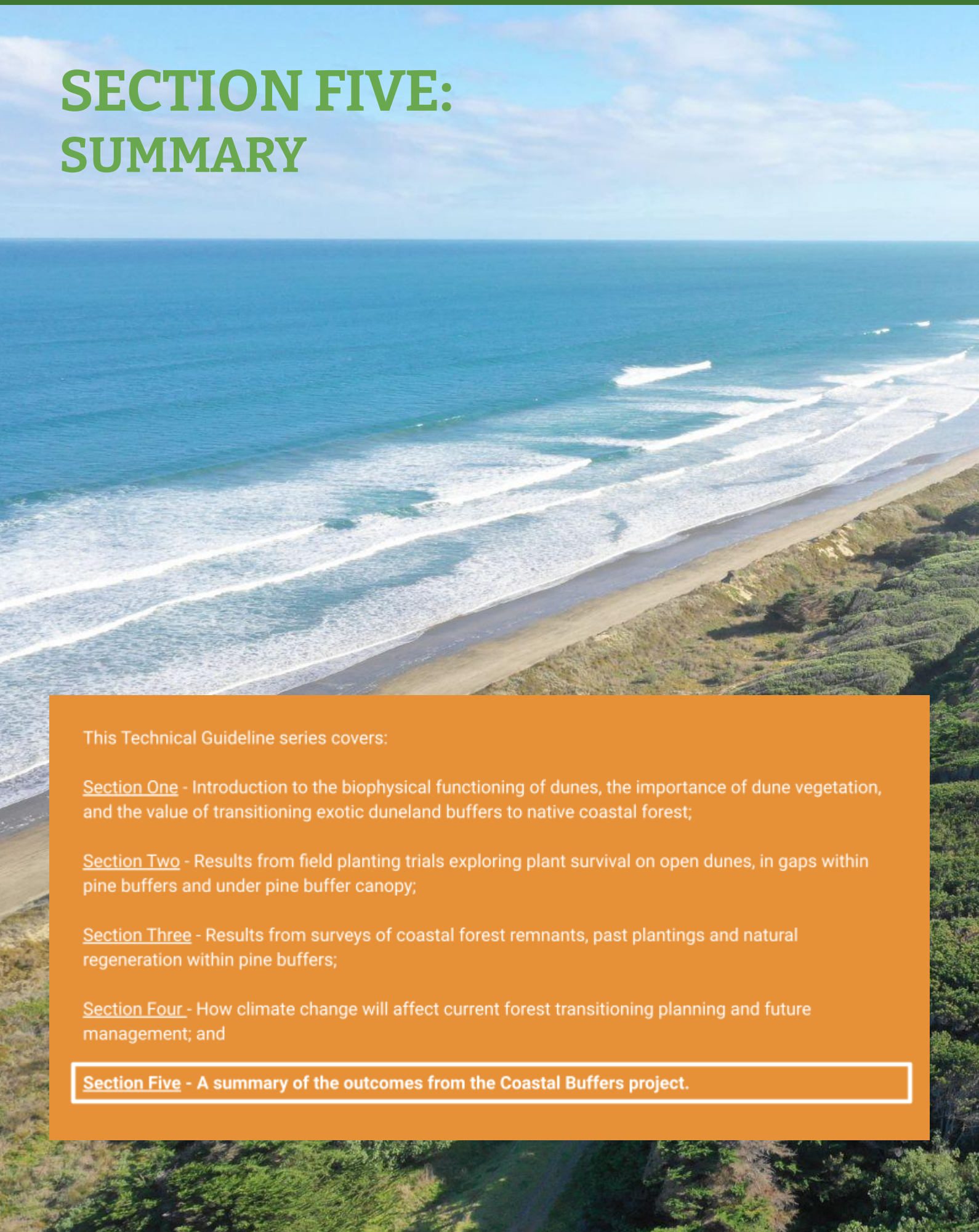
SECTION FIVE:
SUMMARY



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.

Contents

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The Adaptive Management of Coastal Forestry Buffers project compiles results from the three years of investigating methods for transitioning failing exotic coastal buffers in the upper North Island to diverse native forest. Native duneland forests will be more sustainable and resilient particularly in the face of expected impacts of climate change.

This Technical Article provides a summary of preliminary recommendations on an adaptive management approach to transitioning exotic buffers to permanent indigenous coastal buffers that would resemble prehuman coastal native forest.

The Problem

Land clearance, fires and the introduction of exotic browsing animals has resulted in the disappearance of historic dune forests from most of New Zealand's dunelands. Near-intact examples are now left only along the South Island's rugged West Coast and in the Catlins in Otago.

Sand dunes present one of the most difficult ecosystems in which to re-establish native plants. Hostile growing conditions include a combination of exposure to salty winds, sand movement, and relatively infertile substrates that are subject to drought and heat. In addition are various combinations of human-induced pressures such as pest animal browsing, uncontrolled stock, poorly managed beach user access and aggressive competition from exotic plants. The human-induced loss of vegetation cover destabilised and exacerbated migration of sand particularly along the dynamic west coast of the North Island. In places mobile sand dunes swallowed up substantial tracts of potentially productive land as well as threatening coastal communities.

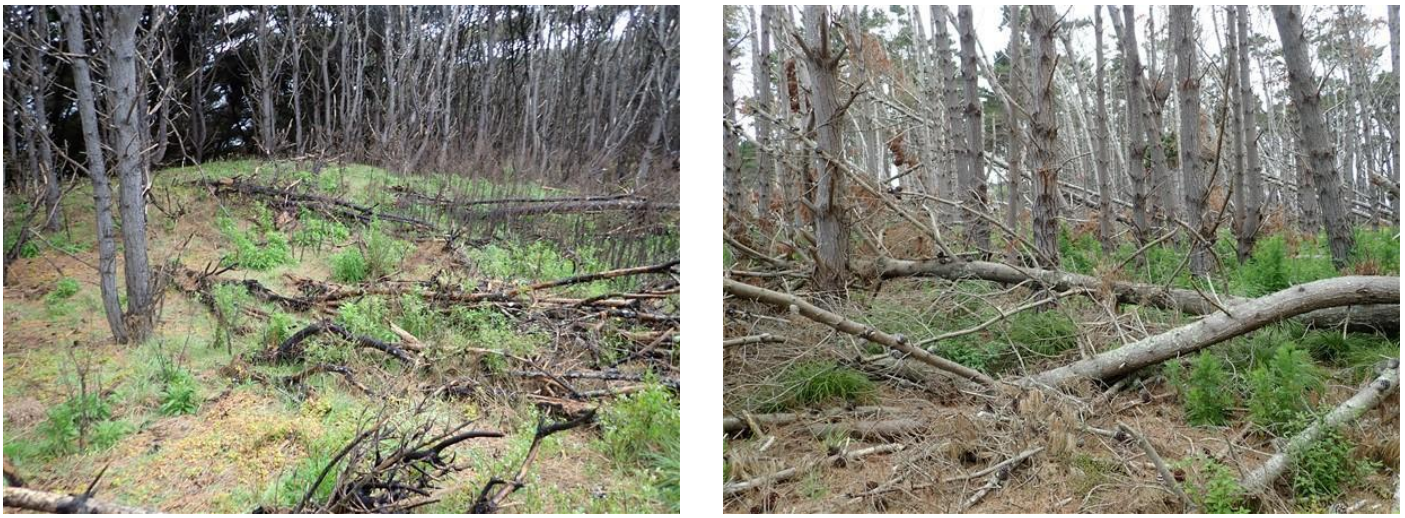
Historically, those involved in developing exotic production forestry and pastoral farming on or near coastal sand dunes had to address these issues. For forestry, their solution often included establishing an exotic planted buffer along the coast to stabilise sand dunes and provide a sheltered environment landward on which to establish production forestry. This buffer zone, some up to 400m in width, was designed to be a long-term 'sacrificial' forest that would not be logged for timber.

Most dune forest sites visited did not show strong signs of successfully transitioning back to diverse coastal forest due to varying pressures. One of the most successful transition examples is the natural regeneration occurring within the pines on the Opoutere DOC dune reserve. Regeneration was particularly noticeable further inland away from the frontal dunes and where the pine canopy was relatively open. In this case, browser pressure is relatively low and there are some native seed sources nearby (but reduced bird populations for spreading this seed). Areas of transition were also observed at 5-Mile Reserve (Muriwai) where a limited seed source was enabling some regeneration but only where fallen pines were restricting deer browse pressure.

Native regeneration under pine canopy at Opoutere, Waikato

The need for change

While planting a buffer of exotic species, particularly radiata pine, has been an effective method to protect inland production forestry for several decades, many of these pine buffers are now over-mature and failing. Forestry companies with dune pine forests are starting to realise that these sacrificial zones of pines will need replacing over the coming decades, if not sooner. In addition are the expected impacts of climate change that will see more pressure on these buffer zones to provide protection to production forest immediately inland.



Gaps in failing pine buffers with no replacement native regeneration.

Interest is building to replace failing exotic buffers with what was once the natural coastal forest along most of our shorelines. There are potentially significant environmental benefits in replacing exotic dominated coastal buffers. Coastal ecosystems are among the most degraded of all of New Zealand's major ecosystem types. Along with wetlands, dunelands have been identified as national priorities for biodiversity restoration in the Statement of National Priorities for Biodiversity and in the New Zealand Coastal Policy Statement.

Another driver of change is the increasing desire for a social licence to operate for those involved in productive land use. This includes working with local communities and iwi to incorporate conservation, social and cultural values as part of economic objectives. For the production forestry sector, these values are the basis of the Forestry Stewardship Council (FSC) requirements to achieve environmentally appropriate, socially beneficial, and economically viable forestry management. A focus on exploring practical methods to replace exotic coastal buffers with a diverse multi-species native forest that once existed on these sites is therefore compatible with these drivers.

Challenges in transitioning exotic buffers to native

Re-establishing a diverse duneland native forest is a long-term vision. In such a harsh environment as the open coastline, and with additional pressures such as exotic browsers, it will take careful management and many decades to achieve.

Therefore, the challenge is to develop innovative guidelines. These are influenced by a range of factors such as:

- New Zealand has very little experience with restoration of indigenous dune forest sequences utilising extensive exotic tree cover and, in the upper North Island, no remnant intact sequences or successful examples of coastal forest managed from an exotic coastal buffer to use as a model;
- Only a limited range of indigenous shrub and tree species are appropriate for the near-shore zone with perceptions that growth rates are typically slow;

- Animal and plant pests are a major constraint in most nearshore duneland environments, significantly restricting successional recovery of native trees and shrubs; and
- A requirement of the project is to test cost effective transitioning methods especially if they are to be implemented at scale whilst maintaining essential protection to the productive forests further landward, a first for New Zealand.

Transitioning from pine to native - The first key step is to develop a long-term (adaptive) management plan that will guide actions and forecast necessary budgets.

Management plans need to address three essential ingredients required to ensure a successful ecological succession from pine to native dune forest –

- **shelter,**
- **seed sources, and**
- **exotic browser density.**

Other factors such as exotic canopy density, native planting density, and buffer width are also important to ensure a sustainable coastal forest buffer over the long term.

Shelter/Shade

Pines are adapted to grow in harsh conditions such as nearshore coastal areas. Once established, this sacrificial pine forest zone provides an effective protective buffer for landward production forestry. Shelter is one of the key requirements influencing growth within coastal environments, so it makes sense to utilise the failing exotic forest buffers to boost the establishment of native coastal forest. Natural ecological succession on backdunes generally involves the establishment of early pioneer native plants (such as pohuehue, karo, taupata, haupata/coastal five finger, pohutukawa) that then allow the later successional native coastal canopy species to grow. These later species include broadleaves like puriri, titoki and kohekohe and conifers such as totara and kauri. The pines replicate this succession by providing the equivalent benefits (e.g. wind shelter, shade, organic matter) of early pioneer vegetation. Our plant trials showed higher survival rates of plantings (particularly tree species) under pine canopy and within pine gaps compared with planting out in open dunes. This advantage will become more important with climate change and increasing droughts.

Native understory under abandoned old pine trees

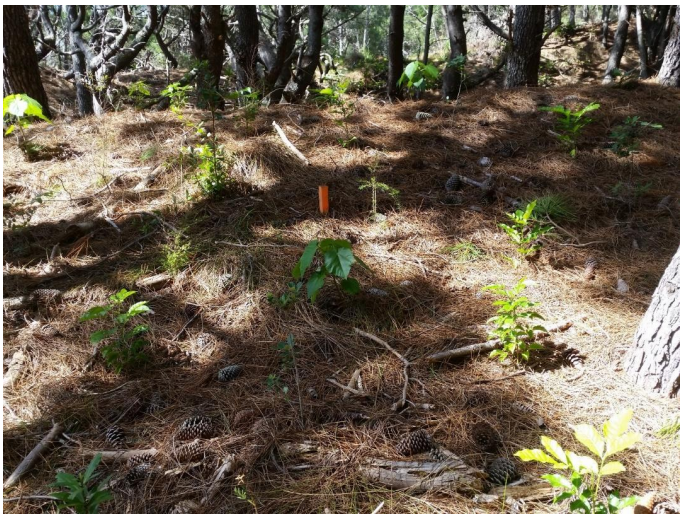
Pines can provide the necessary shade and shelter to ameliorate the effects of droughts and storms and encourage more diverse and less hardy native plant species to establish more quickly than would occur with natural succession trajectories. Therefore, as long as the ongoing forest succession is managed well (e.g. local seed sources are available, browsers are controlled, and canopy light manipulated if it is too low), utilising pine canopy may result in native dune forest establishing potentially decades earlier than would occur if forest recovery had to first wait for the establishment of a hardy native pioneer canopy.

Another benefit of utilising pine as a pioneer canopy is there is generally less risk of weed species dominating. This is due to initial pine growth outcompeting light-demanding weeds, resulting in significantly lower weed management costs compared with native plant establishment in open areas.

Native seed supply

Many of our dunelands are now bereft of native forest or only have small pockets of degraded regenerating scrub/forest. This limits the natural supply and diversity of seed to help initiate native forest regeneration. Native seed can be spread naturally either by wind or animals such as birds. Bird-dispersed seed is generally limited to a few hundred metres in which key birds like kereru will fly and deposit seed. A survey of the natural regeneration under a pine canopy can determine if natural regeneration at a site is limited by a lack of appropriate coastal forest seed sources (and/or if browsing is limiting seed supply - see below).

If seed sources of locally appropriate native canopy and shrub species are scarce or absent they can be added through planting. Depending on the size of the restoration area, planting of **'seed islands'** as long-term sources can be established through the pine buffer zone as stepping-stones for birds to roost and spread seed when flying between one planted grove to the next. The success of seed islands can be boosted with additional protective and enhancement measures such as using large plant sizes and fencing or extra pest control to ensure their early survival if a high level of pest animal control cannot currently be achieved.



A planted 'seed island' under a thinning overstorey of pines. The aim is to provide a long-term seed source of key native shrub and tree species including both wind and bird dispersed seed to encourage natural regeneration.

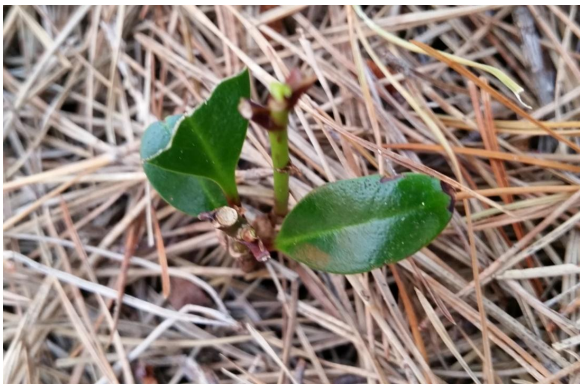
Another way to add native seed sources and provide fire protection is to design 'seed islands' into green firebreaks within a pine forest. Green firebreaks incorporate low flammability natives suited to dunelands such as ngaio, karamu, five finger, hangehange, taupata, karaka, broadleaf, kawakawa, karo and koromiko.

Exotic animal control

A pre-restoration survey of a site will identify any animal browsing issues. On-going browser control will need to be addressed to allow native revegetation to occur and palatable plantings to survive. Pest control should be undertaken before any planting occurs and ongoing monitoring undertaken to determine when further pest control is required. After ensuring domestic grazing stock are excluded including any free roaming horses, the main pest browsing animals to target are rabbits, hares, possums, goats and deer. Pigs can also do enormous local damage by rooting up the soil including planted and regenerating natives.

To improve seed crops and reduce predation of birds which are the main vectors for spreading seed, rodents and mustelids also need to be controlled. Advice regarding pest control can be sought from various sources including regional councils. For animals with large home ranges, pest control will need to be at a large scale to be effective.

Left - Five finger is a very palatable species that can be missing where browsers such as possums, deer or goats are present. RIght - Browsed karaka (germinated from seed), Te Hiku trial






Top and left bottom - Natural backdune regeneration (approx. 200 m inland) where seed sources are nearby and felled pines and pohuehue partially restrict deer access and provide shelter, Muriwai Five Mile Reserve. Right bottom - Plantation buffer open to deer browse, Woodhill Forest, Auckland.

Pine manipulation - based on site conditions

The dense shaded canopy of pines is useful to initially suppress early weed growth and encourage native seedling establishment. However, many of the key native canopy species will not thrive until the pine canopy begins to open to allow in sufficient overhead light to promote sustained growth.

It is therefore a balancing act. On one hand ensuring the pine canopy opens up either naturally or through physical manipulation to encourage dominance of naturally regenerating and/or planted natives. On the other hand, minimising weed invasion and providing shelter from desiccating winds and droughts that cause high mortality on open dune sites.

Natural thinning of a mature pine buffer canopy

Pine trees will naturally senesce over 100 - 150 years and much earlier in harsh environments such as dunelands. The long term trajectory of an aging exotic pine forest is not precisely known, especially as it is likely highly site dependent. There are only limited examples of how those changes might be occurring to draw early conclusions for wider scale application. Succession of ageing exotic pines to natives requires

further investigation. However, this study and other observations are indicating that as the pine canopy ages, gaps can form where trees die from wind damage, disease or old age. Ideally, if this method of attrition of the mature pine canopy continues naturally, the pines can be left in place to be superseded by regenerating native understory canopy species where these occur.

If the desire is to see the transition to a native dominated canopy as quickly as possible or in a controlled manner in relation to specific plantings, then targeted intervention to open the pine canopy can be used.

Targeting small natural gaps in an exotic buffer for planting native seed islands reduces the need for labour-intensive intervention. However, where opening of the pine canopy is required, this can be achieved through either felling or poisoning of selected pine trees. Where it does not cause a health and safety issue it is recommended to poison pine trees. This allows the tree to die and degrade slowly in situ, resulting in gradual opening of the undergrowth to increased light conditions. It also means that existing undergrowth is not damaged by felling of trees.

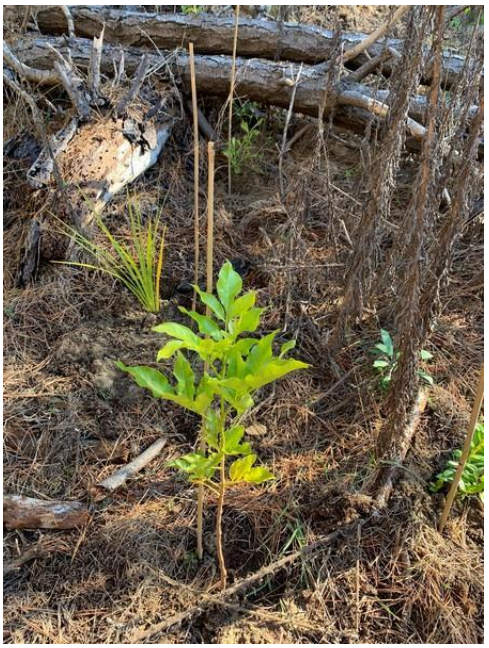
Any open disturbed areas will be susceptible to weed invasion and therefore will require monitoring and weed control where needed.

Mature pine buffer canopy under which planting trials were successfully established, Opoutere

Planting on dunes – small is better

Blanket planting native species at rates of 2-4,000 stems per hectare is in the order of $20,000-40,000 per hectare. Clearly planting at scale is impractical and not cost effective, especially where there can be high mortality as seen on dunes where prolonged droughts are becoming more common.

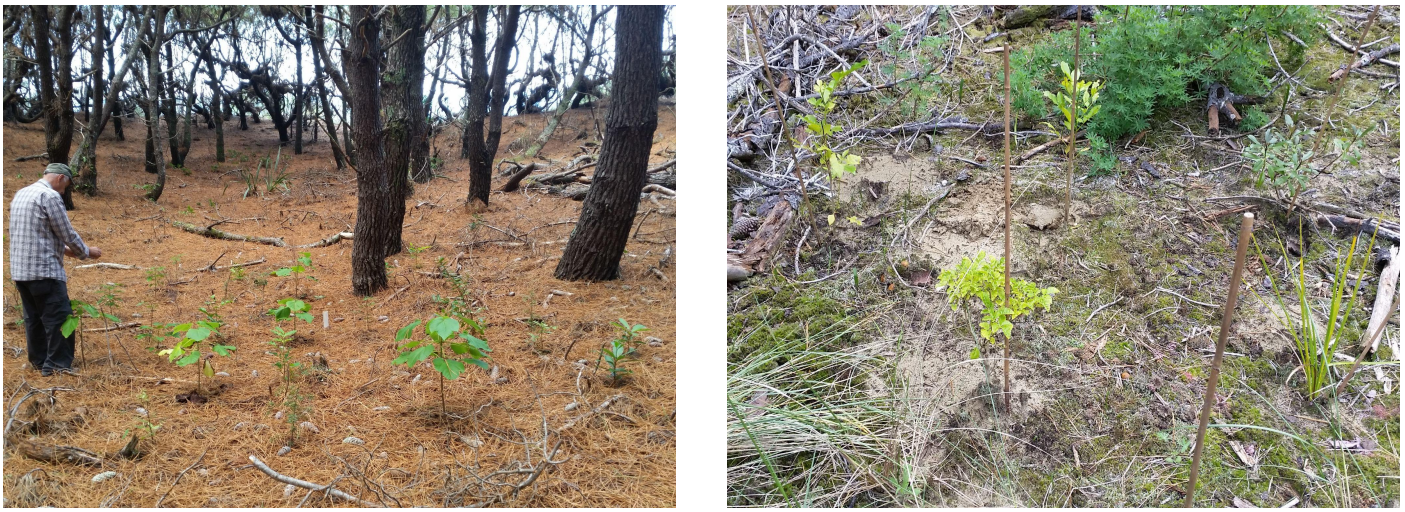
Utilising the shelter of pine buffers, seed islands can be planted to increase local seed sources, which along with pest animal and selective weed control, are measures to encourage the natural transition of exotic buffers to natives at scale. A 10x10m seed island planting per hectare would cost less than $1,000.



But even planting a small number of native seedlings in difficult dune environments can be challenging. While planting trials to date indicate that the shelter of pines is beneficial, there are other treatments that are likely to also increase survival and early growth of planted natives. These include:

- Planting seedlings within microsites that have some shelter from surrounding topography (e.g. dune hollows), other plant growth or woody debris from fallen pines;
- Using good quality tall seedlings with good shoot to root ratio and planting in deep holes;
- Where practical applying mulch of pine needles or other readily available material to conserve moisture around the root zone of seedlings; and
- Other general good planting practices such as inserting a bamboo stake with each seedling for easier location during maintenance and monitoring operations.

It is recommended to plant fewer good quality seedlings in 'seed islands' targeting the best available sites where pines allow in sufficient overhead light and the plantings can be well maintained - rather than plant thousands of native seedlings over a wide area and not have the resources to undertake maintenance such as weed control.



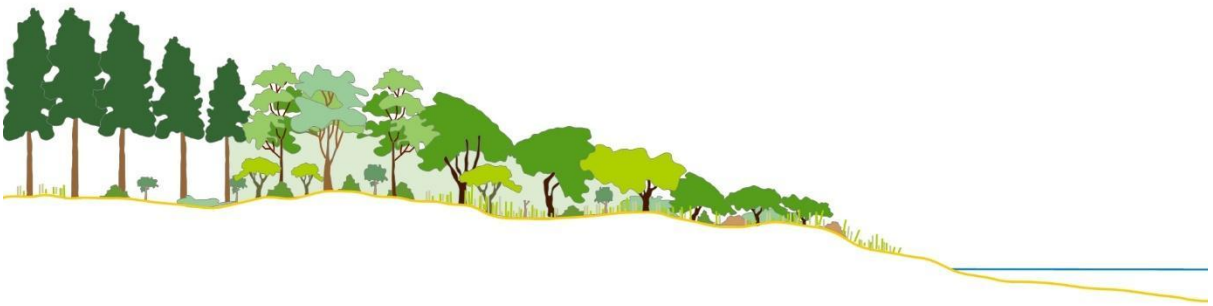
Planted plots - left under pine canopy at Opoutere, Waikato and right in pine gap at Te Hiku, Northland

Long-term resilience

The sustainability of coastal buffers in the face of climate change (particularly sea level rise and increased droughts) will be determined by the:

- **width of the buffer** (to allow for inland migration and reduced edge effects); and
- **diversity and maturity of coastal forest** (reduced threat from fire, drought, disease, weeds)

Studies of historic forest composition using pollen records from wetland cores show that change in species composition is a natural process in response to changes in climate over thousands of years. Several North Island studies indicate an increasingly drier period in recent geological times and subsequent changes in species mix. These observations are relevant to the present project as they reinforce that vegetation changes are likely with future climate change, and the need for production forest buffers to transition to more resilient diverse native coastal ecosystems that are more likely to be able to adapt to future change.



A diagrammatic representation of a native coastal buffer with an exotic production forest sheltered behind.

Adaptive management – learning through action…

It's about making the best assumptions you can from the information and knowledge currently available, then implementing changes and recording the effects. By evaluating the results this allows refinement or even rethinking of methods to best achieve more effective methods.

Forestry companies and landowners are actively removing exotic buffers now and in the meantime are having to replace them with another rotation of exotics until practical methods for establishing natives are available. With the significant challenges in transitioning many kilometres of exotic forest buffer to native forest, and the lack of knowledge on how best to undertake this at scale, an adaptive management approach testing a range of scenarios that will vary across regions over a long-time frame is required.

This approach, known as adaptive management, is an opportunity to learn by management rather than waiting for exhaustive trials to predict outcomes and inform decisions that may take many years to come up with a specific recipe for success. A number of innovative methods will need evaluating over many years to eventually provide forestry managers with what is likely to be a suite of practical methods to transition from pines to native customised to the wide variety of sites and pending impacts of climate change.

With wide scale failing of exotic coastal buffers, forestry companies may decide to only replant the inland half of the buffer with pines to provide a known protective barrier (in the short term) and leave the seaward failing half of the buffer to be used to enhance the transition towards a permanent diverse native coastal forest.

Ongoing collaboration

The project has worked closely with the forest industry, mana whenua, regional and district councils, the Department of Conservation, and local communities including native plant nurseries, environmental trusts, schools and Coastcare groups. Their input has and continues to be critical in:

- Scoping out the various issues and obstacles critical to implementation on a site-by-site basis;
- Identifying existing exotic coastal buffer sites for undertaking surveys that provide insights into how and where any natural regeneration of native forest species occur;
- Assisting in the establishment of a number of long-term trial sites for ongoing monitoring and evaluation of methods, species selection and long-term management requirements;
- Identifying the wider issues for successful uptake at an operational scale in the longer term; and
- Supporting the production of preliminary adaptive management guidelines for restoration of native-dominant coastal buffer zones to replace exotic buffers.

Further government and industry support will be required to continue the collaborative research.