

Closing the window of vulnerability – A pine and Willow trial in the Waikura valley.

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EXECUTIVE SUMMARY

This trial investigates the potential of inter-planting of a willow species alongside radiata pine to reduce the window of vulnerability, post-harvest. Measurements will be taken on a yearly basis to investigate any impact willows may have on the growth of radiata pine. The aim is to compare any impact on radiata pine versus the benefits of closing the window of vulnerability early. The trial is in its third year, with two years of data collected so far. After two years of growth, willow are not significantly impacting the growth of pine. Willow foliage has been impacted by browsing deer. The impact on the root structure of these trees is unknown.

INTRODUCTION

To enable the continuity of harvesting on steep slopes in New Zealand, sustainable methods for preserving soil quality and preventing debris flows post-harvest must be explored. In steep country, post-harvest sites are vulnerable to intense weather events where the risk of erosion and debris flows are increased. There is a period of 8 years post planting, ('window of vulnerability') where the land remains vulnerable until canopy closure. This project will trial willow species Tangoio (*Salix matsudana x alba*) alongside *Pinus radiata* to measure impact of willows on the growth of radiata pine and if this impact would be unacceptable in terms of establishing radiata pine vs the benefits of closing the window of vulnerability early. The willow variety, Tangoio was selected because of its rapid growth of above and below ground biomass (Phillips et al, 2014) and on the recommendation of Gisborne District Council.

The Whangaparaoa 2L trust farming in the Waikura Valley has been granted East Coast Forestry Project funding to restore a large gully erosion site. This trial was incorporated into the restoration site with the Whangaparaoa 2L trust providing in kind support. Since proposing this trial, there has been increased interest in this trial from neighbouring iwi landowners, with a view to carrying out similar planting on their own land should the results be favourable. This project is part of the 'Growing Confidence in Forestry's future' (GCF) research programme.

METHODS

To determine the effect if any of willows on radiata pine for their potential use in hillside stabilisation and their impact on pine productivity. The trial is located in the highly eroded Waikura Valley in the East Coast of New Zealand (Figure 1) and a brief trial site description is provided in Table 1. The trial encompasses a total of 1.5 hectares.

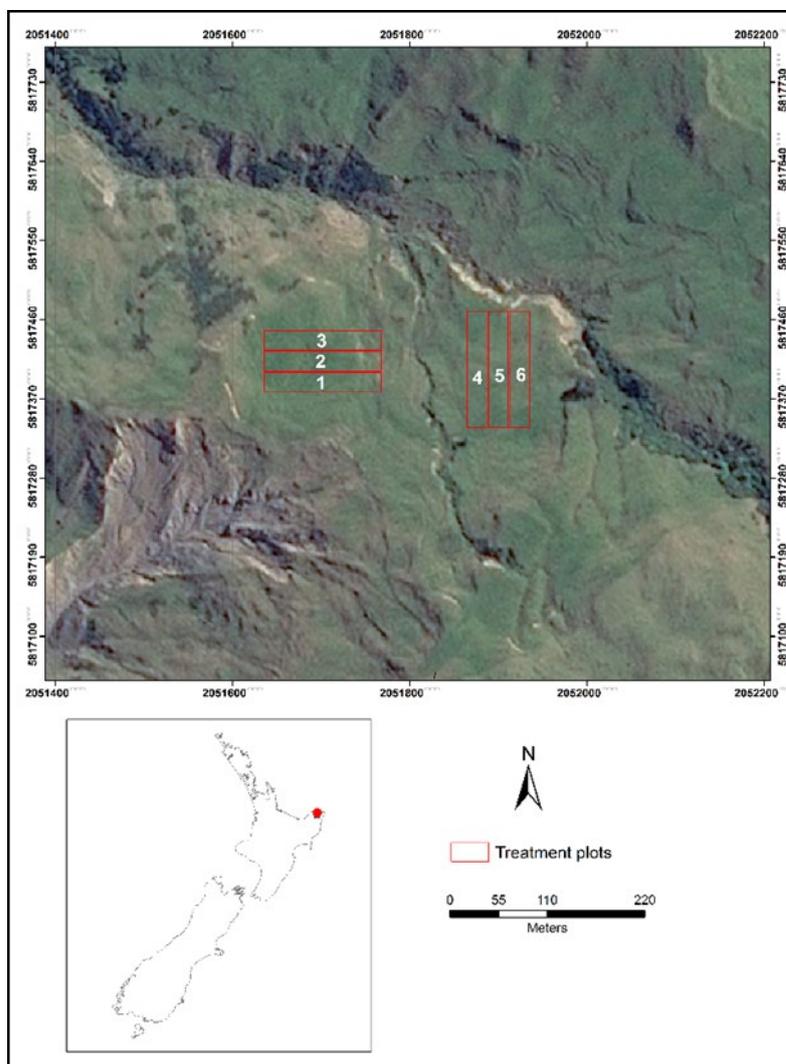


Figure 1. Trial location with six replications of five treatments

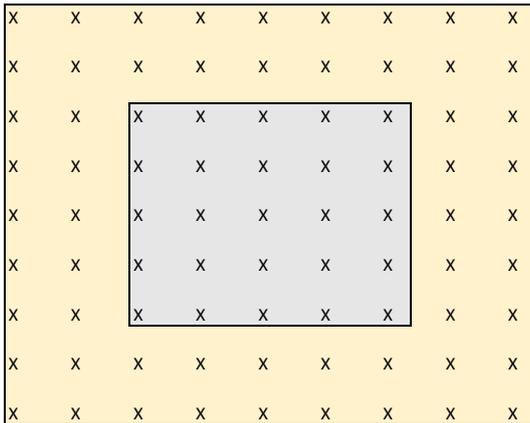
Table 1. Trial site description.

Trial location	Waikura valley, approximately 112 km north to northeast of Gisborne on the east coast of the North Island Latitude 37° 40' 51.636" and longitude 178° 7' 11.388"
Climate	Relatively sheltered; average wind speed of 4 to 6 metres per second (ms ⁻¹) Annual rainfall ranges from 1965 mm to 3046 mm Average mean annual temperature ranges from 11 to 14 °C
Soil	The soils are classified as Recent.
Geology	Mixture of greywacke and crush argillite
Slope	Ranges from 1° to 41° Land use classification rating of class 7e/GD (Lynn et al. 2009)
Gully size	Gully scar covers: 1) Most active southern gully approximately 6 ha; 2) The northern most gully approximately 9 ha. This doesn't include slumped areas. The area has an elevation ranging from 200 to 440 m asl (above sea level).

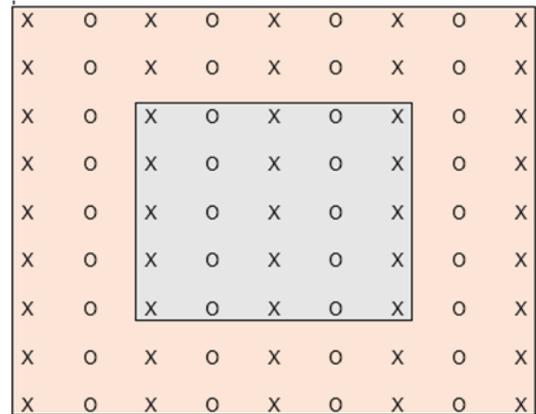
Trial Design

The trial has been designed to consider species and stocking effects. There are five treatments. The treatment blocks are replicated 6 times and treatments were randomly assigned using a random numbers generator. The spacing between trees used to determine species effects is 3 m x 2.5 m. To understand the effects of stocking and species the spacing layout is 1.5 m x 2.5 m. The grey area in each plot is the measurement area and the coloured area is the buffer. Legend: X = *Pinus radiata*, O = Willow.

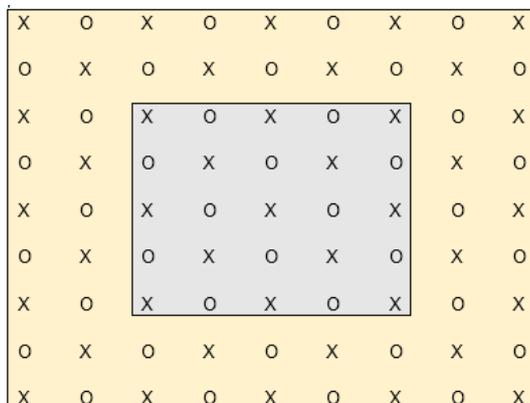
Treatment 1: (Control) Stocking 1333 stems per hectare (sph) - species effect.



Treatment 2: Stocking 1333 sph. Species effect. Stocking 667 sph of *P. radiata* when willows removed.



Treatment 3: Stocking 1333 sph - species effect. Stocking 1111 sph when willows removed.



Treatment 4: Stocking 5333 sph - stocking and species effect. Stocking 1333 sph when willows removed.

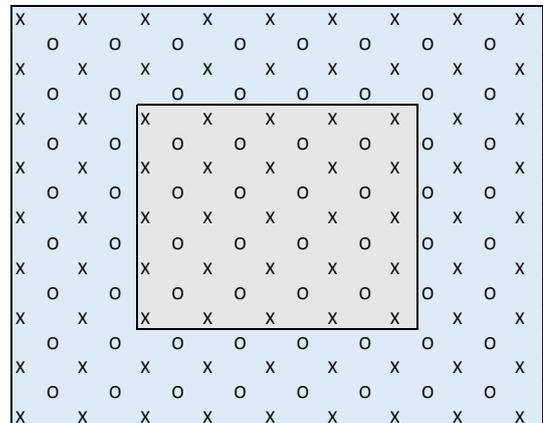
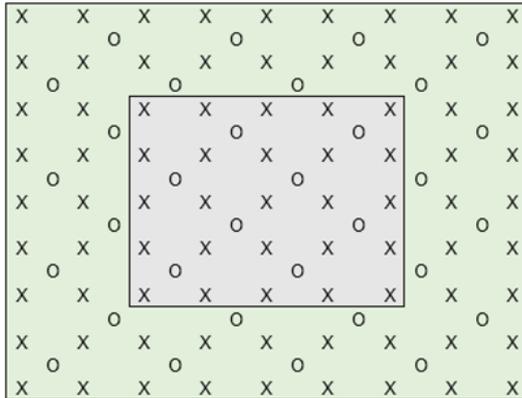


Figure 2. Treatment 5 2666 sph – stocking and species effect. Stocking 1333 sph when willows removed.



Trial establishment and maintenance

Site preparation was carried out in June/July 2015. Tree planting occurred in August/September 2015. To ensure tree survival, trial maintenance was as follows:

- **Pre-plant weed control** – A pre plant spot spray of glyphosate (Roundup) or gardoprim at manufacturer recommended rates.
- **Post-plant weed control** – There were two post-planting spot release spray events in spring and mid-summer depending. No Replanting has occurred to date.
- **Post-trial** - The trial runs for two more years but pole plantings can be managed out at approximately age 5 years (dependent on growth) to leave *P. radiata* if the landowners desire. Management involves using either basal bark herbicide spraying application with standing dead tree or cut stump application requiring tree to be felled (Ledgard, 2009).

INTERIM RESULTS AND DISCUSSION

The trial was measured in September 2017 for height and survival of both species. A browsing factor for willow (see Appendix 1) was added to the 2017 data collection to account for damage from deer and diameter at breast height (dbh) was recorded for pines aged two. The browsing factor provides a qualitative estimate on the amount of browsing damage (10 high 50 low damage). In 2016 there was over 95% survival for both species. The 2017 data collection, which includes the dead tree count from 2016, reveals survival ranging from 90% to 95% (see Figure 2).

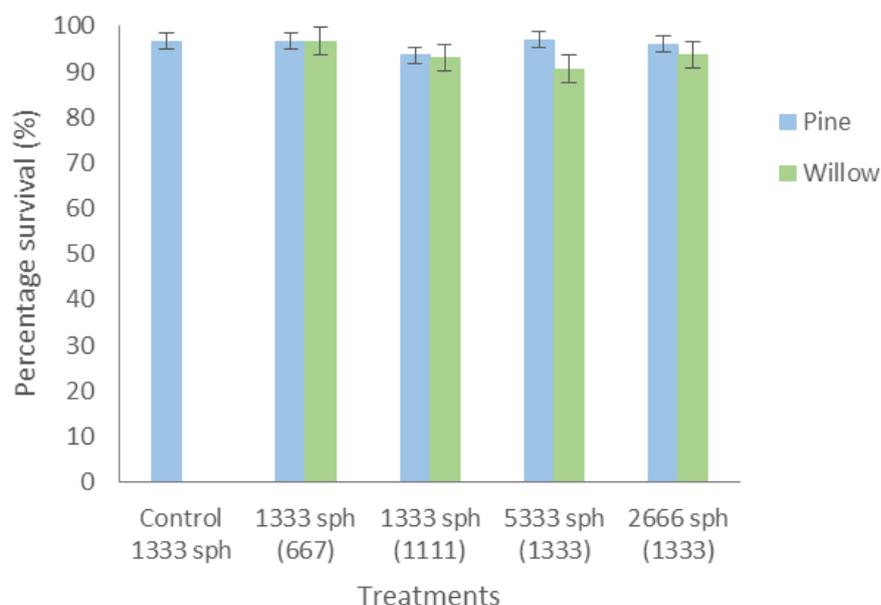


Figure 2. Percentage of survival across all treatments for pine and willow aged 2 years. Numbers in brackets are final stocking rates/sph (stems per hectare) for *Pinus radiata* after willows are removed. Error bars present standard error around the mean.

Browsing damage in this trial occurred in the second year of growth so there may be enough root structure formation in the first year of growth to provide land stabilisation effects. Phillips et al., (2014) observed that 79% of the root biomass was within 1.5 m of the pole of a destructively sampled Tangoio willow, after 9 months of growth. It is yet to be established if this root mass will impact on the growth of neighbouring pine. An analysis of variance (SAS v.9.4 Mixed procedure) revealed no significant difference between treatments for both willow and pine at age 2 (see Table 2). There was no significant difference in pine tree height (for years 1 and 2) or pine dbh (year 2) across treatments (see Figures 3 and 4).

Table 2. ANOVA table showing tests of significance for treatment effects for variables measured at age 2 years. The degrees of freedom of F-ratios are 4 (numerator) and 16 (denominator) (p -value = 0.05).

Variable	F-Ratio	p-value
Survival, pines	0.62	0.66
Survival, willows	0.85	0.49
DBH, pines	0.70	0.60
Height, pines	1.52	0.24
Height, willows	2.50	0.11
Browsing score, willows	1.86	0.19

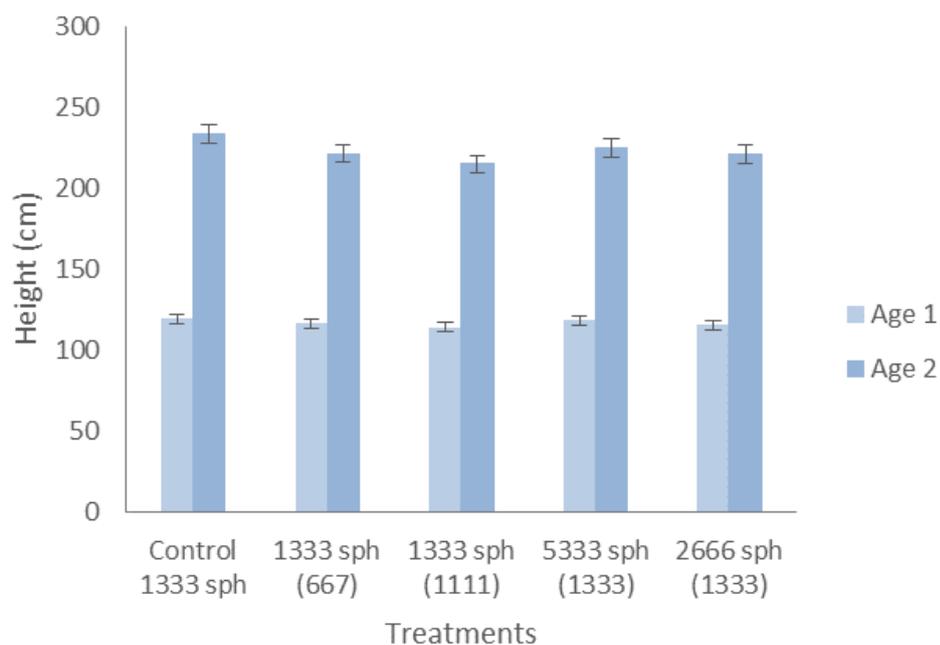


Figure 3. Pine aged 1 and 2 years. Mean height in cm across all replications and treatments. Error bars present standard error around the mean.

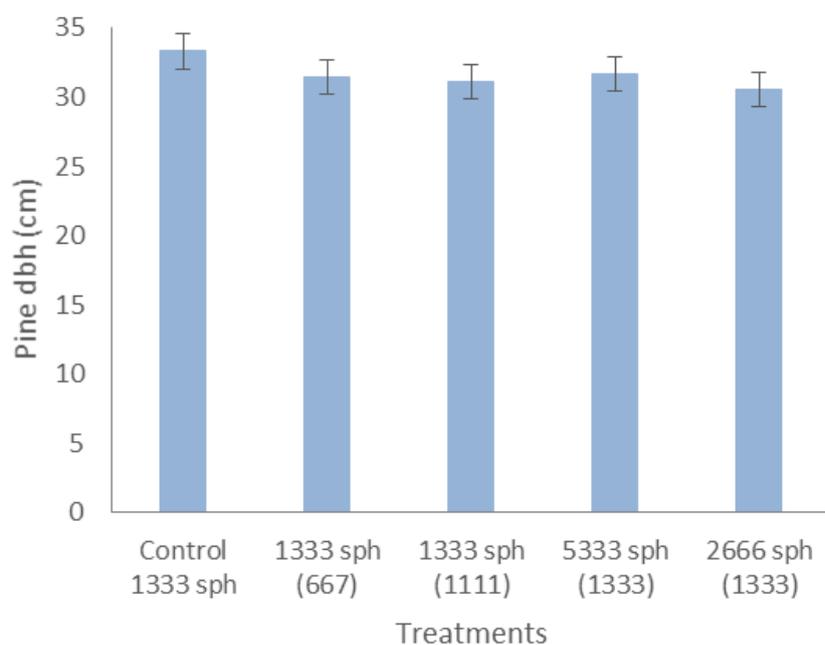


Figure 4. Diameter at breast height (dbh) for pines aged 3 years. Error bars present standard error around the mean.

Replications 1 to 3 were situated on a flat plateau and replications 4 to 6 were at a higher elevation, on a slope. An analysis of variance performed on the two sites showed no significant difference between all variables except for the browsing factor for willows (Fig. 5). Willows on the slope suffered less damage from browsing than those on the flat (Table 3.)(Fig. 6).

Table 3. ANOVA table showing tests of significance for locations comparing lower 3 blocks (flat) with upper 3 blocks (steep) for variables measured at age 2 years. The degrees of freedom of F-ratios are 1 (numerator) and 4 (denominator) (P=0.05).

Variable	F-Ratio	p-value
Survival, pines	6.49	0.0640
Survival, willows	0.45	0.5400
DBH, pines	1.04	0.3700
Height, pines	0.24	0.6500
Height, willows	4.89	0.0920
Browsing score, willows	52.6	0.0019

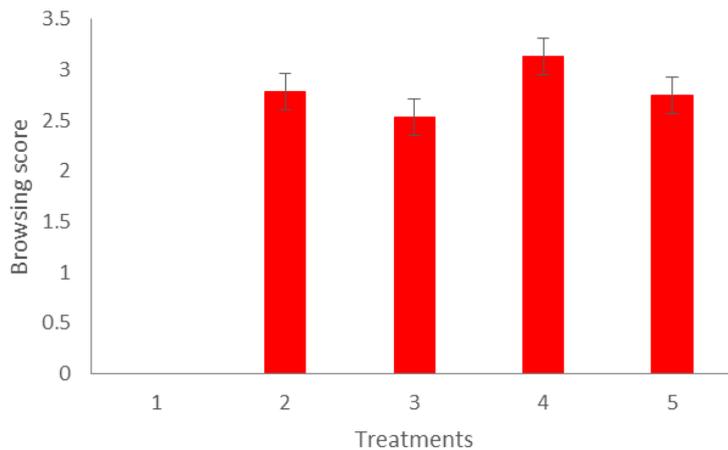


Figure 5. Browsing factor across willow treatments. A lower score means more damage.

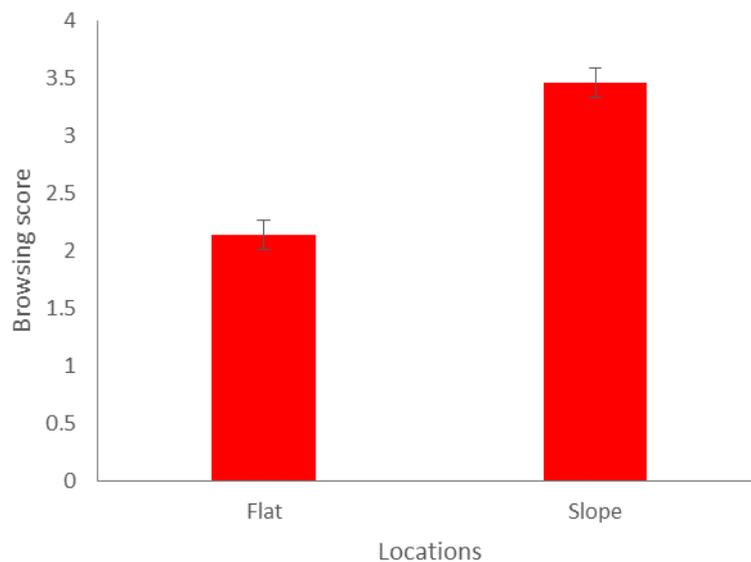


Figure 6. Browsing factor comparison between replications on the flat and on the slope. A lower score means more damage.

Browsing damage from deer is a problem. Although the site is fenced, fencing is only 1 metre high which is no deterrent for deer. The landowner is increasing pest management practices to ensure the deer population is kept under control. After two years of growth, willow are not significantly impacting on the growth of pine.

ACKNOWLEDGEMENTS

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APPENDICES

Appendix: 1 Browsing factor: Score and Images

Score 10



Score 20



Score 30



Score 40



Score 50

