Restoring a Native Coastal Forest Sequence in North Canterbury: Te Kōhaka o Tūhaitara Trust and Coastal Restoration Trust

Final Project Report

David Bergin and Michael Bergin
Coastal Restoration Trust of New Zealand
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Site preparation and completion of the first back dune planting by the Te Kōhaka o Tūhaitara Trust at the start of the coastal forest sequence planting project, Tūhaitara Coastal Park, September 2020. Note the planted biota node in the middle distance, a successful planted cluster of native trees and shrubs.

Prepared by Environmental Restoration Ltd for the Coastal Restoration Trust of New Zealand, in collaboration with Te Kōhaka o Tūhaitara Trust.

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Executive Summary

Overview
This project, a collaboration between Te Kōhaka o Tūhaitara Trust and the Coastal Restoration Trust, aimed to establish a native coastal forest sequence across a degraded dune landscape within the Tūhaitara Coastal Park, North Canterbury. It provides insights into how native ecosystems from foredunes to inland coastal podocarp forest can be restored in coastal Canterbury using practical planting techniques with implications for encouraging natural regeneration.

Results
Despite major setbacks including COVID-19 restrictions, mid-project flooding, and a fire in late 2022 that destroyed much of the planted transect, the project evaluated a range of restoration strategies. In response to the fire, the project also shifted focus to assessing biota nodes: strategically planted clusters of native vegetation established over the past decade by Te Kōhaka o Tūhaitara Trust. These nodes provided valuable insights into effective methods for establishing native ecosystems in challenging coastal dune environments dominated by exotic species such as marram grass and pines. Key findings include:

- **Foredune plantings:** The native sand binder spinifex successfully colonised the seaward faces of foredunes and promoted sand accumulation. However, pīngao plantings were heavily browsed by rabbits, limiting their establishment.
- **Planting within pines:** Although ultimately destroyed by the almost park-wide fire, early results suggested that native species planted in gaps within pine stands initially benefited from the more sheltered environment.
- **Biota nodes:** Strategic cluster plantings across the park showed clear ecological benefits. Older, well-managed nodes exhibited increased native species richness, vegetation height, and resilience, particularly where fencing and maintenance were in place.
- **Seed islands on logged sites:** Attempts to establish groves of native trees and shrubs on inland logged pine sites were largely unsuccessful where exposed and stripped of vegetation. More favourable outcomes were seen in sheltered microsites or where plantings were integrated with exotic regrowth or amongst logging slash.

Assessment of 11 biota nodes and 5 unplanted control sites on the landward dunes found statistically significant increases in native vegetation cover, species diversity, and vertical structure, particularly in nodes planted more than a decade ago. Older nodes also showed a marked reduction in exotic species dominance, especially in the upper vegetation tiers. These trends point to the successful establishment of native-dominated coastal shrubland, with some sites on a clear trajectory toward forest development. Over time, these maturing nodes are likely to act as seed sources, promoting natural regeneration and expansion of native vegetation across the wider dune system.

Recommendations
The project provides practical recommendations relevant to other coastal restoration efforts across Aotearoa New Zealand:

- **Foredune planting:** Spinifex was confirmed as the key native sand binder, performing well, even near its southern natural range limit in Canterbury. Pīngao establishment was limited by rabbit browsing, highlighting the need for effective pest control.

- **Targeted cluster planting more effective than blanket planting:** Clustered plantings such as biota nodes and seed islands can be more successful than large-scale blanket planting a variable, exposed coastal dune landscape. By targeting favourable microsites like dune swales, these biodiversity hubs create sheltered conditions and serve as seed sources to promote natural regeneration.
- **Work with nature:** Restoration strategies aligned with natural succession processes are more successful. This includes using a limited number of hardy, early-successional natives initially to create shelter for later inter-planting of forest species.
- **Integrate operational methods into adaptive practice:** Restoration at Tūhaitara was grounded in practical, hands-on techniques that were refined over time based on what proved most effective. Methods included fencing small cluster plantings to exclude pests, using tree protectors where fencing was not feasible, applying mulch to conserve soil moisture, and restoring wetlands where appropriate.
- **Matching species to appropriate microsites:** A flexible mosaic approach matching species to specific landforms such as foredunes, swales, dune ridges, and flats enhanced survival and growth, building on existing restoration areas. Species selection was limited to those best suited to site conditions.
- **Avoid excessive site clearing and use existing shelter:** Retaining logging slash or low-stature exotic woody cover (e.g. tree lupin, wild broom) helps protect seedlings, retain soil moisture, and reduce browsing. Aggressive species like pine and willow still require active control.
- **Implement strategic pest management:** While fencing improved growth and diversity in some nodes, it is costly and impractical at scale. Alternative strategies include planting less palatable natives (e.g. tauhinu, harakeke) and using biodegradable tree protectors to reduce browse and aid establishment.
- **Support community involvement:** The Trust's engagement with schools, whānau, businesses, and volunteers through events, education, and research was critical to the project's success and long-term stewardship.
- **Prioritise long-term monitoring:** Regular monitoring enables timely maintenance (e.g. weed control, tree protector adjustments, pest damage response), informs adaptive management (e.g. refining species selection and planting methods), and generates valuable insights to guide broader coastal restoration efforts and outcomes (e.g. enhanced ecosystems, improved visitor experience).

Conclusions

The findings support a shift toward nature-based, adaptive restoration tailored to site conditions and ecological dynamics, especially in degraded coastal dune environments. Restoration is most effective when it combines strategic native planting with natural successional processes. Addressing barriers to planting and encouraging natural regeneration such as invasive weeds, pest animals, and seed and bird predators is essential. Long-term success also relies on community involvement, continuing applied research and adaptive management, and ongoing monitoring and maintenance to establish and manage resilient, self-sustaining native ecosystems.

Table of Contents

1. Background and Rationale

New Zealand's coastal ecosystems have been heavily modified since human settlement, with most lowland and coastal areas now dominated by exotic vegetation including productive forestry, pastoral farming, or urban development. In Canterbury, as in most regions of Aotearoa, intact native coastal vegetation sequences with a complete sequence of vegetation dominated by natives are virtually non-existent. Te Kōhaka o Tūhaitara Trust, kaitiaki of the 700-hectare Tūhaitara Coastal Park north of Christchurch, holds a multi-generational vision to restore the park's ecological integrity through re-establishment of indigenous coastal ecosystems.

This project, developed in partnership with the Coastal Restoration Trust, aimed to establish a demonstration coastal sequence of native vegetation – from foredunes through shrublands and wetlands to inland podocarp forest – that reflects the natural dune systems of North Canterbury prior to extensive modification. The rationale is to guide coastal restoration nationwide, promote biodiversity and mahinga kai, and increase resilience to climate change.

2. Project Objectives

The project aimed at demonstrating practical methods for establishing appropriate coastal native vegetation cover as part of the Te Kōhaka o Tūhaitara Trust's long-term vision of rehabilitation and management of the Tūhaitara Coastal Park. Specific objectives of this project included:

- Investigate methods for establishing a 50–100 m wide transect of native coastal plant species to form a sequence from foredunes to landward back dunes.
- Determine practical approaches to convert the current vegetation dominated by exotic pines and marram grass with native sand binders, wetland species, coastal shrubs, and podocarp forest.
- Link existing native restoration areas such as Tūtaepatu Lagoon adjacent to the selected transect to the sequence of natives from foredunes to back dunes.
- Engage the local community, schools, service groups and the public in planting and maintenance to enable them to take ownership and learn of the restoration process.
- Develop practical guidelines for other coastal restoration initiatives for coastal managers, landowners and Coastcare groups in other regions of Aotearoa.

Due to a series of unexpected setbacks, the project broadened its scope to include the following:

- Evaluation of biota nodes (cluster planting) established over the past decade by Te Kōhaka o Tūhaitara Trust.
- Investigation of seed islands planted during this project on a landward back dune zone as a practical restoration method on a recently logged pine site.
- Development of recommendation based on these assessments, regarding the roles of targeted planting and nature-based approaches in supporting the natural regeneration of a native-dominated coastal vegetation sequence.

3. Planting Programme and Implementation

The project commenced in 2020 following a successful application to the Department of Conservation's Community Fund. A planting design involved implementing best practice methods

along a 50-100m wide transect extending from the foredunes to inland zones, located along the northern edge of Tūtaepatu Lagoon. This area was selected by the manager and staff of Te Kōhaka o Tūhaitara Trust, building on a series of earlier restoration initiatives undertaken by the Trust (Figure 1). Key components of the implementation included:

- **Site selection and preparation:** A transect was established through the clearance of marram grass and mature pine trees, the latter felled as part of the park's production forestry programme.
- **Progressive planting:** Approximately 5,000 native plants were planted annually within the transect and adjacent areas from 2020 to 2024.
- **Planting treatments:** Depending on the zone use of tree shelters, slow-release NPK fertiliser tablets, and wood chip mulch were applied to plantings to improve survival by reducing rabbit browse and mitigating moisture loss during summer droughts.
- **Monitoring and evaluation:** Monitoring plots were established within each planting zone to assess early survival and growth, as well as to identify threats and challenges to successful establishment.

Species selection was matched to site conditions along the coastal gradient. On exposed foredune slopes, native sand-binding and salt-tolerant species such as pīngao, spinifex, and shore spurge were established. Mid and back dune zones were planted with a diverse mix of hardy native shrubs and monocots, including tauhinu, harakeke, akeake, tī kōuka, tarata, kōhūhū, koromiko, kāramū, toetoe, mānuka, mingimingi, broadleaf, ribbonwood, kānuka, fivefinger, and putaputawētā. On more sheltered inland sites, groves of long-lived podocarps such as tōtara, mataī, and kahikatea were interplanted within the shrub layer as future canopy trees.

A full list of species referenced in this report, including common, Māori, and botanical names, is provided in the Appendix.

In parallel, Te Kōhaka o Tūhaitara Trust are gradually replacing exotic willows around the lagoon margins by poisoning and underplanting with native species, particularly kahikatea, to support the restoration of indigenous vegetation aligned with mahinga kai values and cultural significance.

A key component of the project was involvement of the local community in the planting along the coastal sequence demonstration area.

Figure 1. Location of the demonstration transect within Tūhaitara Coastal Park, North Canterbury, established to evaluate methods for restoration of native vegetation across a sequence of coastal zones, from foredunes to back dunes.

4. Challenges and Setbacks

The project however, faced several unforeseen events:

- COVID-19 lockdowns implemented within the first 2 years of the project restricted community involvement during early planting seasons resulting in delays in planting some of which had to be done by contractors and park staff.

- Flooding in mid-2022 delayed planting on saturated dune sites during that year and delayed planting until later in the season.
- A major fire in November 2022 burned 160 ha including much of the transect with loss of most of the native plantings and monitoring plots.

As expected for a harsh coastal site typical of the dry eastern coasts of Canterbury, other challenges included browsing by rabbits, dieback and mortality of planted natives during prolonged summer droughts, and competition from aggressive exotic regrowth such as tree lupin and marram grass especially where timely weed control was not carried out.

These setbacks necessitated rescheduling and replanting efforts, supported by additional seedlings from Trees That Count and recovery planning by the Trust that included a focus on assessing foredune sand binder planting, evaluating biota nodes as a planting concept across a challenging dune landscape, extending plantings to seed islands at the inland end of the transect, and recovery of both exotic and native vegetation on burnt areas.

Fire damaged stand of ti kouka planted adjacent to the Tūtaepatu Lagoon with some recovering and regrowth of dense bracken.

View seaward before the transect project started and the land cleared of slash. Note the willows in the foreground before poisoning (left – photo November 2018). Post salvage and removal of burnt pine after fire (right – photo taken May 2025). The pine forest has been recently felled leaving a limited protective buffer.

5. Planting and Early Performance

Establishment and management techniques were adapted to suit the diverse site conditions along the coastal transect from foredune to mid-dune and inland zones building on the restoration work carried out by Te Kōhaka o Tūhaitara Trust.

Foredune planting

Native sand-binding species spinifex and pīngao were established on foredunes using best-practice restoration techniques:

- Planting sites were selected on bare, mobile sand or in areas previously treated with herbicide to control marram grass. High-quality, nursery-raised seedlings were planted into deep pits with slow-release NPK fertiliser tablets. Protective fencing was installed near accessways to minimise trampling by beach users.
- The planting strategy focused on spinifex as the dominant species, with pīngao interplanted in clusters within the spinifex sward.
- Spinifex exhibited high survival and quickly dominated the frontal dune, promoting the formation of low-angle dunes, in contrast to the steeper dune profiles typically formed by marram grass.
- Pīngao suffered extensive browsing by rabbits, limiting its success. Shore spurge (*Euphorbia glauca*), planted in smaller numbers, initially survived but declined over time due to similar browsing pressure.

Refer to the Coastal Restoration Trust Technical Handbook for detailed guidelines on establishment of sand binders on foredunes https://www.coastalrestorationtrust.org.nz/resources/crt-resources/coastal-restoration-handbook/.

Planting of native sand binders spinifex and pingao on the foredune cleared of marram grass in September 2021 at the seaward end of the transect (left). The site was fenced to reduce trampling damage from beach users (right).

A dense sward of spinifex developed within two years of planting, while pīngao suffered severe browsing from rabbits. The foredune was unaffected by the fire in late 2022, as evident from the burnt pines visible in the background (photo taken May 2023).

Over the past four years, the spinifex-dominated dunes have built a low-angle foredune with substantial sand accumulation, burying the fence (right – photo taken May 2025).

Inter-planting among existing mid-dune pines

Before fire destroyed the pine forests, test plots of native shrubs and small trees were established under pine canopies to assess whether the sheltered microclimate would improve native establishment:

- Planted species included ngaio, akeake, kōhūhū, kāramū, and koromiko.
- High survival and vigorous early growth were recorded within the first year.
- All plots were subsequently lost due to fire damage.


Interplanting of native shrub hardwoods within gaps and along edges of the existing pine forest, September 2020 (left). While these seedlings benefited from the shelter of the pines, all planted sites within the transect were lost due to the fire that destroyed 160 ha of the park in late 2023 (right – photo 4 months post fire).

Planting in harvested pine areas

Restoration efforts on exposed dune systems following pine harvest proved challenging due to harsh site conditions and invasive species pressure. Key observations included:

- **Site preparation:** Logging slash was windrowed to facilitate access for planting by community volunteers.
- **Planting approach:** A broad mix of native shrub hardwoods, monocots, and small tree species was established using mulch and tree protectors to mitigate drought stress and browsing pressure.
- **Invasive regrowth:** Cleared areas were rapidly recolonised by invasive species, particularly marram grass and yellow tree lupin, which impeded native establishment.
- **Survival outcomes:** Native plant survival was generally low. However, some success was observed with tauhinu, harakeke, tī kōuka (when not browsed), kōhūhū, koromiko, and akeake.
- **Site variability:** Growth and survival were markedly higher in sheltered, low-lying swales, while exposed dune ridges experienced high mortality due to drought and exposure.

For further information on suitable species and methods for back dune restoration, refer to the Coastal Restoration Trust Technical Handbook https://www.coastalrestorationtrust.org.nz/site/assets/files/1185/8.1_backdunes_-_an_introduction_new.pdf.




Site preparation of the clear-felled pine areas within the mid and back dunes was undertake by excavator and root rake in July 2020 to remove slash ready for planting that was completed by early spring.


With support from Trees That Count, a further 10,000 native seedlings have been planted within the transect following the fire (left). These plantings have been planted in clusters as part of a continued planting and weed control program resulting in scattered mixed aged plantings (right).

Replacement of exotic willows

The Trust has been progressively replacing willow-dominated riparian zones with native species using a staged conversion approach. In this method, willows are poisoned in place, creating a slowly decaying overstorey that provides shelter and moderated microclimates for underplanted native species such as kahikatea. This technique has proven effective across the region and is consistent with established best practice for riparian restoration.

For detailed guidance on this method, including planning, implementation, and species selection, refer to the Tāne's Tree Trust *Technical Handbook*, particularly the section on willow-to-native conversion, much of which was developed through restoration projects in Canterbury https://www.tanestrees.org.nz/site/assets/files/1069/9_5_what_is_it_with_willows.pdf.

6. Performance of biota nodes

Establishment and concept

Te Kōhaka o Tūhaitara Trust has established biota nodes across diverse dune environments, including gaps in pine forests and open sites dominated by exotic grass and woody brush vegetation. These were designed as biodiversity hotspots and long term would become seed sources of native shrubs and trees to assist natural regeneration of the dunes. As described on the Trust's website https://www.tuhaitarapark.org.nz/:

> *The Trust has been establishing a series of 'biota nodes' along the 10.5km length of the Trust's lands at approximately 250m intervals.*
>
> *With 'biota' meaning the ecological system (flora and fauna) of a particular environment, and 'node' being a point of intersection, these biota nodes are a series of small, localised points of native wildlife, which, as they mature, will extend outwards to form a 'biodiversity skeleton' stretching the length of the park. Each contains a freshwater pond and native plant life that will attract birds, aiding seed transfer for easy and eventual self-maintaining propagation.*
>
> *Each node is to be adopted and maintained by a business, school, class, whānau or community group.*
>
> *Currently we have 65 established biota nodes. Over 10,000 native plants including mānuka, harakeke, tī kōuka, tarata, ake ake, kahikatea and tōtara, among others, have been planted.*
>
> *With the support of the Working Waters Trust and the University of Canterbury - Conservation, Systematics and Evolution Research Team, Kōwaro/Canterbury Mudfish fry have been released into a number of nodes. This will help extend the habitat of this threatened species within Tūhaitara Coastal Park.*

There are many examples of cluster planting of natives established over a decade ago by Te Kōhaka o Tūhaitara Trust flourishing with a range of the hardy early successional native shrub and monocot species where later successional tree species can be inter-planted to become a long-term seed source.

Assessment methods

Biota nodes planted within or adjacent to the coastal transect have been assessed to provide additional information on survival and growth of a diverse range of natives both planted and naturally regenerating. The assessment methods included:

- Selection of 11 biota nodes that had been planted with natives ranging in age from 4-13 years old were assessed; and additional 5 unplanted sites were selected and vegetation cover assessed as controls.
- A modified RECCE vegetation monitoring system developed by Tāne's Tree Trust to quantify successional and ecological change over time as native forest develops was used to assess performance of the biota nodes, both planted and regenerating vegetation (Kimberley et al. 2025).
- Reconnaissance plot descriptions (RECCEs) are a versatile technique used for inventory and monitoring in a wide range of vegetation types (refer to Hurst et al. 2022: The Recce method for describing New Zealand vegetation – field manual Manaaki Whenua – Landcare Research (https://nvs.landcareresearch.co.nz/Content/Recce_FieldManual.pdf).
- Monitoring plots ranged in size from 177 m² for control sites to up to 1,750 m² for biota nodes, excluding areas of significant standing water.
- For each plot field measurement included:
    - Mean top height of vegetation, estimated percentage canopy cover of woody species and cover of standing water in ponds where these occurred within biota nodes.
    - Recording species cover abundance within 6 height tiers: 1 = <0.3 m, 2 = 0.3 -2 m, 3 = 2-5 m, 4 = 5-12 m, 5 = 12-25 m, 6 = >25 m.

- Assigning Braun–Blanquet cover abundance scores for each species within each tier: 1 = < 1%, 2 = 1–5%, 3 = 6–25%, 4 = 26–50%, 5 = 51–75%, 6 = 76–100%.
- Browse score for each species: 0 = none; 1 = light; 2 = medium; 3 = heavy.

- Data were analysed to compare top height growth, species richness, mean stand density of woody stems, percentage native cover, and mean Shannon Diversity Index across four age categories: 0 years (control plots), and for planted biota nodes <10 years, ≥10 years (unfenced), and ≥10 years (fenced).

Results and observations

Vegetation characteristics for the 16 assessed plots including stand density, species richness, and the Shannon diversity index for both native and exotic vegetation are presented in Table 1.

Table 1: Characteristics of each biota node and control plot, ranked by age since planting.

Plot No.	Age	Plot area excluding water (m^2)	Fence status	Plot type	Height of tallest stem (m)	Stand density (stems/ha)		Species richness (no. species)		Shannon diversity index % Exotic cover	
						Natives	Exotics	Natives	Exotics	Natives	Exotics
6	0	177	Unfenced	Control	2.1	0	566	1	7	0	0.95
8	0	177	Unfenced	Control	1.5	0	905	1	6	0	0.87
9	0	177	Unfenced	Control	1.3	0	340	2	7	0.69	0.26
10	0	177	Unfenced	Control	4.5	340	113	3	4	0.09	1.37
11	0	177	Unfenced	Control	3.5	0	3678	1	6	0	1.58
4	4	177	Unfenced	<10yr	1.2	2264	453	7	3	1.59	0.8
7	6	540	Unfenced	<10yr	2	19	56	7	4	0.95	0.56
14	6	420	Unfenced	<10yr	4.4	786	0	11	2	2.06	0.22
15	8	320	Unfenced	<10yr	5.1	750	31	9	5	1.16	1.43
3	9	177	Unfenced	<10yr	2.8	1302	340	11	6	1.58	0.51
2a	10	400	Fenced	≥10yr fenced	5.5	1450	625	17	8	2.13	0.53
2b	10	400	Unfenced	≥10yr	4.5	700	750	9	4	1.22	0.4
5	10	177	Unfenced	≥10yr	6	2377	57	15	4	1.71	0.32
12	10	1750	Unfenced	≥10yr	5.5	394	177	15	8	2.49	0.99
13	10	177	Unfenced	≥10yr	5.7	1641	57	13	6	2.21	1.54
1	13	400	Fenced	≥10yr fenced	6.5	1425	100	12	9	2.07	0.96

These plots include unplanted control sites and planted biota nodes. Despite some variability among plots, clear trends emerge:

- Native vegetation shows increasing stand density, species richness, and diversity with time since planting.
- Exotic vegetation generally shows a declining trend in dominance as the biota nodes age.

Analysis of the vegetation data collected using modified RECCE methods reveals the following key patterns (Figure 2):

- **Height of tallest woody stems** increased from a mean of 2.5 m in control plots to 5.5 m in biota nodes ≥10 years old, and up to 6 m where they were fenced at planting. The tallest species in control plots were typically scattered yellow tree lupin (Figure 2A).
- **Native species richness** increased markedly over time from fewer than 2 species in control plots to over 13 species in ≥10-year-old unfenced biota nodes, and over 14 species where fenced. Exotic species richness remained relatively stable (4–8 species) across all plot types (Figure 2B).
- **Native stand density** increased significantly with planting age, rising from <100 stems/ha in control plots to over 1200 stems/ha in older unfenced biota nodes, and over 1400 stems/ha in fenced biota nodes. Meanwhile, **exotic stand density** decreased from over 1000 stems/ha in control plots to <400 stems/ha in older biota nodes (Figure 2C).
- The **Shannon diversity index** for natives increased substantially with time since planting, while diversity for exotics remained relatively unchanged (Figure 2D).

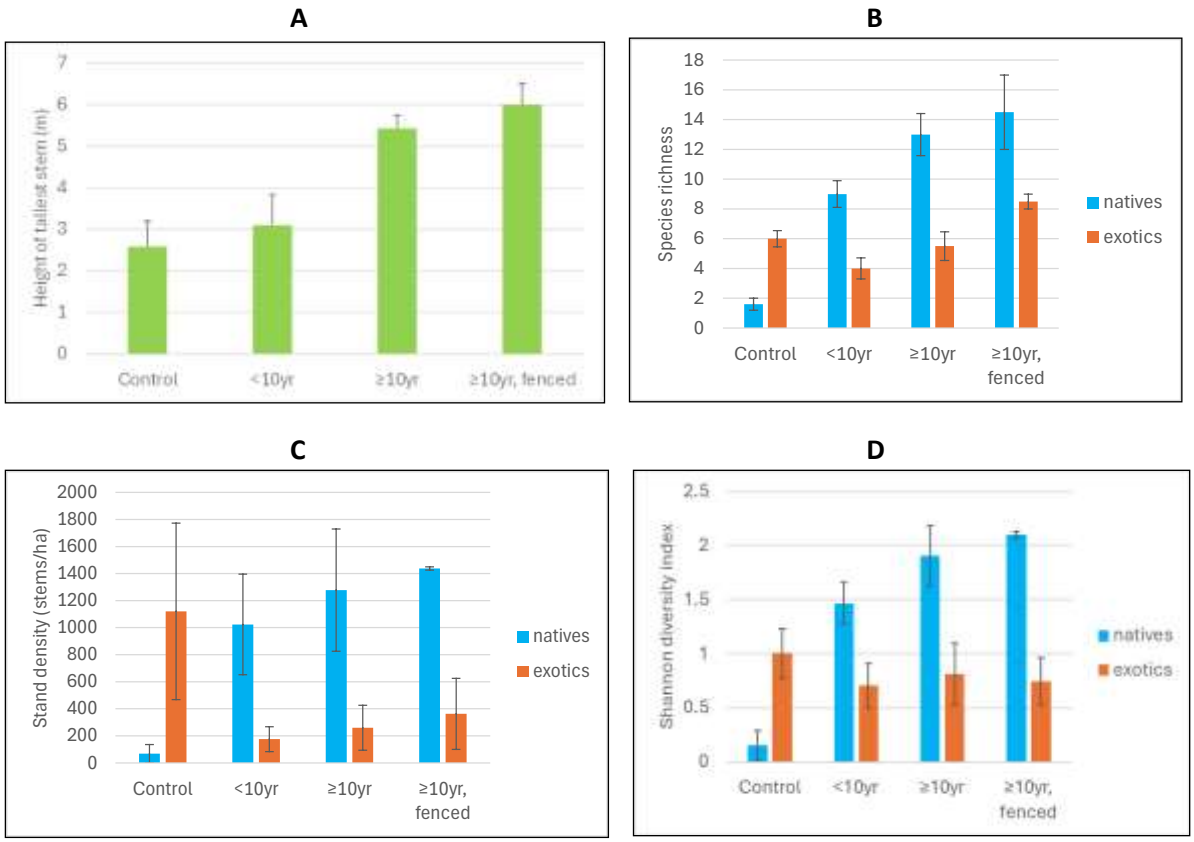

*Figure 2: Mean height of tallest stem by plot type for both all species (**A**), and species richness (**B**), stand density (**C**), and Shannon Diversity Index score (**D**) by plot type for native and exotic species. Error bars show standard errors.*

Vegetation structure by height tier also shows a consistent shift over time (Table 2). Cover values are calculated with equal weighting across tiers, which accentuates exotic dominance in lower tiers of control plots (e.g., exotic grasses and herbs like marram grass dominate Tier 6 in Plots 6, 8, and 9). However, in some control plots (e.g., Plots 10 and 11), native species such as bracken dominate Tier 6, likely due to vegetation recovery following the 2022 fire, just over 2 years before this assessment.

With increasing planting age:

- Exotic dominance in the lower tiers (Tier 6: 0–0.3 m; Tier 5: 0.3–2 m) decreases.
- Natives become increasingly dominant in the higher tiers (Tier 4: 2–5 m; Tier 3: >5 m).
- Only native species were recorded in Tier 3 (>5 m); no exotics were observed at heights above 5 m in any plot.

Table 2: Mean % cover for each plot by tier shown separately for native and exotic species. Plots are ranked from the unplanted control sites to the older planted biota nodes.

Plot No.	Age	Plot type	Natives				Exotics			
			Tier 3	Tier 4	Tier 5	Tier 6	Tier 3	Tier 4	Tier 5	Tier 6
			(>5m)	(2-5m)	(0.3-2m)	(0-0.3m)	(>5m)	(2-5m)	(0.3-2m)	(0-0.3m)
6	0	Control	0	0	0.5	0.5	0	0.5	8.5	46
8	0	Control	0	0	0.5	0.5	0	0	55.5	55.5
9	0	Control	0	0	1	1	0	0	93.5	91
10	0	Control	0	1	89	64	0	0.5	2	2
11	0	Control	0	0	63	38	0	0.5	8	3
4	4	<10yr	0	0	6	6	0	0	1	4
7	6	<10yr	0	0	21	21	0	0	4.5	17
14	6	<10yr	0	1.5	13	10.5	0	0	1	16
15	8	<10yr	0.5	1.5	22	19.5	0	0	2.5	5
3	9	<10yr	0	2.5	25.5	28	0	0	18	70.5
2a	10	≥10yr fenced	0.5	8.5	26	16	0	0.5	6.5	66.5
2b	10	≥10yr	0	4.5	24.5	22	0	0.5	19.5	94.5
5	10	≥10yr	3.5	34.5	42.5	10	0	0	4.5	39.5
12	10	≥10yr	0	1.5	12	10	0	3	18.5	6.5
13	10	≥10yr	0.5	5	13.5	11.5	0	0.5	2	5.5
1	13	≥10yr fenced	4	24	66	16	0	0.5	4.5	44.5

Other observations of the performance of planted biota nodes include:

- Biota nodes established over the past decade, particularly those that were mulched and fenced, exhibited strong resilience, with several surviving recent fire events. Nodes dominated by low- to moderately-flammable native species demonstrated superior performance under fire conditions.
- Although only a small number of nodes were fenced, there was a consistent trend of improved growth and greater species diversity over time compared to unfenced nodes.
- While assessment data indicates a trend toward the development of a dominant native canopy of shrubs and trees within planted biota nodes, exotic woody species are still present in the upper vegetation tiers. Although some of these exotics may eventually be outcompeted or shaded out by native species, aggressive invaders such as pine, poplar, and willow are likely to persist and could potentially dominate restored sites. Ongoing

management will be required to target these tall, persistent exotic species to ensure the successful establishment and long-term resilience of native ecosystems.

- The inclusion of excavated wetlands and ponds at the time of establishment added a valuable dimension to some biota nodes. These features likely enhanced node resilience and contributed to greater biodiversity by providing habitat for a wider range of plant and animal species. In some cases, ponds enabled the reintroduction of native species such as mudfish (kōwaro) by park staff.

View of the 'Tamariki of Woodend' Biota Node – before (left) and after (right) fire impact. This biota node, the oldest planted in the park, was established 13 years prior to the transect project and fenced and planted with a diverse mix of native trees and shrubs around a small pond (left – photo taken November 2018). At the time, it was located within a sheltered gap in tall pine forest, with recently felled pine areas nearby and standing pines to the north. A fire in late 2022 destroyed the remaining pines and surrounding marram-dominated dunes. However, the biota node—now well-established with low to moderately flammable native species—survived the fire (right – photo taken May 2025).

Ponds have been excavated within some of the biota nodes before planting that has enhanced the local habitat allowing a great diversity of native species to establish by planting and natural regeneration. The Trust has also a programme of releasing the endangered New Zealand mudfish kōwaro into these ponds.

7. Planted seed islands on back dunes

Establishment and concept

With loss of plantings in the mid dunes due to fire and restricted access during pine harvesting, restoration efforts focused on establishing 'seed islands' at the landward end of the transect adjacent to Gladstone Road. Site preparation and planting involved:

- Several large clusters of natives were planted in 2023 following the harvesting pines and poplars across a 2.5 ha site.
- While most of the piled larger logging slash was chipped for biofuel and mulch, planting areas were scrapped by excavators down to sand removing leftover small slash material, grass and regrowth of brush weeds broom and gorse.
- Predominately totara was planted with some shrub hardwoods; akeake, akiraho, tarata and ribbonwood.
- All seedlings had cardboard guards added to provide protection on this exposed open site and to reduce rabbit browsing; wood chip/mulch was placed around the base of all planted seedlings with follow up additional chip added 1-2 times since.

Assessment methods

- Twelve baseline monitoring plots 5 meters in diameter were established across the planting cluster within a few weeks of planting in October 2023.
- Remeasurements were completed in July 2024 one year after planting and again in May 2025 two years after planting.
- Field measurements of the bounded plots involved:
    - Height by species of all planted native seedlings.
    - A subjective plant health score in one of 5 classes – 1 = poor, 2 = unthrifty, 3 = average, 4 = good, 5 = excellent.
    - Damage in one of 6 categories – frost, browse, insect, broken, dieback, weeds.
- Regrowth of broom, wilding pine and gorse that was present across the site was recorded if these occurred in the plots.

Inspection of the Gladstone Road totara seed island planting site in May 2025 with the Te Kohaka o Tuhaitara park rangers two years after planting.

Results and observations

Performance of the cluster plantings at the Gladstone Road site was poor two years after planting reflecting the harsh open site conditions (Figure 3). Specifically:

- Mean survival across all species was less than 50%.
- Height was little more than planting height at less than 50 cm.
- Mean plant vigour score was 2 (unthrifty) for all species.
- Most planted seedlings were assessed with dieback or had been swamped by weeds.

Observations of the performance of planted seed islands include:

- Mechanical scraping of planting sites removed surface litter, topsoil, and logging slash, leaving largely bare sand. This likely contributed to poor plant growth and survival, with fewer than 50% of native seedlings surviving within the first two years.
- Improved survival and growth were observed in areas where logging slash remained, likely due to enhanced soil moisture retention, microclimatic shelter, and reduced rabbit browsing.
- Similarly, planting natives within the shelter of existing exotic regrowth such as broom and yellow tree lupin improved performance.
- Collapse of many of the cardboard plant guards particularly where they were supported by only one bamboo stake negatively affected seedling performance by smothering young plants.

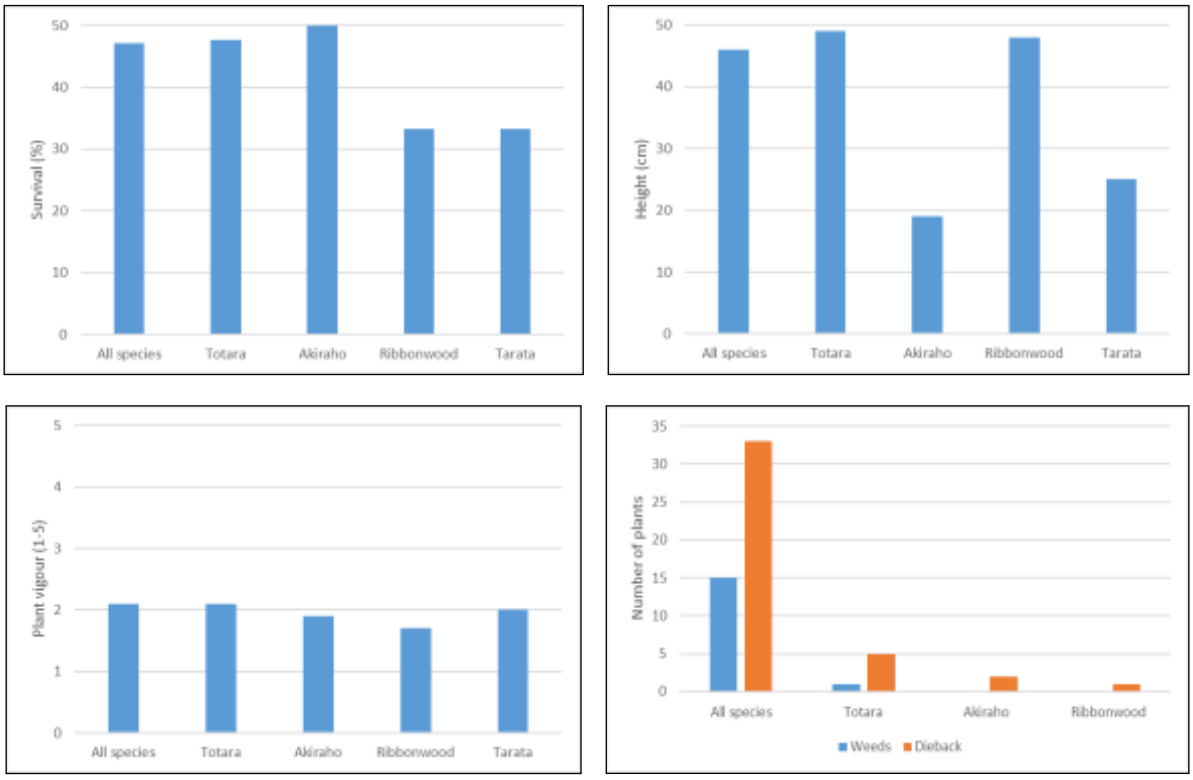

Figure 3: Mean survival, height, plant vigour and damage by species 2 years after planting.


Remeasurement of the planted native seedlings in a more sheltered seed island site. Note the totara which have a higher survival rate and better growth performance likely due to the increased shelter provided by the surrounding broom. Collapsing cardboard tree guards (right) with only one supporting bamboo stake are contributing to poor performance.


Surrounding vegetation such as dense exotic grass (left) and broom (right) have potentially helped with the establishment of the planted natives due to the shelter they provide by reducing exposure to frost and wind in winter and moisture loss in summer.

Although some of the surrounding exotic vegetation may be beneficial to the planted native seed islands such as the broom and exotic grass, other exotic species may pose a future threat and challenge to manage like the wilding pine near the edge of the plot. Work is under way through other parts of the site to fell and kill these wildings before they become too big.

8. Recommendations and Key Findings

The Tūhaitara Coastal Sequence Restoration Project has demonstrated practical and scalable approaches to restoring ecologically challenging coastal environments. Despite major setbacks—including fire, flooding, and COVID-19 restrictions—the project has generated valuable insights that support the long-term vision of Te Kōhaka o Tūhaitara Trust to restore the natural form and function of native coastal ecosystems, enhance indigenous biodiversity, and build resilience to climate change.

A key finding is the effectiveness of **seed islands** and **biota nodes**, both of which use cluster planting in targeted locations, as a strategic alternative to blanket planting. These interventions focus on areas with favourable conditions such as low-lying moist sites, remaining topsoil, or partial canopy from logging debris or regrowth of non-invasive exotic species. These “nodes” and “islands” serve as biodiversity hubs and seed sources, enabling the natural regeneration of native vegetation over time.

The concept and methods for establishing seed islands have been published by Tāne’s Tree Trust (https://docs.tanestrees.org.nz/how-to-establish-seed-islands-of-natives/). Demonstration sites across New Zealand, established in collaboration with Trees That Count, are testing these approaches in a variety of landscapes and forest types.

Evaluation of operational work at Tūhaitara Coastal Park confirms that **strategic placement and ongoing management** of seed islands and biota nodes are more effective than large-scale uniform planting. This approach aligns with ecological principles by working with natural processes to restore native vegetation at scale and over realistic timeframes. A schematic diagram (Figure 4) illustrates how this method can support regeneration from foredunes to back dunes.

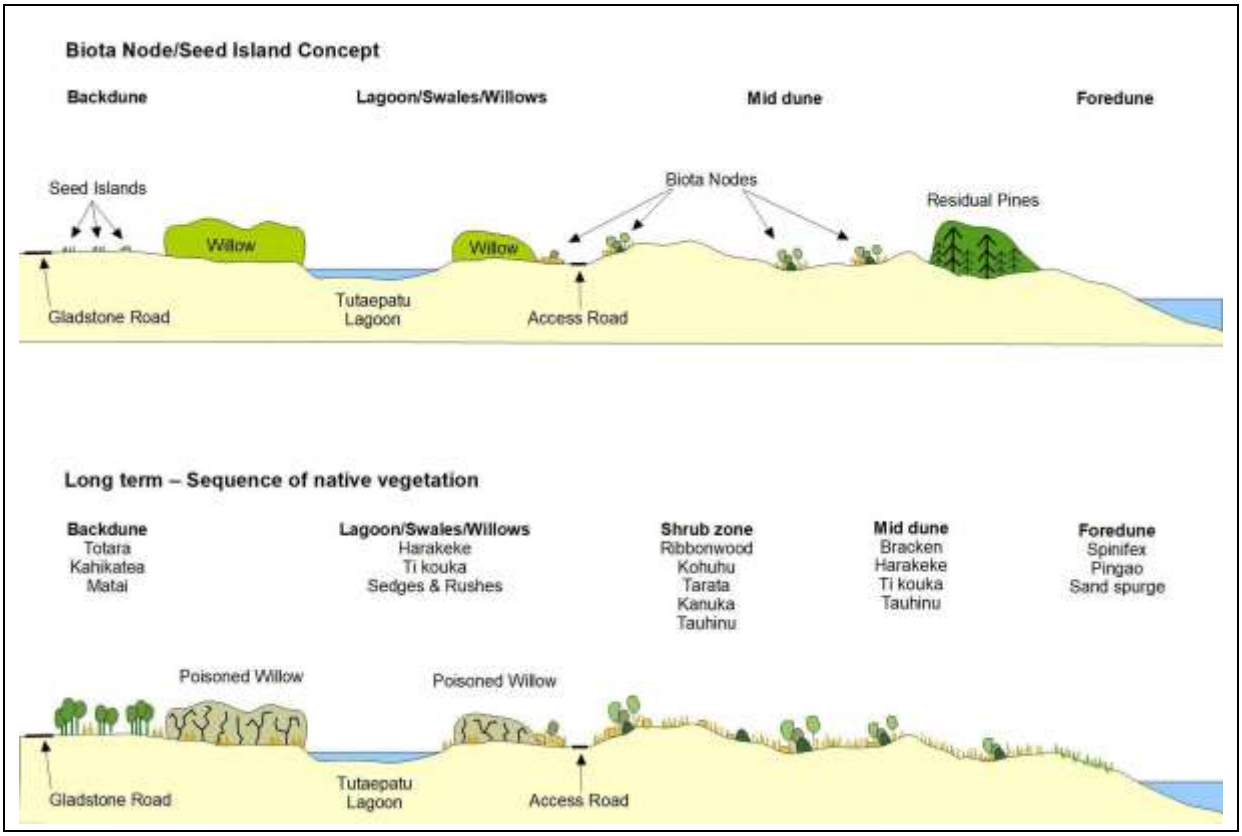

Figure 4: A schematic profile of the coastal sequence where biota nodes established by Te Kōhaka o Tūhaitara Trust and seed islands initiated as part of this project can be used to assist the long-term natural regeneration of native coastal ecosystems across the dune sequence.

The project has provided valuable insights to guide future restoration efforts in coastal environments:

- **Foredune planting:** At Tūhaitara, spinifex demonstrated strong performance in forming a dense sward from the high tide mark to the dune crest, confirming its suitability as the primary native sand-binding species on seaward foredune slopes, even near the southern limit of its natural range. In contrast, pīngao, which is more palatable to rabbits, struggled to establish in areas with high browsing pressure. Unless effective rabbit control measures are in place, planting pīngao in such environments is unlikely to be successful.
- **On landward dune zones, targeted planting may be more effective than blanket planting:** The project confirmed that a blanket approach to planting is often inefficient in difficult coastal settings. Instead, targeted small cluster plantings such as **biota nodes** and **seed islands** on appropriate sites may prove to be more effective and better suited to highly variable sites on dunes. These clustered plantings create biodiversity hotspots that act as nuclei for native vegetation to spread, supporting ecosystem resilience and long-term sustainability.
- **Working with nature is essential at scale:** Restoration approaches that mimic natural succession such as establishing early successional species, followed by inter-planting and creating conditions for natural regeneration are more likely to succeed in creating diverse, self-sustaining native ecosystems over time.

- **Integrate applied research with operational best practice:** Operational methods by Tūhaitara Coastal Park staff, including fencing, mulching, wetland creation, and species selection, have provided valuable insights into adopting an adaptive management approach that will provide practical guidance for other restoration initiatives.
- **Adopting a mosaic restoration approach:** Restoration success is highly dependent on micro-site conditions such as exposure, shelter, soil development, and moisture. A mosaic approach using species-specific plantings tailored to foredunes, dune ridges, swales, wetlands, and inland dunes is recommended. Plantings should also be designed to connect and extend existing restoration areas
- **Leverage existing vegetation cover but control aggressive invaders:** Existing vegetation can provide critical shelter for new plantings, but persistent and fast-growing exotics (e.g. pine, poplar, willow) must be actively managed to prevent them from outcompeting native species.
- **Reduce disturbance during site preparation:** Over-clearing vegetation and logging slash should be avoided where practical. Instead, planting within microsites that retain shelter and organic matter such as within light exotic cover or slash improves moisture retention, seedling survival, and deters rabbit and hare browse.
- **Enhance resilience through strategic species selection:** Focus initial plantings on hardy, early successional native species to establish cover and enable later enrichment planting. Planting low-flammable and salt-tolerant native species is also likely to improve resilience to fire, wind, and climate-related stressors.
- **Strategic planting to reduce pest animal browse**: While pest control is challenging in a publicly accessible park, fencing some biota nodes has improved early growth and species diversity. However, fencing is costly. As a practical alternative, early plantings should include unpalatable natives (e.g. tauhinu, harakeke, ngaio, mingimingi, kānuka, wīwī) to establish cover before introducing more palatable species through inter-planting or natural regeneration.
- **Fostering community involvement and engagement**: Te Kōhaka o Tūhaitara Trust has a long history of engaging the local community in environmental restoration, education, and research. The adoption of biota nodes by schools, businesses, whānau, and community groups exemplifies this model. Engagement is maintained through planting days, educational modules, information signage, and collaboration with researchers across diverse disciplines.
- **Commit to long-term monitoring:** Ongoing ecological monitoring is essential for tracking progress, supporting adaptive management, and sharing lessons learned. This ensures practical guidance is available to other groups restoring native coastal ecosystems in Canterbury and beyond.

9. Conclusions

The findings support a shift toward nature-based, adaptive restoration approaches that respond to site variability and ecological dynamics, particularly in challenging coastal dune environments. They highlight the importance of tailoring restoration strategies to local conditions and working with natural processes, using strategic planting to facilitate and complement natural successional pathways.

While the planting of native species remains essential in many degraded dune systems, it is equally important to identify and address barriers to natural regeneration. These include the targeted control of aggressive exotic weeds, management of pest animals, and where feasible, reduction of seed and bird predators that inhibit dispersal by wind and native fauna.

Successful restoration also depends on the integration of community involvement, applied research and adaptive management, and a sustained commitment to monitoring and ongoing maintenance to build resilient, self-sustaining diverse native coastal ecosystems.

With such a harsh open environment on the mid and back dunes, it is recommended to focus on planting a limited number of the hardiest shrub and monocot species initially to provide shelter for inter-planting and regeneration of other species. These hardy early successional species include tauhinu, harakeke, toetoe, ngāio, ribbonwood, and with rabbit control and more sheltered sites tī kōuka, kōhūhū, karamū, tarata, akeake and koromiko

Planting less tolerant native species to increase diversity within the shelter of existing vegetation including established previous native plantings is likely to see more success.

Protecting planted native seedlings from rabbit damage and providing additional shelter is standard practice at Tūhaitara Coastal Park. The use of biodegradable tree protectors, preferably with adequate support from a minimum of 2 stakes to prevent collapse, is now being implemented rather than plastic alternatives.

10. Acknowledgements

This project has been a collaborative effort between Te Kōhaka o Tūhaitara Trust and the Coastal Restoration Trust of New Zealand. We extend our sincere thanks to Greg Byrnes, former long-time Manager of Tūhaitara Coastal Park, whose enthusiastic support was instrumental in initiating this project. Greg provided staff time and resources, identified suitable sites for planting and demonstration areas, and played a key role in promoting the project with the Te Kōhaka o Tūhaitara Trust, the local community, and for Coastcare groups nationwide.

We are also grateful to the current Trust Manager, Kelli Patterson, for her continued enthusiasm and support. Kelli has played a vital role in overseeing the monitoring and maintenance of the planting sites, assisting with project administration, and liaising with project partners. We acknowledge her dedicated team, including Biodiversity and Community Ranger Christopher Dawson, for his contributions to field assessments and the identification of biota node locations, and Senior Field Ranger Murray Franklin for his extensive operational experience in establishing and managing native vegetation across the park.

A key feature of this project has been the strong involvement of the local community. Over several years, community members have taken part in planting days to establish thousands of native plants within the demonstration transect site. Their efforts have included installing tree guards, applying mulch to improve survival rates, and supporting ongoing post-planting maintenance.

We also acknowledge the valuable contributions of our collaborating partners: Environment Canterbury, Christchurch City Council, University of Canterbury, Trees That Count, Tāne's Tree Trust,

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12. Appendix – species list

Species identified during the RECCE plot monitoring and planting assessments at Tuhaitara Coastal Park. Species were identified in the field as required using the Aotearoa Species Classifier https://apps.apple.com/nz/app/aotearoa-species-classifier/id1633570014.

Species code	Maori/common name	Botanical name	Biostatus
ACANOV	Red bidibid	*Acaena novae-zelandiae*	Native
AMMARE	Marram grass	*Ammophila arenaria*	Exotic
AUSTOE	Toetoe	*Austroderia toetoe*	Native
BETPEN	Silver birch	*Betula pendula*	Exotic
BLEMIN	Swamp kiokio	*Blechnum minus*	Native
CARPUM	Sand sedge	*Carex pumila*	Native
CARSEC	Pukio	*Carex secta*	Native
CARTES	Speckled sedge	*Carex testacea*	Native
COPARE	Thin-leaved coprosma	*Coprosma areolata*	Native
COPCRA		*Coprosma crassifolia*	Native
COPHYB		*Coprosma* hybrid	Native
COPPRO	Mingimingi	*Coprosma propinqua*	Native
COPROB	Karamu	*Coprosma robusta*	Native
CORAUS	Ti kouka	*Cordyline australis*	Native
CYPUST	Giant umbrella sedge	*Cyperus ustulatus*	Native
CYTSCO	Wild broom	*Cytisus scoparius*	Exotic
DACDAC	Kahikatea	*Dacrycarpus dacrydioides*	Native
DODVIS	Akeake	*Dodonaea viscosa*	Native
EUOJAP	Japanese spindleberry	*Euonymus japonicus*	Exotic
EUPGLA	Shore spurge	*Euphorbia glauca*	
FICNOD	Wiwi	*Ficinia nodosa*	Native
FICSPI	Pīngao, pikao	*Ficinia spiralis*	Native
GRILIT	Broadleaf	*Griselinia littoralis*	Native
HOHANG	Narrow-leaved houhere	*Hoheria angustifolia*	Native
HYPAMB		*Hypolepis ambigua*	Native
JUNEFF	Soft rush	*Juncus effusus*	Exotic
JUNPAL	Giant rush	*Juncus pallidus*	Native
KUNROB	Kanuka	*Kunzea robusta*	Native
LEPSCO	Manuka	*Leptospermum scoparium*	Native
LUPARB	Yellow tree lupin	*Lupinus arboreus*	Exotic
MUEAUS	Pōhuehue	*Muehlenbeckia australis*	Native
MYOLAE	Ngaio	*Myoporum laetum*	Native
OLELIN		*Olearia lineata*	Native
OLEPAN	Akiraho	*Olearia paniculata*	Native
OZOLEP	Tauhinu	*Ozothamnus leptophyllus*	Native
PHOTEN	Harakeke	*Phormium tenax*	Native
PINRAD	Radiata pine	*Pinus radiata*	Exotic
PITEUG	Tarata	*Pittosporum eugenioides*	Native
PITTEN	Kohuhu	*Pittosporum tenuifolium*	Native

PLADIV	Marsh ribbonwood	*Plagianthus divaricatus*	Native
PLAREG	Mānatu, ribbonwood	*Plagianthus regius*	Native
POACIT	Silver tussock	*Poa cita*	Native
PODTOT	Totara	*Podocarpus totara*	Native
POPALB	White poplar	*Populus alba*	Exotic
PRUTAX	Matai	*Prumnopitys taxifolia*	Native
PSEARB	Fivefinger, whauwhaupaku	*Pseudopanax arboreus*	Native
PTEESC	Bracken	*Pteridium esculentum*	Native
ROSRUB	Sweet brier	*Rosa rubiginosa*	Exotic
RUBFRU	Bush lawyer	*Rubus fruticosus*	Exotic
SALCIN	Grey willow	*Salix cinerea*	Exotic
SAMNIG	Elderberry	*Sambucus nigra*	Exotic
SCHTAB	Kuawa	*Schoenoplectus tabernaemontani*	Native
SOLCHE	Velvety nightshade	*Solanum chenopodioides*	Exotic
SOPMIC	Kōwhai	*Sophora microphylla*	Native
TYPORI	Raupo	*Typha orientalis*	Native
ULEEUR	Gorse	*Ulex europaeus*	Exotic
VERSAL	Koromiko	*Veronica salicifolia*	Native
VERSTR	Koromiko	*Veronica stricta*	Native
EXOGRA	Exotic grass		Exotic
EXOHER	Exotic herb		Exotic