



Establishing Natives on Sand Dunes

Case Study - Caroline Bay, Timaru

INTRODUCTION

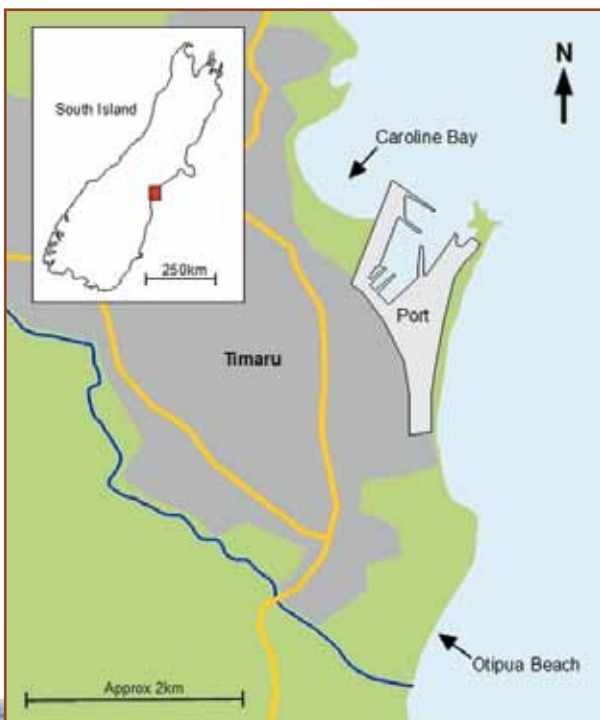
Over the past decade the Timaru District Council has undertaken a major development of the coastal zone along Caroline Bay in Timaru, South Canterbury. The aim has been to improve amenity and recreation use of the bay for local residents and visitors and to enhance indigenous biodiversity to the low sand dune system that is building seaward.

Over the past five years significant planting has been carried out across the area using over 100,000 native seedlings. This article describes the methods and success of establishing a diverse native plant community at Caroline Bay that has been achieved by the council in collaboration with the local community.



SITE DESCRIPTION

In contrast to the extensive sandy beaches of Pegasus Bay to the north of Banks Peninsula, Caroline Bay represents the only sandy beach along the 240 km long South Canterbury coastline where the beaches are otherwise characterised by mixed sand and gravel (Hart et al. 2008). Caroline Bay's isolated sand beach has largely formed and continues to grow in response to the sheltering effects of the Timaru Harbour.



Outside the harbour, high-energy southerly waves drive drifts of foreshore gravels and nearshore sands northward. The eastern breakwater acts as a barrier to the drift of foreshore gravels, causing coarse sediments to accumulate south of the port but nearshore shelf sands are swept past the port and into the entrance of Caroline Bay.

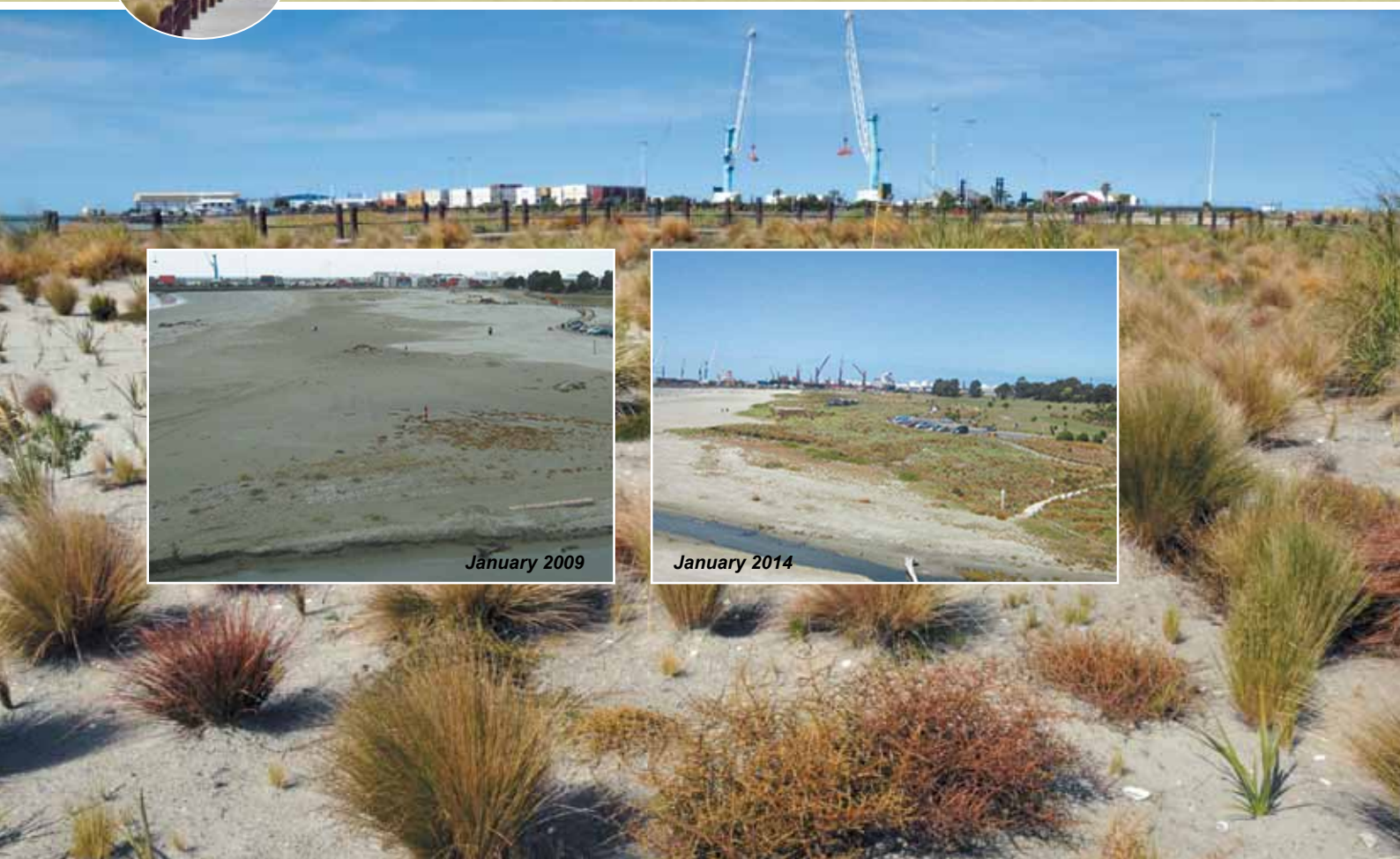
Historical perspective

Before harbour works began in the 19th century, Caroline bay was moderately deep, with a narrow mixed sand and gravel beach and a rocky sea floor. Since construction of the port of Timaru started in 1878, approximately 3,000 m³ of sand has accumulated annually in the shelter of Caroline Bay causing the shoreline to advanced seaward by more than 650 m.

This artificially established sandy beach has allowed the build up a shallow dune system which had become dominated by planted and naturally spreading marram grass (*Ammophila arenaria*).

Caroline Bay is an artificial beach and dune system created by the shelter provided by the Timaru Harbour. A groyne that provides safe passage of ships into the port prevents the northward drift of gravels to build on the south side but allows the finer sands to bypass the port entrance and become deposited in the bay immediately to the north.





The rapid change in vegetation cover along the dunes of Caroline Bay since the restoration programme was initiated. Note the lack of any vegetation seaward of the carpark (left) and the establishment of a 30 m wide dense cover of natives on foredunes seaward of the same carpark five years later (right). Providing formal accessways has been an important component of the dune restoration programme to protect dune vegetation.

RESTORATION PROGRAMME

A wide range of native coastal plant species has been established on the dunes at Caroline Bay by the Timaru District Council and local community groups including Task Force Green over the last five years.

Successional approach

In establishing a native vegetation cover the Council has taken several strategic decisions to guide successful and appropriate revegetation of the dunes at the bay based on the principles of zonation and succession. This has included:

- While Caroline Bay is an artificial sandy beach and dune system, mostly coastal native plants found in the Canterbury region on sand dunes and coastal areas have been selected for planting on backdunes;
- Restoration was initiated by clearing and burying the marram grass to create clear dunes for the construction of boardwalks and planting of natives over several years.
- Ongoing regrowth of marram grass, particularly along the seaward zone, was used to provide initial shelter and sand stability while planted natives established.
- As the dune system continues to pro-grade seaward by up to 1 m per year, the new foredunes with established marram grass are converted to native sand binders by planting and encouraging natural regeneration.
- Once foredunes become stable, landward zones are then interplanted with ground cover native backdune species, with a gradual succession to shrub and taller monocotyledon species.



A diverse mixture of backdune species at Caroline Bay established and managed by the Timaru District Council provides one of the best examples of backdune restoration in the country. Boardwalks and viewing platforms allow beach users easy access to this popular bay while protecting the vegetation cover.

Site preparation

Areas of marram grass on backdunes were progressively sprayed out over a five year period to provide sufficient space for the planting of natives each year. Over 100,000 natives have been planted over this time with virtually all established marram grass areas completed within the five year period of revegetation.

Site preparation involved application of the grass-selective herbicide haloxyfop using knapsacks. This has required repeat applications to ensure complete kill of marram grass at least two months before planting of natives. The natives are then

planted within the open areas and thatch of the sprayed exotic grass cover to reduce sand movement.

Foredunes species

The key species planted along marram grass sprayed foredunes and as the dune advances seaward are pingao (*Fimbristylis diandra*), shore spurge (*Euphorbia glauca*) and spinifex (*Spinifex sericeus*). The inclusion of spinifex has been somewhat speculative as the most southern limit of this species is considered to be Christchurch, over 160 km to the northeast.



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Table 1: Species planted on backdunes over the 5 years of restoration to date, Caroline Bay, Timaru.

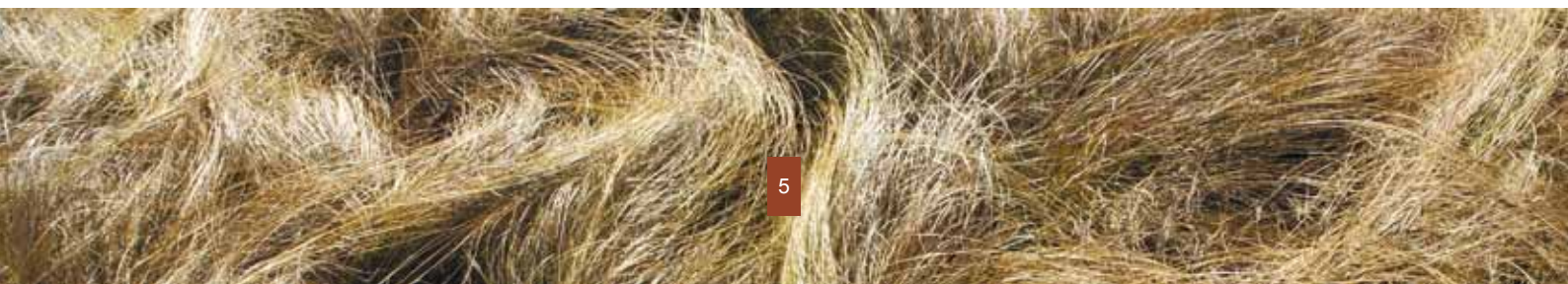
Plant type	Common name	Botanical name
Rushes and sedges	Wiwi	<i>Ficinia nodosa</i>
	Speckled sedge	<i>Carex testacea</i>
	Silver tussock	<i>Poa cita</i>
	Oioi	<i>Apodasmia similis</i>
Ground cover	Shore spurge	<i>Euphorbia glauca</i>
	Pohuehue	<i>Meuhlenbeckia complexa</i> and <i>M. astonii</i>
	Sand daphne	<i>Pimelia villosa</i>
	Cooks scurvy grass	<i>Lepidium oleraceum</i>
	Sand coprosma	<i>Coprosma acerosa</i>
Monocotyledons	Wharariki	<i>Phormium cookianum</i>
	Harakeke	<i>Phormium tenax</i>
	Ti kouka	<i>Cordyline australis</i>
	Toetoe	<i>Austroderia richardii</i>
Shrubs	Mountain tauhinu	<i>Ozothamnus vauvilliersii</i>
	Taupata	<i>Coprosma repens</i>
	Hebe spp.	<i>Hebe salicifolia</i> , <i>H. elliptica</i>
	Shore ribbonwood	<i>Plagianthus divaricatus</i>
	Matagouri	<i>Discaria toumatou</i>
	Korokio	<i>Corokia cotoneaster</i>
Small trees	Mountain akeake	<i>Olearia avicennifolia</i>
	Broadleaf	<i>Griselinia littoralis</i>
	Ngaio	<i>Myoporum laetum</i>

Backdune species

The objective was to plant a wide range of low growing backdune native species landward of a centrally located boardwalk running parallel to the shoreline which provided easy access for beach users. A feature of the backdune planting has been the large diversity of native species used in the restoration of the low dunes at Caroline Bay. The major backdune natives planted over a five year period are listed in Table 1. These have included rushes and sedges, ground cover herbaceous and woody species, monocotyledons, shrubs and small trees.



Planted native shore spurge and wiwi quickly dominate semi-stable backdunes providing a low dense cover, Caroline Bay, Timaru.





EARLY PERFORMANCE

Several vegetation survey transects were established running perpendicular to the coast through the dune system recording the variety and stocking of species planted as well as natural regeneration. An assessment of a sample of each of the major species was undertaken including measurement of plant height and canopy cover, and a subjective measure of plant vigour.

Foredunes and swales

After five years of planting and managing natives at Caroline Bay the foredunes have become increasingly dominated by pingao, shore spurge and sand carex (*Carex pumila*). Of interest is the gradual decline of spinifex that had initially formed along the seaward face of the foredunes from plantings. Over time spinifex has reduced to a few colonies which have been planted more recently on sections of foredune converted from marram grass as part of ongoing revegetation in the bay.

A feature has been the natural regeneration of dense colonies of sand carex along substantial areas of foredunes forming low dunes along the high water mark. Extensive colonies have formed as pure species stands but the species has also become a major component of landward dune zones amongst other species including shore spurge and wiwi.

Other species have become well established within the dunes swales along seaward dunes taking advantage of the damper low lying sites especially wiwi and oioi with speckled sedge (*Carex testacea*), sand daphne and silver tussock (*Poa cita*) on open drier sandy sites.

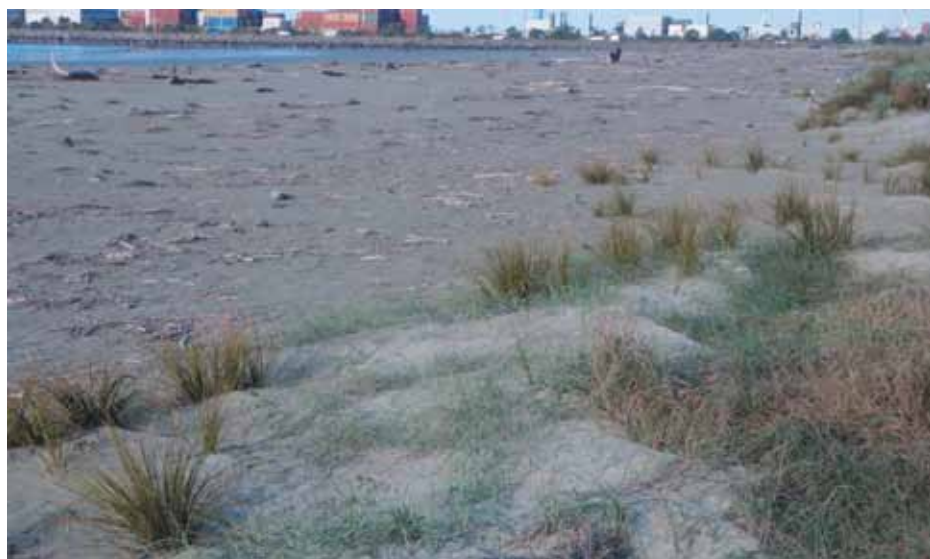
Natural regeneration of sand carex has dominated the toe of foredunes replacing planted spinifex and forming low dunes along the strandline.



Temporary fencing to protect seaward planted and regenerating pingao and shore spurge near a main accessway. Note the build up of a small dune.



Laying out a 50m tape to assess a vegetation survey transect through an area that has been planted with native backdune species over the last 3 years at Caroline Bay, Timaru.





Direct seeding

Revegetation has also been successful for some species from direct seedling of semi-stabilised foredune sites. This has included pingao and kokihi or New Zealand spinach (*Tetragonia tetragonoides*) which has been carried out successfully in some areas by raking the seed into the sand along the strand zone. This has seen significant natural spread and regeneration of selected species.



A range of species are inter-planted in gaps amongst established planted backdunes such as matagouri (above) and *Coprosma propinqua* (below).

Backdunes

Most species planted on the stabilised backdunes have thrived. The hardy ground cover and shrub species that have often done well in coastal dune plantings in other regions have high survival and good growth rates at Caroline Bay including wharariki, harakeke, ti kouka, tauhinu, taupata and ngaio.

There are a surprising number of species that have performed well at Caroline Bay. These include survival and growth of *Meuhlenbeckia* species (pohuehue), sand coprosma, shore spurge and sand daphne. These species have often proved difficult to establish on dunes in many regions and failed in many planting programmes. This is despite considerable effort in evaluating a range of restoration options such as different planting sites, stock sizes, shelter requirements, pest animal control and weed control.

Supplementary planting

Infill plantings has been carried out each year to fill in the gaps created by plant loss or damage that has occurred to the dunes and vegetation by wind and wave erosion or by human interference, particularly trampling. Succession planting is carried out as seaward dune zones begin to stabilise due to established foredune plants. This allows introduction of species of the wider range of ground cover species to be planted thus adding to the area of planted backdunes.

Over time the landward stabilised ground cover zones are interplanted with shrub species with occasional planting of a single or small group of tree species. Care is taken in placement of tree species to ensure that critical view shafts are not going to be compromised long term.

A feature has been the interplanting of less commonly planted species within back dune areas amongst the well-established mixed species of pohuehue, sand carex, sand tussock and sand daphne including mountain akeake, broadleaf, korokio, matagouri, *Coprosma propinqua*, rauhuia or NZ true flax (*Linum monogynum*) and kokomuka or shore koromiko (*Hebe elliptica*).



A wide range of backdune natives established within the last 3 years at Caroline Bay, Timaru. Excellent maintenance, particularly weed control, has seen very high survival and growth of planted natives including toetoe, sand coprosma, sand daphne, pohuehue, harakeke, ti kouka and Carex species.

MAINTENANCE

Weed control

Following planting a maintenance programme is in place to control exotic weed growth throughout the dune system by manual (hand releasing) and chemical spraying. Monthly inspections of sites are undertaken for assessing weed growth. Taskforce Green staff in collaboration with council staff undertake regular hand pulling of weeds that appear amongst the native plantings. Critical to the success of this weed control is trained staff recognising weed species and to minimum loss of natives from any herbicide spraying operations.

Both haloxyfop and glyphosate are applied by knapsack depending on the weed species. However, use of chemicals is kept to a minimum because of the close proximity of native fauna – skinks, penguins and bird nesting habitats are found throughout the site particularly near and under the boardwalks.

The aim for ongoing weed control is to remove all exotic species as practical and in particular marram grass which almost exclusively vegetated the entire bay. There has also been removal of sea rocket (*Cakile maritime*) generally most commonly regenerating along the strandline and seaward slopes of the foredunes. Jersey or weedy cudweed (*Helichrysum luteoalbum*) has been a major weed pest but vigilant weed control has seen this species reduce significantly in abundance.

Other maintenance

An intrinsic component of the development of Caroline Bay and revegetation of the dunes with natives has been to provide an extensive amenity area for Timaru residents and visitors. Extensive boardwalks and fencing provide protection for the planted dunes as a result of very high use that the bay has attracted. These facilities including seating, accessways to the beach, signage and information panels are regularly maintained.



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Other maintenance involves minor fence repairs around the back dunes but by and large there is a reasonably high level of cooperation from beach users with regard to keeping out of the dune areas and using the walkways provided.

Some rabbit control is required from time to time.



A large backdune area dominated by wiwi planted over the last 3 years with new natural regeneration across the rest of the site at Caroline Bay, Timaru.





REVEGETATION OF OTIPUA BEACH

Introduction

Otipua Beach is located on the south eastern coast of Timaru. The area is characterised by a broad shingle bar which has separated a tidal lagoon from the sea. Small numbers of up to 20 native plant species occur at Otipua Beach (Harding 2013). However the site is dominated by rank exotic grass and tree lupin (*Lupinus arboreus*) with remnant mounds of pohuehue on back dune and various sedges nearer lagoon margins.

Restoration

The Timaru District Council, with support from Environment Canterbury, and input from Taskforce Green, have been involved in restoration of this severely degraded sand and gravel dune with natives over the last three years. Several thousand seedlings comprising over 30 species have been planted following spot-spraying with herbicide. Seedlings, mostly Hilson root trainer stock, were planted with a slow-release fertiliser tablet.

Major treatments evaluated include mulches (wood chip, recycled tyre walls) and rabbit exclusion (fencing, plant protectors). Post-plant

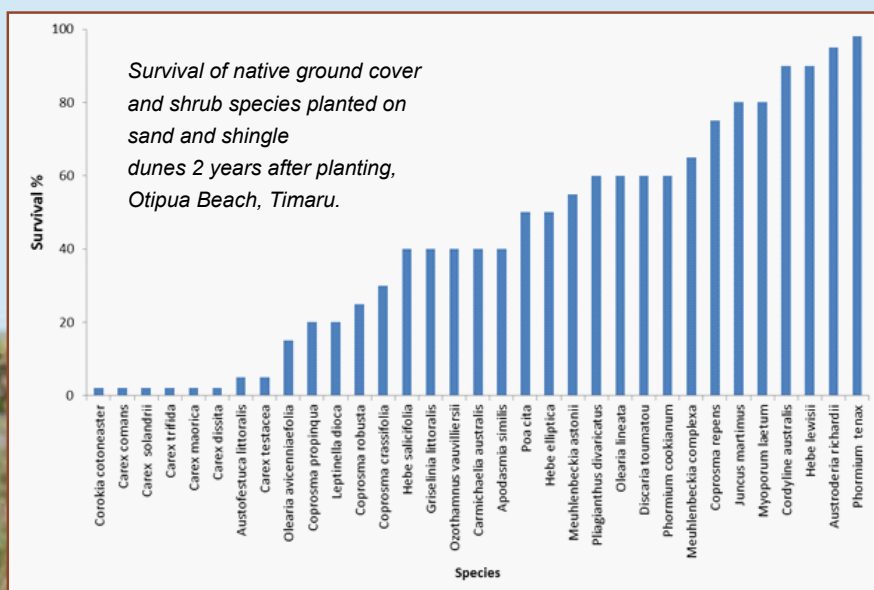
weed control involved both herbicide spraying and hand weeding.

Early performance

In general plants performed better where there was more soil development, where they were planted on lower damper sites, and where they had shelter and shade from tall exotic grass or lupin cover to reduce mortality during the extreme summer droughts. Rabbits remained an issue despite some control operations with growth greater within fenced areas or for plants with protectors installed. Mulching proved useful in keeping weeds free from immediately around seedlings but regular clearing of weeds and grasses around plantings was essential.

Best species

Survival has been significantly compromised by droughts during the first two years after planting. Species with at least 75% survival include harakeke, toe toe, ti kouka, *Hebe lewisii*, ngaio and taupata. Species with survival over 60% included pohuehue (*M. complexa*), shore ribbonwood, (*Plagianthus divaricatus*), *Olearia lineata* and matagouri.



Same hardy species!

The key species for ongoing planting of this area will focus on a mixture of the small number of hardy shrubby species most often used for providing initial cover on difficult coastal sites - e.g. harakeke, toe toe, ti kouka, ngaio and taupata. Once a cover is established, then a more diverse range of species can be planted within sheltered gaps.



BLUE PENGUINS ROOSTING

Since the backdunes have been revegetated in a cover of native plants blue penguins have begun to appear in the dunes. In particular the crawl space under the new boardwalks have proved to be a popular site for overnight roosting of penguins.

Care has been taken with weed control, particularly careful use of herbicides during weed control operations to ensure there is no effect on native skinks and penguins as these are increasingly found amongst the revegetated dunes.



Tracks along the edge of board walks indicate blue penguin have recently begun to utilize parts of the restored backdunes at Caroline Bay, Timaru.



CONCLUSIONS

The revegetation of the largely artificial dunes that have developed at Caroline Bay and which continue to expand seaward has been very successful. Careful consideration of importance of zonation and succession in the planning and selection of species has been instrumental in this success. Equally important in this success has been the attention to the basics of good planting and management practice for restoration of sand dunes including site preparation, provision of shelter amongst sprayed marram grass including use of hardy species for initial planting, use of good quality planting stock, and timely and regular site monitoring and maintenance, especially weed control.



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