Specialty Wood Products Research Partnership

MARLBOROUGH RESEARCH CENTRE
Te Rito Hiranga o Wairau

Performance of naturally durable eucalypt posts in Marlborough vineyards.

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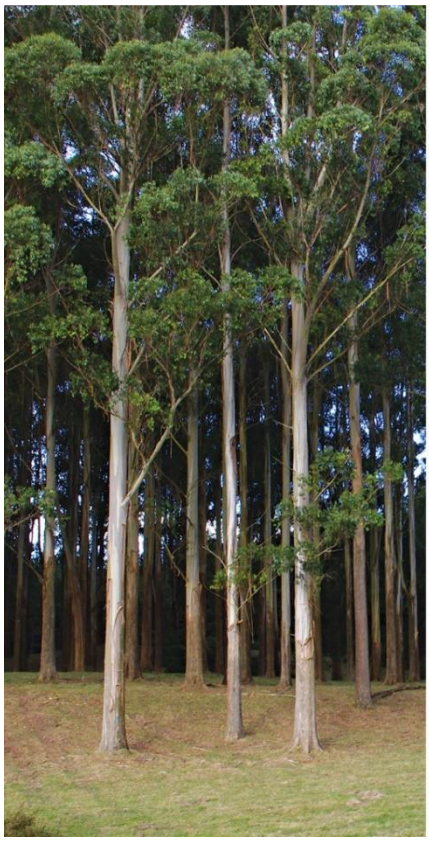
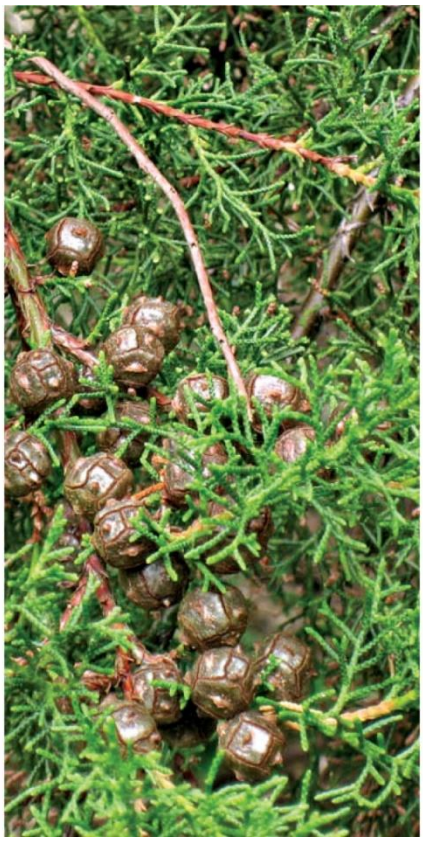
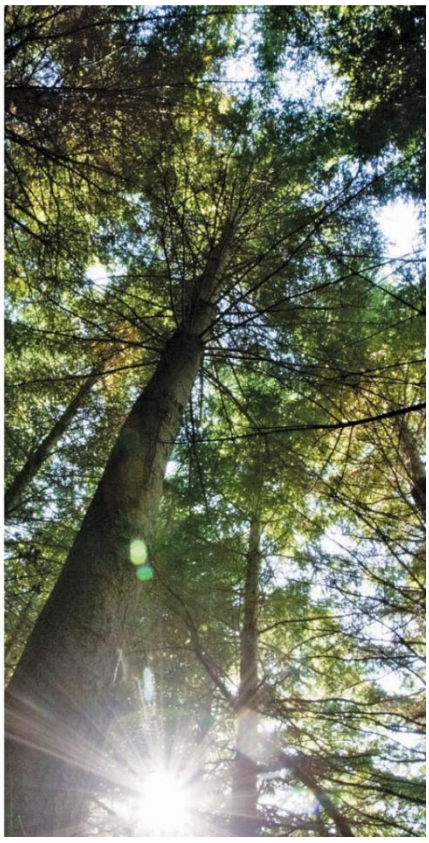

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EXECUTIVE SUMMARY

The area of vineyards in New Zealand is up from that reported in 2015, which was 35,463 ha. Posts in a vineyard average 500-600 per hectare so there are approximately 17.5 to 21 million posts in New Zealand's vineyards. The predominant reason for post breaking is mechanical harvesting and mechanized pruning operations with an estimated 5% of posts failing annually. Therefore, the New Zealand wine industry is estimated to require about 1 million replacement posts annually.

NZ vineyards are dominated by Copper Chromium Arsenate (CCA) treated radiata pine posts. There is opposition to the use of CCA treated wood because of the heavy metals used as preservative. Broken posts can be recycled but ultimately they become hazardous waste requiring a secure landfill or a highly controlled incineration facility for safe disposal.

As a result organic agricultural production standards, both in NZ and overseas, have banned the use of CCA posts for replacements or in new development of certified organic vineyards.

This project aims to demonstrate to forest growers and vineyard owners/managers the potential for naturally durable eucalypt timber to be used as vineyard posts, and to highlight market opportunities to give growers confidence to invest in planting durable eucalypts.

Vineyard Timbers sales records show a total of 746 *E. bosistoana* and 298 *E. globoidea* posts being purchased by six Marlborough vineyard owners from 2006-2009. All posts were installed in vineyard properties within the lower Wairau Valley which is the central locality of vineyards in this region. The posts were installed as replacements for broken CCA posts by four vineyard owners while one owner used them in setting up a new vineyard and another has them in use in a small feijoa orchard. The vineyard owners and their eucalypt posts are the focus of this project.

The six vineyard owners were contacted to answer questions on their knowledge and experience with using these posts and to request access to their vineyard to locate and assess the posts that were still in service.

Five of the vineyard owners manage their properties under organic standards with mechanical harvesting and some mechanical pruning and two with under vine mechanical cultivation.

Five vineyard owners/managers answered the questions about the posts with their feedback generally positive due to the posts being naturally durable and acceptable for their organic standards. Three reported a few posts broke during harvesting. This was attributed to large knots in the posts. No report of failure due to decay was received. The main negative comments were that the timber is too hard for easy nailing or fastening wire hangers – predrilling was deemed necessary taking too much time. Furthermore, the lack of regular supply was raised and one owner had problems with timber twisting in storage due to cross grain.

Four vineyard owners/managers would use the posts again if they were available with two suggesting the posts could be larger. Four also commented that certification of sustainable production or local production was important as was price.

Visits were made to all vineyards to locate and test over 1,000 functional eucalypt posts still in service. During site visits to vineyards 1065 posts were found still in service; another 14 were found broken; 1 failed from decay and 45 were in storage. This was followed by selecting a sample of 150 posts in service across 4 vineyards to assess the post condition in the top 200 mm of the soil horizon where maximum decay is likely to occur.

Generally, *E. bosistoana* posts showed less decay than *E. globoidea* posts after 8-10 years in service. However, this analysis was confounded by site, as not all sites had posts from both species.

E. bosistoana posts performed very well at both assessed sites with many posts showing no sign of decay. Performance of *E. globoidea* was site specific. After 10 years in service posts, *E. globoidea* posts at vineyard 2 had severe decay while posts in a small feijoa orchard at vineyard 3 show little decay.

The posts assessed in this project were not installed in a dedicated scientific test to assess durability but part of commercial vineyard operations. The feedback from vineyard owners/managers and the results of our decay assessments demonstrate that most of the durable eucalypt vineyard posts of both *E. bosistoana* and *E. globoidea* are continuing in service after more than 10 years with a very low percentage of broken posts found in the post assessment; in the case of vineyard 1 this was equivalent to annual breakage of only 0.3%.

It can be expected that most of the posts will continue in service and that another inspection could be made in five years.

INTRODUCTION

NZ Wine Industry Statistics
In May 2016, the Vineyard Register Report 2015-18 stated that the area of vineyard in New Zealand would increase to 37,542 hectares by 2018, up from the 2015 figure of 35,463 ha. Wine New Zealand chief executive Philip Gregan was quoted; 'the forecasts in the just released Vineyard Register report were a minimum', and he expected the actual plantings to be above predictions.
http://www.stuff.co.nz/business/farming/79576323/Wine-industry-forecasts-growth-in-plantings

The report stated 'that the largest producing area is Marlborough which will have 25,119 ha in vines by 2018, followed by Hawke's Bay (4938 ha), Otago (1967 ha), Gisborne (1447 ha), Waipara (1239 ha), Wellington/Wairarapa (1026 ha) and Auckland (351 ha). Marlborough's share of the national producing area is 66.4 per cent.'

In a June 2016 ANZ report titled *New Zealand Wine Industry: FULL BODIED GROWTH* it was reported that NZ grape growers supply NZ's wine makers who 'account for just 1% of total global production and 3% of the value of global wine trade. The larger proportion of value is in the premium New Zealand wine currently commands.'

'The export value of New Zealand wine has reached a record high according to the 2017 Annual Report of New Zealand Winegrowers. Now valued at $1.66 billion, up 6% from 2016 wine now stands as New Zealand's fifth largest goods export.
https://www.stuff.co.nz/business/farming/96217313/nz-wine-exports-hit-record-high-driven-by-strong-us-sales

Post use in New Zealand's vineyards

The average number of posts in a vineyard is 500-600 per hectare adding up to approximately 17.5 to 21 million posts in New Zealand's vineyards. The predominant reason for post failure is mechanical damage with breakage during harvest and mechanized pruning operations. These activities can account for 5% of posts failing annually (refer to Appendix One for photos of both these activities). Therefore, the New Zealand wine industry is estimated to require about 1 million replacement posts annually without taking into account further expansion or vineyard redevelopment.

Vineyards in New Zealand are dominated by Copper Chromium Arsenate (CCA) treated radiata pine posts. Broken posts can be recycled but ultimately they become hazardous waste that requires a secure landfill or highly controlled incineration facility for safe disposal (Townsend & Solo-Gabriele, 2006).

However, there is mounting opposition both within New Zealand and internationally, on the use of CCA treated wood. This includes opposition to the use of heavy metals as a preservative. This is due to the potential for heavy metals to leach into the soil and wider environment, especially in production systems with high concentrations of posts including vineyards.

Also, there is concern about the health effects on people contacting the posts, e.g. fencing workers and children in playgrounds, and with the disposal of treated timber at the end of its life (landfill being the only current safe option) (Read, 2003). As a result, organic agricultural production standards, both in NZ and overseas, have banned the use of CCA posts for replacements or in new development of certified organic food production systems including vineyards.

This has given rise to a plethora of other vineyard posts being produced including those made from plastic, steel and naturally durable timber, all of which have been tried by Marlborough grape growers seeking an alternative (for some examples see Appendix Two).

CCA posts in Marlborough

In the early 2000s, community concern mounted in Marlborough regarding the potential for arsenic leachate from CCA treated pine posts to contaminate the groundwater within the Rarangi area in the lower Wairau Valley. Local newspaper reports resulted in very negative feedback from international wine markets about NZ's wine production given the wine industry's emphasis on NZ's clean and green marketing image.

In 2003, Vineyard Timbers Ltd identified the opportunity to supply a naturally durable eucalypt hardwood post as an alternative. Despite there being few stands of durable eucalypts in New Zealand, Vineyard Timbers Ltd managed to source sufficient mature trees to start sawing square intermediate vineyard posts. The bulk of the posts produced were sawn from mature *E. bosistoana* and *E. globoidea* trees with over 1,000 sold to vineyard owners from 2006-2013. It is these vineyard owners and the Vineyard Timbers Ltd eucalypt posts they installed that are the focus of this project.

Also in 2003 Vineyard Timbers commenced planting research trials of durable eucalypt species in a joint venture between the Marlborough District Council, University of Canterbury and Proseed NZ Ltd. These trials are the foundation for the NZDFI tree breeding and research programme (Millen, 2009).

More recently in Marlborough there has been renewed concern reported by the Marlborough Express about disposal of copper-chrome arsenic treated vineyard posts as it is an ongoing problem with thousands of old or broken posts stockpiled in the region. A $1 million pyrolysis timber recycling plant has been proposed by Waste Transformation Ltd as the answer with Marlborough District Council supporting this and proposing to contribute $450,000. The plant would turn treated and untreated timber into charcoal. The charcoal product would be processed and sold locally as coal replacement or overseas as carbon black. However, this proposal is currently meeting strong community opposition.

Project Objectives

This project aims to demonstrate to forest growers and vineyard owners/managers the potential for naturally durable eucalypt timber to be used to produce vineyard posts, and to highlight market opportunities to give growers confidence to invest in planting durable eucalypts.

This project has four main objectives.

1. To engage vineyard owners/managers with durable eucalypt vineyard posts in a survey to record their knowledge and experience with using these posts.

2. To locate all surviving unbroken *E. bosistoana* and *E. globoidea* vineyard posts in Marlborough vineyards.

3. To assess the level of decay in a sample of 50 posts of each species.

4. To assess the cause of failure for any failed posts found.

METHODS

Vineyard owner/manager survey

Vineyard Timbers Ltd.'s sales records show a total of 746 *E. bosistoana* and 298 *E. globoidea* posts being purchased by six Marlborough vineyard owners from 2006-2009. The records facilitated contacting six vineyard owners who have these posts still in service.

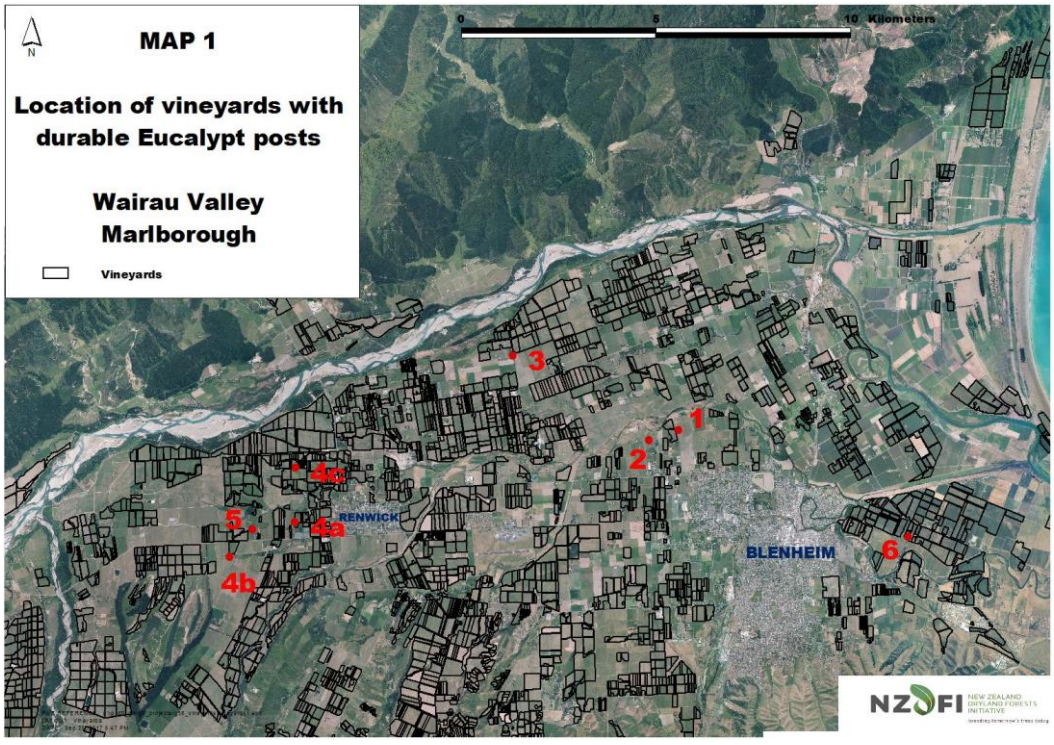
All vineyard owners or their managers were requested to answer the following questions:

1. Do you grant permission for access to locate all surviving durable eucalypt posts in your vineyards?
2. Do you have a record of when you installed the posts?
3. What is the vine management regime in the vineyards where the posts are installed?
4. How do you harvest the grapes from the vineyards where the posts are installed?
5. How do you prune the vines in the vineyards where the posts are installed?
6. What is the soil type of these vineyards?
7. What can you tell me about the performance of the eucalypt posts since installation?
8. How does this compare with your experience/knowledge on the performance of other posts used in your vineyard?
9. What other types of post are in your vineyard?
10. What are the typical causes for failure of the vineyard posts?
11. What are the positives and any negatives about using naturally durable hardwood posts?
12. Would you use them again?
13. Is certification of sustainable production of vineyard posts (like Forest Stewardship Council, PEFC) or local production important when considering purchase?
14. How much does price affect your choice when needing to buy replacement posts?
15. Do you have any further comments?

Their answers were recorded and are summarised in this report under the Results.

Durable eucalypt vineyard post in service assessment

All six Marlborough vineyard owners agreed to allow access to locate and assess the posts that are still in service. All these posts are installed in vineyard properties within the lower Wairau Valley and are numbered on Map 1. This is the central locality of vineyards in this region.



The posts sold by Vineyard Timbers Ltd. were 2.4 m long intermediate posts that were square sawn (65-70 mm in size) from mature (60 years plus) trees grown in New Zealand (see Figures 1 and 2).

Figure 1: Square sawn E. bosistoana posts installed in 2009 in vineyard 5.

Figure 2: E. globoidea posts being installed in 2007 as repalcements for broken CCA pine posts in vineyard 2.

Visits were made to all vineyards to locate and test (using the 'pulling' test) all remaining functional eucalypt posts (Lebow et al. 2014).

Also during the visits to two vineyards, posts sawn from other species of eucalypts (*E. cladoclayx*, *E. paniculata* and *E. saligna*) by Vineyard Timbers Ltd. as well as a small number posts from NZ red beech (*Nothofagus fusca*), were found. These were all of similar dimensions as the *E. globoidea* and *E. bosistoana* posts and therefore could not be accurately differentiated. In these two vineyards all posts found were included in the assessment.

In ground assessment of vineyard post condition

A sample of 150 posts was selected to assess the post condition in the top 200 mm of the soil horizon where decay is most likely to occur. These included 76 *E. bosistoana* posts with 50 located at vineyard 1 and another 26 at vineyard 2; And 74 *E. globoidea* posts with 24 at vineyard 2, 36 in vineyard 3 and 12 in vineyard 4.

Posts were assessed as follows:

- Remove top soil to a depth of ~15-20 cm
- Label posts
- Use pointed knife to judge decay depth
- Decay was classed into the following categories (Figure 6). Note: the deepest point of decay was assessed, not the average decay depth on the post below ground. Therefore 30 mm decay are possible without post failure.
    - < 2 mm
    - 2-5 mm
    - 5-10 mm
    - 10-20 mm
    - 20-30 mm
    - > 30 mm – failed

The decay classes were based on decay rating scales proposed in international standards as summarised by Meyer et al. (2016) or Raberg et al. (2006).

RESULTS

Vineyard owner/manager survey

All six vineyard owners were contacted first by telephone and then the list of questions was sent by e-mail to them or their managers. Three written answers by e-mail were received while two more had their answers recorded during a personal interview. One vineyard owner was contacted by telephone and gave access for the post assessment but did not provide responses to the questions. A brief summary of all responses is provided followed by a full description of the posts' performance based on the responses of the owners/managers.

Summary of responses by vineyard owners/managers

The six vineyard owners/managers that were contacted included three that were the original purchasers of the posts from Vineyard Timbers Ltd. and therefore had considerable knowledge about the posts while the other three vineyard owners/managers have only been working on the property in recent years.

Records show there were a total of 1399 posts purchased between 2006 and 2013. These were sawn from a number of species including 746 *E. bosistoana* posts and 298 *E. globoidea* posts.

The posts were installed as replacements for broken CCA posts by four vineyard owners while one owner used them in setting up a new vineyard and another has them in use in a small feijoa orchard.

Five of the vineyard owners manage their properties under organic standards with mechanical harvesting and some mechanical pruning and two with under vine mechanical cultivation. Three reported a few posts had broken during harvesting due to large knots in the posts but none reported failure due to decay. One commented that wind can also break CCA pine posts.

The feedback of the five vineyard owners/managers about the posts was generally positive. The main aspect was that the posts being naturally durable and acceptable for their organic standards. The main negative comments were that it takes time for nailing or fastening wire hangers as the timber is hard, the lack of regular supply and one owner had problems with timber twisting in storage due to cross grain.

Four vineyard owners/managers would use the posts again if they were available with two suggesting the posts could be larger. Four also commented that certification of sustainable production or local production was important as was price.

Vineyard owner/manager 1

This vineyard owner purchased 288 *E. bosistoana* posts in July 2007 to include in his own trial of alternative vineyard posts. His vineyard is on *'mixed alluvial silt with gravel ridges'*.

He installed 265 posts immediately after purchase in his vineyard trial in rows each one alternated with two plastic covered Greenspan steel posts (see Appendix Two) and he installed another 10 of the posts in another small section of vineyard. The unused posts he had retained for replacements of which he still had 13 in stock at the time of the vineyard visit. The balance of his vineyard is all CCA pine posts although he did try plastic posts in one area that did not perform and were replaced.

This vineyard is managed under best practice 'Sustainable Winegrowing NZ' standards. It is machine harvested and a Klimmer mechanical vine stripper is used followed by hand pruning.

The owner reported that since installation there had been '*a small number of broken posts but no sign of failure from rot'*. He commented that the posts compared *'very well'* with the performance of other posts used in his vineyard which included half round CCA pine posts, steel, plastic and plastic coated steel posts. The typical causes for failure were breakage from *'wind and machinery*

including harvester damage'. *Positives are long life, uses after removed from vineyard, environmental. Negatives are very hard to nail and surface area could be larger.*

He commented he would use them again and that certification of sustainable production did not affect his purchase choice. However, he did comment that *'cost has to be taken into account. For example the plastic coated steel posts were excellent but too expensive'*.

Vineyard owner/manager 2
The manager of this vineyard provided responses to the questions on behalf of the owner. He had only been working at the vineyard for 3 years so was not aware of how many posts had been purchased and the date they were installed by managers before him.

His vineyard is on '*sandy loam to quite stony'*. The posts had been installed as replacements for broken CCA pine posts. Vineyard Timbers Ltd.'s post sales records show that the vineyard owner had purchased 49 *E. bosistoana* posts in October 2006, then 120 *E. globoidea* posts in June 2007 followed by a further 20 *E. bosistoana* posts in December 2008.

The vineyard manger advised that the vineyard is managed under organic 'Bio grow' standards and he commented that it is *'hand pruned apart from spur pruned vines being barrel pruned first'*. *Both machine and hand harvesting as well as undervine mechanical cultivation'.* He commented that *'they compare well with original old pencil (pine) posts that have been in for over 20 years* and reported that '*in 3 years I have only seen 2 broken and 1 was at a big knot. They seem very robust apart from a small number twisting.* He commented that the typical causes for failure were '*Machinery hits. Harvesters mainly, but other equipment also'*. Other posts in this vineyard included Woodsheild posts which are a plastic coated untreated pine peeler cores as well as teak rounds (Appendix Two).

He commented that positives are the posts being *'accepted by BioGro, seem to be comparably durable, look better than steel or black plastic'*. No negatives were reported.

He said he would use the durable eucalypt posts again as certification of sustainable production or local production does affect his purchase choice. He commented that *'price is a factor but the visual aspect is also very important to us'.* Furthermore he added that *'as an organic grower we are always interested in being able to source locally produced and sustainably farmed/made products to use in the vineyard.*

Vineyard owner/manager 3
This vineyard owner was happy to provide access for the posts to be assessed but knew little of the 180 *E. globoidea* posts purchased in August 2007 that were recorded in Vineyard Timbers Ltd.'s sales records. On discussion the vineyard owner commented that the posts had not actually been installed in a vineyard rather they were used as a trellis for a small feijoa orchard that was established on the vineyard property in 2007. He had recently taken over lease of the vineyard and has the property under organic management by a contractor. There is little management in the feijoa orchard so he was unable to provide any feedback about the posts.

Vineyard owner/manager 4
This vineyard owner purchased 120 *E. globoidea* posts in October 2009 followed by a further 90 *E. paniculata* posts in October 2013.

The posts have all been installed progressively to replace broken CCA pine posts across 3 separate vineyards with the last posts being installed this year. The owner commented *'we started using them in 2009 or 2010. We stored some for a while and slowly worked through a pack'*.

The owner advised that his vineyards are on *'mixed alluvial soils'* and managed under *'organic production with sheep grazing between rows (with) mechanical and hand pruning/spraying and machine harvesting'.*

He commented that since installation the eucalypt posts '*have been fine and we have only broken one from memory. It was broken by a harvester, it had a knot in it and it snapped on the knot'.* He considered the eucalypt posts *'equal'* to others he had used which included CCA pine, steel, plastic coated steel and wallaba timber posts. The typical causes for failure in his vineyards were *'mechanical damage'*.

He considered that *'overall they are fine, negatives would be getting a continuous quality supply, also they are slow to install as we find we have to put a point on them. Also we have to pre drill holes for nails and clips'*. He wasn't sure they would use them again as *'currently we are finding steel Eco trellis the best option for replacement posts except in stony ground'*.

He commented that certification of sustainable production or local production was '*the main thing. There are no current certified wooden posts available so local production is a good option as then you know what you are getting',* although he added that *'price is important'*.

Vineyard owner/manager 5

The manager of this vineyard provided responses to the questions on behalf of the owner. He had only been working as the vineyard manager for 2 years so was not aware of how many posts had been purchased and the date they were installed by managers before him.

Vineyard Timbers Ltd.'s post sales records show that the vineyard owner had purchased 20 *E. saligna* and 10 *Nothofagus fusca* posts in October 2003. Then in August 2006, 100 *E. bosistoana* posts were purchased followed by another 100 *E. bosistoana* posts in July 2008. Then 28 *E. globoidea* posts were purchased in December 2008 and 50 *E. cladocalyx* in September 2009.

This vineyard is over 40 hectares. The manager advised it is on a '*mix of clay and stony alluvial soils'* and explained that the eucalypt posts were installed throughout the vineyard as *'replacements of broken posts since 2003. Some have been used and then an area of vineyard was removed and these posts are now in storage for replacements'.*

He advised that the vineyard is managed under organic *'biodynamic farming and also uses undervine cultivation for weed control'.* It is *'100% hand harvested'* and *'mechanical and hand pruning/spraying'* with the typical cause for failure being *'mechanical damage'*.

He commented that the eucalypt posts are '*durable and rigid. They are hard to nail so need to pre drill to attach wire hangers but posts can be installed by hand'*. He advised that '*originally the vineyard was established with all CCA posts. But these are no longer able to be used for replacements. The owner has tried several alternative wooden posts including durable eucalypt square posts and teak rounds. Now considering steel as available and easy to source'.*

He said that the positives are they being *'naturally durable and can be used in biodynamic vineyard'* but added that *'end splitting is an issue in recently purchased round eucalypt strainer posts'.* He would use them again but *'would prefer larger dimension say 80 mm square. Half round posts would be ideal'.*

He considered certification of sustainable production or local production was *'the main thing'* when considering purchase. He said *'there are no current certified wooden posts available so local production is a good option as then I know what I am getting'.* He added that he was '*prepared to pay for a good option*'.

Vineyard owner/manager 6

This vineyard owner purchased 149 *E. bosistoana* posts in July 2007 and he has *'installed some of these progressively since 2010 so they are scattered throughout vineyard'*. His vineyard is on *'sandy loam with poor drainage due to clay pan'*.

He advised that his vineyard management was *'biodynamic with Demeter and Biogrow certification'*. He used *'mechanical harvesting'* and *'hand pruning'*.

He commented that the posts had *'twisted in packs left drying unstrapped. Some had cross sectional grain that broke so not used. There's been no breakage of the posts that have been installed in vineyard'.* He had used half round CCA pine when first establishing the vineyard and that compared to these *'hardwood posts are hard to nail so need to drill to fix wire hanger. Some twisting after being installed results in a wire hanger being out of alignment with wires and it is difficult to clip wire onto*'.

The typical causes for failure in his vineyard have been *'after vineyard establishment there was failure of weaker posts due to branch whorl being at ground level and then hit during pruning and high winds. Fewer posts fail now and generally caused by mechanical harvesting'*.

He considered that positives as being *'no breakages and able to drive in by hand to replace'* and negatives *'too hard to nail and twisting due to poor grain'.*

He said he would use them again provided that *'they are straight grained'* and he added that *'an alternative wooden post is needed for certification and I would have used naturally durable hardwood posts for entire vineyard if they had been available'.*

He commented that *'pricing needs to be similar to other certifiable alternatives including steel and plastic covered pine. Hardwood is preferred as others have a higher carbon foot print for production. US market requires replacements to be sustainable*'.

His final comment was that *'storage over long term requires an understanding of keeping timber strapped and covered to reduce drying degrade'*.

Durable eucalypt vineyard post in service assessment

Vineyard Timbers Ltd. records show a total of 1399 durable eucalypt posts including 746 *E. bosistoana* and 298 *E. globoidea* posts were purchased by six Marlborough vineyard owners from 2006-2009.
These were all 2.4 m long square sawn with dimensions of 65x65 mm and 70x70 mm.

Table 1 shows the Vineyard Timbers sales records with the number of posts found in service, broken or in storage in the course of the project.

Table One: Durable eucalypt vineyard post in service assessment- Summary List

Vineyard owner	No. of posts purchased	Post species	Purchase date	Installed in	No. of posts found in service	No. of posts found broken	No. of posts found failed from decay	No. of posts in storage	No. of posts unaccounted for	No. of posts inground assessment
1	288	E. bosistoana	May-07	Vineyard	267	8	0	13	0	50
	49	E. bosistoana	Oct-06	Vineyard						
	20	E. bosistoana	Dec-08	Vineyard	54	2	0	0	13	25
2	120	E. globoidea	Jun-07	Vineyard	110	4	1	0	5	23
3	180	E. globoidea	Aug-07	Feijoa orchard	162	0	0	0	18	38
	150	E. globoidea	Oct-09	Vineyard						
4	135	E. paniculata	Oct-13	Vineyard	314	0	0	0	1	12
	100	E. bosistoana	Aug-06	Vineyard						
	100	E. bosistoana	Jul-08	Vineyard						
	28	E. globoidea	Dec-08	Vineyard						
	20	E. saligna	Oct-03	Vineyard						
	10	N. fusca	Oct-03	Vineyard						
5	50	E. cladocalyx	Sep-09	Vineyard	121	0	0	32	155	0
6	149	E. bosistoana	Jun-08	Vineyard	37	0	0	?	?	0
Total	1399				1065	14	1	45	192	148

The owner of vineyard 1 purchased 288 *E. bosistoana* posts in May 2007 and installed 265 as a trial in rows each one alternated with two plastic covered Greenspan steel posts (Appendix Two). He installed another 10 elsewhere in his vineyard. In the ten years since establishing the vineyard there have been 8 posts broken some replaced with treated posts. This is 3% breakage of original 275 installed which is equivalent to only 0.3% annual breakage. Several broken posts were found in situ during the site visit with the replacement alongside. Four broken posts were fully excavated for further analysis (Appendix Two). As the posts were all installed at the same time 10 years ago, this vineyard was selected for the in ground post assessment.

Records show that the owner of vineyard 2 purchased 69 *E. bosistoana* and 120 *E. globoidea* posts between October 2006 and December 2008. It is likely they were installed progressively as replacements within 5 years of the final purchase. The two species were able to be differentiated in the vineyard with 54 *E. bosistoana* and 110 *E. globoidea* found still in service. This is 20% breakage for *E. bosistoana* and 8.3% breakage for *E. globoidea* and one post failed from decay. Likely due to being sapwood. The high breakage for the *E. bosistoana* posts is likely due to the cross grain in some of the posts purchased as was reported by the owner of vineyard 6. However, it is possible that not all posts have been found/installed adding to the breakage figures. This vineyard was selected for the in ground post assessment.

Vineyard 3 includes the small feijoa orchard for which 180 *E. globoidea* posts had been purchased. The vineyard was visited and the small feijoa orchard was found. There are a total of 161 posts used to form the trellis including also being used as stays and one is in use as a sign post at the vineyard entrance. There were no breakages evident and the other 19 posts purchased were not found in storage nearby. However, it is possible they may have been used as replacements in the main vineyard on this property. This site was selected for the in ground post assessment.

The owner of vineyard 4 purchased 120 *E. globoidea* posts in October 2009 then 90 *E. paniculata* posts in October 2013. As these posts were difficult to differentiate, all posts were assessed and found in service across 3 separate vineyards except one that the owner had reported was broken last year. Most posts had been installed as replacements except for 12 *E. globoidea* posts that had been installed in a small area of vineyard with a special variety that the owner advised had been established in 2012. This area of vineyard was selected for the in ground post assessment.

The owner of vineyard 5 had purchased a wide variety of posts from 2003 to 2009 that were installed as replacements. As these are all similar dimensions and very difficult to differentiate. A 15 ha part of the vineyard was checked to locate and assess posts. In this area 121 posts were located. A further 30 ha of vineyard was not checked due to time constraints. No broken posts were found but there were 32 posts in storage that had been in use in an area of the vineyard that had been removed.

The owner of vineyard 6 had purchased 149 *E. bosistoana* posts in June 2008 and left these block stacked for some years before starting to use them for replacements. They seasoned unevenly and this combined with some posts having cross grain resulted in twisting and a few breaking before use. The owner did not have an accurate count of those that had broken. A total of 37 were found in service throughout the vineyard during the assessment.

During the vineyard visits to complete in service post assessments, several durable eucalypt posts and a diverse range of different types of posts were photographed (Appendix Two).

Assessment of vineyard post in ground condition

Decay on the posts could be assessed once top soil had been removed from around the posts.

White-rot and brown-rot (and possibly soft-rot) were found on posts of both species (Figure 3).

Figure 3: White-rot (left) and brown-rot (right) on E. bosistoana posts after 10 years in service (post 36 and 40)

Generally, *E. bosistoana* posts showed less decay than *E. globoidea* posts after 9 -11 years in service (Figure 4). However, this analysis was confounded by site, as not all sites had posts from both species.

E. bosistoana posts performed well at both assessed sites (Figure 5) with many posts showing no sign of decay. The full range of decay assessed in *E. bosistoana* posts is shown in Figure 6. This is what would be expected as there is natural variation in the decay rates of wood from different trees of the same species as well as variation in the wood in different parts of the stem. These natural variations are noted in the Australian Standard AS5604 as *'the inner heartwood (the first few growth rings around the pith), generally, has lower natural durability than the rest of the heartwood'.*

Vineyard 2 had posts of both species present and clearly showed the better performance of *E. bosistoana* (Figure 7).

Performance of *E. globoidea* was site specific (Figure 8). After 10 years in service posts at vineyard 2 showed severe decay while posts in the feijoia orchard at vineyard 3 (also in service for 10 years) were performing well (Figure 9). One possible site effect is the under-vine cultivation at vineyard 2 compared to the undisturbed soil at vineyard 3.

All posts assessed for their in ground condition were permanently labelled so they can be revisited and assessed again in the future.

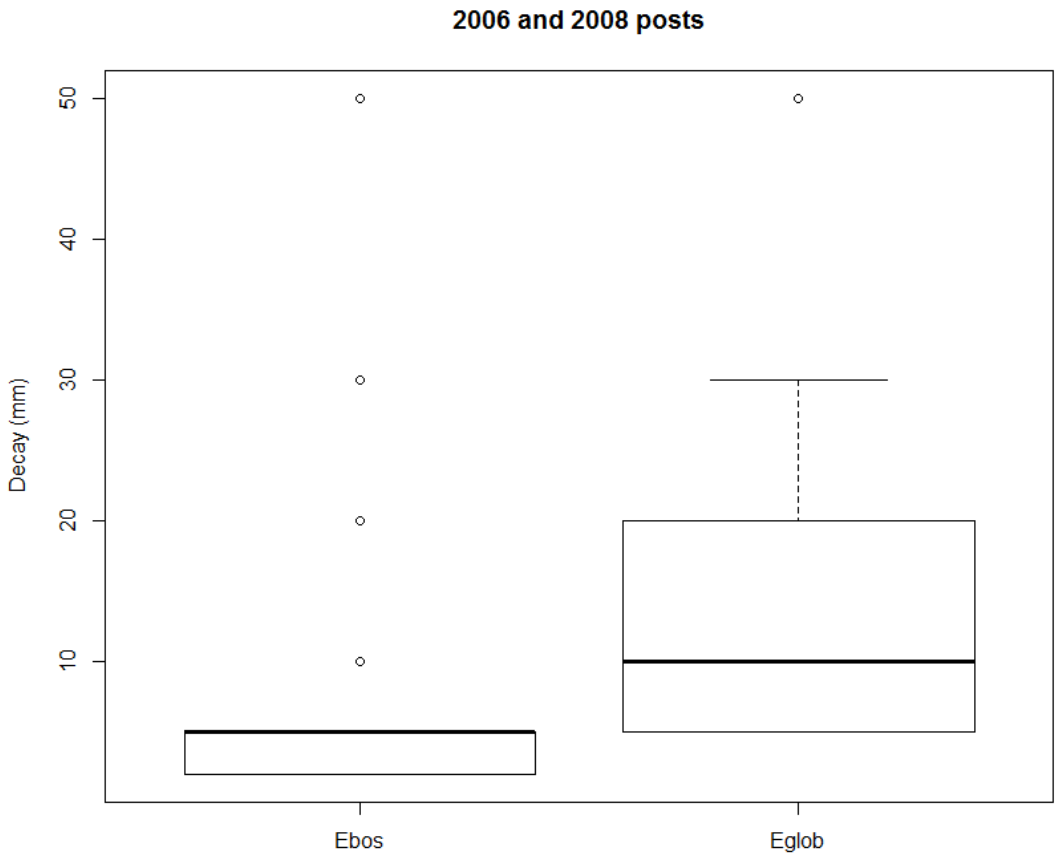


Figure 4: Decay depth of E. globoidea (n=63) after 10 years and E. bosistoana (n=73) posts after 9-11 years in service. Note: confounded by site.

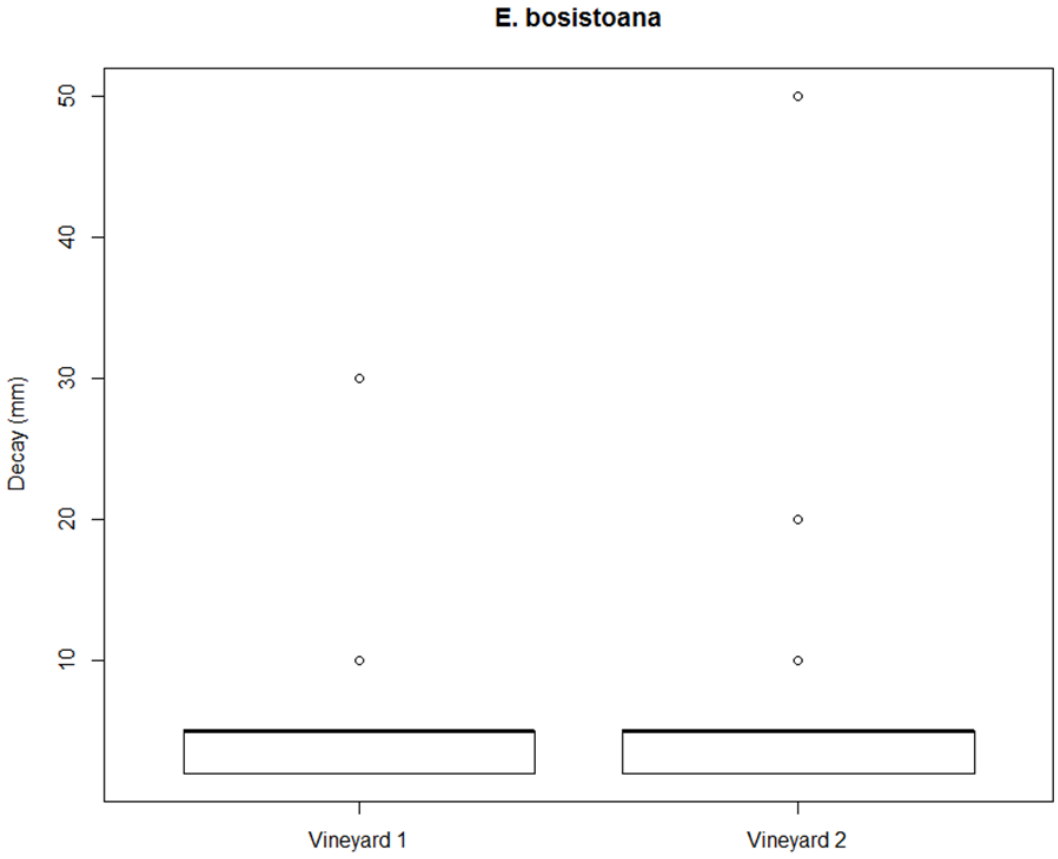


Figure 5: Decay depth of E. bosistoana posts at vineyard 1 (n=50) after 10 years and vineyard 2 (n=23) after 9-11 years in service.

Figure 6: Range of decay in E. bosistoana posts after 10-11 years in service. From left to right: < 2mm; 2-5 mm; 10-20 mm; > 30mm (post 10, 21, 40 and 41). Note: post 41 showed the severest decay of all assessed E. bosistoana posts.

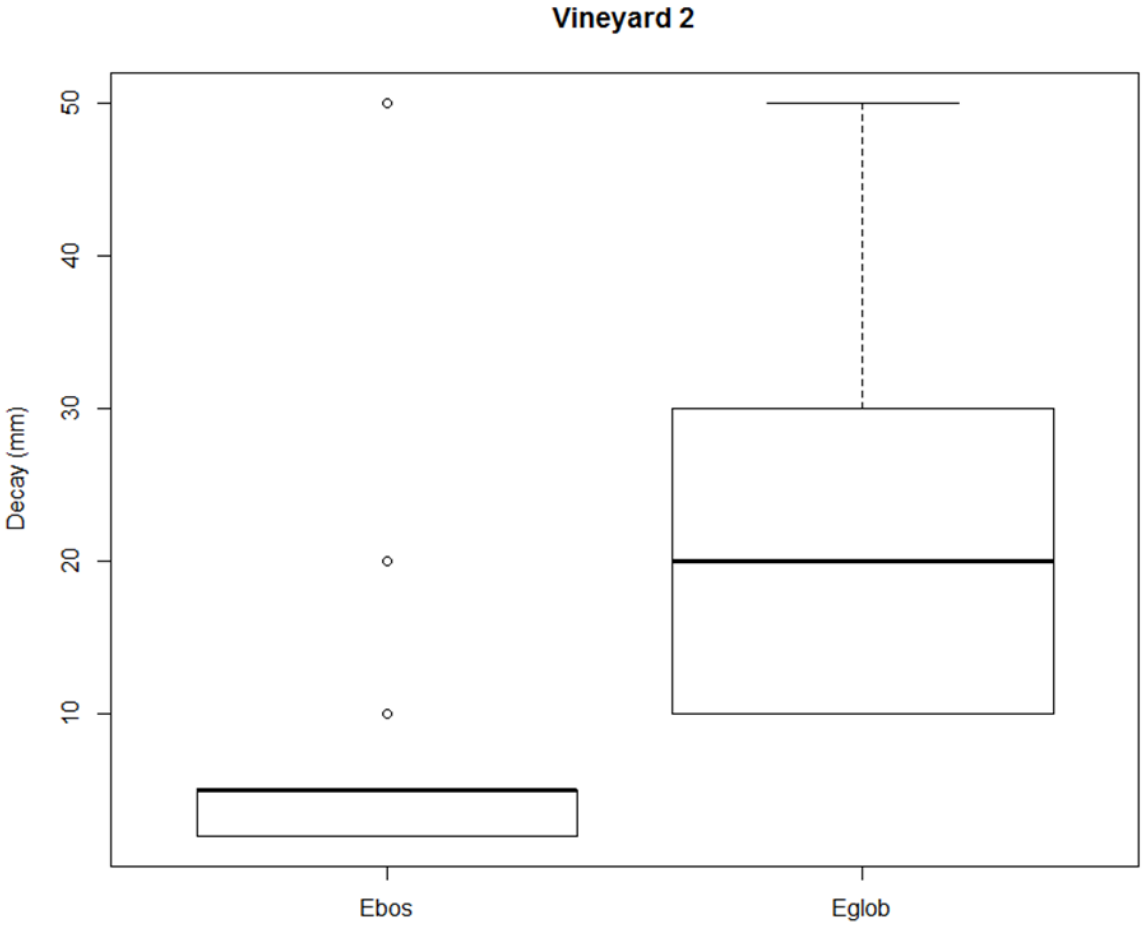


Figure 7: Decay depth of E. globoidea (n=25) and E. bosistoana (n=23) posts after 9-11 years in service.

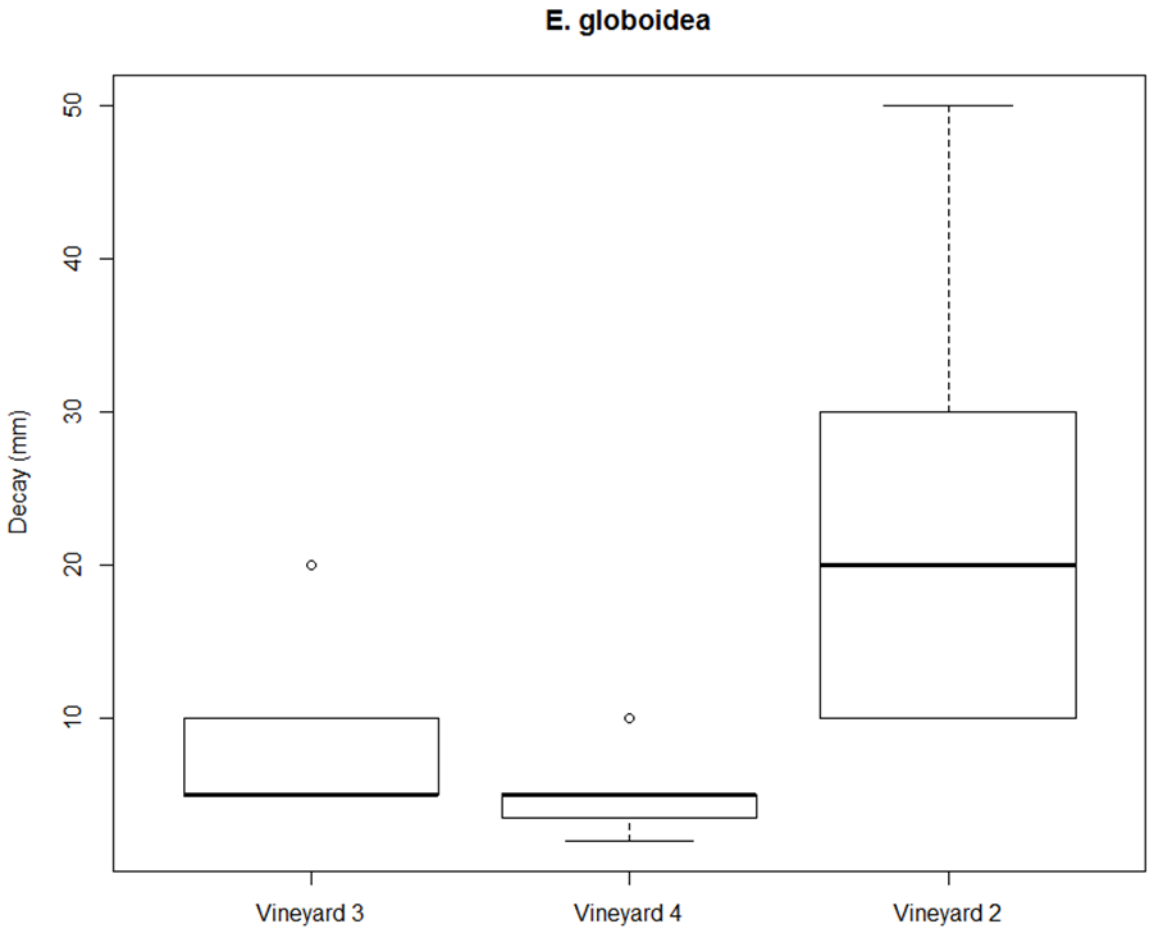


Figure 8: Decay depth of E. globoidea posts at vineyard 3 (n=38) after 10 years; vineyard 4 (n=12) after 5 years and vineyard 2 (n=25) after 10 years).

Figure 9: E. globoidea posts after 10 years in service. Post 116 in feijoa orchard at vineyard 3 showing no sign of decay and failed post 62 at vineyard 2. Note: Post 62 showed the severest decay of all assessed E. globoidea posts.

CONCLUSION

New Zealand's wine industry is heavily reliant on millions of posts installed throughout the national vineyard estate of some 36,000 hectares. While the largest percent of these are CCA treated pine posts, several vineyard owners are using alternatives including naturally durable eucalypt posts.

The major reason for this is that international consumer demand for organic wine, which is increasing. Since the late 2000's, organic wine produces have been required to look beyond the continued use of CCA-treated posts, due to the United States' USDA National Organic Programme (NOP) shunning treated posts for new installation or replacement purposes.

There is also mounting community concern particularly in Marlborough on the general use of CCA treated pine posts as there is now a significant environmental problem with thousands of replaced posts stockpiled in the region and the only option for safe disposal being the Marlborough District Council's regional landfill.

Some Marlborough vineyard owners have chosen to test other posts includeding six local vineyard owners who purchased naturally durable eucalypt posts from Vineyard Timbers Ltd. between 2003 and 2013.

Vineyard Timbers Ltd. first proposed the use of durable eucalypt posts to supply Marlborough's vineyards as a long-term prospect in 2003. This was on the basis that they are suitable for organic vineyards; have minimal breakage; and could offer a service life of 15-20 years for *E. globoidea* and 20-25 years plus for *E. bosistoana.* Also they are easy to dispose of as they can be recycled; burnt using normal incineration or chipped for use as mulch.

While the posts assessed in this project were not installed to be tested under any tight scientific protocol, the feedback from vineyard owners/managers and the results of our assessments demonstrate that most of the durable eucalypt vineyard posts of both *E. bosistoana* and *E. globoidea* are continuing in service after more than 10 years with a very low percentage of broken posts found; in the case of vineyard 1 this was equivalent to annual breakage for *E. bosistoana* posts of only 0.3%.

Much of the feedback by the vineyard owners and managers is very positive. Some reported a few post breakages due to knots but considered the posts were providing acceptable performance in service when compared to others.

The results of our in ground assessment of 150 posts found that nearly all of the 75 *E. bosistoana* posts assessed are still in service with low levels of decay as would be expected due to their class 1 durability classification in the Australian Standard (Bootle 2005). By comparison posts of *E. globoidea*, which is class 2, are showing higher decay rates (particularly on one site) although a large number are still in service and can be expected to continue so for a number years.

It can be expected that most of the posts will continue in service and that another inspection could be made in five years.

NZDFI (www.nzdfi.org.nz) has identified that sustainably-grown naturally durable posts can be produced for the vineyard industry and that durability can be improved by genetic selection. NZDFI's wood quality research and tree breeding programme is doing this.

NZDFI's unique research focus and strategic vision has already engaged many NZ forest growers in east coast regions with about 1,000 hectares of durable eucalypts already planted. The aim is to establish a new hardwood forest industry based 100,000 hectares of naturally durable eucalypt forests, by 2050. These new forests could supply durable posts for NZ's entire vineyard estate.

Delivering the first generation of genetically improved plants of both *E. bosistoana* and *E. globoidea* to growers is planned to commence by 2020. Therefore, NZDFI is encouraging SWP

investors and farm foresters, and supported by government, for investment in regional scale planting programmes of eucalypt forests in NZ's East Coast regions from Gisborne to Marlborough.

ACKNOWLEDGEMENTS

Thanks to the six vineyard owners/manager that provided access to their properties and responded to the questions on the performance of the durable eucalypt posts in their vineyards.

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APPENDICES

Appendix One: Machine harvesting and pruning in Marlborough vineyards

Figure 10: Gregoire grape harvester at work in Marlborough vineyard.

Figure 11: Gregoire harvester and tractor/trailer unit at work in Marlborough vineyard.

Figure 12: During the annual harvest machines need to work day and night to get the grapes off the vines.

Figure 13: A mechanized vine pruner and stripper at work in Marlborough vineyard.

Appendix Two: Durable eucalypt and other types of posts being used in Marlborough vineyards

Figure 14: View across vineyard 1 with the owners trial of E. bosistoana posts in rows with each one alternated with two plastic covered Greenspan steel posts.

Figure 15: In service assessment using the 'pull' test at vineyard 1.

Figure 16: E. bosistoana post broken by machine harvester in vineyard 1.

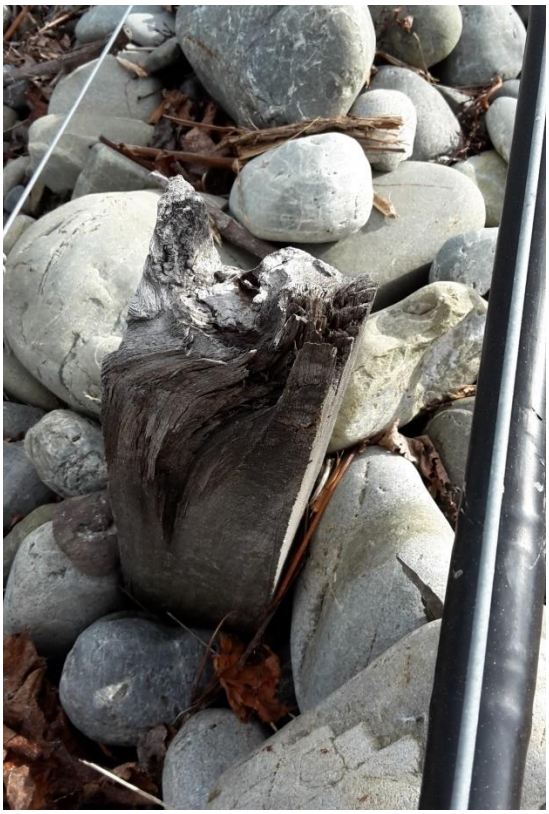

Figure 17: E. bosistoana post broken across knot in vineyard 1.

Figure 18: E. bosistoana showing repeated damage by machine harvester in vineyard 1.

Figure 19: Sections of E. bosistoana postss with no. 1 unused timber and no's 2,3,4 & 5 all sections of broken posts dug out of vineyard 1 after 10 years in ground. Note no. 5 is pith wood.

Figure 20: Broken half round CCA pine post in vineyard 2.

Figure 21: E. globoidea post with recent damage by mechanical undervine cultivation in vineyard 2.

Figure 22: E. globoidea post in feijoa orchard. This one is sawn through the centre of the stem as the line of the pith is evident.

Figure 23: E. globoidea sign post used at entrance to vineyard 3.

Figure 24: E. globoidea showing wire hangers fastened with clouts at vineyard 4c. Note the size of the spike knot.

Figure 25: WoodSheild post manufactured by Fosters in vineyard 4a. This is an untreated pine peeler core encased in 6mm thick of black polyethylene to produce a finished size of 83mm trellis post.

Figure 26: Eco trellis post manufactured by NZ Steel in vineyard 4a. This is a 1.15mm thick heavy zinc coated steel extruded to produce a 80 mm trellis post.

Figure 27: View at vineyard 4a of small vineyard area with E. globoidea trellis posts and Wallaba strainers. Wallaba are imported naturally durable posts that were available in Marlborough through local rural supply agents. This small area of vineyard was part of the in ground post assessment.

Figure 28: New E. paniculata post being installed to replace broken CCA post in vineyard 4a.

Figure 29: Wallaba post used as an intermediate in vineyard 4a.

Figure 30: Imported teak round post decayed at just below ground level and marked for replacement in vineyard 5.

Figure 31: CCA treated pine post cracked across branch whorl at ground level and marked for replacement in vineyard 5.

Figure 32: View of broken CCA post stock pile in an adjoining vineyard to one of those assessed.

Figure 33: View of a Marlborough vineyard using all steel posts with some showing the impact of machine harvesting.