Te Riu-o-Te-Aika-Kawa/Brooklands Lagoon & environs

Ecological restoration and planting plan

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Contents

Introduction

This restoration planting plan is for the areas of Council owned land that collectively comprises Brooklands Spit and Seafield Park (here within called Brooklands and shown in Figure 1). The ecosystems subject to this plan include the coastal dunes, the margins of the lagoon and the adjoining stable dunes and ephemeral wetlands that extend westward across previously residential land to the Styx River. The tidal lagoon, being the coastal marine area administered by DOC, is not included.

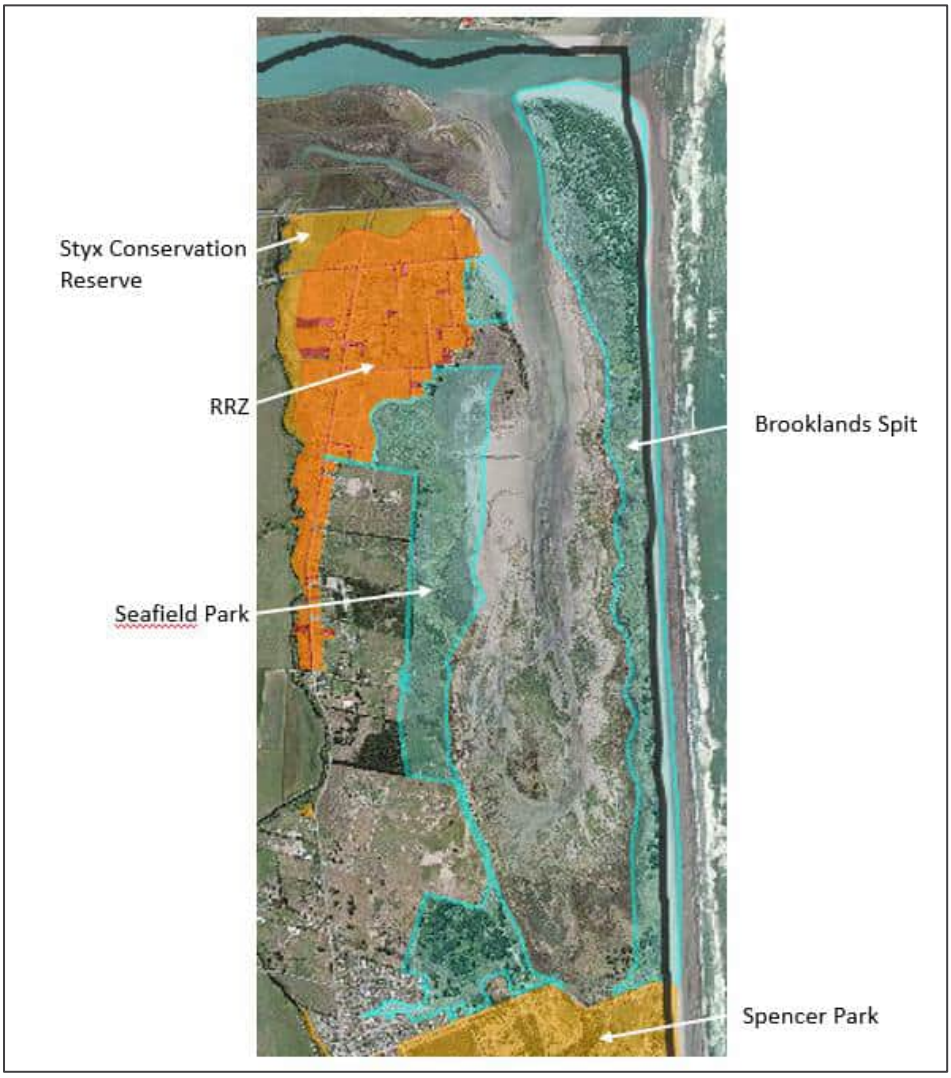

Figure 1: *Te Riu-o-Te-Aika-Kawa/Brooklands Lagoon & environs restoration plan project area*

Brooklands Lagoon is largely classified as Scenic Reserve that is subject to a master plan[1] in which a key objective is ecological restoration. It is also identified as a Schedule A, Site of Ecological Significance (SES – LP5) in the Christchurch District Plan. Council has a statutory obligation to protect and enhance its ecological values as a matter of national importance[2].

[1] https://ccc.govt.nz/assets/Documents/The-Council/Plans-Strategies-Policies-Bylaws/Plans/Park-management-plans/BrooklandsLagoonAreaParksMasterPlan2010.pdf

[2] Ministry for the Environment & Department of Conservation 2000. The New Zealand Biodiversity Strategy. Department of Conservation, Wellington, New Zealand.

Ecological context

Nationally, coastal ecosystems are classified as naturally rare[3] and threatened[4] owing to widespread loss and degradation nationwide. As a result their protection and restoration is an imperative for nature conservation[5].

Brooklands is one of the finest examples in the Canterbury Region of a coastal lagoon ecosystem (Figure 2). The mosaics of saltmarsh vegetation that comprise the lagoon margins are some of the most intact examples remaining in the region, it provides essential habitat for national and international migratory waders, and large numbers of indigenous waterfowl and other wetland/coastal birds. 111 bird species have been recorded, including 48 resident species and 23 seasonal visitors, with more than 20 threatened species and at risk species occurring. The adjoining dunelands, although highly modified, have high heritage values as an example of what was a widespread ecosystem across the eastern parts of district. They are a high priority for restoration where appropriate.

Figure 2: *Typical Te Riu-o-Te-Aika-Kawa/Brooklands lagoon margin.*

Stark environmental gradients are a feature of Brooklands. Most notably is the transition from exposed tidal mud of the lagoon proper through to dry mobile sand and the complex ecotones in between. Other key ecological drivers include degree water inundation from both tidal processes and flooding of the Waimakariri River. There

[3] Williams, P. A.; Wiser, S.; Clarkson, B.; Stanley, M.C. 2007. New Zealand's historically rare terrestrial ecosystems set in a physical and physiognomic framework. New Zealand Journal of Ecology, 31(2): 119–128.

[4] Holdaway, R.J.; Wiser, S.K.; Williams, P.A. 2012. Status assessment of New Zealand's naturally uncommon ecosystems. Conservation Biology, 2012

[5] Protecting our places: Introducing the national priorities for protecting rare and threatened biodiversity on private land. Available at https://www.biodiversity.govt.nz/land/guidance/

are subtle transitions from saline tidal water and brackish water, through to more freshwater influences associated with lagoon edge springs and rain derived ephemeral wetlands of inland swales. The presence of peaty soils, presumably associated with previous freshwater wetlands, also has a key influence on composition of plant communities that would be expected to have been present prior to modification.

The lagoon proper and tidal edges remain in notably in natural condition (Figure 3), supporting mosaics of saline tolerant native plant communities, typified by saltmarsh ribbonwood (*Plagianthus divaricatus*), rushes (*Juncus kraussii and Apodasmia simplex*) and seasonal 3 square (*Schenoplectus pungens*) that are highly representative of the original composition. The estuarine ecosystem shows a high degree of ecological integrity and resilience, as shown by the ability of the native plant communities to readily change composition in response to dynamic nature of the tidal environments.

The lagoon margins comprise a complex inter-tidal zone that extends into the dunes, characterised by convoluted edges of embayments, low dune islands and swales. The vegetation is characterised by mosaics of native salt-marsh, salt-meadow herbfields and reedlands that merge with drier dune margins that are invariably more modified.

Figure 3: *Typical Te Riu-o-Te-Aika-Kawa/Brooklands lagoon western margin at Seafield Park*

Dune hollows and swales that are disconnected from tidal inundation are dominated by saline tolerant exotic grasses such as tall fescue (*Schedonorus arundinaceus*) and/or marram (*Ammophila arenaria*) depending on levels of saturation. Increased salt water intrusion into previously dry swales and embayment appears to be occurring in places, owing to earthquake subsidence and possibly impending sea level rise. This is resulting in natural expansion of saltmarsh vegetation into sites otherwise dominated by tall fescue and other exotic species.

The dunelands are highly modified, dominated by exotic cover, such as marram grass, tree lupin (*Lupinus arborea*), pines (Pinus spp), and silver poplar that has replaced almost all the native plant communities once present. Occasionally present is akeake (*Dodonea lucida*), ngaio (*Myoporum laetum*), tauhinau (*Ozothamnus leptophylla*), bracken (*Pteridium esculentum*)[6], knobby clubrush (*Fincinia nodosa*), manuka (*Leptospermum scoparium*), tree daisy (*Olearia solandri*) and flax (*Phormium tenax*). It is hard to know if these extant native species are naturally occurring, but most are probably planted[7].

The dense cover of marram, pines, silver poplar, etc, has stabilised 'natural' sand movement causing coastal dunes (along the spit in particular) to increase considerably in height from what they would have otherwise attained when in native cover[8]. The loss of natural dune instability, in combination of increased dune height, are limitations to undertaking restoration of 'mobile' dune ecosystems, not least because of the potential risk of excessive sand movement occurring as a result of extensive pine and marram control that would be required. The difficulties of preventing constant reinvasion of weeds, in particular marram grass, further limits sustainable 'natural' restoration of mobile dune ecosystems.

Natural history

There are no detailed accounts of the natural character of Canterbury's terrestrial coastal ecosystems prior to European settlement and the extensive modification that followed. Consequently, there is conjecture over what comprised the 'original' vegetation of the dunes. It is clear, however, that the vegetation comprised coastal plant communities highly adapted to the changing nature of the environment that occurred in distinct zones with increasing distance from the foreshore and decreasing dune mobility. These plant communities merged together forming complex mosaics across sequences of dunes, sandplains and hollows, wetland swales and ponds.

Polynesian arrival and associated burning is likely to have removed the original cover. This would have induced low and patchy seral vegetation, and increased dune instability and mobility. European arrival further exacerbated dune instability, initially through introducing stock resulting depletion of sand binding vegetation such as pingao and spinifex (*Spinifex sericeus*). Early European descriptions[9] of the district mentions wandering dunes" that stretched considerable distances inland, often separated by wide sand plains, with inter-dune wetlands a notable feature. Described as follows[10]:

*"The south portion is fronted all along by a prominent foredune, inland to which is a small extent of dune. Farther inland still are found stable sand-plains. At the extreme end, near the estuary, are found moist sand-hollows. At the north end of the beach there is an artificial foredune for some distance from the pier; farther north there is no foredune. Here the dunes extend farther inland than those of the southern beach; the gently undulating dune-land nearset the shore has little plant covering, the pingao (*Scripus frondosus*) being here, as usual on the active dune, the dominant species. Farther inland the dunes are higher and the hollows deeper; and after rainfall there are numersou lakes, some of which dry up, but others appear stagnant, and have a rich vegetation."*

[6] Large areas of naturally occurring bracken occur on dunes in Seafield Park that is actively spreading and is a notable feature of the site.

[7] There is obvious planting of forest species occurring under silver poplar.

[8] The dunes along the coastal strip were considerably lower than they are today, with the most pronounced dunes were south Pegasus Bay and inland, becoming lower in the north.

[9] Armstrong, J. F. 1870._ On the Vegetation of the neighbourhood of Christchurch, including Riccarton, Dry Bush, etc. Trans. N.Z. Inst., vol. 2, p 119 (1870)

[10] Pegg, M. A. 1913. An Ecological Study of some New Zealand Sand-dune Plants In: Transactions N.Z. Inst. vol., ? Art. XXV.pg 150-176.

[11] "*It is evident from the shifting nature of the ground in the littoral zone that no large or continuous vegetation can occur; at the same time, from its diversified appearance, it is peculiarly interesting to the botanist. There we meet with a few shrubs, such as Cassinia, Carmichaelia, Discaria, Pimelia arenaria with its peculiar baccate fruit; and a considerable variety of herbaceous plants, principally consisting of coarse grasses, Carex, Clematis, Ranunculus, Scleranthus…etc, Tetragona, Pratia, sic species of Orchideae, and among Ferns, Pteris aquiline, Botrychium virginicum, the rare British fern Ophioglossum, and Drosera*."

Dune stabilisation measures that subsequently followed, such as planting marram grass, yellow tree lupin, pines, in combination with urban development, has replaced virtually all the native dune plant communities and vastly reduced the extent of dunelands to the coastal strip[12].

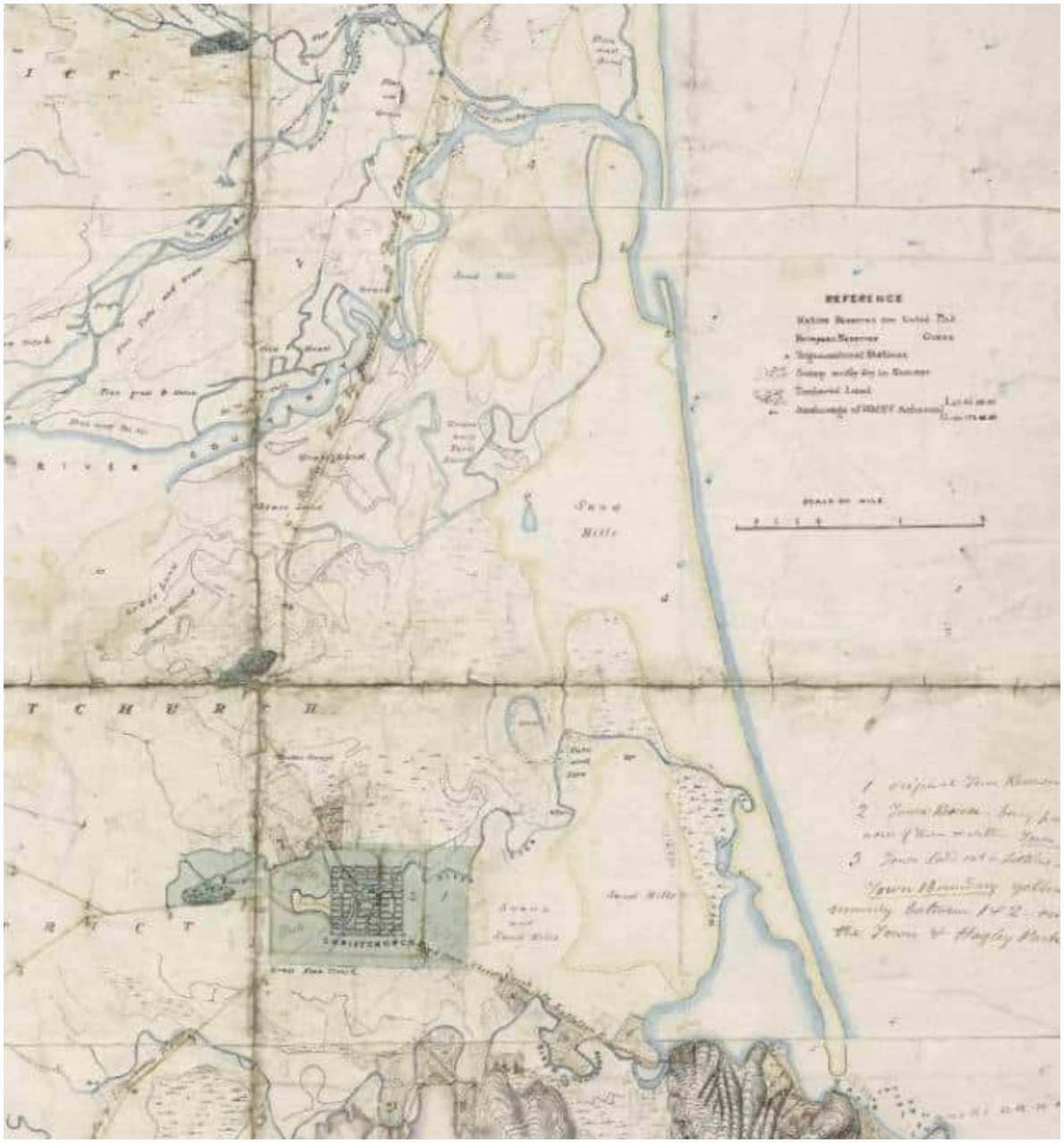

Figure 4: *Early map of Christchurch showing wide extent of "sand hills" inland from the coast.*

[11] Armstrong, J. F. 1870._ On the Vegetation of the neighbourhood of Christchurch, including Riccarton, Dry Bush, etc. Trans. N.Z. Inst., vol. 2, p 119 (1870)

[12] Except for those now under conifer plantations, such as Chaney's and Bottle Lake.

Threatened plants

Numerous plants that are today classified as threatened were present and common among the dunes complexes. Good opportunities exist to re-introduce threatened species, especially on the many dune islands that are present. A list of possible re-introductions is shown below.

Species	Threat Rank	Habitat	Notes
Aciphylla subflabellata	Declining	Damp dune hollows, wetland margins	Locally extinct
Carex litorosa	Declining	Tidal edges	Still extant at Brooklands
Carmichaelia corrugata	Nationally vulnerable	Dry mossfield/grassland	Limited habitats for this species
Carmichaelia kirkii	Nationally vulnerable	Climber through shrubs and forest margins	Was a widespread climber recorded form Brighton dunes
Coprosma acerosa	Declining	Dunes and dune islands	Was very common in dunes, almost extinct
Deschampsia cespitosa	Declining	Damp sand hollows, freshwater wetlands	Extinct low-altitude Canterbury, was common.
Eleaocharis novozealandie	Declining	Damp sand hollows, muddy brackish embayments	Thought extinct in Canterbury
Eryngium vesiculosum	Nationally vulnerable	Damp sand hollows	Almost extinct locally
Euphorbia glauca	Declining	Shady grass and shrub dunes	Formed large colonies, considered extinct in Canterbury
Fincinia spiralis	Declining	Mobile dunes	Was the dominant cover of fore-dune, extinct in Pegasus bay
Gunnera arenaria	Declining	Damp sand hollows	Few good habitats remaining, extinct in the wild
Lepidium agreum ?	Nationally critical	Margins of 'dune islands'	Almost extinct in wild
Libertia peregrinans	Nationally vulnerable	Damp sand hollows	Need to confirm presence
Linum monogynum	Declining	Shady fore and shrub dunes	
Mazus novae-zealandiae subsp impolitus	Nationally endangered	Ephemeral freshwater back dune hollows, freshwater swales	Still extant at Spencer Park
Pimelea villosa (P. arenaria)	Declining	Grass/mobile dune	Locally extinct
Poa billardierei	Declining	Grass/fore-dune	Strictly a foredune species locally extinct, was common dune plant
Ranunculas macropus	Data deficient	Manuka heath swamp	Not suitable for planting
Sonchis kirkii	Declining		Dune islands, shady damp sites
Sebea ovatus	Nationally critical	Damp sand hollows, margins brackish embayments	'closed' saline swales supporting ephemeral turf
Thyridia repens	Naturally Uncommon	Muddy tidal edges	Still common, no need to plant

Descriptions of key habitats

The most descriptive account of New Zealand's natural dune ecosystems that are relevant to Canterbury, describes the following stages of dune development and associated vegetation[13].

Grass (sedge) dune[14]

This is the active fore-dune immediately adjoining the coastal foreshore (Figure 5). Characterised by patchy cover of pingao and spinifex[15] as the invariably dominant species with large areas of bare sand. Other native species on these exposed and highly mobile dunes included sand convolvulous (*Calystegia soldonella*), *Euphorbia glauca* (forming large colonies in places), sand tussock (*Poa billardierii*), and Lachnagrostis. Pingao is recorded as occurring inland for quite a distance on inland dunes, whereas spinifex was almost strictly coastal and only very occasionally occurring inland from the fore-dune on highly mobile sand. On Pingao:

> *"Scirpus frondosus is the most common of all plants on the sand-dunes at New Brighton…Toward the Sumner end of the beach Scirpus frondosus reins in an undisputed sway on the foredune, the only other plant growing being Festuca littoralis…At the extreme end of the New Brighton beach, by the Sumner Estuary, opposite Shag Rock, Scirpus frondosus (pingao) is extremely common, giving to the dunes a very picturesque appearance by its orange red colouring".*

Figure 5: *Natural fore-dune vegetation of pingao, merging into bracken and flax on rear dunes, on the West coast of New Zealand. (Photo Jacob Guillaume).*

[13] Cockayne, L. 'Report on the dune areas of New Zealand plants, their geology, botany, and reclamation.' *Appendices to the Journals of the House of Representatives* 1911, C-13

[14] "Grass dune" is a misnomer given that pingao is the dominant cover that is a sedge.

[15] There is only one record of spinifex naturally occurring in a large patch at South Brighton.

Shrub dune

With slightly less direct exposure to coastal elements allows for the second stage of dune vegetation development to occur through the establishment of shrubs that can tolerate drifting sand (Figure 6), namely *Coprosma acerosa, Pimelea arenaria* [16] and *Ozothamnus leptophylla*. These shrubs merge with pingao and spinifex that dominate the fore-dune zone.

> "*Their abundance increases further from the shore, with pingao and spinifex decreasing and largely confined to leeward slopes of dunes. The grey to yellow colouration is a feature of these highly specialised shrubs and is reflective of their tolerance for desert like conditions"*.

Other species that occur within the initial shrub zone include knobby clubrush and those listed above in the fore-zone, and what Cockayne described as heath dunes that occupy the 3rd stage of dune development.

> "*Cassinia fulvida.* Common on active dunes on both ends of New Brighton beach, where it is a characteristic heath plant"
>
> *"Coprosma acerosa.* Found fairly frequently, in rounded masses, on the dunes at both ends of New Brighton beach; often in company with *Cassinia fulvida*".
>
> *"Pimelea arenaria. Only two shrubs of Pimelea arenaria were found, though it is common in New Zealand dune areas generally; these were at the extreme south end of the beach, near the Sumner Estuary. They grew on the active dune, in exposed position, among Scirpus frondosus".*

Figure 6: *Planted dune vegetation at Spencer Park; pingao on fore-dune, tauhinau on rear-dune.*

[16] The flat spreading cushion form of *Coprosma acerosa* and *Pimelea arenaria* are in effect sand traps that compliment that of pingao and spinifex

Heath dunes

This 3rd stage of dune development occurring with increasing dune stability typically with greater distance from the sea (e.g. Figure 7). Manuka (*Leptospermum scoparium*) is the key species in this zone, together with flax and toetoe as the other commonly associated species. Occasional cabbage tree, ngaio, akeake, would also occur within this zone.

> *"Manuka:* Very common on stable dune, and especially upon heath plains; it forms close broken patches of varying size, interspersed among *Cassinia fulvida, Discaria toumatou, Carmichaelia subulate*[17]*, Leptocarpus simplex*, and *Scirpus nodosus.* On the fixed plains towards the southern end of the beach the manuka is rather more stunted in height, and forms large patches, sometimes near patches of bracken fern *(Pteridium esculentum)*. At the northern end, manuka is commonly found in the vicinity of standing water. Besides occurring on dunes, *L. scoparium* is the dominant heath plant of New Zealand. It occurs also in swamps, bogs and on rocks."

Figure 7: Remnant naturally occur bracken (heath) on stable dunes at Seafield Park.

[17] Today = *Carmichaelia australis*

Fixed dune

This is a more stable/mature version of heath dune on which a greater diversity of species has been able to colonise (e.g. Figure 8). Manuka is still a key species, along with bracken, tutu[18], cabbage trees (*Cordyline australis*), flax, *Muehlenbeckia complexa*, native broom, knobby clubrush, *Olearia solandri*[19], matagouri, Ozothamnus, *Coprosma propinqua*, toetoe (*Austroderia richardii*) and large sedges such as *Carex lurida*[20] and giant umbrella sedge (*Cyperus ustulatus*). Presumably scattered trees that occur on the heath dune zone are also a component here. Within sheltered gullies within the fixed dune zone is where "woods" occurred, comprising trees and shrubs of cabbage tree, pepper tree *(Pseudowintera colorata*), kowhai (*Sophora microphylla*), mahoe (*Melicytus ramiflorus*), ngaio, karamu (*Pittosporum tenuifolium*), Muehlenbeckia complex and presumably akeake.

Figure 8: *Planted shrubs and trees on stable dunes.*

[18] It is unclear what species of Coriaria this refers to, but most likely tree tutu (*C. arborea*).

[19] There are no early (19th C) records of *Olearia solandri.* It was recorded at the "lower Avon River" in 1966 "edge of swampy land" (A. J. Healy; CHR 172675) that is presumed a natural occurrence, and then two later records on the Port Hills (1980s). It is a common dune plant in northern Sth Island. A few plants have been planted at Brooklands and are doing well, but it is unclear how common it naturally was, and whether it should be incorporated in to restoration plantings to any extent.

[20] It is more likely that this species called *Carex lurida* was in fact *C. maorica*

Hollows and sand plains

Hollows (dune slacks) are formed by wind scour typically to the water table (Figure 9). They provide habitats for specialist plants that can tolerate ephemeral wetlands and dry conditions when water dries up, including several species that have become locally extinct and/or are extremely rare and are ranked as nationally threatened. Typical plants included, *Gunnera arenaria, Lobelia anceps*, *Limosella lineata,* batchelors button (*Cotula coronopifolia*), *Epilobium arenaria, E. nerteroides, Selleria radicans, Samolus repens, Eleocharis novozelandica* (common in places), *Libertia peregrinans*, sea holly (*Eyrngium vesiculosum*), *Mazus novae-zealadinae subsp impolitus*

> "Gunnera arenaria: *Common in damp sand-hollows, towards north end of New Brighton beach, not found at south end*"

On dry hollows and sand plains, sand trapping species occur, such as *Carex pumila* sand, *Coprosma acerosa, Pimelea* aenaria and *P. prostrata*, dwarf broom (*Carmichaelia corrugata*) and scab weeds (*Raoulia* and *Scleranthus* spp), similar to that still present at Kaitorete Spit.

> "*Carex pumila is one of few plants to colonise fleeting dry hollows where it builds miniature dunes that pingao may settle*".

Figure 9: *Dune hollow and naturally occurring glasswort.*

Manuka heath swamp

Generally further inland associated with stable wet (brackish and freshwater) hollows. Manuka is again the characteristic species, with cabbage trees, flax, *Carex secta, C. coriacea*[21], raupo, *Mazus novae-zeelandiae, Coprosma propinqua*, umbrella sedge and *Potamegaton cheesemanii, Ranunculus macropus (Figure 10)*. Potentially mature to kahikatea *(Dacrycarpus dacrydioides*) forest given long term stability.

Figure 10: Manuka, raupo, pukio swamp in old dune lake.

[21] Initially called *Carex. terenaria* but it is only found on offshore islands.?

Lakes and swamps

Raupo (*Typha orientalis*) and flax (Figure 11), but if dry out colonised by manuka and eventually kahikatea. The native floating fern (*Azolla rubra*) was noted as an obvious component forming bright red blankets anywhere there was standing water.

Figure 11: *Raupo dominated backswamp lake near Spencer Parkl\.*

The existence of forest?

It is clear from early descriptions that as dunes became less mobile and further from the coast they become wooded, largely in manuka scrub and native shrubs (e.g. Figure 12), but there is limited evidence of natural forest cover occurring on dunes within the Canterbury bight.

In terms of forest trees locally recorded on coastal dunes, only ngaio is mentioned as occurring very infrequently as isolated individuals, primarily on coastal back dunes. A few naturally occurring ngaio are still present at Brooklands and at Kaitorete Spit (as was kowhai and akeake), where it occurs very sparsely as isolated trees, but never as closed canopy forest.

> "*Only one tree was found, on the active dunes south. This is one the rare occurrences of the species on the active dune …"* (Pegg 1913)

Akeake is not recorded at all, being so infrequent it must have been overlooked by early surveys. It does, however, naturally occur at Kaitorete Spit (the natural southern limit), where it occurs as scattered and stunted trees on sparsely vegetated back dunes among pingao. Ngaio is also present, and displays the same sparse occurrence and stunted form. There are also a few scattered individuals of akeake occurring in the back dunes at Brooklands, but otherwise evidence suggests it was always extremely restricted.

In view of these historical accounts it is safe to assume both ngaio and akeake are over represented in coastal restoration plantings where they form the predominant cover. An authentic composition for the dunelands at Brooklands would include ngaio and akeake only occasionally among "shrub" and "heath" dunes. The exception perhaps being among now stable dune hollows where one could expect forest comprising of common hardwood species to progress.

Nevertheless, native forest is known to occur naturally on dunes in similar environments as per that described in the "fixed dune" above, and it is highly likely that native forest was present pre-human times. It could certainly become the dominant cover (on inland dunes at least) given dune stability and shelter from salt and wind, and include many hardwood and podocarp trees.

Figure 12: *Dune forest at Papatowhai, Southland, showing flax and Coprosma edge ecotone.*

Climate change and predicted sea level rise

Climate change, in particular sea-level rise, brings both limitations as well as opportunities for ecological restoration at Brooklands. Not least, it should set the parameters for determining the efficacy of undertaking restoration that is sustainable in terms of lasting gains. Even modest sea-level rise will have considerable impacts at Brooklands, most pertinently likely to result in:

- increased coastal erosion
- tidal encroachment inland
- raised water tables inland and brackish-freshwater wetland expansion

It is prudent therefore to limit restoration to sites that will not be impacted to a significant extent by sea-level rise in particular, if that is at all possible given the vulnerable proximity of Brooklands per se.

Given the spit is a narrow strip of dunes squeezed between the sea and the lagoon, with encroaching sea water along both margins (seaward erosion and lagoon margin inundation), undertaking comprehensive restoration on the Brooklands Spit carries a high degree of risk. A cautious approach for managing the Spit would be to do little other than essential weed control whilst allowing natural process to proceed unimpeded. Monitoring change would also be useful to understand potential opportunities for restoration that may arise, such as if the spit becomes an island and the opportunities this may provide for wildlife.

Increased tidal encroachment will facilitate the natural expansion of saltmarsh throughout the low-lying lagoon margins that are currently dominated by dense exotic grasses. The natural displacement of exotic vegetation with native saltmarsh that is likely to occur is a key opportunity for Brooklands because it will improve considerably ecological complexity and resilience through the provision of wider buffer zones, better habitat connectivity and potentially creating islands for wildlife refuges.

Regardless of sea-level rise, maximizing natural tidal flows throughout the intertidal dune complex is highly desirable. To facilitate inundation, any artificial impediments to tidal processes should be removed, for example the gravel path that interrupts tidal flows through Seafield Park. Little if any planting is necessary for any area that is likely to become inundated with sea-level rise as native saltmarsh species can be expected to colonise unaided. Nonetheless, supplementary planting could exacerbate the natural recovery by planting species such as salt marsh ribbonwood.

Raised ground water is also likely to result in an increase in ephemeral ponding. The area most likely affected is the low-lying wetter soils associated with back dune terraces that extend to the Styx River. This area presents a considerable opportunity to re-establish back dune brackish and freshwater wetlands over a much larger interconnected area, and the restoration of important habitats for numerous rare and threatened flora and fauna.

Restoration guide

In terms of areas appropriate for restoration planting, the distinct areas of dune 'islands' and the intervening dry terraces adjoining the tidal zone within Seafield Park and inland west, provide the best opportunities for restoration. These areas are largely dominated by dense marram and/or tall fescue that requires active intervention to replace with native species regardless of sea-level rise.

Planting should initially be small scale so as to understand more clearly the efficacy of planting to ensure future success that in turn leads to the expansion of areas planted in any one year. It also needs to be undertaken sensitively to avoid damaging other values that could be present, and to increase the likelihood of survival in harsh environments.

It is important that restoration planting is authentic to expected 'natural' composition and does not appear contrived. Vegetation indicators that characterise key planting zones to guide where and what to plant are outlined below.

Planting abundance terms

- ✓ **Dominant** = forming greater than 25% of composition
- ✓ **Common** = forming up to 15% of the composition
- ✓ **Occasional/Scattered** = forming less than 5% of the composition sparsely distributed
- ✓ **Patch** = planted close together to form a distinct patch

Ecosystem: sedge-dune

Dominant Plant Community: sand binding native sedges and associates

Key site indicators: Typically dry sand and marram grass close to the sea and subject to salt spray and winds. Clear distinctions in native vegetation between seaward side and back dunes along the spit especially.

Species	Planting Abundance	Habitat Notes
Coprosma acerosa, sand coprosma	Scattered	more rear dune
Dodonea viscosa, akeake	Occasional tree	more rear dune
Euphorbia glauca, sea spurge	Occasional patch	shady/damp foredune hollows
Fincinia nodosa, wiwi/knobby clubrush	Common, scattered	more reardune
Fincinia spiralis, pingao	Dominant cover	mobile foredunes with little competition
Linum monogynum	Occasional patch	Shady dune slopes, hollows and gullies
Muehelebeckia complexa, pohuehue	Occasional patch	more reardune
Myoporum laetum, ngaio	Occasional tree	more reardune
Ozothamnus leptophylla; tauhinau	Occasional, scattered	more reardune
Pimelea arenaria, sand daphne	Common	mobile dunes with little competition
Poa billardierii, sand tussock	Common	mobile foredunes with little competition
Spinifex sericeus, spinifex	Occasional patch	mobile foredunes with little competition

Ecosystem: fixed/shrub dunes

Dominant Plant Community: shrublands and associated dune species

Key site indicators: Typically dry sand with no direct link to ground water. Invariably dominated by marram grass. Lower dune edges intergrade with sparse marram and tall fescue zones. Clear distinctions in native vegetation between seaward side and back dunes along the spit especially.

Species	Planting Abundance	Habitat Notes
Aciphylla subflabellata, spear grass	Rare, trial planting only	Damp sites/hollows and margins of freshwater wetlands
Austroderia richardii, toetoe	Common scattered	
Carex raoulii	Occasional	Damp sites and interface between dunes and damp terraces
Carmichaelia australis, common broom	Common scattered	
Carmichaelia kirkii, climbing broom	Rare, trial planting only	Climber through shrubs and forest edges
Clematic foetida? C. quadribractiolata?	Rare, trial planting only	Climber through shrubs and forest edges
Coprosma acerosa, sand coprosma	Common scattered	Open cover with little competition
Coprosma crassifolia, mingimingi	Occasional scattered	
Coprosma propinqua, mingimingi	Occasional scattered	Damper margins/hollows
Coriaria arborea? C. sarmentosa, tutu	Common scattered	Damper margins/hollows; unsure which species initially called *C. ruscifolia*
Corokia cotoneaster	Occasional	
Discaria toumatou, matagouri	Common scattered	
Dodonea viscosa, akeake	Occasional tree	
Euphorbia glauca, sea spurge	Occasional patch	Damper margins/hollows
Fincinia nodosa, wiwi/knobby clubrush	Common scattered	
Haloragis erecta	Common scattered	
Leptospermun scoparium, manuka	Common	Damp hollows and margins with damp terraces
Linum monogynum	Occasional patch	Shady dune slopes, damp hollows and gullies
Melicytus alpinus, porcupine shrub	Occasional	
Muehelebeckia astonii, shrubby poheuehue	Occasional	
Muehelebeckia complexa, pohuehue	Common	
Myoporum laetum, ngaio	Occasional tree	
Olearia paniculata, tree daisy	Occasional tree	
Ozothamnus leptophylla, tauhinau	Common scattered	
Parsonsia capsularis, native jasmine	Occasional, trial planting initially	Climber through shrubs and forest edges
Phormium tenax, lowland flax	Common scattered on dunes, dominant on margins with damp terraces	Covers several ecotones from brackish damp to dry.
Pimelea arenaria, daphne	Occasional	Open mobile dunes with little competition
Poa cita, silver tussock	Occasional	Open mobile dunes with little competition
Pteridium esculentum, bracken fern	Common	Can form dominant cover
Rubus schmidelioides, native blackberry	Occasional, trial planting initially	Climber through shrubs and forest edges
Rubus squarrosus, leafless lawyer	Occasional, trial planting initially	Climber through shrubs and forest edges
Sophora microphylla, kowhai	Occasional tree	

Ecosystem: heath/shrub low dunes

Dominant Plant Community: Manuka and flax zones

Key site indicators: Low lying inter-dunes and terraces supporting mixed composition of both marram and tall fescue as the dominant vegetation. Soils a combination of sand and peat, or sand close to water table.

Species	Planting Abundance	Habitat Notes
Austroderia richardii, toetoe	Common, scattered	
Carex raoulii	Occasional; trial planting initially	Trial planting initially
Coprosma propinqua, mingimingi	Common, scattered	
Cordyline australis, cabbage tree	Occasional, scattered, trial planting initially	
Coriaria arborea? C. sarmentosa, tutu	Occasional, scattered, trial planting initially	Trial planting initially
Fincinia nodosa, wiwi/knobby clubrush	Common, scattered	
Leptospermun scoparium, manuka	Dominant cover	
Phormium tenax, lowland flax	Dominant cover	
Rubus schmidelioides, native blackberry	Trial planting initially	

Ecosystem: heath/shrub terraces and hollows

Dominant Plant Community: saltmarsh, saltmeadow, ephemeral turf species

Key site indicators: Saline to brackish, peaty soils dominated by tall fescue. Very closely linked to the tidal zone, not typically inundated but is often saturated in spring tides or high floods. Should naturally comprise saltmarsh but typically supports dense and tenacious tall fescue that needs active intervention (planting or spraying) to replace it. Likely to be affected by sea level rise leading to increased tidal inundation of these areas that may kill it off, but still suitable for restoration planting.

Species	Planting Abundance	Habitat Notes
Apodasmia simplex, oioi	Common	Plant in patches
Juncus krausii, sea rush	Common	Plant in patches
Lepidosperma australe, square sedge	Occasional patches	Trial planting initially
Plagianthus divaricatus, saltmarsh ribbonwood	Common	Plant in patches
Carex litorosa	Occasional patches	Tidal edges
Deschampsia cespitosa	Trial planting initially if obtainable	Brackish swales
Eleaocharis novozealandie	Trial planting initially if obtainable	Open damp sand/muddy embayments; hollows
Gunnera arenaria	Trial planting initially	Open damp sand hollows, *Carex pumila* an indicator species
Lepidosperma australe, square sedge	Occasional patches	Brackish wetland
Leptospermun scoparium, manuka	Common	Damp margins
Mazus novae-zealandiae subsp impolitus	Trial planting initially	Open damp hollows low vegetation. *Centella uniflora* a habitat indicator species
Pimelea prostrata, daphne	Trial planting initially	Margins of damp freshwater ephemeral ponds and dune edges open /low stature vegetation
Sebea ovatus	Trial planting initially if obtainable	Damp sand hollows, margins brackish embayments. *Samolus repens* and *Selleria radicans* are habitat indicator species

Key indigenous bird species using this habitat include swamp harrier, New Zealand kingfisher, white-faced heron and pukeko. All species occur here in low densities.

Ecosystem: sheltered fixed dunes

Dominant Plant Community: forest

Key site indicators: Stable dunes typically under canopy of silver poplar and/or mixed with marram and tree lupin, sheltered from and not directly affected by coastal processes. Especially damp gullies between dune ridges and shady aspects.

Species	Planting Abundance	Habitat Notes
Alectyron excelsus, titoki	Occasional	Trial planting initially
Astelia fragrans, bush lily	Occasional	
Carpodetus serratus, putaputaweta	Occasional	
Coprosma crassifolia, mingimingi	Forest margins	
Coprosma lucida, shining karamu	Occasional	
Coprosma robusta, karamu	Occasional	
Cordyline australis, cabbage tree	Common	
Dodonea viscosa, akeake	Occasional	
Elaecarpus hookerianus, pokaka	Infrequent	Trial planting initially
Elaeocarpus dentatus, hinau	Infrequent	Trial planting initially
Griselinia littoralis, broadleaf	Common	
Hebe salicifolia	Common forest edges	
Kunzea serotina, kanuka	Common	
Lophomyrtus obcordata, rohutu	Occasional	
Melicope simplex	Occasional	Trial planting initially
Melicytus ramiflorus, mahoe	Common	Needs shade to establish
Myoporum laetum, ngaio	Occasional	
Myrsine australis, red matipo	Common	
Myrsine divaricatus, weeping mapou	Occasional	
Parsonsia capsularis, native jasmine	Occasional	
Parsonsia heterophylla, native jasmine	Occasional	
Pennantia corymbosa, kaikamoko	Occasional	
Piper excelsum, kawakawa	Common understory shrub	Trial planting initially, needs shade
Pittosporum eugenioides, kohuhu	Occasional	
Pittosporum tenuifolium, lemonwood	Occasional	
Plagianthus regius, lowland ribbonwood	Occasional	
Podocarpus totara, lowland totara	Occasional	
Prumnopitys taxifolia, matai	infrequent	Trial planting initially
Pseudopanax arboreaus, 5 finger	Common	
Pseudopanax crassifolius, lancewood	Occasional	
Pseudowintera colorata, peppertree	Occasional	
Rubus schmidelioides, Native blackberry	Occasional	
Sophora microphylla, kowhai	Common	
Urtica ferox, tree nettle	Occasional	

Indigenous bird species associated with this habitat include South Island fantail, grey warbler and silvereye.

Ecosystem: brackish to freshwater wetlands

Dominant Plant Community: flax and sedgelands

Key site indicators: Lowlying land and hollows associated with springs and ground water pooling. Mixed sand and peat, typically characterised by wet tolerant exotic vegetation typically creeping buttercup (*Ranunculus repens*), jointed rush *(Juncus articulatus*), monkey musk (*Mimulus guttatus*), willow, etc.

Species	Planting Abundance	Habitat Notes
Apodasmia simplex, oioi	Common in patches	Brackish
Austroderia richardii, toetoe	Occasional	Drier margins
Carex coriacea/geminata	Common in patches	Drier margins
Carex maorica	Common in patches	Brackish and freshwater damp margins
Carex secta, pukio	Dominant	Freshwater
Coprosma propinqua, mingimingi	Occasional	Freshwater
Cyperus ustulatus , Giant umbrella sedge	Occasional	Freshwater
Dacrycarpus dacrydioides, kahikatea	Occasional clumps of trees	Freshwater
Deschampsia cespitosa	Occasional, trial planting initially if can be obtained	Brackish and freshwater
Juncus edgariae	Common	Freshwater
Lepidosperma australe, square sedge	Occasional, trial planting initially	Brackish and freshwater
Leptospermun scoparium, manuka	Common	Brackish and freshwater damp margins
Mazus novae-zealandiae subsp impolitus	Occasional, trial planting initially	Brackish and freshwater damp margins
Phormium tenax, lowland flax	Common	Brackish and freshwater damp margins
Plagianthus divaricatus, saltmarsh ribbonwood	Common	Brackish wetlands linked to tide
Ranunculus macropus	Occasional, trial planting initially if can be obtained	Freshwater
Typha orientalis, raupo	No need to plant	Freshwater

Indigenous bird species using this habitat for feeding and breeding include swamp harrier, New Zealand kingfisher, Australasian bittern, white-faced heron, grey teal, New Zealand shoveler, paradise shelduck, pukeko, marsh crake, spotless crake, spur-winged plover & pied stilt. All occur here in low densities.

Ecosystem: active estuary/tidal zone:

Dominant Plant Community: nil

Key site indicators: Areas regularly inundated with sea water. They are obvious muddy and crab burrowed, supporting native turf species between patches of native rushes (sea rush and/or jointed rush), 3 square etc. Reverting areas are often obvious by dead and/or dying grass etc. Where freshwater spring intrusion occurs e.g. Sth end near Spencer Park, raupo is a key species

This ecosystem supports a wide range and often high densities of indigenous bird species, including waders, waterfowl, swampbirds, herons & spoonbills, gulls, terns, cormorants, harrier & New Zealand kingfisher.

Management Actions:

- ✓ No planting required.
- ✓ Any artificial barrier to tidal intrusion should be removed.
- ✓ Weed control – eradication of spartina, saltmarsh rush (*Juncus gerardii)*

Pest plant & animal control and monitoring

Weed control

The highest priority for weed control is those species that threaten high natural values of the estuarine environment and associated native saline tolerant plant communities. Spartina has been recorded previously and subject to eradication measures, whereas saltmarsh rush (*Juncus gerardii*) is an emerging weed in Canterbury that has similar potential to cause serious degradation to estuarine ecologies. Maintaining vigilance to halt invasion and spread of such weeds is paramount and should require annual surveillance.

For the drier sand dunes and terraces that are highly modified, weed control should be associated with restoration planting as part and parcel to successful establishment of plants. For example , the replacement of silver popular with dune forest as above, or flax/manuka wetlands, and systematically replace tall fescue and marram with species as listed above where specified/appropriate especially on dune 'islands'.

Weed control generally should also be undertaken at sites where natural values are threatened by weed invasion, or where weeds will cause increasing management problems in the future. Weed species that warrant control generally include young wilding pines (Figure 13), gorse, broom, false tamerisk, but not necessarily limited to these species.

Figure 13: Wilding pine removal from dunes is Seafield Park

Monitoring

Key tenets of ecological monitoring is that it is without bias, carried out consistently, the methods are repeatable, and it is parsimonious (cost effective). This is essential to ensure data is reliable, comparable and achievable.

Monitoring can occur at a range of scales. Monitoring vegetation change at the broad scale can be undertaken using high resolution satellite imagery and mapping the extent of key vegetation types present that can then be re-measured and compared in the future to understand the extent of change.

More specifically, to understand more subtle changes in composition, for better or worse, establishing permanent plots in key ecosystems should complement broad scale mapping. For parsimony, placement of pots should focus on ecosystems most prone to change and stratified accordingly. Sites of most interest include:

- Modified edge ecotones
- Cut off swales
- Low lying areas semi connected to tidal processes, and/or ephemeral inundation

Figure 14: *Regional Park Rangers carrying out monitoring of dune restoration project.*

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