First year performance of planted natives, Te Pa Ika restoration project, Maketu Estuary, Bay of Plenty

David Bergin and Michael Bergin

Environmental Restoration Ltd

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Overlooking planting area of Te Pa Ika restoration project 12 months after planting, adjacent to Ford Road and Kaituna River (right), Maketu Estuary, Bay of Plenty.

INTRODUCTION

First-year performance of natives planted as part of the Te Pa Ika restoration project at Maketu Estuary by the Bay of Plenty Regional Council (BOPRC) was undertaken. This restoration is part of a major project to re-create 20 hectares of wetlands around the Maketu Estuary, to help filter nutrients and create breeding areas for birds and fish as an increasing proportion of the Kaituna River's freshwater is rediverted into the estuary and https://www.boprc.govt.nz/our-projects/kaituna-river-rediversion-and-maketu-estuary-enhancement/. Several hectares along the western portion of the wetland adjacent to Ford Road was planted in mid-2019.

Monitoring plots were established along transects to sample the planted area in late October 2019, up to 3 months after the bulk of the planting. This provided a baseline assessment across the plantings and an indication of early performance. Further background to the restoration project and details on the site, species planted, and the design and establishment of monitoring transects and plots is provided in Bergin and Bergin (2019).

This report covers the following:

- Brief account of site characteristics and the restoration planting carried out in mid-2019;
- Design and implementation of monitoring undertaken in October 2019;
- Preliminary results of the baseline assessment in October 2019;
- A brief survival inspection carried out in February 2020; and
- In greater detail, a first-year assessment undertaken in May 2020.

SITE CHARACTERISTICS

Te Pa Ika restoration site is located immediately east of Ford Road and the Kaituna River near the mouth of the river locally known as Te Tumu. Selected contour elevations are shown in Figure 1 across the sites where three zones have been identified (elevations are NZVD new datum):

- Zone 1 – Estuarine rushland 0.5-1m elevation (largely inter-tidal zone);
- Zone 2 – Marsh shrubland 1-1.5m elevation; and
- Zone 3 – Terrestrial shrubland >1.5m and higher elevation.

The main planting area is largely focused across the three zones on the western area of restored wetland adjacent to Ford Road, with some planting extending eastward at the northern end adjacent to the dunes and along the channel at the southern end.

Figure 1: The three planting zones, Te Pa Ika restoration project, adjacent to Ford Road and Kaituna River, Maketu Estuary, Bay of Plenty. Zone 1 estuarine wetland is at 0.5-1m elevation (inter-tidal), Zone 2 marsh shrubland 1-1.5m elevation, and Zone 3 terrestrial is >1.5m elevation. Eight soil survey sites are located throughout the main planting areas mainly along the western portion (image provided by BOPRC).

As indicated by Courtney Bell, Senior Projects Officer (Coastal Catchments) Bay of Plenty Regional Council, this is a difficult open planting site which is highly modified from the construction of the wetland with parts incorporating imported fill, other areas of compaction, a fluctuating tidal saline water table, and little organic matter. Eight soil survey sites located across the main planting areas of the sites are also indicated in Figure 1. Soil tests confirm high soil salinity in places and significantly low pH on other sites. Consequently, there has been early localised loss of plants and some replanting was undertaken.

Wood chip mulch had been added to the plantings over Zone 3 (terrestrial shrubland) and some of Zone 2 (marsh shrubland) varying in depth from 10-20cm.

General view looking north of main planting site alongside Ford Road in October 2019, soon after planting was completed.

SPECIES PLANTED

The area was planted with nearly 65,000 container grown natives comprising over 20 species with planting mostly undertaken in June 2019. Some planting extended for another 2-3 months into spring (refer to Appendix 1 for list of plants).

According to records supplied by BOPRC the following planting was planned:

- Nearly 41,000 natives comprising three species were to be planted in the inter-tidal ***Zone 1***, 75% sea rush and the balance oioi and a small proportion of saltmarsh ribbonwood (refer Appendix 2). All species planted in Zone 1 were at a planned 0.7m spacing. (Note – during this survey, due to the difficulty of distinguishing between Zone 1 and 2, a high proportion

of the sea rush identified as planted in the Zone 1 inter-tidal zone were within what was identified as Zone 2 – marsh shrubland).

- The 7500 natives planted in ***Zone 2*** comprised nine species mostly planted at a planned 1.5m spacing (equivalent to 4444 stems per ha) except for wiwi planted at 0.7m spacing and mingimingi at 2m spacing. Most of the plants were woody shrub species with nearly 40% of them taupata and ngaio.
- The 7500 trees and shrubs planted in ***Zone 3*** included 15 species with 20% manuka, about 15% harakeke, just under 10% for each of akeake and ti kouka, and the rest of the species in minor proportions. Some areas were replanted including a considerable number of oioi at the southwestern end of the main planting.

MONITORING METHODS

Sampling design and layout

The monitoring design involved placing transects 50m apart across the bulk of the main planting area adjacent to Ford Road. Each transect was located perpendicular to the road and for the most part this allowed sampling across the three zones. Along each transect circular bounded plots were established at fixed distances of 15-30m apart, the distance between plots determined by the length of each transect across the planted portion of the wetland and the location of each zone. A treated wooden 50x50mm peg 600mm high was inserted in the centre of each plot. The size of plots in the terrestrial Zone 3 were 10m in diameter, and in Zone 1 and Zone 2 plot diameter was 5m (Figure 2). The aim was to get a minimum sample of 10 plants per plot, preferably 20 plants or more per plot.

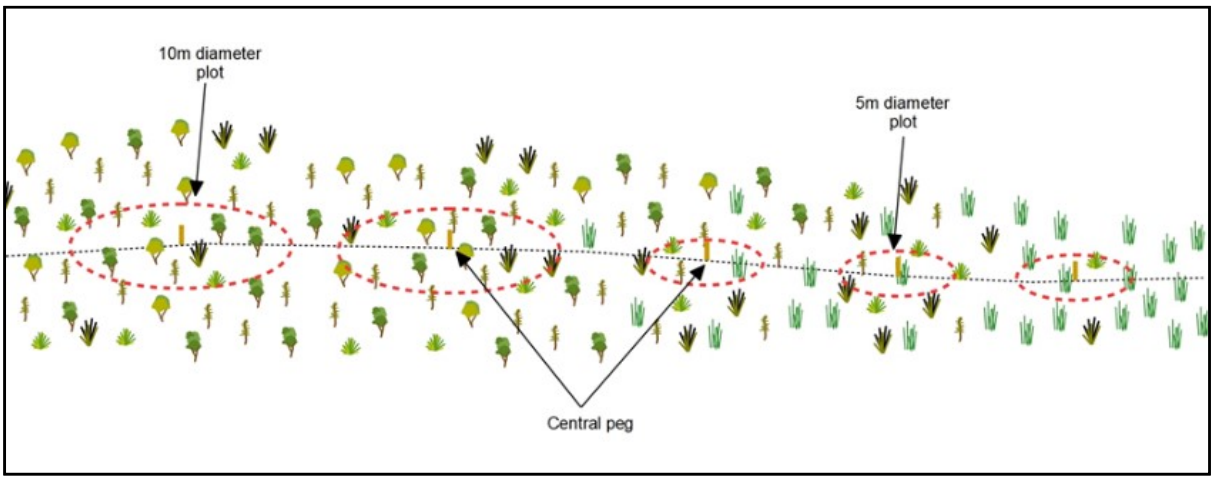


Figure 2: Illustration of plots located along a transect with the central plot peg placed along the transect line at fixed distances. Large plots were established within the wider spaced plantings of the terrestrial Zone 3 and smaller plots established in the more densely planted estuarine and inter-tidal zones Zones 1 and 2.

Sixteen transects were established ranging in length from 50-150m and a total of 52 plots established (Figure 3). GPS coordinates of transect and plot locations are indicated in the establishment report (Bergin and Bergin 2019).

A rapid monitoring method was used to record each species planted within each bounded circular plot using a 5m or 2.5m radius string attached to pig tail standards pivoting around each plot peg.

The parameters recorded within each bounded plot were;

- Species planted;
- Natural plant height to uppermost green/live foliage;
- Plant vigour using a subjective score of general plant health specific to each species of 1-5 where 1=poor, 2=unthrifty, 3=average, 4=good, 5=excellent; and
- Any notes on condition of the planted native such as browsing, dieback, wilting, etc.

Two pig tail standards with connecting cord at a fixed radius of 2.5m or 5m was used to sample the planted natives within bounded circular plots around a centrally located wooden plot peg.

All planted natives within each circular plot were measured by species for natural height with a subjective assessment of plant vigour.

Allocating plots to zones

Demarcating the precise location of zone boundaries along each transect proved problematic in the field, particularly the transition from the lower Zone 1 (inter-tidal zone) and the adjacent more elevated Zone 2. The boundary between Zone 1 and 2 was determined by the position of the high tide wrack line and an assessment of elevation based on the tidal zone. This proved difficult to determine precisely so some of Zone 1 is likely to have been included with Zone 2. Hence a larger proportion of sea rush was located in Zone 2 (as defined in this survey) than is indicated in the BOBRC planting plan (Appendix 2). Each plot was allocated to a zone during the fieldwork based on the bulk of the plot occurring within that zone.

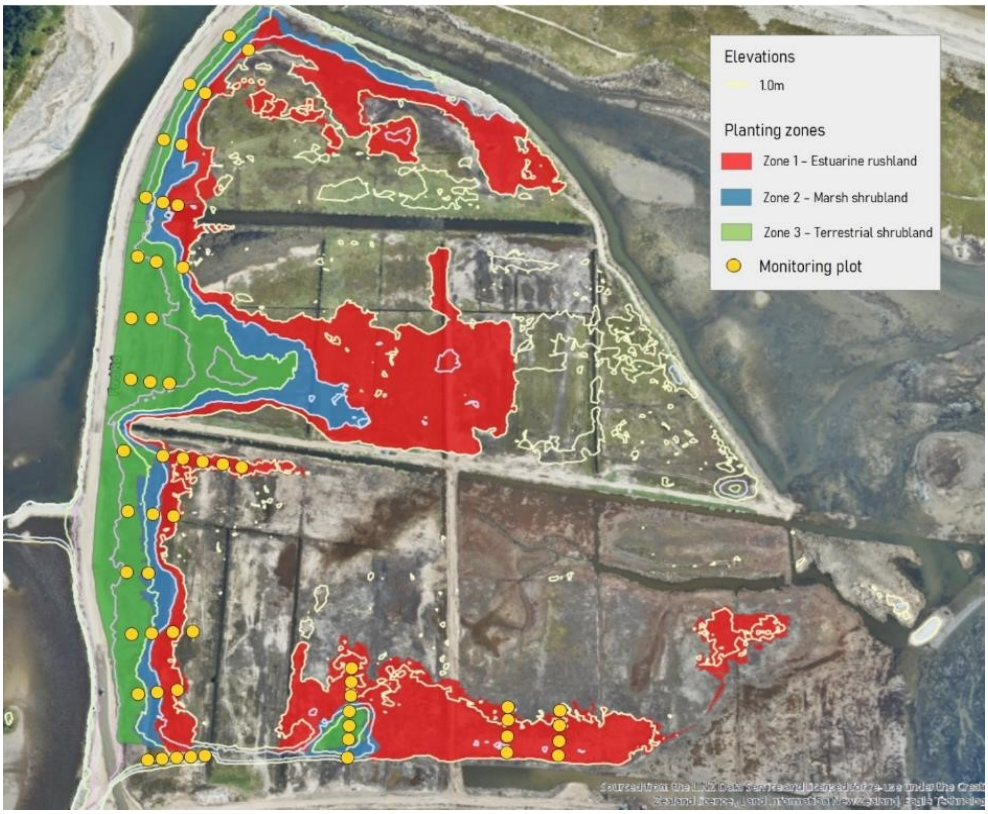


Figure 3: Sixteen transects were established each ranging in length from 50-150m with most transects sampling the 3 planting zones. A total of 52 plots were established ranging from 2-7 plots on each transect.

BASELINE MEASUREMENT (OCTOBER 2019)

The establishment of monitoring transects and plots and the baseline assessment was completed in early October 2019, approximately 3 months after the bulk of the wetland area was planted. Details of this assessment including tables and graphs of species planted and early performance are provided in Bergin and Bergin (2019). Some key points are summarised.

A small proportion of planted natives had already died at this first survey so wherever possible these plants were included in the baseline data. It was not always possible to accurately determine the species of dead plants particularly if it had died some time ago. However, these results will provide some indication of overall early survival of natives in each zone.

A total of 1924 seedlings were assessed across the 52 plots established along the 16 transects. Average plant stock was nearly 12,000 plants/ha, equivalent to a plant spacing of 0.8m. Seven plots were established in Zone 1 (inter-tidal zone), 20 in Zone 2 and 27 in Zone 3. Average stocking was widest in the terrestrial Zone 3 with an average spacing of nearly 1.6m between plants. Zones 1 and 2 ranged in stocking from 12,000 to 15,000 plants per ha.

Early performance (October 2019)

The higher elevated Zones 2 and 3 planted with native shrubs and trees had over 90% survival up to 3 months after planting (Figure 4). Early indications suggested that the more successful species in terms of survival and plant vigour were the commonly planted hardy coastal native species including mingimingi, taupata, ngaio, tauhinu, karo, manuka, karamu, pohuehue, toetoe, houpara, ti kouka and harakeke. Mahoe, akeake, koromiko and saltmarsh ribbowood had reduced survival and species showing poor early performance included whau and karaka.

The oio and wiwi planted on the upper terrestrial zone had high survival and excellent plant vigour although these species had only been recently planted compared to most of the earlier planted shrubs species.

The lower elevated Zone 1 dominated by planted sea rush had 70% survival 3 months after planting with some of this mortality likely due to erosion of plants by waves and dumping of organic debris in places on top of planted natives along the wrack line during high tides.

Figure 4: Survival by zone across all species for planted natives 3 months after planting at Te Pa Ika wetland restoration project. Zone 1 (red) estuarine wetland 0.5-1m elevation, Zone 2 (blue) marsh shrubland 1-1.5m elevation, and Zone 3 (green) >1.5m elevation.

SITE INSPECTION (FEBRUARY 2020)

A brief walk-through inspection of the planting site was undertaken in February 2020. Despite what was the early stages of a prolonged summer drought in many parts of the country, high survival of the commonly planted shrub hardwood species continued across most of the terrestrial Zone 3 and especially where mulch had been used. This combined with a relatively high-water table across parts of the planting site was also likely to have had a positive effect on survival.

Growth appeared to be slow over the first 6-8 months since planting across this exposed open coastal site. There was a clear difference in survival and growth between those sites mulched with wood chip and non-mulched areas. Weeds were not a major issue but would need to be monitored. Mulching was clearly keeping most of the site relatively weed-free.

FIRST YEAR ASSESSMENT (MAY 2020)

A major assessment was completed in May 2020 nearly 12 months after the bulk of natives were planted. This involved recording survival, natural plant height and subjective assessment of plant vigour by species for all 52 plots. Notes and photographs were taken of the site, planted natives and weed growth.

Data was analysed and performance summarized by species in tables and graphs to highlight key factors and successful species across the planting area. These were used to provide recommendations for selection of species and planting methods for further planting and management of the site.

Te Pa Ika restoration project 12 months after planting assessed for survival and performance showing most successful growth of planted natives is on the more elevated zones closest to Ford Road and the Kaituna River.

A summary of mean survival, height and plant vigour data for the species planted is given in Table 1. These are listed in order of best to poorest survival for the latest assessment in May 2020. Note some of the sample sizes for the species are very low so care is required in interpreting the data.

Table 1: Mean survival, height and plant vigour for native species planted as part of the Te Pa Ika restoration project, Maketu Estuary, Bay of Plenty. Note survival for October 2019 was estimated based on originally planted natives as some mortality had already occurred in the period between planting and assessment up to 3 months later. Note sample size is low for some species, so care is required in interpreting the data.

Species	N = Sample size Oct-19	Estimated survival Oct-19 (%)	Survival May-20 (%)	Average Height (cm)	Average Vigour (1-5*)
Houpara	9	88.9	100.0	31.4	3.8
Oioi	218	99.5	92.7	62.0	3.6
Pohuehue	8	87.5	87.5	24.0	3.7
Toetoe	15	100.0	80.0	63.7	3.5
Mingimingi	27	81.5	77.8	30.7	3.7
Sea rush	655	87.8	78.8	49.0	3.3
Mānuka	117	90.6	71.8	62.7	3.2
Karo	65	95.4	64.6	58.7	3.5
Karamu	46	82.6	56.5	48.9	2.7
Harakeke	88	100.0	54.0	46.4	3.5
Saltmarsh ribbonwood	50	62.0	46.0	58.9	3.2
Ti kouka	55	96.4	42.7	36.4	3.9
Akeake	66	69.7	42.4	48.0	3.9
Koromiko	12	75.0	41.7	34.4	1.8
Taupata	102	97.1	41.7	23.2	3.9
Wiwi	129	100.0	40.7	58.7	4.1
Ngaio	151	98.0	34.8	45.5	4.5
Kahikatea	18	100.0	33.3	62.5	2.0
Tauhinu	3	100.0	33.3	39.0	5.0
Mahoe	8	75.0	12.5	26.0	2.0
Karaka	12	25.0	8.3	58.0	3.0
Whau	2	0.0	0.0	0.0	0.0

Plant vigour – subjective score 1=poor, 2=unthrifty, 3=average, 4=good, 5=excellent.

Survival

Mean survival for the main species with 10 or more plants sampled at the baseline assessment within 3 months of planting is shown in Figure 5. Best surviving species with over 50% survival up to one year after planting include oioi, toetoe, mingimingi, manuka, karo, karamu and harakeke planted on the terrestrial Zone 3, with sea rush at close to 80% survival mostly in Zone 2. Five other species in upper Zone 3 have achieved close to 40% survival including saltmarsh ribbonwood mostly planted in Zone 2, and ti kouka, akeake, koromiko, taupata and wiwi in elevated terrestrial Zone 3. Note these results were across all plots including those mulched and non-mulched.

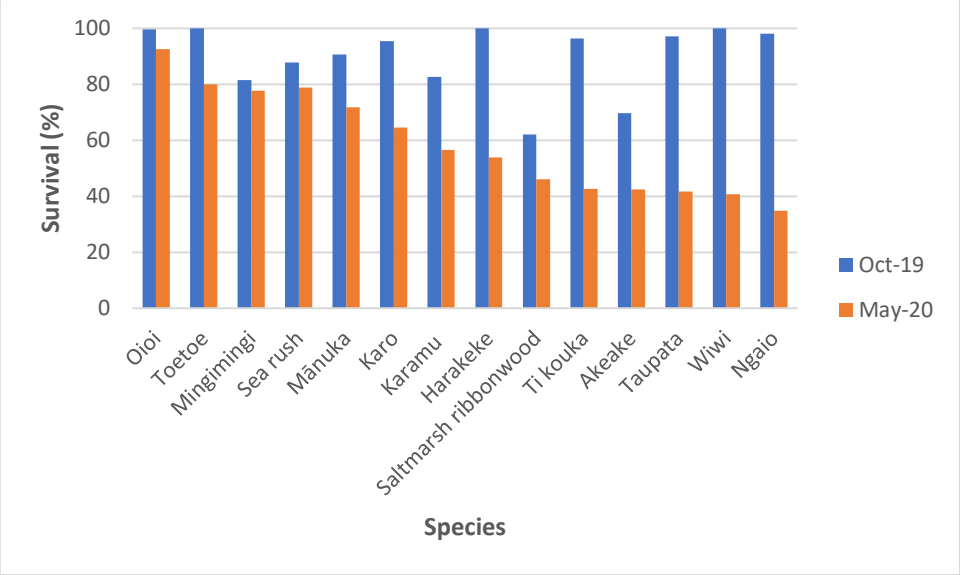


Figure 5: Average survival of natives approximately 3 months (October 2019) and nearly one year after planting (May 2020) for the most successful species with 10 or more plants sampled in the survey plots. Note this was across all plots irrespective of whether mulched or not.

Mean survival was lowest in the inter-tidal estuarine rushland Zone 1 (red) at less than 30% whereas survival in the marsh shrubland zone (blue) and upper terrestrial shrub zone (green) were close to 80%. Survival of the mostly sea rush planted in the inter-tidal Zone 1 has continued to fall from nearly 70% 3 months after planting (Figure 4) to less than 30% at the first-year assessment in contrast to higher survival of sea rush in Zone 2 above the wrack line (Figure 6). Mortality for the upper elevated zones since the first assessment had not been as severe with both around 80% survival, dropping only 10 percentage points (Figure 6).

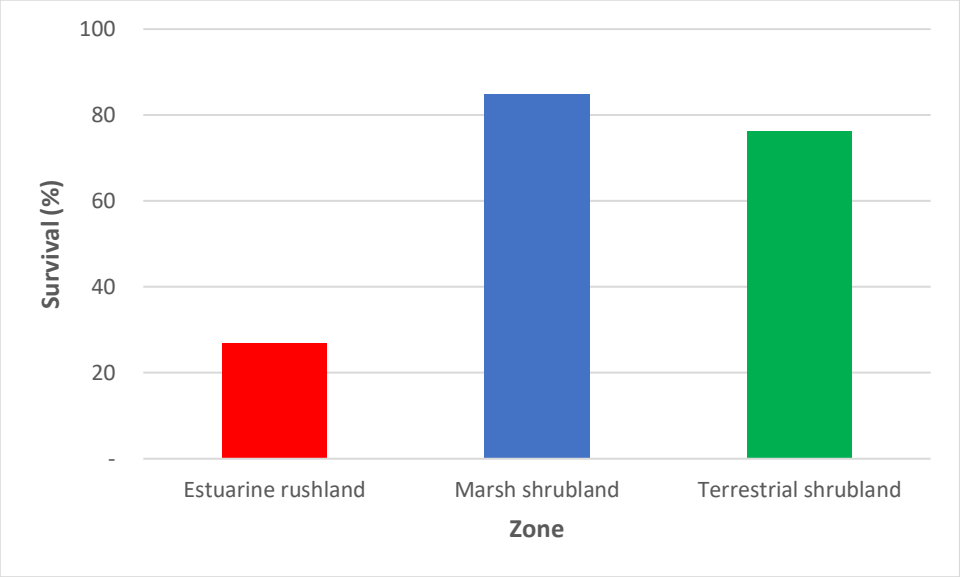


Figure 6: Average survival of natives nearly one year after planting (May 2020) across all species by zone – Red – Zone 1 (Estuarine rushland), Blue – Zone 2 (Marsh shrubland), Green – Zone 3 (Terrestrial shrubland).

There was often poor survival of planted sea rush in Zone 1 within the estuarine rushland inter-tidal zone.

Height

Overall height growth has been minimal for the selected species with higher sample sizes (Figure 7). The tallest native shrub species at 50-60cm in height included manuka, karo, karamu, saltmarsh ribbonwood, akeake and ngaio. Highest monocots included oioi, toetoe and wiwi that occurred mostly in Zones 2 and 3, and sea rush mostly surviving in Zone 2.

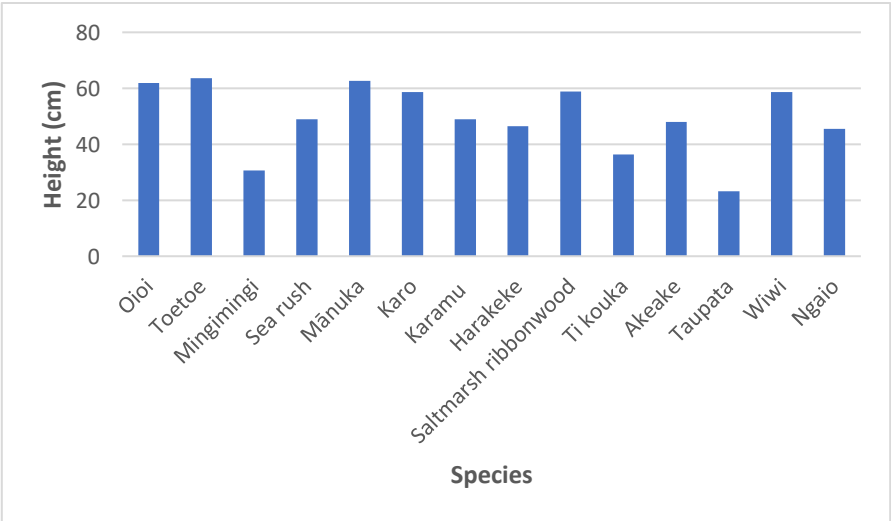


Figure 7: First year mean height for the species with 10 or more plants sampled during the baseline survey.

Plant vigour

Most species were assessed as average to good on the basis of plant vigour scores indicating they were growing well on this exposed coastal site (Figure 8).

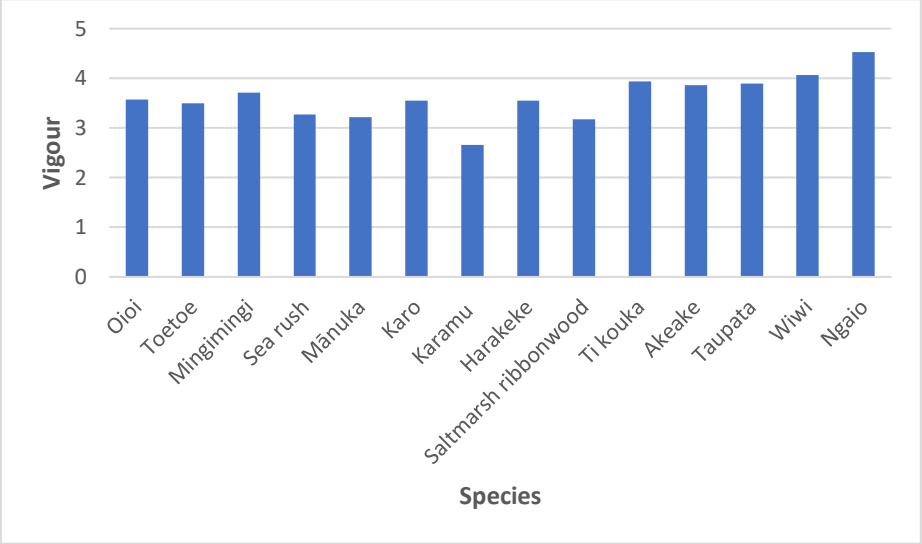


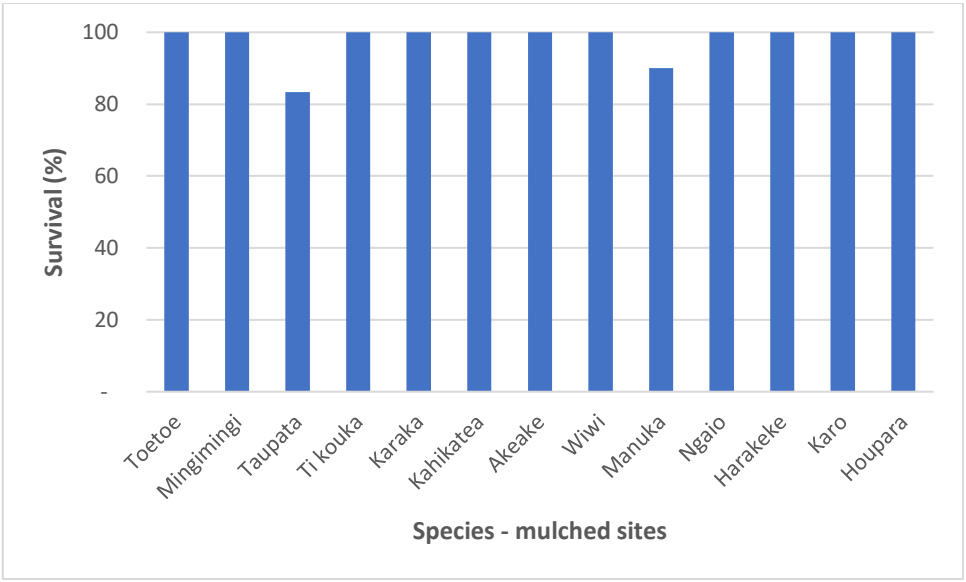
Figure 8: First year mean plant vigour for the species with 10 or more plants sampled during the baseline survey. Plant vigour was assessed using a subjective score 1=poor, 2=unthrifty, 3=average, 4=good, 5=excellent.

Effect of mulch

The single biggest influence on survival and growth has been the application of wood chip mulch that has seen a dramatic difference in boosting survival and growth. This was applied at a depth of at 10-20cm across most of the planting site. While most of the area was mulched, the smaller non-mulched area did not have a sufficient sample of all species to provide a useful comparison.

Of the species sampled in selected plots, survival was 100% for most species where mulch was applied compared to poor survival for species without mulch and where 10 of the 16 species had all died (Figure 9).

Some of the marsh areas had become dominated by the native Bachelor's button *(Cotula coronopifolia)* especially where mulch had not been applied including where it was not practical to spread wood chip near the tidal zones due to occasional inundation.



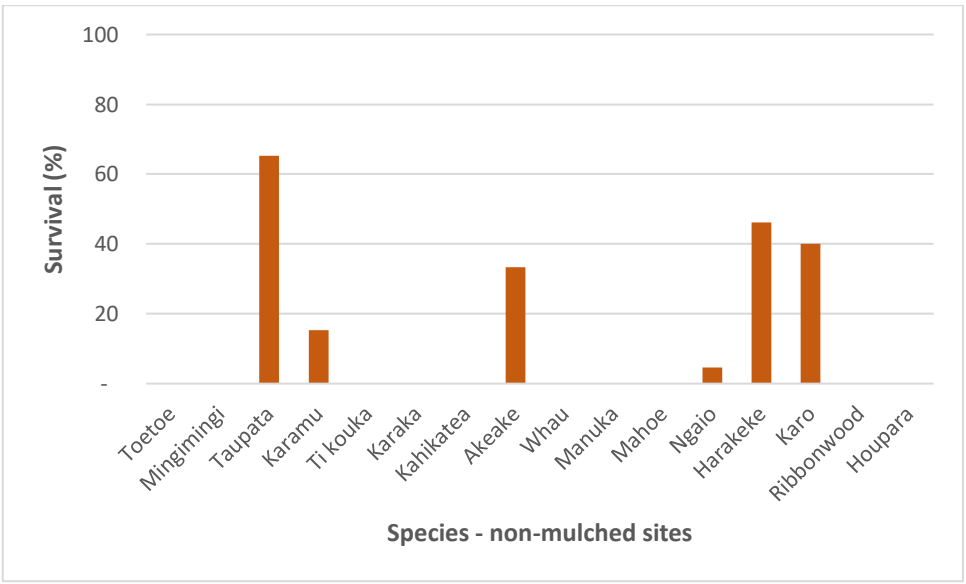


Figure 9: Survival of planted natives in the first year where mulch was applied (above) and for natives where there was no mulch (below). Not all species were in sufficient numbers for an adequate sample size within the mulched vs non-mulched plots selected for comparison.

Performance across all measured parameters of survival, height and vigor of the planted natives was significantly greater where mulch had been applied (above) compared to very poor survival and growth for natives without mulch (below).

Similarly, height and plant vigour were significantly better for natives where mulch had been applied across all species within terrestrial Zone 3 with double the height (Figure 10 - left) and almost triple the plant vigour score (Figure 10 - right) for mulched plants compared to non-mulched sites.

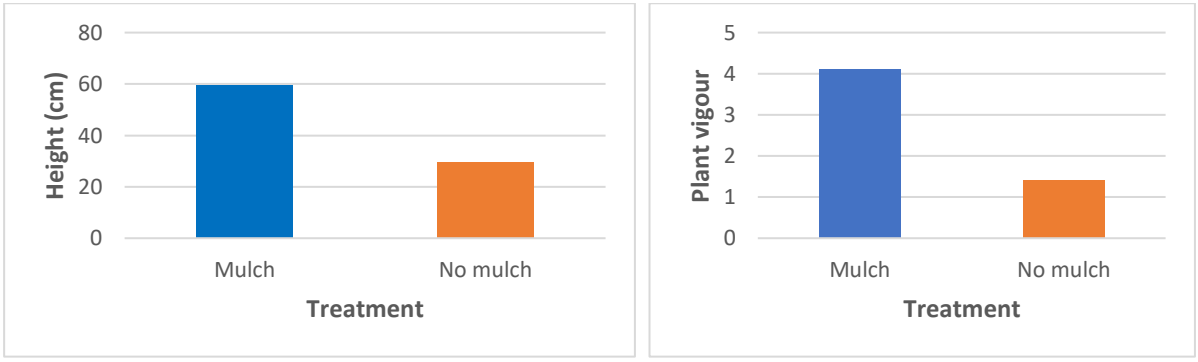


Figure 10: Height and plant vigour of natives in the first year with and without mulch across all species for terrestrial Zone 3.

For five shrub hardwood and harakeke, height (Figure 11) and plant vigour (Figure 12) were higher for natives in mulched plots versus natives in non-mulched areas for terrestrial Zone 3. The first year of planting was characterized by a major drought over most of the country so mulch possibly combined with high water table in places at this planting site were likely having a positive effect on early performance across many species.

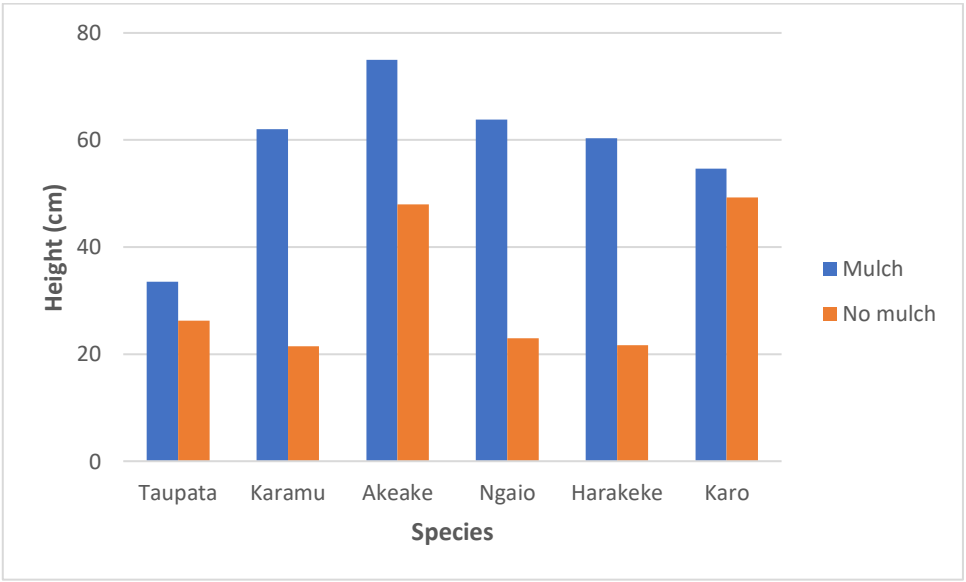


Figure 11: Height of natives after the first year with and without mulch for 5 of the shrub hardwood species and harakeke for terrestrial Zone 3.

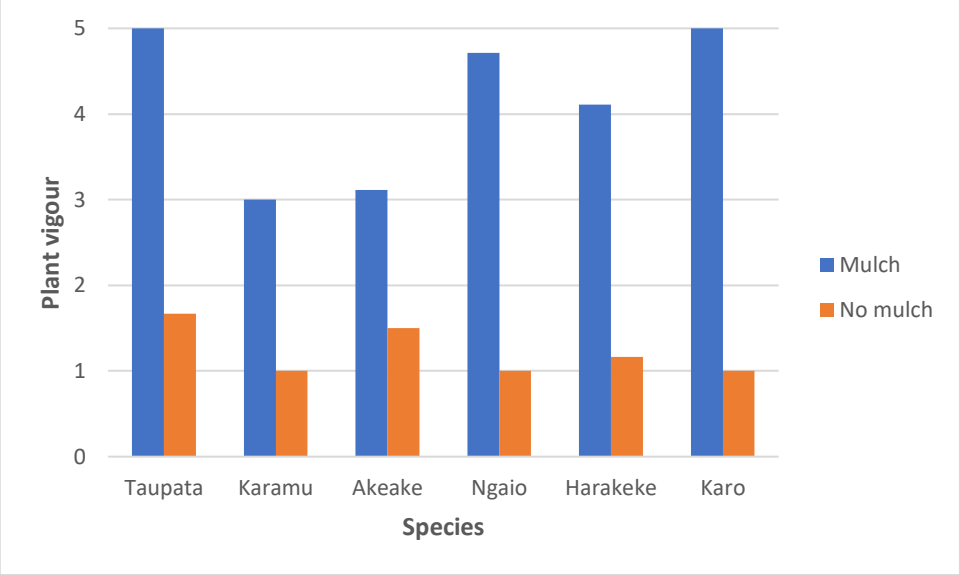


Figure 12: Plant vigour of natives after the first year with and without mulch for 5 of the shrub hardwood species and harakeke for terrestrial Zone 3.

The rushes planted in the upper elevated zones had very good survival and significantly better growth over the first year where mulch had been applied despite a dry summer.

Weed growth

There are no major issues with weeds across the planting area largely due to the mulch applied to most of the native plantings in the Zone 3 terrestrial zone and most of Zone 2. Occasional gorse (*Ulex europaeus*), tree lupin (*Lupinus arboreus*), convolvulus (*Convolvulus arvensis*), wattle (*Acacia* sp.), blackberry (*Rubus fruticosus*), pampas (*Cortaderia* sp.) and small patches of exotic grass and herbaceous species were scattered across the site.

Scattered gorse, tree lupin, wattle and various small patches of exotic grass and herbs are some of the minor weed growth across Zones 2 and 3. The dense layer of wood chip mulch is helping reduce invasion of the planting site by weeds.

DISCUSSION AND RECOMMENDATIONS

Planting in the tidal zone

While the plantings of predominantly sea rush appeared to be surviving well 3 months after planting, this level of survival was not sustained one year after planting within the inter-tidal zone subject to regular tidal inundation and wave action of lower sites. Losses were also evident from dumping of organic debris along the wrack line on some sites.

Planted sea rush and saltmarsh ribbonwood appeared to have improved survival when planted on higher mounds within this zone above the high tide zone demarcated by the wrack line. The success of sea rush on the more elevated Zone 2 sites (as defined during this survey) clearly shows these are preferred planting sites.

Recommendations

- Concentrate most planting of sea rush and other rushes on elevated sites along the upper edge of the tidal zone avoiding sites that are regularly inundated during high tides.
- Use the wrack line of organic debris deposited at high tide as a guide for the most seaward extent of planting this zone with sea rush or other species.
- Plant saltmarsh ribbonwood only on elevated mounds within this zone.

Mulching of terrestrial zones

The placement of wood chip across most of the upper zones of the planted site has resulted in spectacular success of most planted natives in contrast to poor performance on non-mulched sites. The generous depth of wood chip mulch is likely to be having a major positive effect on early plant survival and growth of natives despite a major drought during the first year of planting. The high-water table is also likely to be having a positive effect across most of the elevated sites. The reduced mortality of planted natives where mulch is applied is a major saving in cost of replanting failed areas and in weed control.

Recommendations

- Continue to apply wood chip mulch across all areas above the high tide line to maintain high early survival and growth of planted natives.
- Use clean weed-free wood chip mulch to a depth of at least 10cm across the entire planting area.

Selection of species

Surveys of the planting site at Te Pa Ika restoration project indicate the most commonly planted coastal shrubs and monocot species are best to plant on these exposed sites and especially where mulching with wood chip is carried out.

Recommendations

- Key native shrub species for planting include mingimingi, manuka, karo, karamu, akeake, koromiko, taupata and saltmarsh ribbonwood.
- Key native monocot species to plant on most sites including lower level sites with higher water table include oioi, toetoe, harakeke, ti kouka, and wiwi.
- Sea rush is the key species for the zone at and above the high tide mark.

Plant spacing

The relatively high stocking rates across all zones ranging from 10,000 to 15,000 plants per ha, equivalent to the target planting rates of 0.7m to 1.6m spacing between plants, is likely to assist in rapid development of a canopy cover dominated by natives.

Recommendations

- Continue to plant the most elevated zones with shrubs at 1.5m spacing, equivalent to 4444 stems per hectare.
- Plant rushes and sedges at less than 1m spacing in estuarine zones.

Inter-planting tree species

Most native tree species will perform best when planted within a nurse cover of hardy early successional shrub species. For exposed sites, delaying inter-planting of native trees 1-2 years after planting the shrub nurse cover within gaps will provide essential side shelter for the trees to become established. Care is required to ensure inter-planting of tree species is not left too late before the shrubs dominate the planting site.

Recommendations

- Once a shrub hardwood cover is established and providing some shelter on exposed sites, inter-plant native tree species, probably within 1-2 years of planting the nurse cover on this site at Maketu.
- Native tree species can be interplanted at an average spacing of 4m minimum amongst the nurse shrub cover targeting existing gaps, equivalent to 625 stems per hectare.
- Key tree species is kahikatea for this lowland site; other tree species to test on drier elevated sites include puriri, pukatea, titoki, karaka, pohutukawa and totara.

Management of weeds

The mulch has reduced weed invasion with only scattered blackberry, pampas, gorse, lupin, exotic grass and herbaceous species, wattle and other exotic species occurring across mainly the terrestrial areas of Zones 2 and 3. The reduced level of weed control required on this site compared to most native revegetation sites is largely due to use of the wood chip mulch.

Recommendations

- Monitor weed invasion so that timely weed control can be scheduled to prevent loss of natives from invasion of vigorous weeds with potential to spread and overtop planted natives.
- Spot-spray with herbicide using low pressure spraying with a knapsack, or hand pull scattered exotic weed growth as required; with spraying, use of a shield to reduce spray drift onto planted natives as required.
- Consider the option of using a grass selective herbicide (e.g. haloxyfop) to control invasion amongst native shrub and trees if this becomes a problem.
- Post-plant weed control will be required for 2-5 years after planting or until at least 80% canopy cover has been achieved.
- Replant natives within any large gaps to assist in achieving canopy cover to reduce introduction of exotics.

Ongoing monitoring

Monitoring allows for ongoing evaluation of pest animal browse, identification of any localised major mortality where replanting may need to be considered, and to plan for timely weed control of the more vigorous exotics like scattered blackberry and pampas already present. Rabbits are present at the northern end of site so ongoing monitoring of the effect of these on natives will be essential particularly for newly planted seedlings and for lower growing plants.

Recommendations

- Inspect planting site at least twice yearly to monitor and schedule timely weed and pest animal control as required until near canopy cover is obtained.
- As the most critical time for establishment is within the first 1-2 years of planting, ongoing monitoring of survey plots will provide survival and growth rate data to assist in identifying optimum times for inter-planting of selected tree species.

Trial set up

Earlier pilot planting trials set up by BOBRC proved invaluable in providing insights into species selection and planting pattern particularly of rush species for the lower zones. A shortcoming of the current survey has been the inability (despite the large number of plots established) to sample shrub and tree species planted in small quantities as part of the bulk planting programme. For tree species this includes monitoring greater numbers in trial plots of kahikatea, pohutukawa, puriri, houpara and karaka; and for ground cover, shrub and small tree species this includes pohuehue, coastal tree daisy, tauhinu, mahoe and whau. Other species could also be included in trial plots. However, it is acknowledged that a major constraint is the supply of adequate numbers of nursery-raised stock especially for the less commonly planted natives.

Recommendation

- Suggest plan for establishment of monitoring trial plots with a targeted full range of species in sufficient numbers that can be undertaken at the same time as the main planting events to allow for statistical analysis of survival and growth data.

ACKNOWLEDGEMENTS

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REFERENCES

Bergin, D.; Bergin, M. 2019: Establishment of monitoring plots and completion of baseline survey, Te Pa Ika restoration project, Maketu Estuary, Bay of Plenty. Environmental Restoration Ltd report. 25p.

Appendix 1 – Native seedling orders for planting Te Pa Ika wetland restoration project. List supplied by BOPRC. A second order of plants were required for replanting where localised mortality was high from the first planting.

Botanical name	Common name	Original order	Second order
Apodasmia similis	Oioi	7480	1200
Apodasmia similis	Oioi		1000
Coprosma lucida	Karamu	300	
Coprosma propinqua	mingimingi	400	
Coprosma repens	taupata	1650	
Coprosma robusta	karamu	500	
Cordyline australis	ti kouka	350	
Cordyline australis	Ti kouka (cabbage tree)	250	
Cortaderia toetoe	Toetoe	250	
Corynocarpus laevigatus	Karaka	150	
Dacrycarpus dacrydioides	kahikatea	250	
Dodonaea viscosa	akeake	750	
Entelea arborescens	Whau	250	
Ficinia nodosa	Wiwi	850	1500
Hebe stricta	koromiko	250	
Juncus krausii var. australiensis	Sea Rush	30800	4000
Leptospermum scoparium	mānuka	1000	
Leptospermum scoparium	mānuka	500	
Machaerina articulata	Jointed twig rush	880	
Melicytus ramiflorus	mahoe	100	
Muehlenbeckia complexa	Pohuehue	250	
Myoporum laetum	ngaio	2250	
Olearia solandri	Coastal tree daisy	250	
Ozothamnus leptophylla	Tauhinu	750	
Phormium tenax	Harakeke	620	
Phormium tenax	Harakeke	1380	
Pittosporum crassifolium	Karo	750	
Plagianthus divaricatus	Saltmarsh ribbonwood	2600	
Pseudopanax lessonii	houpara	150	
Vitex lucens	puriri	0	
		55960	7700
TOTAL		**63660**	

Appendix 2 – Allocation of species to the three zones for planting Te Pa Ika wetland restoration project in 2019. List supplied by BOPRC (elevations are in terms of NZVD new datum). The species and numbers planted did not necessarily reflect this planned planting especially between Zones 1 and 2. For example, during this survey, due to the difficulty of distinguishing between Zone 1 and 2, a high proportion of the sea rush identified as planted in the Zone 1 inter-tidal zone were within what was identified as Zone 2 (marsh shrubland).

Botanical name	Common name	Planting comments	Plant spacing	Size	Confirmed available	% by species
ZONE 1 Estuarine rushland between 0.5RL and 1.0RL						
Apodasmia similis	Oioi	Plant between 0.7RL and 1.0RL (*MOT 0.9-1.2)*	0.7x0.7	C28	7480	18.3
Juncus krausii var. australiensis	Sea rush	Plant between 0.5RL and 0.8RL *(MOT 0.7-1.0)*	0.7x0.7	C28	30800	75.3
Plagianthus divaricatus	Saltmarsh ribbonwood	Plant between 0.7RL and 1.0RL (*MOT 0.9-1.2)*	0.7x0.7	1L	2600	6.4
				TOTAL	**40880**	
ZONE 2 Estuarine shrubland - between 1.0RL - 1.5RL						
Coprosma repens	Taupata		1.5x1.5	1L	1250	16.6
Coprosma propinqua	Mingimingi	Above tidal inundation RL 1.1, near freshwater inflows	2x2	C28	400	5.3
Ficinia nodosa	Wiwi	Above tidal inundation RL 1.1, near freshwater inflows	0.7x0.7	C28	850	11.3
Machaerina articulata	Jointed twig rush	Above tidal inundation RL 1.1, near freshwater inflows	1.5x.1.5	C28	880	11.7
Phormium tenax	Harakeke	Above tidal inundation RL 1.1, near freshwater inflows	2x2	C28	880	11.7
Muehlenbeckia complexa	Pohuehue		1.5x1.5	1L	250	3.3
Myoporum laetum	Ngaio		1.5x1.5	1L	1750	23.3
Ozothamnus leptophylla	Tauhinu		1.5x1.5	1L	750	10.0
Pittosporum crassifolium	Karo		1.5x1.5	1L	500	6.7
				TOTAL	**7510**	
ZONE 3 Terrestrial shrubland - 1.5RL and higher						
Coprosma lucida	Karamu		1.5x1.5	1L	300	4.0
Coprosma repens	Taupata		1.5 x 1.5	1L	400	5.3
Coprosma robusta	Karamu		1.5 x 1.5		500	6.6
Cordyline australis	Ti kouka (cabbage tree)		1.5 x 1.5	1L	350	4.6
Cordyline australis	Ti kouka (cabbage tree)		1.5x1.5	C28	250	3.3

Cortaderia toetoe	Toetoe		1.5x1.5	1L	250	3.3
Corynocarpus laevigatus	Karaka		1.5x1.5	1L	150	2.0
Dacrycarpus dacrydioides	Kahikatea		3x3	1L	250	3.3
Dodonaea viscosa	Akeake		2x2	1L	750	9.9
Entelea arborescens	Whau		1.5x1.5	1L	250	3.3
Hebe stricta	Koromiko		1.5x1.5	1L	250	3.3
Leptospermum scoparium	Mānuka		1.5x1.5	c28	1000	13.2
Leptospermum scoparium	Mānuka	In the seepage areas and wetter soils	1.5x1.5	1L	500	6.6
Melicytus ramiflorus	Mahoe	Sheltered positions	1.5x1.5	1L	100	1.3
Metrosideros excelsa	Pohutukawa		1.5x1.5	1.5L	0	0.0
Myoporum laetum	Ngaio		1.5 x 1.5	1L	500	6.6
Olearia solandri	Coastal Tree daisy		1.5x1.5	1L	250	3.3
Phormium tenax	Harakeke		2x2	C28	500	6.6
Phormium tenax	Harakeke		2x2	1L	620	8.2
Pittosporum crassifolium	Karo		1.5x1.5	1L	250	3.3
Pseudopanax lessonii	Houpara		1.5x1.5	1L	150	2.0
Vitex lucens	Puriri		1.5x1.5	1.5L	0	0.0
				TOTAL	**7,570**	