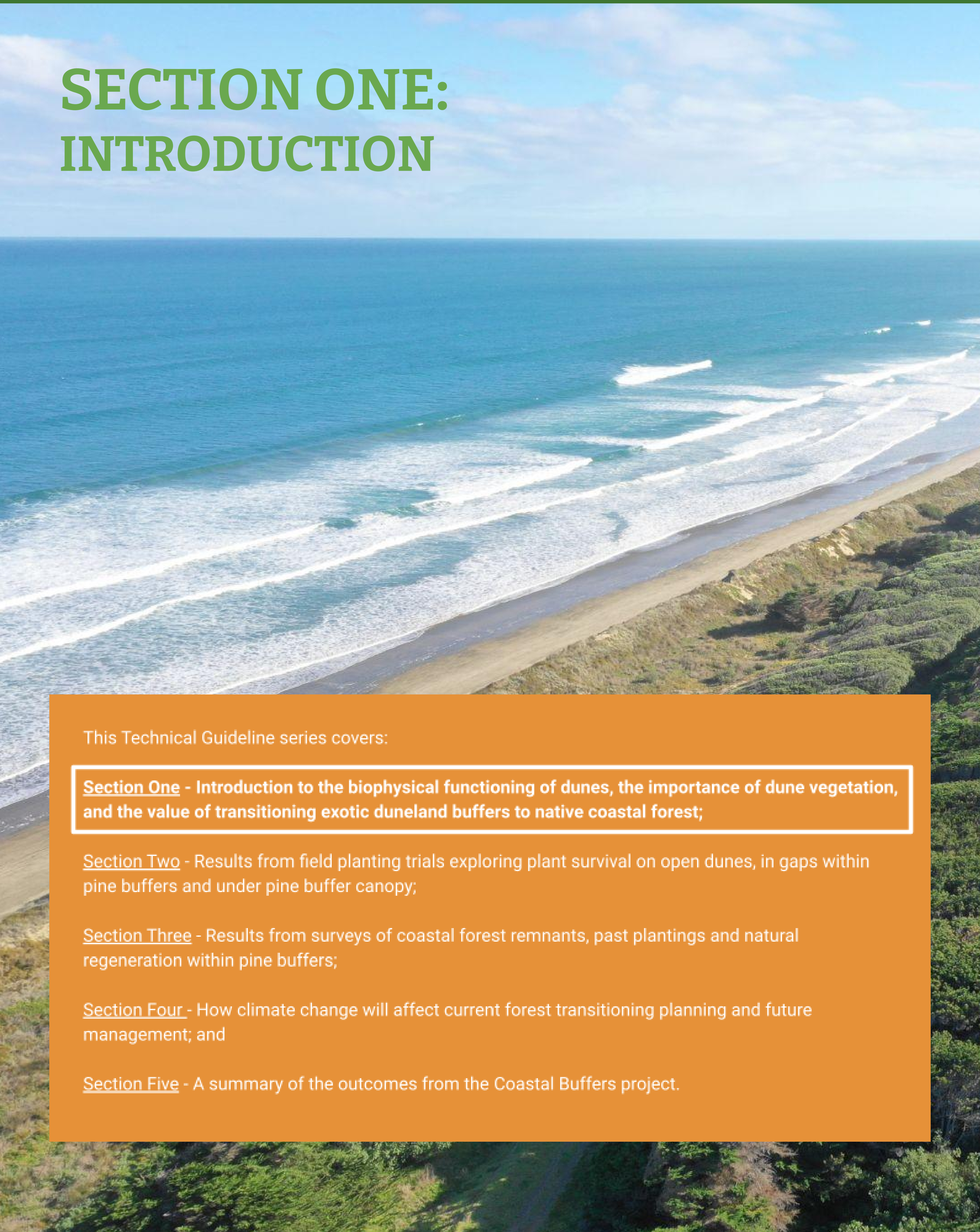
Tāne's Tree Trust
NATIVE FORESTS FOR OUR FUTURE
Hereherea te Wao-nui-a-Tāne

PRELIMINARY TECHNICAL GUIDELINE
Adaptive Management of Coastal Forestry Buffers



SECTION ONE: INTRODUCTION

This Technical Guideline series covers:

Section One - Introduction to the biophysical functioning of dunes, the importance of dune vegetation, and the value of transitioning exotic duneland buffers to native coastal forest;

Section Two - Results from field planting trials exploring plant survival on open dunes, in gaps within pine buffers and under pine buffer canopy;

Section Three - Results from surveys of coastal forest remnants, past plantings and natural regeneration within pine buffers;

Section Four - How climate change will affect current forest transitioning planning and future management; and

Section Five - A summary of the outcomes from the Coastal Buffers project.

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Loss of native duneland forest

It is hard to imagine now in our highly modified environment but, prior to human arrival, tall coastal forests extended close to the high tide zone on the majority of our dunelands. Open spinifex and pingao dominated communities were restricted to narrow bands along the active dune fronts. Land clearance, fires and the introduction of foreign browsing animals resulted in the disappearance of these dune forests from most of New Zealand with near-intact examples now left only along the South Island's rugged West Coast and in the Catlins.

Right - dune sequence extending into podocarp forest within 50m of the frontal dune toe, Catlins (southern Otago).

Below - a podocarp dune forest at Martins Bay (Fiordland).

The loss of forest cover caused dunes to become unstable and subsequent widespread problems with drifting sand in the late 1800s and early 1900s (Cockayne 1911, Hocking 1964). As 'productive' land began disappearing under mobile sand, government agencies undertook extensive work to restabilise dunes during the 1900s. 'Protection zones' established exotic marram grass to provide initial sand stabilisation, followed by exotic tree lupin and then tree species. Invariably most tree species selected for the protection zone were exotic. Species were selected based on their adaptation to the coastal environment, easy procurement and propagation and resistance to animal and insect attack.

Without buffering vegetation, the land behind is open to harsh salty onshore winds and mobile sands. Field trials in the 1970s (Berg 1972) documented the importance of shelter for tree establishment and led to the widespread adoption of protection buffer zones composed of radiata pine often with a narrow frontal band of macrocarpa. Extensive plantation forests were established in the lee of these protection zones.

Natural zonation and succession

Vegetation zonation and succession are important influences on natural duneland forest structure. This has significant implications for the restoration of native ecosystems; particularly in the nearshore areas where the existing pine forest protection zones occur (Dahm 2014).

In nearshore duneland areas, the key stressors in the physical environment (e.g. winds, salt spray, sand deposition and burial, sand movement, sand blasting) vary significantly with increasing distance inland and with dune landform. These variations in the physical environment result in the zonation of ecologically distinct vegetation communities that also vary in height with increasing distance landward (Figure 1).

Figure 1: Schematic diagram of natural zonation of native plant communities in duneland.

With increasing sand stability landward, the diversity of native plant communities increases reflecting the range of habitats from exposed dune crests and seaward facing slopes to more sheltered leeward slope and low-lying swales (Bergin et al. 2014a). Further landward and in the original pre-human dunes, the low vegetation communities gave way to higher vegetation of shrubs and then to diverse coastal forest (Dahm 2014; Bergin et al. 2014b).

Left - broaching a dense forest edge on a secondary dune crest in the Catlins (southern Otago); and right - the forest in the dune hollow behind.

Ecological succession is defined as a change in species composition within an ecosystem over time. At each stage of succession, the plant community contributes to the change in the physical environment (e.g. soil organic matter, light/shading, improved shelter, microclimate, change in nutrient levels in soil) allowing the establishment of another later group of species better adapted to live in the changed environment.

On dunes, the term succession is typically used to refer to the evolution of plant communities over time in back dunes. However, even when a climax community is ultimately reached, climate change and disturbances such as fire may lead to ongoing change – so the process can be very complex over centuries.

Native coastal species

Plant species composition varies depending on site characteristics and especially from north to south. Restoration of a native coastal vegetation sequence requires an understanding of the local species that would naturally occur. Where no trees remain and the site is open, restoration planting focusses initially on the hardy early-successional species.

On the foredunes spinifex dominates many of the northern areas along with pingao, but in the cooler climates to the south pingao dominates foredunes. Immediately landward the diversity increases with a range of other ground cover natives including pohuehue, sand coprosma, wiwi and harakeke. Further landward the shrub and tree zones include hardy coastal shrubs such as ngaio, taupata, tauhinu, ti kouka, karo, toetoe, akeake, coastal tree daisy and houpara which then become dominated by tree species.

While pōhutukawa naturally dominates the northern half of the North Island coastal fringes (see feature box) there are a wide range of other tree species that occur on our southern coasts and increase the diversity behind the shelter of the northern pohutukawa fringe. Research indicates these back dune forest species include conifers such as tanekaha, kauri, rimu, tōtara, kahikatea as well as taraire, karaka, kowhai, pūriri , titoki, kohekohe, tawāpou, nīkau, kanuka and a wide range of small broadleaved trees and shrubs including kanuka, manuka, kawakawa, ngaio, rangiora, kohūhū, mahoe, mapou, five finger and Coprosma species, cabbage tree, mapou, tūrepo/large-leaved milk tree, wharangi and whau - along with a diverse ground-cover including sedges and ferns (e.g. Cockayne 1911, Brook 1999, Giles 1999).

The 'veg wedge' effect

A progressive increase in height with distance landward is commonly observed with remnant native shrubs and trees as well as with exotics. This zone of increasing height is often referred to colloquially as a "veg wedge".

Left - a 'veg wedge' wind shear effect on exposed pōhutukawa; and right - pōhutukawa/macrocarpa, Te Hiku, Te-Oneroa-a-Tōhē/Ninety Mile Beach (Northland).

The slope of the "veg wedge" in these areas (which influences the required width of the protection zone) reflects both environmental factors and the species composition of the zone. For instance, the width of the protection zone tends to be much wider in the stronger wind environments of the west coast of the North Island relative to the east, and where largely composed of radiata pine can be up to 400m in width to be effective.

Right - Wind shear on coastal podocarp dune forest, Martins Bay (Fiordland).

Pōhutukawa – key northern coastal tree

Dominant coastal tree of the north

Pōhutukawa is a key species that helps initiate successional revegetation within its natural northern range of New Zealand. As a drought-tolerant species it can grow in open areas providing shade; lower ground temperatures; leaf litter forming humus that absorbs and stores moisture; and habitat for birds which bring seeds and nutrients (Bergin & Hosking 2006).

Pōhutukawa can dominate forest succession for several centuries (Atkinson 2004) and can have poor floristic composition in comparison to other forest types (Bylsma 2012). Pōhutukawa's combination of persistent leaf litter and dense canopy slows the establishment of later successional species, and also prevents further pōhutukawa from regenerating beneath itself. This can be seen in the Te Hiku Forest Service pōhutukawa planting trial (see Technical Article x.3). This has implications for restoration programmes where pōhutukawa is used as the major initial cover, as plant and animal diversity may increase relatively slowly.

Bylsma's (2012) found Bay of Plenty pōhutukawa populations had regenerated in dense cohorts. Tree stem density declined over a period of around 300 years due to self-thinning. Where disturbance is frequent (e.g. unstable coastal cliffs) pohutukawa can continually replace itself indefinitely (Simpson 2005). However, where disturbance is less frequent, pōhutukawa is succeeded by shade tolerant species. Observations from coastal forest remnants suggests that the diversity of the original duneland forest increased in the more sheltered landward areas.

Establishing a diverse forest

Bergin & Hosking (2006) recommend that in addition to areas planted in pōhutukawa, restoration goals should include establishment and maintenance of other plant communities using a range of species. Pōhutukawa is however the key canopy species that can thrive on the frontal dunes surviving the brunt of sea winds and is therefore most suitable for establishing a protective front to forest buffers.

This is backed up by the presence of large remnant pōhutukawa within 30-40 m of the dune toe, suggests that pōhutukawa forest once extended relatively close to the coast. The remnant trees from earlier pōhutukawa forest, including very large old trees, can typically dominate the higher areas of the older stabilised dunes, forming a band over the area from about 40-120 m inland. Further landwards, on the more sheltered landward margin of the dune complex the remnant trees from the earlier coastal forest were more diverse than on the exposed dune crests – with species observed including taraire, totara, coastal kanuka, puriri,karaka, kohekohe, kawakawa, tawapou, kowhai, houpara, karo and other plants adapted to living in the coastal environment, and kahikatea in lower areas often close to wetlands . Other studies suggest that kauri once grew right down to the coast before logging and farming modified the forest (Regnier, 1987). In sheltered or more inland localities of the coastal zone, tawa also occurs along with small remnants of pohutukawa.

Remnants of extensive stands

Remnant stands of mature pōhutukawa occur on sand at Te Arai Sanctuary, halfway along Te Oneroa-a-Tōhē /Ninety Mile Beach and also on the east coast of the Aupōuri sand tombolo at the southern end of Kokota, the Paerengarenga Harbour sandspit. The trees gather sand around their boles to give rise to a unique hill and bowl landscape with gigantic crowned pōhutukawa and shrubs and ferns beneath.

Schnachenberg (1935) records extensive pōhutukawa forest on back dunes between Kawhia and Aotea Harbours. These were likely typical of coastal forest found on stable dunes along much of the upper North Island's west coast before they were cleared for farming. Pōhutukawa forest is now most often found on rocky coastlines and only a few small pockets survive on semi-stable northern dunes (e.g. Hosking et al, 2010).

On many sites it is the lone, sprawling and twisting pōhutukawa trees that may be all that remains of a once diverse coastal forest (Bergin & Hosking 2006).

Left - Remanent pōhutukawa at Pakiri beach with no natural regeneration (North Auckland).

Natural regeneration

The lack of natural pōhutukawa regeneration on dunelands is likely related to a lack of suitable conditions for germination. Despite the prolific seed produced, Pōhutukawa seed is very small, lacks nutrients and requires moisture and shelter from wind, sun and frost (Bergin & Hoskin 2006). They generally germinate more successfully on logs or other surfaces that provide more favourable microclimates than exposed dry sand. Our research found that seedlings are susceptible to drought and survived better when planted in damper swales. The only notable natural regeneration of pohutukawa found was at Te Arai in oioi dominated swales.

Right - A pōhutukawa seedling naturally regenerating amongst pine debris - Muriwai (North Auckland).

Why transition from exotic to native buffers?

Forestry managers are concerned that existing exotic buffers, typically a monoculture of radiata pine, are many decades old and now failing with significant risk of catastrophic collapse. Most are showing signs of degradation with significant dieback and opening of the canopy to form large gaps allowing prevailing onshore winds to funnel through. There are additional issues from the expected impacts of climate change including more frequent and severe storms, along with increased sea levels and potential retreat of some parts of the coastline.

A key hypothesis in transitioning monocultures of relatively short-lived exotic coastal buffers to a diverse native coastal forest community is that the native buffer is likely to have considerably greater longevity and resilience to major environmental disturbances such as fire, pests and diseases, and projected climate change.

Left - An example of a failing coastal buffer at Te Hiku (Northland) where wind is opening up holes in the buffer- note the production forest in background. Right - A failing coastal buffer at Woodhill Forest (Auckland) with an open canopy and exotic weeds establishing.

Failing pine buffer and unstable advancing dune at Woodhill Forest (Auckland).

Benefits of a coastal native forest buffer zone

There are only a limited range of indigenous shrub and tree species that naturally colonise the near-shore zone, and animal and plant pests are a major constraint that significantly restrict successional recovery of native trees and shrubs.

However, there is a significant benefit to the forestry industry in progressively replacing these exotic forest buffer zones with native coastal dune forest sequences including:

1. Greater longevity and resilience of a diverse mix of species compared with a largely monoculture of exotic radiata pine ;
2. Less vulnerability to fire hazard and wind damage;
3. Improved wind and salt protection potentially within a narrower buffer zone providing more space for productive forestry landward;

4. Increased indigenous biodiversity for coastal ecosystems which are amongst the most threatened in the country;
5. Ongoing protection of cultural sites along coasts;
6. Considerable environmental and social benefits, contributing to Forest Stewardship Council (FSC) certification. Sustainable land management is becoming an expectation of consumers as they demand a full product story.
7. Protection of vulnerable and often rare components of the coastal ecosystem such as dune lakes and wetlands;
8. Reduced potential for weed problems in adjacent environments; and
9. Opportunities to explore other productive uses including:
    - applicability to other land uses along our coasts e.g. the farming industry can benefit from sustainable coastal buffers that have multiple benefits for stock health/management and pastoral production;
    - potential long-term sustainable harvesting of selected native tree species if coastal buffers are wide enough;
    - coastal ecotourism; and
    - long-term permanent carbon sequestration for offsetting carbon emissions of neighbouring land use (e.g. exotic forestry/farming operations).

Transition strategy – adaptive management

Forestry companies and landowners are actively removing failing exotic buffers and are having to replace them by planting another rotation of exotics within the buffer zones until practical and economic methods for converting to natives is possible. However, the sudden removal of the buffer zone leaves adjacent production forests highly vulnerable to dieback from prevailing onshore winds.

There is a lack of knowledge on how best to transition many kilometres of exotic forest buffers to native forest. An adaptive management approach which tests a range of scenarios that will vary across regions over a long time frame is required.

Right - An exposed productive pine stand following the removal of buffer zone forest. Kawhia (western Waikato).

Establishing a native coastal forest buffer zone on a large scale will take generations. Many innovative methods need evaluating over time to eventually provide a suite of practical methods to transition from exotics to native customised to the wide variety of sites. An adaptive management approach is an opportunity to learn by management rather than waiting for long-term trials to predict outcomes and inform decisions.

This project focuses on transition methods for the upper North Island, however many of the principles apply throughout New Zealand. Drought will be more or less important in different regions and species selection for plantings will need to reflect the local natural floral character of an area.

Capitalising on shelter

Research by the Coastal Restoration Trust already indicates the most significant factor that influences growth within coastal environments is the effects of prevailing onshore winds and increasing summer droughts cause high mortality of native plantings. This project capitalises on the existing shelter of exotic forest buffers to assist both natural regeneration and planting of local native tree species which in the long-term can replace failing exotics with a more sustainable and effective buffer.

With a long history of grazing and exotic forestry, dunelands today only support small, limited forest remnants (if any). Where native seed sources are scarce, the establishment of 'seed islands' on selected sites will in time provide a greater diversity of native wind and bird dispersed seed to enhance the forest transition through natural regeneration. This will need to be complemented by more active management such as interplanting; control of grazing stock and pest browsing animals; weed control; and ideally seed predator control to protect seed dispersing birds.

This transition strategy is discussed further in the following guidelines exploring options for establishing native trees via planting and encouraging natural regeneration.

References

Berg, P. 1972: The protective role of Cypressus macrocarpa in coastal plantings at Woodhill Forest. NZ Journal of Forestry (1972) 108-111.

Bergin, D., Dahm J. 2014a: Backdunes – an Introduction. Technical Article No. 8.1 in Restoration of Coastal Sand Dunes using Native Plants Technical Handbook. Dune Restoration Trust of NZ.

Bergin, D., Bergin, M, Dahm, J. 2014b: Native Trees and Shrubs to use on Back Dunes. Technical Article No. 8.3 in Restoration of Coastal Sand Dunes using Native Plants Technical Handbook. Dune Restoration Trust of NZ.

Brook, F.J. 1999: Distribution and conservation status of the dune snail *Succinea archeyi* Powell (Stylommatophora: Succineidae) in northern New Zealand. Science for Conservation 129. Department of Conservation, Wellington. 29p

Cockayne, L. 1911: Report on the dune area of New Zealand, their geology, botany and reclamation. Department of Lands report presented to both Houses of the General Assembly by Command of His Excellency.

Dahm J. 2014: Zonation and Succession on Coastal Sand Dunes. Technical Article No. 2.4. in Restoration of Coastal Sand Dunes using Native Plants Technical Handbook. Dune Restoration Trust of NZ.

Giles, M.G., Newnham, D.J., Lowe, D.J., Munro, A.J. 1999: Impact of tephra fall and environmental change: a 1000 year record from Matakana Island, Bay of Plenty, North Island, New Zealand. Geological Society, London, Special Publications, 161, 11-26, 1 January 1999.

Hocking, G. H. 1964: Sand country of the Wellington west coast. New Zealand Journal of Forestry 9: 128-138.