final report

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Management of Mistletoe in Central West (NSW) Grazing Country

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Introduction

'What to do about mistletoe' had been a key issue of discussion for our Landcare group over several years leading up to an application to Meat and Livestock Australia for PIRD project funding support for farmer based trials on management of mistletoe. On one hand we were concerned about heavy infestations of mistletoe resulting in death or poor health of important shade, shelter and fodder trees while on the other hand noting that mistletoe is a native species providing habitat and food for native birds and marsupials and a species of significant environmental interest.

We noted significant cause / effect / control debate on mistletoe in the scientific and popular literature dating back to the 1950's on whether mistletoe results in poor tree health / death or whether pastoral / forest activity results in poor tree health and subsequent susceptibility to mistletoe infection. In our area large old paddock trees, trees in fenced off remnant vegetation and new tree plantings were all subject to heavy mistletoe loads. On one hand our Landcare group was very busy planting more new trees while on the other we were concerned that we were not adequately caring for our heritage trees or young trees in recent plantings.

We were concerned that loss of important shade and shelter trees would lead to lambing / calving losses, reduced weight gains for young stock, heat / cold stress for older animals, loss of fodder trees, increased susceptibility to wind and water erosion and loss of regional biodiversity.

Project Objectives

Our overall aim was to stop the loss of important shade, shelter and fodder trees, with resulting benefits for animal production, through development of cost effective strategies to manage mistletoe in our pastoral environment. Specifically we aimed:

(i) To determine the level of strategic pruning by physical or chemical means, which is necessary to improve the health of two tree species (Red Gum and Kurrajong) and thus indirectly, shade shelter and fodder reserves for livestock and native habitat;

(ii) To determine cost/benefit ratios for physical and chemical pruning (thinning) of mistletoe on Red Gum and whether significant benefits and tree health can be achieved for less that $25 per tree; and

(iii) To undertake broader scale mistletoe management on at least two thirds of HCLG member properties over the ensuing two year period.

Methodology

3. Preliminary Results – Analysis of the Data

*(a) Physical Pruning of Mistletoe (*Amyema spp*) on Eucalypts*

One hundred and twenty red gum (*Eucalyptus blakelyi*) located over seven properties were subjected to four pruning treatments (*complete* removal of mistletoe, *two thirds* removal, *one third* removal and *nil* removal) in May - June 2008. The pruning was undertaken by an experienced tree surgeon using climbing ropes and small chain saw so as to result in minimal pruning of the trees other than to remove mistletoe.

All trees in this treatment hosted more than six mistletoe, some hosted more than 30 mistletoe and the average mistletoe load was calculated at 19 mistletoe. All treatments were

arbitrarily assigned. Trees treated in each replicate of four treatments grew in relatively close proximity. (ie each treatment tree could be sighted from another tree in the replicate)

All trees in the *complete* removal treatment improved one or two points on our tree health scale (Appendix 1) over the two year period. Half the trees from which *two thirds* of their mistletoe load was removed also showed improved tree health of one point. Most of the trees from which *one third* or *nil* mistletoe was removed showed no change in tree health and some deteriorated in health.

Several additional trees originally assessed in very poor health and subjected to radical pruning, including removal of all misteltoe, but not pollarding, demonstrated remarkable improvement in tree health (2 – 3 points on our scale). Coppicing the trees proved to be a much quicker, though also dramatic, treatment than moving around the tree removing individual mistletoe.

The time taken to prune mistletoe (*complete* or *two thirds* removal) using a professional tree surgeon ranged from 30 – 40 minutes for a relatively compact tree up to 15 metres in height and hosting up to 15 mistletoe to two hours for a large spreading tree, 15 – 20 metres in height and bearing 30 plus mistletoe. On a good day we were able to treat 12 to 20 trees. At $400 per day for the tree surgeon, plus GST and landholder assistance, the cost per tree was $60 to $240 per tree.

As a footnote, while very effective, and ascetically rewarding, pruning mistletoe by this method proved to be very hard work, not for amateurs and is an activity not easily maintained for longer than six hours on cold winter days. Our conclusion is that it is best reserved for high value trees.

NB We replaced red box (*E polyanthemos*) in the original project plan with *E blakelyi* due to available tree numbers and broader distribution on member properties.

(b) Physical Pruning of Mistletoe using a Cherry Picker

Twelve Blakley's red gum Eucalypts and one grey box (*E. microcarpa*) on four properties were pruned of mistletoe by the tree surgeon using a 12 m towable travel tower (cherry picker). The trees selected hosted 7 to 42 mistletoe, with an average of 18 mistletoe per tree.

Pruning using the cherry picker took 30 minutes for an 8 m high tree hosting 8 mistletoe to 90 minutes for a 10 m tree hosting 42 mistletoe. A 15 m tree hosting 26 mistletoe took 2 hours to prune as the travel arm was fully extended at this height and had limited lateral movement. The 20+ m grey box proved too high for use of the cherry picker, even using a pole saw.

The cost of hiring the cherry picker at $300 per day plus GST adds $50 per hour to the cost of pruning, but can be used by less experienced operators to prune smaller trees. Larger travel towers require a ticketed operator, are significantly more expensive and are not readily available in country areas. The cherry picker also takes time to level, or it will not elevate, and is not safe to operate on ground with more than 5 percent slope.

(c) Physical Pruning of Mistletoe using a Pole Saw

Several trees were pruned using a commercial pole saw with a 3.5 m extension arm. This proved a practical method for relatively small trees (up to 6 m high) from the ground, or for higher trees using the cherry picker at minimal extra cost.

Longer pole saws or clippers proved unavailable despite a wide search.

The team also became quite skilled at throwing a shot bag and line over tree branches some 10 m off the ground and physically breaking the host branch to allow the mistletoe to fall to the ground.

(d) Chemical Treatment using 2,4D Tree Trunk Injection

Eight Blakelyi's red gum and two red box (*E. polyanthemos*) on two properties were injected with a 10 percent solution of 2,4-D. The technique and dose rates were developed by Greenham and Brown (1957) of the CSIRO in Canberra and used extensively by Forestry Commissions in NSW and Victoria during the 1960's and 1970's. This involved drilling 25mm diameter holes approx 40mm deep (depending on the thickness of the bark) into the trunk of the tree at 100 to 120mm spacing at chest height (1.2m) around the tree and injecting approx 10ml of the solution into each hole (Appendix B). The Greenham and Brown dose rate is determined from the diameter of the tree at chest height. The treatment was undertaken in the spring of 2008, at a time when we judged sap movement in the phloem of the tree to be most active.

The treated trees ranged from 12 to 25m in height (600 to 1200mm in diameter) and hosted from 8 to 50+ mistletoe (average 24 mistletoe). This treatment had a dramatic impact on both the tree and its mistletoe load. Within six months all trees lost more than 50 per cent of their foliage, most, if not all, mistletoe lost foliage and tree health was rated down one or two points. Within 18 months, most, but not all, trees had recovered their initial tree health score. One very tall tree which hosted in excess of 50 mistletoe remains in poor to fair condition. Only 10 per cent of the mistletoe hosted on the treated trees survived the treatment (average 2.3 per tree).

A further six apple box (*E. bridgesiana*) and four Blakelyi's red gum on an adjoining property were treated using this technique in the spring of 2009. While the impact on the mistletoe was similar, there was no apparent impact on the Blakelyi's red gum by June / July 2010. The treated apple box were all large (> 1m diameter) trees with very thick bark at chest height, and hosting 7 to 23 mistletoe (average 15). To date there is no apparent impact on the trees or significant impact on the mistletoe load, though 2 – 5 on each tree are now dead. 2009 was a dry spring in our area and the 2,4-D solution may have bee adsorbed within the thick apple box bark rather than being taken up into the tree by the phloem sap flow.

Tree trunk injection with 2,4-D proved to be the most cost effective on farm treatment for management of mistletoe. Each tree can be drilled and injected from the ground within 15 – 20 minutes using readily available farm equipment and relatively unskilled labour at a cost estimated at $10 - $12 per tree. However, there is a risk, noted by Greenham and Brown (1957), that some trees may die.

(e) Ground Spraying of Mistletoe using 2,4-D or Roundup CT

Mistletoe on twenty four Blakelyi's red gum were sprayed from the ground using the manufacturers recommended spot spray rate for 2,4-D and Roundup CT (12 trees for each) using a high pressure spray rig operated by the Boorowa based Southern Slopes Noxious Plants Authority in the spring of 2008.

The treated trees ranged from 4 to 15m in height and hosted from two (on the small trees) to 40 mistletoe (average 22 mistletoe). The spray treatments proved to be an operational challenge. While the mistletoe on smaller trees and lower branches could be saturated with spray to run-off point, it proved difficult to saturate spray the higher mistletoe even with a long lance handpiece and maximum spray rig pressure. Even the slightest breeze on a very calm morning also resulted in spray drift.

While the Roundup CT treatment resulted in death of some mistletoe on lower branches the average was less that 0.5 mistletoe per tree. Treatment with 2,4-D spray had similar minimal impact, even though the treatment is quick (10 – 20 minutes per tree) and low cost ($10 – $15 per tree).

(f) Physical Pruning of Mistletoe on Kurrajong

Twenty Kurrajong (*Brachychiton populneus*) located on two properties were subjected to four pruning treatments (*complete* removal of mistletoe, *two thirds* removal, *one third* removal and *nil* removal) in June – July 2008. The pruning was again undertaken by an experienced tree surgeon.

All trees in this treatment hosted more than six mistletoe (*Notothixos subaureus*, a completely different family of mistletoe than those hosted on the Eucalypts), some hosted more than 30 mistletoe and the average mistletoe load was calculated at 17 mistletoe. All treatments were arbitrarily assigned. Trees treated in each replicate of four treatments grew in relatively close proximity. (though due to the rugged rocky terrain in which Kurrajong grow not all treatment tree could be sighted from another tree in the replicate).

All the treatment trees remained in good tree health throughout the two year period. Very little is known about the impact of mistletoe on Kurrajong (David Watson, personal communication) but it appears mature Kurrajong can host quite large mistletoe populations (at least 20 – 30 mistletoe) without significant impact. Most of the pruned trees have responded with new growth. Kurrajongs have been utilised for many years as a supplementary fodder sours in dry times on farm.

Three additional trees hosting in excess of 40 mistletoe each and with less than 5 percent remaining Kurrajong foliage were heavily coppiced. One tree immediately responded with new growth, one has only just responded with new shoots around the trunk after 18 months and the third tree has not responded and appears to be dead (Appendix C).

Kurrajong are relatively squat trees (5 to 16m in height) and with numerous branches which makes it relatively easy for and experienced tree surgeon to climb around within the canopy and prune up to 20 mistletoe within 30 minutes. Our group utilised a larger than normal support group of interested farmers for this part of the trial, but $60 per tree is a reasonable estimate of cost for a two person pruning team for Kurrajong.

(h) Other related trials

Initially the Group planned a number of ad hoc trials, eg the reintroduction of possums to remnant woodland and strategic burning, to complement the pruning treatments above.

Longtime residents of our area believe that mistletoe has become more prevalent since the 1950's when possums also disappeared from remnant bushland and 1080 also was introduced for fox and rabbit control. Possums are now rarely seen in the district and only in farm buildings or in farmhouse roofs. Possum interest in young mistletoe shoots is recorded in the literature.

Despite the strong recorded relationship between possum and mistletoe ecology and possible tree health, NSW Department of Natural Resources officers refused to grant the necessary permits to allow possum relocation.

The trial period also coincided with dry years (the area was drought declared) with resulting lack of ground fuel or inclination on the part of landholder members of our local Bush Fire

Brigade to test David Watson's beliefs on the strong relationship between fire / smoke and mistletoe prevalence.

(i) Field days

Dr David Watson, a Charles Sturt University mistletoe researcher based at Albury, visited the group in August 2007 for a public seminar on mistletoe in south-east Australia, its biology and history of control measures. This was followed by a visit to prospective field treatment sites, a lively debate on mistletoe loads in our area and the planned trials. He considered the mistletoe loads on Eucalypts in our area to be amongst the highest he had observed in south-east Australia and the loads on Kurrajong to be possibly unique. He was unaware of any prior research on mistletoe in Kurrajong. This visit provided a good injection of research knowledge for our farmer based project.

The project has attracted farm and conservation community interest generated in part through articles released to regional media groups. One of our project sites was included in a Hovell's Creek Landcare field day in September 2009, and David Marsh, a Director of the Lachlan Catchment Management Authority was shown over the project in November 2009. The report on the project at the 2009 HCLG AGM resulted in vigorous discussion amongst HCLG members and the large group of neighbours and friends who attended.

Arrangements for the project field day, scheduled for 16 September 2010, have been discussed with the Regional Landcare Coordinator, with offers of assistance also from regional NSW department and LCMA staff.

(j) Broader Scale Mistletoe Management on Farms

The Landcare Group believes that, as a result of the MLA sponsored trial, members now have the knowledge and experience to address broader scale management of Mistletoe on farm.

The Mistletoe loads (number per tree) recorded in our trial are much higher than recorded in the published literature on Mistletoe and is of concern. The 1950's research on mistletoe seems to be unknown or ignored by the current generation of farm advisors, vegetation managers and environmentalists.

Our trial has resulted in two prospective tree / Mistletoe treatments; physical pruning for small or high value trees and tree trunk injection for broad scale use on trees remaining in fair health but with high (>6) Mistletoe loads.

The application of the NSW Native Vegetation Act to broader scale management of mistletoe on farm will need to be clarified with the Lachlan Catchment Management Authority.

In Summary

Tree species	Mistletoe average no / tree	Treatment	Impact on tree health	Impact on mistletoe	Treatment cost per tree $
E blakelyi	19	Nil prune	No change	No change	
		1/3 prune	No change	No change	
		2/3 prune	Minor improve	Minor	
		Full prune	Good response	Maximum	60 - 240
		Coppice	Very good response	Maximum	60 - 120
E blakelyi	18	Cherry picker full prune	Good response	Maximum	100 - 300
E blakelyi	24	2,4-D trunk inject	Mixed	Maximum	10 - 12
E blakelyi	22	2,4-D spray	No change	Minor	10 - 15
E blakelyi		Roundup CT spray	No change	Minor	10 - 15
Kurrajong	17	Nil prune	No change	No change	60
		1/3 prune	Minor	Minor	
		2/3 prune	Minor	Minor	
		Full prune	Minor	Maximum	
		Coppice	Mixed	Maximum	

What did the Group Learn from the Project?

We now know a lot more about Mistletoe in our farm environment and how to manage it. We are also now more aware of Mistletoe loads and trees at risk. As such the Group achieved the planned results

We now have the confidence and skills to address management of Mistletoe on farm. However, the application of the NSW Native Vegetation Act to broader scale management of mistletoe on farm will need to be clarified with the Lachlan Catchment Management Authority.

We are now more confident that management of Mistletoe can address loss of important shade and shelter trees which can lead to lambing / calving losses, reduced weight gains for young stock, heat / cold stress for older animals, loss of fodder trees, and increased susceptibility to wind and water erosion and loss of regional biodiversity.

Report on open / field days

As above, to be advised after 16 September 2010.

Was the group satisfied with the results of the project?

Yes, we now know a lot more about Mistletoe in our farm environment and how to manage it. We are also now more aware of Mistletoe loads and trees at risk. However, we were disappointed that we could not interest research agencies with and interest in Mistletoe to work alongside us on the project.

How could we have done the project better?

In retrospect, the 2,4-D tree trunk injection component of the trial could have been expanded to address additional treatment dose rates for trees in different condition classes.

Is the Group interested in doing another project?

Yes, we are interested in fine tuning the applicable 2,4-D injection dose rates

Would you recommend that other groups undertake their own trials?

Yes. However, our small trial proved demanding and a lot to manage, without back from a professional research agency, for a small farmer based Landcare Group.

Comment on the organisation and management of PIRDs

We appreciated the MLA sponsorship of the project and the advice received from the PIRD program manager.

Appendices

(a) HCLG Tree Health Score Methodology

(b) 2,4-D Tree Trunk Injection Methodology

(c) Trial before & after Photographs

Appendix A

HCLG Tree Health Score

Reid et al (1994) utilised relative foliage biomass (RFB) as their measure of tree health. RFB was an uncalibrated estimate of host foliage biomass, expressed as a percentage of the potential quantity of host foliage biomass on the tree in full leaf, ie with a dense entire crown, without dead or leafless branches and without parasites (Mistletoe). Leafless trees of any size scored 0%, and unaffected trees with a perfect dense canopy scored 100%. The independent estimated of trained observers were usually within 105 and Reid et al considered the measure to be a robust index of tree health.

However, if Mistletoe is a natural and desired component of the Australian landscape, then a healthy tree might be expected to be able to carry a low Mistletoe load without undue impact. For example, some Red Box trees carry very high Mistletoe loads (>10) but still have dense Eucalypt foliage and appear otherwise healthy. On the other hand, Red Gums with a Mistletoe load >10 appear to be in poor health and rapid decline.

HCLG Project measure of tree health:

Tree Score	Description
1	Very Poor health. Little, if any tree, foliage, numerous dead branches. Possibly accompanied by heavy Mistletoe load (>10), constituting the majority of leaf foliage on the tree. Tree considered close to death.
2	Poor health. Sparse tree foliage, many dead or bare branches. Accompanied by high Mistletoe load. Tree considered 'at risk'.
3	Fair health. Medium to good level of tree foliage (for the species), some dead branches (but not excessive). Mistletoe load > 6. Tree considered not yet in danger, but of concern.
4	Good health. Medium to high level of tree foliage, some dead branches (considered normal), tree looking quite vigorous and healthy. Possibly accompanied by low level of Mistletoe load (<6).
5	Very good health. High level of tree foliage (for the species), few, if any, dead branches, tree looking healthy and vigorous. Possibly accompanied by a low level of Mistletoe load (1-2).

Appendix B

Management of Mistletoe by 2,4-D Tree Trunk Injection

The 2,4-D tree trunk injection technique trialed by HCLG was based on the work within CSIRO by Greenham and Brown during the 1940's and 1950's and published in the Journal of the Australian Institute of Agricultural Science in 1957 and 1965.

At that time there was widespread concern about the increase in mistletoe population killing farm shade trees, impacting on soil erosion in water catchments and reducing timber production in forests. Loss of timber production was found to be as high at 55 percent when the Mistletoe replaced 38 percent of the canopy (Nicholson, 1955). The impact of mistletoe on trees has special relevance to current concerns about carbon sequestration.

Basic research work on the movement of selective compounds with Eucalypts indicated that compounds of copper and sulphur were selectively adsorbed by Mistletoe and may result in the selective death of Mistletoes on treated trees. Selective application of 2,4-D to only one side of a tree trunk resulted in mistletoe death on the opposite side of the tree.

In concurrent research work, Hartigan (1949) found spray application of 2,4-D to mistletoe also to be effective but more difficult in hilly terrain and in taller trees.

Greenham and Brown found application of 2,4-D in shallow holes regularly spaced about 100mm apart around the tree to be most effective. Application by way of fewer, deeper holes increase damage to the tree crown and resulted in reduced Mistletoe control.

Application of a 10 percent solution at rates C or D (Figure 1 below) dependent on the size of the tree (as measured by tree trunk diameter at breast height), the season and tree health was recommended. Application of the higher rate (D) in drier seasons and to trees in poorer health resulted in some tree damage and occasional tree death. Lower application rates resulted in less damage to host trees but also slower and lower impact on the Mistletoe (particularly Amyema pendula) population.

Follow up trials by State Forestry Departments in Queensland, New South Wales and Victoria and by the University of Melbourne found the Greenham and Brown technique to give effective control of Mistletoe in a wide variety of Eucalypt species.

In the HCLG trials, a standard livestock drench backpack and gun was used to deliver the dose rate D to 25mm diameter holes drilled, with a power drill and spade bit, 100 – 150mm apart and at a 45 degree angle about 20- 30mm into the tree trunk depending on the thickness of the bark. The hole, when cleaned provided a receptacle for about 10ml of the 2,4-D solution which was adsorbed by the tree in 5 – 10 minutes. In this way two people could treat quite large trees, ie over one metre in diameter, in 10 – 15 minutes.

A) The 2,4-D treatment solution

1. A 10 percent solution of 2,4-D was made by mixing 1 part 2,4-D amine available commercially as 625g/l dimethylamine and diethylamine salt) to 9 parts of water. Always follow safety directions.

B) Equipment

1. Portable drill or other suitable power drill, long extension lead and generator

2. 25 mm spade bit to suit drill
3. Suitable applicator eg, an old drench gun and pack - Note MARK container accordingly
4. Tape measure

C) Treatment procedure

1. Measure the circumference of tree at chest height (1.5m above the ground) and from this calculate the average diameter of the tree, ie circumference divided by 3.14.
2. Calculate the dose for the tree using the graph in Figure 1, below
3. Drill a hole approximately 25 – 40 mm deep (depending on thickness of the bark) at an angle of about 45 degrees down into the trunk. The hole should be 5 - 10 mm into the sapwood underneath the bark and hold approx 10ml of treatment solution.
4. Drill all other holes at 120 – 150mm spacing around the trunk. NB even application is important.
5. Clean out the holes
6. Use the applicator to inject approx 10ml into each hole around the tree.
7. The mix should absorb into the tree in about 5 to 10 minutes

D) Application safety

1. Make up only small quantities of 2,4-D mix that can be used in one treatment period.
2. Follow all manufacturers safety instructions for safe use, storage and clean up after use of 2,4-D

E) Notes

1. Trees should not be treated when highly stressed
2. Treatment is most effective when the tree is in a growth phase, eg autumn or spring
3. Avoid treatment during really hot weather. It is possible that the tree may die
4. Ensure the mixture is measured and applied accurately as applying too much 2,4-D may kill the tree

F) Effects

1. In the HCLG trial, initial effects were seen in 4 to 6 weeks. The mistletoe dropped its leaves and began to die
2. Some trees also showed signs of temporary stress and loss of leaves.
3. After 12 months the tree should recover with the mistletoe burden reduced. It is possible that branches of the tree, or the whole tree, may die.

It is hoped that experience using this method may lead to refinements in the treatment procedure. Your feedback is welcomed.

Figure 1 2,4-D treatment dose rates for Eucalypt recommended by Greenham and Brown (1957)

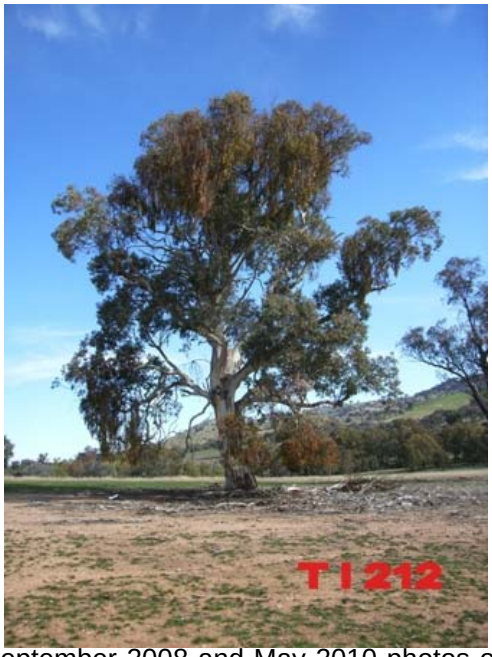
Appendix C Project photo history

Pruning of Mistletoe (Amyma spp.) in red gum (E. blakelyi) by an experienced tree surgeon, using a cherry picker and by use of long pole saws

Spray treatment of Mistletoe using a high pressure unit and long lance nozzle

Tree trunk injection of 2,4-D

May 2008 and April 2010 photos of a red gum (E. blakelyi) on Riversteen from which over 40 mistletoe were removed



September 2008 and May 2010 photos of a Red box on Gvesne treated with 2,4-$ by trunk injection

A Kurrajong (Brachychiton populneus) on Kooringle supporting 25 mistletoe (Notothixos subaureus) of which eight were removed as part of the trial.

This Kurrajong on Kooringle has not responded to removal of >50 mistletoe comprising >95 percent of the tree foliage

Landcare members were concerned about heavy infestations of mistletoe resulting in death or poor health of important shade, shelter and fodder trees

Landcare members also very aware that mistletoe is a native species providing habitat and food for native birds, marsupials and reptiles and a species on significant environmental interest (photos of treatment trees on Willow Glen)

Strategic pruning of both Eucalypts and Kurrajong can result in prolific new growth but how much could be removed to improve the health of the tree while leaving sufficient for wildlife food and habitat (photos of pruned trees on Riversteen and Kendon)