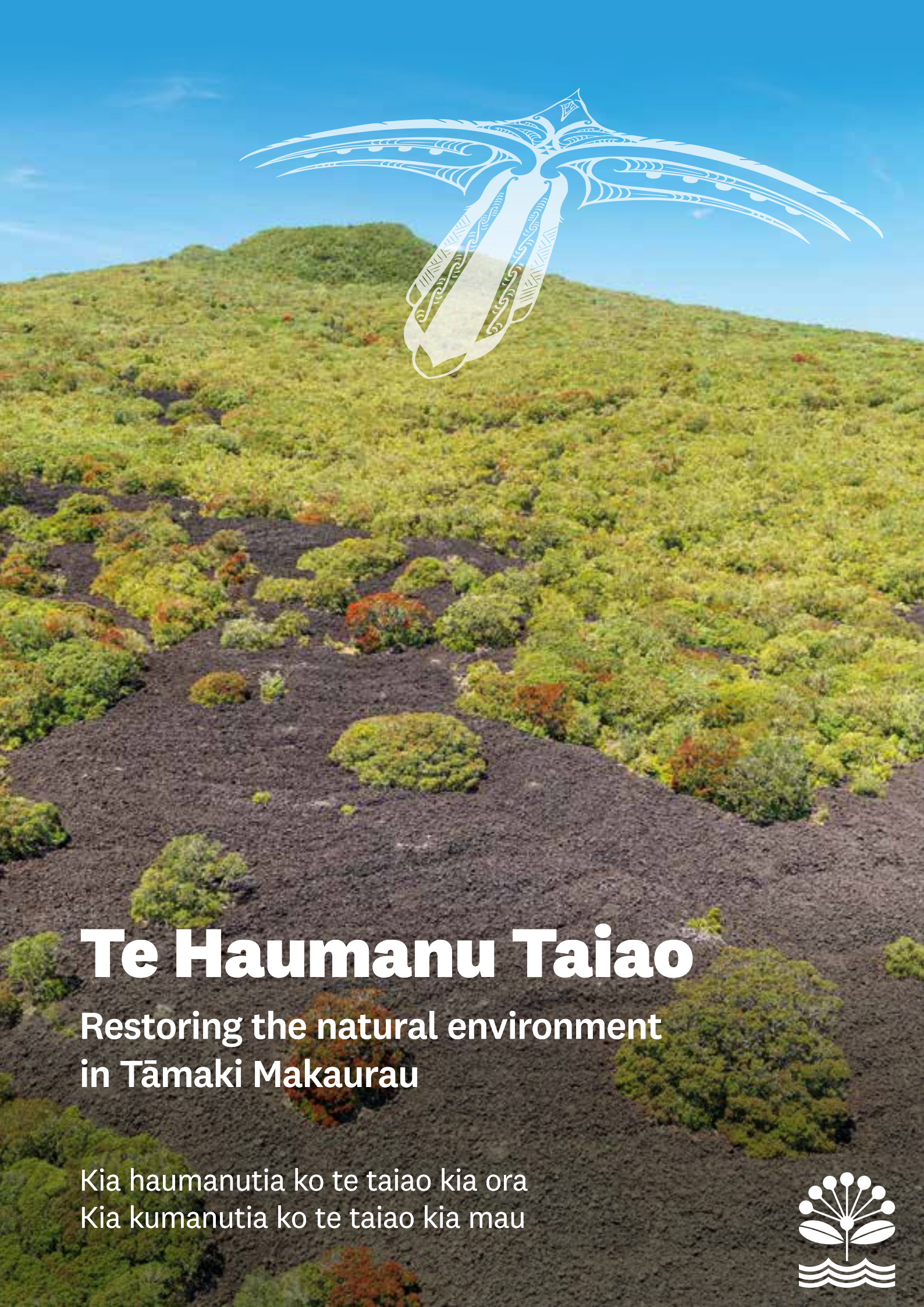


Te Haumanu Taiao

Restoring the natural environment in Tāmaki Makaurau

Kia haumanutia ko te taiao kia ora
Kia kumanutia ko te taiao kia mau

Te Tiriti o Waitangi partnership statement

Te Tiriti o Waitangi (The Treaty of Waitangi) provides the high-level context for the unique relationship between Te Kaunihera o Tāmaki Makaurau (the Auckland Council) and Ngā Iwi Mana Whenua o Tāmaki Makaurau.

Te Kaunihera o Tāmaki Makaurau and Ngā Iwi Mana Whenua o Tāmaki Makaurau acknowledge the unique partnership relationship founded on Te Tiriti o Waitangi. In the design and implementation of ecological restoration projects consideration must be given to determine how to give effect to Te Tiriti o Waitangi.

Note: For the purpose of Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau, the term 'Ngā Iwi Mana Whenua o Tāmaki Makaurau' refers to the nineteen iwi of the greater Auckland region and recognises that each iwi is wholly autonomous, individual and unique.

The information provided in this resource, does not seek to reflect comprehensively the values and principles of individual Iwi Mana Whenua o Tāmaki Makaurau. The mana, mana motuhake, and tino rangatiratanga of each iwi is in no way undermined, constrained or obligated by the contents of Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau.

Cover photo

Ko ngā kōrero tuku iho ā Rangitoto
Ngā Pona Toru ā Peretū (The Three Knuckles of Peretū)
Ngā Tuaitara ā Taikehu (The Dorsal Fins of Taikehu)
Te Rangi-i-toto-ngia-ai-te-ihu ā Tama te Kapua (The day the nose of Tama-te-Kapua bled)
Rangitoto Island

Ngā Pona Toru ā Peretū refers to the three summits of Rangitoto and were named for Ngāi Tai tūpuna Peretū who was born with only three fingers; this was not considered a deformity, but a sign of his descent from a reptile god ancestor. Peretū (pere, dart; tū, pierced) was so named for his father who died of a wound in battle caused by a hand-thrown dart, a weapon that was commonly used by the ancient peoples. Ngā Pona Toru ā Peretū, 'The Three Knuckles of Peretū' today is statutorily acknowledged and recognised by the Crown as the original name of Rangitoto Island.

Taikehu climbed Rangitoto and gave a new name to its peaks. Formally known as 'The three knuckles of Peretū' Taikehu named them 'Ngā Tuaitara a Taikehu', the dorsal fins of Taikehu.

E ai kī ngā kōrero..... according to hearsay, the name "Rangitoto" is said to have been a result of an altercation between Taikehu of the Tainui waka, and Tama-te-Kapua of Te Arawa waka, where they had a disagreement that led to blows being exchanged, and Taikehu gaining an advantage struck the nose of Tama-te-Kapua causing his nose to bleed. The island was then referred to as Te Rangi-i-totongia-ai-te ihu ā Tama-te-Kapua, "the day the nose of Tama-te-Kapua bled".

Other narratives cite this altercation occurred between Hoturoa of Tainui waka and Tama-te-Kapua.

Nā Zaelene Maxwell-Butler, Ngāi Tai ki Tāmaki

Cover photo: Rangitoto (2013). Credit: Alastair Jamieson
All photos and graphics are credit Auckland Council unless otherwise indicated.

Te Haumanu acknowledgement

The Māori graphic designs throughout Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau were created by Hokimai-Anahera Rosieur of Ngāti Manuhiri with the guidance and support of Ngā Iwi Mana Whenua o Tāmaki Makaurau and Auckland Council.

The manu (bird design) is called Te Haumanu, and is symbolic of the role of kaitiaki and kaitiakitanga. The intricate patterns within the design speak to the connection of people and the environment, that we are dependent and vulnerable if we do not look after one another.

Kua eke te wā, me noho mātāmua ko te whakaaro nui ki te Taiao i ngā mahi katoa

No longer will things happen without consideration of the impact within te taiao

(nā Hokimai-Anahera Rosieur, Ngāti Manuhiri)

Te Haumanu takes on all the special characteristics of manu (birds) in their natural environments, whether soaring, diving, wading, perching, swimming, singing, or watching and observing human behaviour and impacts on their natural habitats.

The Ruahine (ancient pattern) on the forehead of Te Haumanu speaks to the foresight and guidance from our tūpuna (ancestors), inspiring better outcomes and overcoming challenges for the current and future wellbeing of te taiao (natural environment). The translucent design of Te Haumanu represents the tūpuna of Ngā Iwi Mana Whenua o Tāmaki Makaurau, and the spiritual connection between the past and the present. Te Haumanu flying through the various images is symbolic of the manaakitanga for te taiao, the spiritual realm, keeping an eye on all we do, urging us to be mindful of the footprint we leave.

The outer tail feathers are representative of leadership, symbolised using the huia feather, (extinct highly prized native bird) and the middle feathers representing the ground swell of collective effort required to transform te taiao to its natural and healthy state, and with the hope that over time te taiao will need less intervention from people and be able to naturally regenerate.

It is the desire of each iwi that has contributed to bringing Te Haumanu to this kaupapa, that it speaks to, and provides Tāmaki Makaurau specific guidance as determined by each individual iwi. Our diversity is our strength, our unity in caring for Ranginui, Papatūānuku, their tamariki and mokopuna (children and grandchildren), we can hope for change that will see our mokopuna grow and thrive in Tāmaki Makaurau, Aotearoa.

Photo: Pōhutukawa treeland/ flaxland/rockland at Te Āhua Point. Credit: Alastair Jamieson

He Kupu Takamua/Foreword

E ngā mana, e ngā reo, e ngā rau rangatira, ngā mihi ki a koutou katoa.

In the development and writing of Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau, Auckland Council has partnered with Ngā Iwi Mana Whenua o Tāmaki Makaurau through the Infrastructure and Environmental Services Mana Whenua Kaitiaki Forum: Ngaati Whanaunga, Ngāi Tai ki Tāmaki, Ngāti Manuhiri, Te Patukirikiri, Ngati Maru, Waikato-Tainui, Ngāti Paoa (Trust Board), Ngāti Tamaoho, Ngāti Tamaterā, Ngāti Te Ata Waiohua, Te Ahiwaru and Te Ākitai Waiohua.

He mihi whakawhetai ki ngā kaitiaki o Ngā Iwi Mana Whenua o Tāmaki Makaurau

Mana whenua representatives Zaelene Maxwell-Butler (Ngāi Tai ki Tāmaki) and Gavin Anderson (Ngaati Whanaunga) alongside Leon Blake (Kounga Ltd) developed the mihimihi and karakia specifically for Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau on behalf of Ngā Iwi Mana Whenua o Tāmaki Makaurau.

He mihi whakawhetai ki ngā kaimahi o tēnei kaupapa

The ecological science content was curated by Jessica Reaburn, Lance Salt (Wildland Consultants Ltd) and Sam Sutherland (Auckland Council). We acknowledge the kaitiaki of Ngā Iwi Mana Whenua o Tāmaki Makaurau and key Auckland Council staff Sandra Jack, Paul Duffy, Sam Hill, Terry Smith, Adrianne Taungapeau, Rebekah Fuller, Darron Leslie, Prue Scott and Wendy Dunick. Thanks also to ecological consultants, restoration practitioners, nursery staff, researchers, and community groups for providing a wealth of knowledge and advice that has contributed to, and enriched, the content of this resource.

He Taonga Tuku Iho – Intellectual Property

The mihimihi, karakia, mahi toi and all other taonga contributed by kaitiaki o Ngā Iwi Mana Whenua o Tāmaki Makaurau are the exclusive intellectual property of iwi named above. These taonga should be treated with respect, not be altered, changed, or reused without seeking appropriate permission from Ngā Iwi Mana Whenua o Tāmaki Makaurau.

He Mihimihi

Maiea te mauri nō tuawhakarere

I wānangatia rā i te pō

I raupītia rā i te ao

Tēnei te mauri nō Rangi e tū nei

Tēnei te mauri nō Papa e takoto nei

Kia haumanutia ko te taiao kia ora

Kia kumanutia ko te taiao kia mau

Ka puta ngā uri whakaheke ki te whaiao, ki te ao mārama

Whano, whano, tau mai te mauri!

Haumi, ē; hui, ē; tāiki, ē!

Kia mātua rere te reo whakamiha o ngā mana whenua kia pāorooro ai ki te tini tangata o tēnā iwi, o tēnā iwi puta noa.

Kia kapohia hoki taua reo rā e te hau maiangi kia tatū ai ki te whare o te hoa patui, o Te Kaunihera o Tāmaki Makaurau. Ina tautokorua ko te whakaaro, he pitomata ka kitea. Ina tukutahi ko te mahi, he puāwai ka manahua. Nō reira, nau mai te mahi tahi!

We call upon the force from time immemorial

That which was conceived in darkness

And nurtured in the world of light

This is the force of the heavens above

This is the force of the earth below

May the environment be restored to total health

May the environment be fostered to last forever

Allowing generations yet unborn to thrive with clarity and enlightenment

Let these words progress the permeation of the force!

We all agree in unison!

It is the wish of the local indigenous people that their collective voice of greeting to all nations rings throughout the region.

May the echo of that voice be carried by the gentle breeze to where our friends, the Auckland Council, reside. When our ideas are in accord, we can envisage our possibilities. When our actions are synchronised, our possibilities become our reality. We look forward to working together!

Nā Zaelene Maxwell-Butler, Ngāi Tai ki Tāmaki; Gavin Anderson, Ngaati Whanaunga; Leon Blake, Kounga Ltd; and Ngā Kaitiaki o I&ES Mana Whenua Kaitiaki Forum (2021)

He whakamārama/explanation

This mihimihi, developed for Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau, enriches the work in Te Tāruke-a-Tāwhiri: Auckland's Climate Plan*. It supports the plan's actions to increase the resilience of indigenous biodiversity, habitats, and ecosystems and to protect and grow the ngahere/forest.

1 aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/Pages/te-taruke-a-tawhiri-ACP.aspx

Photo: Okahu Bay Wharf.

He Karakia Haumanu Taiao

Ko Ranginui e tū nei
Ko Papatūānuku e takoto nei
Kia haumanutia ko te taiao kia ora
Kia kumanutia ko te taiao kia mau
Kia tina! TINA!
Hui, ē; TĀIKI, E!

This is the force of the heavens above
This is the force of the earth below
May the environment be restored to total health
May the environment be fostered to last
forever steadfast
We all agree in unison!

He whakamārama/explanation

This karakia is derived from the mihimihi on page 6 and 7.

Ngā Iwi Mana Whenua o Tāmaki Makaurau encourage the use of the karakia for the purpose of restoration consistent with Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau.

Photo: Shore-bindweed, knobby clubrush-gravelfield/stonefield at Te Titoki Point on Te Hauturu-o-Toi / Little Barrier Island. Credit: Alastair Jamieson

Contents

1. Ngā Whakaaro o Ngā Iwi Mana Whenua o Tāmaki Makaurau ki te Haumanutanga: Mana whenua perspectives on restoration

Photo: Kauri, tōwai, rātā, montane podocarp forest on the summit of Te Hauturu-o-Toi / Little Barrier Island. Credit: Alastair Jamieson

Ngā Iwi Mana Whenua o Tāmaki Makaurau, who have participated in the development of this guide, invite you to partner with them to bring balance back to the whenua. From the mihimihi at the front of Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau, you will be ushered along a journey of restoration and enlightenment that draws on the heart of Te Ao Māori and the narratives of our primal ancestors Ranginui and Papatūānuku.

1.1

Whakapapa o te Taiao/o te Ao Turoa

Maiea te mauri nō tuawhakarere

We call upon the force from time immemorial

The journey through the narrative of whakapapa is a central part of our very existence, our lineage, our genealogy that links us today to our primal ancestors at the very beginning of time. Whakapapa binds the spiritual to the natural and the inanimate to the animate.

Our story upholds these connections of the spiritual and physical realms. From the union of Ranginui and Papatūānuku begat the natural world – Te Taiao first and Te Ira tangata later. Sharing whakapapa with the natural world consolidates our inter-reliance and interdependence with nature, all things – people, birds, fish, birds, and weather patterns are members of the same family, with us as tēina.

In essence, whakapapa is a system that guides our behaviour, sense of belonging and responsibilities. Our collective responsibility is to protect and preserve whole living systems, to ensure we maintain, sustain, and assist the regeneration of the whakapapa relationships that enable the wellbeing of these systems.

1.2
Kaitiakitanga

This intricate system of whakapapa relationships is interwoven with mātauranga and tikanga that has developed across generations and informed cultural practices related to the care for the environment and is commonly referred to as kaitiakitanga. The continuous development across Tāmaki Makaurau / Auckland remains a significant impact on the practice of kaitiakitanga adding to the complexity of mahi that kaitiaki must contend with to maintain, monitor, preserve and protect the health and wellbeing of te taiao.

Restoration activities are positive actions toward environmental wellbeing alongside the distinctive kaitiakitanga practices of mana whenua or tangata whenua. Kaitiakitanga is a concept that is enshrined within tikanga (Tomas, 1994) despite the issues related to the inclusion within various legal, guidance and advocacy documents. According to the late Ngāti Te Ata leader Nganeko Minhinnick:

> "Kaitiaki cannot be filled by a group from anywhere because the status of kaitiaki stems from long tribal associations. Only tangata whenua can be kaitiaki, can identify kaitiaki, and can determine the form and structure of kaitiaki."
>
> **(Minhinnick, N. (1989) Kaitiaki. Print Centre, Auckland).**

Therefore, a key part of the role of mana whenua kaitiaki is to provide expertise and advice on how to maintain the mauri and the mana of te taiao, and how to conserve our maunga, awa, ngahere and moana. Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan, has had significant mātauranga input from mana whenua and describes how to maintain the wellbeing of the unique landscapes across Tāmaki Makaurau / Auckland. Kia Ora Te Tātai incorporates a framework describing three dimensions of sustaining the natural balance and increasing the mauri of te taiao.

- **Ngā Aho Taiao**
  The ability and capacity of te taiao to sustain and maintain whole living systems and regenerate its own mauri, while contributing to the mauri of people and land.
- **Ngā Aho Whenua**
  The ability and capacity of the whenua to sustain and maintain whole living systems and regenerate its mauri, while contributing to the mauri of people and nature.
- **Ngā Aho Tangata**
  The ability and capacity of tangata to sustain and maintain their mauri, while contributing to the mauri of the land and nature. For mana whenua, this relates to their ability and capacity to maintain, sustain, and regenerate their specific whakapapa relationships with land, nature, and people of Tāmaki Makaurau / Auckland. For Māori communities, this relates to their ability and capacity to maintain, sustain, and regenerate whānau and community well-being within Tāmaki Makaurau / Auckland.

Te Tāruke-a-Tawhiri uses a cultural narrative that is deeply embedded in this place – Tāmaki Makaurau / Auckland. It calls for a change in our response to climate change, a shift from a human-centred approach to an ecological approach. Similarly, restoration also requires a shift to an ecological-centred approach given our symbiotic relationships with the natural environment. Refer to Te Tāruke-a-Tawhiri to get an understanding of Te Ao Māori perspectives in relation to climate change that may help provide context for perspectives regarding conservation and restoration activity.

1.3 Te Haumanu Taiao a Ngā Mana Whenua o Tāmaki Makaurau:

Mana whenua of Tāmaki Makaurau / Auckland and restoring the environment

I wānangatia rā i te pō

That which was conceived in darkness

Ecological restoration is a connection between people and place. Te haumanu hauropi – ecological restoration is about bringing balance back to the environment and taking a whole ecosystem approach. From a Te Ao Māori perspective, humans are intrinsically linked with the natural environment including biodiversity and it is important to consider the impact our activities are having on the environment. For example, that we are not removing an important ecological component of the system, whether what we are doing is reversable and whether we are adding value to an area.

1.4 Te āhua o te mahi tahi me ngā iwi mana whenua i ngā kaupapa haumanu:

How to work with mana whenua to collaborate on restoration projects

Understanding how to work with and to collaborate on restoration projects should be guided by specific mātauranga that is held by the kaitiaki of ngā iwi mana whenua from the specific rohe or area.

Mātauranga refers to Māori knowledge systems and practices. There is hapū and iwi based mātauranga within Tāmaki Makaurau / Auckland. Mātauranga a iwi and Mātauranga a hapū are specialised fields of Māori knowledge which are intergenerational and accumulated bodies of knowledge that are place-based.

The definition, use and application of mātauranga is an iwi-only whakaaro (understanding) to be gifted or shared where deemed appropriate by individual iwi. As noted in the Taonga Tuku Iho – Intellectual Property section in the foreword of Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau, iwi have intellectual property rights relating to their mātauranga and you should take care not to share it without their express permission.

1.5 Ngā Whakaaro hei Huritao:

Ideas to consider

I raupītia rā i te ao

And nurtured in the world of light

Mana whenua can contribute to restoration projects by collaborating, partnering, leading projects with you or by providing specialist mātauranga advice. Examples can be seen below:

- **Te Kōwhiri Momo Otaota – Plant species choice**

  Mana whenua understand the historical ecology of an area. This can provide an insight into the original flora and fauna of the area and therefore what plant species are appropriate for restoration projects. Consider sourcing plants from iwi-owned nurseries as seen in Figure 2 or as advised by iwi mana whenua kaitiaki for the specific area.

- **Te Haumanu Oneone hei Tiaki Wāhi Tapu – Revegetation near wāhi tapu**

  Restoration on or around wāhi tapu (sacred sites) requires specialised instruction and guidance from iwi mana whenua. Plant selection, plant placement, access, maintenance and appropriate tikanga is important on or around wāhi tapu.

- **Ngā Tikanga, te Whakamahinga o ngā Rawa – Cultural practices and/or resource uses**

  Discussion with mana whenua can lead to identification of opportunities for appropriate cultural practices and/or resource uses within your project.

Figure 1: Planting on Te Motutapu a Taikehu / Motutapu Island. L-R: Ko Korowai rāua ko Taaniko Lyon-Elzen ētahi mokopuna o Ngāi Tai (Korowai and Taaniko Lyon-Elzen are young descendants of Ngāi Tai).
Credit: Zaelene Maxwell-Butler, Ngāi Tai ki Tāmaki

Figure 2: Planting on Te Motutapu a Taikehu / Motutapu Island. Credit: Zaelene Maxwell-Butler, Ngāi Tai ki Tāmaki.

Figure 3: Te Ahiwaru Matariki planting day on Ihumaatao whenua. Credit: Te Ahiwaru

1.6 Te āhua o te whakapā atu ki Ngā Iwi Mana Whenua o Tāmaki Makaurau:

How to engage with the collective of Mana Whenua Iwi of Tāmaki Makaurau

Whano, whano, tau mai te mauri!

Let these words progress the permeation of the force!

Engagement with Ngā Iwi Mana Whenua o Tāmaki Makaurau should be done at the start of the project planning process. It is important to remember that iwi mana whenua are autonomous and more than one may have an interest in, and knowledge of, your restoration site.

Iwi mana whenua engagement may involve hui and is likely to include considerations of a wide range of strategic documents, maps and plans including, but not limited to, iwi environmental management plans, taiao plans, kaitiaki monitoring plans and heritage overlays. These documents provide an overview of mana whenua expectations, interests, desired outcomes, and values.

How engagement might look or what this might involve will depend on the place including land ownership, the project, and the iwi mana whenua involved. If the site is on public land, contact the relevant land manager (e.g. Auckland Council or the Department of Conservation) for guidance on the process for mana whenua engagement.

When you make initial contact with mana whenua it is critical for you to clearly communicate the details and intentions of the project, the proposed timelines and what you would like to achieve by engaging with them. Sufficient time should be allowed for meaningful engagement to be undertaken including time to understand mana whenua aspirations and priorities.

More specific guidance on how to engage with Ngā Iwi Mana Whenua o Tāmaki Makaurau can be found on tiakitamakimakaurau.nz – Tiaki Tāmaki Makaurau | Conservation Auckland. This information acknowledges the tikanga that has guided the development of Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau. The engagement process is not a tick box exercise; it is an integral part of building and maintaining relationships, acknowledging our Te Tiriti o Waitangi partners, and promoting collaborative partnerships with Ngā Iwi Mana Whenua o Tāmaki Makaurau.

2. What is ecological restoration?

Photo: Mangrove forest and scrub variants at Rangiriri including mangrove forest and scrub (SA1.2), sea rush and oioi (SA1.3) and shell-barrier beach (SA1.5). Credit: Alastair Jamieson

Kia haumanutia ko
te taiao kia ora

May the environment be restored to total health

2.1

Technical understandings of ecological restoration

Ecological restoration (or simply restoration) is generally described as assisting the recovery of ecosystems that have been damaged, degraded, destroyed, or disturbed by human activities[1]. Restoration includes activities to protect and improve existing ecosystems as well as recreating ecosystems that have been lost.

An **ecosystem** is a collection of species that interact with each other and their supporting environment. Thirty-six naturally occurring terrestrial (land-based) and wetland ecosystem types have been identified in Tāmaki Makaurau / Auckland, distinguished by different environmental conditions and species assemblages[2]. They include forests, cliffs, regenerating scrub, freshwater wetlands, coastal wetlands, caves, and geothermal areas.

1 Society for Ecological Restoration definition – see ser-rrc.org/what-is-ecological-restoration/

2 These ecosystem types are described in detail in Auckland Council's 'Indigenous terrestrial and wetland ecosystems of Auckland': knowledgeauckland.org.nz/media/1399/indigenous-terrestrial-and-wetland-ecosystems-of-auckland-web-print-mar-2017.pdf.

2.2 Te Haumanu Taiao

Regeneration

Māori perspectives of ecosystems are framed within a holistic approach to restoration.

Tāmaki Makaurau / Auckland is sustained by our environment which is made up from a range of interdependent ecosystems. Ngā Iwi Mana Whenua o Tāmaki Makaurau work to preserve productive lands, all waterways, natural habitat, and supportive ecology with a great deal of emphasis to mitigating impacts like pollution, intensification, and atmospheric conditions. Our region needs clean air, water, and lands to sustain a high quality of health, wellbeing, and life for both tangata (people) and whenua (land).

Restoration and regeneration of our harbours, prioritising whakapapa, taking a catchment approach, and applying the lessons from the Kaipara Harbour process are central to Ngā Iwi Mana Whenua o Tāmaki Makaurau approaches to restoration. This includes the restoration, regeneration, and replenishment of puna wai (freshwater springs), te repo (wetlands), mahinga kai (gardens, cultivations, places to gather food) and pātaka kai (food storage place).

1 knowledgeauckland.org.nz/media/1399/indigenous-terrestrial-and-wetland-ecosystems-of-auckland-web-print-mar-2017.pdf

2 Refer to the Indigenous ecosystems guide (as above) for more details on ecosystem threat classification.

2.3

Why do we need ecological restoration in Tāmaki Makaurau / Auckland?

Ka puta ngā uri whakaheke ki te whaiao, ki te ao mārama

May the environment be restored to total health

The biodiversity of Tāmaki Makaurau / Auckland is suffering from ongoing decline. Most of the original indigenous vegetation cover of the region has been lost over the last 180 years. Modifications have included vegetation clearance, draining of wetlands, selective logging (especially of kauri), farming, and the introduction of exotic animals and plants. Invasive plants pose a significant threat, smothering and suppressing our native flora and modifying ecosystems. Introduced mammalian predators, such as rodents and mustelids, have had a devastating impact on native fauna, resulting in the loss of many species from the mainland.

An estimated 25 per cent of Tāmaki Makaurau / Auckland's original vegetation cover remains in specific ecological areas within large forests of the Waitākere Ranges, Hūnua Ranges, and smaller areas on offshore islands. Small fragments of indigenous ecosystems are also present – separated by urban development, infrastructure (e.g. motorways), exotic vegetation (e.g. forestry) and farming. This fragmentation and isolation of habitats can have major negative impacts on indigenous species, even if the habitat fragments themselves are in good condition.

Threats and pressures on our indigenous ecosystems remain, including, but not limited to habitat loss (vegetation clearance/degradation, loss/degradation of waterways/wetlands), pest plants, pest animals, and climate change. Indigenous terrestrial and wetland ecosystems of Auckland classifies each indigenous terrestrial or wetland ecosystem type with a regional threat status based on whether and how the ecosystem is degrading, predictions of future decline, and changes in its extent across the region. The threat status of ecosystems in Tāmaki Makaurau / Auckland ranges between Least Concern (i.e. still relatively common) through to Collapse (no longer present in Auckland). Ecosystems for which there is little information available have been classified as Data Deficient.

Restoration projects, whether they cover 100 square metres or 100 hectares, are critical to retaining and extending indigenous biodiversity across Tāmaki Makaurau / Auckland. The potential benefits of carrying out ecological restoration include expansion of areas of indigenous vegetation and threatened ecosystems, greater availability of habitat for indigenous fauna, cleaner waterways, increased resilience to climate change, and more attractive landscapes.

2.4

What is the purpose of Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau?

Kia kumanutia ko te taiao kia mau

May the environment be fostered to last forever

The purpose of Te Haumanu Taiao: Restoring the natural environment of Tāmaki Makaurau, is to empower anyone undertaking restoration in Tāmaki Makaurau / Auckland to achieve their ecological restoration goals and to further enable the biodiversity of our region to heal and flourish. This includes small- to large-scale projects done by Ngā Iwi Mana Whenua o Tāmaki Makaurau, community groups, landowners, businesses, consultant ecologists, and local and central government bodies. It is intended that this guide will inspire more involvement in ecological restoration and will support the implementation of current best practice methods to preserve and enhance indigenous biodiversity in Tāmaki Makaurau / Auckland.

This resource combines and updates previous resources to create a resource that covers the entire region and takes an ecosystem-based approach to restoration. The identification of a target ecosystem type is important as a reference to assess the progress and success of a restoration project against (Reaburn, 2014; Upton, 2020). This approach will ensure that the restored area will become self-sustaining over time, minimising the effort and cost associated with the restoration project.

Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau focuses on preserving and enhancing intact examples of existing ecosystems through restoration actions such as pest plant and animal control, stock exclusion and management of plant diseases. For situations where there is no existing indigenous vegetation, or the previous ecosystem type has been severely degraded, detailed guidance on planting is provided to help ensure that any planted species are appropriate for the location and environmental conditions. Other best practice resources for Tāmaki Makaurau / Auckland are referenced for further reading where appropriate.

The objectives of this resource are to provide:

- guidance on how to maximise and measure ecological outcomes of a restoration project
- current best practice methods for common forms of restoration in Tāmaki Makaurau / Auckland
- ecosystem-specific guidance to restore specific terrestrial, wetland, and riparian ecosystem types
- cultural perspectives on the maximisation and measurement of Māori outcomes of a restoration project including:
  - principles of kaitiakitanga
  - the prioritisation of iwi mana whenua tikanga kaitiaki principles (the protective practices of local tribal authorities) to uphold ‘Te Mana o te Taiao’
  - responsible and efficient decision making related to te taiao
  - ensuring consistency and accountability
  - promoting a zero tolerance approach to the wilful destruction of ‘Te Mana o te Taiao’
  - supporting and promoting rāhui as a kaitiaki initiated protection mechanism to ensure that the priority of te taiao as a taonga that must be protected and maintained
  - to benefit a specific species (e.g. increasing population of an indigenous bird species)
  - aquatic ecosystems (marine or freshwater).

Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau has no formal regulatory status but provides best practice guidance for restoration projects and conservation planting that may be required as part of resource consent processes in the Tāmaki Makaurau / Auckland region.

Figure 4: A ‘Trees for Survival’ planting. Credit: Anna Birchall

3. Restoration project planning and implementation

Photo: Pōhutukawa, pūriri, broadleaved forest on Waiheke Island.
Credit: Alastair Jamieson

Kia mātua rere te reo whakamiha o ngā mana whenua kia pāorooro ai ki te tini tangata o tēnā iwi, o tēnā iwi puta noa

It is the wish of the local indigenous people that their collective voice of greeting to all nations rings throughout the region

3.1

What are the priorities for restoration in Tāmaki Makaurau / Auckland?

The main priority is to protect and enhance existing indigenous ecosystems and habitats, especially threatened ecosystems. Restoration projects may be simple or complex, with a variety of goals, and have the potential to require long timeframes, large project teams, and ongoing funding. To maximise the ecological outcomes and efficient use of resources, it is important to prioritise actions that will have the greatest long-term benefits. Selection of priority restoration actions will be influenced by the:

- existing site conditions and main ecosystem/riparian pressures (see Section 4 for ecosystem specific restoration guidance and see Section 5 for riparian restoration guidance)
- overall project vision, goals, and objectives
- project budget, available resources, and timeframe.

In most situations, carrying out revegetation planting in severely degraded or cleared areas will be the last step in a project. General principles which can be used to help guide priorities for restoration are outlined below.

3.1.1 Protect and enhance existing indigenous vegetation and ecosystems

Where existing indigenous vegetation is present, ecological values can be protected by reducing pressures on the ecosystem, e.g. fencing to exclude stock or controlling pest plants and animals. Reducing pressures on an ecosystem should allow the area to naturally regenerate. This is especially true for wetlands, which regenerate rapidly if seed sources are present.

Increasing ecological values by reducing pressures on existing indigenous ecosystems generally provides better value for your dollar, as well as resulting in more natural ecosystems than can be recreated through planting. More tangible results may also be achieved in a reasonable timeframe, compared to 'starting from scratch'. Only once pressures have been managed should planting be considered. Planting of existing ecosystems may be necessary to create protective buffers between the ecosystem and neighbouring areas, or to replace missing species that are unlikely to naturally re-establish.

3.1.2 Once existing indigenous ecosystems are protected and enhanced, explore opportunities for planting

Natural spread of forest ecosystems into areas with no existing indigenous vegetation may take decades or centuries. Planting can be used to accelerate these timeframes. Once existing areas are enhanced then you can look at creating new areas of planting. Priorities for planting include riparian areas, creating linkages between areas of existing vegetation, and building stepping stones that can facilitate movement of indigenous species throughout the landscape. Planting close to existing indigenous vegetation may help accelerate development of a planted area to a more natural state due to the proximity of local seed sources (e.g. Sullivan et al., 2009).

- **Consider staging the restoration project**
  Depending on the size of the restoration project, its complexity and available budgets and resources, it might be best to stage the restoration project by dividing the site into suitably sized management units. This approach may be suitable for:
  - sites with multiple ecosystems and/or riparian areas
  - sites with large pest plant infestations which are controlled in stages and progressively replanted to prevent re-invasion
  - large revegetation projects where you do not want to plant an area greater than you can maintain.

Figure 5: Community planting day at Matheson Bay Reserve to buffer and extend the forest. Credit: Matheson Bay Community Association.

Figure 6: Staged restoration planting at Shakespear Regional Park. Kōwhai Glen and retired gullies view south. Credit: Tim Lovegrove

3.2

Restoration project site assessment

I wānangatia rā i te pō,
I raupītia rā i te ao

That which was conceived in darkness, and nurtured in the world of light.

A high-level site assessment is essential for assisting with the development of the vision, goals, objectives, and actions for your restoration project.

3.2.1 Are there any restrictions on where you can carry out a project or what you can do at a site?

A critical first step is to identify whether there are any restrictions on where or what kinds of restoration can be undertaken on the site. Things to consider include:

- If you do not own the land, you will need landowner permission (including public reserve land). Ensure property boundaries are clearly defined when talking to landowners.
- Check if there are any easements, covenants or conditions associated with a resource consent application for the property. If restoration is being done to satisfy a condition of a resource consent, or to enable rural subdivision, ensure you are meeting all the consent and/or plan requirements and seek advice from Auckland Council ecologists if required.
- Check for the presence of heritage sites (cultural, historical or archaeological). Refer to Appendix 2 for advice on avoiding risk to heritage sites from restoration activities.
- Check for the presence of infrastructure (including underground), contaminated land, and planned future development.
- Check whether restoration activities require a resource consent or other application. Refer to Appendix 3 for an overview of statutory documents relevant to restoration in Tāmaki Makaurau / Auckland.

It is important that you do your due diligence and seek appropriate advice to ensure that planned restoration activities do not require a resource consent, consultation, or other application.

3.2.2 What existing (or potential) ecosystems are present at your site?

Figure 3.1 displays the main ecosystem components to assess at the site for both existing indigenous ecosystems and sites where indigenous ecosystems could be recreated.

The following methods can be used to determine the existing ecosystem type or **potential ecosystem** type:

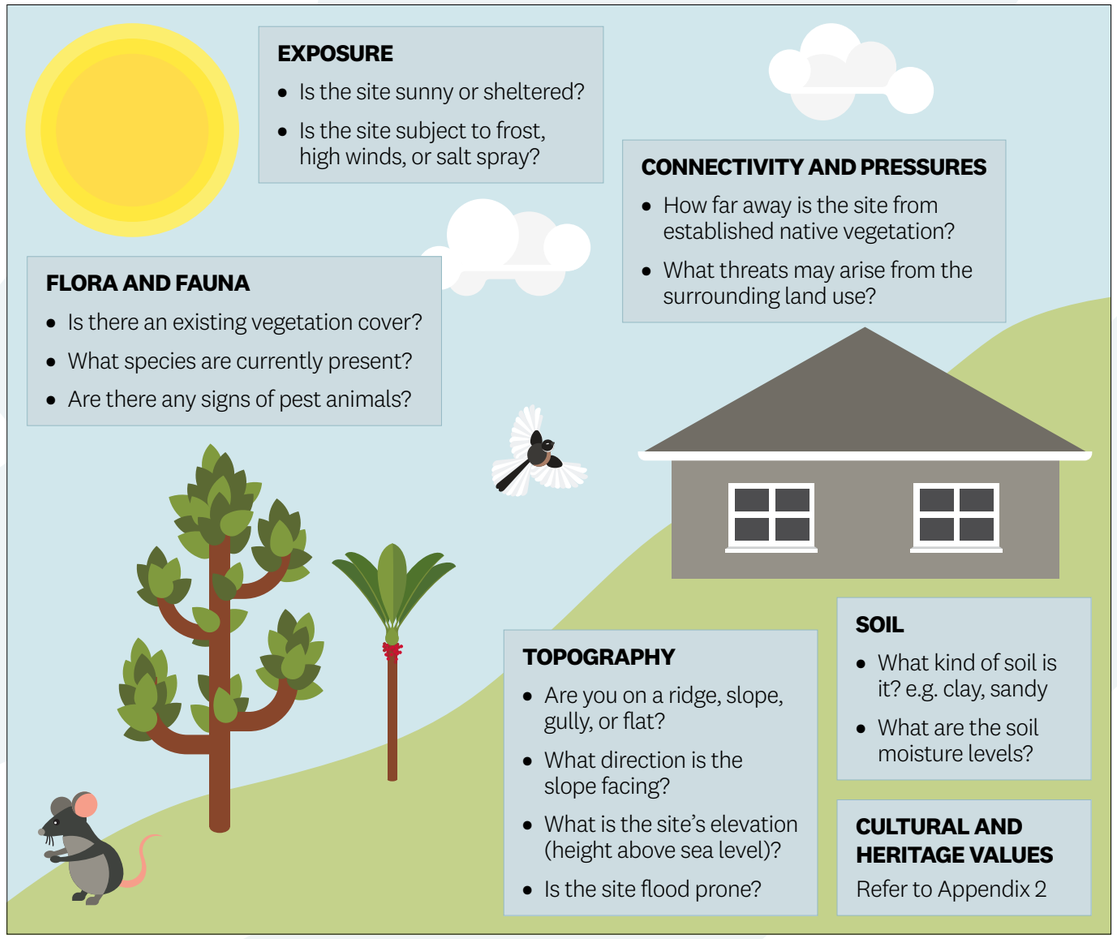
- Assess location:
  - geographical location within Tāmaki Makaurau / Auckland
  - topographical location, i.e. ridge, slope, gully, or flat
  - climate, hydrology, and soil conditions.

Note: Information on soils, topography, and exposure will be most useful at sites where revegetation planting is proposed to identify the potential ecosystem type, although a more detailed pre-planting site assessment will also be required (see Section 3.7).

- During engagement with mana whenua, discuss the historical narrative to understand the cultural and ecological landscape.
- Look at historical photos, including aerial imagery.
- Assess presence of regenerating indigenous vegetation and mature canopy species on the site and/or in the local area. Some areas may be degraded or lack vegetation which may make identification of the ecosystem type difficult.
  - Refer to the 'Indigenous terrestrial and wetland ecosystems of Auckland' knowledgeauckland.org.nz/media/1399/indigenous-terrestrial-and-wetland-ecosystems-of-auckland-web-print-mar-2017.pdf for full descriptions of ecosystem types. Also refer to the ecosystem keys in Section 4 of this resource to assist with identification of ecosystem types.
  - Look at the 'Current Ecosystem Extent' and 'Potential Ecosystem Extent' layers available on the Conservation Map – Tiaki Tāmaki Makaurau | Conservation Auckland – tiakitamakimakaurau.nz/conservation-map. These GIS layers display mapping carried out in line with the Indigenous ecosystem guide (Singers et al. 2017), based on current vegetation and other environmental features. Note that this mapping is broad-scale and should be checked for accuracy on site.
- Contact a specialist at Auckland Council by using the Contact Us feature at the bottom of each webpage on Tiaki Tāmaki Makaurau | Conservation Auckland – tiakitamakimakaurau.nz/contact-us

Refer to Section 4 for ecosystem specific restoration advice.

Figure 3.1: Key components of a site assessment for planning your restoration project. Kōwhai Glen and retired gullies view south. Credit: Tim Lovegrove



3.2.3 Are there any waterways present on the site?

Assess whether there are any waterways or waterbodies on the site and the quality of the vegetation surrounding them. Refer to Section 5 for riparian restoration guidance for sites that contain a river, stream, or lake margins. Sites that contain streams through wetland areas can use the riparian restoration guidance in combination with ecosystem-specific advice for the target wetland ecosystem.

3.2.4 What pressures may affect your project site?

Indigenous ecosystems and riparian areas in Tāmaki Makaurau / Auckland may be degraded by a wide variety of pressures. Identification of these pressures will assist in forming the goals and actions required for each project. Pressures common to ecosystems in Tāmaki Makaurau / Auckland are outlined in Table 3.1. Pressures specific to individual ecosystem types are discussed in Section 4 of this resource.

Figure 7: Myrtle rust on ramarama.
Credit: Wildland Consultants Limited

Figure 8: Drought effects on taraire at Tāwharanui Regional Park. Credit: Tim Lovegrove

Figure 9: Climbing asparagus smothering the understorey. Credit: Tim Lovegrove

Figure 10: Possum and rat at fantail nest. Credit: Ngā Manu

Table 3.1: Ecosystem pressures in Tāmaki Makaurau / Auckland

	Pressure	Why is this a problem?	What can be done to fix it?
Land use change	**Urban development and associated vegetation clearance**	Vegetation has been removed and fragmented by clearance for roads and buildings, with impacts on plant species recruitment and movement of wildlife. Vegetation clearance can increase edge effects (see Glossary).	Protect areas of existing vegetation. Where possible, create new areas of vegetation to connect or buffer existing habitat patches.
	Vegetation clearance and earthworks near waterways	Clearance of vegetation near waterways can increase sediment, contaminants, and water temperatures.	Maintaining setbacks from waterways and existing indigenous ecosystems with buffer planting as required, fencing, and strategically planting around identified point and diffuse discharge areas.
	Farming, horticulture, exotic plantation	Wetlands are drained to allow low-lying and swampy areas to be grazed or farmed. Streams are modified through damming, culverts, and other structures.	Seek specialist advice on appropriate actions and any resource consent requirements to restore hydrology or remove exotic plantings or earthworks.
		Stock graze and trample indigenous ecosystems and prevent regeneration of seedlings. Stock may also spread *Phytophthora agathidicida* (causal agent of kauri dieback via soil movement).	Exclude stock by fencing wetlands and forest fragments. Protect intact examples to provide seed sources for regeneration of surrounding areas. Enrichment planting may be required in areas which are heavily degraded and unlikely to regenerate without assistance (e.g. due to no nearby seed sources).
		Vegetation clearance and/or intensive grazing strips topsoil and accelerates erosion.	Avoid further clearance, exclude stock, and restore vegetation cover.
Pest species (plants and animals)	**Pest plants**	Indigenous species are unable to grow or regenerate due to competition and smothering by pest plants. Include vines that grow on other vegetation and/or along the ground (e.g. Japanese honeysuckle), plants that cover the ground (e.g. wild ginger), or tree/shrub species that can exist in the canopy or sub-canopy (e.g. Chinese privet). Dumping of green waste is often an issue in urban environments. Can change quality of habitat for indigenous flora and fauna.	Implement pest plant and animal control programmes. The Auckland Regional Pest Management Plan 2020-2030 (RPMP) includes a full list of species that are identified as pests in Tāmaki Makaurau / Auckland. Control or management of many species is a requirement under the RPMP. Check out the pest plant and animal resources on Tiaki Tāmaki Makaurau | Conservation Auckland – tiakitamakimakaurau.nz including the 'Pest animal control guidelines for the Auckland region' pdf.
	Pest animals – herbivores	Species such as rabbits/hares, goats and deer eat seedlings and inhibit natural regeneration. Possums browse on fruits, flowers, and foliage and can cause canopy dieback. Rats and mice are seed predators.	
	Pest animals – predators	Species such as rats, mustelids and possums eat indigenous birds and other wildlife, reducing population size and impacting plant dispersal. Pigs prey on invertebrates e.g. pūpū rangi/kauri snails.	
	Pest animals – competitors	Species such as Argentine ants and plague skinks compete with indigenous biodiversity for food and resources.	
	Pest animals – trampling/rooting	Large pest animals e.g. deer, goats and pigs trample vegetation preventing regeneration of seedlings. Pigs may disrupt nutrient cycling through rooting. These animals can also spread *Phytophthora agathidicida* (causal agent of kauri dieback via soil movement).	

	Pressure	Why is this a problem?	What can be done to fix it?
Plant pathogens	**Myrtle rust** *(Austropuccinia psidii)*	This fungal disease affects the new growth of infected plants in the Myrtaceae plant family. This family includes common indigenous species (e.g. mānuka, kānuka, pōhutukawa, rātā), so could have large impacts on indigenous ecosystems. Spread by wind or via insects, birds, people, and machinery.	Monitor plants for signs of infection. Source Myrtaceae species for planting from nurseries accredited under Plant Pass: plantpass.org.nz For further information including advice on recognising the symptoms and what to do when you find myrtle rust, see myrtlerust.org.nz For site-specific advice contact a specialist at Auckland Council by using the Contact Us feature at the bottom of each webpage on Tiaki Tāmaki Makaurau | Conservation Auckland or tiakitamakimakaurau.nz/contact-us
	Kauri dieback *(Phytophthora agathidicida)*	This disease is caused by a soil-borne pathogen that affects kauri trees. Symptoms include canopy dieback, and basal lesions. Infects and can kill kauri of all ages, potentially wiping out entire forest stands where kauri is dominant. Spread through movement of soil, e.g. dirty footwear, animals, equipment and vehicles.	Monitor plants for signs of infection and maintain kauri-friendly hygiene procedures (i.e. thoroughly cleaning gear and equipment of soil) when working near kauri. Contact Auckland Council for advice around best practice kauri hygiene. There are rules under the RPMP that restrict the movement of kauri to certain locations (e.g. Hauraki Gulf Islands). For more information /guidance and site-specific advice contact a specialist at Auckland Council by using the Contact Us feature at the bottom of each webpage on Tiaki Tāmaki Makaurau | Conservation Auckland or tiakitamakimakaurau.nz/contact-us For further information including advice on recognising disease symptoms and how to reduce the risk of spread, see kauriprotection.co.nz
Climate change	**Changes in temperature and weather conditions**	Drought and/or elevated temperatures that affect species survival and increase fire risk. Increased storm damage.	Planting of riparian areas to shade streams and reduce flood flows. Planting can sequester carbon. Consider the predictions of future sea level rise and what impact this may have on restoration of coastal ecosystems and riparian areas near the coast. Adaptive management will be important for (e.g. managed retreat) for coastal ecosystems which may be affected by sea level rise.
	Sea level rise	Coastal ecosystems being flooded, causing erosion, or elevated water levels that change plant species composition and results in a loss of habitat for species that depend on coastal habitats e.g. birds.	

3.3

What restoration actions are suitable for my project?

Ina tautokorua ko te whakaaro, he pitomata ka kitea

When our ideas are in accord, we can envisage our possibilities.

Several restoration actions could be appropriate for managing pressures at your restoration site (Section 3.4.4.). To help narrow down which actions may be suitable, complete the Project Planning Checklist (Section 3.1). Methods for each action are outlined below.

3.3.1 Stock exclusion

Where stock have access, stock exclusion is often the first step in restoring an area of indigenous vegetation to prevent browsing and trampling of indigenous vegetation and encourage natural regeneration. Effective fencing to exclude sheep and cattle for restoration purposes should be a permanent five or seven wire post-and-batten fence and may also be electrified. Fencing of a suitable standard can also be used to exclude larger pest animals, such as feral deer, goats, and pigs, which reduces the need for ongoing control if the fences are maintained.

Fences should be adequately set back from your restoration area to prevent stock reaching over the fence and grazing vegetation. Careful consideration should be given to fencing locations, especially in areas that will be difficult for fencing contractors to access, or that may be subject to flooding (e.g. around wetlands or streams). Specialist advice may be required if archaeological sites have been identified in that location. Fencing costs will increase in very steep locations where fencing by hand (rather than machinery) may be required. Fences should be regularly checked and maintained to ensure the restoration area remains stock free.

Alternatively, rather than fencing a restoration site, stock could be completely removed from a property. In these situations, it may still be useful to mark out the restoration project boundary with posts or temporary fencing.

Figure 11: Grazed understorey. Credit: Tim Lovegrove

Figure 12: Impact of fencing forest fragments. Credit: Sam Sutherland

3.3.2 Pest control

Pests do not recognise property boundaries. We encourage you to work with your neighbours and people in your neighbourhood – this minimises the chance of reinvasion into your area. Also, the wider an area of control, the more chance there is for ecosystem and species/habitat recovery.

Pest plant control

Controlling pest plants is a critical aspect of restoration projects and is an ongoing requirement for both existing areas of vegetation and revegetation sites. Identification of pest plants present within the restoration site and surrounding areas (future invaders), and surveying their abundance and distribution, is an important aspect of site visits at the planning stages. Strategies and control methods for the pest plants present should be included in the restoration plan for a site. The approach used will depend on the site and the objectives and pest plant control methods.

Further information on pest plant control is provided in Appendix 4.

Pest animal control

Controlling pest animals is often a key activity to restore existing indigenous ecosystems as well as to protect restoration planting. Comprehensive control programmes covering several species are recommended to avoid flow-on effects. For example, controlling stoats may increase rat populations due to a reduction in predation. Monitoring of a range of pest animals can also be undertaken and adaptive management implemented. For existing indigenous ecosystems, pest control often includes possums, mustelids, rats, and any large pest mammals (e.g. goats, pigs, deer). For dunes and planting areas, control of rabbits/hares is often required.

Pūkeko may be a nuisance in planting areas as they are known to pull new plants out of the ground soon after planting, particularly in wetlands. This risk can be reduced through use of plant guards and bird-scaring devices.

Check out the pest animal resources on Tiaki Tāmaki Makaurau | Conservation Auckland – tiakitamakimakaurau.nz including the ‘Pest animal control guidelines for the Auckland region’ pdf.

Figure 13: Pest control in an area of buffer plantings around a forest remnant. Credit: Wildland Consultants Limited.

Figure 14: Bait station or trap within locked box.

3.3.3 Restoration of hydrology

Hydrology is the movement of surface and ground water and is often critical to the type of ecosystem that develops. Therefore, changes to the natural hydrology (e.g. water levels and salinity) can contribute to the degradation of swamp forest, wetland, and riparian ecosystems.

The following aspects of hydrology should be considered when planning a restoration project around a waterway or wetland:

- What are the sources of water for the site, e.g., rainfall, overland flow, streams, groundwater?
- Is the site near the coast, and is it influenced by tides?
- How do water levels vary throughout the site and throughout the year (e.g., flooding)?
- Have there been any artificial changes to water levels, e.g., from drainage, damming, stormwater inputs, or tide gates? Do these artificial devices have heritage protection?
- Have natural watercourses been modified, e.g. by channel deepening or straightening?

Restoration of the natural hydrology will, in most cases, require reversal of the past modifications, such as benching back over steepened banks, removal of dams or flood gates, or the infilling of drains. Specialist advice should be sought on any planned hydrological modification particularly around any resource consent requirements (see Appendix 3).

3.3.4 Assisted natural regeneration

In many situations, planting will not be required to restore indigenous vegetation to an area, as there will already be plentiful seed sources for natural regeneration to occur once pressures are managed. Such situations may include:

- Forest fragments with a degraded understorey: Excluding stock and controlling pest plants and animals will allow plants to regenerate. This works especially well when the restoration site is near healthy forest that provides a seed source for missing species.
- Degraded wetlands: Restoring the hydrology, excluding stock, and controlling pest plants and animals will allow the indigenous seeds in the soil to germinate and grow. Indigenous wetland species can naturally regenerate in as little as 1-2 years in suitable conditions.

Assisted natural regeneration may require similar maintenance methods as planting, including ongoing stock exclusion, pest plant and animal control. Supplementary planting may be required in situations where natural seed sources are scarce, or key species are missing for the ecosystem type.

Figure 15: Tree ferns naturally regenerating through kikuyu at Tāwharanui Regional Park. Credit: Tim Lovegrove

Figure 16: Natural regeneration at Tāwharanui Regional Park. Credit: Tim Lovegrove

3.3.5 Direct seeding

Direct seeding involves planting or sowing seeds in a restoration area. This action has an uncertain success rate as it has not been widely implemented in Tāmaki Makaurau / Auckland. As this action is investigated further and technology improved, there may be improvements in germination rates that make direct seeding a more cost-effective option to revegetation planting.

3.3.6 Planting

Planting projects may include:

- buffer planting to extend and protect an existing forest, wetland, or waterway
- riparian planting to protect stream qualities, prevent bank erosion, and increase resilience to flooding
- enrichment planting in areas of existing indigenous vegetation that are species-poor or lacking key species for the ecosystem type that are unlikely to naturally establish
- planting to create linkages or stepping stones between areas of existing indigenous vegetation
- revegetation of exposed hillslopes or erosion-prone gullies retired from grazing
- planting to prevent re-establishment of environmental pest plant infestations, for example a previously weedy corner of a reserve
- planting to provide habitat and food for indigenous fauna.

There are five essential components to any planting project: planning, species selection and plant numbers; plant supply; site preparation; planting; and maintenance.

Figure 17: Retired and planted gully at Shakespear Regional Park. Credit: Tim Lovegrove

Figure 18: Restored wetland at Tāwharanui Regional Park. Credit: Tim Lovegrove

Figure 19: Dune planting at Ngā One Haea/Pakiri Beach. Credit: Tim Lovegrove

Figure 20: ‘Trees for Survival’ planting. Credit: Anna Birchall

3.4

Planning, species selection and plant numbers

Ina tukutahi ko te mahi

When our actions are synchronised.

3.4.1 Introduction

The planting advice below is best practice for most situations aiming to restore terrestrial, wetland, and riparian ecosystems, however, this is not a one size fits all approach and alterations to this guidance may be required in some instances.

Identification of the appropriate ecosystem type (see Section 3.5) will assist in using this resource effectively. In situations where a site has no original indigenous vegetation, it will be important to look at the physical site characteristics (e.g. soils, topography, hydrology) and use other resources such as historic aerial photos to determine the ecosystem type.

Note that if planting is for other purposes (i.e. not to restore a specific ecosystem), then a general forest planting mix for initial planting can be found in Section 4.2.

Whatever the purpose of planting, it is important to establish a robust planting area with as low a perimeter to area ratio as possible (i.e. short and fat, rather than long and skinny). This will reduce edge effects, such as ongoing re-invasion of pest plants and animals. Wider planting areas also allow for the development of a wider variety of microsite conditions, and, in turn, greater potential for natural recruitment of additional species into the planted area.

3.4.2 Site assessment

While a high-level site assessment is necessary for the early stages of planning your restoration project, a more in-depth site assessment (Table 3.2) is required before planting. Understanding the characteristics of a site is a key step to ensuring the correct species and plant numbers are selected, site preparation requirements are understood, and maintenance requirements are accurately predicted.

Table 3.2: Requirements for a pre-planting site assessment

Site assessment characteristic	Target information
Climate	What is the current climate (e.g. temperature, rainfall), and how might this change in the future? What micro-climatic conditions are present at the site?
Ecological district	What part of Tāmaki Makaurau / Auckland is my site in, and how might that affect what should be planted (see Eco-sourcing details in Section 3.8.2)?
Soil characteristics and drainage	What are the components of the soil (e.g. clay, silt, sand) and how wet is it?
Landform	What is the topography of the site (e.g. ridge, slope, gully) and what direction does it face? Are there streams, overland flow paths, floodplains, or wetlands present?
Exposure	Will the site be subject to adverse environmental conditions such as wind, frost, sunlight, or salt spray?
Pressures	Does stock have access to the site? Are there pest plant and animal species requiring control?
Vegetation	What is the extent of existing indigenous and exotic vegetation? Are there other areas of indigenous vegetation nearby that could guide understanding the ecosystem type and species mix? How close these more intact examples are to the site may determine whether planting is necessary, i.e. if there are no remnant indigenous areas of vegetation nearby to provide seed sources, the site is less likely to naturally regenerate.
Planting restrictions	Are there constraints that may affect what can be planted, e.g. infrastructure, archaeological sites, cliffs, access tracks?

Timeframes and staging

In Tāmaki Makaurau / Auckland, the best planting season is during the winter months (May to August) when soil moisture levels are adequate for effective plant establishment. However, watering of plants may be required under drought conditions. If the site is prone to frosts, it is recommended plants are planted later in the planting season. For wetland sites, plant species that grow in standing water or swampy ground are more easily accessed and may establish better in spring/summer when water levels are lower.

Refer to Figure 3.4 for a proposed schedule for different activities associated with planting including site preparation, planting and maintenance which are discussed further below. The project plan should consider how much can reasonably be achieved during a planting season (e.g. based on budgets, resources including plant supply and site size) and if the planting might need to be staged over multiple years. In these situations, it will be important to consider access to sites for future stages.

Plant schedules and species selection

A plant schedule or plan is an essential tool for all planting projects to guide plant sourcing, planning, and implementation. The schedule will list the plant species, the grade (size of container the plant is supplied in), the plant spacing, and the numbers of plants required of each species. Several plant schedules may be required for larger projects.

Species lists for restoring the terrestrial and wetland ecosystems within Tāmaki Makaurau / Auckland for initial (pioneer species), enrichment, riparian, and buffer plantings are provided in Sections 4 and 5 of this resource. These can be used to develop a plant schedule for the site based on the restoration objectives and site characteristics.

Examples of considerations for species selection include:

- sites exposed to wind, sun, and drying soils require species that can cope with and establish in a range of conditions (pioneer species) e.g. kānuka, mānuka or karamū
- at sites with abundant pest plants that are expected to re-establish following planting, quick-growing tree and shrub species should be selected
- if the objectives are to restore sites that have an existing indigenous canopy of pioneer species but lack key mature-phase species, select enrichment species appropriate for the ecosystem type
- if the project requires sight lines or view shafts to be preserved, smaller growing plants can be selected for those areas
- if fire risk is an issue, then species that have higher flammability (e.g. mānuka and kānuka) could be avoided. Other ways to manage fire risk include appropriate setbacks between plantings and buildings and green breaks (areas of less flammable species)
- refer to Section 5.5 for additional species selection considerations in riparian areas.

Clues as to what will grow well on a site can be provided by observing other similar sites nearby. However, not all species establish easily by planting. Generally, species that provide structure to an ecosystem (e.g. trees and shrubs) will be suitable for planting, while species that grow on and around the structure species (e.g. ferns, vines, and epiphytes) are best left to naturally regenerate. Species such as ferns will colonise planted areas when micro-climatic conditions become suitable, which can take several decades after the planting has established (Reaburn, 2014).

A variety of species should be planted in both initial and enrichment plantings to increase initial species richness, resilience, and opportunities for further increases in diversity over time. The inclusion of species that attract seed dispersing birds should be considered in species choice. Research on plantings in Tāmaki Makaurau / Auckland that has found greater species diversity is associated with increasing biodiversity and a more rapid return towards the target ecosystem type (Forbes and Craig, 2013; Quadling, 2006; Reaburn, 2014; Sullivan et al., 2009). Further increases in diversity have been shown to result from carrying out enrichment planting in planted areas (Haselhoff, 2019).

For further advice on what species to plant, including the appropriateness of planting threatened species, contact a specialist at Auckland Council. Use the Contact Us feature at the bottom of each webpage on Tiaki Tāmaki Makaurau | Conservation Auckland or tiakitamakimakaurau.nz/contact-us

Figure 21: Inclusions of future canopy species suitable to open sites can facilitate succession. For example, the inclusion of pukatea in a wetland planting.

Figure 22: Planting at Hūnua Domain by Hūnua School 2021. Credit: Ben Paris

Determining the total number of plants

Area

The area of ground that is able to be planted should be identified and measured, either on the ground (by multiplying the length by the width) or using an online mapping tool (e.g. tiakitamakimakaurau.nz/conservation-map or Google Earth). The gradient of the slope needs to be considered (by providing extra plants) because the planting area on steeper sites can be greater than a flat site (due to the differences between a two dimensional and three-dimensional area).

Any areas within the site that cannot be planted need to be subtracted from the calculation. Such areas can include existing vegetation, access tracks to be retained, or buffer areas (e.g. between the planted area and a fence).

Spacing

Plant spacing refers to the average distance that should be provided between other plants of the same species or same growth form. For example:

- a mānuka plant should be planted between 1-1.4m away from other mānuka plants and other shrubs
- a pūrei plant should be planted at least 0.75-1m away from other sedges
- canopy trees should be planted at least 5m away from each other but can be planted within 1-1.4m of shrub species.

Appropriate plant spacing is required for the initial planting to achieve rapid canopy closure to minimise pest plant invasion and provide conditions suitable for other species to establish (e.g. shade, moisture).

The optimum average distance between all plants across the site should be influenced by site characteristics and the restoration objectives. Recommended initial plant spacings for different species in different environments are included in the plant schedules in Sections 4 and 5 of this resource. Following these plant spacings is likely to lead to canopy closure within five years for forest, dunes, and riparian ecosystems, and within three years for wetland ecosystems.

Sites where enrichment planting is being carried out will have variable spacing depending on the extent of existing indigenous vegetation and type of species being planted, e.g. large canopy tree species should be planted at least five metres apart.

Plant number calculation

The following formula can be used to determine the total number of plants based on an average plant spacing for the restoration area (see examples in Table 3.3).

Total planting area (m2) ÷ plant spacing $(m)^2$
= Total number of plants

Table 3.3: Relationship between plant spacing and number of plants for a 1000m2 planting area

Plant spacing (m)	Plant spacing x plant spacing (m2)	Calculations	No. of plants
0.5	0.25	= 1000 ÷ 0.25 = 4000	4000
1	1	= 1000 ÷ 1 = 1000	1000
1.4	2	= 1000 ÷ 2 = 500	500
5	25	=1000÷25 =40	40

For enrichment planting within indigenous vegetation, the average distance between enrichment plants can be estimated across a site based on existing vegetation cover.

Determining the number of species and number of each species

Select the plant species you want to plant from the relevant plant schedule in Section 5 of this resource and assign a percentage based on the recommendations. The percentage ranges provided have been informed by experience in planting projects. Ensure the total percentages of all species adds to 100 per cent.

The number of plants per species can be calculated by multiplying the total plant numbers by the percentage converted to a fraction (by dividing by 100). The reality, however, is that the plant spacing is often different for different kinds of plants particularly for wetland and riparian environments. In these situations, it is easier to use online resources to calculate plant numbers. The Coastal Restoration Trust of New Zealand provides a useful plant calculator – www.coastalrestorationtrust.org.nz/resources/planting-calculator – that can be used to automatically calculate number of plants per species at different plant spacings.

Note, however, that this uses a different formula to calculate plant numbers.

Figure 23: Tōtara Park Matariki planting 2018.

Determining the required size of plants supplied

The plant grade refers to the size and shape of the container that the potting mix and root system of the plant is supplied in and is generally grouped by litre sizes. It does not always correlate with the height of the plant. Plants can be supplied in individual pots/bags of various sizes, or trays comprising internal cells that plants are grown in (e.g. root-trainers).

Generally, slower growing or canopy (usually enrichment species) are supplied in larger grades (i.e. 1.5L-2L). These species usually require a larger and well-developed root ball to establish well after planting. Fast-growing pioneer species tend to establish easily and can be planted at smaller grades (i.e. 0.5L-1L) and, longer term, can outperform plantings from larger grade stock. Smaller grade plants are also often cheaper and may be more appropriate for sites with difficult access (e.g. isolated steep slopes) as they are easier to transport.

Plant supply

An important aspect of planning planting projects is determining where the plants will be supplied from. For some larger projects it might be feasible to set up a nursery, however, for most planting projects, plants will likely be purchased from an existing commercial nursery. While this resource does not go into plant propagation, some guidelines on how to collect seed for nurseries can be found in Appendix 5. These have been included to ensure appropriate seed collection is done, particularly on local and regional parks.

Figure 24: Pricking out mānuka seedlings.
Credit: Brendan Mackie

Plant quality

The quality of plant stock strongly influences plant establishment and survivorship, particularly over the first few months following planting. The root structure within the container or bag they are supplied in should fill to the edges without being root bound (when roots form a dense, tangled, often circular and woody mass, that allows little or no space for further growth), and should comprise a high proportion of fibrous roots.

Ideally, plant stock should be well hardened off (i.e. acclimatised to climatic conditions of the site) before planting and be in good health. For example, plants that are to be established in shallow water within wetlands should have had similar growing conditions in the nursery. If tall thin plants fresh from nurseries are unable to self-support when planted, they should be trimmed back to allow the plant to stand up on its own. Tall thin plants will blow around in the wind and struggle to establish to the new site.

Communication with the plant nursery in the lead up to planting is important to ensure the plants will be at the optimum stage at the time of planting. For large orders, it may be advisable to undertake a site visit to the nursery to check the quality of the stock prior to shipment.

Plant supply lead-in time

To ensure a supply of good quality eco-sourced (see below) plants of the required grade for each species at the time of planting, sufficient time is required before planting to order or grow plants. Eco-sourced seed collection (which is seasonal for most species), germination, and pricking out and potting on for supply in the required grade, are all nursery processes that take time.

Larger plant supply nurseries might have some common species available eco-sourced from the required area at short notice, but to ensure supply of large orders comprising several eco-sourced species, contract ordering at least one year in advance is often required. Harder to grow/slow growing species, or species not frequently grown, may require a longer lead in time for ordering, particularly for supply in larger grades.

Figure 25: Plants growing in a nursery.
Credit: Brendan Mackie

Eco-sourcing

What is eco-sourcing?

This term refers to the practice of sourcing plant stock (i.e. seeds) from the same area in which you are planting. If plants are eco-sourced from nurseries, for example, the seeds of these plants would have been collected from naturally occurring plants in the local area and with similar environmental conditions as your planting site.

Figure 26: Kawakawa fruit. Credit: Brendan Mackie

What counts as the local area?

All plants planted in Tāmaki Makaurau / Auckland should be sourced from the Auckland Ecological Region, as close as possible to your planting site. The region has been grouped into 12 Ecological Districts based on areas with similar environmental conditions, including topography, soils, and in the case of offshore islands, geographic isolation (Figure 3.2). These ecological districts can be used to assist with identifying the appropriate locations to eco-source plants from, but it is recognised that birds as vectors for seed dispersal as well as wind dispersal do not follow these boundaries.

The general rule is that plants should be sourced from as close as possible to your planting site. This often relates to sourcing plants from the same ecological district. Some of the ecological districts are rather large (e.g. Rodney extends from Te Ārai in the north to Waitākere in the south) which is why it is still important to try to eco-source from the local area. There are also some species which have narrow environmental tolerances or natural geographic distributions (e.g. regional variations of kānuka and kōwhai) and in these instances it will be more important to source these from as close as possible to your planting site.

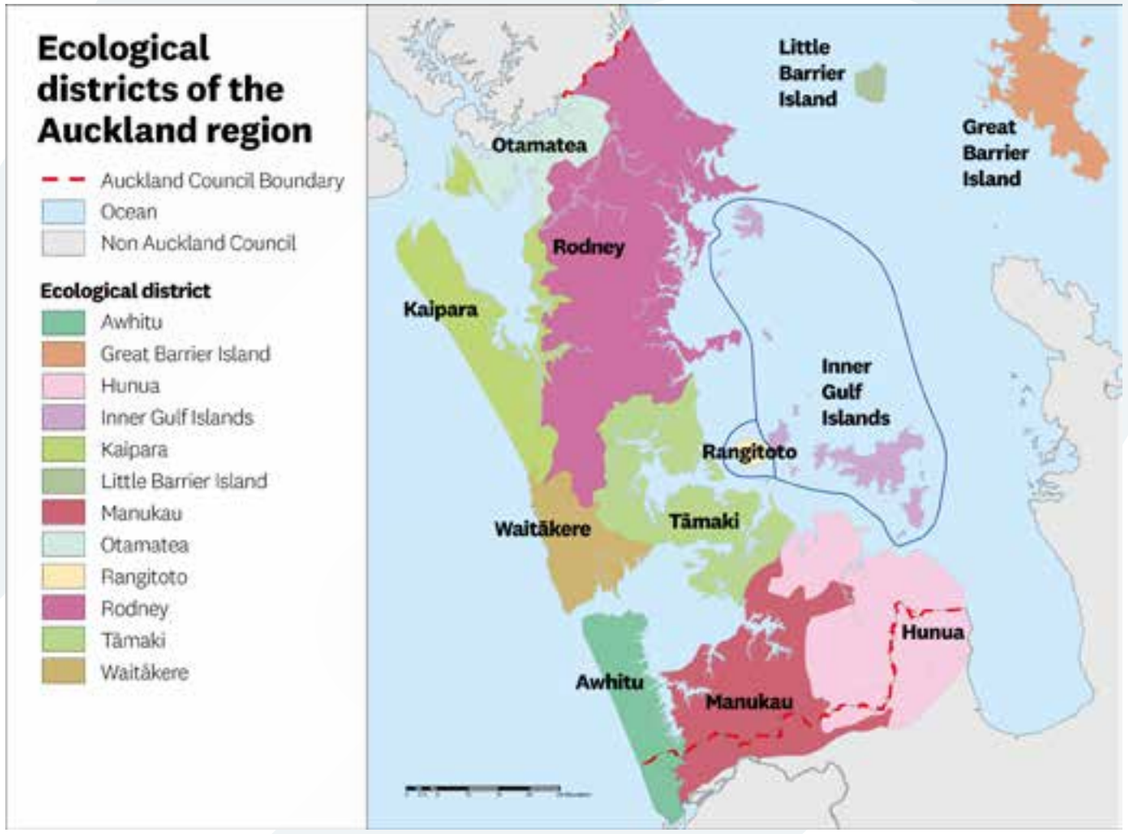
A planting site may be close to the boundary of one or more ecological districts. In these situations, it may be appropriate to source from a neighbouring ecological district provided the conditions at your planting site are similar to where the plant was sourced.

Some species which were historically present within an area may no longer exist so that it is impossible to eco-source from the same ecological district. These are likely to relate to threatened species and it is recommended that advice is sought from the council on where to appropriately source plants from.

Iwi mana whenua knowledge

Local knowledge, such as knowledge from Ngā Iwi Mana Whenua, will be important in determining where and how to source your plants, especially if seeds are being collected on a local or project-specific scale. When ordering plants from a reputable indigenous restoration plant nursery, they should be able to tell you where the seeds were sourced from.

Figure 3.2: Ecological Districts of Tāmaki Makaurau / Auckland.
Credit: Map produced by Auckland Council. Ecological district data courtesy of the Department of Conservation.



Why do we need to eco-source?

Environmental conditions vary widely across the region, and each plant species has its own geographical distribution. Planting plants sourced from alternative locations runs the risk of them growing poorly or dying. There are also geographic variations in genetic pools and, planting from the same area will provide greater certainty of maintaining these genetic pools and preserving the biodiversity of the local area.

Te Ao Māori eco-sourcing

From a Te Ao Māori perspective, eco-sourcing is important to maintain the whakapapa (genealogy) of plants within an area, in particular any taonga plant species. The restoration project should demonstrate localised eco-sourcing has been undertaken to the nearest natural populations where possible. The site-specific placement of plants is also important to ensure that the right plant species is in the right place, not only to ensure success of a restoration project but to also to maintain the ecological integrity of the environment.

Biosecurity and sustainability

Care not to inadvertently introduce or spread pests or diseases into an area is an important consideration for plant supply. Pest plants and/or their propagules, pathogens such as *Phytophthora agathidicida* (causal agent of kauri dieback) or myrtle rust, and pest animals such as plague skink or Argentine ants could be carried within potting mix, on plant material, or in plant containers or trays. Nurseries should have robust biosecurity procedures in place to ensure plant material, potting mix and trays and containers are pest free. To ensure best practice management for biosecurity (and specifically plant pathogens) in nurseries has been done, source plants from nurseries that are accredited under the Plant Pass where possible.

Site preparation

Overview

Site preparation involves making the area suitable for planting. This may include stock exclusion, pest plant control as well as removal of anything else that may inhibit planting such as rubbish. In addition to pest plants, exotic grasses (e.g. kikuyu) and broadleaved plants with the potential to smother or compete with young indigenous plants require control before planting. Non-invasive exotic canopy trees can be retained and controlled in a staged manner as, in the interim, they will provide shade and shelter for the indigenous plants growing around them.

The restoration objectives may dictate how site preparation can be done. For example, if the use of herbicides is not consistent with project objectives that require organic only methods, complete control of exotic vegetation will not be possible at the time of planting.

A well-prepared planting site will reduce maintenance requirements in the first year following planting and facilitate better plant establishment and growth rates. Additional visits for follow-up pest plant control will be required at locations that had bare earth prior to planting (e.g. cut banks alongside new roads). Planting should not be attempted on sites with untreated exotic vegetation where there aren't adequate resources for intensive maintenance following planting to keep plants alive. Staging may be required in these instances to ensure ongoing maintenance is achievable.

Herbicides

Best practice methods, including herbicide used, should always be employed in pest plant control and site preparation works. Generally, this will mean using the most effective herbicide and method to achieve the desired control, with the least impact on the environment (including the herbicide itself, or the result of the use of the herbicide).

Where rank (mature, tall, dense) kikuyu and/or other invasive smothering vegetation covers a planting site, it is usually preferable to control the whole site and replace it with fast growing indigenous vegetation at closer spacing as soon as possible. However, a 'scorched earth' approach (killing all vegetation so that bare earth remains) should be minimised at some sites, such as erosion prone sites. It may also be advantageous to leave exotic trees on a planting site if they are required for erosion control or providing another valuable ecological function (e.g. fauna habitat).

Blanket spraying is particularly effective on sites with rank kikuyu grass or other dense exotic grass/broadleaf herbaceous vegetation which requires good control prior to planting. On sites with very dense kikuyu, blanket spraying should be done several months before planting to allow the sward to break down after it dies; this also facilitates easier planting. Depending on the herbicide used, a standdown period may also be required to allow residual herbicides (e.g. metsulfuron) to break down in the soil. A follow-up spot spray shortly prior to planting is recommended to target patches of regrowth. Spot spraying (over a diameter of 0.6-1m) can also be carried out where existing vegetation is less likely to smother young plants.

If using herbicide methods, spraying should be undertaken by Growsafe certified operators, in line with the Agrichemical Users' Code of Practice (NZS 8409 2004: The Management of Agrichemicals) and industry best practice.

Figure 27: Fenced and sprayed kikuyu prior to planting at Puhinui Reserve.

Manual control

If control by herbicides is not an option, planting sites will require intensive manual methods such as using petrol-powered brush cutters to reduce the exotic ground-cover vegetation to as close to ground level as possible. The vegetation will likely quickly grow back, so a means of further control will be required such as covering the ground with a vegetation suppressing mulch (see below), either over the whole site or around individual plants. Intensive maintenance visits will be required post-planting if using this method of site preparation.

Stock grazing

On farm sites, stock can be used for site preparation to graze the vegetation down hard, then be removed (and excluded with a stock proof fence) immediately before planting. The grazed pasture can then be planted.

Mulching

Mulching a planting site prior to planting may be an appropriate site preparation action for small, accessible sites which are not steeply sloping. Most large-scale revegetation projects for ecological restoration (rather than landscape or amenity purposes) will not include mulching due to the resources required and the inability of mulch to effectively control some pest plants (e.g. kikuyu). This method is also unsuitable for assisted natural regeneration as it may inhibit indigenous regeneration as well as exotic.

Planting

Plant delivery

For small planting projects that can be completed within 2-3 continuous days, all the plants might arrive to or near the planting site at once. If the project is likely to last for a longer timeframe, either stagger plant deliveries so that what is delivered is planted within 2-3 days or have a temporary plant holding area available where the plants can be watered and looked after before being distributed on the planting site.

Figure 28: Plant trays at Shakespear Regional Park ready for layout. Credit: Tim Lovegrove

Figure 29: Planting layout. Credit: Anna Birchall

Figure 30: Planting layout at Shakespear Regional Park. Credit: Tim Lovegrove

Plant layout and planting

Distributing plants in suitable locations around the site will require careful planning, particularly for large or complex sites with various microclimates (e.g. gullies, flats, ridges, slopes, enrichment areas). For large sites, instead of laying out plants from the initial delivery point, it is suggested to drop batches of plants at suitable points around the edge of the planting site and then to layout from there as the planters get to each new batch. This saves plants from drying out and ensures you have the correct mix of species throughout the site.

Plants supplied in individual pots can be placed out on the site in their positions with their pots on prior to planting. Plants supplied in multicell trays must be taken out of their container prior to planting if they are to be placed individually in their planting positions. The amount of time between layout and planting for multicell plants must be minimised to avoid the root ball from drying out or becoming damaged. It is often easier to plant small grade plants from multi-cell trays without laying them out on the ground first. Staking plants, while not required, can be useful for locating plants during maintenance visits.

For open planting sites, all pioneer species within the plant schedule should be spread appropriately across the site as a mix in their relative proportions but tailored to the microsite conditions. Secondary or enrichment species should be sited where appropriate so that eventual canopy species are spaced at least five metres apart from each other. The best way to achieve this is to:

1. Layout and plant the secondary or canopy species across an area of the site first to get the required distance and correct microsite placement.
2. Infill between the canopy species with the initial species mix planted at the correct (pre-determined) spacing.

Plants should be randomly mixed to avoid planting large groups or rows of single species. The distance between plants should be continuously assessed and tweaked, as necessary.

Figure 31: Planting layout. Credit: Anna Birchall

Planting methods are shown in Figure 3.3. Wetland plants to be established in shallow water should be planted at the driest time of the year and with the top of the plant above the water level when planted. Wetland environments without shallow water are best planted in spring. On active dunes (spinifex, pīngao grassland/sedgeland – DN2) sand-binders (i.e. spinifex and pīngao) should be planted deeper than other species to stimulate growth and prevent plants from being blown or washed away.

Figure 3.3: How to plant a revegetation grade plant

1. Skim any grass or weeds off the top of the planting site using a spade or grubber. If left they will compete with and could rapidly smother the plant. (You may need to spray if kikuyu is present. Do this several months in advance).

2. Prepare the planting hole. The hole should be larger than the plant container or root ball. Once the hole is large enough, loosen the soil on the sides and in the bottom of the hole, to allow the plant's roots to penetrate the soil more easily. The hole should be deep enough so the collar (base of the stem where the roots start) is lightly below (1 cm) ground level on most sites, and slightly above (1-2 cm) on wet or saturated sites.

3. Remove the plant from its pot, plastic bag or root trainer carefully retaining as much soil around the roots as possible. If the roots are tightly bound, gentle tease them apart. Root bound plants are slower growing and take longer to become well established.

4. Place the plant in the hole so the stem is the correct depth in relation to the adjacent soil surface. Before placing the plant in the hole, apply fertiliser if there is some available, to gie the plant an extra growing boost. Mix the fertiliser with the loose soil in the bottom of the hole. Don't spread the fertiliser on the surface as this will just promote more weed growth.

5. Gradually add soil into the hole around the roots, firming each layer with the hands.

6. Firm the soil well after the hole is filled with the heel of your boot, leaving a slight depression to catch any rain or water run off.

Figure 32: Loosening plant roots at a dune planting. Credit: Ailsa Carroll

Figure 33: It is important to add soil around the plant and firm in. Credit: Anna Birchall

Fertiliser

The addition of fertiliser to planting holes at the time of planting indigenous species is not recommended for most situations, because indigenous revegetation species are generally adapted to lower fertility soils. Revegetation sites on previously grazed pasture, for example, will usually have sufficient fertility levels for the successful establishment of the revegetation species. Plants supplied from commercial nurseries often already have slow-release fertiliser included within potting mix and the additional nutrients from fertiliser added at the time of planting are not required for plant establishment. Use of surface fertiliser is not recommended near streams or wetlands, particularly if rain is expected, as the additional nutrients may be washed into the water way.

Plant maintenance

The plant maintenance phase begins following the initial planting and includes actions to ensure the successful establishment of plantings. This includes plant releasing, pest plant and animal control and infill planting (if required). Figure 3.4 outlines a typical maintenance schedule for revegetation plantings timed to the Auckland Council financial year. For initial plantings, maintenance visits should be done 3-4 times per year in the first few years after planting. These should be timed to control spring, summer, and autumn exotic plant growth, and to monitor pest plant competition and damage from animal browse. A lack of or inappropriate maintenance is often the main reason restoration projects fail. Maintenance often contributes up to half the cost of a restoration project and resources need to be provided accordingly.

Plant releasing

Plant releasing involves removing exotic vegetation from around plants (both planted and naturally established) to ensure they can receive enough sunlight to grow and thrive. As the plants become established, they will begin to out compete other exotic species and the frequency of releasing can decrease. After 3-5 years, releasing should not be necessary. Plant releasing can be by manual methods (e.g. hand-pulling grasses and other weeds away from the plant), or chemical (herbicide) methods. Care should be taken to avoid damage to indigenous vegetation.

Figure 34: Bindweed smothering native sedges planted in riparian area.

Figure 35: Plant releasing.

Pest plant and animal control

Maintenance visits should include checking for pest plant presence and for animal browse or damage. Pest plants should be controlled early before they become larger and more difficult to control. Possums, hares, rabbits, feral goats and feral deer should be controlled as soon as detected (including before planting) to prevent animals from causing planting failure.

Infill planting

Some plant losses are to be expected. The occasional random plant loss will not require replacing, but if several plants within a certain area do not establish, replanting these areas could be necessary to prevent pest plant establishment. It is useful to take note of what species have failed or are doing poorly, as these species should not be used for infilling.

Figure 36: Stakes can be used to assist with relocation of plantings and sleeves can be used to prevent rabbit browse.

Figure 37: Dieback on mānuka due to drought. Credit: Tim Lovegrove

Figure 3.4: Schedule for site preparation, planting, and ongoing maintenance until canopy closure

Year 1

Task	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Site preparation – initial pest plant control												
Site preparation – follow-up pest plant control												
Final site preparation												
Set up of traps and bait stations												
Planting												

Year 2

Task	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Planting												
Infill site preparation (if required)												
Follow-up pest plant control												
Monitoring of planting and releasing where necessary												
Pest animal control pulses (four per year)												

Year 3-4

Task	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Infill planting (if required)												
Follow up pest plant control												
Monitoring of planting and releasing where necessary												
Pest animal control pulses (four per year)												

Year 5 + (or once canopy closure is achieved)

Task	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Pest plant control												
Monitoring of planting and releasing where necessary												
Pest animal control pulses (four per year)												

3.4.3 How can you protect the area for the future?

There are multiple avenues for protecting an area where ecological restoration has been or is being carried out. Common protection mechanisms, most of which allow the current landowner to retain ownership, are outlined below.

Queen Elizabeth II National Trust Open Space Covenant

This involves a private agreement between the landowner and the National Trust, an independent charitable trust established in 1977. The covenant is registered against the land title, with each having individual terms reflecting the aims of the landowner.

See qeiinationaltrust.org.nz for further information.

Conservation covenant with Auckland Council or Department of Conservation

This involves an agreement between the landowner and Auckland Council or the Department of Conservation on behalf of the Crown. The covenant is registered against the land title, with minimum conditions usually specifying avoidance of vegetation clearance.

Covenants administered by Auckland Council are related to resource consents and may include additional conditions such as maintenance of fencing and ongoing control of pest plants and pest animals.

Ngā Whenua Rāhui nā te Kawenata (covenant)

The Ngā Whenua Rāhui fund provides protection of Māori-owned land for the purpose of preserving indigenous biodiversity. Kawenata (covenants) are applied for under the fund and may protect areas of indigenous forest, wetlands, tussock lands, and coastal dune ecosystems. The type of protection mechanism granted will depend on the land status and extent of protection being sought.

See doc.govt.nz/get-involved/funding/nga-whenua-rahui/nga-whenua-rahui-fund for further information.

Agreements with the Department of Conservation

Protection or management agreements may be arranged between private landowners and the Department of Conservation. Agreements for protection are administered under the Reserves Act 1977, recorded on the land title, and provide a similar level of protection to a covenant. Management agreements are not recorded on the land title and may need to be renegotiated if ownership changes hands.

Donating or selling land

In addition to these mechanisms, a landowner can gift or sell their restored area to organisations including Auckland Council, Department of Conservation, the Native Forest Restoration Trust, or the QEII National Trust.

3.5

How do you monitor your restoration project progress?

Monitoring involves the observation and reporting on the progress of your restoration project over a period of time. It can be used to help pinpoint what is working, and what is not, to refocus further efforts throughout the span of a project. There are two components to monitoring.

1. Activity monitoring – tracking your progress against the restoration actions in your project plan, e.g. assessing how many plants have been planted at the end of a planting season or recording how many possums have been caught in traps.
2. Outcome monitoring – tracking the progress of your combined restoration actions towards achieving your project goals and vision, e.g. an increase in number of bird species using habitat in your project area.

The steps for both monitoring components include:

3. Selecting an appropriate monitoring method for your project (see below). Appropriateness will be determined by a combination of the project goals and objectives, the skills of the people carrying out the monitoring, the time/cost effort involved, and how regularly the monitoring needs to be carried out to be useful.
4. Carrying out baseline monitoring before the project begins. This will give you an idea of the current attributes of the site that future monitoring results can be measured against.
5. Identifying information to be collected (indicators) in future monitoring rounds, when and where this monitoring will be carried out, and how the results will be assessed. Details can be set up in a 'monitoring form' that simply needs to be filled out on each monitoring trip.
6. Implementation of the monitoring programme and compilation of results to assess progress. Online resources such as trap.nz, weedmanager.nz, and inaturalist.nz are available for recording data.

3.5.1 What method should you use for monitoring?

Common monitoring methods for different project goals are outlined below (Table 3.4). There is more information at knowledgeauckland.org.nz/publications/auckland-community-ecological-monitoring-guide-a-framework-for-selecting-monitoring-methods on many of these methods.

Table 3.4: Summary of common monitoring methods that could be used to track progress of restoration projects

Monitoring method	Summary	Potential use
Kaitiaki monitoring	To be used when your project has engaged iwi mana whenua in a collaborative kaitiaki monitoring plan.	To be collaborated on.
Photo points	Photos are taken at the same angle from the same location on a regular basis. Locations can be marked with GPS and/or a peg or post placed in the ground.	• Monitoring growth of revegetation planting. • Monitoring success of pest animal control.
Pest animal surveys	Presence of pest animals is surveyed by use of chew cards, tracking tunnels, camera traps, or observations on pest control (e.g. bait uptake).	Monitoring decrease in pest animals.
Pest plant surveys	Presence and extent of pest plant observations is monitored by ground surveys and mapped.	Monitoring success of pest plant control.
Myrtle rust monitoring	Monitor existing and planted myrtle species for infections. Report myrtle rust via the iNaturalist App.	Monitoring health of planted or existing myrtles to reduce the risk of further myrtle rust spread.
Kauri dieback monitoring	Check for disease symptoms in standing and planted kauri. See kauriprotection.co.nz/about-kauri/identify-the-disease for more information.	Monitoring health of planted or existing kauri to reduce the risk of kauri dieback spread.
Indigenous fauna surveys	Presence and diversity of indigenous fauna groups is measured by targeted surveys such as: • five-minute bird counts • spotlighting for geckos • electro-fishing. Seek advice from the council on any training or wildlife permit requirements.	Monitoring improvements in indigenous fauna diversity due to other restoration actions (e.g. pest animal control).
Aerial photos	Aerial photos available on Auckland Council GeoMaps and Google Earth can be used to tracked change in vegetation cover over time.	Monitoring canopy closure following managed natural regeneration or revegetation planting.
Vegetation plots	Permanent plots (e.g. 20 x 20m) are set up within the restoration site and data on vegetation (e.g. species richness, tree number, tree size) within the plot methodically collected and recorded.	Monitoring development of target ecosystem type.
Water level gauge	A measuring device is placed is a permanent location and consulted for water level readings.	Monitoring restoration of suitable hydrology for restoring wetland ecosystems.
Stream habitat assessment (riparian components)	Information is gathered on physical, hydrological, and biogeochemical function of the stream to obtain a habitat/value score. The riparian functions of a habitat assessment can be used to monitor progress of riparian restoration, while the overall assessment can indicate wider outcomes.	Monitoring improvements in stream water quality and habitat value for indigenous freshwater fauna.

Figure 38: Bird monitoring.

Figure 39: Setting tracking tunnels.

3.5.2 How to use monitoring to adapt management of your project?

Monitoring could show that you need to adjust your project to achieve your goals and objectives. **Adaptive management** is a systematic approach to re-evaluating original goals and restoration actions, based on the monitoring results. For example, a post-planting inspection may show signs of browse damage from rabbits on plants in an area where rabbits have not previously been recorded. To address this issue, rabbit control could be added as a restoration action for the project, with a goal of decreasing rabbit numbers and increased survival of plants.

It is important to recognise that not achieving your original goals does not necessarily mean the project has failed. Monitoring can highlight where you may be fighting a losing battle and allow efforts and resources to be focused where they will be more valuable. Monitoring also allows information to be obtained on what went wrong to prevent the same mistakes from being made again in future projects. Obtaining good quality information on the site and carrying out detailed project planning before getting started will increase the chance of a successful project.

Figure 40: 'Trees for Survival' photo point monitoring from 2011 to 2021 for a riparian planting.

3.6

Setting a vision, goals, and objectives

Our possibilities become our reality

He puāwai ka manahua

3.6.1 What is your vision? Why are you carrying out this restoration project?

The vision of the project is a short high-level statement of what you want to achieve in the long term, for example, Ark in the Park's project vision is restoring the natural world of the Waitākere Ranges[1].

The vision is often inspirational and helps to guide project planning, including development of goals, objectives, and actions. It also assists with retaining volunteers and sourcing funding. The vision, goals and objectives are usually determined by the project team, with input from stakeholders such as the local community.

The vision of a restoration project may also incorporate iwi mana whenua aspirations such as:

- restoration that assists in building the ecology of the site
- restoration to provide suitable habitat for taonga (treasured) species
- planting for traditional use.

3.6.2 Why you need to set goals and objectives

Goals and objectives are useful for breaking down your project vision into achievable tasks. They will be linked to budgets, timeframes, resources, site characteristics and the overall vision. Investing time at the planning stage will help to make sure you are not setting a project up to fail.

3.6.3 Restoration goals

The goals describe the long-term intentions of a restoration project and are not time-dependent.

Some common restoration goals are:

- increasing indigenous biodiversity on your property or in your local park
- reducing the effects of or removing pest plants and animals
- restoring suitable conditions for re-introduction of an iconic or threatened plant or animal species
- improving water quality and habitat values of watercourses and wetlands
- connecting existing areas of indigenous forest, scrub, or wetlands
- contributing to climate change resilience
- creating jobs and education opportunities for the local community.
- Improving landscape values, natural beauty, and amenity.

3.6.4 Restoration objectives

Each restoration goal should be associated with a series of objectives that will outline what will need to be done, and by when, to reach your goals. We recommend using the SMART framework for setting objectives:

S is for Specific. Quantify your objectives and set deadlines, rather than just aiming for a general improvement.

M is for Measurable. Work out how you could monitor your objectives and what measurements will be carried out to assess success.

A is for Attainable. Be realistic about what can be achieved with the resources you have available.

R is for Relevant. Select objectives that will work towards the overall vision and prioritise restoration actions based on what will be most effective.

T is for Time-bound. Accept that success will not happen overnight but set a deadline for each objective that can be used to track progress.

For example, if a goal is to increase indigenous biodiversity within a bush fragment on your property, the objectives may include:

- completion of stock proof fencing around the bush fragment within the first dry season following the start of the project
- control of all pest plant species within the bush fragment to low enough levels that they can be maintained in one control session per year
- observe yearly increases in the number of indigenous plant species, with enrichment planting to be carried out if there are no increases from natural regeneration within five years.

3.6.5 What is your budget and how will you pay for your restoration project?

Costs associated with restoration projects vary widely depending on the activities chosen, the use of paid or unpaid workers, and how long the project will run for. Common costs include fencing, pest plant control, pest animal control, and labour costs. Professional specialist advice may also be needed for difficult projects or where resource consent is required. For projects that incorporate revegetation planting, additional budget will be required for site preparation, plant purchase, planting labour, and ongoing maintenance.

Available finances will often determine the amount of work possible. For example, a low-budget project may focus on excluding stock (by fencing) from a forest to encourage regeneration of indigenous plants. Should more money become available the project may be expanded to include intensive pest control and enrichment planting if required. Projects are often staged to ensure each action planned can be achieved within the budget.

Depending on your location and the purpose of your project, subsidies or full funding may be available from sources such as Auckland Council, Department of Conservation, other government programmes and organisations such as Trees That Count. Additional programmes such as Trees for Survival can supply labour for planting projects.

1 Ark in the Park is a large-scale restoration project in the Waitākere Ranges, with pest control and supporting restoration actions largely carried out by volunteers. See arkinthepark.org.nz for further information.

3.7

Planning checklist for your restoration project

The checklist below outlines the different things you will need to consider when developing your restoration project. These are generally listed in order of how they would be carried out, however the steps are not all linear and not every step will be required for every project. At every stage of a project, refer to your vision, goals, and objectives, to keep your project structured and on track.

In difficult or unusual situations, for example projects with multiple ecosystem types, or requiring complicated site preparation, or modifications to hydrological conditions, we recommend engaging a professional experienced in restoration projects to assist with project planning.

Further details on how to develop these steps is provided in the following sections.

- Identify the extent of your proposed restoration project (location and geographical extent). Determine if there are any other local restoration projects.
- Identify the land title and landowners (e.g. Auckland Council, Department of Conservation, private landowner) and ensure you have all the required permissions to undertake a restoration project on the site.
- Determine if there are any site constraints[1] (e.g. heritage sites, underlying management requirements, access requirements, existing restoration plans, infrastructure, future development) that may affect what can be done on the site.
- Carry out a site visit to assess the existing site characteristics (topography, environmental characteristics (e.g. climate, soil, hydrology), vegetation, ecological pressures, current and/or potential ecosystem type).
- Engage with Ngā Iwi Mana Whenua – refer to Sections 1.6 and 3.2.1. For projects on public land, the land manager (e.g. Auckland Council or the Department of Conservation) will lead and guide the engagement process.
- Connect with neighbours to identify opportunities to work together to enhance restoration efforts.
- Determine the project team – who will be involved? What skills do they have and how much time do they realistically want to commit?
- Identify your overall vision. Sum this up in a short, simple sentence.
- Set goals for your project – what are the outcomes that will achieve your vision?
- Develop project objectives – what will need to be done, and by when, to reach your goals?
- Determine the budget and timeframes to achieve project objectives.
- Assess whether the goals and objectives are realistic, based on the project team, budget, timeframes, and applications required, and re-evaluate as necessary.
- Determine whether resource consent or other applications or consultation is required for restoration activities (e.g. for planting in or nearby archaeological sites, restoration of wetlands).
- Identify the appropriate restoration actions to achieve your objectives and develop a restoration action plan, i.e. a list of steps and timeframes.
- Ensure there are processes in place to manage the health and safety of those involved.
- Allocate restoration plan tasks to members of the project team.
- Identify how progress towards goals will be measured or tracked.
- Complete baseline monitoring and reporting as required.
- For private land, consider whether you want to legally protect your restoration area and what additional maintenance requirements may be associated with this.
- Undertake monitoring of project progress and implement adaptive management if required.

Photo: Pōhutukawa, pūriri, broadleaved forest on Waiheke Island. Credit: Alastair Jamieson

1 Auckland Council's GeoMaps will provide some of this information. We also recommend searching on the Council website and online to determine whether a restoration plan has been previously prepared for the site.

4. Ecosystem-specific restoration guidelines

Photo: Sea rush and oioi (SA1.3) and herbfield (SA1.4) at Āwhitu Regional Park. Credit: Alastair Jamieson

Tēnei te mauri nō
Rangi e tū nei
Tēnei te mauri nō
Papa e takoto nei

This is the force of the heavens above.
This is the force of the earth below.

4.1 Overview

This section contains restoration guidelines for indigenous terrestrial and wetland ecosystems within Tāmaki Makaurau / Auckland. The priority is to protect existing indigenous ecosystems through management of pressures. If planting is to be undertaken, an ecosystem approach should be undertaken to ensure the area becomes self-sustaining and is ecologically appropriate for the site.

This section includes:

- A short description of the ecosystem type. The publication 'Indigenous terrestrial and wetland ecosystems of Auckland' knowledgeauckland.org.nz/media/1399/indigenous-terrestrial-and-wetland-ecosystems-of-auckland-web-print-mar-2017.pdf contains full ecosystem descriptions. Keys have been included where appropriate to assist with identification of the ecosystem type.
- Identification of the most important/relevant pressures for each ecosystem type. These pressures should be prioritised when carrying out a project to restore that ecosystem type. A list of general ecosystem pressures is provided in Section 3.4.

- Plant schedules have been included for ecosystem types where planting is an appropriate restoration action and have not been included for ecosystem types where restoration should be solely focused on managing ecosystem pressures. Identified species in each plant schedule are listed in order of proportion (i.e. species that should be planted in the greatest proportions are listed first, and optional species are listed last). Guidelines for using the plant schedules are included in Appendix 6.

4.2

Forest ecosystems

Forest ecosystems are the most common former ecosystem type in Tāmaki Makaurau / Auckland. Forests originally covered a wide range of locations and landforms, including gullies, hillslopes, ridges, swamps, floodplains, lava flows, and stabilised dunes. There are 12 naturally occurring forest ecosystem types identified in the region. Refer to Figure 4.1 to help determine which forest ecosystem restoration guidelines will apply to your site.

Figure 41: Forest gecko can be found in forest ecosystem in Tāmaki Makaurau / Auckland. Credit: Dylan van Winkel

Planting guidance for forest ecosystems

The plant schedules included in this chapter are split into **Initial** or **Enrichment** planting:

- Initial plant schedules are intended for open areas where there is no existing indigenous vegetation (such as pasture or recently cleared ground). In these situations, it is important to establish early successional/pioneer forest species that have high rates of survival in exposed conditions (e.g. full sun, wind). Using these species will achieve rapid canopy closure to prevent pest plant establishment and provide suitable conditions for recruitment of additional plant species groups. The initial plant schedules can also be used for buffer planting of existing forest ecosystems. Generally, the bigger the better in terms of buffer planting width, but it will depend on site characteristics, cost, and condition of the existing forest remnant.
- Enrichment plant schedules are intended for areas where there is an existing indigenous tree canopy (planted or natural) to infill canopy gaps and/or to increase species diversity. It may also be suitable for sites where a canopy of exotic trees (e.g. pine, privet) is being controlled in stages. If project planning allows for multiple stages of planting, it is recommended to wait 5-10 years after the initial planting before carrying out enrichment planting to allow for development of suitable environmental conditions.

Generally, for initial planting for forest ecosystems, the planting proportions of different species are:

- kānuka and/or mānuka: combined 50 per cent maximum, ideally less
- other pioneer tree and shrub species: 40+ per cent
- future canopy trees tolerant of open sites (ecosystem type specific): 10 per cent.

In the past, mānuka and kānuka have been used in high percentages due to their fast growth and wide environmental tolerances. Research in Tāmaki Makaurau / Auckland, however, has shown that plantings with a high percentage of these species have a lower species diversity over time (Haselhoff, 2019; Quadling, 2006; Pothecary, 2012). Mānuka and kānuka are also a potential myrtle rust risk. Best practice is for planting to have a greater diversity of species with lower proportions of mānuka and kānuka. The inclusion of fleshy-fruited species (e.g. karamū, māhoe) in the initial planting, will attract seed-dispersing birds (e.g. tūī, tauhou/silvereye, kererū) and will increase the likelihood that species richness will increase over time. This is because around 70 per cent of Aotearoa / New Zealand forest species are dispersed by bird.

Figure 42: Enrichment planting at Āwhitu Regional Park. Credit: Alastair Jamieson

Figure 43: Monoculture of kānuka with lack of understorey. Credit: Sam Sutherland

4.2.1 General forest revegetation mix for initial planting

For planting of pasture or recently cleared areas, there are some common species which are suitable for restoration planting projects with different goals. The general forest revegetation mix for initial planting in open areas (Table 4.1) is suitable for multiple common ecosystem types:

- WF7: Pūriri forest
- WF9: Taraire, tawa, podocarp forest
- WF10: Kauri forest
- WF11: Kauri, podocarp, broadleaved forest
- WF12: Kauri, podocarp, broadleaved, beech forest.

This initial plant schedule can be combined with enrichment planting schedules outlined under each forest ecosystem type (WF7; WF9; WF10; WF11; WF12) if the intent of restoration is to restore a target ecosystem. This mix can also be used for buffer planting around fragments of the above remnant forest ecosystems. As this plant schedule includes common species it is also suitable for forest restoration projects where the purpose is not to establish a specific ecosystem type, e.g. erosion control.

Note: Separate tailored initial plant schedules have been provided for the following forest ecosystem types as they have more specific requirements for species selection:

- WF4: Pōhutukawa, pūriri, broadleaved forest [Coastal broadleaved forest],
- WF5: Tōtara, kānuka, broadleaved forest [Dune forest]
- WF8: Kahikatea, pukatea forest
- MF4: Kahikatea forest.

Figure 44: Tōtara Park planting supported by Vector Ltd.

Figure 45: Three common plant species used within revegetation plantings – kānuka, māhoe and karamū. Credit: Anna Birchall

Figure 4.1: Key for the identification of indigenous forest ecosystem types in Tāmaki Makaurau / Auckland

Which forest ecosystem am I trying to restore?

SOILS

SAND

SILT-CLAY

VOLCANIC

TOPOGRAPHY

Well-drained

Seasonally water-logged

High altitude (> 450m a.s.l) slopes and ridges

Inland hill country (150-550 a.s.l)

Lowland slopes and ridges

Lowland slopes, ridges and gullies

Alluvial flats (frost-free)

LOCATION

Stabilised dunes; e.g. Āwhitu, Tapora, South Head

Hūnua Ranges

> 600 metres altitude; peaks of LBI and GBI

Hūnua and Waitākere Ranges

Nutrient poor /acidic soils

Nutrient poor soils; south facing slopes in south and east Auckland

Coastal; within 600-800m of shore

Nutrient poor soils, high rainfall

Nutrient rich soils, frost-free

Free-draining alluvial terraces

Flood plains with some water-logging

Alluvial flats and basins

Frost-free; usually coastal

Frost-prone inland areas; e.g. Clevedon, Coatesville, Kaipara Flats

VEGETATION

Ecosystem type	Other key species
MF24: Rimu, tōwai forest	Northern rātā, miro

Ecosystem type	Other key species
MF25: Kauri, tōwai, rātā, montane podocarp forest	Tāwari, rimu, miro

Ecosystem type	Other key species
WF5.1: Kānuka on dunes (early successional)	Tōtara, pōhutukawa, māhoe
WF5.2: Podocarp-broadleaved forest on dunes (later successional)	Tōtara, pōhutukawa, karaka, rewarewa, tītoki

Ecosystem type	Other key species
WF10: Kauri forest	Rimu, kahikatea, northern rātā

Ecosystem type	Other key species
WF12: Kauri, podocarp, broadleaved, beech forest	Taraire, hard beech, tānekaha

Ecosystem type	Other key species
WF13: Tawa, kohekohe, rewarewa, hīnau, podocarp forest	Rimu, kahikatea, northern rātā

Ecosystem type	Other key species
WF11: Kauri, podocarp, broadleaved forest	Taraire, kahikatea, rimu, tōtara, pūriri

Ecosystem type	Other key species
WF4: Pōhutukawa, pūriri, broadleaved forest [Coastal broadleaved forest]	Kohekohe, taraire, karaka, nīkau

Ecosystem type	Other key species
WF9: Taraire, tawa, podocarp forest	Rimu, kahikatea, northern rātā, kohekohe

Ecosystem type	Other key species
WF7.3: Kahikatea, pūriri forest	Kohekohe, nīkau

Ecosystem type	Other key species
WF7.1: Pūriri, tōtara forest	Mataī, kahikatea, tītoki

Ecosystem type	Other key species
MF4: Kahikatea forest	Ribbonwood, houhere, divaricating shrubs

Ecosystem type	Other key species
WF8: Kahikatea, pukatea forest	Kiekie, supplejack, māpere

Ecosystem type	Other key species
WF7.2: Pūriri, taraire forest	Karaka, kohekohe

Key: Planting is not recommended for this ecosystem type; restoration to focus on pressure management | Limited planting advice is provided for this ecosystem type | Plant schedules are provided for this ecosystem type

Note: Vegetation is only diagnostic in areas that retain an indigenous vegetation cover.

Table 4.1: General indigenous forest [WF7, WF9, WF10, WF11, WF12]* revegetation mix for initial planting in open areas in Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	Planting location			% of planting mix	Plant spacing	Planting notes
					Ridge	Slope	Gully			
Kānuka[1, 2]	*Kunzea robusta*		Tall shrub/tree	10m	✓	✓		≤50% total, with proportion of each dependent on site conditions	1-1.4m	Kānuka more suitable than mānuka on fertile, well drained soils.
Mānuka[2]	*Leptospermum scoparium*		Tall shrub/tree	5m	✓	✓	✓		1-1.4m	Use higher proportions in harsh soil conditions such as water-logged soil or bare clay. Can be added in other situations for diversity.
Karamū	*Coprosma robusta*		Tall shrub/tree	6m	✓	✓	✓	10-20%	1-1.4m	Versatile across a range of soil conditions, i.e. moist to dry.
Tī kōuka/cabbage tree	*Cordyline australis*		Tall shrub/tree	8m+		✓	✓	5-20%	1-1.4m	Plant higher proportions in moister soils.
Māhoe	*Melicytus ramiflorus*		Tall shrub/tree	6m	✓	✓	✓	5-10%	1-1.4m	Survives better on fertile soils with some shelter.
Houhere/lacebark	*Hoheria populnea*		Tall shrub/tree	8m	✓	✓	✓	< 10%	1-1.4m	Requires well drained soils.
Koromiko	*Veronica stricta* var. *stricta*		Shrub	2m	✓	✓	✓	< 10%	1-1.4m	Versatile across a range of soil conditions, i.e. moist to dry.
Māpou	*Myrsine australis*		Tall shrub/tree	6m	✓	✓	✓	< 10%	1-1.4m	Can have poor establishment rates due to slow initial growth.
Harakeke/flax	*Phormium tenax*		Herb	3m	✓	✓	✓	< 10%	1-1.4m	Versatile across a lot of soil conditions, i.e. moist to dry.
Kahikatea	*Dacrycarpus dacrydioides*		Canopy tree	10m		✓	✓	< 5%	5-8m	Survives better in gullies with fertile soils and some shelter.
Kōhūhū	*Pittosporum tenuifolium*		Tall shrub/tree	6m	✓	✓		< 5%	1-1.4m	Requires well drained soils.
Pūriri	*Vitex lucens*		Canopy tree	10m +	✓	✓	✓	< 5%	5-8m	Survives better in warmer sites with fertile soils. Plant in sun with some shelter.
Tōtara	*Podocarpus totara*		Canopy tree	10m +	✓	✓		< 5%	5-8m	Use sparingly unless common in target ecosystem.

1 The *Kunzea* genus has several species in Tāmaki Makaurau / Auckland. Look in the local area to see which species is suitable for your site and eco-source from the nearest natural populations. Talk to an ecologist if you are having trouble deciding which *Kunzea* to plant at your site. Generally, *K. linearis* should be planted instead of *K. robusta* on dunes between Mangawhai and Leigh.

2 Kānuka and mānuka should be sourced from a nursery accredited under Plant Pass where possible.

* Likely to be suitable for the following forest ecosystem types: WF7: pūriri forest; WF9: taraire, tawa, podocarp forest; WF10: kauri forest; WF11: kauri, podocarp, broadleaved forest; and WF12: kauri, podocarp, broadleaved, beech forest.

Key:
Shade tolerant
Tolerant of wet soils
Plant with shelter from wind
Frost tender
Provides food for birds/bats/lizards
Plant in canopy gaps
Deer browse tolerant
Improves in-stream habitat for fish
Tolerant of salt-spray
Improves bank stability

4.2.2 WF4: Pōhutukawa, pūriri, broadleaved forest [Coastal broadleaved forest]

Regional threat status: Endangered

Pōhutukawa, pūriri, broadleaved forest (coastal broadleaved forest) is found on coastal hillslopes subject to wind and salt spray, usually within 800m of the shore. Examples of this ecosystem are found along the eastern shoreline of Rodney from Leigh to Waiwera, on Waiheke Island, and in parts of the western Waitākere Ranges. The original extent is expected to have covered a much greater area, including the coastline from Beachlands to Orere Point.

Figure 47: Kererū in a kawakawa. Kererū are the only species capable of dispersed larger fruited plant species. Credit: Tim Lovegrove

Figure 46: Pōhutukawa, pūriri, broadleaved forest on Waiheke Island. Credit: Alastair Jamieson

Pōhutukawa, pūriri, broadleaved forest is at risk from the pressures outlined in Table 4.2.

Table 4.2: Ecosystem pressures and suggested restoration actions for pōhutukawa, pūriri, broadleaved forest [WF4]

Key pressures	Explanation	Suggested restoration actions
Urban development	Vegetation clearance may occur around dwellings or for new dwellings to allow for sea views.	Avoid and then minimise clearance. Carry out buffer planting between forest fragments and nearby developed areas to reduce potential edge effects.
Pest animals – herbivores	Possum browse may affect canopy health where broadleaved tree species (e.g. pōhutukawa, pūriri and taraire) are common. Seed predation by rats may affect plant species recruitment.	Manage animal pests, particularly possums. In situations where pest animal density is high, a site-specific pest control and monitoring plan should be implemented. Success can be measured by the recovery of susceptible species or pest-specific monitoring.
Pest animals – predators	Rats, mustelids, and possums predate birds. Loss of frugivorous (fruit eating) birds may indirectly affect recruitment of fleshy fruited plant species. Kererū are the only species capable of dispersing larger fruited species e.g. pūriri, karaka.	
Pest plants	Pest plant species impact indigenous regeneration, with higher densities in urban areas. Climbing asparagus is a common invader of this forest type, particularly on Waiheke Island and the North Shore.	Control pest plants to allow restoration of indigenous vegetation.
Stock grazing	Stock graze understorey of forest and prevent regeneration of seedlings.	Exclude stock by fencing forest fragments and regularly monitor fence condition. Enrichment planting can be carried out in areas where the understorey vegetation has been heavily degraded and is unlikely to regenerate without assistance (e.g. due to no nearby seed sources).
Myrtle rust	Pōhutukawa is a main canopy species in this forest type and is susceptible to infection from this plant pathogen.	Monitor pōhutukawa and other myrtle species (e.g. mānuka, kānuka) for the presence of myrtle rust. Protect intact examples of this ecosystem type in areas where myrtle rust has not been recorded.
Sea level rise	Climate change is expected to result in sea level rise, which may flood low elevation forest areas.	Protect intact examples of ecosystem type at higher elevations to provide seed sources for regeneration of surrounding areas. Identify sites where managed retreat of the shoreline can allow for inland migration of coastal ecosystem types.

Figure 48: Open grazed understorey of pōhutukawa, pūriri, broadleaved forest. Credit: Alastair Jamieson

Figure 49: Fenced pōhutukawa, pūriri, broadleaved forest in Mahurangi. Credit: Sam Sutherland

Figure 50: Possum browsed kohekohe. Credit: Tim Lovegrove

If management of pressures alone will not allow for regeneration of key ecosystem components, revegetation planting could be carried out to assist with the restoration of former areas of pōhutukawa, pūriri, broadleaved forest (Table 4.3 and Table 4.4). Note that:

- Coastal areas have additional requirements for species selection, such as those that may withstand prolonged exposure to salt spray and high winds.
- Pōhutukawa is an essential component of the coastal broadleaved forest ecosystem type, however plantings of this species may present ongoing challenges due to the risk of myrtle rust. This species should only be planted where sourced from nurseries accredited under Plant Pass. Ongoing inspections for potential infection should be carried out.
- The initial plant schedule can also be used for buffer planting.

Table 4.3: Pōhutukawa, pūriri, broadleaved forest [WF4] revegetation mix for initial planting in open areas in Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	Planting location			% of planting mix	Plant spacing	Planting notes
					Ridge	Slope	Gully			
Kānuka[1,2]	*Kunzea robusta*		Tall shrub/tree	10m	✓	✓		20–40% total, with proportion of each dependent on site conditions.	1-1.4m	Kānuka more suitable than mānuka on fertile well-drained soils.
Mānuka[2]	*Leptospermum scoparium*		Tall shrub/tree	5m	✓	✓	✓		1-1.4m	Use higher proportions in harsh soil conditions such as water-logged soil or bare clay.
Karamū	*Coprosma robusta*		Tall shrub/tree	6m	✓	✓	✓	10-30%	1-1.4m	Versatile across a range of soil conditions i.e. moist to dry.
Tī kōuka/cabbage tree	*Cordyline australis*		Tall shrub/tree	8m+		✓	✓	5-20%	1-1.4m	Plant higher proportions in moister soils.
Houpara/coastal five-finger	*Pseudopanax lessonii*		Tall shrub/tree	6m	✓	✓	✓	5-15%	1-1.4m	Suitable for areas exposed to salt spray.
Karo	*Pittosporum crassifolium*		Tall shrub/tree	6m	✓	✓		5-10%	1-1.4m	Suitable for areas exposed to salt spray.
Māhoe	*Melicytus ramiflorus*		Tall shrub/tree	6m	✓	✓	✓	5-10%	1-1.4m	Survives better on fertile soils with some shelter.
Taupata	*Coprosma repens*		Tall shrub/tree	5m	✓	✓	✓	5-10%	1-1.4m	Plant in areas exposed to salt spray at the interface of coastal forest and the coast.
Harakeke/flax	*Phormium tenax*		Herb	3m	✓	✓	✓	< 10%	1-1.4m	Suitable for areas exposed to salt spray.
Houhere/lacebark	*Hoheria populnea*		Tall shrub/tree	8m	✓	✓	✓	< 10%	1-1.4m	
Koromiko	*Veronica stricta* var. *stricta*		Shrub	2m	✓	✓	✓	< 10%	1-1.4m	Versatile across a range of soil conditions i.e. moist to dry.
Karaka	*Corynocarpus laevigatus*		Canopy tree	10m		✓	✓	< 5%	5-8m	
Ngaio	*Myoporum laetum*		Tall shrub/tree	6m	✓	✓		< 5%	1-1.4m	Suitable for areas exposed to salt spray. Important to eco-source from natural populations and avoid planting in locations where it may hybridise with Tasmanian ngaio. Toxic to livestock.
Pōhutukawa[2]	*Metrosideros excelsa*		Canopy tree	10m	✓	✓		< 5%	5-8m	Plant with caution due to risk of myrtle rust.
Pūriri	*Vitex lucens*		Canopy tree	10m +	✓	✓	✓	< 5%	5-8m	Survives better on fertile soils. Plant in sun with some shelter.
Whau	*Entelea arborescens*		Tall shrub/tree	5m		✓	✓	< 5%	1-1.4m	

1 The *Kunzea* genus has several species in Tāmaki Makaurau / Auckland. Look in the local area to see which species is suitable for your site and eco-source from the nearest natural populations. Talk to an ecologist if you are having trouble deciding which *Kunzea* to plant at your site.

2 Pōhutukawa should be sourced from a nursery accredited under Plant Pass. Kānuka and mānuka should also be sourced from a Plant Pass accredited nursery where possible.

Key: Shade tolerant; Tolerant of wet soils; Plant with shelter from wind; Frost tender; Provides food for birds/bats/lizards; Plant in canopy gaps; Deer browse tolerant; Improves in-stream habitat for fish; Tolerant of salt-spray; Improves bank stability

Table 4.4: Pōhutukawa, pūriri, broadleaved forest [WF4] revegetation mix for enrichment planting in Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	Planting location			% of planting mix		Planting notes
					Ridge	Slope	Gully	Partial shade	Full shade	
Houpara/coastal five-finger	*Pseudopanax lessonii*		Tall shrub/tree	6m	✓	✓	✓	10-15%	< 10%	
Tī kōuka/cabbage tree	*Cordyline australis*		Tall shrub/tree	8m+		✓	✓	10-15%	–	
Kawakawa	*Piper excelsum*		Shrub	5m	✓	✓	✓	10-15%	15-20%	Plant in frost-free areas with shelter.
Harakeke/flax	*Phormium tenax*		Herb	3m	✓	✓	✓	< 10%	–	Plant in canopy gaps or margins of restoration site.
Porokaiwhiri/ pigeonwood	*Hedycarya arborea*		Tall shrub/tree	8m	✓	✓	✓	<10%	10-15%	
Karaka	*Corynocarpus laevigatus*		Canopy tree	10m		✓	✓	5-10%	10-15%	
Pūriri	*Vitex lucens*		Canopy tree	10m +	✓	✓	✓	5-10%	10-15%	Plant in frost-free areas.
Taraire	*Beilschmiedia tarairi*		Canopy tree	8m	✓	✓	✓	5-10%	10-15%	Slow growing; plant sparingly.
Kōwhai[2]	*Sophora chathamica*		Canopy tree	8m	✓	✓	✓	5-10%	< 5%	
Pōhutukawa[1]	*Metrosideros excelsa*		Canopy tree	10m	✓	✓		<5%	–	Plant in canopy gaps.
Kohekohe	*Didymocheton spectabilis*		Canopy tree	10m		✓	✓	< 5%	<10%	
Kōwharawhara/ coastal astelia	*Astelia banksii*		Herb	1m	✓	✓		< 5%	< 5%	Plant on dry slopes.
Nīkau	*Rhopalostylis sapida*		Canopy tree	8m		✓	✓	< 5%	< 5%	Slow growing; plant sparingly.
Tawāpou	*Planchonella costata*		Canopy tree	10m	✓	✓		< 5%	< 5%	Slow growing; plant sparingly.
Wharangi	*Melicope ternata*		Tall shrub/tree	4m	✓	✓		< 5%	< 5%	

1 Pōhutukawa should be sourced from a nursery accredited under Plant Pass. Mānuka should also be sourced from a Plant Pass accredited nursery where possible.

2 There are multiple species in the *Sophora* genus that vary with location and conditions. Look in the local area to see which species is suitable for your site and eco-source from the nearest natural populations. *S. fulvida* likely to be more appropriate in Waitākere.

Key:
- Shade tolerant
- Tolerant of wet soils
- Plant with shelter from wind
- Frost tender
- Provides food for birds/bats/lizards
- Plant in canopy gaps
- Deer browse tolerant
- Improves in-stream habitat for fish
- Tolerant of salt-spray
- Improves bank stability

4.2.3 WF5: Tōtara, kānuka, broadleaved forest [dune forest]

Regional threat status: Critically Endangered

Tōtara, kānuka, broadleaved forest [dune forest] is found on stabilised sand dunes in localised areas of Tāmaki Makaurau / Auckland, including South Head, Tapora and Āwhitu Peninsula. Soils range from recently consolidated dunes on the coast to older sands with a higher clay content further inland. Most examples of this forest type are early successional and dominated by kānuka (variant WF5.1), while there are few remaining examples (less than 1 per cent of original range nationally) of mature podocarp-broadleaved forest (variant WF5.2) dominated by either tōtara or pōhutukawa and associated canopy trees.

Figure 51: Tōtara, kānuka, broadleaved forest. Credit: Jason Hosking

Figure 52: Tōtara, kānuka, broadleaved forest on the edge of Lake Rototoa. Credit: Tim Lovegrove

Tōtara, kānuka, broadleaved forest is at risk from the pressures outlined in the Table 4.5.

Table 4.5: Ecosystem pressures and suggested restoration actions for Tōtara, kānuka, broadleaved forest [WF5]

Key pressures	Description	Suggested restoration action
Pest animals – herbivores	A high density of pest animals such as possums restrict development of the broadleaved component of this ecosystem type. Deer are a major problem for areas of dune forest in South Head and Āwhitu Peninsula. Seed predation by rats may affect plant species recruitment.	Manage animal pests, particularly possums and deer. In situations where pest animal density is high, a site-specific pest control and monitoring plan should be implemented. Success can be measured by the recovery of susceptible species or pest-specific monitoring.
Pest animals – predators	Rats, mustelids, and possums predate birds. Loss of frugivorous birds may indirectly affect recruitment of fleshy fruited plant species. Kererū are the only species capable of dispersing larger fruited species e.g. pūriri, karaka.	
Pest plants	Pest plant species impact indigenous regeneration, with higher densities where there is an incomplete canopy. Japanese honeysuckle and gorse are common invaders of this forest type.	Control pest plants to allow restoration of indigenous vegetation.
Stock grazing	Stock graze understorey of forest and prevent regeneration of seedlings. In turn, this impacts succession to the more mature variant of this forest type.	Exclude stock by fencing forest fragments and regularly monitor fence condition. Enrichment planting can be carried out in areas where the understorey vegetation has been heavily degraded and is unlikely to regenerate without assistance (e.g. due to no nearby seed sources).
Urban development	Vegetation clearance may occur around dwellings or for new dwellings to allow for sea views.	Avoid and then minimise clearance. Carry out buffer planting between forest fragments and nearby developed areas to reduce potential edge effects.
Change in land use	Vegetation (particularly that which is regenerating) may be cleared to return the area to pasture or to establish plantation forestry.	Protect good quality examples of this forest type to prevent clearance in future.
Forestry	Many remaining examples of this forest type abut pine forests (e.g. Woodhill Forest), resulting in increased pest plant invasion and presence of wildling pines.	Monitor for and control wilding pines in areas adjacent to forestry. Carry out buffer planting between forest fragments and forestry, where possible, or implement more intensive pest plant control.
Myrtle rust	Kānuka is a main canopy species in this forest type and is susceptible to infection from this plant pathogen.	Monitor kānuka, pōhutukawa, and other myrtle species for the presence of myrtle rust. Protect intact examples of ecosystem type in areas where myrtle rust has not been recorded.

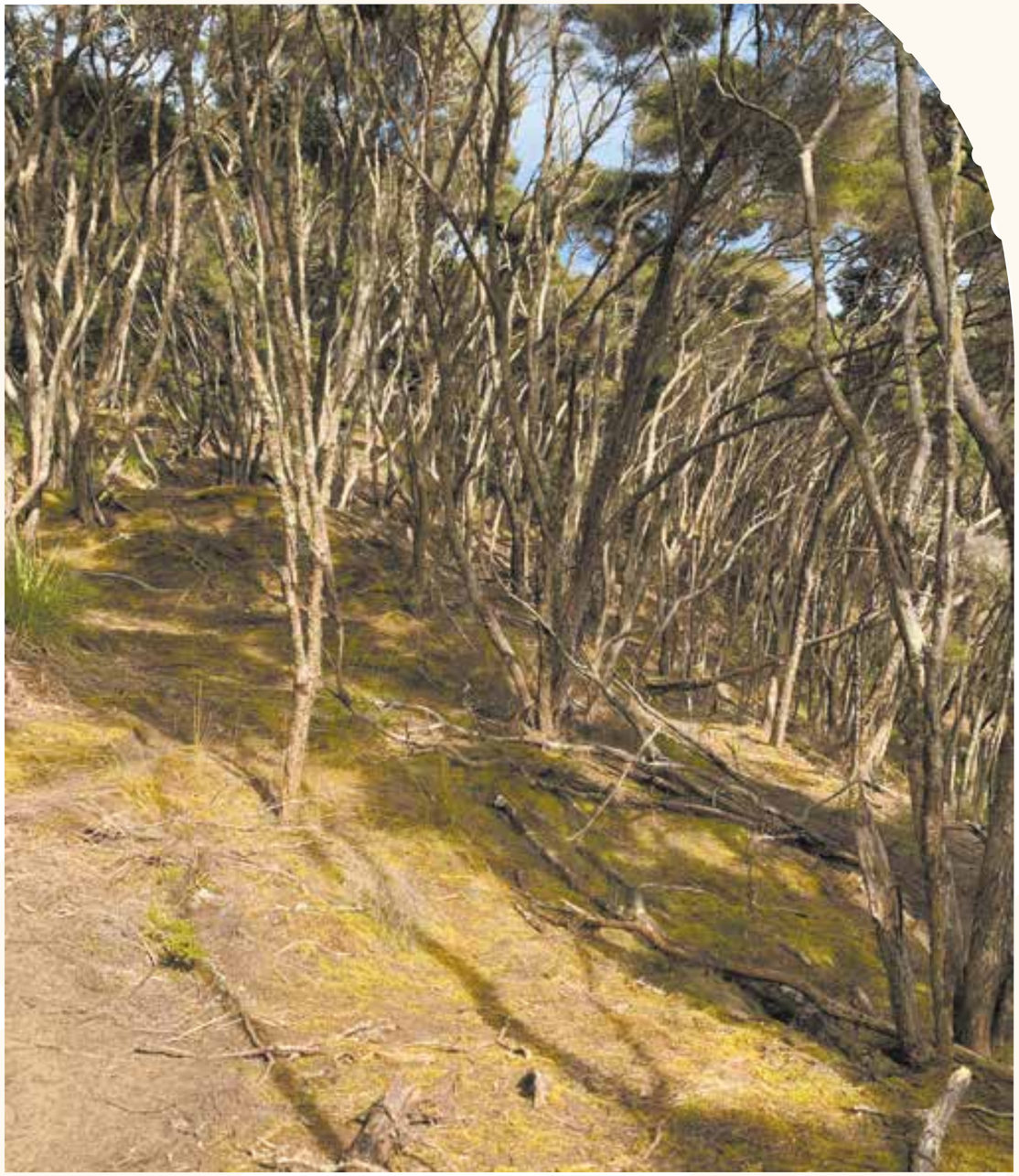


Figure 53: Tōtara, kānuka, broadleaved forest lacking an understorey due to deer browse at South Head.
Credit: Ellice Protheroe

If management of pressures alone will not allow for regeneration of key ecosystem components, revegetation planting could be carried out to assist with the restoration of former areas of tōtara, kānuka and broadleaved forest (Table 4.6 and Table 4.7). Note that:

- plant species selected for the plant schedules are adapted to sandy soils
- higher proportions of deer browse tolerant species should be used in locations with risk of herbivory e.g. deer in South Head
- the initial plant schedule can also be used for buffer planting.

Table 4.6: Tōtara, kānuka, broadleaved forest [WF5] revegetation mix for initial planting in open areas in Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	Planting location			% of planting mix	Plant spacing	Planting notes
					Ridge	Slope	Gully			
Kānuka[1,2]	*Kunzea amathicola; Kunzea robusta; Kunzea linearis*		Tall shrub/tree	10m	✓	✓		30-50%	1-1.4m	*Kunzea* species appropriate for the site will depend on the location.
Houpara/coastal five-finger	*Pseudopanax lessonii*		Tall shrub/tree	6m	✓	✓	✓	5-20%	1-1.4m	Suitable for areas exposed to salt spray.
Karamū	*Coprosma robusta*		Tall shrub/tree	6m	✓	✓	✓	5-20%	1-1.4m	Versatile across a range of soil conditions i.e. moist to dry.
Māhoe	*Melicytus ramiflorus*		Tall shrub/tree	6m	✓	✓	✓	5-20%	1-1.4m	Survives better on fertile soils with some shelter.
Tī kōuka/cabbage tree	*Cordyline australis*		Tall shrub/tree	8m+		✓	✓	5-20%	1-1.4m	Plant higher proportions in moister soils.
Harakeke/flax	*Phormium tenax*		Herb	3m	✓	✓	✓	< 10%	1-1.4m	Suitable for areas exposed to salt spray.
Karo	*Pittosporum crassifolium*		Tall shrub/tree	6m	✓	✓		< 10%	1-1.4m	Suitable for areas exposed to salt spray.
Koromiko	*Veronica stricta* var. *stricta*		Shrub	2m	✓	✓	✓	< 10%	1-1.4m	Versatile across a range of soil conditions i.e. moist to dry.
Tōtara	*Podocarpus totara*		Canopy tree	10m +	✓	✓		< 10%	5-8m	Survives better on fertile soils. Plant in sun with some shelter.
Whau	*Entelea arborescens*		Tall shrub/tree	5m		✓	✓	< 10%	1-1.4m	Suitable for areas exposed to salt spray.
Karaka	*Corynocarpus laevigatus*		Canopy tree	10m		✓	✓	< 5%	5-8m	
Pōhutukawa[2]	*Metrosideros excelsa*		Canopy tree	10m	✓	✓		< 5%	5-8m	Plant with caution due to risk of myrtle rust.

1 The *Kunzea* genus has several species in Tāmaki Makaurau / Auckland. Look in the local area to see which species is suitable for your site and eco-source from the nearest natural populations. Talk to an ecologist if you are having trouble deciding which *Kunzea* to plant at your site.

2 Pōhutukawa should be sourced from a nursery accredited under Plant Pass. Kānuka should also be sourced from a Plant Pass accredited nursery where possible.

Key:
Shade tolerant
Tolerant of wet soils
Plant with shelter from wind
Frost tender
Provides food for birds/bats/lizards
Plant in canopy gaps
Deer browse tolerant
Improves in-stream habitat for fish
Tolerant of salt-spray
Improves bank stability

Table 4.7: Tōtara, kānuka, broadleaved forest [WF5] revegetation mix for enrichment planting in Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	Planting location			% of planting mix		Planting notes
					Ridge	Slope	Gully	Partial shade	Full shade	
Māhoe	*Melicytus ramiflorus*		Tall shrub/tree	6m	✓	✓	✓	10-20%	10-20%	
Houpara/coastal five-finger	*Pseudopanax lessonii*		Tall shrub/tree	6m	✓	✓	✓	10-20%	< 10%	
Porokaiwhiri/ pigeonwood	*Hedycarya arborea*		Tall shrub/tree	8m	✓	✓	✓	10-20%	< 10%	
Tōtara	*Podocarpus totara*		Canopy tree	10m +	✓	✓		< 10%	< 10%	Plant in canopy gaps.
Twiggy coprosma	*Coprosma rhamnoides*		Shrub	2m	✓	✓		< 10%	< 10%	
Tī kōuka/cabbage tree	*Cordyline australis*		Tall shrub/tree	8m+		✓	✓	< 10%	–	Plant in moister soils.
Kawakawa	*Piper excelsum*		Shrub	5m	✓	✓	✓	< 10%	< 10%	Plant in frost-free areas with some shelter.
Pūriri	*Vitex lucens*		Canopy tree	10m +	✓	✓	✓	< 5%	< 10%	Plant on older dunes with higher clay content in soil.
Karaka	*Corynocarpus laevigatus*		Canopy tree	10m		✓	✓	< 5%	< 10%	Plant on older dunes with higher clay content in soil.
Kohekohe	*Didymocheton spectabilis*		Canopy tree	10m		✓	✓	< 5%	< 10%	Plant on older dunes with higher clay content in soil.
Tītoki	*Alectryon excelsus* subsp. *excelsus*		Canopy tree	10m	✓	✓	✓	< 5%	< 5%	Plant on older dunes with higher clay content in soil.
Pōhutukawa[1]	*Metrosideros excelsa*		Canopy tree	10m	✓	✓		< 5%	–	Plant in canopy gaps.
Rewarewa	*Knightia excelsa*		Canopy tree	10m	✓	✓		< 5%	–	Can be hard to establish in some situations.
Nīkau	*Rhopalostylis sapida*		Canopy tree	8m		✓	✓	–	< 10%	Plant on older dunes with higher clay content in soil. Slow growing.

Key: Shade tolerant; Tolerant of wet soils; Plant with shelter from wind; Frost tender; Provides food for birds/bats/lizards; Plant in canopy gaps; Deer browse tolerant; Improves in-stream habitat for fish; Tolerant of salt-spray; Improves bank stability

1 Pōhutukawa should be sourced from a nursery accredited under Plant Pass.

4.2.4 WF7: Pūriri forest

Regional threat status: Critically Endangered

Pūriri forest was once the main forest cover of the Tāmaki Makaurau / Auckland isthmus, but was cleared, firstly for farming and then for urban development. There are three variants of this forest type, with composition determined by soils and landform. Pūriri is the dominant species in all variants, growing alongside other broadleaved trees and podocarps in some instances.

The three variants are:

- WF7.1: Pūriri, tōtara forest on alluvial terraces with free-draining soil
- WF7.2: Pūriri, taraire forest on volcanic rock
- WF7.3: Kahikatea, pūriri forest on alluvial terraces with silty soils.

Figure 54: Pūriri forest in Smiths Bush. Credit: Sam Sutherland

Figure 55: Abundant natural regeneration in Smiths Bush. Credit: Sam Sutherland

Pūriri forest is at risk from the pressures outlined in Table 4.8.

Table 4.8: Ecosystem pressures and suggested restoration actions for pūriri forest [WF7]

Key pressures	Description	Suggested restoration action
Urban development and fragmentation	Continuing vegetation clearance in urban areas, for example to facilitate housing intensification, resulting in increased fragmentation, declining quality of remaining habitat, and greater distance between fragments.	Prevent further reduction in extent of ecosystem type over time and restore forest fragments through pest plant control and enrichment planting where suitable. Carry out buffer planting between forest fragments and nearby developed areas to reduce potential edge effects.
Pest animals – herbivores	A high density of possums may affect canopy cover where broadleaved tree species (e.g. pūriri, kohekohe and taraire) are common. Seed predation by rats may affect plant species recruitment.	Manage animal pests, particularly possums. In situations where pest animal density is high, a site-specific pest control and monitoring plan should be implemented. Success can be measured by the recovery of susceptible species or pest-specific monitoring.
Pest animals – predators	Rats, mustelids, and possums predate birds. Loss of frugivorous birds may indirectly affect recruitment of fleshy fruited plant species. Kererū are the only species capable of dispersing larger fruited species e.g. pūriri, taraire.	
Pest plants	Pest plant species impact indigenous regeneration, with higher densities in urban areas. Due to the dense, leafy canopy, shade tolerant species (e.g. ginger, ivy, plectranthus, tradescantia) are a problem in this forest type.	Monitor pest plants particularly those that are shade-tolerant and implement control programmes where necessary.
Stock grazing	Stock graze understorey of forest and prevent regeneration of seedlings. This ecosystem type is rare in rural areas, so this pressure is not as severe as for some other forest ecosystem types.	Exclude stock by fencing forest fragment and regularly monitor fence condition. Enrichment planting can be carried out in areas where the understorey vegetation has been heavily degraded and is unlikely to regenerate without assistance (e.g. due to no nearby seed sources).

If management of pressures alone will not allow for regeneration of key ecosystem components, revegetation planting could be carried out to assist with the restoration of former areas of pūriri forest.

Initial planting should follow the General indigenous forest revegetation mix (Table 4.1), and for enrichment planting see Table 4.9 and Table 4.10.

Note that the two enrichment planting schedules are included to cover the differing soil types this forest ecosystem may grow on. Slight differences for the recommended species between the two alluvial soil variants are indicated in the table.

Figure 56: The pūriri moth caterpillar spends much of its life living inside the trunk of a tree (for example pūriri, putaputawētā, wineberry or lacebark). Credit: Ngā Manu

Table 4.9: Pūriri forest revegetation mix for enrichment planting in Tāmaki Makaurau / Auckland – alluvial soils (variant WF7.1 and WF7.3)

Ingoa Māori/Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	Planting location			% of planting mix		Planting notes
					Ridge	Slope	Gully	Partial shade	Full shade	
Māhoe	*Melicytus ramiflorus*		Tall shrub/tree	6m	✓	✓	✓	10-20%	10-20%	
Shiny karamū	*Coprosma lucida*		Shrub	3m	✓	✓	✓	< 10%	15-20%	
Hangehange	*Geniostoma ligustrifolium* var. *ligustrifolium*		Tall shrub/tree	4m	✓	✓	✓	< 10%	< 10%	Use sparingly where likely to naturally regenerate.
Porokaiwhiri/ pigeonwood	*Hedycarya arborea*		Tall shrub/tree	8m	✓	✓	✓	< 10%	< 10%	
Pūriri	*Vitex lucens*		Canopy tree	10m +	✓	✓	✓	< 10%	< 10%	Plant more where not already common in canopy.
Kahikatea	*Dacrycarpus dacrydioides*		Canopy tree	10m		✓	✓	< 10%	–	Plant more in gullies and flood plains.
Kōwhai[1]	*Sophora microphylla*		Canopy tree	8m	✓	✓	✓	< 10%	–	
Tōtara	*Podocarpus totara*		Canopy tree	10m +	✓	✓		< 10%	–	
Kawakawa	*Piper excelsum*		Shrub	5m	✓	✓	✓	< 5%	< 10%	Plant in frost-free areas with some shelter.
Kohekohe	*Didymocheton spectabilis*		Canopy tree	10m		✓	✓	< 5%	< 10%	
Nīkau	*Rhopalostylis sapida*		Canopy tree	8m		✓	✓	< 5%	< 10%	Plant more in gullies. Slow growing.
Taraire	*Beilschmiedia tarairi*		Canopy tree	8m		✓	✓	< 5%	< 10%	Plant in variation WF7.1 only.
Tītoki	*Alectryon excelsus* subsp. *excelsus*		Canopy tree	10m	✓	✓	✓	< 5%	< 5%	
Matai	*Prumnopitys taxifolia*		Canopy tree	10m	✓	✓	✓	< 5%	–	Inland sites. Can handle wet and dry soils but prefers periodically wet soil.

Key: Shade tolerant; Tolerant of wet soils; Plant with shelter from wind; Frost tender; Provides food for birds/bats/lizards; Plant in canopy gaps; Deer browse tolerant; Improves in-stream habitat for fish; Tolerant of salt-spray; Improves bank stability

1 There are multiple species in the *Sophora* genus that vary with location and conditions. Look in the local area to see which species is suitable for your site and eco-source from the nearest natural populations.

Table 4.10: Pūriri forest revegetation mix for enrichment planting in Tāmaki Makaurau / Auckland – volcanic soils (variant WF7.2).

Ingoa Māori/Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	Planting location			% of planting mix		Planting notes
					Ridge	Slope	Gully	Partial shade	Full shade	
Kawakawa	*Piper excelsum*		Shrub	5m	✓	✓	✓	10-20%	10-20%	Plant in frost-free areas with some shelter.
Māhoe	*Melicytus ramiflorus*		Tall shrub/tree	6m	✓	✓	✓	10-20%	10-20%	
Shiny karamū	*Coprosma lucida*		Shrub	3m	✓	✓	✓	< 10%	10-20%	
Hangehange	*Geniostoma ligustrifolium* var. *ligustrifolium*		Tall shrub/tree	4m	✓	✓	✓	< 10%	< 10%	Use sparingly where likely to naturally regenerate.
Karaka	*Corynocarpus laevigatus*		Canopy tree	10m		✓	✓	< 10%	< 10%	
Pūriri	*Vitex lucens*		Canopy tree	10m +	✓	✓	✓	< 10%	< 10%	Plant more where not already common in canopy.
Kohekohe	*Didymocheton spectabilis*		Canopy tree	10m		✓	✓	< 5%	< 10%	
Nīkau	*Rhopalostylis sapida*		Canopy tree	8m		✓	✓	< 5%	< 10%	Plant more in gullies. Slow growing.
Houpara/coastal five-finger	*Pseudopanax lessonii*		Tall shrub/tree	6m	✓	✓	✓	< 5%	< 5%	Appropriate where this ecosystem type is present in coastal areas.
Mangeao	*Litsea calicaris*		Canopy tree	10m		✓	✓	< 5%	< 5%	Very hard to establish – can have high mortality rates when planted.
Porokaiwhiri/ pigeonwood	*Hedycarya arborea*		Tall shrub/tree	8m	✓	✓	✓	< 5%	< 5%	
Taraire	*Beilschmiedia tarairi*		Canopy tree	8m		✓	✓	< 5%	< 5%	
Tītoki	*Alectryon excelsus* subsp. *excelsus*		Canopy tree	10m	✓	✓	✓	< 5%	< 5%	
Rangiora	*Brachyglottis repanda*		Tall shrub/tree	4m		✓	✓	< 5%	–	
Rewarewa	*Knightia excelsa*		Canopy tree	10m	✓	✓		< 5%	–	Can be hard to establish in some situations.

Key:
Shade tolerant
Tolerant of wet soils
Plant with shelter from wind
Frost tender
Provides food for birds/bats/lizards
Plant in canopy gaps
Deer browse tolerant
Improves in-stream habitat for fish
Tolerant of salt-spray
Improves bank stability

4.2.5 WF8: Kahikatea, pukatea forest

Regional threat status: Critically Endangered

Kahikatea, pukatea forest is one of the two types of swamp forest in Tāmaki Makaurau / Auckland which grow in gullies and plains with seasonally high-water tables. This swamp forest type occurs in frost-free areas, along both the eastern and western coastlines. An excellent example occurs at Omaha Taniko Wetlands Scientific Reserve (north-east Auckland). Kahikatea, pukatea forest has been reduced in extent, primarily due to draining and clearance for agriculture.

Figure 57: Kahikatea, pukatea forest in Omaha Taniko Wetlands Scientific Reserve. Credit: Andrew Macdonald, Biospatial Ltd, 2018

Figure 58: Kahikatea, pukatea forest in Omaha Taniko Wetlands Scientific Reserve. Credit: Jason Hosking

Kahikatea, pukatea forest is at risk from the pressures outlined in Table 4.11.

Table 4.11: Ecosystem pressures and suggested restoration actions for kahikatea, pukatea forest [WF8]

Key pressures	Description	Suggested restoration action
Pest plants	Pest plant species impact indigenous regeneration, with higher densities in urban areas or forest margins where light levels are higher. Pest plants tolerant of moisture will readily invade this forest type.	Focus on control of pest plants that invade forest margins and those that are tolerant of shade and wet soils e.g. tradescantia and African clubmoss. Restore or maintain high canopy cover to reduce potential for further pest plant invasion. Monitor development of indigenous plant communities following pest plant control and stock exclusion.
Pest animals – predators	Rats, mustelids, and possums predate birds. Loss of frugivorous birds may indirectly affect recruitment of fleshy fruited plant species.	Manage animal pests. In situations where pest animal density is high, a site-specific pest animal control and monitoring plan should be implemented. Success can be measured by the recovery of susceptible species or pest-specific monitoring.
Pest animals – herbivores	Seed predation by rats may affect plant species recruitment.	
Draining	Construction of drains around the perimeter of forest fragments will lower soil water levels, making the land more suitable for farming and reducing persistence of moisture-loving plant species.	Avoid draining of pasture where this may impact nearby forest. Monitor water levels and restore hydrology if/where required. Seek specialist advice on appropriate actions and any resource consent requirements to restore hydrology.
Stock grazing	Stock graze understorey of forest and prevent regeneration of seedlings. Vegetation may also be cleared to increase land available for grazing.	Exclude stock by fencing forest fragment and regularly monitor fence condition. Enrichment planting can be carried out in areas where the understorey vegetation has been heavily degraded and is unlikely to regenerate without assistance (e.g. due to no nearby seed sources).
Climate change	The warming climate will increase drought conditions which will affect this forest type through reduction in soil moisture. Often found near the coast, so may also be affected by sea level rise leading to increased salinity levels.	Protect intact examples of this ecosystem type to provide seed sources for regeneration of surrounding fragments.

If management of pressures alone will not allow for regeneration of key ecosystem components, revegetation planting could be carried out to assist with the restoration of former areas of Kahikatea, pukatea forest (Table 4.12 and Table 4.13). Note that:

- species selected generally must be tolerant of wet soils
- restoration of hydrology (e.g. infilling of drains) may be required before this forest type can be restored, depending on the level of past modification
- kahikatea swamp forest may naturally establish through areas of flax and cabbage tree swamps (wl18)
- planting locations (i.e. ridge/slope/gully) are not included as all areas will be in gullies or on flat land
- the initial plant schedule can also be used for buffer planting.

Figure 59: Kahikatea plantings in Āwhitu Regional Park. Credit: Alastair Jamieson

Table 4.12: Kahikatea, pukatea forest [WF8] revegetation mix for initial planting in open areas in Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	% of planting mix	Plant spacing	Planting notes
Harakeke/flax	*Phormium tenax*		Herb	3m	25-35%	1-1.4m	
Tī kōuka/cabbage tree	*Cordyline australis*		Tall shrub/tree	8m+	25-35%	1-1.4m	Plant higher proportions in moister soils.
Mānuka[1]	*Leptospermum scoparium*		Tall shrub/tree	5m	10-20%	1-1.4m	Use as a buffer around other plants to protect them while they establish and to help retain soil moisture.
Kahikatea	*Dacrycarpus dacrydioides*		Canopy tree	10m	10-20%	5-8m	Survives better with some shelter.
Karamū	*Coprosma robusta*		Tall shrub/tree	6m	10-20%	1-1.4m	Versatile across a range of soil conditions i.e. moist to dry.
Māhoe	*Melicytus ramiflorus*		Tall shrub/tree	6m	< 10%	5-8m	Plant in drier examples of this ecosystem type, and on the margins.
Putaputawētā	*Carpodetus serratus*		Tall shrub/tree	6m	< 10%	1-1.4m	Plant in wetter areas.
Mingimingi	*Coprosma propinqua* var. *propinqua*		Shrub	3m	< 5%	1-1.4m	

1 Mānuka should be sourced from a nursery accredited under Plant Pass where possible.

Key:
Shade tolerant
Tolerant of wet soils
Plant with shelter from wind
Frost tender
Provides food for birds/bats/lizards
Plant in canopy gaps
Deer browse tolerant
Improves in-stream habitat for fish
Tolerant of salt-spray
Improves bank stability

Table 4.13: Kahikatea, pukatea forest [WF8] revegetation mix for enrichment planting in Tāmaki Makaurau / Auckland

Ingoa Māori/ Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	% of planting mix		Planting notes
					Partial shade	Full shade	
Kahikatea	*Dacrycarpus dacrydioides*		Canopy tree	10m	10-15%	10-15%	
Forest sedge	*Carex dissita*		Sedge	0.5m	< 10%	< 10%	
Kiokio	*Blechnum novae-zelandiae*		Fern	1m	< 10%	< 5%	
Putaputawētā	*Carpodetus serratus*		Tall shrub/tree	6m	< 10%	< 10%	
Karamū	*Coprosma robusta*		Tall shrub/tree	6m	< 10%	–	Versatile across a range of soil conditions i.e. moist to dry.
Mingimingi	*Coprosma propinqua var. propinqua*		Shrub	3m	< 5%	–	
Kohekohe	*Didymocheton spectabilis*		Canopy tree	10m	< 5%	< 10%	Only suitable for drier ground.
Pukatea	*Laurelia novae-zelandiae*		Canopy tree	8m	< 10%	< 10%	Plant in wetter areas.
Maire tawake/ Swamp maire[1]	*Syzygium maire*		Canopy tree	8m	< 10%	< 10%	Plant sparingly due to risk of myrtle rust.
Taraire	*Beilschmiedia tarairi*		Canopy tree	8m	< 5%	< 10%	Only suitable for drier ground.
Tawa	*Beilschmiedia tawa*		Canopy tree	8m	< 5%	< 10%	Only suitable for drier ground.
Swamp astelia	*Astelia grandis*		Herb	2m	< 5%	< 5%	
Tītoki	*Alectryon excelsus* subsp. *excelsus*		Canopy tree	10m	< 5%	< 5%	Plant in drier areas within this ecosystem type.
Kiekie	*Freycinetia banksii*		Vine	3m	–	< 5%	Can be slow to establish.
Rimu	*Dacrydium cupressinum*		Canopy tree	10m	–	< 5%	Slow growing. Low survival rates on exposed sites.

Key: Shade tolerant; Tolerant of wet soils; Plant with shelter from wind; Frost tender; Provides food for birds/bats/lizards; Plant in canopy gaps; Deer browse tolerant; Improves in-stream habitat for fish; Tolerant of salt-spray; Improves bank stability

1 Maire tawake/Swamp maire should be sourced from a nursery accredited under Plant Pass.

4.2.6 WF9: Taraire, tawa, podocarp forest

Regional threat status: Endangered

Taraire, tawa, podocarp forest is widely distributed in Tāmaki Makaurau / Auckland, especially in the southern parts of the region where kauri is less common. The best examples are present in the northern Hūnua Ranges.

Figure 60: Taraire, tawa, podocarp forest. Credit: Jason Hosking

Figure 61: Grazed understorey of taraire, tawa, podocarp forest.

Figure 62: Tradescantia smothering the forest floor.

Taraire, tawa, podocarp forest is at risk from the pressures outlined in Table 4.14.

Table 4.14: Ecosystem pressures and suggested restoration actions for taraire, tawa, podocarp forest [WF9]

Key pressures	Description	Suggested restoration action
Urban development and fragmentation	Continuing vegetation clearance in urban areas, for example to facilitate housing intensification, resulting in increased fragmentation, declining quality of remaining habitat, and greater distance between fragments.	Prevent further reduction in extent of ecosystem type over time and restore forest fragments through pest plant control and enrichment planting where suitable. Carry out buffer planting between forest fragments and nearby developed areas to reduce potential edge effects.
Pest animals – herbivores	Possum browsing may affect canopy health where broadleaved tree species (e.g. taraire) are common. Goat browsing may also impact understorey regeneration e.g. around the Hūnua Ranges. Seed predation by rats may affect plant species recruitment.	Manage animal pests, particularly possums and goats. In situations where pest animal density is high, a site-specific pest control and monitoring plan should be implemented. Success can be measured by the recovery of susceptible species or pest-specific monitoring.
Pest animals – predators	Rats, mustelids, and possums predate birds. Loss of frugivorous birds may indirectly affect recruitment of fleshy fruited plant species. Kererū are the only species capable of dispersing larger fruited species e.g. taraire, tawa.	
Pest plants	Pest plant species impact indigenous regeneration, especially where this forest type has been fragmented by development and occurs near dwellings (e.g. around Clevedon). Shade tolerant species (e.g. tradescantia, ginger, monkey apple) are a particular issue as they can invade the interior forest.	Monitor pest plants particularly those that are shade-tolerant and implement control programmes where necessary.
Stock grazing	Stock graze understorey of forest and prevent regeneration of seedlings. This is an issue for fragments present on farms, such as around Kaukapakapa and Pūhoi.	Exclude stock by fencing forest fragment and regularly monitor fence condition. Enrichment planting can be carried out in areas where the understorey vegetation has been heavily degraded and is unlikely to regenerate without assistance (e.g. due to no nearby seed sources).

If management of pressures alone will not allow for regeneration of key ecosystem components, revegetation planting could be carried out to assist with the restoration of former areas of taraire, tawa, podocarp forest. Initial planting should follow the General indigenous forest revegetation mix (Table 4.1). See Table 4.15 for enrichment planting.

Table 4.15: Taraire, tawa, podocarp forest [WF9] revegetation mix for enrichment planting in Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	Planting location			% of planting mix		Planting notes
					Ridge	Slope	Gully	Partial shade	Full shade	
Porokaiwhiri/ pigeonwood	*Hedycarya arborea*		Tall shrub/tree	8m	✓	✓	✓	5-15%	10-20%	
Kahikatea	*Dacrycarpus dacrydioides*		Canopy tree	10m		✓	✓	5-10%	–	Plant more in gullies.
Hangehange	*Geniostoma ligustrifolium* var. *ligustrifolium*		Tall shrub/tree	4m	✓	✓	✓	< 10%	10-15%	Use sparingly where likely to naturally regenerate.
Shiny karamū	*Coprosma lucida*		Shrub	3m	✓	✓	✓	< 10%	< 15%	
Taraire	*Beilschmiedia tarairi*		Canopy tree	8m		✓	✓	< 10%	< 15%	Slow growing.
Tawa	*Beilschmiedia tawa*		Canopy tree	8m	✓	✓	✓	< 10%	< 15%	May be difficult to source. Slow growing.
Houhere/lacebark	*Hoheria populnea*		Tall shrub/tree	8m	✓	✓	✓	< 10%	< 5%	
Tōtara	*Podocarpus totara*		Canopy tree	10m +	✓	✓		< 10%	–	
Kohekohe	*Didymocheton spectabilis*		Canopy tree	10m		✓	✓	< 5%	< 15%	
Twiggy coprosma	*Coprosma rhamnoides*		Shrub	2m	✓	✓		< 5%	< 15%	
Pūriri	*Vitex lucens*		Canopy tree	10m +	✓	✓	✓	< 5%	–	Survives better on fertile soils. Plant in sun with some shelter.
Rewarewa	*Knightia excelsa*		Canopy tree	10m	✓	✓		< 5%	–	Can be hard to establish in some situations.
Rimu	*Dacrydium cupressinum*		Canopy tree	10m	✓	✓	✓	< 5%	–	Slow growing. Will not survive on exposed sites.
Karaka	*Corynocarpus laevigatus*		Canopy tree	10m	✓	✓		< 5%	–	Slow growing.

Key:
Shade tolerant
Tolerant of wet soils
Plant with shelter from wind
Frost tender
Provides food for birds/bats/lizards
Plant in canopy gaps
Deer browse tolerant
Improves in-stream habitat for fish
Tolerant of salt-spray
Improves bank stability

4.2.7 WF10: Kauri forest

Regional threat status: Endangered

Kauri trees can change the composition of the soil in which they grow. The slow decomposition of kauri litter leads to the development of acidic soil conditions suitable for a range of associated understorey species adapted to these conditions, such as toru, needle-leaved neinei, and kauri grass. This forest type has a canopy dominated by kauri and may include mature examples (variant WF10.1) or regenerating stands of kauri (WF10.2). Kauri forest is found on hillslopes and ridges, mainly in the Waitākere and Hūnua Ranges, and on Aotea / Great Barrier Island. There are scattered smaller fragments present around the North Shore and Rodney District, although several of these have been impacted by kauri dieback disease.

Figure 63: Kauri are a keystone species and help define the entire ecosystem. Credit: Tim Lovegrove

Figure 64: Kauri Forest provides habitat for common forest birds such as ruru/morepork.

Kauri forest is at risk from the pressures outlined in Table 4.16.

Table 4.16: Ecosystem pressures and suggested restoration actions for kauri forest [WF10]

Key pressures	Description	Suggested restoration action
Pest animals – predators	Rats, mustelids, and possums predate birds. Loss of frugivorous birds may indirectly affect recruitment of fleshy fruited plant species.	Implement a pest animal control and monitoring programme, including control of pest animals that may be negatively impacting flora and fauna populations. Control pest animals such as pigs that may be contributing to spread of *Phytophthora agathidicida* (causal agent of kauri dieback).
Pest animals – herbivores	Seed predation by rats may affect plant species recruitment.	
Urban development	Vegetation clearance and fragmentation occur through development of vacant residential sites covered in forest.	Avoid and then minimise clearance and carry out buffer planting post-development where appropriate.
Kauri dieback *(Phytophthora agathidicida)*	This plant pathogen has the potential to cause dieback of kauri in this forest type, some areas of which are currently closed to limit spread.	Contain existing known areas of kauri dieback and manage access into unaffected areas. Restrict site access due to potential risk of spreading kauri dieback and implement appropriate kauri dieback hygiene protocols for access to sites. Kauri should be monitored on a regular basis.
Pest plants	Pest plant species impact indigenous regeneration, especially in urban and suburban environments where this forest type has been fragmented by development and occurs near dwellings (e.g. Titirangi, Albany).	Control pest plants to allow for regeneration of indigenous vegetation. Focus on shade tolerant species in internal forest areas (e.g. ginger). Focus on restoring or maintaining high canopy cover to reduce potential for pest plant invasion.
Stock grazing	Stock graze understorey of forest and prevent regeneration of seedlings. Stock may also spread *Phytophthora agathidicida* (causal agent of kauri dieback) via soil movement.	Exclude stock, and regularly monitor fence condition.

Figure 65: Kauri dieback at Huia visible by spindly crowns of kauri. Credit: Alastair Jamieson

Notes on kauri forest revegetation

- Restoration should focus on protecting existing fragments and managing pressures. Provided there is a seed source and pressures are managed this ecosystem should naturally regenerate.
- Planting of all plant species, not just kauri, presents the risk of introducing kauri dieback in soil media. Revegetation planting is only recommended in areas away/downslope from existing kauri or ecosystems that contain kauri. Refer to Appendix 6 for further information on sourcing and planting kauri. It is strongly recommended that Auckland Council is contacted for advice specific to the restoration project so that they can assist with a kauri dieback risk assessment and revegetation advice.
- Refer to the General indigenous forest revegetation mix (Table 4.1) for initial planting and buffer planting around this ecosystem type. Buffer planting can be undertaken adjacent to kauri forest provided it is not upslope of kauri or near an existing kauri rootzone (e.g. within three times the dripline).
- An enrichment plant schedule has not been included as most kauri-associated understorey species have specific growing requirements and are not available at commercial nurseries.

4.2.8 WF11: Kauri, podocarp, broadleaved forest

Regional threat status: Endangered

Kauri, podocarp, broadleaved forest is one of the most common remaining forest ecosystem types in Tāmaki Makaurau / Auckland, particularly in the Waitākere Ranges, Rodney District, forest reserves on the North Shore, and on Aotea / Great Barrier Island. Likewise, it is the expected original ecosystem type for a large portion of the region. Remnant examples are often dominated by podocarp and broadleaf species only, with kauri having been previously logged, or only gully vegetation remaining.

Figure 67: Kauri, podocarp, broadleaved forest provides habitat for tomtits.

Figure 66: Kauri, podocarp, broadleaved forest at Huia. Credit: Alastair Jamieson

Table 4.17: Ecosystem pressures and suggested restoration actions for kauri, podocarp, broadleaved forest [WF11]

Key pressures	Description	Suggested restoration action
Urban development	Vegetation clearance and fragmentation occur through development of vacant residential sites covered in forest.	Avoid and then minimise clearance and carry out buffer planting post-development where appropriate.
Kauri dieback *(Phytophthora agathidicida)*	This plant pathogen has the potential to cause dieback of canopies where kauri is common, particularly in the Waitākere Ranges, parts of which are currently closed to limit spread.	Restrict site access due to potential risk of spreading kauri dieback and implement appropriate kauri dieback hygiene protocols for access to sites. Kauri should be monitored regularly.
Pest plants	Pest plant species impact indigenous regeneration, especially in urban and suburban environments where this forest type has been fragmented by development and occurs near dwellings (e.g. Titirangi, Chatswood).	Control pest plants to allow restoration of indigenous vegetation. Focus on shade tolerant species in the interior of forest areas (e.g. ginger, climbing asparagus). Restore or maintain high canopy cover to reduce potential for pest plant invasion.
Pest animals – herbivores	A high density of possums may affect the canopy cover where pūriri and taraire are common. Seed predation by rats may affect plant species recruitment.	Implement a pest animal control and monitoring programme, including control of pest animals that may be negatively impacting flora and fauna populations. Control pest animals such as pigs that may be contributing to spread of *Phytophthora agathidicida* (causal agent of kauri dieback).
Pest animals – predators	Rats, mustelids, and possums predate birds. Loss of frugivorous birds may indirectly affect recruitment of fleshy fruited plant species. Kererū are the only species capable of dispersing larger fruited species e.g. pūriri, taraire.	
Stock grazing	Stock graze understorey of forest and prevent regeneration of seedlings. Stock may also spread *Phytophthora agathidicida* (causal agent of kauri dieback via soil movement).	Exclude stock by fencing forest fragments and regularly monitor fence condition. Enrichment planting can be carried out in areas where the understorey vegetation has been heavily degraded and is unlikely to regenerate without assistance (e.g. due to no nearby seed sources).

Figure 68: Kauri dieback at Pakiri Scenic Reserve. Credit: Alastair Jamieson

If management of pressures alone will not allow for regeneration of key ecosystem components, revegetation planting could be carried out to assist with the restoration of former areas of kauri, podocarp, broadleaved forest. Initial and buffer planting should follow the General indigenous forest revegetation mix (Table 4.1). See Table 4.18 for enrichment planting. Buffer planting can be done adjacent to kauri, podocarp, broadleaved forest provided it is not upslope of kauri or near an existing kauri rootzone (e.g. within three times the dripline).

Note that planting of all plant species, not just kauri, presents the risk of introducing kauri dieback in soil media. Revegetation planting is only recommended in areas away/downslope from existing kauri or ecosystems that contain kauri. Refer to Appendix 7 for further information on sourcing and planting kauri. It is strongly recommended that Auckland Council is contacted for advice specific to the restoration project so that they can assist with a kauri dieback risk assessment and revegetation advice.

Table 4.18: Kauri, podocarp, broadleaved forest [WF11] revegetation mix for enrichment planting in Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	Planting location			% of planting mix		Planting notes
					Ridge	Slope	Gully	Partial shade	Full shade	
Porokaiwhiri/ pigeonwood	*Hedycarya arborea*		Tall shrub/tree	8m	✓	✓	✓	5-20%	15-20%	
Twiggy coprosma	*Coprosma rhamnoides*		Shrub	2m	✓	✓		10-15%	15-20%	
Māhoe	*Melicytus ramiflorus*		Tall shrub/tree	6m	✓	✓	✓	10-15%	< 15%	
Kahikatea	*Dacrycarpus dacrydioides*		Canopy tree	10m		✓	✓	5-15%	–	Plant more in gullies.
Pūriri	*Vitex lucens*		Canopy tree	10m +	✓	✓	✓	< 15%	–	Survives better on fertile soils. Plant in sun with some shelter.
Tōtara	*Podocarpus totara*		Canopy tree	10m +	✓	✓		< 15%	–	
Mamangi/tree Coprosma	*Coprosma arborea*		Tall shrub/tree	6m	✓	✓	✓	<10%	<15%	
Taraire	*Beilschmiedia tarairi*		Canopy tree	8m		✓	✓	< 10%	< 15%	
Whauwhaupaku/ five-finger	*Pseudopanax arboreus*		Tall shrub/tree	8m	✓	✓	✓	< 10%	< 15%	
Kauri[1]	*Agathis australis*		Canopy tree	10m	✓	✓		< 10%	–	Follow kauri planting advice in this guide and consult with Auckland Council.
Rewarewa	*Knightia excelsa*		Canopy tree	10m	✓	✓		< 10%	–	Can be hard to establish in some situations.
Kohekohe	*Didymocheton spectabilis*		Canopy tree	10m		✓	✓	< 5%	< 10%	
Kawaka	*Libocedrus plumosa*		Canopy tree	6m	✓	✓		< 5%	–	Can also be planted in initial mix. Use a large grade and plant in clusters to reduce canopy competition.
Horoeka/ lancewood	*Pseudopanax crassifolius*		Tall shrub/tree	8m	✓	✓	✓	< 5%	–	
Rimu	*Dacrydium cupressinum*		Canopy tree	10m	✓	✓	✓	< 5%	–	Slow growing. Will not survive on exposed sites.
Tānekaha	*Phyllocladus trichomanoides*		Canopy tree	10m	✓	✓		< 5%	–	Plant with some shelter.

1 Kauri should be sourced from a nursery accredited under Plant Pass.

Key: Shade tolerant; Tolerant of wet soils; Plant with shelter from wind; Frost tender; Provides food for birds/bats/lizards; Plant in canopy gaps; Deer browse tolerant; Improves in-stream habitat for fish; Tolerant of salt-spray; Improves bank stability

Case study:

12ha gully restoration in the Waiwera River catchment

This 12ha block of private land in the Waiwera River catchment was restored as an offsite compensation for a development project near Ōrewa. The site is a gently to moderately sloping gully with a stream.

Project timeframe	Five years, starting in 2018
Target ecosystem type	WF11 Kauri, podocarp, broadleaved forest
Ecosystem pressures at site	Goats, kikuyu grass, locally abundant gorse, soil variations within the site including an area of infertile podzol soils, risk of kauri dieback
Restoration actions	Stock exclusion, pest plant control, pest animal control (goats, possums and pūkeko), revegetation planting, five years of planned maintenance
Project carried out by	Contracted restoration staff

This is an example of a large-scale revegetation project requiring input and completion of a restoration plan by a professional ecologist. Restoration actions included stock exclusion and planting. While adjacent to an area of mature kauri, podocarp, broadleaved forest, kauri was not planted within the area as a precautionary approach to reduce the spread of kauri dieback. Kauri dieback hygiene procedures were followed when visiting the site.

More than 75,000 plants were planted in the winter of 2018. The revegetation plan was approved earlier that year which meant that some plants from the original schedule were not available. The project team sought expert advice from an ecologist and nursery staff to determine suitable replacements for the site conditions. The species mix planted (in order of quantity) included kānuka, mānuka, karamū, tī kōuka, kōhūhū, māhoe, tōtara, and pūriri on hillslopes, and mānuka, putaputawētā, tī kōuka, harakeke, pūkio, and rautahi around the stream.

The steep terrain of the project site made site preparation and planting very difficult. A novel approach was used to reduce labour time with a helicopter spraying herbicide for the initial site preparation and then distributing plants across the hillslopes.

Goats at the site posed a potential issue with grazing of the new plants. This was addressed by carrying out shooting immediately after planting. Additional pest control including control of pest plants such as gorse in addition to pest animals has had benefits to existing bush fragment as well as the planted area.

Monitoring using fixed photo points was set up prior to planting with photos taken at each location each year. Photo comparison has indicated good progress towards canopy closure.

Photo point monitoring three years after completion of planting

4.2.9 WF12: Kauri, podocarp, broadleaved, beech forest

Regional threat status: Endangered

Kauri, podocarp, broadleaved, beech forest occupies a similar environment to kauri, podocarp, broadleaved forest; however, hard beech provides a larger contribution to the canopy. Due to the limited dispersal ability of hard beech, and the loss of most of this forest type from Tāmaki Makaurau / Auckland, it is difficult to accurately determine the historic distribution or exact conditions needed for its development. Remaining examples the region tend to be located on steep, south-facing slopes interspersed with ridges. These areas include forest in the Hūnua Ranges, and in localised parts of the Waitākere Ranges, the Rodney District, the North Shore and on Kawau Island and Te Hauturu-o-Toi / Little Barrier Island.

Figure 69: Kauri, podocarp, broadleaved, beech forest on Te Hauturu-o-Toi / Little Barrier Island. Credit: Tim Lovegrove

Restoration of kauri, podocarp, broadleaved, beech forest should focus on protecting existing fragments and managing pressures. Provided there is a seed source and pressures are managed this ecosystem should naturally regenerate.

Planting of all plant species, not just kauri, presents the risk of introducing kauri dieback in soil media. Revegetation planting is only recommended in areas away/downslope from existing kauri or ecosystems that contain kauri. Refer to Appendix 7 for further information on sourcing and planting kauri. It is strongly recommended that Auckland Council is contacted for advice specific to the restoration project so that they can assist with a kauri dieback risk assessment and revegetation advice.

In relation to carrying out revegetation planting of this ecosystem type, also note that:

- For initial and buffer planting, refer to the General indigenous forest revegetation mix (Table 4.1). Buffer planting can be undertaken adjacent to kauri, podocarp, broadleaved, beech forest provided it is not upslope of kauri or near an existing kauri rootzone (e.g. within three times the dripline).
- Enrichment planting could also be carried out generally as per the Kauri, podocarp, broadleaved plant schedule (WF11), but with the addition of hard beech (around Hūnua Ranges only).
- Hard beech is only suggested for planting in the vicinity of the Hūnua Ranges where this species naturally occurs in high abundance. Hard beech will establish best if planted into canopy gaps. This may be best achieved by planting hard beech 5-10 years after initial planting. Altering the initial planting mix to include a higher proportion of species which cast light shade (e.g. mānuka) may also facilitate establishment, as hard beech is light demanding, and will be suppressed by broadleaved species such as karamū.

Kauri, podocarp, broadleaved, beech forest is at risk from the pressures outlined in Table 4.19.

Table 4.19: Ecosystem pressures and suggested restoration actions for kauri, podocarp, broadleaved, beech forest [WF12]

Key pressures	Description	Suggested restoration action
Kauri dieback *(Phytophthora agathidicida)*	This plant pathogen has the potential to cause dieback of canopies where kauri is common. This is a high risk for this forest type in the Hūnua Ranges, where *Phytophthora agathidicida* has not been previously recorded.	Restrict site access due to potential risk of spreading kauri dieback and implement appropriate kauri dieback hygiene protocols for access to sites. Kauri should be monitored on a regular basis. Monitor growth of planted or naturally regenerating canopy species to ensure diversity and increase resilience against potential loss of kauri.
Pest animals – herbivores	A high density of possums may affect the canopy cover where beech and broadleaved species are common. Goats may also impact understorey regeneration around the Hūnua Ranges. Seed predation by rats may affect plant species recruitment.	Implement a pest animal control and monitoring programme, including control of pest animals that may be negatively impacting flora and fauna populations. Control pest plants to allow restoration of indigenous vegetation. Focus on shade tolerant species in the interior of forest areas (e.g. ginger, climbing asparagus). Restore or maintain high canopy cover to reduce potential for pest plant invasion.
Pest animals – predators	Rats, mustelids, and possums predate birds. Loss of frugivorous birds may indirectly affect recruitment of fleshy fruited plant species. Kererū are the only species capable of dispersing larger fruited species e.g. miro, tawa.	
Pest plants	Mature examples of this forest type have a closed canopy and are generally resistant to pest plant invasion. There is still a risk of invasion by shade tolerant species.	Control pest plants to allow restoration of indigenous vegetation. Focus on shade tolerant species in internal forest areas (e.g. ginger, tradescantia).
Stock grazing	Stock graze understorey of forest and prevent regeneration of seedlings. Stock may also spread *Phytophthora agathidicida* (causal agent of kauri dieback via soil movement).	Exclude stock by fencing forest fragment and regularly monitor fence condition. Enrichment planting can be carried out areas where the understorey vegetation has been heavily degraded and is unlikely to regenerate without assistance (e.g. due to no nearby seed sources).

4.2.10 WF13: Tawa, kohekohe, rewarewa, hīnau, podocarp forest

Regional threat status: Vulnerable

Tawa, kohekohe, rewarewa, hīnau, podocarp forest is found in higher altitude areas (> 450m above sea level) with moderate to high humidity. All examples of this forest type in Tāmaki Makaurau / Auckland are found on public conservation land, including the Hūnua and Waitākere Ranges, and Te Hauturu-o-Toi / Little Barrier Island.

Figure 70: Tawa, kohekohe, rewarewa, hīnau, podocarp forest in the Hūnua Ranges. Credit: Alastair Jamieson

Tawa, kohekohe, rewarewa, hīnau, podocarp forest is at risk from the pressures outlined in Table 4.20.

Table 4.20: Ecosystem pressures and suggested restoration actions for tawa, kohekohe, rewarewa, hīnau, podocarp forest [WF13]

Key pressures	Description	Suggested restoration action
Pest plants	Mature examples of this forest type have a closed canopy and are generally resistant to pest plant invasion. There is still a risk of invasion by shade tolerant species.	Control pest plants to allow regeneration of indigenous vegetation. Focus on shade tolerant species in internal forest areas (e.g. ginger, privet).
Pest animals – herbivores	A high density of possums may affect the canopy cover where beech and broadleaved species are common. Goats may also impact understorey regeneration around the Hūnua Ranges. Intensive pressure from either species can cause canopy collapse and/or prevent regeneration. Seed predation by rats may affect plant species recruitment.	Implement a pest animal control and monitoring programme, including control of pest animals that may be negatively impacting flora and fauna populations.
Pest animals – predators	Rats, mustelids, and possums predate birds. Loss of frugivorous birds may indirectly affect recruitment of fleshy fruited plant species. Kererū are the only species capable of dispersing larger fruited species e.g. tawa.	

Restoration should focus on protecting existing fragments and managing pressures. Provided there is a seed source and pressures are managed this ecosystem should naturally regenerate. Revegetation advice has not been included for this ecosystem as it has a limited extent on higher elevations on public land.

4.2.11 MF4: Kahikatea forest

Regional threat status: Critically Endangered

Kahikatea forest is one of the two types of swamp forest in Tāmaki Makaurau / Auckland, which grow in gullies and plains with seasonally high-water tables. This swamp forest type occurs in frost-prone lowland areas in the region, including Coatesville, Kaukapakapa and Clevedon. This ecosystem type often grades into non-forested wetland areas. Kahikatea forest has been reduced in extent, primarily due to draining and clearance for agriculture.

Figure 72: Fallen kahikatea fruit. Credit: Tim Lovegrove

Figure 71: Kahikatea forest near Clevedon. Credit: Jason Hosking

Table 4.21: Ecosystem pressures and suggested restoration actions for kahikatea forest [MF4]

Key pressures	Description	Suggested restoration action
Change in land use	Increases in farming intensity (e.g. change from beef to dairy farming) in surrounding catchment may raise nutrient levels and alter plant species composition.	Exclude stock from forest fragment, carry out buffer planting where possible to filter nutrients through overland flow.
Draining	Construction of drains around the perimeter of forest fragments will lower soil water levels, making the land more suitable for farming but restricting persistence of moisture-loving indigenous plant species, and increasing growth of dryland pest plants.	Avoid draining of pasture where this may impact nearby forest. Monitor water levels and restore hydrology if/where required. Seek specialist advice on appropriate actions and any resource consent requirements to restore hydrology.
Stock grazing	Stock graze understorey of forest and prevent regeneration of seedlings. Vegetation may also be cleared to increase land available for grazing.	Exclude stock by fencing forest fragments and regularly monitor fence condition. Enrichment planting can be carried out in areas where the understorey vegetation has been heavily degraded and is unlikely to regenerate without assistance (e.g. due to no nearby seed sources).
Pest plants	Pest plant species impact indigenous regeneration, with higher densities in urban areas or forest margins where light levels are higher. Pest plants tolerant of moisture will readily invade this forest type.	Focus on control of pest plants that invade forest margins and those that are tolerant of shade and wet soils e.g. tradescantia and African clubmoss. Focus on restoring or maintaining high canopy cover to reduce potential for further pest plant invasion. Monitor development of indigenous plant communities following pest plant control and stock exclusion.
Pest animals – herbivores	Seed predation by rats may affect plant species recruitment.	Manage animal pests. In situations where pest animal density is high, a site-specific pest animal control and monitoring plan should be implemented. Success can be measured by the recovery of susceptible species or pest-specific monitoring.
Pest animals – predators	Rats, mustelids, and possums predate birds. Loss of frugivorous birds may indirectly affect recruitment of fleshy fruited plant species.	
Climate change	The warming climate will increase drought conditions which will affect this forest type through reduction in soil moisture.	Protect intact examples of ecosystem type to provide seed sources for regeneration of surrounding fragments.

Kahikatea forest is at risk from the pressures outlined in Table 4.21.

Figure 73: Grazed kahikatea forest remnant on the left lacking an understorey compared to dense fenced forest remnant to the right.

If management of pressures alone will not allow for regeneration of key ecosystem components, revegetation planting could be carried out to assist with the restoration of former areas of kahikatea forest (Table 4.22 and 4.23). Note that:

- species selected must generally be tolerant of wet soils
- restoration of hydrology (e.g. infilling of drains) may be required before this forest type can be restored, depending on the level of past modification
- planting location (i.e. ridge/slope/gully) not included as all areas will be in gullies or on flat land
- buffer planting a 'hedge' of fast-growing initial plant species around existing remnants can assist with soil moisture retention. Suitable species include harakeke/flax, tī kōuka/cabbage tree, mānuka and karamū.

Table 4.22: Kahikatea forest [MF4] revegetation mix for initial planting in open areas in Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	% of planting mix	Plant spacing	Planting notes
Mānuka[1]	*Leptospermum scoparium*		Tall shrub/tree	5m	10-20%	1-1.4m	Use higher proportions in harsh soil conditions such as water-logged soil or bare clay. Can be added in other situations for diversity.
Karamū	*Coprosma robusta*		Tall shrub/tree	6m	10-20%	1-1.4m	Versatile across a range of soil conditions i.e. moist to dry.
Māhoe	*Melicytus ramiflorus*		Tall shrub/tree	6m	10-20%	1-1.4m	Survives better on fertile soils with some shelter. Avoid very wet soils.
Tī kōuka/cabbage tree	*Cordyline australis*		Tall shrub/tree	8m+	10-20%	1-1.4m	Plant higher proportions in moister soils.
Kānuka[1, 2]	*Kunzea robusta*		Tall shrub/tree	10m	10-15%	1-1.4m	Plant in drier areas.
Kahikatea	*Dacrycarpus dacrydioides*		Canopy tree	10m	10-15%	5-8m	Survives better in gullies with fertile soils and some shelter. Grows best in areas with year-round moisture.
Harakeke/flax	*Phormium tenax*		Herb	3m	< 10%	1-1.4m	
Houhere/lacebark	*Hoheria populnea*		Tall shrub/tree	8m	< 10%	1-1.4m	
Putaputawētā	*Carpodetus serratus*		Tall shrub/tree	6m	< 10%	1-1.4m	Plant in wetter areas.
Ribbonwood/mānatu	*Plagianthus regius* subsp. *regius*		Tall shrub/tree	10m +	< 10%	1-1.4m	Avoid very wet soils. Plant on stream banks and floodplain areas.
Matai	*Prumnopitys taxifolia*		Canopy tree	10m	<5%	5-8m	Can handle wet and dry soils but prefers periodically wet soil.
Kōwhai[3]	*Sophora microphylla*		Canopy tree	8m	< 5%	5-8m	
Pūriri	*Vitex lucens*		Canopy tree	10m +	< 5%	5-8m	Survives better on fertile soils. Plant in sun with some shelter.
Tītoki	*Alectryon excelsus* subsp. *excelsus*		Canopy tree	10m	< 5%	5-8m	Survives better in gullies with fertile soils and some shelter.

1 Kānuka and mānuka should be sourced from a nursery accredited under Plant Pass where possible.

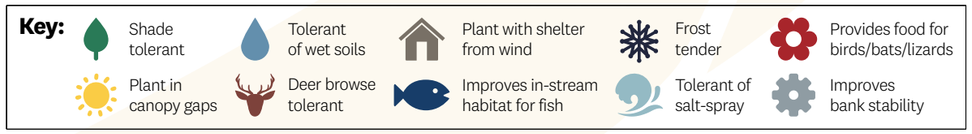
2 The *Kunzea* genus has several species in Tāmaki Makaurau / Auckland. Look in the local area to see which species is suitable for your site and eco-source from the nearest natural populations. Talk to an ecologist if you are having trouble deciding which *Kunzea* to plant at your site.

3 There are multiple species in the *Sophora* genus that vary with location and conditions. Look in the local area to see which species is suitable for your site and eco-source from the nearest natural populations.

Key:
Shade tolerant
Tolerant of wet soils
Plant with shelter from wind
Frost tender
Provides food for birds/bats/lizards
Plant in canopy gaps
Deer browse tolerant
Improves in-stream habitat for fish
Tolerant of salt-spray
Improves bank stability

Table 4.23: Kahikatea forest [MF4] revegetation mix for enrichment planting in Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	% of planting mix		Planting notes
					Partial shade	Full shade	
Kahikatea	*Dacrycarpus dacrydioides*		Canopy tree	10m	< 30%	–	Plant higher percentage where not already present. Grows best in areas with year-round moisture.
Thin-leaved coprosma	*Coprosma areolata*		Shrub	4m	< 5%	10-15%	
Forest sedge	*Carex dissita*		Sedge	0.5m	< 10%	< 15%	
Kiokio	*Blechnum novae-zelandiae*		Fern	1m	< 10%	< 10%	This species and other ferns are likely to naturally establish given sufficient time.
Māhoe	*Melicytus ramiflorus*		Tall shrub/tree	6m	< 10%	< 15%	
Putaputawētā	*Carpodetus serratus*		Tall shrub/tree	6m	< 10%	15%-20%	
Ribbonwood/mānatu	*Plagianthus regius* subsp. *regius*		Tall shrub/tree	8m	< 10%	–	Avoid very wet soils. Plant on stream banks and floodplain areas.
Swamp astelia	*Astelia grandis*		Herb	2m	< 5%	< 5%	
Tītoki	*Alectryon excelsus* subsp. *excelsus*		Canopy tree	10m	< 5%	< 10%	Plant in drier areas within this ecosystem type.
Tūrepo	*Streblus heterophyllus*		Tall shrub/tree	5m	< 5%	< 10%	
Harakeke/flax	*Phormium tenax*		Herb	3m	< 5%	<10-15%	Can be used as a hedge/shelter species around the outside to retain moisture.
Kaikōmako	*Pennantia corymbosa*		Tall shrub/tree	8m	< 5%	–	May be included at inland sites (Rodney, south Auckland, and Hūnua Ranges).
Kōwhai[1]	*Sophora microphylla*		Canopy tree	8m	< 5%	–	
Pūriri	*Vitex lucens*		Canopy tree	10m +	< 5%	–	Survives better on fertile soils with some shelter.



1 Note that the *Sophora* genus has several species in Tāmaki Makaurau / Auckland that vary with location and conditions. Seed should be collected from the nearest available natural source.

4.2.12 MF24: Rimu, tōwai forest

Regional threat status: Critically Endangered

Rimu, tōwai forest is found on higher elevation (more than 450m above sea level) hillslopes, ridges, and plateaus, with high rainfall. Distribution in Tāmaki Makaurau / Auckland is restricted to a small area of the Hūnua Ranges, entirely owned and managed by Auckland Council.

Figure 74: Rimu, towai forest in Hūnua Ranges. Credit: Jason Hosking

Table 4.24: Ecosystem pressures and suggested restoration actions for Rimu, tōwai forest [MF24]

Key pressures	Description	Suggested restoration action
Pest animals – herbivores	Possum browse may affect canopy health where broadleaved trees are common. Goats may also impact understorey regeneration in the Hūnua Ranges. Intensive pressure from either species can cause canopy collapse and/or prevent regeneration. Seed predation by rats may affect plant species recruitment.	Implement a pest animal control and monitoring programme, including control of pest animals that may be negatively impacting flora and fauna populations.
Pest animals – predators	Rats, mustelids, and possums predate birds. Loss of frugivorous birds may indirectly affect recruitment of fleshy fruited plant species.	
Pest plants	Mature examples of this forest type have a closed canopy and are generally resistant to pest plant invasion. There is still a risk of invasion by shade tolerant species.	Control pest plants to allow regeneration of indigenous vegetation. Focus on shade tolerant shrub species in internal forest areas (e.g. monkey apple, privet).

Restoration should focus on protecting existing fragments and managing pressures. Revegetation advice has not been included for this ecosystem as it has a limited extent on higher elevations on public land. Provided there is a seed source and pressures are managed this ecosystem should naturally regenerate.

4.2.13 MF25: Kauri, tōwai, rātā, montane podocarp forest

Regional threat status: Endangered

Kauri, tōwai, rātā, montane podocarp forest is found in higher altitude areas (more than 600 metres) and is often referred to as 'cloud forest'. This forest type is only found in Tāmaki Makaurau / Auckland on the peaks of Te Hauturu-o-Toi / Little Barrier Island and Aotea / Great Barrier Islands which are subject to high winds and regular rainfall.

Figure 75: Kauri, tōwai, rātā, montane podocarp forest on the summit of Te Hauturu-o-Toi / Little Barrier Island. Credit: Alastair Jamieson

Kauri, tōwai, rātā, montane podocarp forest is at risk from the pressures outlined in Table 4.25.

Table 4.25: Ecosystem pressures and suggested restoration actions for kauri, tōwai, rātā, montane podocarp forest [MF25]

Key pressures	Description	Suggested restoration action
Climate change	The warming climate will increase drought conditions, which may affect this forest type through reduction in rainfall.	Protect intact examples of this ecosystem type to provide seed sources for regeneration of surrounding fragments.
Pest animals – trampling/rooting	Pigs on Aotea / Great Barrier Island trample vegetation and root up the soil preventing regeneration of seedlings and erode stream banks.	
	Implement a pest animal control and monitoring programme where necessary, including control of all predators that may be negatively impacting flora and fauna populations. Control pest animals that may be contributing to spread of *Phytophthora agathidicida* (causal agent of kauri dieback) e.g. pigs.	Control pest plants to allow regeneration of indigenous vegetation. Focus on shade tolerant shrub species in internal forest areas (e.g. monkey apple, privet).
Pest animals – predators	Most predators have been eradicated from Te Hauturu-o-Toi / Little Barrier Island and Aotea / Great Barrier Islands. However, unowned cats and rats are still present on Aotea. These species predate birds. Loss of frugivorous birds may indirectly affect recruitment of fleshy fruited plant species.	
Kauri dieback *(Phytophthora agathidicida)*	This plant pathogen has the potential to cause dieback of canopies where kauri is common.	Contain known areas of kauri dieback and manage access into unaffected areas. Restrict site access due to potential risk of spreading kauri dieback and implement appropriate kauri dieback hygiene protocols for access to sites. Kauri should be monitored on a regular basis.

Restoration should focus on protecting existing fragments and managing pressures. Revegetation advice has not been included for this ecosystem as it has a limited extent on higher elevations on public land. Provided there is a seed source and pressures are managed this ecosystem should naturally regenerate.

4.3

Cliff ecosystems

Cliff ecosystems are present throughout Tāmaki Makaurau / Auckland in high-exposure environments such as steep coastal slopes, erosion-prone slopes with landslides, and inland rocky outcrops and bluffs.

There are two naturally occurring cliff ecosystem types identified in the region. Refer to Figure 4.2 to determine which cliff ecosystem restoration guidelines will apply to your site.

Figure 4.2: Key for the identification of indigenous cliff ecosystem types in Tāmaki Makaurau / Auckland

Which forest ecosystem am I trying to restore?

LOCATION

Coastal
Cliffs and steep hill slopes; widespread in Auckland

Inland
Cliffs, rock outcrops and bluffs; e.g. in Waikakere Ranges and Hunua Ranges

VEGETATION

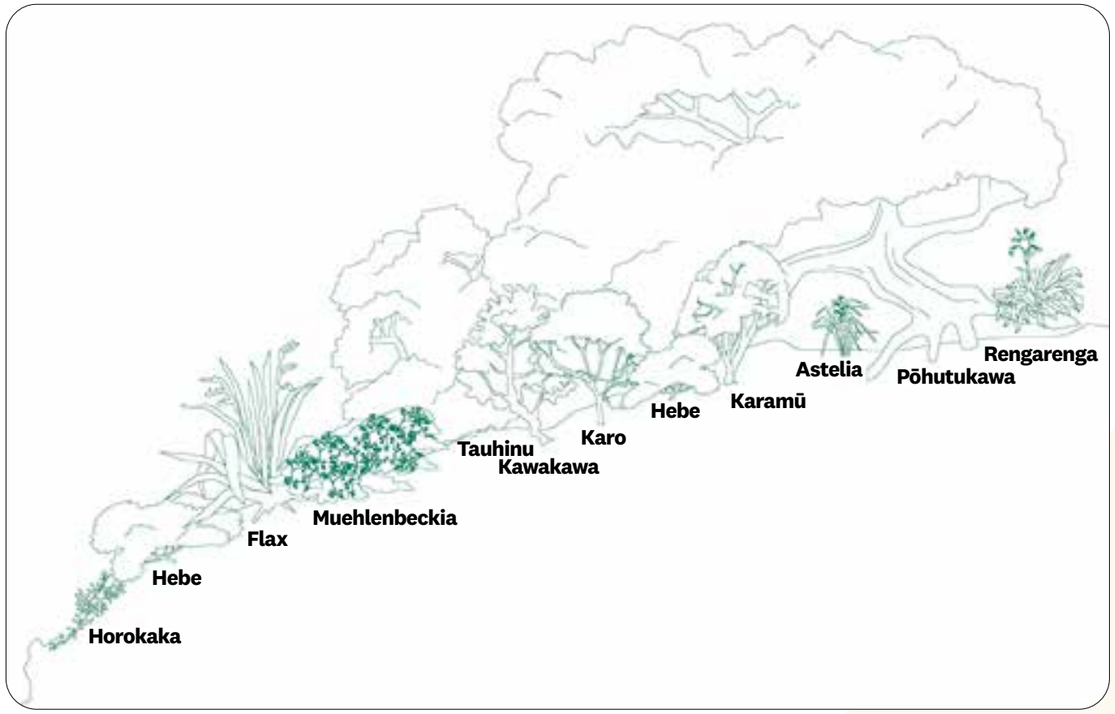
Ecosystem type	Other key species
CL1: Pohutukawa treeland/ flaxland/rockland	Houpara, harakeke, hebe

Ecosystem type	Other key species
MF24: Rimu, tōwai forest	Northern rātā, miro

Note: Vegetation is only diagnostic in areas that retain an indigenous vegetation cover.

Key: Planting is not recommended for this ecosystem type; restoration to focus on pressure management. Plant schedules are provided for this ecosystem type

Figure 4.3 provides a cross-section guide for species that commonly occur in cliff ecosystems [CL1] in Tāmaki Makaurau / Auckland



4.3.1 CL1: Pōhutukawa treeland/flaxland/rockland

Regional threat status: Vulnerable

Pōhutukawa treeland/flaxland/rockland is a coastal cliff ecosystem present on steep slopes subject to strong winds and salt spray. Examples of this ecosystem are found on Te Hauturu-o-Toi / Little Barrier Island and Aotea / Great Barrier Island, along the western coast of the Waitākere Ranges and in fragments on the East Coast. The plant species typically present are tolerant of high levels of airborne salt and may also include wetland species in small seeps.

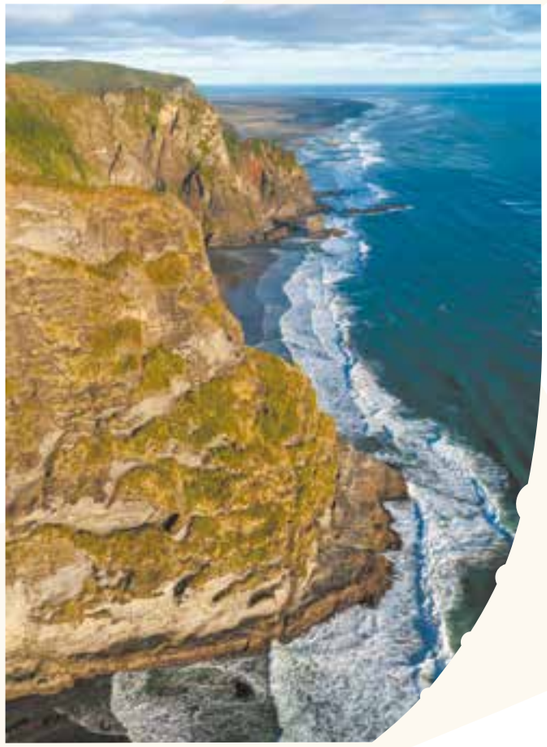


Figure 76: Pōhutukawa treeland/flaxland/rockland at Te Āhua Point. Credit: Alastair Jamieson

Pōhutukawa treeland/flaxland/rockland is at risk from the pressures outlined in Table 4.26.

Table 4.26: Ecosystem pressures and suggested restoration actions for pōhutukawa treeland/flaxland/rockland [CL1]

Key pressures	Description	Suggested restoration action
Pest plants	Pest plants, such as Mexican daisy, boneseed, pampas, and gorse, readily invade open areas caused by erosion.	Control pest plants to allow restoration of indigenous vegetation. Control should be carried out in a staged manner to avoid further slope failure. Buffer planting can be undertaken to prevent pest plant establishment.
Pest animals – herbivores	Possum browse on pōhutukawa may affect canopy cover and health, increasing risk of erosion. Rats are seed predators.	Manage animal pests, particularly possums. In situations where pest animal density is high, a site-specific pest animal control and monitoring plan should be implemented. Success can be measured by the recovery of susceptible species or pest-specific monitoring.
Pest animals – predators	Predators such as rats, mustelids, and cats have reduced seabird populations and associated nutrient cycling in this ecosystem type.	
Urban development	Encroachment into coastal cliff ecosystems is occurring as houses and subdivisions are developed close to the cliff edge to maximise scenic views (e.g. on Whangaparāoa Peninsula)	Provide a setback between houses and the cliff edge, avoid steep slopes, and carry out restoration planting in intervening areas where appropriate.
Erosion	Extreme weather conditions, including high rainfall and storm surges, can uproot vegetation and result in slope failure.	Where possible (away from cliff edge), increase vegetation cover through buffer planting to stabilise slopes, especially under large trees.
Sea level rise	Climate change is expected to result in sea level rise, which may flood low elevation cliff areas.	Monitor the potential for sea-level rise to impact the base of cliffs and cliff tops with low elevation. Protect intact examples of ecosystem type at higher elevations to provide seed sources for regeneration of surrounding areas.
Myrtle rust	Pōhutukawa is a main canopy species in this ecosystem type and is susceptible to infection from this plant pathogen.	Monitor pōhutukawa and other myrtle species (e.g. mānuka) for the presence of myrtle rust. Protect intact examples of this ecosystem type in areas where myrtle rust has not been recorded.

Figure 77: Pōhutukawa treeland/flaxland/rockland on North Shore showing a variety of pressures such as houses built close to cliff edge, erosion, and pampas.

Erosion is a natural feature of this ecosystem type and generally planting is not recommended. There are also health and safety concerns around access. Buffer planting may, however, be suitable on the edge of this ecosystem type (i.e. at the top of the cliff). See Table 4.27. Buffer planting may be appropriate where indigenous species are not naturally regenerating following pest plant control or other disturbance e.g. fire. Larger tree species should be planted back from the cliff edge to reduce erosion risk from their weight. Advice on buffer widths is the same as forest ecosystems (the bigger the better) but will depend on site characteristics, cost, and condition of the existing vegetation.

Pōhutukawa is an essential component of the coastal cliff ecosystem type, however plantings of this species may present ongoing challenges due to the risk of myrtle rust. This species should only be planted where sourced from nurseries accredited under Plant Pass. Ongoing inspections for potential infection should be carried out.

Figure 78: Pōhutukawa is a key component of this ecosystem but at risk of myrtle rust. Credit: Tim Lovegrove

Table 4.27: Pōhutukawa treeland/flaxland/rockland [CL1] revegetation mix for Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	% of planting mix	Plant spacing	Planting notes
Harakeke/flax	*Phormium tenax*		Herb	3m	10-20%	1-1.4m	Suitable for planting up to the cliff edge.
Koromiko	*Veronica stricta* var. *stricta*		Shrub	2m	10-20%	1m	Versatile across a range of soil conditions i.e. moist to dry.
Kōwharawhara/ Coastal astelia	*Astelia banksii*		Herb	1m	10-15%	1m	Can grow on rocks. Plant on dry slopes.
Toetoe	*Austroderia splendens*		Grass	2.5m	10-15%	1m	Can grow on dry, disturbed sites.
Houpara/coastal five-finger	*Pseudopanax lessonii*		Tall shrub/tree	6m	10-15%	1-1.4m	Suitable for areas exposed to salt spray.
Karo	*Pittosporum crassifolium*		Tall shrub/tree	6m	10-15%	1-1.4m	Suitable for areas exposed to salt spray.
Mānuka[1]	*Leptospermum scoparium*		Tall shrub/tree	5m	10-15%	1-1.4m	Forms stabilising root system.
Kawakawa	*Piper excelsum*		Shrub	5m	< 10%	1-1.4m	Plant in frost-free areas with shelter.
Taupata	*Coprosma repens*		Tall shrub/tree	5m	5-10%	1-1.4m	Suitable for areas exposed to salt spray.
Pōhutukawa[1]	*Metrosideros excelsa*		Canopy tree	10m	< 5%	5-8m	Plant with caution due to risk of myrtle rust. Plant back from cliff edge.
Rengarenga lily	*Arthropodium cirratum*		Herb	0.5m	< 5%	0.75-1m	Can grow on rocks.
Wharangi	*Melicope ternata*		Tall shrub/tree	4m	< 5%	1-1.4m	

1 Pōhutukawa should be sourced from a nursery accredited under Plant Pass. Mānuka should also be sourced from a Plant Pass accredited nursery where possible.

Key:
- Shade tolerant
- Tolerant of wet soils
- Plant with shelter from wind
- Frost tender
- Provides food for birds/bats/lizards
- Plant in canopy gaps
- Deer browse tolerant
- Improves in-stream habitat for fish
- Tolerant of salt-spray
- Improves bank stability

4.3.2 CL6: Hebe, whararikiflaxland/rockland

Regional threat status: Least Concern

Hebe, whararikiflaxland/rockland is an inland cliff ecosystem present on rocky outcrops, steep slopes, and rocky banks of streams and rivers. These locations have very thin layers of soil and are exposed to harsh environmental conditions such as high winds. Examples of this ecosystem are found in the Waitākere and Hūnua Ranges, and on Te Hauturu-o-Toi / Little Barrier Island and Aotea / Great Barrier Island. Due to the regular disturbance, this ecosystem features a mosaic of vegetation types including shrubs, grasses, herbs, and lichens.

Figure 79: Hebe, whararikiflaxland/rockland in the Waitākere Ranges. Credit: Jason Hosking

Hebe, whararikiflaxland/rockland is at future risk from the pressures outlined in Table 4.28. Revegetation planting advice as not been provided as this ecosystem type is confined to areas on public land.

Table 4.28: Ecosystem pressures and suggested restoration actions for Hebe, whararikiflaxland/rockland

Key pressures	Description	Suggested restoration action
Pest plants	Pest plants, such as pampas, gorse, Mexican daisy, and cotoneaster, readily invade open areas caused by erosion.	Control pest plants to allow restoration of indigenous vegetation. Control should be carried out in a staged manner to avoid slope failure.
Pest animals – predators	Rats, mustelids, and possums predate birds. Loss of frugivorous birds may indirectly affect recruitment of fleshy fruited plant species.	Implement a pest animal control and monitoring programme, including control of pest animals that may be negatively impacting flora and fauna populations, especially goats in affected areas.
Land slips	Extreme weather conditions, including high rainfall and storm surges, can disrupt soil and vegetation development on a regular basis.	Monitor regenerating vegetation to ensure indigenous species colonise first.

4.4

Regenerating ecosystems

Following human settlement of Tāmaki Makaurau / Auckland, many indigenous ecosystems were destroyed to make way for crops, farming, and urban development. Regenerating ecosystems represent the recovery of these areas following past disturbance. The successional trajectory is usually towards a forest ecosystem type; however, many areas are not developed enough to determine which forest type they will become.

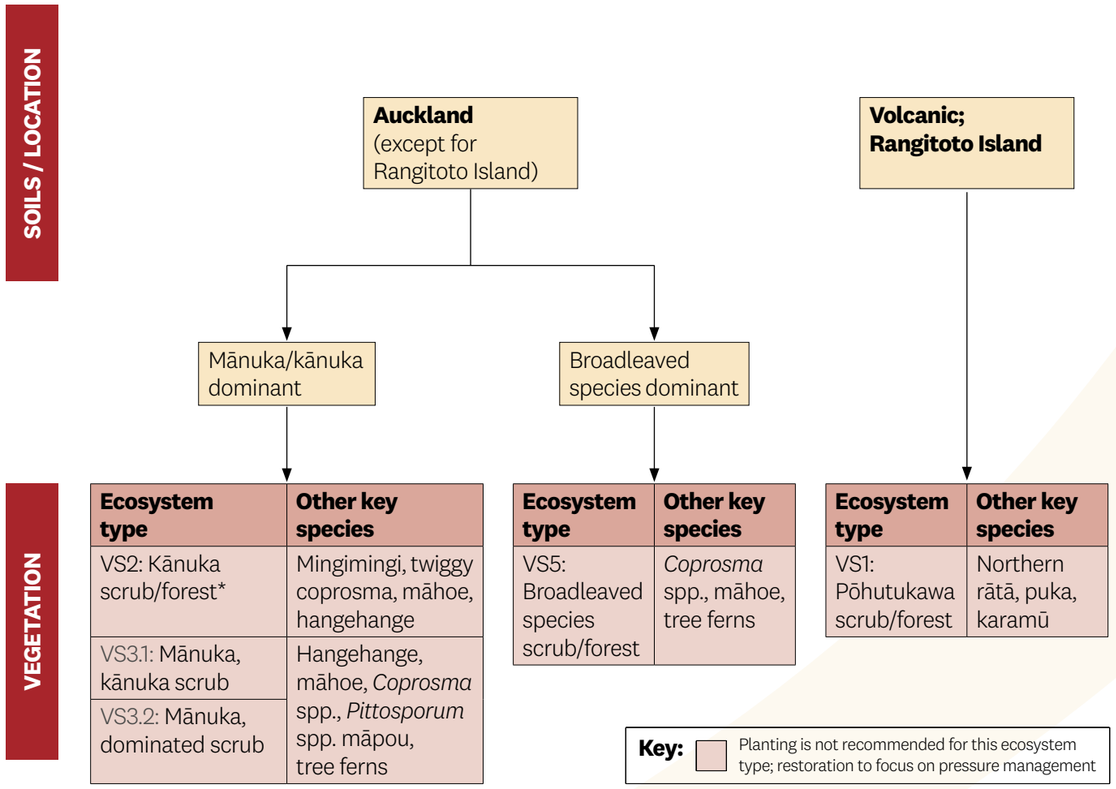
Regenerating ecosystems are characterised by ‘pioneer’ or ‘early-successional’ species, the most common of which are mānuka and kānuka. In less common cases, broadleaved species can be the first to colonise. There are four naturally occurring regenerating ecosystem types in Tāmaki Makaurau / Auckland. Refer to Figure 4.4 to determine which regenerating ecosystem restoration guidelines will apply to your site.

Although it recognised that initial planting for forest ecosystem types will be similar to regenerating ecosystems, the intent for both these plantings and the regenerating ecosystems is the restoration of mature forest. As such, specific planting guidance is not included in this chapter. Advice on buffer widths is the same as forest ecosystems (the bigger the better) and it will depend on site characteristics, cost, and condition of the existing regenerating ecosystem. Protection and enhancement of regenerating ecosystems is encouraged to facilitate the succession to more threatened forest ecosystem types.

Figure 80: Regenerating ecosystems (e.g. VS2 and VS3) provide habitat for geckos such as the Auckland green gecko. Credit: Dylan van Winkel

Figure 4.4: Key for the identification of indigenous regenerating ecosystems in Tāmaki Makaurau / Auckland

Which regenerating ecosystem am I trying to restore?



Note: Regenerating kanuka forest on sandy soils/dunes is identified as WF5.1 and covered in the Forest Ecosystems chapter.

4.4.1 VS1: Pōhutukawa scrub/forest

Regional threat status: Endangered

Pōhutukawa scrub/forest is a regenerating ecosystem found on lava fields. In Tāmaki Makaurau / Auckland, it occurs on Rangitoto Island and Te Hauturu-o-Toi / Little Barrier Island. Species in the Metrosideros genus, including pōhutukawa and northern rātā, form the canopy of this ecosystem type, growing with other early-successional species tolerant of minimal soil and exposed conditions. The trees often grow in 'islands' of vegetation, interspersed by open lava fields bare of plants.

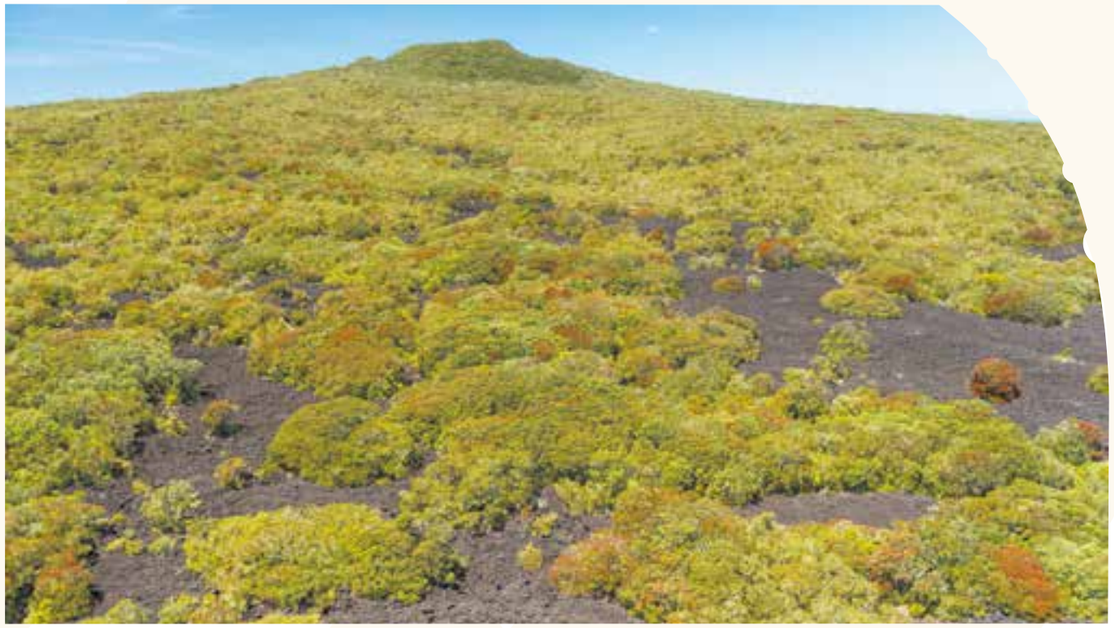


Figure 81: Pōhutukawa scrub/forest on Rangitoto Island. Credit: Alastair Jamieson.

Pōhutukawa scrub/forest is at risk from the pressures outlined in Table 4.29.

Table 4.29: Ecosystem pressures and suggested restoration actions for Pōhutukawa scrub/forest [VS1].

Key pressures	Description	Suggested restoration action
Pest plants	Pest plants, such as boneseed, smilax, evergreen buckthorn, and pine, can invade this ecosystem type and disrupt development of an indigenous vegetation cover.	Control pest plants to allow restoration of indigenous vegetation.
Pest animals – herbivores	Pōhutukawa is highly susceptible to browse from herbivores such as possums and rabbits. As Rangitoto Island and Te Hauturu-o-Toi / Little Barrier Island are pest-free, this risk is low, however incursions could still occur.	Sustain biosecurity procedures for boats travelling to and from Rangitoto Island to the mainland.
Land slips	Extreme weather conditions, including high rainfall and storm surges, can disrupt soil and vegetation development on a regular basis.	Monitor regenerating vegetation to ensure indigenous species colonise first.
Sea level rise	Climate change is expected to result in sea level rise, which may flood low elevation regenerating areas.	Protect intact examples of ecosystem type at higher elevations to provide seed sources for ongoing regeneration.
Myrtle rust	Pōhutukawa and northern rātā are the main canopy species in this ecosystem type and are susceptible to infection from this plant pathogen.	Monitor myrtle species for the presence of myrtle rust. Protect intact examples of ecosystem type in areas where myrtle rust has not been recorded, to provide seed sources for ongoing regeneration.

Revegetation planting advice as not been provided as this ecosystem only occurs on publicly owned/managed offshore islands in the Hauraki Gulf.

4.4.2 VS2: Kānuka scrub/forest

Regional threat status: Least Concern

Kānuka scrub/forest is widespread throughout Tāmaki Makaurau / Auckland, having developed due to both natural causes (e.g. fire, erosion), and abandonment of pasture, especially on steep slopes. Kānuka often develops instead of mānuka on well-drained more fertile soils. Extensive examples of this type are found at Muriwai, on Aotea / Great Barrier Island, west of the Hūnua Ranges, and throughout the Rodney District, often on infrequently grazed parts of private farms. Older examples of this ecosystem type may support seedlings and saplings of future canopy species such as tōtara and tānekaha.

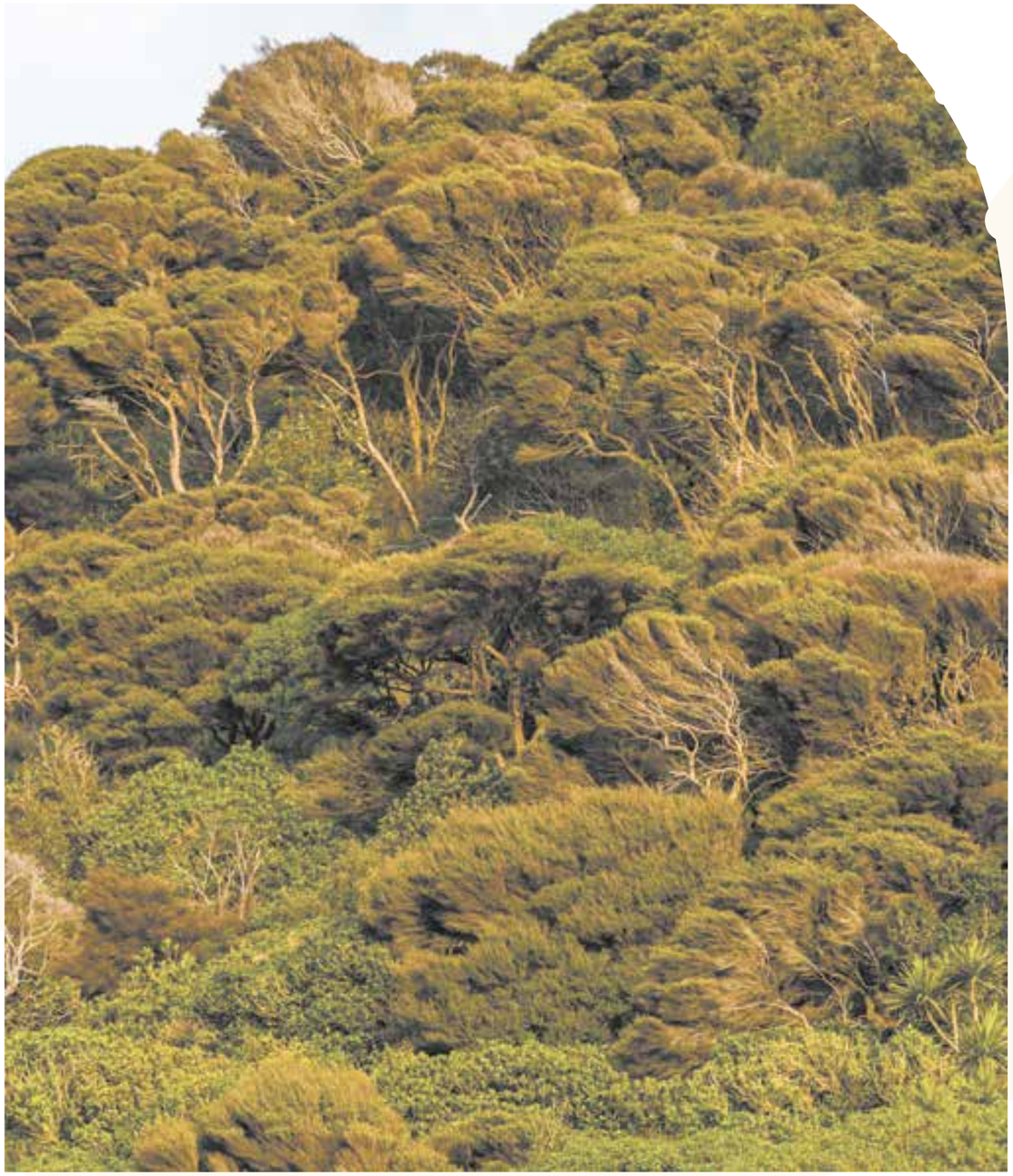


Figure 82: Kānuka scrub/forest at Karekare. Credit: Jason Hosking

Kānuka scrub/forest is at risk from the pressures outlined in Table 4.30.

Table 4.30: Ecosystem pressures and suggested restoration actions for kānuka scrub/forest [VS2]

Key pressures	Description	Suggested restoration action
Change in land use	As this forest type is often located on steep slopes less suitable for stock grazing, land may be cleared to establish plantation forests. In rarer cases, scrub may be cleared to return the area to pasture.	Protect good quality examples of this forest type to prevent clearance in future.
Urban development	Encroachment into regenerating ecosystems is occurring as houses are developed on vacant sites covered in scrub e.g. Waitākere Ranges, Waiheke Island.	Avoid and then minimise clearance. Carry out buffer planting around remaining scrub following construction, manage potential increases in pest invasion.
Pest plants	Pest plant species impact indigenous regeneration, especially species that will grow large enough to be present in the canopy (e.g. gorse, privet, pine).	Control pest plants to allow restoration of indigenous vegetation. Focus on larger species that may prevent a kānuka canopy from developing. Focus on restoring or maintaining high canopy cover to reduce potential for pest plant invasion. Monitor growth of naturally regenerating indigenous species to ensure species richness is increasing.
Pest animals – herbivores	Kānuka is resistant to browse, however browsers (e.g. possums, goats, deer) may restrict development of associated species such as māhoe that are browse sensitive. Some browsers (e.g. wallabies on Kawau Island) can prevent natural succession from occurring through sustained herbivory of all palatable understorey species.	Implement a pest animal control and monitoring programme, including control of pest animals that may be negatively impacting flora and fauna populations.
Pest animals – predators	Rats, mustelids and possums predate birds. Loss of frugivorous birds may indirectly affect recruitment of fleshy fruited plant species.	
Stock grazing	Stock graze understorey of forest and prevent regeneration of seedlings, inhibiting succession to a mature forest type.	Exclude stock by fencing forest fragment and regularly monitor fence condition.
Myrtle rust	Kānuka is a main canopy species in this ecosystem type and is susceptible to infection from this plant pathogen.	Monitor kānuka and other myrtle species for the presence of myrtle rust. Protect intact examples of this ecosystem type in areas where myrtle rust has not been recorded, to provide seed sources for ongoing regeneration.

If buffer planting is carried out, the general forest revegetation plant schedule can be used (refer to Table 4.1). If the potential forest ecosystem type can be determined, use the initial plant schedule for the relevant ecosystem type instead.

Figure 83: Clearance of kānuka scrub/forest on Waiheke for construction of dwellings and views. Credit: Blair Balsom

4.4.3 VS3: Mānuka, kānuka scrub

Regional threat status: Least Concern

Mānuka/kānuka scrub is widespread in previously disturbed areas throughout Tāmaki Makaurau / Auckland, especially in the Waitākere Ranges, and in areas recovering from past fires on Aotea / Great Barrier Island. This ecosystem type includes suitable conditions for both mānuka and kānuka, and usually comprises free draining soils with moderate rainfall.

Drier areas may have a greater proportion of kānuka, while wetter or more infertile areas have a greater proportion of mānuka. Two variations of this ecosystem type are recognised: VS3.1 which comprises a mosaic canopy of both species; and VS3.2 which is mānuka-dominant. Younger examples have a very high density of stems which thin out with time. Kānuka grows taller than mānuka and can also progressively shade mānuka out. Kauri, podocarp, and broadleaved canopy trees will readily colonise this ecosystem type where there are nearby seed sources and stock are excluded.

Figure 84: Mānuka/kānuka scrub. Credit: Jason Hosking

Figure 85: Mānuka. Credit: Alastair Jamieson

Mānuka/kānuka scrub is at risk from the pressures outlined in Table 4.31.

Table 4.31: Ecosystem pressures and suggested restoration actions for Mānuka/kānuka scrub [VS3]

Key pressures	Description	Suggested restoration action
Change in land use	As this ecosystem type is often located on steep slopes less suitable for stock grazing, land may be cleared to establish plantation forests. In rarer cases, scrub may be cleared to return the area to pasture (e.g. by aerial spraying).	Protect good quality examples of this forest type to prevent clearance in future.
Urban development	Encroachment into regenerating ecosystems is occurring as houses are developed on vacant sites covered in scrub e.g. Waitākere Ranges, Waiheke Island.	Avoid and then minimise clearance. Carry out buffer planting around remaining scrub following construction, manage potential increases in pest invasion.
Pest plants	Some pest plants (e.g. prickly hakea, wattle) frequently colonise following fire and grow alongside mānuka and kānuka in the initial development of this ecosystem type. Bird-dispersed pest plants such as blackberry may also be present in the understorey. These types of pest plants can prevent regeneration of indigenous species.	Control pest plant species that may grow taller and shade out kānuka and mānuka, along with shade tolerant species. Focus on restoring or maintaining high canopy cover to reduce potential for pest plant invasion. Monitor growth of naturally regenerating indigenous species to ensure species richness is increasing.
Pest animals – herbivores	Kānuka is resistant to browse, however browsers (e.g. possums, goats, deer) may restrict development of associated species such as māhoe that are browse sensitive.	Implement a pest animal control and monitoring programme, including control of pest animals that may be negatively impacting flora and fauna populations.
Pest animals – predators	Rats, mustelids, and possums predate birds. Loss of frugivorous birds may indirectly affect recruitment of fleshy fruited plant species.	
Stock grazing	Stock graze understorey of forest and prevent regeneration of seedlings, restricting succession to a mature forest type.	Exclude stock by fencing forest fragments and regularly monitor fence condition.
Myrtle rust	Both the canopy species in this ecosystem type are susceptible to infection from this plant pathogen.	Monitor kānuka, mānuka, and other myrtle species for the presence of Myrtle rust. Protect intact examples of this ecosystem type in areas where myrtle rust has not been recorded, to provide seed sources for ongoing regeneration.

If buffer planting is carried out, the general forest revegetation plant schedule can be used (refer to Table 4.1). If the potential forest ecosystem type can be determined, use the initial plant schedule for the relevant ecosystem type instead.

4.4.4 VS5: Broadleaved species scrub/forest

Regional threat status: Least Concern

Broadleaved species scrub/forest regenerates on lower fertility hillslopes that had a former forest cover, and often develops from or grows with a mosaic of other regenerating ecosystems dominated by mānuka and kānuka. As such, the ecosystem type occurs throughout Tāmaki Makaurau / Auckland, however it is particularly prominent on cooler south-facing slopes in the southern part of the region. The dominant species vary on a site-to-site basis, but usually include a mixture of tree ferns, and shrubs such as Coprosma species, Pseudopanax species, Olearia species, māhoe, and māpou.

Figure 86: Broadleaved species scrub/forest. Credit: Jason Hosking

Broadleaved species scrub/forest is at risk from the pressures outlined in Table 4.32.

Table 4.31: Ecosystem pressures and suggested restoration actions for Mānuka/kānuka scrub [VS3]

Key pressures	Description	Suggested restoration action
Change in land use	Scrub may be cleared to return the area to pasture.	Protect good quality examples of this type to prevent clearance in future. Use stock proof fencing in grazed areas where vegetation is retained.
Pest plants	Pest plant species impact indigenous regeneration, especially species that will grow large enough to be present in the canopy (e.g. privet), and vines that will smother low-growing vegetation (e.g. Japanese honeysuckle).	Control pest plants to allow restoration of indigenous vegetation. Focus on pioneer woody species and vines that may prevent a canopy from developing. Maintain a high canopy cover to reduce potential for pest plant invasion. Monitor growth of naturally regenerating indigenous species to ensure species richness is occurring.
Pest animals – herbivores	Broadleaved species are susceptible to browse by pests such as possums, goats, and deer. Heavy herbivore presence may skew the vegetation community towards tree ferns.	Implement a pest animal control and monitoring programme, including control of pest animals that may be negatively impacting flora and fauna populations.
Pest animals – predators	Rats, mustelids, and possums predate birds. Loss of frugivorous birds may indirectly affect recruitment of fleshy fruited plant species.	

If buffer planting is carried out, the general forest revegetation plant schedule can be used (refer to Table 4.1). If the potential forest ecosystem type can be determined, use the initial plant schedule for the relevant ecosystem type instead.

4.5

Wetland ecosystems

Wetland ecosystems are naturally very diverse, forming the link between land and water habitats, with species that are specially adapted to living within these environmental conditions. This section covers freshwater wetland types; coastal wetlands with a saline water influence are covered in the following chapter. There are nine naturally occurring freshwater wetland ecosystem types identified in Tāmaki Makaurau / Auckland, with one of these now extinct. Refer to Figure 4.5 to determine which wetland ecosystem restoration guidelines will apply to your site. Wetlands often occur as a mosaic so restoration of your site may incorporate several wetland ecosystems.

Restoration of natural wetlands is a high priority for biodiversity protection nation-wide, as less than 10 per cent of original wetland ecosystems remain. This is due to past modifications such as vegetation clearance, draining, and conversion to farming. Many wetland flora and fauna species, such as mātātā/fernbird and matuku/Australasian bittern, are now nationally At Risk or Threatened. Continued drainage, stock grazing, and invasion by terrestrial pest plant species, pose significant ongoing pressures to wetland ecosystems. Management of these pressures is often all that is required to restore a wetland ecosystem, as indigenous wetland plant species can persist in the soil for long periods of time and grow rapidly once restoration has started.

Figure 87: Matuku. Credit: Ngā Manu

In cases where restoration cannot be achieved through natural regeneration, planting advice is included for three more common wetland ecosystems in Tāmaki Makaurau / Auckland (WL11; WL18; WL19). In these and other cases, buffer planting may also be beneficial.

In terms of wetland buffer widths (whether planted or natural), the advice is similar to riparian areas i.e. the bigger the better but generally at least 20m is recommended (Section 5.1.2).

Figure 4.5: Key for the identification of indigenous wetland ecosystem types in Tāmaki Makaurau / Auckland

Which wetland ecosystem am I trying to restore?

SOILS

ORGANIC SOILS

- Nutrient rich
  - **MOISTURE**
  - Saturated ground; may dry over summer
    - **LOCATION**
    - Freshwater margins of estuaries and rivers; e.g. Waitāere Ranges, Great Barrier Island
      - **VEGETATION**

Ecosystem type	Other key species
WL10: Oioi restiad rushland/ reedland	*Machaerina* spp., *Bolboschoenus* spp., kuta lake clubrush, raupō

    - Shallow depressions or margins of lakes and estuaries; e.g. Great Barrier Island South Head
      - **VEGETATION**

Ecosystem type	Other key species
WL12: Mānuka, tangle fern, scrub/ fernland (Mānuka fen]	*Machaerina* spp., *Cosprosa* spp., *Carex* spp., *Gahnia* spp.

    - Floodplans of rivers, streams, and coastal area; e.g. Wayby Valley, Whatipū
      - **VEGETATION**

Ecosystem type	Other key species
WL18: Flaxland	Tī kōuka, *Carex* spp., kiokio

  - Permanently saturated ground with shallow water
    - **LOCATION**
    - Shallow depressions or lake margins; wide distribution in Auckland
      - **VEGETATION**

Ecosystem type	Other key species
WL11: *Machaerina* sedgeland	*Eleocharis* spp., *Carex* spp., lake clubrush

    - Inundated valley floors and ponds, lake margins; wide distribution in Auckland
      - **VEGETATION**

Ecosystem type	Other key species
WL19: Raupō reedland	Lake clubrush, swamp millet, pūkio

- Nutrient poor
  - **MOISTURE**
  - Seasonally wet; receive water only from rainfall
    - **LOCATION**
    - Hillslopes and flats with gumland soils; e.g. Albany, Orewa, Whangaparaoa
      - **VEGETATION**

Ecosystem type	Other key species
WL1: Mānuka, gumland grass tree-*Machaerina* scrub/ sedgeland (Gumland)	*Schoenus* spp., *Gahnia* spp., tangle fern

  - Saturated ground; may dry over summer
    - **LOCATION**
    - Depressions and margins of dune lakes; e.g. Te Arai
      - **VEGETATION**

Ecosystem type	Other key species
WL2: Mānuka, greater wirerush, restiad rushland	Tangle fern

SAND AND GRAVEL

- **MOISTURE**
- Only saturated when take water levels are high
  - **LOCATION**
  - Lake margins
    - **VEGETATION**

Ecosystem type
WL15: Herbfield (Lakeshore turf)

Note:
- Includes currently dry areas that would have been wet in the past, but have been drained.
- Swamp forest wetland types are included in the 'Forest Ecosystems' chapter.
- Vegetation is only diagnostic of areas that retain an indigenous vegetation cover.

Key: Planting is not recommended for this ecosystem type; restoration to focus on pressure management. Plant schedules are provided for this ecosystem type.

4.5.1 WL1: Mānuka, gumland grass tree–Machaerina scrub/sedgeland [Gumland]

Regional threat status: Critically Endangered

Mānuka, gumland grass tree–Machaerina scrub/sedgeland [Gumland] is found on hillslopes and gullies with low fertility soils in areas where kauri has been present in the past. This ecosystem type is often associated with, or maintained by, a history of fires. The soil type, referred to as a 'podzol', restricts drainage and leads to saturation of soils and development of wetland vegetation. These wetlands may be seasonally dry and have the appearance of a terrestrial scrub ecosystem type over the summer months and in drought conditions. There are few areas of true gumland heath (variant WL1.1) remaining in Tāmaki Makaurau / Auckland, with the most notable example being in Waikumete Cemetery in West Auckland. Other examples of this ecosystem type (variant WL1.2), present around Albany and the Hibiscus Coast, may be lacking key soil characteristics, indicator species, or are further along the successional pathway to a mixed podocarp/broadleaved forest type.

Figure 89: Gumland provides habitat for sun orchids (e.g. *Thelymitra longifolia*) and sundews.

Figure 88: Gumland at Waikumete Cemetery. Credit: Jason Hosking

Mānuka, gumland grass tree–Machaerina scrub/sedgeland is at risk from the pressures outlined in Table 4.33.

Table 4.33: Ecosystem pressures and suggested restoration actions for mānuka, gumland grass tree–Machaerina scrub/sedgeland [WL1]

Key pressures	Description	Suggested restoration action
Urban development	Vegetation clearance and fragmentation occur through residential development in areas such as Albany and Ōrewa.	Avoid and then minimise clearance and carry out buffer planting post-development where possible. Manage potential increases in pests invading vegetation that is retained.
Change in land use	As this wetland type is often located on flat land or gentle slopes, land may be cleared for farming.	Protect good quality examples of this ecosystem to prevent clearance in future.
Pest animals – predators	Predators such as rats and mustelids may impact bird and lizard communities within this ecosystem type. Mice may be a threat to lizards if only larger predators are controlled.	Implement a pest animal control and monitoring programme for pest animals that may be negatively impacting flora and fauna populations, including mice.
Pest plants	Pest plant species impact indigenous regeneration. There may be high densities of pest plants adapted to nutrient poor conditions, such as hakea, pine, wattle, and gorse.	Control pest plants to allow restoration of indigenous vegetation. Focus on larger species that may prevent an indigenous canopy from developing and species that have the potential to change soil chemistry (e.g. nitrogen) such as gorse, broom, and wattles. Monitor development of indigenous plant communities following pest plant control and fires.
Myrtle rust	Mānuka is a main canopy species in this ecosystem type and is susceptible to infection from this plant pathogen.	Monitor mānuka for the presence of Myrtle rust. Protect intact examples of ecosystem type in areas where myrtle rust has not been recorded, to provide seed sources for ongoing regeneration.

Figure 90: Pines, wattle, gorse, hakea and aristea are common pest plants within gumland at Waikumete Cemetery.

Figure 91: Pines, wattle, gorse, hakea and aristea are common weeds at Waikumete Cemetery.

Management of the ecosystem type should focus on addressing pressures; provided there is a seed source nearby, areas should naturally regenerate. If buffer planting is to be undertaken, mānuka should be the main species used for planting with diversity added based on-site conditions. It is important that species used are appropriate for the ecosystem to reduce the potential for other planted species to invade the wetland ecosystem and change the plant community over time.

4.5.2 WL2: Mānuka, greater wire rush, restiad rushland

Regional threat status: Critically Endangered

Mānuka, greater wire rush, restiad rushland is found in moderate fertility soils with a fluctuating water table throughout the year. In Tāmaki Makaurau / Auckland, this wetland ecosystem type has a distribution restricted to the margins of dune lakes around Te Ārai and Tomorata. (Tomorata, Spectacle and Slipper lakes are known by Ngāti Manuhiri as Ngaroto). Due to waterlogging and the accumulation of peat, this ecosystem type has reduced availability of nutrients for plant growth, however, draining on the edges may disrupt this process and lead to invasion by less desirable plant species.

Figure 92: Mānuka, greater wire rush, restiad rushland at Te Arai. Credit: Brenda Osborne

Mānuka, greater wire rush, restiad rushland is at risk from the pressures outlined in Table 4.34.

Table 4.34: Ecosystem pressures and suggested restoration actions for mānuka, greater wire rush, restiad rushland [WL2]

Key pressures	Description	Suggested restoration action
Stock grazing	Stock graze rushes within wetlands and trample other plant species (e.g. tangle fern), affecting regeneration and persistence of an indigenous understorey.	Exclude stock by fencing wetland fragment and regularly monitor fence condition. Fence should be appropriately setback from the wetland edge to provide a buffer. Buffer planting may be necessary if there is a lack of existing indigenous vegetation and ongoing pest plant invasion is likely to be an issue.
Pest animals – predators	Predators such as rats, cats and mustelids may impact bird and lizard communities within this ecosystem type. Mice may be a threat to lizards if only larger predators are controlled.	Implement a pest animal control and monitoring programme for pest animals that may be negatively impacting flora and fauna populations, including mice.
Pest plants	Pest plant species impact indigenous regeneration and will readily invade the drier edges of this wetland ecosystem type. The most common invaders are grey willow and blackberry.	Control pest plant species particularly those that are invading the wetland margins and moisture tolerant species (e.g. willow) that could readily invade the interior of the wetland. Focus on restoring or maintaining a dense vegetation cover to reduce potential for further pest plant invasion. Monitor development of indigenous plant communities following pest plant control.
Draining	Construction of drains around the perimeter of these wetlands will lower soil water levels, making the land more suitable for farming and restricting persistence of wetland plant species.	Avoid draining of pasture where this may impact nearby wetlands. Restore previous examples of this ecosystem type, through restoration of hydrology where possible. Seek specialist advice on appropriate actions and any resource consent requirements to restore hydrology.
Myrtle rust	Mānuka is a main canopy species in this ecosystem type and is susceptible to infection from this plant pathogen.	Monitor mānuka and other myrtle species for the presence of Myrtle rust. Protect intact examples of ecosystem type in areas where myrtle rust has not been recorded, to provide seed sources for ongoing regeneration.

Management of the ecosystem type should focus on addressing pressures to allow for natural regeneration to occur. If buffer planting is carried out, mānuka should be the main species used with diversity added based on-site conditions. It is important that species used are appropriate for the ecosystem to reduce the potential for other planted species to invade the wetland ecosystem and change the plant community over time.

4.5.3 WL3: Bamboo rush, greater wire rush, restiad rushland

Regional threat status: Collapse

Bamboo rush, greater wire rush, restiad rushland was historically present in Tāmaki Makaurau / Auckland in seasonally wet raised bogs within the lowland plains in the south of the region. Due to drainage and conversion to pasture, all remaining examples are restricted to the Waikato region. The plant species that form this ecosystem type may take thousands of years to develop soil conditions suitable for the persistence of this ecosystem type. As such, restoration within Tāmaki Makaurau / Auckland is no longer feasible.

4.5.4 WL10: Oioi, restiad rushland/reedland

Regional threat status: Endangered

Oioi, restiad rushland/reedland is a wetland ecosystem type found in the freshwater and brackish zones of estuaries, and occasionally around inland lakes. Its presence has not been widely surveyed in Tāmaki Makaurau / Auckland, but it is likely to be found at river mouths and estuaries, such as along the Waitākere coastline and on Aotea / Great Barrier Island. Oioi, restiad rushland/reedland grades into salt marsh (SA1.3) by the coast, or Machaerina sedgeland (WL11)/raupō reedland (WL19) upstream as the saline influence decreases.

Figure 93: Oioi, restiad rushland/reedland. Credit: Jason Hosking

Figure 94: Oioi, restiad rushland/reedland, Raupō reedland and restoration plantings at Āwhitu Regional Park. Credit: Alastair Jamieson

Figure 95: Blackberry within Oioi, restiad rushland/reedland at Āwhitu Regional Park. Credit: Alastair Jamieson

Oioi, restiad rushland/reedland is at risk from the pressures outlined in Table 4.35.

Table 4.35: Ecosystem pressures and suggested restoration actions for Oioi, restiad rushland/reedland [WL10]

Key pressures	Description	Suggested restoration action
Pest animals – herbivores	A high density of rabbits may affect regeneration of indigenous plants.	Implement a pest animal control and monitoring programme, including control of pest animals that may be negatively impacting flora and fauna populations.
Pest animals – predators	Predators such as rats and mustelids may impact bird communities within this ecosystem type.	
Sea level rise	Climate change is expected to result in sea level rise, which may inundate this ecosystem type.	Identify sites where managed retreat of the shoreline can allow for inland migration of coastal ecosystem types.
Pest plants	Pest plant species tolerant of soil moisture, such as grey willow, pampas, and alligator weed, may invade the wetland, and affect recruitment of indigenous plant species.	Control pest plants that are invading the wetland margins and moisture tolerant species (e.g. willow) that could readily invade the internal wetland. Focus on restoring or maintaining a dense vegetation cover to reduce potential for further pest plant invasion.
Draining	Construction of drains around the perimeter of these wetlands will lower soil water levels, making the land more suitable for farming and restricting persistence of wetland plant species.	Avoid draining of pasture where this may impact nearby wetlands. Seek specialist advice on appropriate actions and any resource consent requirements to restore hydrology.
Stock grazing	Stock graze and trample rush and sedge species within wetlands, affecting regeneration and persistence of indigenous vegetation.	Exclude stock by fencing wetland fragments and regularly monitor fence condition. Fence should be appropriately setback from the wetland edge to provide a buffer. Buffer planting may be necessary if there is a lack of existing indigenous vegetation and ongoing pest plant invasion is likely to be an issue.

Buffer planting of this wetland type should include species tolerant of exposure to coastal winds and salt spray. The initial plant schedule for Coastal broadleaved forest (see Table 4.3) could be used to guide buffer planting.

4.5.5 WL11: Machaerina sedgeland

Regional threat status: Critically Endangered

Sedgeland dominated by Machaerina and other sedge species is found throughout Tāmaki Makaurau / Auckland. It develops in areas of permanently saturated ground, shallow water on the margins of sheltered lakes and lagoons, and in shallow depressions within gully systems. Examples in the region include the margins of Lake Rototoa and Lake Tomorata, and Carex sedgeland around slow-flowing watercourses. Machaerina sedgeland is the most restored wetland ecosystem type in Tāmaki Makaurau / Auckland, as a variety of easy-to-source plants are suitable.

Not all locations that could be restored as sedgeland would have been wetland historically. Former stream channels within forested areas have been converted into wetland environments through a combination of vegetation clearance and stock grazing/trampling. Restoration of these areas as sedgeland is appropriate for the existing hydrology of these sites, and with vegetation succession (and associated bank stabilisation and shading), these may in time transition back into forested stream gullies.

Figure 96: *Machaerina* sedgeland at Whatipū. Credit: Alastair Jamieson

Figure 97: *Machaerina* sedgeland on the edge of Lake Rototoa. Credit: Sam Sutherland

Machaerina sedgeland is at risk from the pressures outlined in Table 4.37.

Table 4.37: Ecosystem pressures and suggested restoration actions for Machaerina sedgeland [WL11].

Key pressures	Description	Suggested restoration action
Change in land use	Increases in farming intensity (e.g. change from beef to dairy farming) in surrounding catchment may raise nutrient levels and result in a shift to the raupō reedland wetland ecosystem type.	Exclude stock from wetland and waterways into wetland, carry out buffer planting where possible to filter nutrients through overland flow.
Pest plants	Pest plant species tolerant of high soil moisture, such as grey willow, pampas, reed sweet grass, and Mercer grass, may invade the wetland and suppress recruitment of indigenous plant species. Note that some indigenous species (e.g. swamp millet) may appear weedy and should be identified by a specialist if required.	Control pest plants to allow for regeneration of indigenous vegetation. Focus on species that are invading the wetland margins and moisture tolerant species (e.g. willow) that could readily invade the internal wetland and outcompete indigenous plants. Monitor natural regeneration of indigenous wetland plant species following pest plant control and stock exclusion to determine whether planting is necessary.
Draining	Construction of drains around the perimeter of these wetlands will lower soil water levels, making the land more suitable for farming but restricting persistence of wetland plant species.	Avoid draining of pasture where this may impact nearby wetlands. Seek specialist advice on appropriate actions and any resource consent requirements to restore hydrology.
Stock grazing	Stock graze and trample sedge species within wetland, affecting regeneration and persistence of indigenous plant diversity.	Exclude stock by fencing wetland fragment and regularly monitor fence condition. Fence should be appropriately setback from the wetland edge to provide a buffer. Buffer planting may be necessary if there is a lack of existing indigenous vegetation and ongoing pest plant invasion is likely to be an issue.

Buffer planting of this wetland type can generally follow the riparian planting guidelines included in Section 5 of this resource.
If management of pressures alone will not allow for regeneration of key ecosystem components, revegetation planting could be carried out to assist with the restoration of former areas of Machaerina sedgeland (Table 4.38).

Figure 98: *Machaerina* sedgeland infested with parrot's feather in Te Henga wetland. Credit: Tim Lovegrove

Figure 99: Buffer planting around a *Machaerina* sedgeland in Pākiri Regional Park in 2019. Credit: Tim Lovegrove

Figure 100: Two-year-old buffer planting around *Machaerina* sedgeland in Pākiri Regional Park. Credit: Frankie Hofland

Table 4.38: Machaerina sedgeland [WL11] revegetation mix for Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Growth form	Height after 30 years	% of planting mix			Plant spacing	Planting notes
				Standing water[1]	Boggy/swampy areas	Moist edges		
Jointed twig rush	*Machaerina articulata*	Sedge	2m	40-60%	20-30%	–	0.5-0.75m	Will grow in water up to 0.3m deep.
Pūrei	*Carex secta*	Sedge	1.5m	30-40%	–	–	0. 75-1m	Plant at edges of water up to 0.1m deep. Forms tussocks on trunk-like stems.
Kuawa/Lake clubrush	*Schoenoplectus tabernaemontani*	Sedge	2m	20-30%	< 10%	–	0.5-0.75m	Will grow in water up to 0.3m deep.
Kuta	*Eleocharis sphacelata*	Sedge	1m	< 10%	–	–	0.5-0.75m	Plant at edges of water. Will grow in water up to 1m deep.
Giant umbrella sedge	*Cyperus ustulatus*	Sedge	1.5m	–	15-25%	20-30%	0. 75-1m	Plant in wet soils up to edges of water.
Rautahi	*Carex geminata; C. lessoniana*[2]	Sedge	1m	–	15-25%	20-30%	0. 75-1m	Sward-forming.
Pūkio	*Carex virgata*	Sedge	1m	–	10-20%	10-20%	0. 75-1m	
Tī kōuka/cabbage tree	*Cordyline australis*	Tall shrub/tree	8m+	–	< 10%	10-20%	1m	
Mānuka[3]	*Leptospermum scoparium*	Tall shrub/tree	5m	–	< 10%	10-20%	1-1.4m	
Harakeke/flax	*Phormium tenax*	Herb	3m	–	< 10%	< 10%	1m	Plant in clumps.
Baumea	*Machaerina rubiginosa*	Sedge	1m	–	< 10%	-	0.5-0.75m	
Sharp spike sedge	*Eleocharis acuta*	Sedge	1m	–	< 10%	-	0.5-0.75m	
Kahikatea	*Dacrycarpus dacrydioides*	Canopy tree	10m	–	< 5%	< 5%	5-8m	Should not be planted in standing water.
Karamū	*Coprosma robusta*	Tall shrub/tree	6m	–	-	< 10%	1-1.4m	
Putaputawētā	*Carpodetus serratus*	Tall shrub/tree	6m	–	-	< 10%	1-1.4m	

1 Some standing water is likely to remain unplanted in this ecosystem type, depending on water depth and accessibility for planters.

2 These species are often confused with another. Look in your local area to see which species is suitable for your site, and eco-source from the same area of Tāmaki Makaurau / Auckland.

3 Mānuka should be sourced from a nursery accredited under Plant Pass where possible.

4.5.6 WL12: Mānuka, tangle fern scrub/fernland [Mānuka fen]

Regional threat status: Critically Endangered

Mānuka, tangle fern scrub/fernland (mānuka fen) is found in moderate fertility soils with saturated ground, and potential summer drying. This ecosystem type occurs in shallow depressions, and on the margins of lakes or estuaries, such as Kaitoke Swamp on Aotea / Great Barrier Island and around dune lakes on South Head. This wetland type often grows in close association with Machaerina sedgeland and raupō reedland, which occur in adjacent wetter areas.

Figure 101: Mānuka, tangle fern scrub/fernland. Credit: Alastair Jamieson

Mānuka, tangle fern scrub/fernland is at risk from the pressures outlined in Table 4.39.

Table 4.39: Ecosystem pressures and suggested restoration actions for Mānuka, tangle fern scrub/fernland [WL12]

Key pressures	Description	Suggested restoration action
Pest animals – predators	Predators such as rats and mustelids may impact bird and lizard communities within this ecosystem type.	Implement a pest animal control and monitoring programme, including control of pest animals that may be negatively impacting flora and fauna populations.
Pest plants	Pest plant species impact indigenous regeneration and will readily invade the drier edges of this wetland ecosystem type. The most common invaders are pampas and blackberry.	Control pest plants to allow restoration of indigenous vegetation. Focus on species that are invading the wetland margins and moisture tolerant species (e.g. pampas) that could readily invade the interior of wetlands. Focus on restoring or maintaining high canopy cover to reduce potential for further pest plant invasion.
Draining	Construction of drains around the perimeter of these wetlands will lower soil water levels, making the land more suitable for farming but restricting persistence of wetland plant species.	Avoid draining of pasture where this may impact nearby wetlands. Restore existing areas of this ecosystem type through restoration of hydrology where possible. Seek specialist advice on appropriate actions and any resource consent requirements to restore hydrology.
Stock grazing	Stock graze sedges within wetlands and trample other plant species (e.g. tangle fern), affecting regeneration and persistence of an understorey.	Exclude stock by fencing wetland fragment and regularly monitor fence condition. Fence should be appropriately setback from the wetland edge to provide a buffer. Buffer planting may be necessary if there is a lack of existing indigenous vegetation and ongoing pest plant invasion is likely to be an issue.
Myrtle rust	Mānuka is a main canopy species in this ecosystem type and is susceptible to infection from this plant pathogen.	Monitor mānuka for the presence of Myrtle rust. Protect intact examples of this ecosystem type in areas where myrtle rust has not been recorded, to provide seed sources for ongoing regeneration.

Management of the ecosystem type should focus on addressing pressures to allow for natural regeneration to occur. If buffer planting is carried out, mānuka should be the main species used with diversity added based on-site conditions. It is important that species used are appropriate for the ecosystem to reduce the potential for other planted species to invade the wetland ecosystem and change the plant community over time.

4.5.7 WL15: Herbfield [lakeshore turf]

Regional threat status: Critically Endangered

Herbfield [lakeshore turf] wetland ecosystems are present on the ephemeral margins of inland and coastal lakes, meaning they only become wet or inundated when lake water levels are high. Soils generally comprise inorganic materials, such as sand and gravel, that support growth of small herbaceous species rather than larger sedges, rushes, or shrubs. Presence of herbfield wetland has not been widely surveyed in Tāmaki Makaurau / Auckland but has been recorded on the margins of dune lakes where there is a gentle gradient, including Lake Rototoa at South Head.

Figure 102: Herbfield, *Machaerina* sedgeland and raupō reedland around the margins of a dune lake in Te Ārai Regional Park. Credit: Alastair Jamieson

Figure 103: NZ sneezeweed growing within lakeshore turf.

Herbfield [lakeshore turf] is at risk from the pressures outlined in Table 4.40.

Table 4.40: Ecosystem pressures and suggested restoration actions for Herbfield [lakeshore turf] [WL15]

Key pressures	Description	Suggested restoration action
Changes in hydrology	This wetland ecosystem type develops in very restricted hydrological conditions and may be disturbed by either increases in water levels (e.g. from vegetation clearance in the catchment) or decreases in water levels (e.g. the catchment of small dune lakes being planted in plantation forestry).	Remove pines within the catchment (although this may result in loss in extent of lakeshore turf) and avoid clearance of native vegetation.
Pest plants	Pest plant species tolerant of changing water levels, such as Mercer grass and crack willow, may invade the wetland and smother indigenous herbs.	Control pest plants to allow retention of indigenous vegetation communities, focussing on those that are invading the wetland margins.
Stock grazing	Stock graze and trample herb species within wetland, affecting regeneration.	Exclude stock by fencing wetland fragments and regularly monitor fence condition. Fence should be appropriately setback from the wetland edge to provide a buffer. Buffer planting may be necessary if there is a lack of existing indigenous vegetation and ongoing pest plant invasion is likely to be an issue.
Pest fish	Presence of pest fish, within the adjacent lake (e.g. koi carp) may reduce water clarity for lakeshore turf species.	Control pest fish where possible, obtaining appropriate permits from Fish & Game New Zealand where required.

4.5.8 WL18: Flaxland

Regional threat status: Critically Endangered

Flaxland occurs in permanently saturated swamps that regularly flood or receive surface flow from the surrounding land. In Tāmaki Makaurau / Auckland, these areas are often adjacent to streams and lakes, most commonly in the Rodney District. In some examples of this wetland ecosystem type, tī kōuka and other shrubs becomes as common as harakeke, providing a wider range of food sources for indigenous fauna.

Figure 104: Flaxland buffering kahikatea forest in the Wayby Valley. Credit: Jason Hosking

Flaxland is at risk from the pressures outlined in Table 4.41.

Table 4.41: Ecosystem pressures and suggested restoration actions for Flaxland [WL18]

Key pressures	Description	Suggested restoration action
Change in land use	Increases in farming intensity (e.g. change from beef to dairy farming) in surrounding catchment may raise nutrient levels and result in an increase of species such as Isolepis prolifera, pūkio and raupō (as well as pest plants; see below).	Exclude stock from wetland and waterways into wetland, carry out buffer planting where possible to filter nutrients through overland flow.
Draining	Construction of drains around the perimeter of these wetlands will lower soil water levels, making the land more suitable for farming and lead to the loss of wetland plant species.	Avoid draining of pasture where this may impact nearby wetlands. Monitor water levels and restore hydrology if/where required. Seek specialist advice on appropriate actions and any resource consent requirements to restore hydrology.
Pest plants and exotic plants	Pest plant species impact indigenous regeneration. Species such as water celery and water pepper will readily invade open water areas of this ecosystem type. Willows may also invade and change the ecosystem structure.	Control pest plants to allow restoration of indigenous vegetation. Focus on moisture tolerant species (e.g. willow) that could readily invade the interior of wetlands. Restore or maintain high canopy cover to reduce potential for further pest plant invasion. Monitor development of indigenous plant communities following pest plant control and stock exclusion to determine whether planting is necessary.
Stock grazing	Stock graze and trample wetland species, affecting regeneration.	Exclude stock by fencing wetland fragment and regularly monitor fence condition. Fence should be appropriately setback from the wetland edge to provide a buffer. Buffer planting may be necessary if there is a lack of existing indigenous vegetation and ongoing pest plant invasion is likely to be an issue.

Buffer planting of this wetland type should consist of harakeke/flax, tī kōuka/cabbage tree, mānuka and karamū. If management of pressures alone will not allow for regeneration of key ecosystem components, revegetation planting could be carried out to assist with the restoration of former areas of flaxland (Table 4.42).

Table 4.42: Flaxland [WL18] revegetation mix for Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Growth form	Height after 30 years	% of planting mix			Plant spacing	Planting notes
				Standing water*	Boggy/swampy areas	Moist edges		
Harakeke/flax	*Phormium tenax*	Herb	3m	70-90%	50-70%	30-50%	1m	Plant in clumps.
Pūrei	*Carex secta*	Sedge	1.5m	15-30%	–	–	0.75-1m	Plant in water up to 0.1 m deep. Forms tussocks on trunk-like stems.
Jointed twig rush	*Machaerina articulata*	Sedge	2m	15-20%	< 10%	–	0.5-0.75m	Will grow in water up to 0.3m deep.
Giant umbrella sedge	*Cyperus ustulatus*	Sedge	1.5m	–	10-20%	10-20%	0.75-1m	
Pūkio	*Carex virgata*	Sedge	1m	–	10-20%	< 10%	0.75-1m	
Mānuka[1]	*Leptospermum scoparium*	Tall shrub/tree	5m	–	< 10%	10-20%	1-1.4m	
Tī kōuka/cabbage tree	*Cordyline australis*	Tall shrub/tree	8m +	–	< 10%	10-20%	1m	
Kahikatea	*Dacrycarpus dacrydioides*	Canopy tree	10m	–	< 10%	< 10%	5-8m	Plant with shelter from wind.
Kiokio	*Blechnum novae-zelandiae*	Fern	1m	–	< 10%	< 10%	0.75-1m	Grows in full sun or shade.
Baumea	*Machaerina rubiginosa*	Sedge	1m	–	< 10%	–	0.5-0.75m	
Karamū	*Coprosma robusta*	Tall shrub/tree	6m	–	–	< 10%	1-1.4m	

* Standing water in this ecosystem type is likely to be shallow and temporary (i.e., <0.05m, and not too deep for harakeke).

1 Mānuka should be sourced from a nursery accredited under Plant Pass where possible

4.5.9 WL19: Raupō reedland

Regional threat status: Endangered

Raupō reedland is typical of high nutrient wetlands with shallow water, including the margins of lakes, lagoons, ponds, river oxbows, and in flooded valleys. Naturally, this wetland ecosystem was common in coastal areas, however, it has now developed in areas with high nutrient levels resulting from farming, such as gullies on farms. Raupō is a competitive species, especially in the summer growing season, so often forms the dominant vegetation cover with little diversity in the upper wetland tier. The largest examples of raupō reedland in Tāmaki Makaurau / Auckland are Te Henga wetland and Kaitoke Swamp.

Figure 105: Raupō reedland at Little Shoal Bay. Credit: Alastair Jamieson

Raupō reedland is at risk from the pressures outlined in Table 4.43.

Table 4.43: Ecosystem pressures and suggested restoration actions for Raupō reedland [WL19]

Key pressures	Description	Suggested restoration action
Pest plants	Pest plant species tolerant of shallow water, such as reed sweet grass, willow, and alligator weed, may invade the wetland, and affect recruitment of indigenous plant species.	Control pest plants to allow restoration of indigenous vegetation. Focus on moisture tolerant species (e.g. reed sweet grass) that could readily invade the interior of wetlands and outcompete indigenous plants. Monitor natural regeneration of indigenous wetland plant species following pest plant control and stock exclusion to determine whether planting is necessary.
Draining	Construction of drains around the perimeter of these wetlands will lower soil water levels, making the land more suitable for farming and restrict wetland plant species.	Avoid draining of pasture where this may impact nearby wetlands. Seek specialist advice on appropriate actions and any resource consent requirements to restore hydrology.
Stock grazing	Stock graze and trample indigenous plant species within wetlands, affecting regeneration, especially in drought conditions	Exclude stock by fencing wetland fragment and regularly monitor fence condition. Fence should be appropriately setback from the wetland edge to provide a buffer. Buffer planting may be necessary if there is a lack of existing indigenous vegetation and ongoing pest plant invasion is likely to be an issue.
Change in land use	Increases in farming intensity (e.g. change from beef to dairy farming) in surrounding catchment may raise nutrient levels and result in a monoculture of raupō with little species diversity.	Exclude stock from wetland and waterways into wetland, carry out buffer planting where possible to filter nutrients through overland flow.

Figure 106: Cattle grazing and trampling raupō wetland. Credit: Tim Lovegrove

Buffer planting of this wetland type can generally follow the riparian planting guidelines included in Section 5. If management of pressures alone will not allow for regeneration of key ecosystem components, revegetation planting could be carried out to assist with the restoration of former areas of raupō reedland (Table 4.44).

Table 4.44: Raupō reedland [WL19] revegetation mix for Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Growth form	Height after 30 years	% of planting mix			Plant spacing	Planting notes
				Standing water[1]	Boggy/swampy areas	Moist edges		
Raupō	*Typha orientalis*	Reed	3m	50-70%	10-20%	–	0.5-0.75m	Will grow in water up to 1m deep.
Jointed twig rush	*Machaerina articulata*	Sedge	2m	20-30%	20-30%	–	0.5-0.75m	Will grow in water up to 0.3m deep.
Pūrua grass	*Bolboschoenus fluviatilis*	Sedge	1.5m	10-20%	10-20%	–	0.5- 0.75m	In coastal areas.
Kuawa/Lake clubrush	*Schoenoplectus tabernaemontani*	Sedge	2m	10-20%	< 10%	–	0.5-0.75m	Will grow in water up to 0.3m deep.
Pūrei	*Carex secta*	Sedge	1.5m	10-20%	–	–	0.75-1m	Plant at edges of water up to 0.1m deep. Forms tussocks on trunk-like stems.
Kuta	*Eleocharis sphacelata*	Sedge	1m	< 10%	–	–	0.5-0.75m	Plant at edges of water. Will grow in water up to 1m deep.
Giant umbrella sedge	*Cyperus ustulatus*	Sedge	1.5m	–	10-20%	15-20%	0.75-1m	
Pūkio	*Carex virgata*	Sedge	1m	–	10-20%	15-20%	0.75-1m	
Mānuka	*Leptospermum scoparium*	Tall shrub/tree	5m	–	< 10%	15-20%	1-1.4m	
Tī kōuka/cabbage tree	*Cordyline australis*	Tall shrub/tree	8m+	–	< 10%	15-20%	1m	
Kahikatea	*Dacrycarpus dacrydioides*	Canopy tree	10m	–	< 10%	< 10%	5-8m	Plant with shelter from wind.
Harakeke/flax	*Phormium tenax*	Herb	3m	–	–	< 10%	1m	Plant in clumps.
Karamū	*Coprosma robusta*	Tall shrub/tree	6m	–	–	< 10%	1-1.4m	
Putaputawētā	*Carpodetus serratus*	Tall shrub/tree	6m	–	–	< 10%	1-1.4m	

1 Mānuka should be sourced from a nursery accredited under Plant Pass where possible.

Case study:

Raupō reedland restoration at Te Rau Pūriri

This wetland is located at the base of a steep, east-facing hillslope and is over 5ha in size. The vegetation is raupō-dominated (WL19) with small patches of Machaerina sedgeland (WL11), but there are also wetland areas dominated by exotics due to the long history of grazing by both cattle and sheep. On small, raised mounds within the wetland there are small stands of kānuka, mānuka, cabbage tree and wheki. The wetland drains into a nearby channelised watercourse, discharging at the beach 200m away. The wetland is surrounded by pasture with some exotic trees and kānuka to the north and west.

Project timeframe	2019-ongoing
Target ecosystem type	WL19 raupo reedland and WL11 Machaerina sedgeland
Ecosystem pressures at site	Pest plants such as kikuyu, arum lily and pampas. Flame trees on edge of wetland. Pest animals likely present include rats, mustelids, and possums. Deer are occasional visitors to park. Run-off from farm paddocks.
Restoration actions	Stock exclusion. Other pressure management and buffer planting proposed for the future.
Project carried out by	Regional Parks and Healthy Waters

Figure 109: Raupō and *Machaerina* dominated wetland in the foreground, Te Rau Pūriri. Credit: Andrew Macdonald, Biospatial Ltd, 2021

This is an example of a wetland restoration project where the area is being left to restore naturally regenerate rather than more active restoration being done. In mid-2020, fencing around the wetland was upgraded from a 4-wire electric in poor condition that was ineffective against sheep and lambs to a 7-wire post and batten fence that gave full stock exclusion. Stock exclusion prevents trampling and browsing of indigenous vegetation. Excluding stock from the wetland will also improve water quality within the wetland and therefore the Kaipara Harbour through reduction in nutrient and sediment inputs from stock.

A pest plant survey is proposed to prioritise future pest plant control efforts. Pest animal control (e.g. mustelids, rats) would benefit wetland birds such as matuku/bittern which are known to frequent wetlands at South Head. Revegetation planting around the buffer of the wetland is proposed and will reduce run off from surrounding land entering the wetland. Wetland planting may be also considered to prevent pest plant invasion or to increase species diversity depending on the level of natural regeneration, but this is lower priority. Deer are an issue at this site and this will need to be considered with regards to future planting (e.g. selecting browse tolerant species).

Figure 108: Fenced raupō reedland at the northern end of the wetland, 2021.

4.6

Coastal saline ecosystems

Tāmaki Makaurau / Auckland has an extensive coastline which includes the Waitematā, Manukau, Kaipara, and Mahurangi Harbours as well as numerous estuaries. Coastal saline ecosystems are wetlands located at these coastal interfaces. A range of indigenous species adapted to salt water live in these environments (Figure 4.6). There are four naturally occurring coastal saline ecosystems identified in the region. Refer to Figure 4.7 to determine which coastal saline ecosystem restoration guidelines will apply to your site.

Dynamic coastal conditions can make it difficult to determine the appropriate species mixes for planting at some sites. For most coastal ecosystems, it is therefore recommended that restoration focuses on the management of pressures and monitoring natural regeneration. Tāmaki Makaurau / Auckland's coastal ecosystems are particularly vulnerable to changes in climate and sea level. Advice on buffer widths for coastal saline ecosystems (both planted and natural) is the same as forest ecosystems (the bigger the better) particularly given future effects of climate change.

Figure 4.6: Typical cross-section for indigenous saline ecosystem species

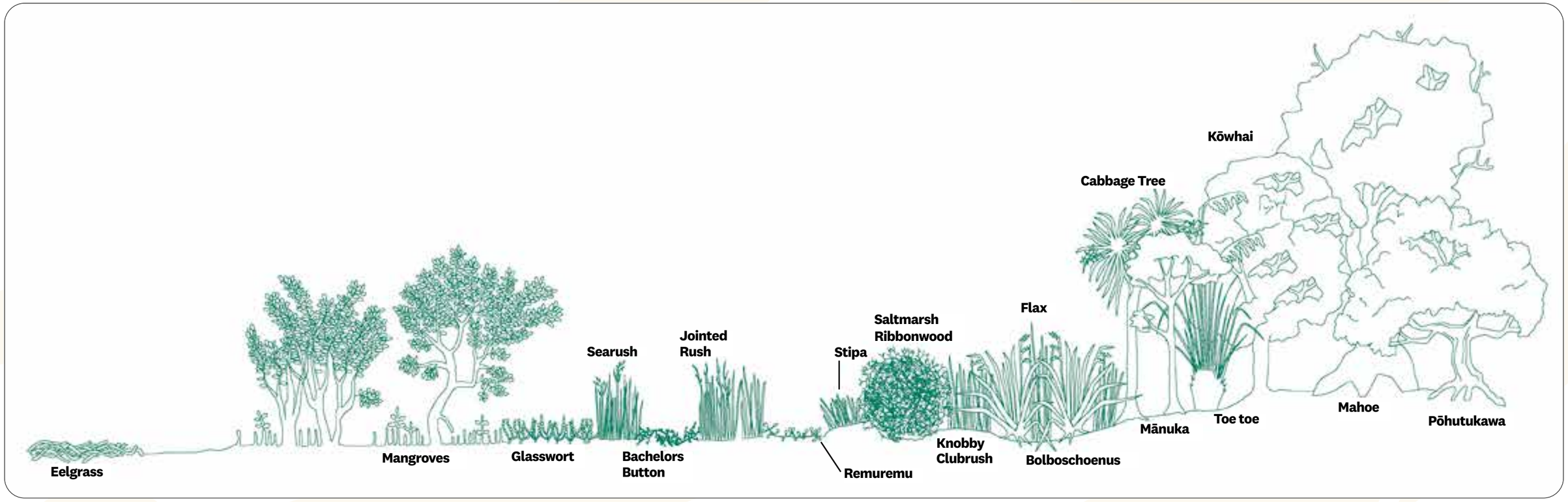


Figure 4.7: Key for the identification of indigenous coastal saline ecosystem types in Tāmaki Makaurau / Auckland

Which saline ecosystem am I trying to restore?

SOILS

LOCATION

ESTUARY

- Intertidal
  - **Ecosystem type:** SA1.1: Sea grass
  - **Ecosystem type:** SA1.2: Mangrove forest and scrub
  - **Ecosystem type:** SA1.3: Sea rush and oioi
  - **Ecosystem type:** SA1.4: Halophytic herbfield — **Other key species:** Glasswort, sea primrose
- Above high tide
  - Volcanic rock/ lava flows; e.g. Rangitoto Island, Anns Creek, Mangere shoreline
    - **Ecosystem type:** SA1.7: Basaltic lava rockland/ coastal needle grass tussockland — **Other key species:** Oioi
  - Sand bars and raised mounds within estuaries
    - **Ecosystem type:** SA1.6: Coastal scrub — **Other key species:** Salt marsh ribbonwood, harakeke,, coastal tree daisy

BEACH (ABOVE HIGH TIDE)

- Gravel/stone; very rare in Auckland e.g. Little Barrier Island, Whakatiwai
  - **Ecosystem type:** SA4: Shore-bindweed, knobby clubrush-gravelfield/stonefield
- Rock/ consolidated sand and gravel on shorelines
  - **Ecosystem type:** SA5: Herbfield (Coastal turf) — **Other key species:** Half star, sea primrose, native spinach
- Shell barrier; e.g. Shoal Bay, Pollen Island
  - **Ecosystem type:** SA1.5: Shell-barrier beaches (Chenier Plains) — **Other key species:** Occasional glasswort, immorality grass

HILL SLOPES AND CLIFFS

- Sea bird burrows and bare ground; rare in mainland Auckland
  - **Ecosystem type:** SA7: Iceplant, glasswort herbfield/ loamfield — **Other key species:** Taupata houpara (petrel scrub)

VEGETATION

Key: Planting is not recommended for this ecosystem type; restoration to focus on pressure management — Plant schedules are provided for this ecosystem type

Note: Vegetation is only diagnostic of areas that retain an indigenous vegetation cover.

4.6.1 SA1: Mangrove forest and scrub

Regional threat status: Least Concern

Mangrove forest and scrub, and other ecosystem variants, are found in frost-free intertidal estuarine environments in Tāmaki Makaurau / Auckland. Variations in vegetation communities are related to location in the intertidal zone, which affects how fast or slow the tide moves, and the proximity and volume of nearby freshwater inputs (i.e. from streams and rivers).

The seven variants are:

- SA1.1: Sea grass on low-lying mud or sand flat with long tidal inundation
- SA1.2: Mangrove forest and scrub in intertidal areas with high levels of silt, usually at the mouths of streams and rivers.
- SA1.3: Sea rush and oioi [saltmarsh] in upper estuarine zone with freshwater influence
- SA1.4: Herbfield [estuarine] in intertidal depressions
- SA1.5: Shell-barrier beaches [Chenier Plains]
- SA1.6: Coastal scrub on low mounds and estuarine margins
- SA1.7: Basaltic lava rockland/coastal needle grass tussockland on saline margins of lava flows.

Figure 109: Mangrove forest and scrub variants at Rangiriri including mangrove forest and scrub (SA1.2), sea rush and oioi (SA1.3) and shell-barrier beach (SA1.5). Credit: Alastair Jamieson

Figure 110: Sea rush and oioi (SA1.3) and herbfield (SA1.4) at Āwhitu Regional Park. Credit: Alastair Jamieson

Figure 111: Mangrove forest and scrub at Tauhoa. Credit Alastair Jamieson

Figure 112: Spartina is a pest plant in estuaries.

Mangrove forest and scrub is at risk from the pressures outlined in Table 4.45.

Table 4.45: Ecosystem pressures and suggested restoration actions for Mangrove forest and scrub [SA1]

Key pressures	Description	Suggested restoration action
Changes in hydrology	Construction of stop banks and flood gates around this ecosystem type will lower the water table and allow for conversion to grazing land.	Restore hydrology to previous drained areas where possible. Seek specialist advice on appropriate actions and any resource consent requirements to restore hydrology.
Sea level rise	Climate change is expected to result in sea level rise, which may inundate this ecosystem type.	Identify sites where managed retreat of the shoreline can allow for inland migration of coastal ecosystem types.
Change in land use	Increases in farming and urban development in surrounding catchment may raise nutrient and sediment levels, encouraging growth of mangroves at the expense of other ecosystem variants. Ecosystem processes can also be disrupted by mangrove clearance.	Exclude stock from waterways draining into estuaries, carry out buffer planting around estuaries where possible to filter nutrients through overland flow. Monitor extent of mangrove scrub and manage land use in the surrounding catchment to reduce sediment inputs if sediment shows to be increasing over time.
Pest animals – herbivores	Rabbits are a key browser of some of the low growing coastal species.	Implement a pest animal control and monitoring programme, targeting predators of rabbits and indigenous species (e.g. rats, mustelids) in addition to rabbits themselves, to ensure there are not flow on effects to indigenous species.
Pest plants	Pest plant species tolerant of saline conditions (e.g. saltwater paspalum, sharp rush and spartina) may invade and affect recruitment of indigenous plant species.	Control pest plants, particularly those invading the margins, to allow restoration of indigenous vegetation.

Buffer planting of this wetland type should include species tolerant of exposure to coastal winds and salt spray. The initial plant schedule for Coastal broadleaved forest (Table 4.3) would be suitable for buffer planting where the adjacent land is at higher elevation. At lower elevations, the plant schedule for Coastal scrub (Table 4.46) can be used. Planting of other variants of this ecosystem type is not considered necessary as they will regenerate naturally following restoration of the right environmental conditions.

Table 4.46: Coastal Scrub [SA1.6] revegetation mix plant schedule for Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	Planting location		% of planting mix	Plant spacing	Planting notes
					Raised mounds	Low-lying flats			
Harakeke/flax	*Phormium tenax*		Herb	3m	✓	✓	15-20%	1-1.4m	
Mānuka[1]	*Leptospermum scoparium*		Tall shrub/tree	5m	✓		15-20%	1-1.4m	
Coastal tree daisy	*Olearia solandri*		Shrub	4m	✓	✓	15-20%	1-1.4m	
Salt marsh ribbonwood	*Plagianthus divaricatus*		Shrub	2m	✓	✓	15-20%	1-1.4m	
Tī kōuka/cabbage tree	*Cordyline australis*		Tall shrub/tree	8m+	✓	✓	10-20%	1-1.4m	Plant higher proportions in moister soils.
Ngaio	*Myoporum laetum*		Tall shrub/tree	6m	✓		5-10%	1-1.4m	Suitable for areas exposed to salt spray. Important to eco-source from natural populations and avoid planting in locations where it may hybridise with Tasmanian ngaio. Toxic to livestock.
Knobby clubrush	*Ficinia nodosa*		Sedge	1m	✓	✓	5-10%	0.5-0.75m	Plant in sandy areas.
Oioi	*Apodasmia similis*		Rush	1.5m		✓	5-10%	0.5-0.75m	Plant at inundated saline margins.
Small-leaved pōhuehue	*Muehlenbeckia complexa*		Vine	5m	✓	✓	5-10%	1m	
–	*Machaerina juncea*		Sedge	1m	✓	✓	5-10%	0.5-0.75m	Plant at inundated saline margins. Difficult to source and establish.
Kōwhai[2]	*Sophora microphylla*		Canopy tree	8m	✓		< 5%	5m	

1 Mānuka should be sourced from a nursery accredited under Plant Pass where possible.

2 The *Sophora* genus has several species in Tāmaki Makaurau / Auckland that vary with location and conditions. Seed should be collected from the nearest available natural source.

Key:
Shade tolerant
Tolerant of wet soils
Plant with shelter from wind
Frost tender
Provides food for birds/bats/lizards
Plant in canopy gaps
Deer browse tolerant
Improves in-stream habitat for fish
Tolerant of salt-spray
Improves bank stability

4.6.2 SA4: Shore-bindweed, knobby clubrush-gravelfield/ stonefield

Regional threat status: Endangered

Shore-bindweed, knobby clubrush-gravelfield/ stonefield is found on gravel and boulder beaches experiencing high exposure to salt spray and tidal movement. Plant species present must be tolerant of dry conditions as the permeable substrate is poor at holding moisture. Examples in Tāmaki Makaurau / Auckland are limited and mainly found on offshore islands (Waiheke Island and Te Hauturu-o-Toi / Little Barrier Island). Some smaller examples occur on the Firth of Thames coastline near Waharau.

Figure 113: Shore-bindweed, knobby clubrush-gravelfield/stonefield at Te Titoki Point on Te Hauturu-o-Toi / Little Barrier Island. Credit: Alastair Jamieson

Shore-bindweed, knobby clubrush-gravelfield/stonefield is at risk from the pressures outlined in Table 4.47.

Table 4.47: Ecosystem pressures and suggested restoration actions for Shore-bindweed, knobby clubrush-gravelfield/stonefield [SA4]

Key pressures	Description	Suggested restoration action
Pest plants	Pest plant species tolerant of exposure to coastal conditions (e.g. gorse, blackberry, nasturtium) can colonise rapidly and modify the indigenous plant community. Some areas of this ecosystem type are vulnerable to invasion by garden escapes (e.g. aloes and other succulents).	Control pest plants to allow restoration of indigenous vegetation. Focus on woody plants and those that will form extensive ground cover. Focus on restoring or maintaining indigenous ground cover to reduce potential for further pest plant invasion.
Pest animals – predators	Predators such as rats and mustelids may impact bird and lizard communities within this ecosystem type.	Implement a pest animal control and monitoring programme, including control of pest animals that may be negatively impacting flora and fauna populations.
Stock grazing	Stock graze and trample vegetation, affecting regeneration and persistence of indigenous species.	Exclude stock by fencing coastal area. Fence should be appropriately setback to provide a buffer. Buffer planting may be necessary if there is a lack of existing indigenous vegetation and ongoing pest plant invasion is likely to be an issue.
Access to vehicles	Vehicles driving along beach may trample indigenous vegetation within this ecosystem type.	Fence or demarcate edge of areas on beach that vehicles can access without causing damage.

Management of the ecosystem type should focus on addressing pressures to allow for natural regeneration to occur. If buffer planting is carried out in line with recommendations of Table 4.47, species tolerant of exposure to coastal winds and salt spray should be used. The initial plant schedule for Coastal broadleaved forest (Table 4.3) would be suitable for buffer planting where the adjacent land is at higher elevation. At lower elevations, the plant schedule for Coastal scrub (Table 4.46) can be used.

4.6.3 SA5: Herbfield [coastal turf]

Regional threat status: Critically Endangered

Herbfield [coastal turf] coastal ecosystems are present on rocky outcrops and consolidated sand and gravel subject to high winds and salt spray. These areas are expected to have been used frequently in the past by sea birds, and as haul outs for New Zealand fur seals. The extent of coastal herbfield is limited in Tāmaki Makaurau / Auckland, but it is found on the west coast of the Waitakere Ranges and on the northeast coast of Aotea / Great Barrier Island.

Herbfield [coastal turf] is at risk from the pressures outlined in Table 4.48.

Table 4.48: Ecosystem pressures and suggested restoration actions for Herbfield [coastal turf] [SA5]

Key pressures	Description	Suggested restoration action
Sea level rise	Climate change is expected to result in sea level rise, which may inundate this ecosystem type.	Identify sites where managed retreat of the shoreline can allow for inland migration of coastal ecosystem types.
Exotic plant invasion (including pest plants and other exotic species)	Salt-tolerant exotic plant species, such as plantain, saltwater paspalum, and lotus, may invade the herbfield and smother indigenous herbs.	Control exotic species to allow retention and regeneration of indigenous vegetation communities.
Stock grazing	Stock graze and trample herb species within herbfield, affecting regeneration.	Exclude stock by fencing ecosystem fragment. Fence should be appropriately setback from the herbfield edge to provide a buffer. Buffer planting may be necessary if there is a lack of existing indigenous vegetation and ongoing pest plant invasion is likely to be an issue.

Management of this ecosystem type should focus on addressing pressures to allow for natural regeneration to occur. If buffer planting is carried out in line with recommendations of Table 4.48, species tolerant of exposure to coastal winds and salt spray should be used. The initial plant schedule for Coastal broadleaved forest (Table 4.3) would be suitable for buffer planting where the adjacent land is at higher elevation. At lower elevations, the plant schedule for Coastal scrub (Table 4.46) can be used.

Figure 114: Coastal turf north of Anawhata.

4.6.4 SA7: Iceplant, glasswort herbfield/loamfield

Regional threat status: Critically Endangered

Iceplant, glasswort herbfield/loamfield is found on coastal hills/slopes and cliffs where seabirds nest in burrows. The vegetation community is frequently disturbed by bird activity and comprises a mosaic of lower growing herbfield and coastal scrub, known as petrel scrub. As pest animals have significantly reduced the presence of burrowing seabirds on mainland Tāmaki Makaurau / Auckland, this ecosystem type is primarily restricted to predator-free offshore islands.

Figure 115: Iceplant, glasswort, herbfield/loamfield on Mahuki Island. Credit: Alastair Jamieson

Iceplant, glasswort herbfield/loamfield is at risk from the pressures outlined in Table 4.49.

Table 4.49: Ecosystem pressures and suggested restoration actions for Iceplant, glasswort herbfield/loamfield [SA7]

Key pressures	Description	Suggested restoration action
Exotic plant invasion	Salt-tolerant exotic plant species, such as plantain and exotic iceplant, may invade the ecosystem and smother indigenous herbs.	Control exotic species to allow retention and regeneration of indigenous vegetation communities.
Pest animals – predators	Predators such as rats, mustelids, and cats reduce populations of burrowing seabirds, removing the species needed to retain this ecosystem type.	Implement pest animal control and monitoring in all remaining areas.

4.7

Dune ecosystems

Dune ecosystems are frequently found on Tāmaki Makaurau / Auckland's beaches. They are present immediately landward of the beach and may include plains, slopes, hollows and slacks. They support a variety of indigenous species, including threatened flora and fauna species. Maintenance of vegetation cover is important for stabilising dune ecosystems. There are two naturally occurring dune ecosystem types identified in the region. Refer to Figure 4.8 to determine which dune ecosystem restoration guidelines will apply to your site, and Figure 4.9 for a cross-section guide for dune plant communities.

Dune ecosystems are at high risk from urban development due to their location near beaches. Since the mid-1900s, 85 per cent of Tāmaki Makaurau / Auckland's dunelands have been lost to urban development. Further pressures on these ecosystems include pine plantations and invasion of exotic dune plants such as marram grass. Restoration can include both pressure management and supplementary planting within degraded dunes to reinstate indigenous vegetation cover and species that have been lost.

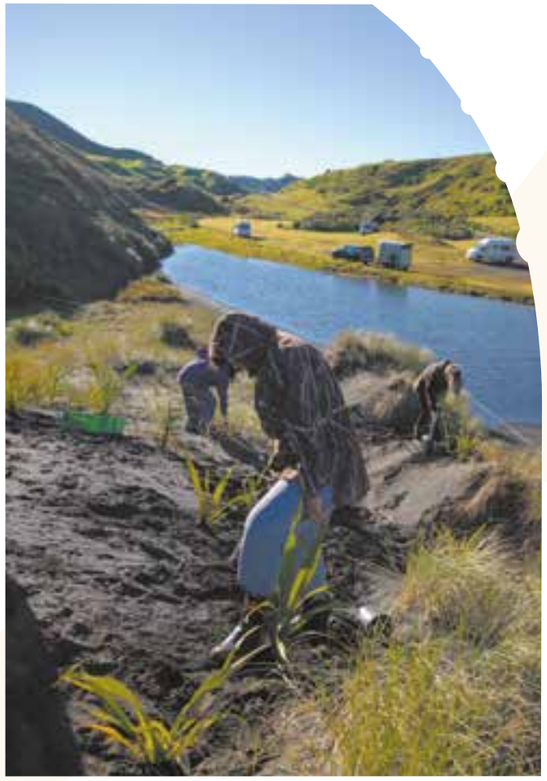


Figure 117: Dune planting at Waimatuku. Credit: Alisa Carroll

Figure 116: Tātahi skinks inhabit dune ecosystems. Credit: Dylan van Winkel

Figure 4.8: Key for the identification of indigenous dune ecosystem types in Tāmaki Makaurau / Auckland

Which dune ecosystem am I trying to restore?

LOCATION

Active dunes subject to frequent disturbance and ovement

Stablised dune plains and hollows with areas of seasonal wetland

VEGETATION

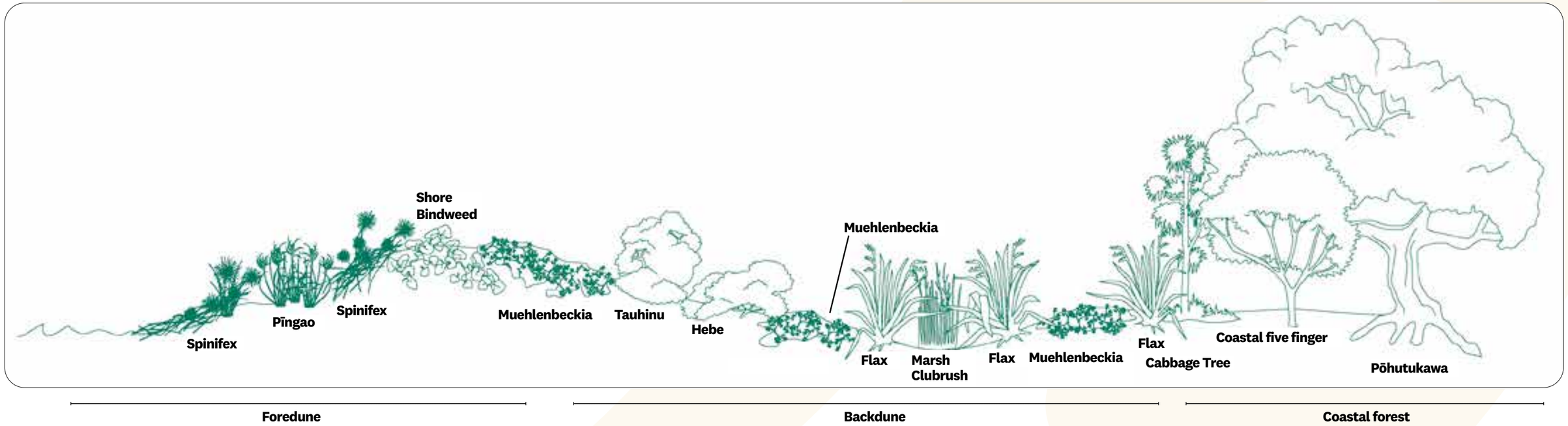
Ecosystem type	Other key species
DN2: Spinifex, pīngao grassland/ sedgelandd	Shore bindweed, sand tussock

Ecosystem type	Other key species
DN5: Oioi, knobby clubrush sedgeland	Harakeke, toetoe, sand sedge

Note: Vegetation is only diagnostic of areas that retain an indigenous vegetation cover.

Key: Plant schedules are provided for this ecosystem type

Figure 4.9: Typical cross-section for indigenous dune ecosystems in Tāmaki Makaurau / Auckland where Spinifex, pīngao grassland/sedgeland grades into pōhutukawa, pūriri, broadleaved forest (WF4).



4.7.1 DN2: Spinifex, pīngao grassland/sedgeland

Regional threat status: Endangered

Spinifex, pīngao grassland/sedgeland is found on active sand dunes subject to frequent disturbance and movement. Other environmental conditions include periodic drought and high temperatures, and exposure to salt spray and high winds. As the dunes become more stabilised, the vegetation community shifts towards woody species behind the foredune. This dune ecosystem type is found throughout Tāmaki Makaurau / Auckland on both the west and east coasts, and on offshore islands.

Figure 118: Spinifex, pīngao grassland/sedgeland on Manukapua Island.

Figure 119: Sand coprosma grows in spinifex, pīngao grassland/sedgeland.

Spinifex, pīngao grassland/sedgeland is at risk from the pressures outlined in Table 4.50.

Table 4.50: Ecosystem pressures and suggested restoration actions for Spinifex, pīngao grassland/sedgeland [DN2]

Key pressures	Description	Suggested restoration action
Pest animals – herbivores	Browse by rabbits and hares may affect regeneration of indigenous plants e.g. pīngao. Possums also browse pīngao.	Implement a pest animal control and monitoring programme, including control of all pest animals that may be negatively impacting flora and fauna populations.
Pest animals – predators	Predators such as rats and mustelids will reduce presence of fauna such as shore skink in this ecosystem. Cats are a significant predator in shorebird habitat.	
Pest plants and pine plantation	Pest plant species may invade dunes and affect regeneration of indigenous plant species. Marram grass is the largest problem in this ecosystem, although other common weeds include pampas, tree lupin, gorse, exotic iceplant and boxthorn. Pine is regularly planted in dune ecosystems.	Control pest plants and fell pines to allow restoration of indigenous vegetation. Active planting of indigenous species may be required if there is a lack of nearby seed sources or to create a dense vegetation cover to prevent pest plant invasion.
Stock grazing	Stock graze and trample grass and sedge species on dunes, reducing indigenous vegetation cover and dune stability.	Exclude stock by fencing landward of dunes.
Urban development	Housing developments have historically occurred in this ecosystem type and may continue to be carried out in close proximity. This disturbs indigenous species and introduces additional risks from dogs and vehicles.	Fence or demarcate sensitive dune areas to prevent public access.
Access to vehicles	Vehicles driving on dunes will trample indigenous vegetation within this ecosystem type.	Fence or demarcate edge of areas on beach that vehicles can access without causing damage.
Sea level rise	Climate change is expected to result in sea level rise, which may inundate this ecosystem type.	Identify sites where managed retreat of the shoreline can allow for inland migration of coastal ecosystem types.

If management of pressures alone will not allow for regeneration of key ecosystem components, revegetation planting could be carried out to assist with the restoration of former areas of spinifex, pīngao grassland/sedgeland (Table 4.51).

Figure 120: Vehicle access, pines, and other pest plants such as pampas and lupin are pressures in spinifex, pīngao grassland/sedgeland at Muriwai Beach.

Figure 121: Dune planting at Waimatuku. Credit: Ailsa Carroll

Table 4.51: Spinifex, pīngao grassland/sedgeland [DN2] revegetation mix for Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Growth form	Height after 30 years	% of planting mix		Plant spacing	Planting notes
				Foredune (active)	Back dune		
Kōwhangatara/spinifex	*Spinifex sericeus*	Grass	0.3m	40-60%	–	0.5-0.75m	Bury at least half of leaves below sand surface.
Pīngao/golden sand spiralis	*Ficinia spiralis*	Sedge	0.4m	40-60%	–	0.5-0.75m	Bury at least half of leaves below sand surface.
Small-leaved pōhuehue	*Muehlenbeckia complexa*	Vine	5m	10-20%	10-20%	1m	Plant on interface of active and stabilised dunes.
Rauparaha/shore bindweed	*Calystegia soldanella*	Vine	0.1m	<10%	<10%	0.5-0.75m	
Sand coprosma	*Coprosma acerosa*	Shrub	0.4m	<10%	<10%	0.5-0.75m	Threatened species – seek advice from the council.
Harakeke/flax	*Phormium tenax*	Herb	3m	–	10-20%	1m	Plant in damp dune hollows.
Kānuka, rawiritoa[1, 2]	*Kunzea linearis; K. amathicola*	Tall shrub/tree	8m	–	10-20%		Can also tolerate mobile sands further inland than the seaward face. *Kunzea* species appropriate for the site will depend on the location. May be difficult to source.
Oioi	*Apodasmia similis*	Rush	1.5m	–	10-20%	0.75-1m	Plant on low-lying ground close to salt marsh estuary.
Toetoe	*Austroderia splendens*	Grass	2.5m	–	10-20%	1m	Tolerates drought.
Tauhinu	*Ozothamnus leptophyllus*	Shrub	5m	–	5-10%	1-1.4m	Will tolerate dry conditions and wind, more suitable for West Coast sites.
Akeake	*Dodonaea viscosa*	Tall shrub/tree	–	<5%		1-1.4m	Dry sites only.
Giant umbrella sedge	*Cyperus ustulatus*	Sedge	1.5m	–	<5%	0.75-1m	Plant in damp dune hollows.
Karo	*Pittosporum crassifolium*	Tall shrub/tree	6m	–	<5%	1-1.4m	Tolerates strong winds.
Speckled sedge	*Carex testacea*	Sedge	0.4m	–	<5%	0.5-0.75m	Plant in back dune.
Tī kōuka/cabbage tree	*Cordyline australis*	Tall shrub/tree	8m+	–	<5%	1-1.4m	Plant in damp dune hollows.

1 The *Kunzea* genus has several species in Tāmaki Makaurau / Auckland. Look in the local area to see which species is suitable for your site and eco-source from the nearest natural populations. Talk to an ecologist if you are having trouble deciding which *Kunzea* to plant at your site.

2 Kānuka should be sourced from a nursery accredited under Plant Pass where possible.

4.7.2 DN5: Oioi, knobby clubrush sedgeland

Regional threat status: Critically Endangered

Oioi, knobby clubrush sedgeland forms on flat sandy areas (dune plains) near the coast. This ecosystem is found in close association with active dunes and may include areas of seasonal wetland in locations where dunes have moved. As the dunes become more stabilised, the vegetation community shifts towards moisture tolerant woody species and flaxland. This dune ecosystem type is found along the west coast of Waitākere from Whatipū up to South Head, and large areas have historically been converted to pine plantation.

Oioi, knobby clubrush sedgeland is at risk from the pressures outlined in Table 4.52.

Table 4.52: Ecosystem pressures and suggested restoration actions for Oioi, knobby clubrush sedgeland [DN5]

Key pressures	Description	Suggested restoration action
Pest animals – herbivores	Browse by rabbits or hares may affect regeneration of indigenous plants.	Implement a pest animal control and monitoring programme, including control of all pest animals that may be negatively impacting flora and fauna populations.
Pest animals – predators	Predators such as rats, mustelids, and hedgehogs will reduce presence of fauna species such as shore skink in this ecosystem. Cats are a significant predator in shorebird habitat.	
Pest plants	Pest plant species may invade dunes and affect regeneration of indigenous plant species. Pampas is a large problem in this ecosystem type. Moisture tolerant grasses (e.g. Yorkshire fog) may also invade.	Control pest plants to allow restoration of indigenous vegetation. Focus on restoring or maintaining a dense vegetation cover to reduce potential for further pest plant invasion. Depending on dune location, active planting of indigenous species may assist with restoration. Vegetation cover can be monitored with photo points.
Stock grazing	Stock graze and trample grass and sedge species on dunes, reducing indigenous vegetation cover and dune stability.	Exclude stock by fencing landward of dunes.
Change in land use	Large areas of this ecosystem type have historically been converted to forestry and agriculture.	Where soil conditions have not been significantly altered, it may be possible to restore areas through planting on a small scale.
Access to vehicles	Vehicles driving along beach will trample indigenous vegetation within this ecosystem type.	Fence or demarcate edge of areas on beach that vehicles can access without causing damage.
Sea level rise	Climate change is expected to result in sea level rise, which may inundate this ecosystem type.	Identify sites where managed retreat of the shoreline can allow for inland migration of coastal ecosystem types.

If management of pressures alone will not allow for regeneration of key ecosystem components, revegetation planting could be carried out to assist with the restoration of former areas of oioi, knobby clubrush sedgeland (Table 4.53).

Figure 122: Whatipū dune ecosystems from DN2 to DN5. Credit: Tim Lovegrove

Table 4.53: Oioi, knobby clubrush sedgeland [DN5] revegetation mix for Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Growth form	Height after 30 years	% of planting mix		Plant spacing	Planting notes
				Foredune (active)	Back dune		
Knobby clubrush	*Ficinia nodosa*	Sedge	1m	30-40%	40-60%	0.75-1m	Suitable for dune plains and hollows.
Oioi	*Apodasmia similis*	Rush	1.5m	30-40%	40-60%	0.75-1m	
Toetoe	*Austroderia splendens*	Grass	2.5m	10-20%	10-20%	1m	Tolerates drought.
Harakeke/flax	*Phormium tenax*	Herb	3m	10-20%	–	1m	Plant in damp dune hollows.
Sand sedge	*Carex pumila*	Sedge	0.3m	< 10%	10-20%	0.5-0.75m	
Giant umbrella sedge	*Cyperus ustulatus*	Sedge	1.5m	< 5%	–	0.75-1m	Plant in damp dune hollows.
Mānuka	*Leptospermum scoparium*	Tall shrub/tree	5m	< 5%	–	1-1.4m	Prone to establishment failure during drought. Plant in damp areas.
Tī kōuka/cabbage tree	*Cordyline australis*	Tall shrub/tree	8m+	< 5%	–	1-1.4m	Plant in damp dune hollows.
Akeake	*Dodonaea viscosa*	Tall shrub/tree	7m	–	< 5%	1-1.4m	Dry sites only.
Kānuka, rawiritoa[1,2]	*Kunzea linearis; K. amathicola*	Tall shrub/tree	8m	–	< 5%	1-1.4m	Can also tolerate mobile sands further inland than the seaward face. *Kunzea* species appropriate for the site will depend on the location. May be difficult to source.
Ngaio	*Myoporum laetum*	Tall shrub/tree	6m	–	< 5%	1-1.4m	Suitable for areas exposed to salt spray. Important to eco-source from natural populations and avoid planting in locations where it may hybridise with Tasmanian ngaio. Toxic to livestock.

1 The *Kunzea* genus has several species in Tāmaki Makaurau / Auckland. Look in the local area to see which species is suitable for your site and eco-source from the nearest natural populations. Talk to an ecologist if you are having trouble deciding which *Kunzea* to plant at your site.

2 Kānuka should be sourced from a nursery accredited under Plant Pass where possible.

4.8

Geothermal ecosystems

4.8.1 GT2: Geothermally heated water and steam

Regional threat status: Data Deficient

Geothermal ecosystem types are nationally rare and are found where heat generated from the earth's interior rises to the surface. Tāmaki Makaurau / Auckland originally had three areas of geothermal ecosystems, located at Parakai, Waiwera, and on Aotea / Great Barrier Island. The former two areas have been lost due to development. The last remaining area is found on land administered by the Department of Conservation at Kaitoke Hot Springs on Aotea / Great Barrier Island. Due to extreme pH levels and temperatures, very few flora and macrofauna species can survive in these conditions. Biodiversity, therefore, mainly comprises micro-organisms, as well as algae, fungi, bryophytes, and invertebrates. Geothermally heated water and steam is at high risk from changes in land use such as farming, forestry, mining, and urbanisation.

4.9

Cave ecosystems

4.9.1 CV1: Subterranean rockland/stonefield

Regional threat status: Data Deficient

There is one cave ecosystem type described in Aotearoa / New Zealand, which can develop in both limestone karst and areas of volcanic rock. In Tāmaki Makaurau / Auckland, subterranean rockland/stonefield is associated with lava flows in volcanic areas such as Maungakiekie / One Tree Hill, Te Tātua-a-Riukiuta / Three Kings, and Rangitoto. As the region's volcanic areas are relatively young, there has been limited development in biodiversity of these ecosystems. Further research and ongoing protection of subterranean rockland/stonefield in Tāmaki Makaurau / Auckland is encouraged.

Figure 123: Sub-terranean rockland/stonefield. Credit: Alastair Jamieson

Subterranean rockland/stonefield is at risk from the pressures outlined in Table 4.54.

Table 4.54: Ecosystem pressures and suggested restoration actions for Subterranean rockland/stonefield [CV1]

Key pressures	Description	Suggested restoration action
Change in land use	Clearance of vegetation surrounding cave ecosystems, either for farming or urban development, can increase erosion rates and affect levels of sediment and water in the cave. Many lava caves have been filled in, used for rubbish or stormwater disposal, or had their entrances covered.	Retain and protect caves and cave entrances, including adjacent vegetation cover. Any development works should be halted if caves are discovered (see Appendix 2).
Pest animals – predators	Predators such as rats and mice may feed on invertebrates residing within the cave and change the ecosystem composition.	Implement a pest animal control and monitoring programme within and around the cave ecosystem.

4.10

Anthropogenic ecosystems

4.10.1 AVS1: Anthropogenic tōtara forest

Anthropogenic tōtara forest is tōtara-dominant forest that has formed because of human activity, primarily farming, in areas such as Rodney and Manukau.

Following vegetation clearance in areas where grazing has been less intensive, tōtara has been the main species to regenerate, as it is resistant to browsing animals and is suited to high light environments. Stands of gorse can also facilitate the establishment of tōtara forest by impeding stock access.

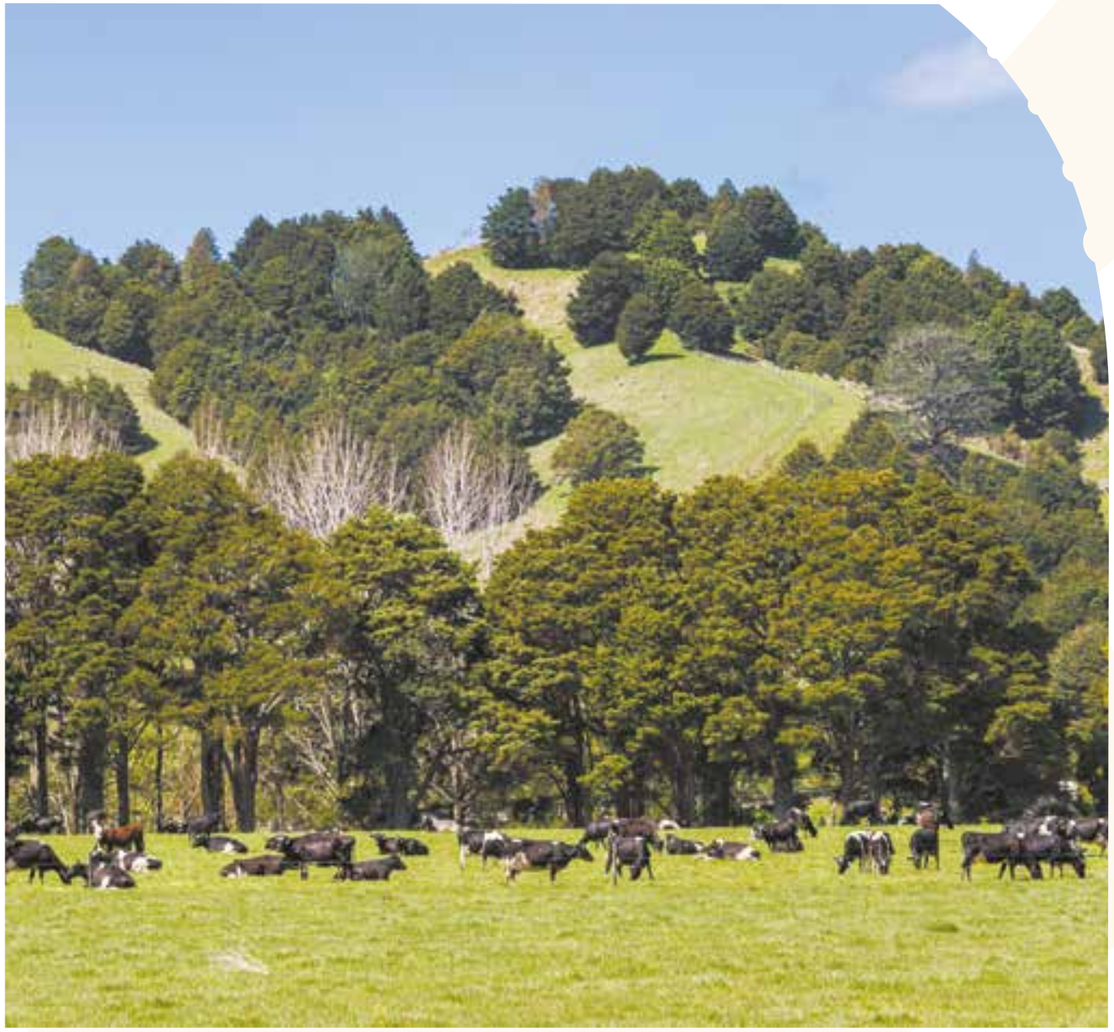


Figure 124: Anthropogenic tōtara forest. Credit: Jason Hosking

Anthropogenic tōtara forest is at risk from the pressures outlined in Table 4.55.

Table 4.55: Ecosystem pressures and suggested restoration actions for Anthropogenic tōtara forest [AVS1]

Key pressures	Description	Suggested restoration action
Pest plants	Pest plant species impact indigenous regeneration, especially in areas where species such as woolly nightshade have regenerated in association with tōtara.	Control pest plants to allow restoration of indigenous vegetation. Focus on internal forest areas; gorse can be left as a nurse crop species to provide a buffer on forest margins. Restore or maintain high canopy cover to reduce potential for pest plant invasion. Monitor growth of naturally regenerating indigenous species to ensure species richness is increasing. If not, enrichment planting can be carried out*.
Stock grazing	Stock graze understorey and edges of forest, preventing regeneration of a wider variety of forest species.	Exclude stock by fencing forest fragment. Enrichment planting can be carried out in areas where the understorey vegetation has been heavily degraded and is unlikely to regenerate without assistance (e.g. due to no nearby seed sources)*.
Land conversion to exotic forestry	As this forest type is often located on steep slopes less suitable for stock grazing, land may be cleared to plant exotic forest which is more economical.	Protect good quality examples of this forest type to prevent clearance.

*Refer to the enrichment plant schedule for the potential forest ecosystem type.

5. Riparian restoration guidelines

Photo: *Machaerina* sedgeland at Whatipū.
Credit: Alastair Jamieson

5.1

Introduction to riparian restoration

5.1.1 What is a riparian zone?

The riparian zone is the interface between land and water, along both sides of streams and rivers and extends from the edge of the watercourse to the upper flood extent. Riparian vegetation provides benefits to both aquatic and terrestrial environments, including:

- Providing ecological corridors of habitat for terrestrial-based indigenous fauna such as birds, bats, and lizards.
- Reducing water temperatures within stream by shading. This optimises habitat for indigenous fish and aquatic invertebrates.
- Improving instream habitat through the provision of woody debris, snags, leaf litter and roots. These habitat features provide both food and refuge for freshwater fish and invertebrates.
- Improving water quality of streams by filtering nutrients and contaminants out of overland flow before it enters the streams.
- Reducing stream bank erosion and maintaining stream channel shape.
- Increasing resilience to flooding and climate change/anthropogenic induced erratic stream flow regimes.

5.1.2 Riparian restoration for multiple purposes

As this resource focuses on terrestrial ecosystems, the riparian restoration advice relates to improving terrestrial biodiversity rather than water quality. However, restoration for biodiversity purposes will also likely benefit water quality and aquatic biodiversity. Additional ecological outcomes that could be incorporated into a restoration project include:

- To improve instream habitat for aquatic fauna:
  - Plant canopy trees species on slopes to shade the stream and provide organic matter inputs.
  - Create refuges for indigenous fish by planting tree and tree fern species with strong root characteristics close to the channel edge on gentle sloped banks (avoid if there is already active erosion occurring).
  - If īnanga habitat is present, plant sedges on the stream edge to provide spawning habitat.
  - Assess whether there are any barriers to fish passage (fishpassage.niwa.co.nz). Contact the council for advice tiakitamakimakaurau.nz/contact-us
- To reduce stream bank erosion:
  - Plant herbaceous species, including indigenous sedges, on stream edges. These species blanket the stream edge and lie down flat with the flow of the water, protecting the stream bank from potential erosion.
  - On slopes, plant species with known bank stabilising qualities i.e. plants whose roots help bind the soil. Ensure you are not planting species that grow to a heavy mass (e.g. Harakeke/flax) on the edge of the streambank to reduce the risk of bank failures.
- To reduce nutrient inputs from the surrounding catchment:
  - Fence (and plant if required) seeps, springs, and wet hollows into your riparian restoration area.
  - Include a filter strip of indigenous sedge species tolerant of wet soils in locations where surface flows join and enter the stream.

Figure 125: Kahikatea roots on the edge of the stream stabilising the stream bank and providing refuges for native fish.

Figure 126: Īnanga. Credit: Jay Farnworth

Instream habitat restoration for fauna

Banded kōkopu are one of the most common indigenous fish species in small coastal streams across Tāmaki Makaurau / Auckland. Planting alongside streams helps shade the small forest pools they most favour. Not only does warm water hold less dissolved oxygen, it also gives up its dissolved oxygen less easily making it harder for fish to extract. Stream shade can mean the difference between life and death for banded kōkopu over long, dry summers.

However, pools are of little value to banded kōkopu and other indigenous fish species without structure and cover. Undercuts formed by wood and tree roots protruding out into the channel provide fish with daytime cover and shelter in floods. Large, submerged wood complexes also influence channel form and help maintain the depth profile of small pools by facilitating localised streambed scour.

Without wood, small, soft-bottomed streams in Tāmaki Makaurau / Auckland would be dominated entirely by run habitat of uniform depth.

Pool depth becomes ever more important in streams up-catchment because, when intermittent stream sections stop flowing, kōkopu rely on water lingering in isolated pools to get them through the driest months. At such times, a small pool's dissolved oxygen reserves will quickly become depleted if there is no overhead riparian cover and the pool is exposed to the sun.

Conversely, īnanga, another of Tāmaki Makaurau / Auckland's whitebait species, prefer habitat dominated by streams with average water speed (no white water) and uniform depth. These habitats are found in the lowland sections of coastal streams. Where banded kōkopu prefer deep shade provided by a tree canopy, they prefer trailing edge cover provided by indigenous sedges (*Carex* spp.) and toetoe (*Austroderia fulvida*) and which may not necessarily reach all the way across the channel.

5.1.3 How wide should a riparian restoration area be?

A general rule of thumb for riparian restoration is 'the wider the better'. Prior to human disturbance, the riparian zone would have transitioned into other terrestrial ecosystem types.

To provide effective biodiversity habitat for terrestrial flora and fauna species, a width of at least 20m either side of a waterway is recommended to reduce pest plant invasion and ongoing pressures from the surrounding land uses. For a self-sustaining riparian buffer with virtually no maintenance, Aotearoa / New Zealand research (e.g. Fenemor and Samarasinghe 2020; Parkyn et al., 2000) recommends a minimum buffer width of 15-20m on both sides of the stream. This helps maintain internal humidity and shade at a level necessary to prevent pest plant species encroaching from the riparian edge. Opting for a buffer substantially narrower than that will limit natural regeneration of indigenous species and on-going maintenance will be required to keep the buffer free of pest plants.

5.1.4 What else should you consider before restoring riparian zones?

Detailed guidance of what to consider before carrying out a restoration project is provided in Section 3. Additional considerations for riparian restoration projects may include:

- Hydrological considerations: How often will the riparian zones be flooded, and for how long? How wet is the soil usually?
- Geomorphology: What is the shape of the streambank? Is the gradient a suitable slope to allow plants to establish or is it too steep/unsuitable and requires further assessment of erosion mitigation options
- Hydraulic conditions: Is the stream in an urban or rural area? Is the stream downstream of a channelised waterway or structure (culvert)? Are there impervious surfaces in the catchment (surfaces that do not allow water to drain, e.g. concrete)? These factors will impact how fast the water will flow in a high rainfall events.
- Drainage: Has the watercourse been created artificially as a drain for the surrounding land (e.g. dries out the land to make it suitable for use) and will it need ongoing access (e.g. for desilting)?
- Urban development: How close are the adjacent buildings or structures (e.g., retaining walls), and how will this affect what can be planted?
- Infrastructure: This can limit the space available for riparian restoration to establish – also take care when selecting what to plant as some plant roots can damage these structures/devices over time (e.g. culverts, pipes, outfalls, erosion protection) or block access for maintenance.
- Instream fauna: What fish or invertebrates may be living in the stream, and what can be planted to improve habitat for these species (Section 5.1.3)?
- Whether there are any resource consent requirements.

5.2 Riparian pressures and restoration actions

Riparian areas may occur across different terrestrial and wetland ecosystem types and the general pressures for riparian areas are similar (Section 3.4). The most important/relevant pressures for riparian restoration areas are outlined in Table 9.1.

Table 9.1: Ecosystem pressures and suggested restoration actions for riparian restoration areas

Key pressures	Description	Suggested restoration action
Pest plants	Pest plant species tolerant of high soil moisture, such as grey willow and pampas, readily invade riparian zones and affect recruitment of indigenous plant species. In many cases, willow and poplar have been actively planted for erosion control. Likewise, shade-tolerant pest plant species such as tradescantia can significantly impact natural succession by creating expansive, impenetrable mats that carpet the forest floor.	Control pest plants to allow restoration of indigenous vegetation. If using herbicides for pest plant control, these need to be specially formulated for use over or nearby water. Maintain a high canopy cover to reduce potential for pest plant invasion. Pest plant control could be carried out in stages to retain shading and erosion control for the stream while regenerating or planted indigenous vegetation establishes. Some shade-tolerant pest plants spread vegetatively and will be impossible to eradicate if they are present upstream (e.g. tradescantia, montbretia and plectranthus). However, maintaining these pest plants at low levels is often enough to give indigenous plants a competitive edge. See further details on pest plant control in Appendix 4.
Stock grazing	Stock graze and trample riparian zones causing bank slumping and stream sedimentation. This prevents regeneration of indigenous vegetation cover and results in further degradation of stream quality.	Exclude stock by fencing streams. Fence should be sufficiently set back from the stream edge to protect existing riparian vegetation or to allow assisted natural regeneration to occur or buffer planting to be done if required.

Key pressures	Description	Suggested restoration action
Urban development	Residential intensification in urban environments can result in vegetation clearance and fragmentation of riparian zones. This can also create additional pressures such as dumping of rubbish and garden waste and increased pest plant seed sources from gardens. Dumping is often worse in in residential settings where solid boundary fences are built next to streams because of the visual separation it creates (out of sight, out of mind). Urban development can also alter the hydrology of streams through an increase in impervious surfaces and vegetation clearance in the catchment. The stream itself may also be modified to allow dwellings to be built as close to the waterway as possible (e.g. channelled with retaining walls).	Minimise clearance and maintain riparian setbacks for development. Carry out riparian planting post-development where appropriate. Manage potential increases in pest plants invading retained vegetation. Resist fencing streams out of your property and adopt stream corridors as a feature and natural extension to your property. Encourage neighbours to do the same. See-through fences (such as those used next to swimming pools) are an option where safety and security is a priority.
Pest animals – herbivores	Possum browse may affect canopy health where broadleaved trees are common. Seed predation by rats and browse of seedlings by goats and deer may affect plant species recruitment.	Manage animal pests. In situations where pest animal density is high, a site-specific pest control and monitoring plan should be implemented.
Pest animals – predators	Rats, mustelids and possums predate birds. Loss of frugivorous birds may indirectly affect recruitment of fleshy fruited plant species. Rats and cats may predate on pepeketua/ Hochstetter's frog and native fish. Rats may predate kākahi.	
Pest animals – trampling/rooting	Large pest animals e.g. deer, goats and pigs, trample vegetation preventing regeneration of seedlings and erode stream banks.	

Figure 127: Stream lacking riparian vegetation that has been pugged by cattle.

Figure 128: Tōtara hedged by possum browse. Credit: Tim Lovegrove

Figure 129: Riparian planting around stream infested with reed sweet grass.

5.3

Riparian planting

Riparian planting will often be carried out in areas with no existing cover of indigenous trees or shrubs. In other cases, planting will be carried out in stages as pest plants are removed, or to supplement existing indigenous vegetation. A site-specific assessment of environmental conditions in the riparian zones around your stream should be carried out prior to preparing the planting plan. The plant schedule provided below (Table 9.2) is most suitable for open environments (i.e. initial planting; see Appendix 6), however plants suitable for shade (i.e. enrichment planting) are indicated by the planting key. If enrichment planting is carried out on well-drained slopes outside the flood zone (i.e. adjacent to the riparian zone), we recommend working out the potential forest ecosystem type for the site (see Figure 4.1) and using the corresponding enrichment planting schedule.

This plant schedule identifies species suitable for the four planting environments which may be present within the riparian zone, although not all may be present at every site (Figure 9.1).

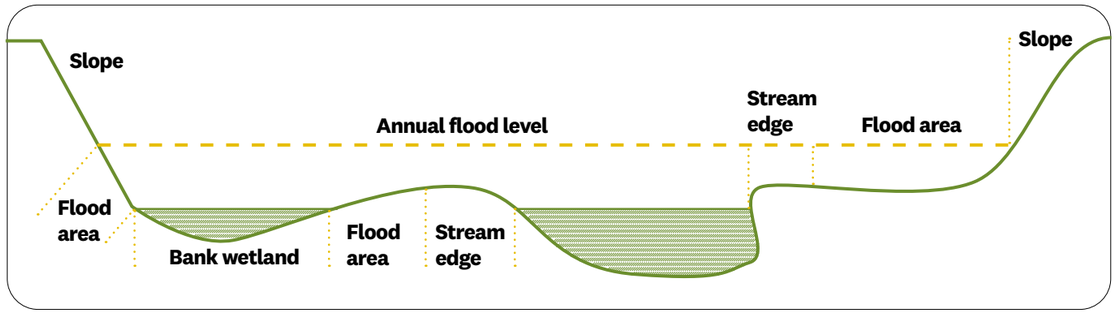
- The **stream edge** planting unit is on the edges of stream channels. This planting unit is subject to frequent erosion when stream water levels are high. Species planted here should be able to 'lie down' when flood waters rush over them.
- The **flood area** planting unit becomes wet and boggy over winter but is dry over summer. Plants in this zone need to be able to cope with fluctuating soil moisture and high flood events.
- The **back wetland** is the area where streams have changed course or where springs emerge. The plants within these areas will be in the floodplain and need to be able to tolerate permanently wet conditions.
- The **slopes** are the well-drained areas of the outer riparian zones.

Plant maintenance for riparian planting will be similar to terrestrial and wetland ecosystems covered in this resource (refer to Section 3.6.6.). Narrow riparian zones are likely to be subject to higher rates of pest plant invasion and will require regular visits to monitor and control pest plants.

Figure 130: Riparian planting in Puhinui Reserve.

Figure 131: Harakeke attracts tūī to riparian areas facilitating seed dispersal.

Figure 9.1: Planting environments potentially present within riparian zone restoration sites.



The riparian planting guidelines can also be used for buffer planting around WL11, WL15 and WL19 wetlands as well as lakes through selection of species based on soil moisture.

Figure 9.2: Typical cross-section for riparian areas (or wetland/lake buffers) in Tāmaki Makaurau / Auckland.

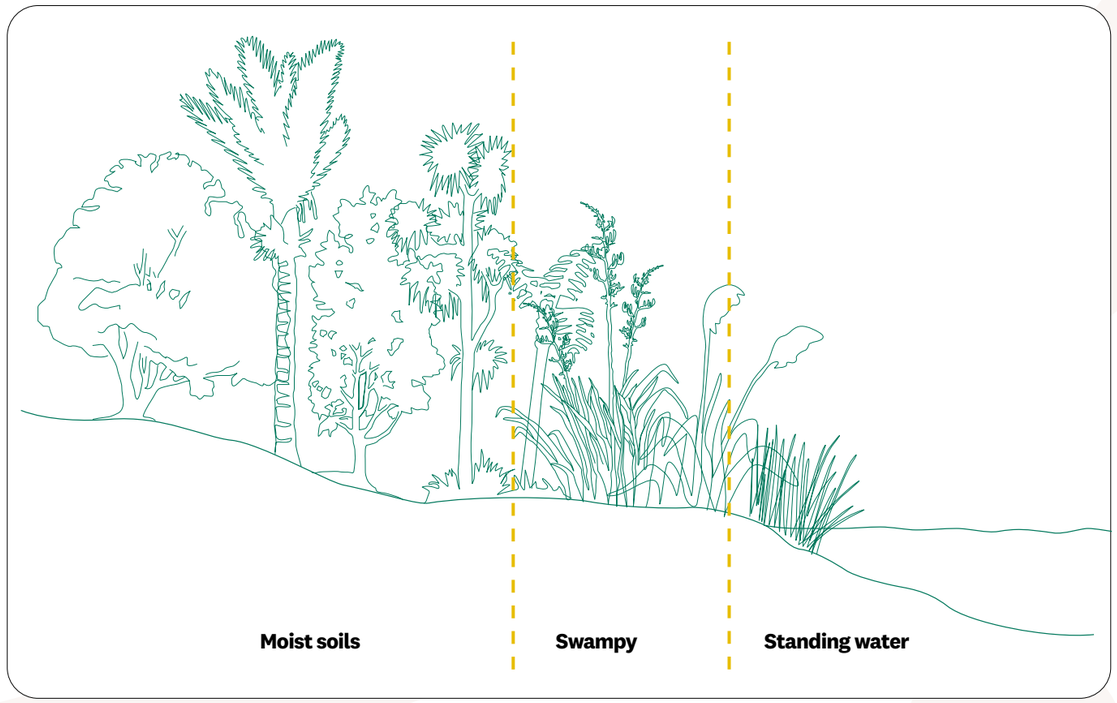


Figure 132: Established planting around a dam at Āwhitu Regional Park. Credit: Alastair Jamieson

Figure 133: Project Twin Streams Riparian Planting.

Table 9.2: Revegetation Schedule for Riparian Zones in Tāmaki Makaurau / Auckland

Ingoa Māori/Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	Planting location				Plant spacing	Planting notes
					Wet		Semi-Wet	Dry		
					Stream edge	Back wetland	Flood area	Slope		
Rautahi	*Carex geminata; C. lessoniana*[1]		Sedge	1m	20-40%	20-30%	< 10%	–	0.75-1m	Good for bank stability. Blankets the lower bank – providing coverage and protection from erosion.
Pūkio	*Carex virgata*		Sedge	1m	20-30%	20-30%	5-15%	–	0.75-1m	Use more in wetter riparian zones. Good for bank stability on the lower bank.
Tī kōuka/cabbage tree	*Cordyline australis*		Tall shrub/tree	8m+	10-20%	5-15%	5-15%	5-15%	1-1.4m	Provides good food sources for fauna.
Forest sedge	*Carex dissita*		Sedge	0.5m	< 10%	< 10%	< 10%	< 10%	0.5-0.75m	Good for shady sites.
Toetoe	*Austroderia fulvida*		Grass	1.5m	< 10%	< 10%	< 10%	–	1-1.4m	Plant on flat or gently sloping areas.
Kiokio	*Blechnum novae-zelandiae*		Fern	1m	< 10%	< 5%	< 5%	–	0.75-1m	At most sites, will establish without planting. Consider planting at sites isolated from established indigenous vegetation.
Koromiko	*Veronica stricta* var. *stricta*		Shrub	2m	< 10%	–	< 10%	5-15%	1-1.4m	Fast-growing.
Putaputawētā	*Carpodetus serratus*		Tall shrub/tree	6m	< 10%	–	< 10%	5-10%	1-1.4m	Establishes best with shelter.
Giant umbrella sedge	*Cyperus ustulatus*		Sedge	1.5m	–	20-30%	–	–	0.75-1m	Plant in wetland environments only.
Harakeke/flax	*Phormium tenax*		Herb	3m	–	10-20%	5-15%	< 10%	1-1.4m	Do not plant on stream banks as can be pulled out of the bank during floods.
Mānuka[2]	*Leptospermum scoparium*		Tall shrub/tree	5m	–	5-15%	5-15%	10-20%	1-1.4m	Fast-growing and will colonise sites with harsh environmental conditions.
Kahikatea	*Dacrycarpus dacrydioides*		Canopy tree	10m	–	< 5%	< 5%	< 5%	5-8m	Slow growing. Plant in clusters so they are not shaded out by faster growing species.
Pukatea	*Laurelia novae-zelandiae*		Canopy tree	8m	–	< 5%	< 5%	–	5-8m	Slow growing. May be hard to source from nurseries.
Maire tawake/ Swamp maire[2]	*Syzygium maire*		Canopy tree	8m	–	< 5%	< 5%	–	5-8m	Only plant where soils are permanently wet. Plant sparingly due to risk of myrtle rust.
Patē	*Schefflera digitata*		Tall shrub/tree	8m	–	< 5%	–	5-10%	1-1.4m	Fast-growing.
Kōwhai[3]	*Sophora microphylla*		Canopy tree	8m	–	–	5-10%	5-10%	5-8m	

1 Look in the local area to see which *Carex* species is suitable for your site but be aware that these species are difficult to identify. Eco-source from the nearest natural populations

2 Maire tawake/Swamp maire should be sourced from a nursery accredited under Plant Pass. Kānuka and mānuka should also be sourced from a Plant Pass accredited nursery where possible.

3 The *Sophora* genus has several species in Auckland that vary with location and conditions. Seed should be collected from the nearest available natural source.

4 The *Kunzea* genus has several species in Tāmaki Makaurau / Auckland. Look in the local area to see which species is suitable for your site and eco-source from the nearest natural populations. Talk to an ecologist if you are having trouble deciding which *Kunzea* to plant at your site.

Note: Some other species (e.g. tree ferns) not listed in this table are suitable for riparian zones but not recommended for planting as they will naturally establish. If desired, these could be included in low numbers in a species mix to create additional structure for instream fauna.

Key:
Shade tolerant
Tolerant of wet soils
Plant with shelter from wind
Frost tender
Provides food for birds/bats/lizards
Plant in canopy gaps
Deer browse tolerant
Improves in-stream habitat for fish
Tolerant of salt-spray
Improves bank stability

Ingoa Māori/Māori name and/or common name	Species	Planting key	Growth form	Height after 30 years	Planting location				Plant spacing	Planting notes
					Wet		Semi-Wet	Dry		
					Stream edge	Back wetland	Flood area	Slope		
Māhoe	*Melicytus ramiflorus*		Tall shrub/tree	6m	–	–	< 10%	5-15%	1-1.4m	Establishes more slowly than other bank stabilising species. Has great root systems for bank stabilisation.
Karaka	*Corynocarpus laevigatus*		Canopy tree	10m	–	–	< 5%	< 5%	5-8m	Provides good food sources for fauna.
Kānuka[2,4]	*Kunzea robusta*		Tall shrub/tree	10m	–	–	–	10-20%	1-1.4m	Fast-growing. Requires well drained soils.
Karamū	*Coprosma robusta*		Tall shrub/tree	6m	–	–	–	5-15%	1-1.4m	Fast-growing. Versatile across a range of soil conditions i.e. moist to dry.
Porokaiwhiri, pigeonwood	*Hedycarya arborea*		Tall shrub/tree	8m	–	–	–	5-10%	1-1.4m	Requires shelter from wind and frost.
Houhere/lacebark	*Hoheria populnea*		Tall shrub/tree	8m	–	–	–	< 10%	1-1.4m	Good bank stabilising species.
Kōhūhū	*Pittosporum tenuifolium*		Tall shrub/tree	6m	–	–	–	< 10%	1-1.4m	Requires well drained soils.
Māpou	*Myrsine australis*		Tall shrub/tree	6m	–	–	–	< 10%	1-1.4m	Can have very poor establishment rates.
Pūriri	*Vitex lucens*		Canopy tree	10m +	–	–	–	< 5%	5-8m	Requires well drained soils.
Ribbonwood	*Plagianthus regius* subsp. *regius*		Tall shrub/tree	8m	–	–	–	< 5%	1-1.4m	Fast-growing.
Tōtara	*Podocarpus totara*		Canopy tree	10m +	–	–	–	< 5%	5-8m	Requires well drained soils. Use sparingly unless common in current/ potential ecosystem type.

1 Look in the local area to see which *Carex* species is suitable for your site but be aware that these species are difficult to identify. Eco-source from the nearest natural populations

2 Maire tawake/Swamp maire should be sourced from a nursery accredited under Plant Pass. Kānuka and mānuka should also be sourced from a Plant Pass accredited nursery where possible.

3 The *Sophora* genus has several species in Auckland that vary with location and conditions. Seed should be collected from the nearest available natural source.

4 The *Kunzea* genus has several species in Tāmaki Makaurau / Auckland. Look in the local area to see which species is suitable for your site and eco-source from the nearest natural populations. Talk to an ecologist if you are having trouble deciding which *Kunzea* to plant at your site.

Note: Some other species (e.g. tree ferns) not listed in this table are suitable for riparian zones but not recommended for planting as they will naturally establish. If desired, these could be included in low numbers in a species mix to create additional structure for instream fauna.

Key:

- Shade tolerant
- Tolerant of wet soils
- Plant with shelter from wind
- Frost tender
- Provides food for birds/bats/lizards
- Plant in canopy gaps
- Deer browse tolerant
- Improves in-stream habitat for fish
- Tolerant of salt-spray
- Improves bank stability

Case study:

Riparian planting at Shakespear Regional Park

A 9100 m2 riparian restoration project has been carried out in Shakespear Regional Park and is part of a wider gully restoration project at the park.

Project timeframe	Ongoing since 1994
Target ecosystem type	Riparian planting around an intermittent/permanent stream flowing into a wetland
Ecosystem pressures at restoration site	Stock, pest plants, pest animals, public visitors
Restoration actions	Stock exclusion, pest plant control, revegetation planting, ongoing maintenance
Project carried out by	Park rangers and volunteers

Riparian planting at Shakespear Regional Park.

Auckland Council Regional Parks, such as Shakespear Regional Park, have numerous restoration projects encompassing both existing indigenous ecosystem fragments and revegetation planting. Often, planting locations have been selected to extend existing vegetation and connect fragments within the park.

This site was previously a degraded stream with no riparian vegetation and full stock access. The planting aimed to both protect and enhance the stream and to expand a gully forest fragment around a raupō wetland downstream of the site.

Site preparation for this project involved fencing to exclude stock, control of pasture species, and establishment of plants. Plant species included those common to council plantings at the time – mānuka, kānuka, karamū, māpou, and tī kōuka. Pest control has been carried out regularly since completion of planting, in conjunction with wider pest control programmes in the park, by council staff and volunteers in the Shakespear Open Sanctuary Society.

The current canopy height, 27 years after planting, ranges between 4m (mānuka) and 10m (tī kōuka). The area has an average canopy cover of 70-80 per cent. While there are some gaps in the canopy, indicating early failures in the planting carried out, the solid area of revegetation up to 20m wide on both sides of the stream is generally free of pest plants. Regeneration of additional understorey species (not planted), including ponga, shaking brake, basket grass, Coprosma areolata, Carex dissita, toatoa, and kiokio, indicates the area is becoming self-sustaining and will provide ongoing protection for the stream.

5.3.1 Plant maintenance

Plant maintenance for riparian planting will be similar to terrestrial and wetland ecosystems in Section 3.6.6. Additional monitoring for incursions.

5.3.2 Monitoring of riparian restoration projects

Monitoring of riparian restoration projects will generally be similar to terrestrial and wetland ecosystems covered in Section 3.7. Additional monitoring that could be carried out in riparian restoration projects relates to the condition of the stream itself, including water quality, habitat values, and presence of indigenous freshwater fauna. Potential methods to monitor improvements in stream quality resulting from riparian restoration are outlined below (Table 9.3).

Table 9.3. Summary of methods for monitoring stream health

Monitoring method	Summary	Further info
General	Resources for community catchment groups (note these were created for Southland groups but still contain relevant information for the Tāmaki Makaurau / Auckland region).	Getting started: Ecosystem health monitoring for catchment groups. Cawthron Institute Report No. 3704. Prepared for Thriving Southland by MacNeil and Holmes (Dec 2021). cawthron.org.nz/wp-content/uploads/2022/01/Getting-started-ecosystem-health-monitoring-for-catchment-groups.pdf And this supporting document which cover citizen-led catchment monitoring in more detail: A river health monitoring framework for Southland catchment groups. Cawthron Institute Report No. 3862. Prepared for Thriving Southland by MacNeil and Holmes (Aug 2021). cawthron.org.nz/wp-content/uploads/2022/01/A-river-health-monitoring-framework-for-Southland-catchment-groups.pdf
Macroinvertebrate Community Index (MCI)	Calculated using tolerance values assigned to macroinvertebrate taxa found within streams.	National Environmental Monitoring Standards document – Collection and processing of macroinvertebrate samples from rivers and streams, Version 1.0.0, June 2022 nems.org.nz/documents/macroinvertebrates/ Department of Conservation document – Introduction to macroinvertebrate monitoring in freshwater ecosystems, Version 1.0, 2013 doc.govt.nz/globalassets/documents/science-and-technical/inventory-monitoring/im-toolbox-freshwater-ecology/im-toolbox-freshwater-ecology-introduction-to-monitoring-macroinvertebrates-in-freshwater-ecosystems.pdf
Rapid Habitat Assessment Method	Scores the stream based on 10 parameters.	National rapid habitat assessment protocol development for stream and rivers. Cawthron Institute Report No. 2649. Prepared for Northland Regional Council by Clapcott J. (2015). envirolink.govt.nz/assets/Envirolink/1519-NLRC174-National-Rapid-Habitat-Assessment-Protocol-for-Streams-and-Rivers.pdf

Monitoring method	Summary	Further info
Stream Ecological Valuation (SEV)	Quantifies the value of streams based on the performance of their key ecological functions.	Stream ecological valuation (SEV): a user's guide. By Storey R., Neale M., Rowe D., Collier K., Hatton M., Joy M., Maxted J., Moore S., Parkyn S., Phillips N., and Quinn J. (2011). Auckland Council Publication 2011/001, reprinted 2015. https://knowledgeauckland.org.nz/media/1398/gd2011-001-stream-ecological-valuation-sev-users-guide-reprint-nov-2015.pdf Stream ecological valuation: application to intermittent streams. By Neale, M W., Storey, R G and Quinn, J L (2016). Prepared by Golder Associates (NZ) Limited for Auckland Council. Auckland Council Technical Report, TR2016/023. knowledgeauckland.org.nz/media/1285/tr2016-023-stream-ecological-valuation-application-to-intermittent-streams.pdf
Wai Care	Water quality monitoring, education, and action programme for stream restoration in Tāmaki Makaurau / Auckland. May include water quality sampling and macroinvertebrate surveys.	waicare.org.nz

Figure 134: Wai Care monitoring in Dunn's Bush.

Kia kapohia hoki taua reo rā e te hau maiangi kia tatū ai ki te whare o te hoa patui,

May the echo of that voice be carried by the gentle breeze to where our friends reside.

Nō reira, nau mai te mahi tahi!

We look forward to working together!

Photo: Mānuka.
Credit: Alastair Jamieson

Appendix 1

Kuputaka/Glossaries

Kuputaka Hauropi o Ngā Iwi Mana Whenua o Tāmaki Makaurau
Glossary of ecological and other terms of the iwi of Tāmaki Makaurau / Auckland

For other Māori words that feature in this resource we recommend Te Aka Māori Dictionary maoridictionary.co.nz

Term	Definition
Awa	Waterway, either a stream, creek or river.
Hauropi	Ecology
Haumanu	To revive, restore to health, to rejuvenate.
Hapū	A number of whānau sharing descent from a common ancestor; kinship group, sub-tribe.
Hui	Gathering, meeting
Ingoa Māori	Māori name
Iwi	A number of hapū (section of a tribe) related through a common ancestor.
Iwi mana whenua	For the purposes of Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau, the term is used to refer to individual iwi.
Kaitiaki	Trustee, minder, guard, custodian, guardian, caregiver, keeper, steward.
Kaitiakitanga	Guardianship, stewardship, trusteeship, trustee. (Source: Te Aka/Māori Dictionary maoridictionary.co.nz Accessed – 9 February 2023)
Karakia	An incantation or chant – refer to the karakia at the front of the guide.
Kōiwi	Human bone(s)
Te Kōwhiri Momo Otaota	Plant species choice
Mahinga kai	Garden, cultivation, or food gathering place.
Mahere ā-Rohe Whakahaere Kaupapa Koiora Orotā mō Tāmaki Makaurau	Auckland Regional Pest Management Plan
Mahi toi	Artwork - design elements in this resource
Mana whenua	Hapū and iwi with ancestral relationships to certain areas wherein they exercise customary authority.
Manu	Bird
Mātauranga	Māori knowledge and expertise.
Mātauranga a Iwi	The body of accumulated knowledge passed down through the generations of whanau from several connected hapū which forms the basis of collective iwi knowledge.
Mātauranga a hapu	The body of knowledge passed down through the generations of a whanau from a specific hapū or extended whanau.
Mihimihi	A formal speech of greeting or introductions.
Ngā Iwi Mana Whenua o Tāmaki Makaurau	For the purposes of Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau, the term refers to the nineteen iwi of the greater Auckland region, and recognises that each iwi is wholly autonomous, individual and unique.
Ngā Tikanga, te Whakamahinga o ngā Rawa	Cultural practices and/or resource uses.
Pā	Māori fortified settlement usually found on hill tops, escarpments, and ridgelines. Kāinga (villages) are settlements that may (or not) be near a pā (or more than one). Settlement areas tend to be on flatter land behind dunes, terraces below windy hilltops, or a series of pits and terraces on flat land near a water supply and on good horticultural soils.
Pātaka kai	Place for food storage
Puna wai	Freshwater springs
Rāhui	Temporary ritual prohibition, conservation measure on a particular area of whenua, water, or resource.
Taiao	The world, earth, natural world, environment and nature.
Tāmaki Makaurau	Auckland
Tangata	People
Taonga	A treasured item, tangible, or intangible.
Taonga Tuku Iho	In the context of Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau, the term refers to the intellectual property rights of Ngā Iwi Mana Whenua o Tāmaki Makaurau.
Te Ao Māori	The Māori world or the Māori world view.
Te haumanu hauropi	Ecological restoration which is about bringing balance back to the environment.
Te Haumanu Oneone hei Tiaki Wāhi Tapu	Revegetation near wāhi tapu.
Te repo	Wetlands, swamps, bogs, and marshes
Te Tiriti o Waitangi	The Treaty of Waitangi refers to the Treaty signed in 1840 and recognised as the founding document of Aotearoa / New Zealand.
Tikanga	Customs or protocols.
Urupā	Burial site. Knowledge of these is held by iwi mana whenua, but some are known, and you can be advised by Heritage New Zealand or Auckland Council Heritage Unit. Sites are not just physical remains of kōiwi (bones) but can reflect adjacent streams and vegetation where rituals occurred.
Wāhi tapu	Sacred ancestral sites and places of significance to iwi, hapū or whanau. This can include stones (mauri), caves, streams (awa) and ara (tracks) and have significant intangible values in Te Ao Māori.
Whakaaro	Understanding; idea
Whakapapa	Genealogy that links Māori to their ancestors.
Whenua	Land

Glossary of ecological terms

Term	Definition
Adaptive management	A systematic approach to re-evaluating original goals and restoration actions (management strategy), based on progress and feedback.
Agrichemicals	Any substance, whether inorganic or organic, artificial, or naturally occurring, modified or in its original state, that is used in any agriculture, horticulture, or related activity, to eradicate, modify or control flora and fauna.
Anthropogenic	Caused or produced by humans.
Archaeological site	A site or place of human activity that occurred before 1900. These are protected by the Heritage New Zealand Pouhere Taonga Act 2014, and it is a legal requirement to obtain an authority prior to earthworks starting. Some of these places also have significance to Europeans. There are also post-1900 places that may be significant and have protection.
Baseline monitoring	Carried out prior to a restoration project starting.
Biodiversity	A biological community of interacting organisms and their physical environment.
Broadleaf	Evergreen flowering trees.
Browse	Feeding on plants e.g. young shoots.
Buffer	A protective zone around sensitive or vulnerable areas to lessen the impact of human activity and land disturbance.
Canopy closure	The percentage of area covered by a layer of trees or vegetation when viewed from above.
Climate change	The long-term shift in global or regional climate patterns attributed directly or indirectly to human activity.
Damming	The activity of impounding surface water (and any substances dissolved in, suspended in, or otherwise combined with the water) with any structure. This excludes water held in tanks, rain gardens, culverts and culvert headwalls and reclamation or drainage which results in the creation of dry land.
Dripline	The outer extent of the branch spread.
Ecological corridor	Space that facilitates movement of animals (or plants over time) between larger patches of distinct habitat.
Ecological integrity	The ability of an ecological system to support and maintain a community of organisms that has species composition, diversity, and functional organization comparable to those of natural habitats within a region.
Ecological restoration	The process of assisting the recovery of ecosystems that have been damaged, degraded, destroyed, or disturbed by human activities.
Eco-sourcing	The process of harvesting seed from specimens that live in the same area as they are to be planted in.
Ecosystem	A community of plants, animals and other organisms that function together as a unit along with their environment.

Term	Definition
Edge effects	Changes in population or community structures that occur at the boundary of two or more habitats, especially after sudden changes in habitat boundaries (e.g. vegetation clearance). For example, plants on the edge of a forest are exposed to increased light, greater fluctuations in temperature and lower humidity than those in the forest interior which can result in changes to forest structure and greater pest plant invasion. See https://www.doc.govt.nz/get-involved/run-a-project/restoration-advice/bush-restoration/understand-the-bush/edge-effects/ for more information.
Enrichment planting	The planting of understorey and canopy species to increase diversity and accelerate succession in areas of existing vegetation.
Fauna	The animals of a particular region or habitat.
Flora	The plants of a particular region or habitat.
Flow-on effects	Unanticipated or unforeseen effects of a restoration action that may alter other ecosystem components (e.g. invasion of pest plants following pest plant clearance, increase in rat numbers after control of stoats).
Frugivorous	Feeding on fruit.
Heritage sites	Archaeological or not, these can be walls, buildings, notable trees (exotic or not) that have some level of protection in a District Plan. Consultation with the local council is a legal requirement and may be separate, or part of, the resource consent application process.
Hydrology	The study of the movement, distribution, and management of water.
Indigenous ecosystem	A biological system comprising a community of living organisms and its associated non-living environment, interacting as an ecological unit that occur naturally in Aotearoa/New Zealand, including self-introduced species, but not human-introduced ones.
Initial planting	The planting of pioneer species in an area that has no existing native vegetation cover.
Kauri dieback disease	Disease caused by a soil-borne pathogen called *Phytophthora agathidicida* that affects kauri trees.
Microclimate	A set of climatic conditions that are different from the surrounding area.
Monitoring	The observation and reporting on the progress of an area over a period of time.
Myrtle rust	Fungal pathogen (*Austropuccinia psidii)*, infecting hundreds of species in the family Myrtaceae (myrtles).
Pest animal	An undesirable animal species, usually introduced/exotic, whose introduction or spread threatens biodiversity.
Pest plant	An undesirable plant species, usually introduced/exotic, whose introduction or spread threatens biodiversity.
Pioneer/early successional species	The first species to colonise and establish on a cleared or recently disturbed sites.
Plant grade	The size of the pot or bag that a plant is grown in.
Podocarp	Plants belonging to the podocarp family, Podocarpaceae.
Podzol	Type of low fertility soil which develops under the acidic leaf litter of native trees (especially, conifers, beech, and kauri) in a wet temperate climate. It can form an impervious layer in the subsoil which results in low fertility and poor drainage.
Potential ecosystem	Ecosystem that would have been present at a site pre-human.
Propagule	Structure of a plant (e.g. seed, spore, cutting) from which a new individual may develop.
Plant Pass	A voluntary certification scheme for New Zealand plant producers recognising good biosecurity practice. See plantpass.org.nz for more information.
Plant releasing	The plant maintenance process whereby the area around a plant is cleared of undesirable vegetation.
Riparian zone	The strip of land on either side of a waterway (including streams, rivers, lakes, and estuaries). Encompasses the area of direct interactions between land and water ecosystems.
Site constraint	Limiting factors that govern whether or how a site may be restored. Limiting factors that govern whether or how a site may be restored.
Statutory document	A document that has legal weighting under Aotearoa/New Zealand law.
Succession	The process by which an ecological community changes over time.
Waterway	May include streams, rivers, lakes, estuaries, and wetlands.
Wetland	permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions.

Kuputaka Ngāi Tipu

Native Flora Glossary

Throughout the text, common and Māori pl ant names have been used where possible. The following alphabetical list gives the Māori, common and scientific names of native plant species.

Ingoa Māori/Māori name	Common name	Scientific name
Akeake		*Dodonaea viscosa*
	Aristea	*Aristea ecklonii*
	Bindweed	*Calystegia marginata*
	Broom	*Carmichaelia* spp.
	Greater wire rush	*Sporadanthus ferrugineus*
Hangehange		*Geniostoma ligustrifolium* var. *ligustrifolium*
Harakeke	Flax	*Phormium tenax*
Hinarepe	Sand tussock	*Poa billardierei*
Hīnau; hangehange; pōkākā; whīnau		*Elaeocarpus dentatus* var. *dentatus*
Horoeka	Lancewood	*Pseudopanax crassifolius*
Horokaka	Native iceplant	*Disphyma australe* subsp. *australe*
Houhere	Lacebark	*Hoheria populnea*
Houpara	Coastal five-finger	*Pseudopanax lessonii*
	Immorality grass	*Austrostipa stipoides*
	Jointed twig rush	*Machaerina articulata*
Kahikatea		*Dacrycarpus dacrydioides*
Kaikōmako		*Pennantia corymbosa*
Kakaha	Swamp astelia	*Astelia grandis*
Kakaha, Kōwharawhara	Coastal tree daisy	*Olearia solandri*
Kanono, manono	Thin-leaved coprosma	*Coprosma areolata*
Kānuka		*Kunzea* spp.
Karaka		*Corynocarpus laevigatus*
Karamū; Karamū		*Coprosma robusta*
Karamū	Shining karamu	*Coprosma lucida*
Kareao	Supplejack	*Ripogonum scandens*
Karo		*Pittosporum crassifolium*
Kauri		*Agathis australis*
Kauri grass		*Astelia trinervia*
Kawaka		*Libocedrus plumosa*
Kawakawa		*Piper excelsum* subsp. *excelsum*
Kiekie		*Freycinetia banksii*
Kiokio		*Blechnum novae-zelandiae*
Kohekohe		*Didymocheton spectabilis*
Kōhūhū		*Pittosporum tenuifolium*
Koromiko	Hebe	*Veronica stricta* var. *stricta*
Kōwhai		*Sophora chathamica*
Kōwhangatara; Spinifex		*Spinifex sericeus*
Kōwharawhara	Coastal astelia	*Astelia banksii*

Ingoa Māori/Māori name	Common name	Scientific name
Kuawa; Lake clubrush		*Schoenoplectus tabernaemontani*
Kuta		*Eleocharis sphacelata*
Māhoe		*Melicytus ramiflorus*
Maire tawake	Swamp maire	*Syzygium maire*
Mākaka	Salt marsh ribbonwood	*Plagianthus divaricatus*
Makomako	Wineberry	*Aristotelia serrata*
Makura	Carex	*Carex* spp.
Makura pūrei, pūreirei, pūrekireki, pūkio, mātā, mātātā, makura, mārū; tamatea	Forest sedge	*Carex dissita*
Mamaku		*Cyathea medullaris*
Māmāngi	Tree coprosma	*Coprosma arborea*
Mānatu	Ribbonwood	*Plagianthus regius* subsp. *regius*
Mānawa	Mangrove	*Avicennia marina* subsp. *australasica*
Mangeao		*Litsea calicaris*
Mānuka		*Leptospermum scoparium* var. *scoparium*
Māpere		*Gahnia* spp.
Māpou		*Myrsine australis*
Mataī		*Prumnopitys taxifolia*
Matua-rarauhe; waewae-kākā, waewae-kōtuku, waewae-matuku, matua-rarauhe	Tangle fern	*Gleichenia* spp.
Mingimingi		*Coprosma propinqua* var. *propinqua*
Mingimingi	Twiggy coprosma	*Coprosma rhamnoides*
Miro		*Prumnopitys ferruginea*
Moku au toto; rākau pakeha	Baumea	*Machaerina rubiginosa*
	Myrtle species	Myrtaceae
	Native spinach	*Tetragonia trigyna*
Neinei	Needle-leaved	*Dracophyllum latifolium*
Ngaio		*Myoporum laetum*
Nīkau		*Rhopalostylis sapida*
Northern rātā		*Metrosideros robusta*
Oioi		*Apodasmia similis*
Panahi, paraha, pōhue, poue	Shore-bindweed	*Calystegia soldanella*
Patē		*Schefflera digitata*
Pīngao		*Ficinia spiralis*
Pōhuehue		*Muehlenbeckia complexa* var. *complexa*
Pōhutukawa		*Metrosideros excelsa*
Ponga		*Cyathea* spp.
Porokaiwhiri;	Pigeonwood	*Hedycarya arborea*
Prickly hakea		*Hakea sericea*
Pukatea		*Laurelia novae-zelandiae*
Pūkio		*Carex virgata*
Pūkio and raupō		*Isolepis prolifera*
Pūrei		*Carex secta*
Pūriri		*Vitex lucens*

Ingoa Māori/Māori name	Common name	Scientific name
Pūrua	Marsh clubrush	*Bolboschoenus fluviatilis*
Putaputawētā		*Carpodetus serratus*
Ramarama		*Lophomyrtus bullata*
Rangiora		*Brachyglottis repanda*
Rātā		*Metrosideros* spp.
Raupō		*Typha orientalis*
Rautahi	Cutty grass	*Carex lessoniana*
Remuremu	Half star	*Goodenia radicans*
Rengarenga lily	Rengarenga lily	*Arthropodium cirratum*
Rewarewa		*Knightia excelsa*
Rimu		*Dacrydium cupressinum*
Tarakupenga	Sand coprosma	*Coprosma acerosa*
	Sand sedge	*Carex pumila*
	Shaking brake	*Pteris tremula*
	Sharp spike sedge	*Eleocharis acuta*
	Sea primrose	*Samolus repens* var. *repens*
	Sun orchids	*Thelymitra* spp.
	Sundew	*Drosera* spp.
	Speckled sedge; New Zealand Hair sedge;	*Carex testacea*
	Swamp millet	*Isachne globosa*
	Sea primrose	*Samolus repens* var. *repens*
Tānekaha		*Phyllocladus trichomanoides*
Taraire		*Beilschmiedia tarairi*
Tarutaru	Bamboo Rush	*Sporadanthus ferrugineus*
Tauhinu		*Ozothamnus leptophyllus*
Taupata		*Coprosma repens*
Tawa		*Beilschmiedia tawa*
Tawāpou		*Planchonella costata*
Tāwari		*Ixerba brexioides*
Tawhai; Tawai	Basket grass	*Oplismenus hirtellus* subsp. *imbecillis*
Tawhai raunui; hutu; hututawai	Hard beech	*Fuscospora truncata*
Tī kōuka;	Cabbage tree	*Cordyline australis*
Tītoki		*Alectryon excelsus* subsp. *excelsus*
Toetoe-tūhara, pēpepe	Machaerina	*Machaerina* spp.
Toetoe upoko-tangata	Giant umbrella sedge	*Cyperus ustulatus*
Toatoa		*Haloragis erecta* subsp. *erecta*
Toetoe		*Austroderia splendens; A. fulvida*
Toru		*Toronia toru*
Tōtara		*Podocarpus totara* var. *totara*
Tōwai		*Pterophylla sylvicola*
Tūrepo		*Streblus heterophyllus*
	Tussock swamp twig rush	*Machaerina juncea*
Ureure	Glasswort	*Salicornia quinqueflora*
Wharangi		*Melicope ternata*
Wheki		*Dicksonia squarrosa*
Whau		*Entelea arborescens*
Whauwhaupaku	Five finger	*Pseudopanax arboreus*
Wīwi	Knobby club rush	*Ficinia nodosa*

Native plants endemic to Tāmaki Makaurau / Auckland

The following Auckland Botanic Gardens' list refers to endemic native plants within the Auckland Council boundary. It does not include lichens, mosses or liverworts.

Plant	Area
Celmisia major var. *major*	Waitākere Coast, Aotea / Great Barrier Island
Kunzea sinclairii	Aotea / Great Barrier Island
Lepidium amissum (extinct)	Waitākere
Libertia flaccidifolia	Mt Tamahunga (Warkworth)
Myosotis pansa subsp. *pansa*	Waitākere
Olearia allomii	Aotea / Great Barrier Island
Senecio repangae subsp. *pokohinuensis*	Mokohinau Islands
Veronica bishopiana	Waitākere
Veronica jovellanoides	West Auckland
Veronica pubescens subsp. *rehuarum*	Aotea / Great Barrier Island
Veronica pubescens subsp. *sejuncta*	Aotea / Great Barrier Island, Te Hauturu-o-Toi / Little Barrier Island, Mokohinau Islands

Non-native Flora Glossary

Throughout the text, common and Māori plant names have been used where possible. The following alphabetical list gives the common name and scientific name of non-native plant species. Those marked with an asterisk (*) are non-native species.

Common name	Scientific name
African clubmoss*	*Selaginella kraussiana*
Alligator weed*	*Alternanthera philoxeroides*
Aloes	*Aloe* spp.
Arum lily	*Zantedeschia aethiopica*
Blackberry*	*Rubus fruticosus* agg.
Boneseed*	*Chrysanthemoides monilifera* subsp. *monilifera*
Boxthorn*	*Lycium ferocissimum*
Brush wattle*	*Paraserianthes lophantha*
Chinese privet*	*Ligustrum sinense*
Climbing asparagus*	*Asparagus scandens*
Cotoneaster*	*Cotoneaster* spp.
Crack willow	*Salix xfragilis*
Evergreen buckthorn*	*Rhamnus alaternus*
Exotic iceplant*	*Carpobrotus* spp.
Flame tree	*Erythrina xsykesii*
Gorse*	*Ulex europaeus*
Grey Willow*	*Salix cinerea*
Ivy*	*Hedera helix* subsp. *helix*
Japanese honeysuckle*	*Lonicera japonica*
Kikuyu*	*Cenchrus clandestinus*
Lotus*	*Lotus pedunculatus*
Marram grass*	*Ammophila arenaria*
Mercer grass*	*Paspalum distichum*
Mexican daisy*	*Erigeron karvinskianus*
Monkey apple*	*Syzygium smithii* syn. *Acmena smithii*
Montbretia*	*Crocosmia x crocosmiiflora*
Nasturtium*	*Tropaeolum majus*
Pampas*	*Cortaderia jubata; C. selloana*
Parrot's feather	*Myriophyllum aquaticum*
Pine*	*Pinus* spp.
Plantain*	*Alisma plantago-aquatica*
Plectranthus*	*Plectranthus ciliatus*
Poplar	*Populus* spp.
Privet*	*Ligustrum lucidum*
Reed sweet grass*	*Glyceria maxima*
Saltwater paspalum*	*Paspalum vaginatum*
Sharp rush*	*Juncus acutus*
Smilax*	*Asparagus asparagoides*
Spartina*	*Sporobolus alterniflorus; Sporobolus anglicus; Sporobolus x townsendii*
Sydney golden wattle*	*Acacia longifolia*
Tradescantia*	*Tradescantia fluminensis*
Tree lupin*	*Lupinus arboreus*
Water celery*	*Helosciadium nodiflorum*
Water pepper*	*Persicaria hydropiper*
Wattle*	*Acacia* spp.
Wild ginger*	*Hedychium gardnerianum; H. flavescens*
Woolly nightshade*	*Solanum mauritianum*
Yorkshire fog*	*Holcus lanatus*

Kuputaka a Ngāi Kīrehe: Fauna Glossary

Throughout the text, common and Māori fauna names have been used where possible. The following alphabetical list gives the Māori, common and scientific names of fauna. Those marked with an asterisk (*) are non-native species.

Ingoa Māori/Māori name	Common name	Scientific name
	Argentine ant*	*Linepithema humile*
	Auckland Green Gecko	*Naultinus elegans*
Hea	Hare*	*Lepus europaeus*
Hetiheti	Hedgehog*	*Erinaceus europaeus*
Īnanga	Whitebait	*Galaxias maculatus*
Kākahi	Freshwater mussel	*Echyridella* spp.
Kekeno	NZ fur seal	*Arctocephalus forsteri*
Kererū; Kūkupa	Native wood pigeon	*Hemiphaga novaeseelandiae*
Kiore	Rat*	*Rattus* sp.
	Koi Carp*	*Cyprinus carpio*
Kōkopu	Banded kōkopu	*Galaxias fasciatus*
Mātātā	Fernbird	*Bowdleria punctata*
Matuku	Australasian bittern	*Botaurus poiciloptilus*
Moko	Shore skink	*Oligosoma smithi*
	Mustelid*	*Mustela* sp.
Ngeru	Cat*	*Felis catus*
Pepeketua	Hochstetter's frog	*Leiopelma hochstetteri*
	Plague skink*	*Lampropholis delicata*
Paihamu	Possum*	*Trichosurus vulpecula*
Poaka; kunekune	Pig*	*Sus scrofa*
Pōpokoriki; Pōpokorua	Ant	*Formicidae* spp.
Pouhawaiki	Mouse*	*Mus musculus*
Pūkeko		*Porphyrio melanotus*
Pūpū rangi	Kauri snail	*Paryphanta* spp.
Rāpeti	Rabbit*	*Oryctolagus cuniculus*
Tauhou	Silvereye	*Zosterops lateralis*
Tia	Deer*	*Cervus, Axis, Dama, Odocoileus, Elaphurus* spp.
Toriura	Stoat*	*Mustela erminea*
Tūī		*Prosthemadera novaeseelandiae*
Warapī	Wallaby*	*Macropus* sp.

Appendix 2

Ecological restoration near heritage sites

Before starting a restoration project in Tāmaki Makaurau / Auckland, check if there are any known heritage (cultural, historical, or archaeological) sites at that location. It is your responsibility to do this before your project starts, as heritage sites have different types of protection. The best outcome for heritage sites is to avoid them completely.

Examples of heritage sites include pā (fortified village) or kāinga (occupation) sites, remains of cultivation areas (gardens) and midden (rubbish) sites. Urupā (burial sites) can be extensive and include trees and other natural features. Māori buildings and artefacts, some European buildings, structures, some trees, and industrial sites can also have different levels of protection.

For ecological restoration, anything that results in soil disturbance has the potential to cause damage to heritage sites (e.g. digging when planting, construction of fencing). Particular pest plant control methodologies also have the potential to affect heritage sites if they relate to Māori or European agricultural sites. Some exotic trees may be protected, restricting their removal. Former kauri dam sites or early weirs can also be heritage sites which may limit hydrology reinstatement.

Figure 135: Fenced off kumara pit, Puhinui Reserve.

How do I avoid risks to heritage sites?

Early contact and discussion of your ecological restoration project with the following people can assist with site specific planning.

1. 1Talk to iwi mana whenua of the area to check for culturally sensitive sites and to get advice on whether the proposed restoration activities are appropriate.
2. Use online resources to check for known heritage sites:
   - The Cultural Heritage Inventory holds information for more than 16,000 cultural heritage sites in Auckland. Search online at chi.net.nz/ or email heritage@aucklandcouncil.govt.nz
   - Use archsite.eaglegis.co.nz/NZAAPublic to look at your location on the map which shows some known archaeological sites. For public users, the scale and labels are not included; this tool is more an indicator of presence or absence.
3. Contact an archaeologist and get their assessment (in writing) of the risk your restoration project has to heritage (if any). See nzarchaeology.org for a directory of consultants.
4. Check with the Heritage Unit at Auckland Council, either through heritage@aucklandcouncil.govt.nz or heritageconsents@aucklandcouncil.govt.nz
5. Check with Heritage NZ Pouhere Taonga (HNZPT) on either 09 307 9920 or by email: infonorthern@heritage.org.nz

Why should I check?

Ecological restoration projects should avoid heritage sites. Legally, any place of human activity that dates before 1900 (i.e. an archaeological site), whether recorded or not, is protected from unconsented modification or destruction by the Heritage New Zealand Pouhere Taonga Act 2014. Some places are also scheduled in the Auckland Unitary Plan, as buildings, archaeological sites or 'Sites and Places of Significance to Mana Whenua'. Some trees are also scheduled as notable trees.

Works on or near a heritage site may require resource consent from Auckland Council as well as an archaeological authority from HNZPT. The Auckland Unitary Plan also sets out requirements applying to the accidental discovery of sensitive material such as lava caves, archaeological sites, kōiwi (bones), cultural artefacts and fossils, or contaminated land. These are regional and district rules which must be complied with[1] (see the Auckland Unitary Plan: Chapters E11 and E12).

What to do if you discover a heritage site during restoration?

If you think you have found any kind of heritage site or have concerns about something you encounter, stop work immediately. Provide a buffer to the area around the object/site to protect it from any further damage and place a temporary cover over it to keep it out of sight.

Immediately contact Auckland Council's Compliance team on 09 301 0101 (24 hours). They will forward your call to an available member of the Heritage Team.

Auckland Council's Compliance and Heritage Teams will provide advice and direction. They may direct you to contact HNZPT directly. If kōiwi are identified, the police may also become involved. The direction taken by HNZPT, police and Auckland Council will depend on the nature of the material found, any consents or permits held (or not) and requests from iwi mana whenua. Any resolution (or re-start) of activity will be in joint agreement of all parties.

Figure 136: Midden discovered during restoration planting.

1 Under the Auckland Unitary Plan, the accidental discovery rule is located within Chapter E (Auckland-wide) in both the district and regional land disturbance sections, and in the infrastructure section, at E11.6.1, E12.6.1 and E26.5.5.1.

Appendix 3

Statutory documents related to restoration

Several statutory documents, including those at both regional and national levels, have requirements and/or provisions for carrying out ecological restoration. Documents relevant to ecological restoration in Tāmaki Makaurau / Auckland are outlined below.

For up-to-date information, refer to online documents as per the links provided and Tiaki Tāmaki Makaurau | Conservation Auckland.

Te Tiriti O Waitangi /The Treaty of Waitangi

In the design and implementation of your restoration project you need to give effect to Te Tiriti O Waitangi/ Treaty of Waitangi.

Refer to further guidance at tiakitamakimakaurau.nz – Tiaki Tāmaki Makaurau | Conservation Auckland.

Auckland Council/Te Kaunihera o Tāmaki Makaurau documents

- **Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan**
  While not containing direct guidelines for carrying out restoration, it is also recognised that efforts to preserve and plant indigenous vegetation are in line with objectives of Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan and Auckland's Urban Ngahere (Forest) Strategy.
  Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan has more information.
- **Auckland's Urban Ngahere (Forest) Strategy**
  The strategy recognises the social, environmental, economic, and cultural benefits of our urban ngahere and sets out a strategic approach to knowing, growing, and protecting it.
  Auckland's Urban Ngahere (Forest) Strategy has more information.
- **Auckland Unitary Plan**
  The Unitary Plan provides a consenting framework for Tāmaki Makaurau / Auckland to ensure development is carried out in line with requirements of the Resource Management Act and other government standards. Ecological restoration is often required for resource consent applications to maintain or enhance ecological values of streams, wetlands, and indigenous vegetation, and guidelines for revegetation plantings are included in the plan (see Appendix 15 and Appendix 16). These guidelines cover additional information requirements specific to carrying out revegetation under resource consent and should be adhered to in these situations. The plan provides for some rural subdivision associated with ecological restoration (protection of indigenous vegetation or revegetation planting) in certain areas. Consent is generally not required under the Unitary Plan for voluntary restoration actions such as pest plant removal or conservation planting provided certain conditions are met. Consent may be required for restoration of wetland hydrology to facilitate wetland restoration. Restoration projects relating to an approved resource consent may have additional requirements around project planning, monitoring, and timeframes.
  The Auckland Unitary Plan has further information.
- **Mahere Whakahaere Kīrearea ā-Rohe: Regional Pest Management Plan (RPMP)**
  The current Regional Pest Management Plan spans 2020 to 2030 and sets out priorities and goals for managing animal and plant pests. Regulations outlined in this plan must be adhered to under the Biosecurity Act. These include requirements for control of specified pest plants in specific locations, requirements on movements and ownership of pest animal species, and additional biosecurity provisions. This document will provide guidance in restoration projects, specifically in relation to what needs to be controlled/managed, and to what extent.
  The full plan provides further information.

National environmental regulations

- **National Environmental Standards for Freshwater**
  The National Environmental Standards for Freshwater (NES-F) put in place regulatory standards for activities that pose risks to the health of freshwater and freshwater ecosystems. They include specific conditions for the management of activities within and surrounding wetlands, including for restoration activities. This includes vegetation clearance and land preparation, planting of appropriate indigenous species, managing impacts on indigenous birds and fish, and requirements for machinery, tools and materials used within wetlands. Any consent required for under the NES-F for wetland restoration will require specific information to be provided as part of a Wetland Restoration Plan. General restoration methods, such as assessments of vegetation, hydrology, and planting are covered in this resource, however, it is likely you will need to engage a specialist if providing a Restoration Plan to meet more specific requirements.
  The NES-F provides further information.
- **National Policy Statement for Freshwater Management 2020**
  The overall objective of the NPS-FM is to ensure that natural and physical resources are managed in a way that prioritises the health and well-being of water bodies and freshwater ecosystems. The Auckland Unitary Plan will be updated to give effect to the direction provided within NPS-FM, with any plan changes to be notified before the end of 2024. Any restoration activities around freshwater ecosystems before then should still consider the direction and objectives within the NPS-FM.
  The NPS-FM provides further information.
- **National Policy Statement for Indigenous Biodiversity**
  The objective of the National Policy Statement for Indigenous Biodiversity (NPS-IB) is to maintain indigenous biodiversity across Aotearoa New Zealand so that there is at least no overall lossy after the commencement date of August 2023. The NPS-IB is a regulatory document that provides direction to councils on their roles and responsibilities for identifying, protecting and maintaining indigenous biodiversity. It requires regional councils to have a regional biodiversity strategy and to promote the restoration of indigenous biodiversity and vegetation cover.
  The National Policy Statement for Indigenous Biodiversity provides further information.

Appendix 4

Tips for pest plant control

1. Ensure that you have correctly identified the pest plant (i.e. that it is not an indigenous species) and determine the best control method based on its biology and how it spreads.
2. Refer to online resources at tiakitamakimakaurau.nz – Tiaki Tāmaki Makaurau | Conservation Auckland for advice on identification and pest plant control methods (physical, chemical/herbicide or biological) including 'Pest Search'. Select the method with the least toxicity that is practicable for the situation and is effective for controlling the pest plant species targeted. Note: Only certain herbicides are suitable for use in riparian areas and some may require permits. Seek advice specialist advice if required.
3. Use control methods that cause the least disturbance, to minimise the risk of re invasion of bare ground resulting from control of the target species.
4. Consider how the site conditions can be managed to minimise pest plant invasion, e.g. maintain canopy closure, replant bare areas following pest plant control.
5. Stage your pest plant control.
   - Prioritise pest plants that have the greatest impact, e.g. for forest sites, focus on shade tolerant species that can invade the understorey over light-demanding species (such as gorse) which are likely to only be an issue on an edge.
   - Start with control of the smallest, outlying pest plant infestations and then work towards the largest core infestations.
6. Consider the timing and sequencing of pest plant control.
   - Control pest plants before they fruit/set seed and spread further.
   - In riparian zones – for pest plants that resprout from fragments (e.g. tradescantia) start control upstream, otherwise the site will be constantly reinfested from upstream sources.
7. Maintain good hygiene of boots and equipment and appropriate disposal of pest plant waste material to avoid spreading pest plants.
8. Remember that pest plant control is not a one-off and follow-up control will often need to occur regularly.
9. Consider working with neighbours to reduce pest plant invasion from the surrounding area.
10. Monitor the success of past pest plant control efforts, e.g. has the density of the pest plants reduced? Which control methods have been successful?

Appendix 5

Seed collection guidelines

Finding collection sites

- Contact mana whenua, Auckland Council specialists or local experts who may be able to provide advice on possible locations of target species near the planting site.
- Ensure you have landowner permission to visit the site and then subsequently collect seed. To collect seed from local parks and regional parks, you will need either landowner approval or Auckland Council approval if it concerns regional parks.
- Undertake a scoping trip early in the season (ideally when flowering) to locate populations of the target species to confirm species identification and estimate when plants will fruit. Take GPS coordinates and record a description of how to relocate populations.

Confirming identification of the target species

- Target species need to be accurately identified. Familiarise yourself with the key characteristics of the species using online resources, field guides or seeking advice from specialists.
- Take any identification resources with you into the field and consider inviting along someone who is more familiar with the identification of the species if required.
- Take detailed photos of the key characteristics of the species in the field if the identification needs to be verified.
- Ensure populations are natural (i.e. not planted); if you are unsure seek advice.
- Check the habitat of the target species. It is vital to collect seed from a similar habitat to where the plants will be planted so they have a good chance of survival.

Assess the size of the population of the target species

To have a representative sample of the target species, seed should be collected from many individual plants randomly across the extent of the population (ideally at least 50). If the population is small, you may need to find another population of the same species. For a naturally uncommon species with fewer than 50 individuals, you cannot collect more than 10 per cent of the available seed and from as many individuals as possible.

Timing of seed collection

Time seed collection when plants will be fruiting based on the results of your scoping trip and known information on fruiting times. Seed must be collected at the optimum stage of development. Look for:

- changes in fruit or seed coat colour
- fruits breaking or splitting open
- seeds rattling
- dry and hard seeds
- if seed has already dispersed.

You want to collect seed when the plant would naturally disperse it so that it has fully developed and is viable. If you see seed on the ground, this is a good indicator it is time to collect seed. You can perform a cut test of seeds to see if the inside has fully formed, is entire and is white in colour, If all these criteria are met, then seed is suitable for collection. Note that for some species there may be variability in fruit timing even within one population.

Collecting seed

Consider using He Karakia Haumanu Taiao/the karakia at the beginning of this resource before starting.

Useful equipment includes plastic and paper seed bags, secateurs, loppers, extension loppers, gardening gloves, plant identification apps and/or identification books.

Ideally, you want to collect from at least 50 individuals to genetically represent a population.

Some plant families have many non-viable seeds (e.g. affected by insect damage, empty seeds) and you may need to collect more seeds to account for this. Before collecting, sample a capsule or fruit and check the proportions of seeds that are healthy, damaged, or non-viable. You can then calculate how many seed you will need to collect to compensate for the potentially non-viable seeds.

When sourcing seed it is important to ensure that seed collection does not impact on natural populations.

- Do not collect more than 10 per cent of seeds on a single plant so that there are sufficient seed available for natural regeneration.
- For endangered plant species with small natural populations, we recommend you seek advice from council specialists. This is because it is even more important to ensure collection does not endanger natural populations and to ensure plants will be planted in the appropriate habitat and location.

Fleshy fruits should be put in plastic bags and stored in the fridge to prevent rotting. Dry fruits/capsules should be put in paper bags and stored out of the fridge to prevent sweating.

Record keeping

It is important to keep detailed records of where you sourced plants. Write clearly on the bag label and provide details such as date, species, number of seed and collection locality.

Data to record for each collection should include:

- species name
- date of collection
- collector name
- location of collection (description and GPS coordinates)
- number of plants you collected/sampled from.

Appendix 6

Guidelines for using plant schedules

The following table provides an explanation of the detail included in the plant schedules provided in Te Haumanu Taiao: Restoring the natural environment in Tāmaki Makaurau and how this can be used to plan your planting project.

Category	Explanation
Initial or enrichment planting	The plant schedule title for forest ecosystems refers to one of two categories: • Initial: This plant schedule should be used in open areas with no existing woody vegetation. • Enrichment planting: This plant schedule should be used in areas with an existing canopy of eith er indigenous or exotic trees. Note that plant schedules for other ecosystem types are not split into initial and enrichment, as planting in areas with an existing canopy would be uncommon. The planting key for these schedules outlines species that require shade or shelter from wind, where applicable.
Ecosystem type	The ecosystem type in the plant schedule title corresponds to what ecosystem the planting mix is aiming to achieve over time.
Common name	Common name of the plant – how it is usually referred to.
Species	Scientific name of the plant (as of 2021).
Planting key	The planting key details features of the plant that will assist in species selection and species placement on site. • Deer browse tolerant – unpalatable to deer. • Frost tender: if the site receives frosts, plants that may be better to plant in late winter or spring. • Plant in canopy gaps: species suitable for planting in canopy gaps (i.e. full sun). • Plant with shelter from wind – needs shelter from wind e.g. do not plant on the edge of a planting area. • Provides food for birds/bats/lizards: species that can be used to provide food for fauna. • Shade tolerant: can be planted in shade. • Tolerant of wet soil – can be planted in areas with wet soil. Not all categories are covered in every table, as often the ecosystem type or planting stage (initial or enrichment) will dictate the environment conditions and suitable species.

Category	Explanation
Growth form	What type of plant it is, in one of the following categories? **Woody species** • Shrub: Common in early-stage ecosystem regeneration or open areas; unlikely to form part of the canopy in mature forest (mature height <5m). • Tall shrub/tree: Common in early-stage forest regeneration or open areas (e.g. wetland margins); may form part of the canopy or understorey in mature forest (mature height range 5-12m). • Canopy tree: Tall tree species that forms part of the canopy of mature forest (mature height 12m+). **Herbaceous species** • Herb: Harakeke/flax and Astelia species; equivalent of a shrub but not woody (height < 3m). • Sedge/rush/reed/grass/fern: Tufted or sward forming herbaceous vegetation that will form a ground cover in the planting area (height range < 2m). **May be woody or herbaceous** • Vine: Species that scrambles across ground and climbs other plants (height depends on growth and surrounding vegetation).
Height	How tall the plant may reach after 30 years of growth. Note that for the purpose of the planting schedules, 30 years has been selected as an average reference point corresponding to the lifetime of those carrying out the restoration project. Most species included in the plant schedules will reach their maximum height well before 30 years, and some in as little as 2-3 years (e.g. sedge and reed species). Canopy trees (e.g. kahikatea) may grow much taller than their 30m height, but this will take hundreds of years.
Planting location	The planting locations have different environmental conditions, particularly different soil moisture levels.
Percentage of planting mix	Recommended proportion of each species in your planting mix. • Species with a minimum percentage provided should definitely be included in your planting. • Species with no minimum percentage (e.g. <5 per cent) are optional. What species you select, and the percentage of each species will be specific to your site and project, and based on the environmental conditions and the objectives of your project. For enrichment plant schedules there are percentages for: • Partial shade: Where the canopy is patchy or contains frequent gaps. • Full shade: Where there is a closed canopy and dense shade throughout the area.
Plant spacing	This is the average distance that should be provided between other plants of the same species or same growth form. Note that plant spacings are not provided for forest enrichment planting schedules as these will vary widely depending on the extent of existing vegetation. As a rule of thumb, no canopy trees to be planted within 5m of each other. Planting locations should be determined by gaps in existing vegetation and suitable microsite conditions.
Planting notes	Any additional information that may assist with selection of plant species for your project.

Appendix 7

Managing the risk of kauri dieback

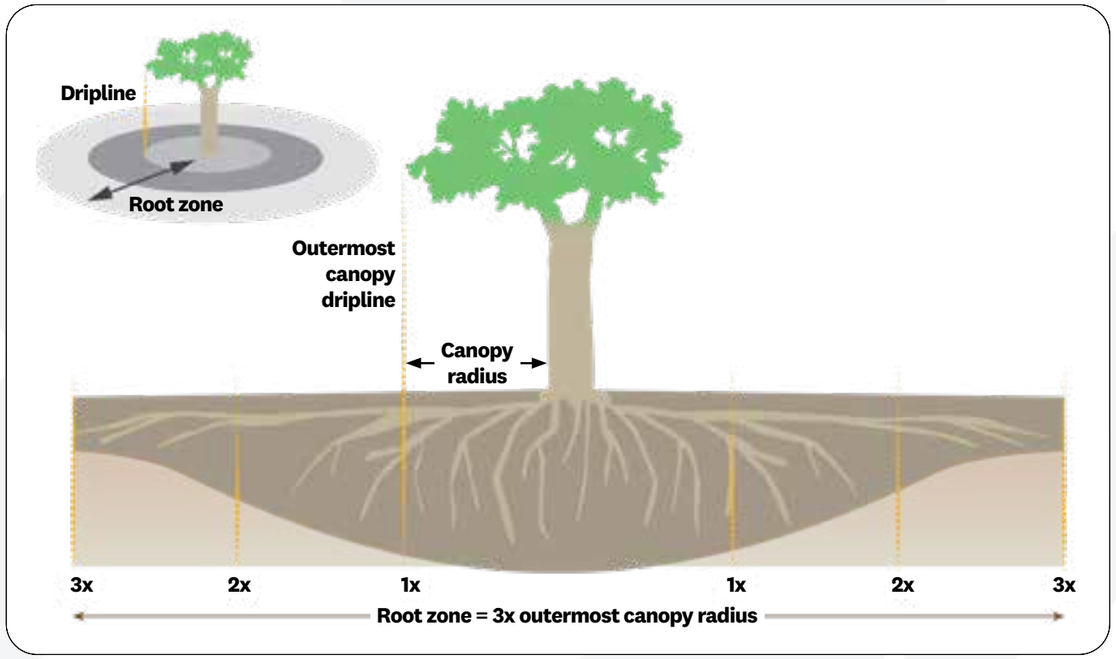
Planting near kauri (within three times the dripline of kauri), areas upslope of kauri or within ecosystems that contain kauri is not recommended due to the risk of introducing kauri dieback.

This applies to the planting of all plant species, not just kauri, due to the risk of introducing the pathogen in soil media. Buffer planting could be done next to an ecosystem that contains kauri (but not within) provided it is not upslope of kauri or near an existing kauri rootzone (e.g. within three times the dripline).

Generally, the planting of kauri is not recommended due to risks associated with kauri dieback. There may be some rare circumstances where, provided the risks can be managed, planting of kauri is appropriate (e.g. for sites that are too distant from existing kauri stands to recruit seedlings naturally). Ensure that kauri are not planted in unsuitable and inappropriate areas, as there are potential management cost implications, e.g. near existing tracks, in suburban areas, in areas with a mowing schedule and roading corridors.

It is strongly recommended you contact Auckland Council for specific advice on planting kauri or near kauri so that they can assist with a kauri dieback risk assessment and revegetation advice. They will also be able to advise on any regulatory requirements under the Auckland Unitary Plan, e.g. there are rules that restrict the movement of kauri to certain areas and standards that must be met when working within three times the dripline of kauri.

Kauri should only be planted where ongoing inspections for potential infection can be carried out. Kauri should be sourced from nurseries accredited under Plant Pass.



Credit: Tiakina Kauri | Kauri Protection Agency.

Appendix 8

Links to additional resources

Pest plant and animal control

- Pest search – information on both pest plants and pest animals
  tiakitamakimakaurau.nz/protect-and-restore-our-environment/pests-in-auckland/pest-search/
- An introductory guide to pest plant control
  tiakitamakimakaurau.nz/protect-and-restore-our-environment/how-to-guides-for-conservation/guide-to-controlling-pest-plants/
  More detailed pest plant information
  tiakitamakimakaurau.nz/resource-library/pest-plants-and-management/
- An introductory guide to pest animal control
  tiakitamakimakaurau.nz/protect-and-restore-our-environment/how-to-guides-for-conservation/guide-to-controlling-pest-animals/
  More detailed pest animal information
  tiakitamakimakaurau.nz/resource-library/pest-animals-and-management/
- Auckland Council Regional Pest Management Plan (RPMP)
  aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/topic-based-plans-strategies/environmental-plans-strategies/Pages/regional-pest-management-plan.aspx
- Auckland Council Weed Management Policy for parks and open spaces
  aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-policies/Documents/weedmanagementpolicy.pdf

Protection

- Legal protection of land
  tiakitamakimakaurau.nz/resource-library/legal-protection-of-land/
- Nominating a notable tree
  aucklandcouncil.govt.nz/building-and-consents/working-on-around-trees/Documents/guidance-for-nominating-notable-trees.pdf

Pathogens

- Myrtle rust
  - myrtlerust.org.nz
  - tiakitamakimakaurau.nz/resource-library/myrtle-rust/
- Kauri dieback
  - kauriprotection.co.nz
  - tiakitamakimakaurau.nz/protect-and-restore-our-environment/guide-to-managing-kauri-dieback

Heritage

- Caring for archaeological sites
  doc.govt.nz/our-work/heritage/heritage-publications/caring-for-archaeological-sites/

Funding

- Funding opportunities
  tiakitamakimakaurau.nz/resource-library/funding-opportunities/

Other conservation resources

- Conservation map of Tāmaki Makaurau / Auckland
  tiakitamakimakaurau.nz/conservation-map/
- Auckland Conservation Directory
  tiakitamakimakaurau.nz/get-involved/auckland-conservation-directory
- Indigenous terrestrial and wetland ecosystems of Auckland
  knowledgeauckland.org.nz/media/1399/indigenous-terrestrial-and-wetland-ecosystems-of-auckland-web-print-mar-2017.pdf
- Landcare Reserve – What is this bug?
  landcareresearch.co.nz/tools-and-resources/identification/what-is-this-bug
- New Zealand Plant Conservation Network
  nzpcn.org.nz

Need help?

- Contact an Auckland Council specialist
  tiakitamakimakaurau.nz/contact-us

Auckland Council Environmental Strategies

- Te Tāruke-ā Tāwhiri: Auckland's Climate Action Plan
  aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/topic-based-plans-strategies/environmental-plans-strategies/aucklands-climate-plan/Pages/default.aspx
- Auckland's Urban Ngahere (Forest) Strategy
  aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/topic-based-plans-strategies/environmental-plans-strategies/Documents/urban-ngahere-forest-strategy.pdf
- Indigenous Biodiversity Strategy
  aucklandcouncil.govt.nz/environment/what-we-do-to-help-environment/Documents/indigenous-biodiversity-strategy.pdf
- Low Carbon Auckland
  aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/topic-based-plans-strategies/environmental-plans-strategies/docslowcarboncopy/low-carbon-strategic-action-plan-full.pdf

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