Waikura Valley Land Restoration Project

Tree assessment nine years post afforestation.

An afforestation experimental trial established to test the survival of different tree species in a remote erosion prone area in Tairāwhiti

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The Waikura Valley is situated in Tairāwhiti, a region significantly affected by wide-scale erosion that is largely due to historical deforestation and extreme rainfall on vulnerable soils and geology.

Whangaparaoa 2L Trust, trading as Mataraoa Station, are located in the Waikura Valley. In 2014 the trust were successful in winning a Sustainable Farming Fund (Ministry of Primary Industries) to trial afforestation with different tree species. In collaboration with Scion the trust undertook research on the restoration of active erosion sites). This project was part of wider Waikura Valley Land Restoration Project in the area.

Planting trees to control erosion

Tree roots are effective at reinforcing steepland soils and reducing the risk of erosion. To be effective at reducing the erosion risk the planted tree species first need to survive and then establish a forest.

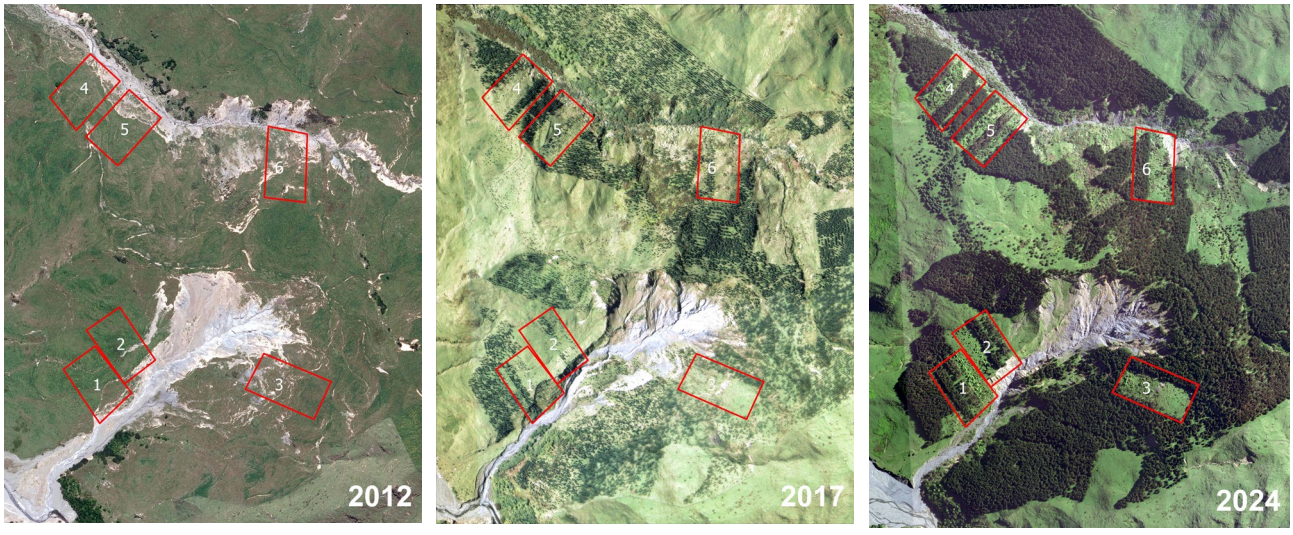
Radiata pine is a key tree species used in afforestation plantings to reduce erosion risk in New Zealand. However, there are aspirations to diversify beyond radiata pine. Data underpinning alternative species for afforestation is limited, including data on tree survival and growth post afforestation.

The research trial

In 2015 an experimental afforestation trial was established on Mataraoa Station. Six trial blocks were installed targeting two active gully erosion areas. Tree species plus mānuka were tested included either single exotic or native species and mixed species that would have the potential for soil reinforcement and environmental protection.

Top: View of site ready for afforestation.
Bottom: establishing the trial.

Time series images of the trial area



Aerial view of the trial site over time
(L-R: 2012, 2017, 2024) *showing the six trial blocks.*

Tracking progress

Nine years after planting, tree survival and growth was assessed, extending the existing dataset on tree survival collected in 2015 and 2016.

Tree growth was assessed with a measurement of stem diameter at breast height (DBH; 1.4 m stem height) on five of the six blocks. Time constraints prevented an assessment of all six blocks. Tree height was collected from all blocks using an Unmanned Aerial Vehicle (UAV) equipped with Light Detection and Ranging (LiDAR) and a Red Green Blue (RGB) spectrum camera.

Species	Traits			
	Roots	Growth rate	Drought tolerance	Wind tolerance
Mānuka				
Tōtara + Willow pole				
Native mix (12 species)				
Coast redwood (71%) + Cypress (29%)				
Eucalyptus				
Radiata pine				

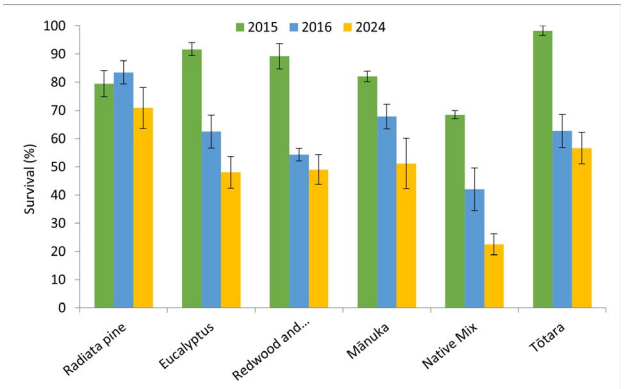
Species trait guide

No data | Very good | Good | Moderate | Low

Observations at Waikura Valley

While visiting the site in 2024 several observations were made:

- Farm animal browsing and rubbing had damaged trees, particularly the cypress and native trees.
- Many of the larger trees had toppled and resprouted – toppling likely due to cyclone Gabrelle in February 2023.
- Since 2017 the willow poles had died or been removed and were unable to be assessed.
- Additional trees were planted in the trial area. Although not measured they are likely to have impacted on the growth of some species.



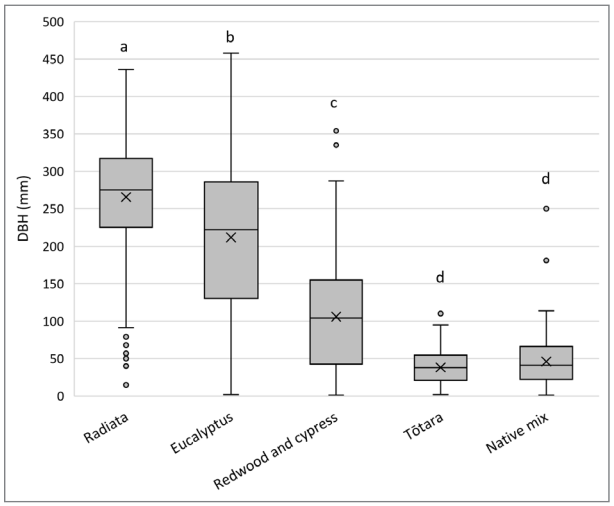
Mean survival of treatments by year.

Treatment	No. surviving		% mortality since 2016
	2016	2024	
Radiata pine	496	425	14%
Eucalyptus	375	288	23%
Redwood* and cypress**	336	294	13%
Mānuka	409	307	25%
Native Mix	252	135	46%
Tōtara	390	340	13%
Redwood only*	249	250	0%
Cypress only**	87	44	49%

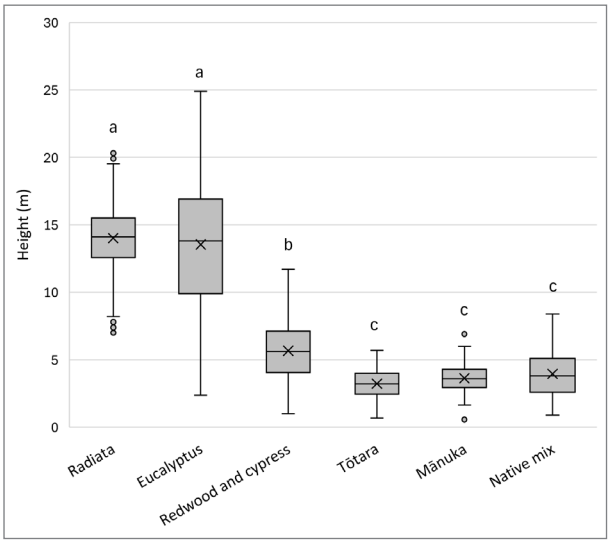
Number of surviving trees and percentage mortality of each treatment betweeen 2016 and 2024.

Tree survival

Nine years post afforestation the survival rate of radiata pine (71%) was significantly higher than that of all the other treatments. The lowest survival rate was in the native mix with mortality in 80% of the trees. Of the twelve native species planted only four species remained (kahikatea, kānuka, mānuka and tōtara). There were species that showed high mortality in the first year followed by mortality that matched radiata pine (e.g., tōtara).



Mean tree stem diameter (DBH) from the 2024 assessment. Different letters indicate significant differences between treatments ($p < 0.0001$).



Mean tree height in 2024. Different letters indicate significant differences between treatments ($p < 0.0001$).

Nine years of growth

After nine years radiata pine and eucalyptus growth far exceeds the other planted tree species for stem diameter and height. Both the eucalyptus and radiata were vulnerable to wind damage (topping) due to the higher growth rates.

Eucalyptus had also grown much larger than the other tree species, although mortality was much higher than radiata and higher than most of the other tree species. Tōtara has not achieved the same growth and size as the exotic tree species after nine years. But the survival rate of this native species is second only to radiata pine.

The potential of alternative species to radiata pine

Radiata pine has outperformed the other species at this site, which is unsurprising given its long-established effectiveness in erosion control on unstable hill country. Its proven adaptability and resilience continue to make it a benchmark species for afforestation in challenging environments.

While early survival rates of alternative species are often lower than those of radiata pine, some alternative species, such as tōtara, can achieve comparable survival once established. Addressing the challenges associated with establishing alternative species is essential to increasing confidence in their broader use.

This research trial highlights the promise of several alternative species for erosion control, while also underscoring the difficulties of afforesting remote, steep, and erosion-prone terrain in the Tairāwhiti region.

Acknowledgements

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References

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Further information

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