex.

*Table 1: Species eaten by feral and domestic sheep on Pitt Island after Rudge 1983*

| **Species** | **Common Name** | **Feral sheep** | **Domestic sheep** |
|---|---|---|---|
| *Acaena anserinifolia* | Biddybid | √ | √ |
| *Callitriche sp.* | Starwort | √ | |
| *Centella uniflora* | Centella | √ | √ |
| *Cirsium sp.* | Thistle sp. | √ | |
| *Epilobium sp.* | Willowherb sp. | √ | |
| *Gunnera monoica* | | √ | √ |
| *Helychrysum bellidioides* *now* *Anaphalioides bellidioides* | Hells bells | √ | √ |
| *Linum monogynum* | Linen flax | | √ |
| *Lobelia anceps* | NZ lobelia | √ | √ |
| *Plantago chathamicum* | Plantain | | √ |
| *Pratia arenaria* now *Lobelia arenaria* | Sand lobelia | √ | √ |
| *Ranunculus hirtus* | Hairy buttercup | | √ |
| *Trifolium repens* | White clover | √ | √ |
| *Blechnum capense* *now* *Blechnum novae-zelandiae* | Kiokio, palm leaf fern | √ | √ |
| *Blechnum penna-marina* | Hard fern | √ | √ |
| *Phymatosorus diversifolius* *now* *Microsorum pustulatum* | Kowaowao<br>Hounds tongue fern | √ | |
| *Pteridium aquilinum* *now* *Pteridium esculentum* | Rarauhe<br>Bracken | √ | √ |
| *Coprosma chathamica* | Chatham Island karamu | √ | √ |

| Species | Common Name | Feral sheep | Domestic sheep |
|---|---|---|---|
| *Hymenanthera chathamica* now *Melicytus chathamicus* | Chatham Island Māhoe | √ | |
| *Myrsine chathamica* | Chatham Island matipo | √ | √ |
| *Olearia traversiorum* | Chatham Island akeake | √ | √ |
| *Plagianthus chathamicus* | Chatham island ribbonwood | √ | |
| *Pseudopanax chathamicus* | Hoho, Chatham Island lancewood | √ | √ |
| *Ripognum scandens* | Supplejack | √ | |
| *Rubus fruticosus* | Bramble | √ | √ |
| *Urtica australis* | Onga Onga<br>Southern nettle | | √ |

There is opportunity to plant a wide variety of species on the Henga paddocks. In a checklist of vascular plants recorded from the Chatham Islands (de Lange et al., 2011) the authors provide a record of endemic, indigenous and introduced plants. The endemics are listed below in Table 2 but should be supplemented with indigenous species.

Local knowledge will be the best source of advice on what will grow on the site. It may be necessary to make successive plantings allowing tougher species to establish and then supplementing with species less able to stand the wind once some protection is achieved. The stocking rate of sheep will have to be carefully managed as the plants establish, particularly the herbs, as will the fences. Not only will the plantings on Henga conserve many island species but they will provide habitat for birds including those that were once harvested for food, for example wood pigeon (pare) and tūī (koko) (Shand, 1894).

The lagoon fence on the eastern side of Henga borders cliffs above the lagoon. This would be an ideal site for the regeneration of *Lepidium* and other herbaceous species, free from stock challenge. These species would be grown in the planted paddock but the rarest could be given a refuge on the cliff as well as in MEG.

*Table 2 Endemic taxa of Chatham Islands. Adapted from Lange, Heenan and Rolfe (2011)*

| | |
|---|---|
| *Aciphylla dieffenbachii* | *Hebe chathamica* |
| *Aciphylla traversi* | *Hebe dieffenbachia* |
| *Asplenium chathamense* | *Leptecophylla robusta* |
| *Astelia chathamica* | *Leptinella featherstonii* |
| *Austroderia turbaria* | *Linum monogynum var chathamicum* |
| *Brachyglottis huntii* | *Melicytus chathamicus* |
| *Callitriche petriei* | *Myoporum semotum* |
| *Carex chathamica* | *Myosotidium hortensium* |
| *Carex ventosa* | *Myrsine coxii* |
| *Coprosma chathamica* | *Olearia chathamica* |
| *Coprosma propinqua var martini* | *Olearia telmatica* |
| *Corokia macrocarpa* | *Olearia traversiorum* |
| *Disphyma papillatum* | *Poa chathamica* |
| *Dracophyllum arboretum* | *Plagianthus regius subsp. Chathamicus* |
| *Festuca coxii* | *Pseudopanax chathamicus* |
| *Geranium traversii* | *Pterostylis silvicultrix* |
| *Gentianella chathamica* | *Senecio radiolatus* |
| *Hebe barkeri* | *Sonchus grandifolius* |
| | *Sporadanthus traversii* |

The Eastern Buff Weka, *(Gallirallus australis hectori)* was introduced into the islands in 1905 (www.rnbeattie.co.nz). They have thrived, as there are no predators such as ferrets, stoats or weasels, so much so that many now view weka as a pest. It is legal to hunt weka on the islands and numbers are taken each year. However, it is not legal to export the carcass to Aotearoa New Zealand mainland without a permit from the Department of Conservation. Weka are found all through MEG and Henga already and would provide another income stream if they could be exported from the island ready to eat as a ‘wild’ food.

*Figure 11: Buff weka in MEG*

The triangle between the north road and the airport road is also gorse covered.

In 2009 a Sustainable Farming Fund project reported upon the possibilities of using karaka, the Māori name for Kōpi, as a “new New Zealand nut crop” (Klinac et al., 2009). The authors reviewed the history of the tree, investigated pollination, fruiting and seed sizes. Fruits were sent to them from all around Aotearoa New Zealand, and those from the Chathams were found to be larger and fat, *“better in terms of size and quality than other fruit.”*

They record that there is an ancient grove of fruiting Kōpi planted in a circle with a single tree in the centre and speculate as to whether this tree was selected as a pollinator. It is important that there is a good pollinator present or else many berries can be produced that do not contain the kernels. Farmers on the island attest to the preferred palatability of Kōpi to stock and Klinac et al. (2009) record that farmers from the mainland feed leaves, twigs and berries to stock and quote Taranaki farmers saying *“if a cow refuses karaka give her the .22.”*

For humans, the karaka nut is a healthy food option, being gluten free with high dietary fibre and higher energy content than chestnuts and a similar fat content to walnuts. They have been compared in terms of nutrition to hazelnuts. The raw berry flesh has a higher sugar content than kiwifruit or grapes and could be successfully dried, opening the potential for a fruit as well as a nut product.  Klinac et al.  include a list of suggestions for Kōpi products such as gluten free bakery products, liqueur, dried berries, coffee, health bars, porridge and other baked goods. Extracts may have possum repellent and other natural insecticide applications.

*Figure 12:  Fruiting Kōpi tree in MEG*

The paddocks along the western boundary of Henga have been fertilised and sown down with improved grasses.  The gorse is not such a problem in these paddocks and any future incursions can be controlled.  The western paddocks might either hold lambing ewes and calving cows or could be used to fatten off young stock from Kaingaroa station.

Chatham Island wool is sought after (2010), being clean and white with a good yield.  Wethers run on these paddocks could provide a valuable clip.

Although the paddocks have been top dressed, fertiliser has to be imported onto the islands, at considerable expensive.  Fish is processed on the island; the waste could be turned into fertiliser with seaweed added.  Not only would this help the soil microbiology, but a processing unit would also create more employment.  There is a lime pit on the farm and lime is spread on parts of Henga.

If a more local, low fertility pasture were to be required, then the findings of Cockayne (1902) are useful.  He described the pasture that developed under grazing on the Waitangi racecourse, noting a number of species associations.  *Crantzia lineata,* which is probably *Lilaeopsis novae-zelandiae,* and sand lobelia (*Pratia arenaria* now *Lobelia arenaria*) formed a large part of the turf, and were renowned as good grazing species by local farmers. He noted other species that all combined to produce a "thick turf" (Table 3).

*Table 3: Species noted in Cockayne's "Thick turf", Waitangi Racecourse*

| Scientific Name | Common Name |
|---|---|
| *Poa pratensis* | Kentucky blue grass |
| *Potentilla anserine* | Silverweed *or* possibly *Potentilla anserinoides* the native silverweed |
| *Hydrocotyle asiatica* | This is likely to be one of the waxweed species occurring on Rēkohu such as *Hydrocotyle heteromeria* |
| *Epilobium caespitosum,* now *Epilobium pedunculare* | Willowherb |
| *Myriophyllum pedunculatim* | |
| *Lagenophora forsteri,* now *Lagenophora pumila* | Papataniwhaniwha |
| *Eleocharis* gracillima, now *Eleocharis gracilis* | Slender spike rush |
| *Gnapphalium collinum,* now *Euchiton japonicas* | Creeping cudweed |

Shelter should be planted along the fence lines on the improved paddocks, at least several species thick and of varying heights, perhaps focusing on species that would support bees so that a local honey could be produced.

There is already a large pear tree in the yards, more fruit trees could be planted in sheltered areas, **but** the area around the old dip should be retired as it is likely to be contaminated with sheep dip. This area should be tested and then planted with species appropriate for phytoremediation. A small vegetable unit could provide vegetables for Moriori returning to the marae, as it is expensive to purchase imported fruit and vegetables in the local shop and the costs of living on top of the airfare could prove to be a barrier to return. Any surplus could be sold locally. The vegetable unit should be sited in a convenient sheltered location with water.

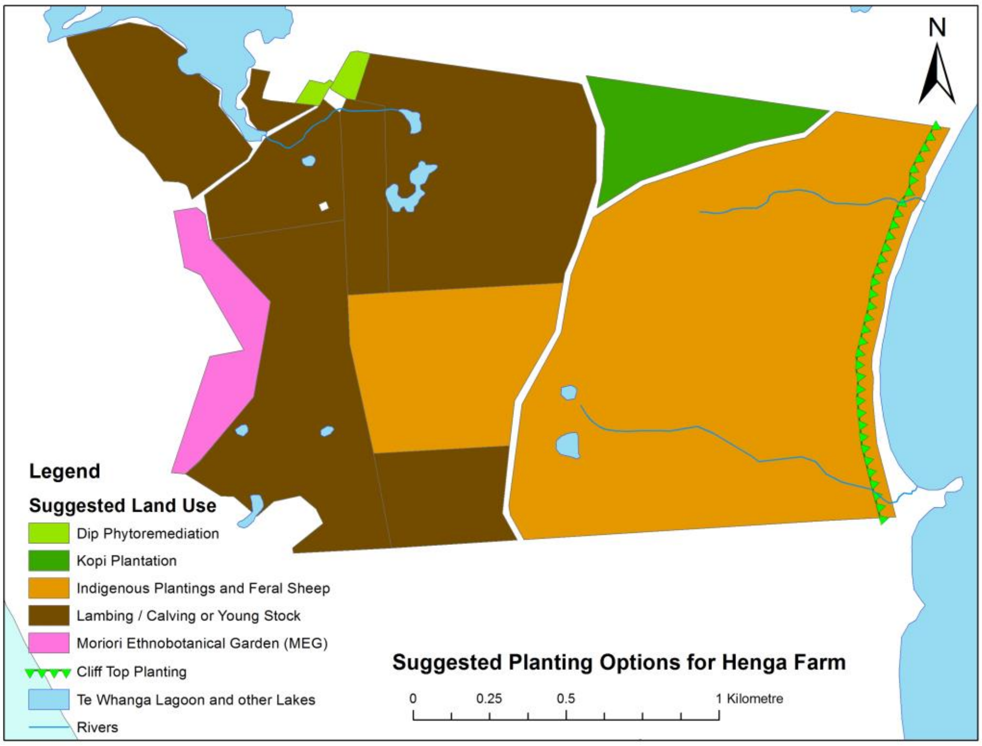


*Figure 13: Map of Land Use Suggestions for Henga*

The cost of taking stock off the island to slaughter has always been prohibitive. In addition, there are increasing concerns about the live transport of stock by sea and long trucking distances. Bringing a mobile abattoir over to the island and exporting the processed carcasses might overcome these problems. For example: www.netherbymeats.co.nz/processing/mobile-abbattoir or www.canterburyhomekill.co.nz. Netherby meats can process cattle, sheep and pigs on site; the carcasses can then be chilled and cut.

As Henga has a good range of stock handling facilities, the farm would be a useful training venue for young people. Courses could be run for Moriori wishing to farm but living on the mainland with no opportunity. Although the art of farming is not traditional knowledge *per se* for Moriori, the care of their land is. By being involved with Henga and MEG and managing the land to reflect and conserve the island ecology, and with their knowledge of plants and Moriori culture, traditions can be revitalised. There are many older Moriori willing to share their knowledge with a younger generation. The young could then nurture Henga and

MEG to become a true memorial to the Moriori who peacefully cared for the earth of Rēkohu.

## 13.10 Is it Agroecology?

Altieri et al. (2012) presented a set of questions that should be asked as the management of a farm moves towards agroecological management. Considering the questions will guide the trustees in their decisions.

*Table 4: A Guide to Agroecological Practice*

| |
|---|
| Is the farm using local and improved crop varieties and livestock breeds, enhancing genetic diversity and adaptation to changing biotic and environmental conditions? |
| Is the farm avoiding the use of agrochemicals and other technologies for example heavy machinery or transgenic crops that harm the environment and impact human health? |
| Is the use of resources such as water, nutrients and energy efficient and has the farm reduced the use of external inputs and non-renewables? |
| Are agroecological principles and processes being used to promote nutrient recycling, biological nitrogen fixation, allelopathy and biological control? Is functional biodiversity being encouraged through diversified farming systems? |
| Is the best of traditional and scientific knowledge being used and is innovation welcomed? Are cultural identities, participatory methods and farmer networks recognised? |
| Are efforts being made to reduce the ecological footprint of production, distribution and consumption to minimise pollution, soil damage and Greenhouse Gas emission? |
| Are practices promoted enhancing clean water availability, carbon sequestration and conservation of biodiversity, soil and water? |
| Is there a balance between long-term adaptability and short-term efficiency and an ability to cope with short-term change? |
| Is there improved adaptive capacity and resilience through maintaining agroecosystem diversity so that the farm is responsive to change and to secure key farming functions? |
| Is the farm conserving agricultural heritage supporting social cohesion and a sense of pride to help reduce migration from rural areas? |

Table 5 lists the questions proposed by Koohafkan et al. (2011) to evaluate whether a developing agricultural system is likely to be sustainable and to support local communities. If the system is based on agroecological principles the answers will positive, the fewer positives the less sustainable the system. The answers have been suggested by the author for Henga and MEG but will benefit from consultation with the community and Hokotehi trust.

*Table 5: A series of questions posed by Koohafkan and colleagues to evaluate the sustainability of a farming system and the support it might offer local communities and the responses for an agroecologically driven development on Henga farm*

| **Is the development a sustainable one?** | **Henga** |
|---|---|
| Reduce poverty? | Yes, food is provided for Moriori in need, and income is generated from the farm for Hokotehi trust |
| Based on rights and social equity? | The farm belongs to Moriori and is managed by Hokotehi trust for the benefit of the whānau whenua |
| Reduce social exclusion women, minorities indigenous peoples? | The farm is owned by people indigenous to the area. Employment would be provided that includes women, and opportunities would be provided for youth. The specific plantings encourage the resumption of traditional skills and provide the raw materials for cultural revitalisation |
| Protect access and rights to land, water and other natural resources? | The proposed management incorporating extensive planting will protect the water and heal the land. By planting many island endemics the resources of the island will be conserved. The Kōpi plantings in MEG and on Henga will support the revitalisation of knowledge |
| Favour redistribution (rather than concentration) of productive resources? | The farm is owned by Hokotehi and is managed for Moriori. The proposed scheme will see future generations benefit |

| Is the development a sustainable one? | Henga |
|---|---|
| Substantially increase food production and contribute to household food security and improved nutrition? | Food production will be increased once the farm has transitioned to agroecological management. A much greater variety of products will be produced from the range of enterprises both for local consumption and export. The farm will provide for Moriori in need and will also provide training opportunities |
| Enhance water access and availability? | The riparian plantings and wetland plantings will help conserve and clean the water, enhancing the production of favoured crops such as watercress |
| Regenerate and conserve soil, increase or at least maintain soil fertility? | Managing the entire farm according to agroecological principles will conserve the soils. Planting and lightly stocking most of the farm will prevent further erosion |
| Reduce soil loss/ degradation and enhance soil regeneration and conservation? | Riparian and agroforestry plantings will reduce soil degradation and aid in its conservation. On the more intensively managed areas the use of cover crops and deep rooting species will protect the soil and increase organic matter. The encouragement of soil biota will help regenerate it |
| Maintain or enhance organic matter and biological life and biodiversity of the soil? | All the plantings will support the agroecosystem and encourage nutrient cycling. By maintaining soil cover and a diversity of species, including livestock, the biology of the soil will be protected and enhanced. If fish/seaweed fertiliser is used the biology will be further supported |

| **Is the development a sustainable one?** | **Henga** |
|---|---|
| Prevent pest and disease outbreaks? | As there will be no monocultures and plentiful mixed species plantings the likelihood of pest and disease are reduced. As the livestock will have a broader diet and access to plants for self-medication, including anthelminthic plants, they will be healthier. The stocking rate will be maintained at a level easily supported by the farm so there will be no undue stress on stock |
| Conserve and encourage agrobiodiversity? | The planting of a variety of endemic and indigenous and species will conserve and encourage agrobiodiversity |
| Reduce GHG? | The plantings and non-intensive husbandry of the land will increase carbon sequestration and decrease greenhouse gas production |
| Increase income opportunities and employment? | The farm will generate employment at defined times such as Kōpi harvest. Opportunities will be provided through training programmes. The planting scheme will create employment and some maintenance of plantings will be required. The farm manager will still have to oversee operations at Henga. MEG employs a manager but as the garden becomes more complex, further help will be required to maintain it |
| Reduce variation in agricultural production under climatic stress? | The farm contains a number of management zones building in resilience. Pastures should be planted with diverse deep rooting species to encourage persistence. The proposed management system is largely low input but diverse and includes traditional food sources |

| Is the development a sustainable one? | Henga |
|---|---|
| Enhance farm diversification and resilience? | The proposed land classification, plantings and alternative income streams will promote resilience |
| Reduce investment costs and dependence on external inputs? | The investment in infrastructure will be high but once the farm is developed and running there will be little investment required and few external inputs |
| Increase degree and effectiveness of farmer organisations? | The farm should stand as an example of how land can be managed according to Moriori tradition and Indigenous Agroecology |
| Increase human capital formation? | The changes in management will create employment opportunities. Importantly with the accessibility of plants, materials and restored bush and wetlands young people will be able to rekindle their culture and learn traditional ways |
| Contribute to local or regional food sovereignty? | The farm will provide food and resources for local Moriori and the wider community |

The suggestions of opportunities for Henga farm and MEG need to be costed. Any changes will require time to trialed and implemented. However, the suggested options have arisen whilst walking the land and listening, and are presented in the spirit of Me rongo.

## References


DoC 1999. *Plants of the Chathams* (Wellington, Department of Conservation).

DoC. *Chatham Islands Conservation Management Stategy* (Wellington, Department of Conservation).

Radio NZ 2010. *Chatham Islands Farming* (Radio New Zealand).

Altieri , M., Bartlett, A.K., Callenius, C., Campeau, C., Elasser, K., Hagerman, P., Kenny, G., Lambrechts, K., Miga, W.P., j.P., Prove, P., Saracini, N., Ulmer, K. 2012. *Nourishing the world sustainably:scaling up Agroecology* (www.e-alliance.ch, Ecumenical Advocacy Alliance), p. 47.

Anon. 2005. *Plants of the Chatham islands* (Department of Conservation Te Papa Atawhai).

Anon. 2011. *Some rongoā Rēkohu* (New Zealand Plant Conservation network).

Cockayne, L., 1902. A short account of the Plant covering of the Chatham Islands. *Transactions of the New Zealand Institute* 34, 243-235.

Dalton, C. 2014. *New Zealand agricultural history - sheep breeding on the Chatham Islands* (http://woolshed1.blogspot.co.nz/2014/02/new-zealand-agricultural-history-sheep.html).

de Lange, P.J., Heenan, P.B., Rolfe, J. 2011. *Checklist of vascular plants recorded from Chatham Islands* (Wellington, Department of Conservation), p. 57.

Greenwood, R., 1992. Some differences between plants of the Chatham Islands and the New Zealand mainland *New Zealand Journal of Ecology* 16, 51-52.

Holmes, D., 1993. *My seventy years on the Chatham Islands*. Shoal Bay press, Christchurch, 184 p.

Hunt, F., 1866. *Twenty five years experience in New Zealand and the Chatham Islands an Autobiography*. William Lyon, Wellington New Zealand, 64 p.

King, M., 1989. *Moriori: A people rediscovered, Second Edition*. Penguin Books, Auckland New Zealand.

Klinac, D., Benton, R.A., Rentoul, S. 2009. *Karaka nuts: a 'new' NZ nutcrop* (Sustainable Farming Fund).

Koohafkan, P., Altieri , M., Holt-Gimenez, E., 2011. Green Agriculture: foundations for biodiverse, resilient and productive agricultural systems. *International Journal of Sustainability* 10, 61-75.

Madden, E.A., Healy, A.J., 1959. The adventive flora of the Chatham Islands. *Transactions of the Royal Society of New Zealand* 87, 221-228.

Molloy, B. 2002. *Orchids of the Chatham Islands* (Wellington New Zealand, Department of Conservation), p. 22.

NZPCN. *New Zealand Plant Conservation Network*

Riley, M., 1994. *Māori Healing and Herbal New Zealand Ethnobotanical Source book, 3 Edition*. Viking Sevenseas N.Z.Ltd, Paraparaumu New Zealand, 528 p.

Rudge, M.R., 1983. A reserve for feral sheep on Pitt island, Chatham group, New Zealand. *New Zeal J Zool* 10, 349-363.

Shand, A., 1894. The Moriori people of the Chatham islands;Their Traditions and History. *The Journal of the Polynesian Society* 3, 76-92.

Solomon, M., Thorpe, S., 2012. Taonga Moriori:Recording and revival. *Journal of Material Culture* 17, 245-263.

Whitaker, A.H. *Feral Sheep in New Zealand* (www.rarebreeds.co.nz/whitaker.html, Rare Breeds Society New Zealand).

Wilson, H., 2002. *Hinewai: The Journal of a New Zealand naturalist*. Shoal Bay Press, Christchurch New Zealand, 168 p.

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# 14 Nāku te rourou nau te rourou ka ora ai te iwi: With your basket and my basket the people will live

Marion Johnson

*"Nāku te rourou nau te rourou ka ora ai te iwi*

*With your basket and my basket the people will live"*

## 14.1 Agriculture at a Crossroads

A dispassionate summation of the facts affecting agriculture illustrates that:

- Our waters are polluted;
- The biology of our soils is compromised;
- Many of our livestock are unwell and have short lives;
- Our pastures are based on a decreasing number of species,
- The diversity of species and habitats on our farms is minimal, and;
- Many of our farming families are struggling to cope on a day-to-day basis, never mind with crisis climatic events such as floods and droughts.

The industrial model is failing. Commodity prices are declining in real terms, the more so for those who produce raw or unprocessed product. The 'economic' unit size is increasing within that commodity model. We are told to increase energy inputs, more fertiliser and more replacement of pastures with the 'new and improved' ryegrass that requires soluble nitrogen fertiliser to thrive. We are told that there are new technologies that will increase our profit margins. And as production increases the prices come down again, because the buyers of low value commodities will always bargain down any small 'efficiency' gain farmers make with the new technology. This is called the "technology treadmill" (Levins & Cochrane, 1996), a race to an inevitable bottom. Farmers produce more, homogenise and specialise, grow in scale, argue for the right to pollute or exploit, employ less people – including migrants – on poorer conditions, and the margins keep falling. Rural populations fall, and more and more money is extracted from a place to owners who live elsewhere. Farmers and rural communities run faster and faster to not simply stand still, but to go backwards.

In addition to the economic and social costs, the environmental consequences of the industrial technology approach involve a continuing degradation of our land and soil, our water, our biodiversity, our climate, and the gifts that nature freely provides should we look for and care for them.

The result is not just the requirement for yet more costly and finite off-farm inputs to make up for the loss of physical *stocks* (for example soil, nutrients, organic matter). There are also more inputs required to compensate for the loss of *function* (for example soil water-holding, infiltration rates, stock health and nutrition).

Our land is degrading, and the long-term consequence of that degradation is a social and economic demise.

The dichotomy of western science and indigenous knowledge, them and us, does not serve to help the land. Nor does the entrenchment of agribusiness whether Māori, European or oversea-owned. The destructive core of these operations lies in the way they view land, and their personal relationship with it:

*"We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect."*

Aldo Leopold (1949)

If we treat land, people and the living things that are part of the land as a commodity; if we see ourselves as outside that social and environmental system; then we will not progress to a sustainable farming future.

The need for change, for redesign, for new thinking and new ways of action, was a key message in Dr Morgan Williams' (2004) PCE report: *Growing for Good*. We need to find a way forward that regenerates the land and delivers on the aspirations and expectations of all of Aotearoa New Zealand society.

## 14.2 Agroecology the Path Ahead

Indigenous Agroecology, illuminated by the cultures of Māori and Moriori, is a way forward. Agroecology has been endorsed internationally by the United Nations and others as the means by which we can mitigate climate change, rural inequity, the various degrading environmental functions, as well as increasing food production (IAASTD, 2009; de Schutter, 2011).

This report illustrates some of the areas of knowledge that are important to agroecology. It also highlights the need for the awareness and practice of agroecology by specialists, farmers and whānau, for us all to be talking, working, learning and adapting together.

## 14.3 The Importance of People Working Together

When proposing change, we must understand what Māori (Reid et al., 2013) and Moriori want, and to clarify the attitudes and desires of all New Zealanders.

Whānau whenua proposed by Pehi and Johnson (2015) begins the discussion of persuading people to walk together, and Indigenous Agroecology provides the pathway.  Agroecology enables a genuine dialogue between all members of a community and encourages the conservation of flora and fauna on productive lands restoring the mauri and providing healthy food.

During a discussion of cooperative land management, Blackford et al. (1993) found that *"all those affected agree there is crisis, but they do not agree on the nature of the problem or the means by which the problem should be addressed."*

Care of our natural systems should not be a battleground; it should be a place of respect, honest dialogue and valuable contribution.  Discussion will illuminate problems, enhance understanding of local ecology and interconnecting processes; and then minds can work to solve the problems, guided by agroecology, by seeing the broadest possible picture and not being blinkered by narrow and personal agendas and greed.

Given knowledge, tools and social support, communities can resolve many problems.  Farmers have often regarded themselves as stewards of the environment; we should take pride in a regenerated farmscape, in which the welfare of people and the health of the land is paramount.

## 14.3 The Importance of the Local

As the influences on agriculture in Aotearoa New Zealand change – for example climate, shrinking rural populations or demands of export markets – local communities perceive the problems and agroecology provides a framework to take remedial action. Agroecology is predicated on being local.  Local, traditional and ecological knowledge is critical to understanding a place, and therefore to making the right decisions within that particular piece of land, in this particular time, with these particular constraints, and with these particular purposes and values.  To 'know' sufficient to be wise in our decisions, communities must have a dialogue in common with each farm, applying shared agroecological principles to every particular set of environmental, social and economic issues.

Indigenous Agroecology contributes to the development of an alternative land management paradigm in Aotearoa New Zealand. It is a framework for a new dialogue.

*Whenua ora, Wai ora, Tangata ora.*

*Healthy land, Healthy water, Healthy communities*

## References


Blackford, C., Ackroyd, P., Williams, T. 1993. *Co-operative land management in New Zealand* (Lincoln University, Centre for Resource Management).

De Schutter, O. 2011. *Agroecology and the Right to Food*, Report presented at the 16th Session of the United Nations Human Rights Council [A/HRC/16/49], 8 March 2011

International Assessment of Agricultural Knowledge, Science & Technology for Development (IAASTD) 2009. *Agriculture at a Crossroads*. Island Press

Leopold, A. 1949. *A Sand County Almanac and Sketches from Here to There*. Oxford University Press, London

Levins, R.A. and W. W. Cochrane 1996. The Treadmill Revisited. *Land Economics* 72 (4): 550-553

Parliamentary Commission for the Environment 2004. *Growing for good: Intensive farming, sustainability and New Zealand's environment*. Wellington: Parliamentary Commissioner for the Environment

Pehi, P., Johnson, M., 2015. Whenua Whānau: Walking the Land with Indigeneity & Science to find Our Home, In: Kēpa, M., McPherson, M., Manu'atu, L. (Eds.) *Home: Here to Stay Ngā Pae o te Māramatanga Edited Collection.* Huia Publishers, Wellington, p. 217.

Reid, J., Barr, T., Lambert, S. 2013. Indigenous Sustainability Indicators for Māori farming and Fishing enterprises. In *The New Zealand Sustainability Dashboard* (www.nzdashboard.org.nz, Ngai Tahu Research Centre University of Canterbury), p. 41.

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I hope we have begun the journey.

## Glossary and acronyms

| | |
|---|---|
| **Ahikā/ahi-kā-roa** | Long burning fires of occupation |
| **Ahuwhenua** | Māori farming (in a modern context) |
| **Aotearoa** | New Zealand |
| **Aroha** | Compassion, love, concern |
| **Aronga** | Worldview |
| **Atua Māori** | Māori god |
| **Awa** | A body of fresh water usually a river or stream |
| **Eruhe/Aruhe** | Fern root |
| **Hapu** | Extended family group describing a Māori community group, typically defining a group of families that inhabit a certain place |
| **Haerenga** | Journey |
| **Haukainga** | True home, marae |
| **Hawaiki** | Ancient homeland from which Māori migrated to Aotearoa New Zealand |
| **He kai-haukai** | A return feast |
| **He ngakinga-a-mate** | Payment for a death |
| **He pa-kuha** | Betrothal |
| **He whanaunga i tono kainga mahinga kai ranei** | A relative has requested a house or an area for cultivating food |
| **Hikoi** | Journey |
| **Hine-ahu-one** | The first women to be created |
| **Hinengaro** | Mind, consciousness |
| **Hopo** | Albatross |
| **Hokorongo tiringi** | The hearing of the ears |
| **Hue** | Gourd |
| **Imi** | Tribe extended kinship group |
| **Iwi** | Tribe, extended kinship group |

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|---|---|
| **Ka Tiritiri o te Moana** | The southern alps |
| **Kai** | Food |
| **Kai Tahutanga** | Ngai Tahu knowledge |
| **Kaitiaki** | Guardians |
| **Kaitiakitanga** | Guardianship and protection: relating to the environment based on the Māori worldview |
| **Karaki** | Prayer |
| **Kaputi** | Cup of tea |
| **Kaumatua** | Elder |
| **Kaupapa** | Purpose, programme |
| **Kauteretere** | Floating |
| **Ki uta ki tai** | From the mountains to the sea |
| **Kō** | A Māori digging implement |
| **Ko Matangi Ao** | The dawn of time |
| **Koiora kanorau** | Biodiversity |
| **Korare** | Greens, edible leaves |
| **Kōrero** | Discussion |
| **Kopi** | *Corynocarpus laevigatus* |
| **Kūmara** | sweet potato |
| **Mahinga kai** | Food gathering, cultivation |
| **Mana** | Authority, prestige, honour or power of a person, people or thing |
| **Mara kai** | Māori gardening |
| **Marae** | Complex of buildings, meeting area |
| **Manaakitanga** | Hospitality |
| **Māori** | Indigenous people of Aotearoa New Zealand |
| **Maramataka** | Māori lunar calendar |
| **Mātauranga Māori** | The local knowledge of the indigenous people (Māori) |
| **Mōteatea** | Traditional chants |
| **Ngāhere** | Bush, forest |

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|---|---|
| **No ro hunu ake** | Sprung from the earth |
| **Ora** | Alive, well, healthy |
| **Pākehā** | New Zealander of European descent |
| **Papatūānuku** | Earth mother, wife of Ranginui |
| **Pepeha** | Ancestral saying |
| **Pou** | pillar, post |
| **Pūrakau** | Creation narratives/stories of origin |
| **Rakau momori** | Dendroglyphs on Kōpi trees |
| **Rangatahi** | Youth |
| **Rangatehi** | Youth |
| **Rangatira** | Chief, leader |
| **Ranginui** | Skyfather, husband of Papatūānuku |
| **Raupatu** | War/conquest |
| **Rohe** | The boundaries or territory of tribal groups |
| **Rongoā** | Māori traditional medicine |
| **Rongoā rākau** | Plants used in Māori traditional medicine |
| **Ta ika** | The land |
| **Take raupatu** | Conquest of new land |
| **Take tuku** | Transfer of land |
| **Take tupuna** | Ancestral rights |
| **Takiwa** | District, area |
| **Tāne** | God of birds, forests and people |
| **Tangaroa** | God of the sea and fish |
| **Tangata ora** | Healthy people |
| **Tangata Whenua** | People of the land: indigenous name for Māori |
| **Tangihanga** | Funeral |
| **Taonga** | Treasure |

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| **Tāpae toto** | Non-permanent transfers of land |
| **Taunaha whenua/tapatapa whenua** | Gifting or allocation of land |
| **Tāwhirimātea** | God of winds |
| **Tchakat Henu** | Moriori people of the land |
| **Te Ao-marama** | The world of light |
| **Te reo Māori** | Māori language |
| **Te Tiriti o Waitangi** | Treaty of Waitangi |
| **Te whānau o te rangi** | Heaven born |
| **Tikanga** | Practice/custom |
| **Timiriki** | Children |
| **Tinana** | Body |
| **Tino rangatiratanga** | Self-autonomy |
| **Tohinga** | Sacred covenant |
| **Tohu** | Guidance |
| **Tuahu** | Sacred altar |
| **Tuahu kōrero** | Place where sacred words are shared |
| **Tuakana** | Elder sibling |
| **Tūmatauenga** | God of war and the spirit of man |
| **Tuna** | Eel |
| **Tupuare** | Moriori wooden staff |
| **Wai Māori** | Fresh water |
| **Wai moana** | The sea |
| **Wai ora** | Healthy water |
| **Wairua** | Spirit |
| **Waka** | Canoe |
| **Waka ama** | Outrigger canoe |
| **Waka hourua** | Double canoe |
| **Wānanga** | Learning place |

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|---|---|
| **Whaikōrero** | Discussion |
| **Whakahaere** | Leadership |
| **Whakapapa** | Genealogical links, lineage/ancestry |
| **Whakapara/whakaota** | Method of Māori agriculture |
| **Whakataukī** | Saying, proverb |
| **Whānau** | Family |
| **Whānaukatanga** | Relationship building |
| **Whare wānanga** | Tribal university |
| **Whenua** | Earth, the land or placenta |
| **Whenua kite hou** | Discovery of new land |
| **Whenua ora** | Healthy land |