Prickly Acacia in the Northern Territory: Costs and Benefits of eradication

Report prepared for the Northern Territory Department of Environment and Natural Resources

October 2017

Executive Summary

Data records maintained by the Weeds Management Branch (WMB) of the Northern Territory Department of Environment and Natural Resources (DENR) show a clear increase in prickly acacia (PA) infestation in both the Barkly and Victoria River Districts (VRD) of the Northern Territory. To date there has not been the same level of production impact from high density infestations as seen in parts of Queensland, however without regular monitoring and control PA still has the potential to invade large areas of the NT reducing livestock carrying capacity, increasing mustering costs and causing erosion. Based on the DENR data and expert opinion from experienced land managers, it is estimated that up to 350,000 hectares of the Barkly could be infested within 10 years while over a million hectares of the VRD could be infested if left uncontrolled.

The costs and benefits of eradicating PA at the property level were analysed using a standard cost-benefit analysis framework to account for the future flows of costs and benefits. The most important variables are density, rate of spread, rate of eradication and productivity impact. Due to data limitations some broad assumptions as to the value of these variables had to be made. To account for these known margins of error, comprehensive sensitivity analysis was conducted to test the robustness of the analysis. A 'decision-tool' for land managers has also been produced to provide managers the opportunity to test their own estimates of rate of spread and other factors impacting costs.

Across all areas prompt treatment of existing small areas provides the best return on investment. Analysis of a case study infestation on the Barkly showed that for an area of approximately 5,200 hectares the total cost of an eradication program over four years would be approximately $9,000. Ongoing monitoring would be required at an approximate cost of $450-$500 per annum. By delaying treatment for five years the total costs over 20 years would rise to over $68,000.

The VRD case study was based on a property which has undertaken a comprehensive control program over the last 15-20 years. In this case almost total eradication has been achieved with only scattered plants now found over an area of approximately 3,500 hectares. However, a neighbouring property has experienced rapid spread of PA due to lack of treatment. Based on the rate of spread exhibited on the neighbouring property this small area could increase to over 127,000 hectares within 10 years if eradication efforts were discontinued. Due to the topography of the VRD eradication has been shown to be slower than on the Barkly. As a result, it is expected that eradication of the primary infestation will take another six years at a total cost of approximately $30,000. Ongoing monitoring will cost in the range $450-$700 per annum. If not started for five years total treatment costs would be over $180,000.

Prickly acacia has been declared a Class A weed in the NT which gives the WMB the authority to impose penalties on landholders who do not take measures to control this weed. On this basis the total costs for the Barkly case study (if treatment does not commence immediately) could rise to between $365,000 and $3 million depending on the level of penalties imposed. In the VRD delayed treatment and maximum penalties could increase total costs to over $12 million. It should be noted that the penalties do not necessarily depend on the area of infestation.

Against the costs of control in terms of chemical and labour are the benefits of increased or avoided losses in carrying capacity. Including these benefits shows that early eradication efforts produce a higher Net Present Value (NPV) for the Barkly and VRD case studies over 20 years. This result is robust to variations in assumptions regarding rate of spread, livestock productivity and control costs.

The analysis shows that even in the absence of penalties, there is a positive return for early treatment of PA in the NT.

Table of Contents

1 Introduction

Prickly Acacia (*Acacia nilotica*) is a thorny shrub introduced to Australia as an ornamental, shade, and fodder tree before 1900. Due to its ability to spread quickly, out-compete productive pasture species and contribute to erosion it has been declared a Class A weed in the Northern Territory. Based on this declaration a management plan has been developed with the objective of eradicating all existing infestations and preventing further establishment of prickly acacia in the Northern Territory.

The majority of current infestations are on pastoral land and cattle are a key vector to spread the seed as the seeds remain viable even after passing through the gut of cattle. Since pastoralists will have the greatest responsibility for the control and eradication of prickly acacia it is pertinent to review the relative costs and benefits of control from a pastoralists perspective. This report will aim to do so by focussing on two case studies in the Barkly and Victoria River Districts and by creating a decision support tool which pastoralists can use to undertake analysis on their own properties.

2 Scope and Approach

The given objective for this project was to conduct an economic analysis of prickly acacia control on pastoral leases in the Victoria River District (VRD) and Barkly Regions of the Northern Territory. The analysis includes estimates of:

a. Cost per unit of area affected
b. Expected area affected by prickly acacia on the Barkly and VRD under eradication versus unmitigated spread over time
c. Economic analysis including current and predicted landholder revenue losses, cost increases and asset value effects from prickly acacia over 20-year period on the Barkly and VRD Regions, under the following weed management scenarios –
    i. Do nothing
    ii. Eradication
    iii. Slow the spread
d. Case studies for one property in the Barkly and one property in the VRD that demonstrate investment into prickly acacia management over time and outcomes of the investment

The desired result was to produce a set of communication and extension materials to support cost-effective landholder investment in eradication or management.

As such the report focusses on the costs and benefits of control at the individual landholder level rather than identifying an efficient response from a central management perspective.

3 Background

3.1 Successful control of Prickly acacia in QLD

Prickly acacia has been recognised as a significant problem in Queensland for many years but recently substantial investment by both landholders and government has resulted in positive outcomes.

Between 2013 and 2018 a total of $5.66 million will be invested to control prickly acacia, primarily on Mitchell grass country (Desert Channels Queensland 2016). The current program which is administered by Desert Channels Queensland (DCQ) commenced because there had been a greater than three-fold increase in the infested area in less than 20 years (Desert Channels Queensland 2016). Much of the DCQ area experienced much higher than average rainfall over the 2009/10 wet season which resulted in a mass germination. As a result, based on the current rate of spread 95% of the Mitchell grass region was expected to be impacted by 2030 (Desert Channels Queensland 2016).

The DCQ project has identified a number of key lessons to be considered in efforts to control/eradicate prickly acacia which are applicable regardless of location. The basis of these lessons is that a strategic, coordinated approach between landholders, supported by government and based on accurate mapping is essential (Wiggins 2016). Following the 2009/10 wet season many landholders felt that they had lost the fight as they were no longer able to afford to control core seed producing areas due to restrictions on clearing native vegetation and limits on control measures near water courses. Thus, future control measures need to be flexible and outcome focussed with ongoing careful monitoring, even once eradication is believed to have been achieved. Some options for integrated weed control were also identified including excluding stock during seeding, the possibility of using camels for biological control and changing fence and watering point positions to control cattle movements.

An economic analysis of the DCQ project comparing different treatment options found that there was a net cost of treatment across all scenarios if only production impacts are considered but highlighted the value of early treatment to reduce future liabilities (McLean 2015). The analysis also found that the new treatment method using an unmanned aerial vehicle (UAV) and alternative chemical regime were more cost-effective than previous hand spraying methods. However, it should be noted that the UAV was found to be most cost effective in high density areas and cost effectiveness is greatly impacted by travel distances between infestations.

3.2 Prickly Acacia in the Northern Territory

It is not known exactly when Prickly acacia was first introduced into the Northern Territory but the earliest records are from 1980 where there were a number of recorded points on the Barkly Tableland (Department of Environment and Natural Resources 2017). A known incursion also occurred on the Barkly Tableland in 2000 when cattle were brought in from Queensland (Mills, pers. comm. 2017). In the VRD prickly acacia was noted at a similar time but was not formally recorded until 2001 (Department of Environment and Natural Resources 2017). At the territory level this data shows that the majority of prickly acacia occurs in occasional patches, contained within localised areas (see Figure 1).

Since it was first recorded weed surveys have found prickly acacia on 67 land systems across the NT from coastal floodplains to basalt hills. The data does show that the number of recorded locations has increased from 15 in 1990 to over 650 in 2016 and that prickly acacia is now found in all regions of the northern NT (see Figure 2).

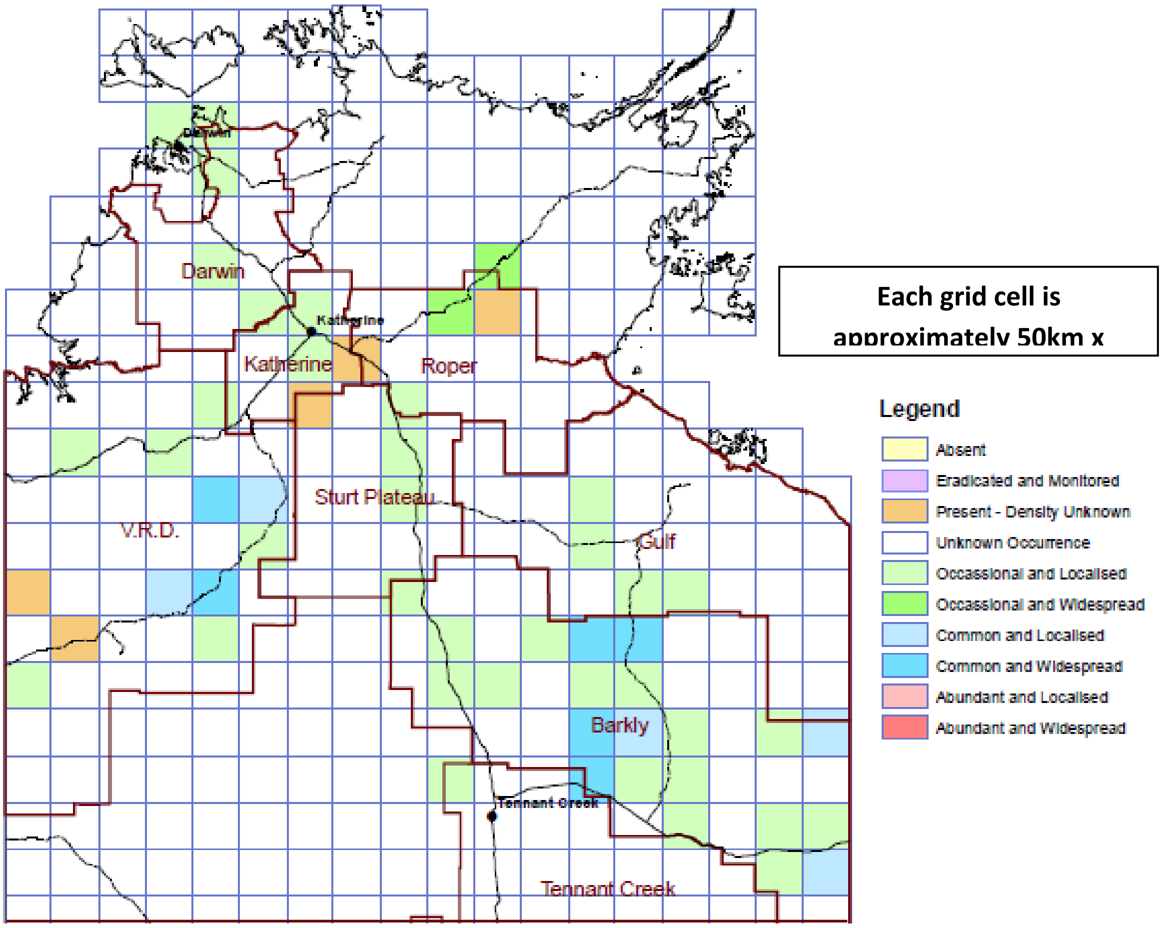

Figure 1 Prickly acacia distribution 2017 (NT DENR)

The data shows that the number of recorded sites and the total recorded area of infestation has generally increased, particularly since 2005, and there were two major spikes in recording in the VRD in 2012 and 2014.

Although the recorded extent of prickly acacia has increased markedly, on individual properties the spread and impact has been much slower than what has been observed in QLD. For example, since the known incursion occurred at Brunette Downs in 2000 prickly acacia has only spread across two noticeable patches which have been regularly treated. At this stage it has not had a discernible impact on productivity nor is it causing significant erosion issues. Similarly, in the VRD, the rate of spread of prickly acacia has so far not caused significant productivity impacts although some impact on mustering costs has been noted in core areas. However, due to the potential for this weed to spread rapidly particularly during good seasons a territory-wide statutory management plan was approved in 2015 with the goal of eradicating prickly acacia from the NT.

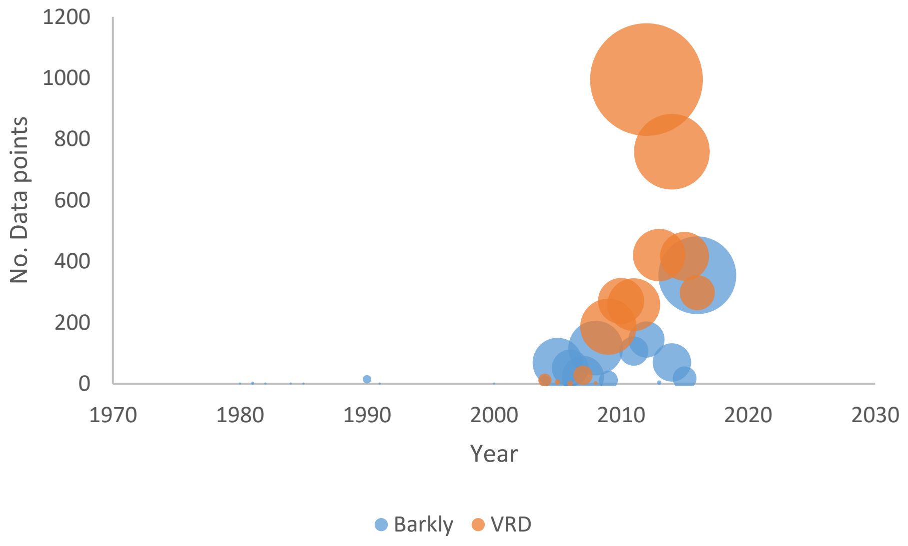

Figure 2 NT prickly acacia infestation rates (size of 'bubbles' indicates the total area infested)

The density of infestations has also increased which is where the primary production costs occurs in reducing available cattle feed. Recorded infestations are rated according to the density scale shown below

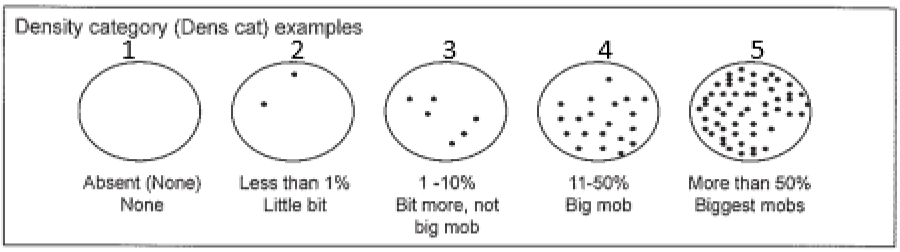

Figure 3 Density rating scale (Department of Environment and Natural Resources)

As shown in Figure 4 the majority of prickly acacia across the whole NT is in very low-density patches with only about 17% of the total area recorded at a density (4 or 5) where it would cause noticeable production impacts.

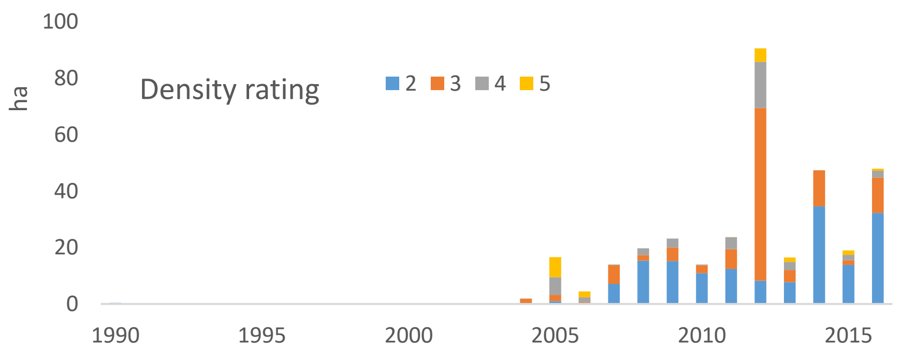

Figure 4 Density rating of recorded prickly acacia in the NT

The recorded data provides a good starting point to understanding the extent and spread of prickly acacia in the NT but there are significant gaps as not all properties were surveyed each year. To demonstrate the data was split into individual properties. Figure 5 highlights the gaps in the data and shows how the area of infestation shrinks when treatment occurs but often then increases again.

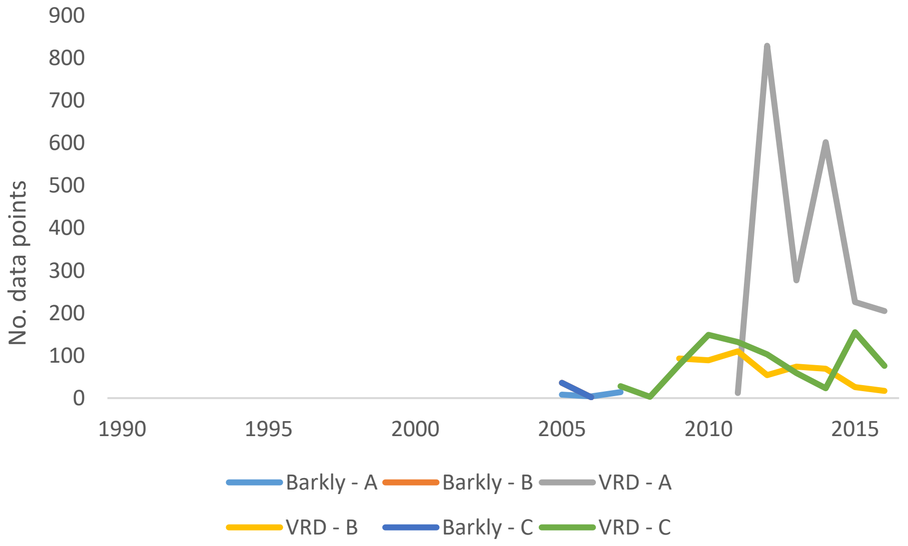

Figure 5 Recorded data points by property

Although the rate of spread to date has been fairly slow, the potentially feracious nature of prickly acacia and its ability to infest significant areas in a short period of time was demonstrated at one case study location on the Barkly. At one recorded point where just 3 mature trees were not killed in the 2016 treatment round, at least 500 seedlings were found including between 50 and 80 immediately surrounding each of the dead mature trees. At the time of inspection (August 2017) all the mature trees had begun to seed and given that the treatment round for 2017 was not completed until mid-October it is likely that a seed bank will continue to be viable for some years to come. Given the extensive scale of properties on the Barkly and the potential for areas to go unmonitored for several years controlling weeds like prickly acacia when they are present in small numbers is critical to ensure they do not reach a critical mass.

On a nearby station the prickly acacia infestation is concentrated around two water points and there is a clear spread pattern radiating out from these points along cattle pads. In this instance there is a productivity impact as the density of trees has impacted on grass production and the location of the infestation near a gateway has made mustering more difficult. However, in relation to the scale of the station the proportion of land infested with prickly acacia is small and quantifying the current impact is difficult.

Similar circumstances exist in the VRD where the presence of prickly acacia has been recorded for at least 20 years. A challenge in the VRD area is that, unlike the Barkly Tableland, prickly acacia has infested areas which are very difficult to access. Where land managers in this area have taken a proactive approach to controlling the weed it is currently not impacting livestock carrying capacity however when there have been lapses in management significant spikes in infestation have occurred. An observation from a very experienced rangeland manager was that prickly acacia appeared to spread very slowly for a long period of time which has allowed a level of complacency to develop. However, under the right conditions it will reach a critical mass at which time the density and extent of infestation is likely to increase extremely rapidly (Cornall pers.comm).

4 Methodology

The current levels of prickly acacia in the Northern Territory are relatively low and at present are causing very little if any measurable production impacts. However, the risk to producers is that if left untreated prickly acacia is likely to spread and result in much higher costs both in terms of control and the impact on production. As a result, it is necessary to conduct the analysis over a period of time, accounting for future costs and benefits and discounting these back to present values.

This analysis was constructed using a standard benefit-cost framework based on the assumption that a landholder will control/eradicate prickly acacia when, (in present value terms) the costs of treatment are less than or equal to the costs of the loss of production caused by prickly acacia.

The following sections outline the key variables and the assumptions made to calculate values for these variables.

4.1 Cost Benefit Analysis

Cost Benefit Analysis (CBA) is a structured way of analysing a decision, to determine objectively whether it is the best use of the available funds and resources. This is done by converting all the costs and benefits back to the same unit (dollars). CBA is a recognised methodology commonly used by governments and private industry to analyse investment decisions and has been extensively applied to analyse investments in biosecurity prevention and containment measures (Kompas 2017).

To account for future flows of costs and benefits which occur over differing time periods all costs and benefits are typically discounted back to present values. The rate used to discount values may vary but is usually based on a conservative estimate of the cost of capital (i.e. commercial interest rates). For the purposes of this study the base discount rate used is 7%.

By discounting these values, the 'Net Present Value' (NPV) can be calculated. The NPV is a robust indicator that can be used to determine both whether or not an investment is likely to return a positive outcome and to rank alternative projects. The NPV is calculated using the following formula:

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_0$$

where

C_t = net cash inflow during the period t
C_0= total initial investment costs
r = discount rate, and
t = number of time periods
In many investment decisions, there are both public and private costs and benefits to be considered. In this case the private costs and benefits will accrue to the owner/operator of the pastoral property, while public costs and benefits may impact on the broader industry. For the purposes of this

analysis only the private costs and benefits to the individual pastoral manager have been explicitly calculated. Some commentary on the potential extrapolated costs and benefits to the pastoral industry at the territory level has been provided.

4.2 Rate of spread

The rate of uncontrolled weed spread is key to estimate the value of control. In Queensland the rate of spread was increased by deliberate plantings for shade and fodder when first introduced. In particular these plantings occurred along flowing bore drainage lines which proved to be ideal habitat for prickly acacia. In comparison, prickly acacia was inadvertently introduced into the NT and there are far fewer permanent surface water sources.

Based on available data the unmitigated rate of spread of prickly acacia in the NT is a function of:

- Size and location of initial incursion
- Climate
- Time to maturity
- Seed production, dispersion, germination, and survival
- Topography
- Soil
- Livestock
- Human-induced spread (e.g. on machinery)

Studies in Queensland have shown that a mature tree can produce up to 175,000 seeds in a single year. However, the number of years to reach this level of production, the germination rates of these seeds and the area over which they are likely to disperse is not well understood. Developing a model which accurately includes the interactions between each of these factors would require much greater data collection plus expertise in plant biology and ecology (Wiles 2004).

Alternatively, if data is available on the area of infestation in two time periods and the likely maximum infestation area, a logistic model of growth can be assumed in the form

$$A_t = \frac{A_0 A_{max}}{A_0 + (A_{max} - A_0)e^{-rt}}$$

Equation 1 (Bourdôt et al. 2015)

Solving for *r* gives the estimated growth rate.

$$r = \frac{-1}{t} \times ln\left(\frac{A_0(A_{max} - A_t)}{A_t(A_{max} - A_0)}\right)$$

Equation 2

A_0 is the area infested in year 0
A_t is the area infested in year *t*
A_{max} is the maximum potential area of infestation
The logistic model is a commonly accepted model for population growth in both plant and animal species (Bourdôt et al. 2015). The advantage of this model is that it is based on actual areas of infestation however it is reliant on the accuracy of the area measurements and the assumption that no control was applied between the two periods.

A third possible method is to estimate the rate of spread based on an expected germination rate of seedlings. This method was used by McLean (2015) to estimate the savings from early control of prickly acacia in Queensland. The assumption used in this analysis was that a maximum of 20% of seedlings would reach maturity on the open downs with up to 50% reaching maturing in riparian areas. This difference reflects a study by Radford et al (2001) which found two distinct patterns of dispersion for riparian and non-riparian areas. This method produces an estimate of the number of plants however does not produce an estimate of the total area infested nor the density, both of which affect the production cost of infestation and the cost of control.

Given that the majority of prickly acacia in the NT has been found in isolated patches rather than concentrated thickets in riparian areas and the available data is measured in square metres rather than number of individual plants, the logistic model has been chosen as the preferred method.

As the available data set does not have consistent records for the same location each year, it was split into individual properties and a growth rate calculated for each one. The data for each property was analysed to identify a time period in which no treatment was done. For some properties there was more than one period available, hence more than one *'r'* was calculated. The maximum potential area of infestation (A_{max}) was assumed to be the whole property.

The calculated *r* values were then compared to estimates from land managers and weeds officers to check validity.

4.3 Rate of eradication

The rate at which prickly acacia can be eradicated will depend entirely on the level of investment by individual property managers. Control efforts to date have included a mix of government projects including funding and supply of labour and individual property investment. To evaluate the success of eradication efforts to date the data was analysed (again at the property level) to identify time periods in which treatment had occurred. The percentage of area infested in the year following treatment was calculated.

Across the Barkly records it was found that in years when at least 95% of known sites were treated, an average of 82% eradication was achieved by the following year. To account for data errors this was revised down to a more conservative estimate of 75%. For the VRD it is much more difficult to calculate a rate of eradication as much of the data includes new sites which had not been identified in previous years when treatment was conducted. As a conservative estimate, based on Mt Sanford which has the most consistent records, it is expected that a minimum of 42% of the area could be eradicated each year with a well-managed treatment plan. The lower rate for the VRD is primarily due to the topography of this area which includes sharp, rocky hills and many small creeks and springs which make ideal habitat for prickly acacia but are difficult to access.

4.4 Treatment costs

There are two main options for treating prickly acacia; basal bark spraying with a mixture of Access® and diesel or aerial application of tebuthiuron pellets. On the Barkly due to the large areas but relatively easy access treatment has generally involved aerial survey of prickly acacia populations followed by basal bark spraying by a ground crew on ATVs or foot. In Queensland the cost of chemical for basal bark spraying was estimated at $2.20 per tree. The cost of labour is dependent on the density of plants and the travel time between sites.

For the case studies the costs of treatment were estimated based on treatment records from the case study properties. Chemical costs were taken from recent quotes and labour costs based on typical unskilled labour award wages. Full details of the costs are shown in the case study sections.

4.5 Production impacts

The production impacts of dense prickly acacia have been well demonstrated in Queensland. In one report it was estimated that when there is just 25% canopy cover from prickly acacia that there can be up to a 50% reduction in pasture (Mackey 1996). At 50% canopy cover there was a complete loss of productive pasture (Mackey 1996). A more recent study estimated that if there were just 650 plants per hectare (1 plant per $15m^2$) that there would be a 50% loss of pasture (Gutteridge and Shelton 2005).

The average carrying capacity of prickly acacia prone land systems on the Barkly Tableland 0.9 Adult Equivalents (AE) per square kilometre on southern red soils up to 8.25AE per square kilometre on Mitchell grasslands, assuming land is in 'A' condition (Pettit 2011a). In the VRD the range is from 1.25 $AEkm^{-2}$ on red soils right up to 17.75$AEkm^{-2}$ on basalt areas (Pettit 2011b). For both case studies it was assumed that at density 1-2 there would be no impact on carrying capacity, at density 3 carrying capacity would be reduced by 10%, at density 4 by 25% and at density 5 by 50%. The proportion of total infestation at each density level is provided in the case study assumptions.

The average gross margin for each region is estimated at $145/AE (Barkly) and $130/AE (VRD) (Chudleigh 2017).

It is also estimated that heavy infestations of prickly acacia could increase mustering time and costs by up to twice the normal rate.

Other costs which have been noted in Queensland such as personal injuries and damage to vehicle tyres have not been noted as a significant problem in the NT hence they are not included.

4.6 Asset values

The effect of prickly acacia on the capital asset value of pastoral properties in the NT has not been tested by the market. Even in Queensland, where prickly acacia is far more widespread and the production impacts have been well documented, there does not appear to have been a consistent discount factor applied to properties with prickly acacia (Rowley 2017). Thus, for the purposes of this analysis the costs of prickly acacia are limited to the costs of control and the reduction in carrying capacity.

5 Results

Consultation with property managers dealing with prickly acacia produced a range of estimates regarding the potential rate of spread if treatment did not occur. On the Barkly properties it was estimated that it would take at least 5 years for serious productivity impacts to occur while in the VRD estimates ranged from a potential doubling of area following a good wet season to similar estimates as the Barkly.

Using the logistic model described in Equation 2 the following potential infestation paths were identified.

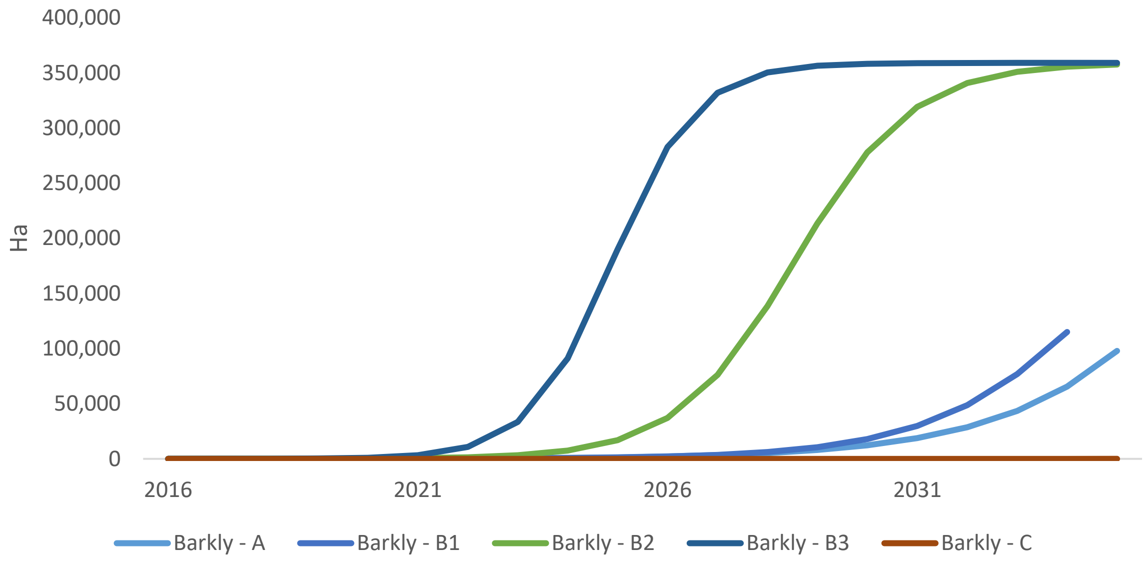

Figure 6 Barkly potential infestation rates

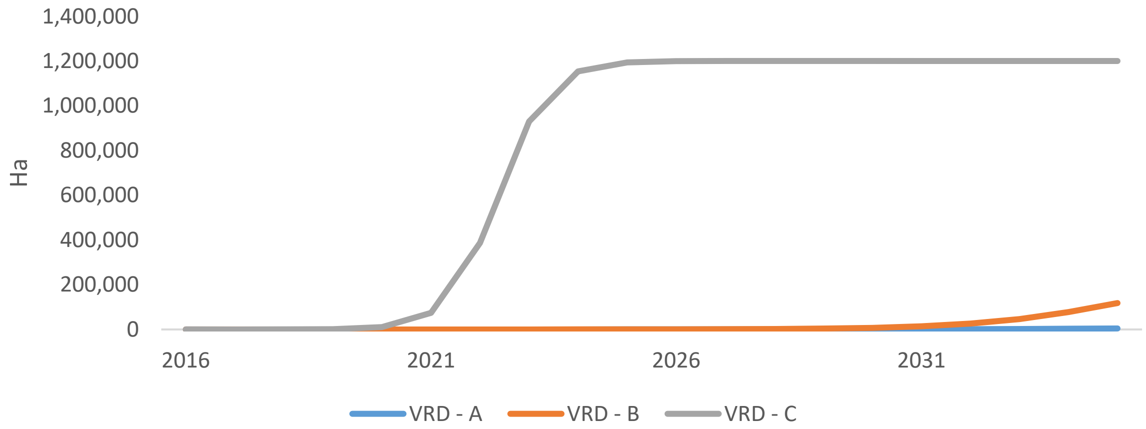

Figure 7 VRD potential infestation rates

As shown in the graphs above there is significant variation in the potential spread rates and using the logistic model complete infestation could occur in a relatively short period of time. To check the model the annual percentage increase in area for each of the periods in which no treatment had been recorded was calculated.

The results of this calculation (see Table 1) show that the average annual increase when no treatment occurs is over 200%, that is the area would at least double each year if no treatment occurred.

Table 1 Recorded spread rates of prickly acacia in the Northern Territory

Property	Start Year	End Year	% change
Barkly - A	2000	2016	120%
Barkly - B1	2006	2008	73%
Barkly - B2	2012	2014	133%
Barkly - B3	2000	2005	166%
Barkly - C	1984	2005	25%
VRD - A	2000	2012	209%
VRD - B	2000	2009	274%
VRD - C	2003	2005	623%
		Average	203%

6 Case studies

6.1 Barkly Tablelands

Prickly acacia has been identified on a number of properties across the Barkly Tablelands. It is unknown exactly when or how it was introduced into the Northern Territory but known introductions have occurred since 2000. Almost 1000 data points noting the location, density, and treatment (if any) of prickly acacia have been recorded across the Barkly.

Unlike western Queensland, the Barkly Tableland does not have flowing bores which provide a year-round supply of flowing water which has likely helped to slow the spread of prickly acacia and restrict the main vector to cattle manure. Based on the mapped data points and on ground observations the majority of infestations occur around artificial water points where cattle have camped for extended periods of time and along semi-permanent creeks. There are distinct patterns of radial spread along cattle pads out from water points and denser patches in shallow depressions which hold water for longer periods of time. At one such location a single mature plant had been left untreated as it was under water at the time of treatment. Within one year this plant was estimated to have produced over 150 seedlings and the 6 treated mature trees in the area had also produced at least 60 seedlings each.

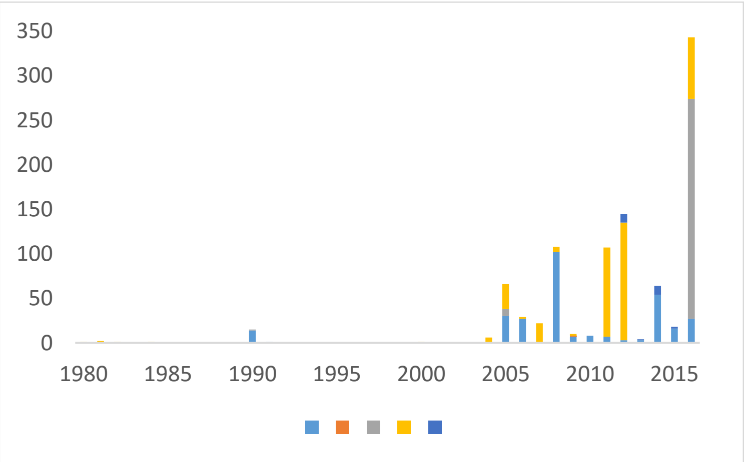

Figure 8 Prickly acacia on the Barkly Tableland - number of identified locations and treatments

6.1.1 Barkly case study

The Barkly case study is based on the successful treatment of prickly acacia on Walhallow Station. The property was purchased by new owners in late 2015 who immediately commenced an extensive development program including full weed assessment and control. The objective of their weed management program is to eradicate prickly acacia. In 2016 a full survey of prickly acacia across Walhallow was undertaken with a total of 274 individual GPS data points mapped. The major infestation is centred on a water point which is also adjacent to a set of yards. In the immediate vicinity of the water trough and gate the prickly acacia was rated a density of 4 out of 5.

In 2017 a total of approximately 5,200 hectares was treated which equated to approximately 3,000 individual plants. Treatment took a total of 13 person days and used a total of 5.1 litres of Access®. The resources used for the 2017 treatment were used as the basis for the costs benefit analysis. Full details of the assumptions used are detailed in Table 2.

Table 2 Barkly case study assumptions

Variable	Value		Source/Justification
Area Yr. 1 (2017)	5,200 hectares		Rangelands officer
No. Plants Yr. 1 (2017)	3,000		Rangelands officer
Density	D2: 70% D3: 20%	D4: 5% D5 5%	Average of density recordings across Barkly (Weeds Dept. database)
Annual reduction in area infested (corresponds to annual reduction in chemical and labour costs)	75%		Average annual reduction across Barkly is 82% (Weeds Dept. database). Reduced to 75% to account for margin of error.
Minimum costs	1 hour survey + 1 hour labour + 1ha worth of chemical		Expectation that total eradication almost impossible to achieve and ongoing monitoring will be required.
Access®	5.1L @ $380/5L		Rangelands officer
Diesel	300L @ $1.5/L		Rangelands officer
Tebuthiuron pellets	60kg @ $350/20kg		Rangelands officer
Helicopter survey	3 hours @ $420/hour		Rangelands officer
Labour	13 days x 10hrs/day @ $20/hr		Rangelands officer + award wage
Carrying capacity (AE/km^2)	D2: 17 D3: 90%	D4: 75% D5: 50%	Base rate based on current stocking rates provided by property manager. Reduction in carrying capacity estimated based on observations and QLD data
Penalties for non-compliance with weeds act	385-3850 penalty units @ $154ppu.		Territory Revenue Office
Length of analysis	20 years		Standard analysis period for benefit cost
Discount rate	7%		Conservative estimate of long term interest rates.

6.1.2 Barkly Results

The analysis was based on the 5,200 hectares currently infested and compares the costs of treating this area, the current and potential carrying capacity if treated against the reduced carrying capacity, higher treatment costs and penalties incurred if treatment is delayed.

Figure 9 below shows the potential area of infestation if eradication treatment was not conducted and Figure 10 shows the corresponding carrying capacity in total Adult Equivalents.

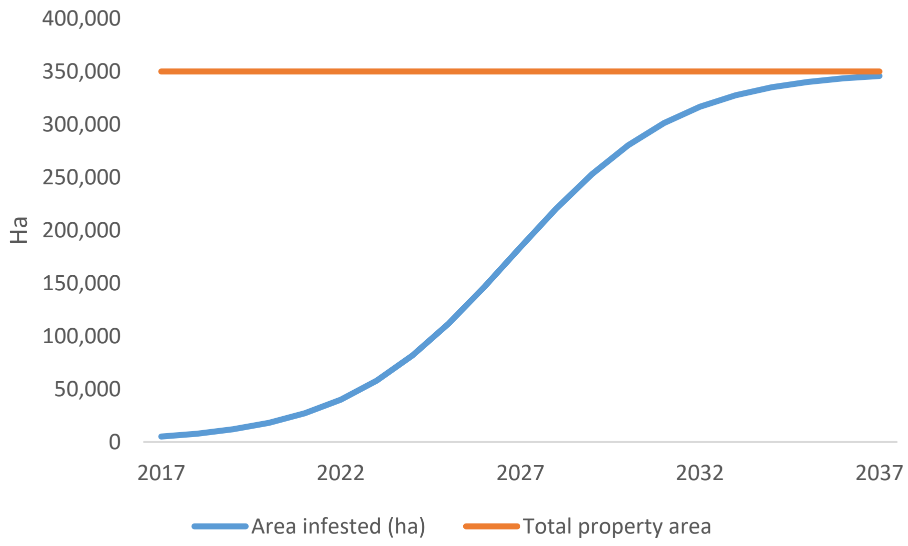

Figure 9 Barkly case study potential rate of spread

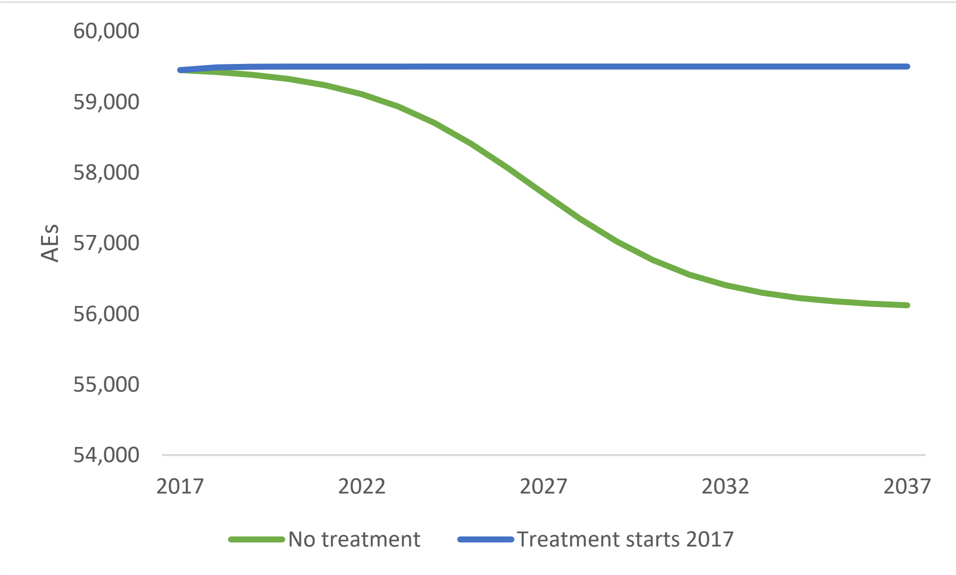

Figure 10 Barkly Total number of AEs

Based on this expected rate of spread if eradication treatments are delayed the chemical and labour costs of control will increase. The NT DENR has also indicated their strong ability and intention to impose enforcement activity on landholders who do not comply with Prickly Acacia weed management regulations. The net cash flows of treatment options including the maximum allowable fine (3,850 penalty units) are shown below. The direct impact of the penalties is shown in the lower starting cashflow for the delayed treatments compared to commencing control immediately. With delayed treatment the spread of prickly acacia will also gradually reduce the carrying capacity of the property, thus future cash inflows are reduced. The net cashflow reaches a minimum in the year that treatment commences. Assuming that treatment continues as long as necessary to achieve eradication, cash inflows will gradually increase as carrying capacity is restored.

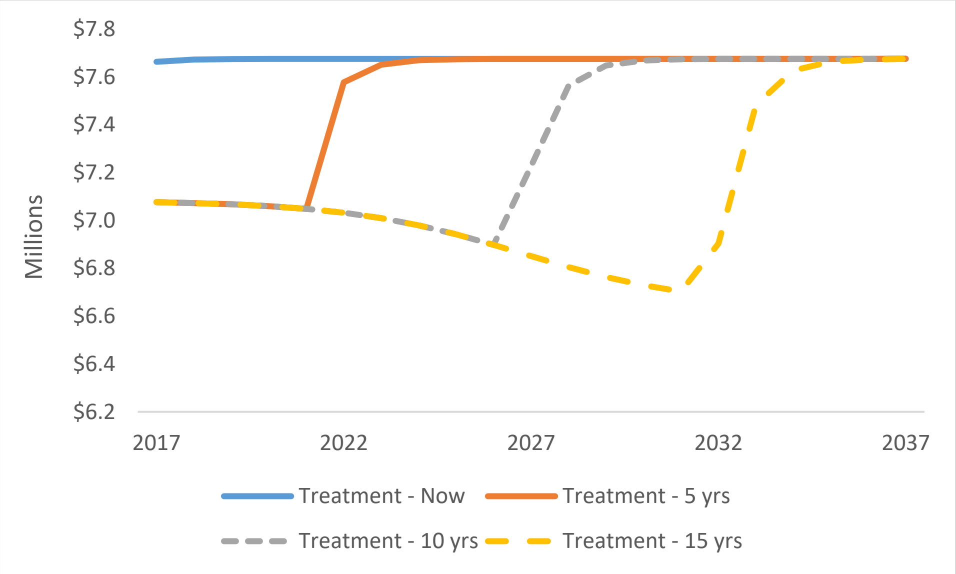

Figure 11 Barkly case study cashflow under different treatments

Using discounted cashflow analysis the costs and benefits over 20 years were calculated in NPV terms. The results show that even if there is no fine applied, starting the eradication treatment sooner rather than later produces an overall higher return.

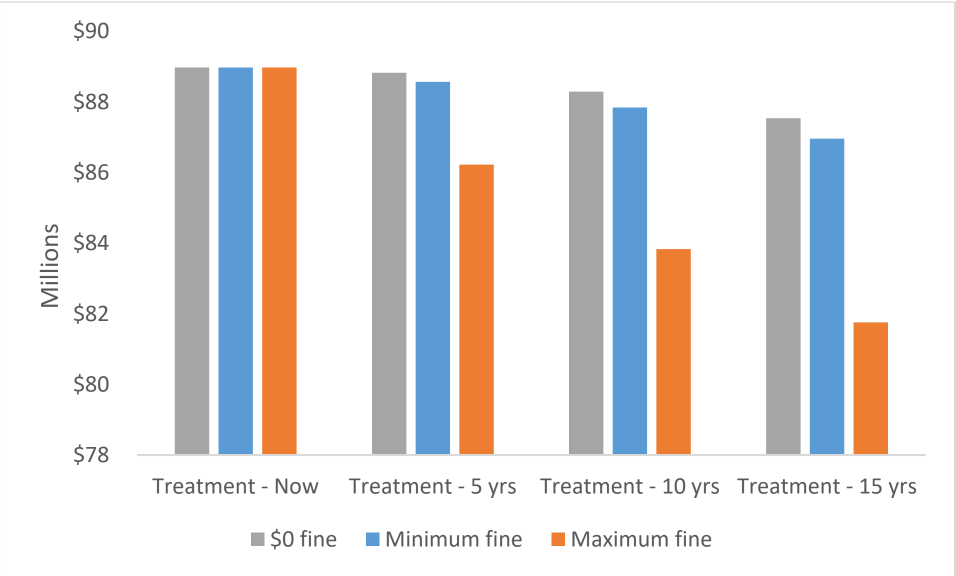

Figure 12 Barkly case study Net Present Values

6.2 Victoria River District

6.2.1 VRD case study

Prickly acacia was first noted at Mt Sanford in 2000 and there have been consistent efforts to identify and control it since.

As a result of this effort the prickly acacia infestation has been reduced to approximately 20 sites over approximately 30-40km^2. In 2017 it took 4 people 2 days to conduct a survey of the known and any possible sites. This was followed up by 5 hours of helicopter work to spread tebuthiuron pellets. Previous control had taken a full week with a crew of 5 on quadbikes. When the helicopter was first brought in it took approximately 12 hours to cover the infested area. The main challenge on Mt Sanford now is that the weed is located in very hard to access areas which are not regularly monitored from the ground. As a result, all helicopter mustering pilots are provided with a container of tebuthiuron pellets on every muster and asked to treat any plants on sight. This requires that pilots are well trained to identify and accurately treat the prickly acacia.

Further control efforts have been implemented by managing the stock which use the paddocks infested with prickly acacia. These are currently used as terminal paddocks for cows which are weaning a final calf before being culled. So long as proper quarantine of the weaners is practiced and fences are maintained this will assist in reducing the risk of spread to other areas of the property.

While the level of infestation has never reached a point of reducing pasture and therefore carrying capacity, due to the terrain it had contributed to making mustering more difficult. As a result of controlling the prickly acacia in these paddocks it is estimated that mustering time has been reduced and the likelihood of a ‘clean’ muster has been increased.

As for the Barkly case study the analysis was conducted on the basis of treating the currently known area using the costs and resources required for the 2017 treatment round as a base. The assumptions made are shown in Table 3.

Table 3 VRD case study assumptions

Variable	Value		Source/Justification
Area Yr. 1 (2017)	3,500 hectares		Property manager
No. sites Yr. 1 (2017)	20		Property manager
Density	D2: 67% D3: 23%	D4: 9% D5 1%	Average of density recordings across VRD (Weeds Dept. database)
Annual reduction in area infested (corresponds to annual reduction in chemical and labour costs)	40%		Average annual reduction across VRD
Minimum costs	1 hour helicopter survey + 1ha worth of pellets (assumed weighted average of density)		Expectation that total eradication almost impossible to achieve and ongoing monitoring will be required.
Tebuthiuron pellets	400kg @ $350/20kg		Rangelands officer/Property manager

Helicopter	5 hours @ $420/hour		Property manager
Labour (ground survey)	8 days x 10hrs/day @ $20/hr		Property manager + award wage
Carrying capacity (AE/km^2)	D2: 10 D3: 90%	D4: 75% D5: 50%	Current stocking rate provided by property manager Reduction in carrying capacity estimated based on observations and QLD data
Penalties for non-compliance with weeds act	385-3850 penalty units @ $154ppu.		Territory Revenue Office
Length of analysis	20 years		Standard analysis period for benefit cost
Discount rate	7%		Conservative estimate of long term interest rates.

6.2.2 VRD results

The analysis was based on the 3,500 hectares currently infested and compares the costs of treating this area, the current and potential carrying capacity if treated against the reduced carrying capacity, higher treatment costs and penalties incurred if treatment is delayed.

Figure 13 below shows the potential area of infestation if eradication treatment was not conducted and Figure 14 shows the corresponding carrying capacity in terms of Adult Equivalents (AEs).

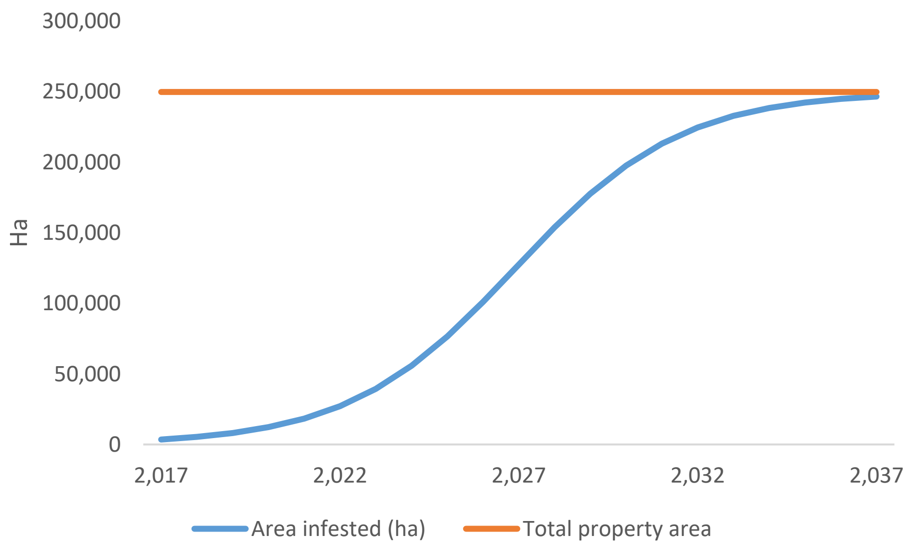

Figure 13 VRD case study potential infested area

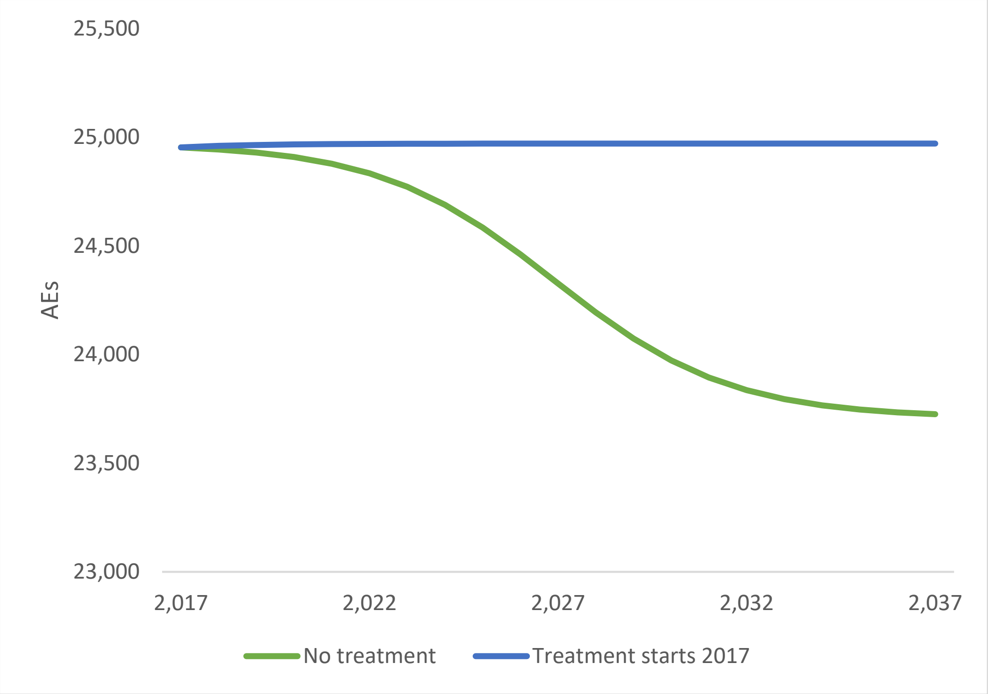

Figure 14 VRD Total AEs

As for the Barkly case study the net cash flows over time depending on start time of treatment and the NPV of each scenario are shown below. Again, even if penalties are not imposed the total net discounted cash flows are highest if treatment begins as soon as possible.

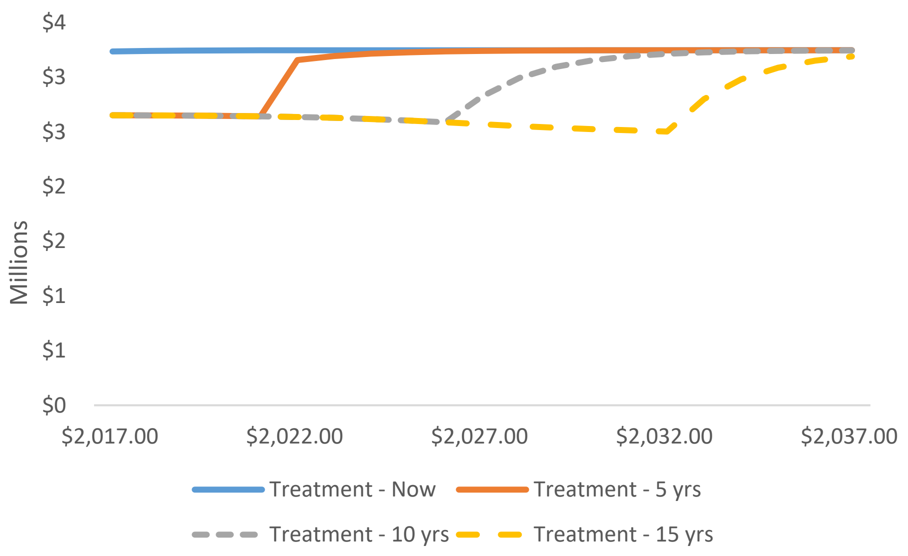

Figure 15 VRD case study cashflows

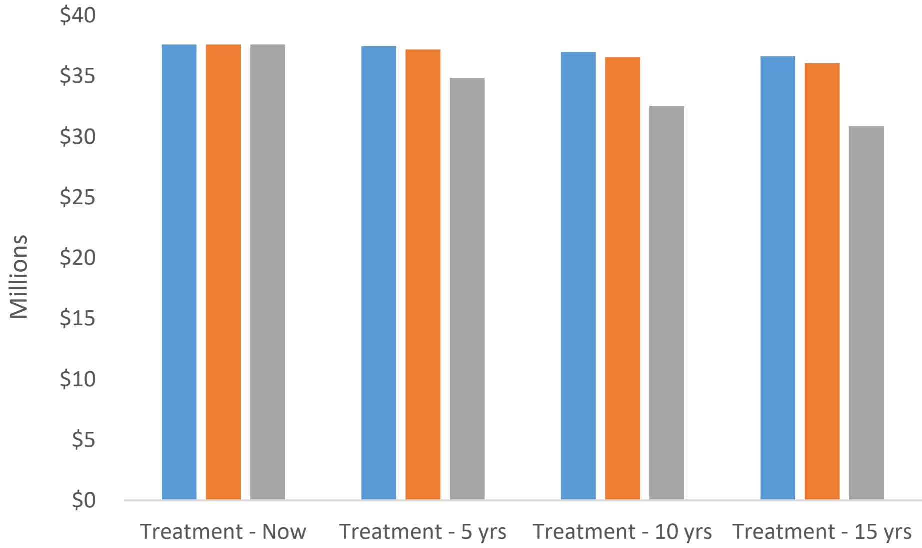

Figure 16 VRD Case study NPV

6.2.3 Sensitivity Analysis

As discussed in the methodology a number of assumptions had to be made regarding the values of many variables in this analysis. To check the robustness of these assumptions sensitivity analysis on growth rate, corresponding carrying capacity, livestock gross margin and cost of control were conducted.

For the both case studies, even if the chemical and labour costs of treatment were five times higher than the base assumptions it is still better to commence treatment immediately. These sensitivity analyses were conducted on the basis that no fine were imposed. If penalties were imposed it would simply exaggerate these results further.

The only scenario in which delaying treatment produces a higher NPV is if no penalties are imposed and the rate of spread of prickly acacia was only 40% of the base assumption in the Barkly and 60% of the base rate for the VRD.

7 Decision tool for producers

The case studies demonstrate the potential for prickly acacia to have a significant negative effect on production and environmental values of the Northern Territory. However, by necessity the case studies were based on a mix of available data and assumptions regarding productivity and weed spread variables. In particular, the expected spread rate and impact on production are likely to vary widely based on landtype, topography, climate and weather patterns, current land condition and land management. As a result, it is useful for land managers to be able to conduct their own analysis based on variables relevant to a particular infestation or property area. To assist in this an excel based decision support tool has been developed. The tool includes default values, by region, for all variables including expected spread rate, density, costs of control, carrying capacity, gross margin, and rate of control. Users can override these default values based on their own estimates or records to improve the accuracy of the analysis. The tool includes a full set of instructions and has been ‘locked’ so that formulas cannot be inadvertently changed.

For copies of the decision support tool please contact the NT Department of Environment and Natural Resources.

8 Conclusions and Recommendations

Analysis of the available data on the extent and spread of prickly acacia in the Northern Territory shows that without careful management the costs of this weed could become significant within a very short space of time.

Case studies on the Barkly and VRD show that while infestations remain relatively small that eradication can be achieved at a relatively low cost. While small, low density infestations do not cause significant productivity losses, the analysis shows that it is far more cost effective to treat these infestations while they are small than to allow them to reach a point at which they do impact productivity.

Based on this analysis it is recommended that all land managers who have prickly acacia on their properties conduct a full survey to measure the current extent and estimate the potential impact on productivity. The companion decision support tool to this report can then be used to review options for treatment and identify the most cost-effective path to eradication.

Publication bibliography

Bourdôt, G.; Basse, B. et al. (2015): Cost-benefit analysis blueprint for regional weed management. Nassella neesiana (Chilean needle grass) as a case study. In *New Zealand Journal of Agricultural Research* 58 (3), pp. 325–338. DOI: 10.1080/00288233.2015.1037460.

Chudleigh, Fred (2017): Improving the performance of beef enterprises in northern Australia. State of Queensland.

Department of Environment and Natural Resources: Weed Data Collection. A field guide for collecting weed data for the NT. Northern Territory Government.

Department of Environment and Natural Resources (2017): Prickly Acacia database: Northern Territory Government.

Desert Channels Queensland (2016): Listening, researching, innovating, implementing: three Years of Unprecedented Success. DCQ Prickly Acacia Eradication Program - 2013-2016. Available online at http://dcq.org.au/wp-content/uploads/2016/11/Three-Years-of-Unprecedented-Success.pdf, checked on 8/3/2017.

Mackey, A.P (1996): Prickly acacia in Queensland. Department of Natural Resources and Mines (Pest status review series, Land Protection Branch). Available online at http://www.southwestnrm.org.au/sites/default/files/uploads/ihub/mackey-ap-ed-1996-prickly-acacia-acacia-nilotica-queensland.pdf, checked on 8/3/2017.

McLean, Ian (Ed.) (2015): The economics of Prickly Acacia control. Queensland Weed Symposium. Longreach.

Pettit, Caroline (2011a): Barkly District - Land Condition Guide. Northern Territory Government.

Pettit, Caroline (2011b): Victoria River District - Land condition guide. Northern Territory Government.

Radford, Ian J.; Nicholas, D. Michael et al. (2001): Paddock-scale patterns of seed production and dispersal in the invasive shrub Acacia nilotica (Mimosaceae) in northern Australian rangelands. In *Austral Ecology* 26 (4), pp. 338–348. DOI: 10.1046/j.1442-9993.2001.01119.x.

Rowley, Linda (2017): Weekly Property Review. A prickly subject for future cattle land values. In *Beef Central*, 3/8/2017. Available online at https://www.beefcentral.com/property/weekly-property-review-a-prickly-subject-for-future-cattle-property-values/.

Wiggins, Simon (2016): Road-to-Eradication QLD DC.

Wiles, L. (2004): Economics of Weed Management: Principles and Practices. In *Weed Technology* 18, pp. 1403–1407. Available online at https://www.jstor.org/stable/3989660?seq=5#page_scan_tab_contents, checked on 10/10/2017.