final report

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Impact of fluoroacetate toxicity in grazing cattle

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Executive summary

This project was undertaken to investigate the production and economic impacts of fluoroacetate toxicity in grazing cattle in affected regions of Australia

Objectives

The project objectives are to quantify the production and economic impacts of fluoroacetate toxicity in grazing cattle including:

- Direct production losses including cattle mortalities;
- Direct management costs;
- Opportunity costs associated with management conducted to prevent toxicity;
- Geographic location; and
- Numbers of livestock affected.

Methods

The project was conducted through participatory and literature research and involved a process of literary review, engagement with landholders and others involved in the cattle industry throughout Australia, conduct of field visits and data analysis..

The project team identified potentially affected regions, selected properties within these regions and conducted two surveys on selected properties to collect information from affected and non-affected landholders. Discussions were held with affected landholders, government and industry advisors and researchers and specialist toxicologists. Case studies were selected following the conduct of surveys and these properties were visited and data collected to form case studies.

Data collected from the surveys and the case studies were utilised in statistical and economic analysis to quantify the impact of fluoroacetate toxicity in the affected regions.

The livestock production and management results presented in the report are based on information supplied by affected landholders through the survey process and through property visits and discussions.

Results

Survey findings suggest that in each of the three regions, a substantial proportion of cattle producers indicate that they are affected by fluoroacetate containing plants and that fluoroacetate toxicity is perceived to be an important cause of a range of adverse impacts.

The impact of fluoroacetate toxicity has real economic consequences in the Desert Uplands and North Queensland regions of Queensland and the Georgina Basin in Queensland and the Northern Territory. Toxicity in these areas is caused by two different plants – *Gastrolobium grandiflorum* (Heartleaf Poison Bush) in the Desert Uplands and North Queensland and *Acacia georginae* (Georgina Gidgee) in the Georgina Basin.

Increased mortality rates and reduced stocking rates are the most consistent and immediate impacts of fluoroacetate toxicity. Restrictions on management options including mustering and selling times, costs of management strategies and reductions in productivity also contribute to production and economic impacts.

The issues associated with fluoracetate toxicity are quite different in the different regions. In the regions affected by *Gastrolobium* (Desert Uplands and North Queensland) the landholder responses indicate that the problem presents impacts typically associated with a poisonous plant, (increased mortality rates, and productivity losses) albeit with rather unpredictable consequences. *Acacia georgina* as well as being a poisonous plant is also described by landholders as an important source of high quality nutrition and this results in a more complicated set of circumstances.

All affected producers surveyed reported making management changes and adaptations as a result of the toxicity problems and a number of producers reported that parts of their properties are unused due to the presence of fluoroacetate containing plants.

It is estimated that Fluoroacetate toxicity has the potential to affect approximately 2.9% of the Australian herd and currently costs the industry approximately $45 million annually due to increased death rates and associated productivity impacts.

The impacts locally are highly significant with stock losses of over 20% recorded on individual properties and the potential for increased productivity reaching levels of 70 to 100%. The impact of an ongoing high mortality rate in all affected areas has economic, social, welfare and emotional impacts on the landholders, livestock managers and on the livestock.

Recommendations

1. It is recommended that identification, documentation, communication and implementation of regionally implemented best management practices be conducted as an interactive process with affected landholders.

2. It is recommended that Research leading to a better understanding of the method of poisoning and the relationship between the plant and the animals be supported.

3. The development and communication of a post mortem methodology and a key to identifying post mortem characteristics of fluoroacetate poisoning.

4. It is recommended that research is continued in the process of developing or discovering a rumen micro-organism which will detoxify fluoroacetate in the rumen and to examine the feasibility of the use of intra ruminal detoxification.

Acknowledgements

The LPM team would like to gratefully acknowledge the support and assistance of the producers in all regions involved in this study. Producers completed surveys, attended meetings, welcomed team members to their homes and showed them around their country, all gladly and with a very co-operative spirit. This helped to make the conduct of this project a pleasure for all involved.

LPM team members also acknowledge the willing input and assistance of a wide range of researchers, extension officers, botanists and livestock disease specialists. The fluoroacetate problem involves a large area throughout Queensland, the Northern Territory and Western Australia and assistance has been received from people in all these areas.

The initiative of MLA in committing resources to this project and to the affected cattle industry is gratefully acknowledged.

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1 Introduction

1.1 Background

This report presents the result of a project aimed at establishing the production losses, direct management costs and opportunity costs associated with fluoroacetate toxicity in grazing cattle in Australia. The project, which is funded by MLA involves a survey of producers affected by fluoroacetate poisoning in Qld, NT and WA, the analysis of data collected and presentation of results and recommendations for further action.

Fluoroacetate toxicity causes production and economic losses in a number of cattle producing regions in Queensland and the Northern Territory. Generally it is caused by ingestion of *Gastrolobium* species and some Acacia species, e.g. Georgina Gidgee.

Fluoroacetate occurs naturally in a number of plants which occur throughout Queensland, the Northern Territory and parts of Western Australia. About 40 species of endemic Australian plants produce fluoroacetate. Most are *Gastrolobium* species and there is at least one Acacia species which produces fluoroacetate (Chandler 2002). Toxicity occurs in some of these areas following the ingestion of *Gastrolobium* species and Georgina Gidgee (*Acacia georginae*). Losses were first reported in South West Western Australia in the late 1830's and 1840's (Chandler 2002), in the ranges east of Barcaldine in the 1860's (Towner 1962) and in the Georgina region soon after it was first stocked in the 1880's (Bell, Newton et al. 1955) (Barnes 1958). Losses are still reported in these regions and landowners and cattle managers have developed a range of strategies aimed at avoiding losses due to fluoroacetate toxicity.

Generally problems associated with toxicity are experienced in regions of Australia where cattle are managed extensively over large areas. The economic impact of fluoroacetate toxicity is caused by stock losses, altered management regimes, control and eradication of the plant and the reduction of grazing capacity in much of the affected country. A detailed assessment of the losses and economic impact of fluoroacetate toxicity has not been conducted to date. This project aims to provide an accurate assessment of the management and economic impacts of fluoroacetate in the regions in which it is recognised as a problem.

1.2 Project objectives

The project objectives as described in the project proposal were to quantify the production and economic impacts of fluoroacetate toxicity in grazing cattle including:

- Direct production losses including cattle mortalities;
- Direct management costs;
- Opportunity costs associated with management conducted to prevent toxicity;
- Geographic location; and
- Numbers of livestock affected.

2 Literature review

2.1 Introduction

Monofluoroacetate compounds were developed as potential rodenticides in the 1930s and 40s. Research in the USA in the early 1940s involved assessment of a number of candidate compounds, driven in part by war-time restrictions on other poisons that had been used previously for rodent control. Sodium monofluoroacetate was one of these compounds and had been assigned the laboratory acquisition number 1080 in early tests (Atzert 1971).

At around the same time independent research in South Africa identified sodium fluoroacetate as the main toxic component in a South African poisonous plant – gifblaar (poison leaf; *Dichapetalum cymosum*) in the 1940s (Marais 1944). Monofluoroacetic acid has since been reported as a toxic component in several plants in Australia, Africa and Brazil. A number of additional plants have been demonstrated to produce sodium monofluoroacetate in the presence of high levels of inorganic fluoride.

Sodium monofluoroacetate is a white, odourless and water-soluble compound that is described as tasteless or with a mild, salty or vinegar like taste (Atzert 1971). It is readily absorbed through the gastrointestinal tract or respiratory system or through mucous membranes and skin wounds or abrasions. It is not readily absorbed through intact skin.

1080 has been used around the world as a poison for control of wildlife pests since the 1940s and 50s and in Australia and New Zealand since the 1950s and 60s.

Synthetic 1080 produced for use in toxic baits has been shown to be chemically and toxicologically identical to the sodium fluoroacetate discovered in poisonous plants (Eason 2002).

A variety of different names are used to refer to the ingredient in 1080 including: sodium fluoroacetate, sodium monofluoroacetate, fluoroacetate, monofluoroacetate and compound 1080.

2.2 Brief review of 1080

Sodium fluoroacetate (1080) is widely used as a pest control agent in Australia and New Zealand. It is commonly applied in meat or offal baits (dingoes, wild dogs, foxes), or in a range of grains or vegetables (rabbits and pigs).

2.2.1 What does 1080 do at the cellular level

Once absorbed, sodium fluoroacetate is metabolized in cells to form fluorocitrate (also called fluorocitric acid).

Fluorocitrate inhibits the normal activity of the Kreb’s cycle. There is some debate over the precise mechanisms of action for fluorocitrate but it appears to inhibit the activity of aconitase hydratase and also to inhibit citrate transport, two steps that are vital to normal processes within the Kreb’s cycle within mitochondria (Eason, Miller et al. 2011).

The Kreb’s cycle is a series of chemical reactions used by all cells to generate ATP (adenosine triphosphate). ATP is one of the major sources of energy within cells and the energy released when ATP is metabolized is the major driver of most of the energy-consuming reactions in cells including things such as formation of other compounds, transmission of nerve impulses and muscle contractions.

Fluorocitrate interrupts the Kreb's cycle and causes elevation of citrate (or citric acid) and reduction in ATP. The effect is to disrupt the ability of cells to generate or replenish energy through the Kreb's cycle.

2.2.2 Clinical signs

Symptoms of 1080 poisoning appear within 0.5-3 hours of ingestion of poison. There is considerable species variation in susceptibility to 1080 and in typical signs shown by poisoned animals (Eason, Miller et al. 2011).

Dogs and other carnivores and rodents and many wildlife species are highly susceptible. Mammalian herbivores have intermediate sensitivity, birds and reptiles have increasing resistance and fish are generally more resistant.

There is limited evidence to suggest that pregnancy may make ewes more susceptible to 1080 poisoning, perhaps due to increased bioavailability in pregnancy resulting in higher serum 1080 levels (O'Connor, Milne et al. 1999).

The main target organs are the central nervous system (CNS), cardiovascular system and respiratory system. Signs appear as soon as 30 minutes after poisoning and are maximal by 4 hours. Nervous signs include tremors and hallucinations, convulsions and respiratory depression. Cardiac signs include arrhythmias, ventricular fibrillation and cardiac arrest.

In general the types of signs shown are associated with species of animals. Carnivores (dogs) show primarily CNS signs including convulsions and running movements with death due to respiratory failure. Herbivores (rabbit, goat, sheep, cattle, horse) show primarily cardiac effects with ventricular fibrillation and little or no CNS signs.

Signs reported in sheep experimentally administered lethal doses of 1080 included excessive salivation, lethargy, tachypnea, dyspnea, tremors and muscle spasms, coma and terminal tonic convulsions (Gooneratne, Eason et al. 1008). Clinical signs were generally mild until the final 15-20 minutes of life when dying animals showed spasms progressing to seizures and coma. Animals that recovered tended to show salivation, tachypnoea and lethargy.

Omnivores (cat, pig) may show both CNS and cardiac signs.

Severity of clinical signs is dose related. Animals that ingest (or receive) a sub-lethal dose will show variable clinical signs and will progressively recover. Sub-lethal doses are metabolised and excreted within a few days. Fluoroacetate residues are found mainly in the blood, muscle, heart and kidneys, with lower residues in the liver. Metabolism occurs in the liver and metabolites are excreted in urine. All traces of the poison are eliminated with a week or so of administration of a sub-lethal dose.

2.2.3 Secondary toxicity

Toxic compounds (fluoroacetate and fluorocitrate) can persist for some time in the carcass of animals that have died from 1080 poisoning and as a result secondary poisoning may be possible in animals that eat the carcass of a poisoned animal. However, fluoroacetate is rapidly eliminated from animals after ingestion so secondary toxicity would require a relatively high dose in the first instance (Eason, Gooneratne et al. 1994). There is little evidence for any risk of accumulation of fluoroacetate in soil over time because soil bacteria defluorinate the compound over time and render it non-toxic (Weinstein and Davison 2004; Eason, Miller et al. 2011).

2.2.4 Chronic effects

There are suggestions that more prolonged sub-lethal exposure may have some potential for longer term effects but these suggestions appear to be based on work in other species and may not be confirmed or may not be relevant for cattle. Caution is therefore required in interpreting such suggestions.

Malformed foetuses have been described following administration of sub-lethal doses of 1080 to pregnant rats (Eason, Wickstrom et al. 1999).

In addition cardiomyopathy and testicular degeneration have also been described in rats and mink receiving long term sub-lethal doses of 1080 (Savarie 1984, Eason and Turck 2002). No evidence of recovery of testicular function was observed in male rats followed for up to 56 days after cessation of 1080 administration(Eason and Turck 2002) but earlier studies had described complete recovery from 1080-induced testicular degeneration in male rats after a 165-day recovery period (Mazzanti, Lopez et al. 1968).

Histopathologic changes have been described in cardiac tissue of sheep and in testes, brain and kidneys of rats following lethal 1080 poisoning (Gooneratne, Eason et al. 1008). Ewes receiving a sub-lethal single dose of 1080 were followed for two years and showed no evidence of any adverse effects on general health or reproductive performance.

There were some scattered foci of myocardial fibrosis in sheep that were necropsied at the end of the experiment and some evidence of small focal neuronal degeneration in brain tissue. These findings may have been associated with prior exposure to 1080 but the clinical significance is uncertain given the general lack of any appreciable adverse effect on health and production measures (Gooneratne, Eason et al. 1008). Similar findings were reported in a study of pregnant ewes receiving a single acute dose or multiple lower doses of 1080. Ewes that survived the toxin went on to deliver normal lambs (O'Connor, Milne et al. 1999).

It is hypothesized that there may be species variation in tissue susceptibility with heart, epididymides, testes and foetus being most sensitive to sub-lethal exposure in rats while heart may be most sensitive in sheep (Eason and Turck 2002). However, further work may be required to be confident of these conclusions in livestock species in particular.

2.2.5 Diagnosis

Diagnosis is based on evidence of exposure, clinical signs, necropsy findings and chemical confirmation. Gross necropsy signs are generally non-specific and likely to reflect the effects of cardiac failure and hypoxaemia.

Samples for chemical confirmation include bait, vomitus, stomach or rumen content, liver and kidney. A sample of bait or stomach or rumen content can be tested for fluoroacetate. Blood or tissue samples can be tested for citric acid levels.

A number of other non-specific biochemical changes are suggestive including hyperglycaemia, hypocalcaemia, hypokalemia and metabolic acidosis.

Differential diagnoses include lead, strychnine, chlorinated hydrocarbons and plant alkaloids capable of poisoning animals.

2.2.6 Treatment

Inducing vomiting is likely to be useful only if the effect can be achieved before onset of clinical signs i.e. if an animal is known to have consumed poison and is able to be treated before signs develop. Once clinical signs have developed absorption has already occurred.

There is no effective and reliable treatment for 1080 poisoned animals. Treatment is largely supportive and is based on controlling signs and providing time for the toxin to be metabolised and eliminated. Anticonvulsants, muscle relaxants and mechanical ventilation are all potentially useful.

2.3 Sodium monofluoroacetate in plants

Fluoroacetate is one of a small list of naturally occurring organofluorines that occur in plants. Many plants may accumulate organofluorines including trace amounts of fluoroacetate, including soybeans, tea plants and some grasses. There is some suggestion that plants may produce fluoroacetate and fluorocitrate if they are growing in soils containing fluoride though for most plants there is insufficient production to present a health risk to animals (Weinstein and Davison 2004). There is a small number of plants that are capable of production of sufficient amounts of fluoroacetate to pose a health risk to animals feeding on those plants (Weinstein and Davison 2004). It is possible that this capacity has developed as a protective mechanism in response to grazing pressure from animals and invertebrates (Weinstein and Davison 2004).

Fluoroacetate was reported as the toxic ingredient within a number of plants poisonous to livestock including *Dichapetalum* (1944), *Acacia georginae* (1961), *Palicourea marcgravii* (1963) and *Gastrolobium* spp. (1964) (Twigg 1999; Weinstein and Davison 2004).

In Australia the distribution of major known plants causing fluoroacetate poisoning are shown below. Weinstein and Davison (2004) describe losses of cattle and sheep from exposure to *Acacia georginae* in the area involving western Queensland and adjacent parts of the Northern Territory. The distribution of poisoning associated with *Acacia georginae* appears to be limited to the basin of the Georgina River (Bell, Newton et al. 1955; Whittem and Murray 1963). According to records presented on the Australian Virtual Herbarium there are isolated occurrences of Georgina Gidgee in other parts of Queensland as far afield as the Longreach, Aramac and Charleville districts. There are also suggestions that large tracts of Georgina Gidgee to the east and north-east of Alice Springs may be non-toxic. It is difficult to distinguish between Gidgee (*Acacia cambagei)* and Georgina Gidgee (*A. georginae*). *A. cambagei* is widespread and abundant in western Queensland (Bell, Newton et al. 1955) and does not appear to be either palatable or poisonous to livestock.

According to the Australian Virtual Herbarium *Gastrolobium grandiflorum* is located in Queensland primarily in the Desert Uplands and adjacent Einasleigh Uplands, and in parts of the Northern Territory and northern Western Australia. Various published papers refer to

Gastrolobium, Oxylobium and Nemcia genera of legumes but in the 1990s and early 2000s taxonomic revision has assigned all of these plants to *Gastrolobium* spp (Weinstein and Davison 2004). There are a number of *Gastrolobium* spp described in the south-west part of Western Australia (Weinstein and Davison 2004).

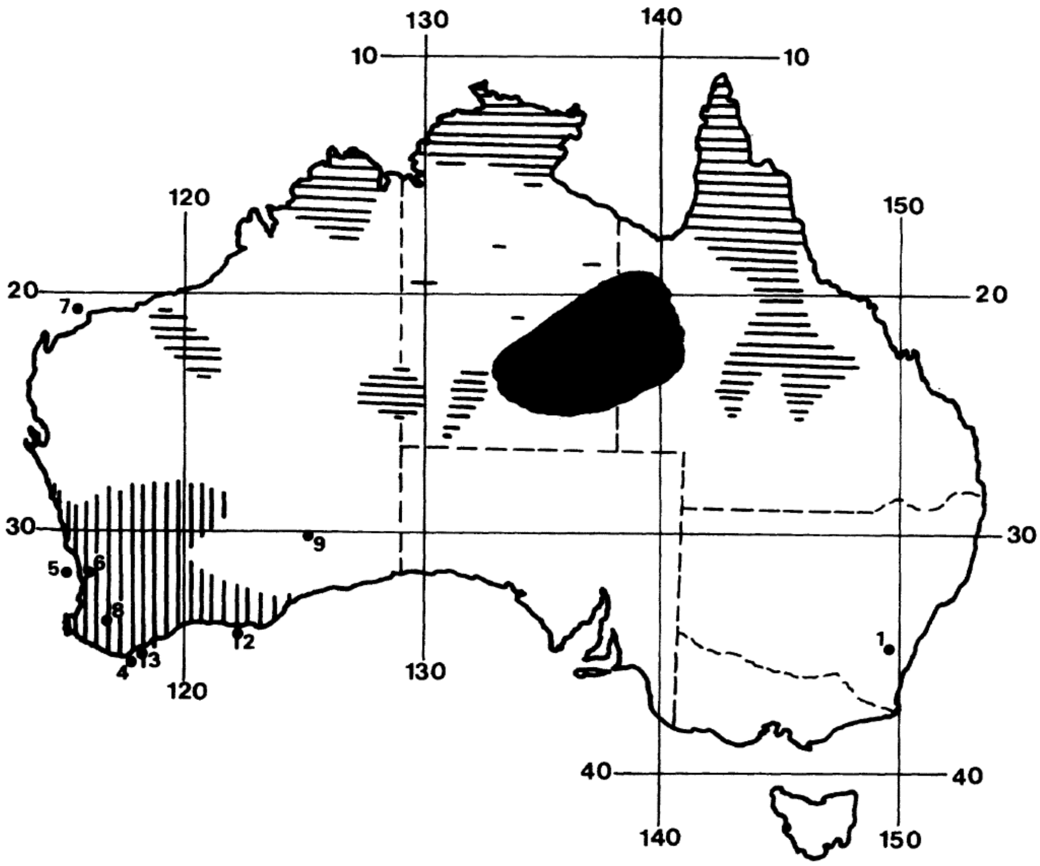


Figure 1: Distribution of fluoroacetate bearing plants in Australia. Vertical lines show species of Gastrolobium and Oxylobium, horizontal lines show Gastrolobium grandiflorum and the solid area shows Acacia georginae (Twigg and King 1991)

Fluoroacetate toxicity in plants is a major cause of sudden death in livestock in Brazil (Camboim et al. 2012; Furlan et al. 2012) and is described in other countries including South Africa (Weinstein and Davison 2004).

The first detailed description of Georgina poisoning, or Georgina River disease, was reported in Bell et al (1955) and taken from an earlier Queensland Department of Agriculture description of an event in 1910:

> *"After we had travelled them half a mile, the owner pointed out a red cow which he said was showing signs of poison. His reason for saying so was that she spread some ten yards from the mob and would have taken shade under a tree had she been allowed. She was put back with the others and travelled another half mile. During this time I watched her closely and saw no signs that anything was the matter with her. Suddenly she stopped, turned around and shook her head as if to charge, then*

> *turned to follow the mob, stopped, moved her legs as if balancing herself, gradually sank on her sternum, lay over and died without the slightest struggle. From the time she turned as if to charge until she was dead would be about 60 seconds."* (Bell, Newton et al. 1955)

Descriptions of clinical signs and progression of signs in Australian animals poisoned by exposure to fluoroacetate containing plants are reported in most detail in publications from the mid-20th century (Bell et al 1955; Barnes 1958).

Terminal symptoms are consistent with acute heart failure (Barnes 1958). Affected cattle on pasture may show signs for some hours before death. In early stages affected animals may be reluctant to move and if forced, move with a staggering and high-stepping gait. Fright, excitement or exercise may result in sudden death in affected animals. If left undisturbed affected animals may recover (Bell, Newton et al. 1955).

Up to 50% of reported deaths were noted within minutes of drinking with affected animals, attributed to increased intra-abdominal pressure on a compromised heart (Barnes 1958).

In feeding trials it was possible to observe a sub-acute syndrome that it is not often detected in naturally occurring cases. Animals were lethargic and dull, had a clear nasal discharge, salivation and a tendency to drag the hind feet. Animals had elevated respiratory and heart rates and stiff gaits and muscular fibrillation, arched back, frequent urination and some level of bloat (Barnes 1958).

At necropsy there are no pathognomic (diagnostic) signs. The major pathology in sheep and cattle has been described as acute multifocal injury to the myocardium (Bell, Newton et al. 1955, Barnes 1958; Whittem and Murray 1963).

There is a lack of clear and unequivocal information describing patterns of occurrence of naturally occurring poisonings in livestock and plant characteristics that may pose increased or reduced risk of poisoning.

In affected regions some properties appear to be more affected than others and deaths may occur in almost every year in some areas and intermittently or rarely in others.

Variation has been reported in toxicity of plant material sourced in different seasons from known poison areas as well as in plants from different areas (Barnes 1958, Whittem and Murray 1963). Large tracts of Georgina Gidgee to the east and north-east of Alice Springs have been described as being non-toxic. Suggestions that variation in soil concentrations of fluoride may explain the distribution of poisonous and non-poisonous *A. georginae* have been refuted by soil surveys showing no variation in surface soil fluoride levels between areas with poisonous or non-poisonous Gidgee. It is possible that deeper soil concentrations of fluoride may be responsible with affected areas being drier and therefore trees having to seek out moisture from deeper soil and in the process accessing more fluoride (Weinstein and Davison 2004). This appears to be as yet unproven.

There is a seasonal pattern to incidence with deaths occurring mostly from October to December and typically this period is dry and associated with scarcity of normal pasture (Bell, Newton et al. 1955, Barnes 1958). Deaths appear to be rare in good seasons, perhaps because of availability of alternative feeds.

A variety of views have been provided on the toxicity of different plant components. Livestock have been observed to eat larger leaves from *A. georginae* without apparent adverse effects while ingestion of fresh, green foliage from regrowth or young growing plants resulted in toxicity (Bell, Newton et al. 1955). Seed pods are also toxic, including seeds alone and pods that have been air dried for two years (Bell, Newton et al. 1955). These descriptions are consistent with suggestions that levels of fluoroacetate may be present in plants all year but may rise dramatically when plants are growing rapidly and at the flowering and pod-filling stages (Weinstein and Davison 2004). Concentrations of fluoroacetate can rise dramatically within weeks given favourable conditions and there may be large variation between different trees growing only hundreds of metres apart.

A variety of management strategies have been used by livestock owners and managers over many years to mitigate risks of fluoroacetate poisoning in livestock. Many of these strategies appear to be based on anecdotal observations and trial and error. The simplest strategy has been to manage animals to prevent access to poisonous plants by fencing off affected areas or removing poisonous plants using physical or chemical means.

Animals may be grazed with care in areas containing fluoroacetate plants depending on time of year and assessment of poisoning risk. Barnes (Barnes 1958) described management methods used to prevent losses while still retaining some grazing utilization of poisonous land areas. Safe bores can be placed in country free of *A. georginae* and fencing used to prevent cattle in the safe area from walking into known poisonous areas. Cattle can be grazed on Gidgee country while there is good feed available. When the ground feed is dry and losing its nutritive value, cattle should be shifted from poison to safe areas. This should occur before any losses are observed. Care is required because losses may be initiated by mustering and moving cattle. Cattle require about two weeks on safe country to enable them to recover from the effects of prior exposure to the poison and then they can more safely be driven for larger distances. Barnes suggests that cattle are unlikely to die until they have been in toxic Gidgee country for four to five weeks, meaning that it may be possible to move cattle into poisonous country and have them graze for some weeks and then carefully move them out and avoid losses (Barnes 1958).

Animals that have been exposed to poisonous plants should be moved with great care to avoid undue exercise or stress and should be left alone if they show any signs of toxicity at all to avoid inadvertently exacerbating signs and increasing the risk of collapse and sudden death.

Because of the association between drinking water and sudden death in affected animals some people will manage access to water in livestock grazing in areas with poisonous plants. There is anecdotal evidence of African smallholders purposefully delaying livestock access to water until late in the day to allow increased time for any toxin ingested during the day to be metabolised (Lee 2014).

In some areas of pastoral importance, producers have managed over time to largely eradicate fluoroacetate plants from pastoral lands. Land clearing and management of pastoral lands in south west Western Australia appears to have resulted in many *Gastrolobium* species becoming rare or restricted to areas that are not used for grazing of livestock such as roadsides or parks (Chandler 2002).

In some areas where fluoroacetate accumulating plants are common, local fauna appear to have developed adaptive mechanisms that allow them to feed on the plants in their area without toxicity. Many native animals in Western Australia can generally eat toxic plants containing 1080 (fluoroacetate) with little risk of being poisoned while the same native animals from eastern Australia remain very susceptible to fluoroacetate poisoning (Twigg and King 1991; Deakin 2013). Tolerance may result from variation in the rate of conversion of fluoroacetate to fluorocitrate, sensitivity of aconitase and citrate transport mechanisms to fluorocitrate and the capacity to detoxify fluoroacetate (Weinstein and Davison 2004).

Experimental studies have assessed the potential of genetically modified rumen bacteria capable of expressing genes allowing degradation of fluoroacetate (Gregg 1995). Enzymes that metabolise fluoroacetate are present in many bacteria and a gene encoding fluoroacetate dehalogenase has been identified in selected soil bacteria (Gregg 1995). Trials have been conducted on steers in containment conditions and a significant reduction in toxicity was observed (Padmanabha 2004). The work appears to be have been interrupted in part because of concerns that genetically modified bacteria may potentially transfer resistance to 1080 into pest animal species currently controlled in part by 1080 bait programs. In addition it may potentially lead to increased grazing pressures on fluoroacetate containing plants with perhaps unintended long-term consequences for animals and the environment. More recently researchers have been assessing naturally occurring fluoroacetate-degrading bacteria as an option that may allow ruminants to be inoculated with bacterial species as a way of increasing tolerance to fluoroacetate plants (Camboim et al 2012).

2.3.1 Web resources useful for identification of plants

The following web sites are provided as potential sources of additional information on appearance, distribution and identification of *Gastrolobium* spp and *Acacia georginae*, the two plant groups most likely to be associated with fluoroacetate poisoning in Australian livestock.

***Gastrolobium* spp**

- Monograph of *Gastrolobium* (Chandler et al 2002). Available at http://chabg.gov.au/cpbr/publications/bayer-publications/71.Aust.Syst.Bot.15_619-739.pdf

- Queensland Department of Agriculture and Fisheries information on weeds. Available at

  https://www.daff.qld.gov.au/plants/weeds-pest-animals-ants/weeds/a-z-listing-of-weeds/photo-guide-to-weeds/heart-leaf-poison-bush

- Australian weeds and livestock site developed by Helen Simmonds and the Mangrove Mountain Computer Club. Available at

  http://www.weeds.mangrovemountain.net/data/Gastrolobium%20grandiflorum%20-%20Desert%20poison%20bush.pdf

- The Atlas of Living Australia. Available at

  http://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:apni.taxon:691901

- Florabase database for Western Australia. Available at

  https://florabase.dpaw.wa.gov.au/browse/profile/22431

Acacia georginae

- Flora of Australia Online - http://www.anbg.gov.au/abrs/online-resources/flora/redirect.jsp
- Queensland Government Department of Environment and Heritage Protection Wetland Information - http://wetlandinfo.ehp.qld.gov.au/wetlands/ecology/components/species/?acacia-georginae
- The Atlas of Living Australia - http://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:apni.taxon:257348
- World Wide Wattle site. Available at http://www.worldwidewattle.com/speciesgallery/georginae.php

- Australian weeds and livestock site developed by Helen Simmonds and the Mangrove Mountain Computer Club - http://www.weeds.mangrovemountain.net/data/Acacia%20georginae%20-%20Georgina%20gidgee.pdf

3 Methodology

3.1 Methodology overview

Practical information was collected from livestock and property managers, government departmental staff and advisors within potentially affected regions. The data collected were analysed to produce results which present a realistic picture of the impact of fluoroacetate toxicity on grazing cattle in the affected regions.

Broadly, the methodology identified potentially affected regions, selected properties within these regions and conducted two surveys on selected properties to collect information from affected and non-affected properties. Case studies were selected following the conduct of surveys and these properties were visited and data collected to form case studies.

As the project was conducted it became apparent that there was demand for and potential for benefit from the conduct of workshops or small meetings within the affected areas in North Queensland and the Desert Uplands. Meetings were conducted at three locations in these regions.

The methodology used in this project involved the following steps –

- Identification of affected regions

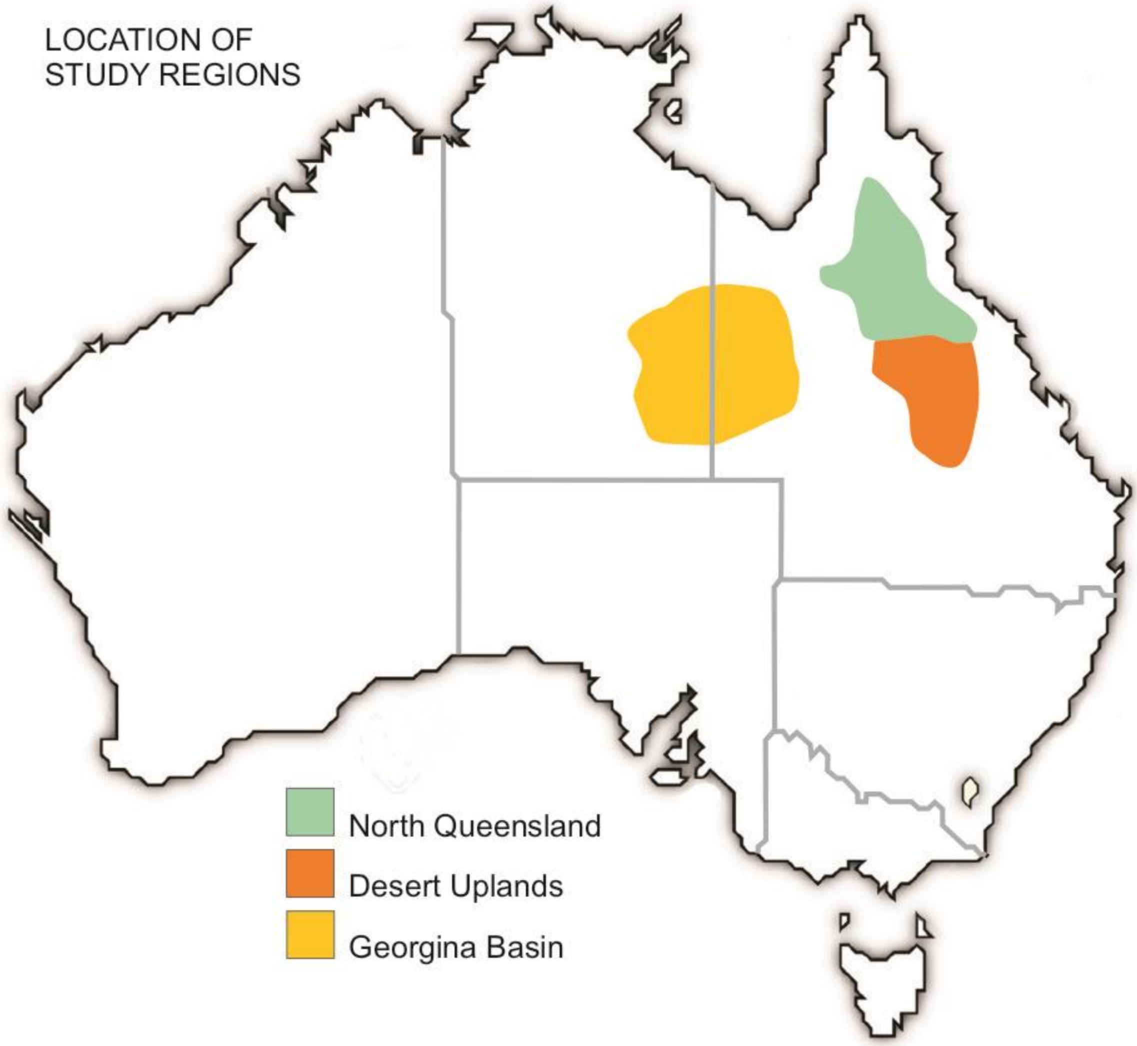
- Establishment of property details within the affected regions and sample selection

- Identification of contact details

- Conduct of stage 1
- Conduct of stage 2
- On-property visits to develop detailed case studies
- Small group meetings
- Data analysis
- Development of recommendations and conclusions

3.2 Selection of regions

Affected regions were identified through a literature search and through contact and discussion with relevant specialists including Agricultural Department beef cattle specialists, veterinary pathologists and researchers from the Agricultural Departments in Queensland, the Northern Territory and Western Australia. Discussions were also held with property managers, landowners and pastoral company staff throughout Queensland, the Northern Territory and Western Australia. The map below presents a graphic presentation of the regions.



3.3 Selection of properties

The affected areas in the Desert Uplands and North Queensland regions in Queensland, the Georgina region in Queensland and the Northern Territory and the south west of Western Australia were identified on maps using a geographic identification system (GIS). A cadastral layer was overlaid on the regional maps. A list of potentially affected properties was generated from the cadastral layer and a process of randomisation was applied to this list. This process resulted in a randomised list of properties from each affected region.

3.4 Identification of contact details

Contact details for selected properties were obtained using a range of methods including discussion with local landowners and industry advisors and representatives, local knowledge of team members, access to the PIC database and use of internet search facilities.

3.5 Stage 1

Stage 1 involved a very brief phone call that asked a small number of questions mainly aimed at:

- determining whether the property meets eligibility criteria and gathering a small amount of summary information such as average number of breeders / cattle on the property and property area to contribute to denominator descriptions;
- asking whether the property has experienced problems due to fluoroacetate poisoning in the past decade or so or whether management changes have been implemented to combat potential fluoroacetate poisonings.

Based on responses to these initial questions, properties were classified as *affected* or *unaffected*. Each respondent was then asked if they would be prepared to contribute to a more detailed survey (Stage 2 survey) to provide additional information that will allow the effects of fluoroacetate poisoning to be assessed.

3.6 Stage 2

Stage 2 surveys were sent by email to a minimum number of properties from each region. The sample size here was based on gathering information from sufficient properties to be able to analyse and present results as typical or representative for that region.

The target was to receive a minimum of five completed Stage 2 surveys from both *affected* and *unaffected* properties within each of the six regions (10 completed surveys per region).

Stage 2 surveys included a part that is related to general production / management information that could be completed by both *affected* and *unaffected* properties. It also included a second part asking specific questions about fluoroacetate poisoning and management changes to counteract this threat. This part was only completed by *affected* properties.

Increased priority was generally given to maximising sample size for *affected* properties while trying to achieve target numbers for *unaffected* properties.

3.7 On-property visits/case studies

On-property visits were conducted to collect in depth information to form the basis of four case studies. Properties were selected after discussion with local landholders and visits were conducted by two project team members. Each visit took approximately one day and time was spent gathering information and inspecting relevant landscapes, cattle, watering points and handling facilities.

The case studies developed and presented in this report are an amalgam of information collected and are not meant to be representative of any particular situation or property.

The Georgina River

3.8 Small group meetings/workshops

Telephone discussion with landholders in the Desert Uplands and North Queensland regions indicated strong support for a series of small meetings in those regions. With the assistance of local landholders in each area meetings were organised in the Torrens Creek, Aramac and Jericho areas.

The meetings were facilitated by project team members and served to collect specific information required by team members and as a process of sharing experiences among the landholders. Discussion was engaging and each producer had stories and experiences to share.

3.9 Data Analysis

Analysis was conducted on property level information within each region and group (*affected, unaffected*) to generate summary information for impact of fluoroacetate poisoning for the participating properties and regions.

Information from the Stage 1 survey was used to amplify impact estimates derived from the participating properties in order to produce region-level estimates of impact.

Financial analysis has been conducted using the information collected through the surveys, group discussions and case studies.

4 Results

4.1 Research results and survey response

4.1.1 Northern Territory top end

Discussions were held with Northern Territory Department of Primary Industries and Fisheries staff including the recently retired Chief Veterinary Officer, the CEO of the NT Berrimah Veterinary Laboratory, the Director of Livestock industries Development and researchers and livestock advisors associated with the industry.

Fluoroacetate poisoning of livestock from *Gastrolobium* spp in the northern parts of the NT and from Georgina Gidgee in the Georgina River Basin area is documented in a range of government and industry materials. All of the people from the NT that were contacted agreed that the major problem due to fluoroacetate toxicity in the Northern Territory is associated with Georgina Gidgee and is restricted to the Georgina basin. Poisoning associated with *Gastrolobium* species in the northern NT was considered to be sporadic and not of sufficient concern to warrant further detailed investigation. On the basis of this evidence the project team concluded that project resources were best directed to the Georgina region.

4.1.2 Western Australia – Northern parts

Discussions were held with a number of personnel from the Western Australian Department of Agriculture and Food (DAFWA), including the department's principal veterinary toxicologist and beef cattle advisors from Kununurra, Broome, Carnarvon, Geraldton and Kalgoorlie. While there are a number of potentially toxic *Gastrolobium* species throughout the north and rangeland areas the people contacted all agreed that there was little evidence for widespread severe livestock losses associated with fluoroacetate toxicity. As a result of these findings the project team concluded that there was insufficient evidence of impact to warrant further survey activity involving producers from northern parts of Western Australia.

4.1.3 Western Australia – Southwest area

A number of species of fluoroacetate containing plants are known to occur in the southwest part of Western Australia (south and west of a line running roughly from Geraldton to Esperance).

Project team members contacted a range of DAFWA personnel including the chief veterinary toxicologist to gather information about poisonings in this area. The project team also randomly selected properties from multiple shires across this region, focussing mainly on shires with higher populations of cattle. A total of 25 producers were contacted in Stage 1 of the survey from this area.

Information gathered from DAFWA personnel and from producers contacted in southwest WA clearly indicated that while poisonous plants do occur in the region, there was little evidence of any severe or widespread poisoning problem involving livestock. It appears that toxic fluoroacetate containing plants have either been removed over time from pastoral land or are confined largely to areas not used for livestock grazing.

As a result of these findings stage 2 surveys were not undertaken in southwest WA.

4.1.4 Desert Uplands, North Queensland, Georgina Basin

Responses to Survey 1 and discussions with service providers, researchers and laboratory personnel demonstrated that fluoroacetate toxicity problems do occur in the Desert Uplands, North Queensland and Georgina Basin regions.

Survey 2 and further analysis was therefore conducted on the Desert Uplands, North Queensland and Georgina Regions.

Producers, landowners and livestock managers responded well to the project and were in the main very willing to assist wherever possible. Landowners and livestock managers are understandably busy and while the initial telephone survey yielded immediate results it took some time for all the replies to Survey 2 to be returned.

The following is a summary of numbers of people contacted and surveys completed.

Numbers	Regions			
	Desert Uplands	North Qld	Georgina	SW WA
Initial contact	70	30	25	25
Survey 1 completed	51	22	20	25
Survey 2 completed	19	12	10	

4.1.5 Meeting attendance details

Location	Numbers
Torrens Creek	5
Aramac/Lake Dunn	20
Jericho	7

4.1.6 Regional Descriptions

4.1.6.1 Desert Uplands

The Desert Uplands Region covers 75,000 square kilometers, on both sides of the Great Dividing Range, and is the headwaters of two major catchments (the Burdekin and Lake Eyre Basin) that almost split the region in half, north-south. The region extends to the north of the Flinders Highway near Torrens Creek whilst the southern boundary is approximately 50 km north west of Tambo. The area is bounded by a line from Blackall to Hughenden through Barcaldine in the west and the Belyando River in the east. Towns within the Desert Uplands are Barcaldine, Jericho, Alpha, Hughenden, Prairie, Torrens Creek, Pentland, Aramac, and Muttaburra.

The Region is characterised by hard, red sandy soils with relatively low fertility. Sandstone ridges and sand plains dominate the landscape, supporting predominantly native pastures, including; spinifex (*Triodia pungens* spp.), wire grasses (*Aristida* spp.), and small patches of Mitchell grass (*Astrebla* spp.). Buffel (*Cenchrus ciliaris)* grass, an introduced pasture species can be found throughout the region. The majority of the area is heavily timbered with species such as Desert oak (*Acacia coriacea)*, Gidyea (*Acacia cambagei*), Box (*Eucalyptus populnea*), Ironbark (*Eucalyptus melanophloia*), Yellow Jacket (*Eucalyptus similis*), and a number of Wattles (*Acacia* spp.)

The region has a semi arid climate with variable rainfall. The average annual rainfall across the region is 456 mm.

Properties in the Desert Uplands have an average size of between 20,000 and 25,000 ha. The median property size is 13,300 to 18,900 ha.

4.1.6.2 North Queensland

The area described in this project as North Queensland is an area based around Charters Towers, Georgetown and Mareeba. This region covers a series of rugged hills and ranges, dissected plateaus and alluvial and sand plains. The soils are generally lighter soils and the region is dominated by eucalypt woodland with substantial woody cover.

The region has a tropical climate with moderate to high rainfall summers. Across the region annual rainfall averages 700 mm.

Most of the region is grazed by beef cattle in extensive management systems.

4.1.6.3 Georgina Basin

The Georgina River rises near the Queensland/Northern Territory border north-west of Camooweal and flows south and south-west. The catchment covers approximately 205,000sq klm and covers land in Queensland and Northern Territory.

The landscape includes typical channel country forming multiple braided channels, floodplains, waterholes and wetlands, sandy spinifex covered plains, scattered shrubs over stony plains and limestone or ironstone hills.

The Georgina catchment is situated in the Australian semi-arid to arid zone with a highly variable climate and annual rainfall averaging 200 to 400 mm.

Most of the region is grazed by beef cattle in extensive management systems, landholdings are large and are currently a mixture of company and privately owned enterprises.

4.2 Descriptive summary of survey responses

The following section provides descriptive measures for survey respondents by region. A small number of respondents provided combined information for two properties in one response and this has the potential to influence summary measures for land area and cattle numbers.

Table 1: Summary of producer responses for those producers participating in Stage 2 of the survey by region

	Units	Desert Uplands	North QLD	Georgina	Total
Producers	n	19	12	7	38
Land area	ha	512,845	598,520	6,259,306	7,370,671
Breeders in 2013	n	27,042	29,325	72,987	129,354
Median stocking rate	ha per breeder	23.6	21.3	73.2	25.8

A total of 38 of the 41 respondents to the stage 2 survey provided detailed estimates of livestock numbers and land areas as part of the survey. This allowed generation of estimates of median hectares per breeder for each region based on the survey sample.

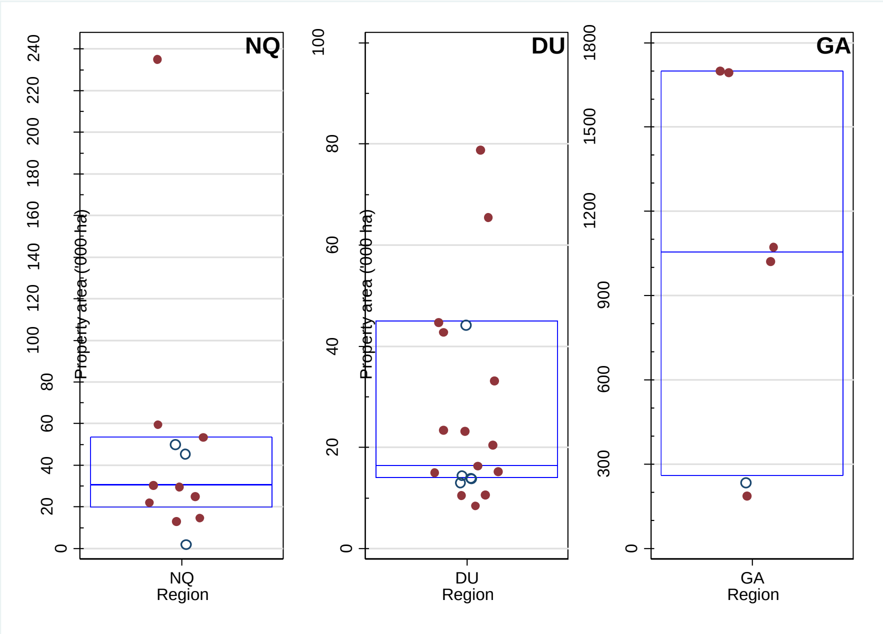


Figure 2: Summary plot of property area in 1,000 ha units for three regions: NQ, DU and GA. Red coloured symbols denote affected properties, non-filled symbols denote unaffected properties, blue box shows the interquartile range (25th to 75% percentile) with the line inside the blue box showing the median area

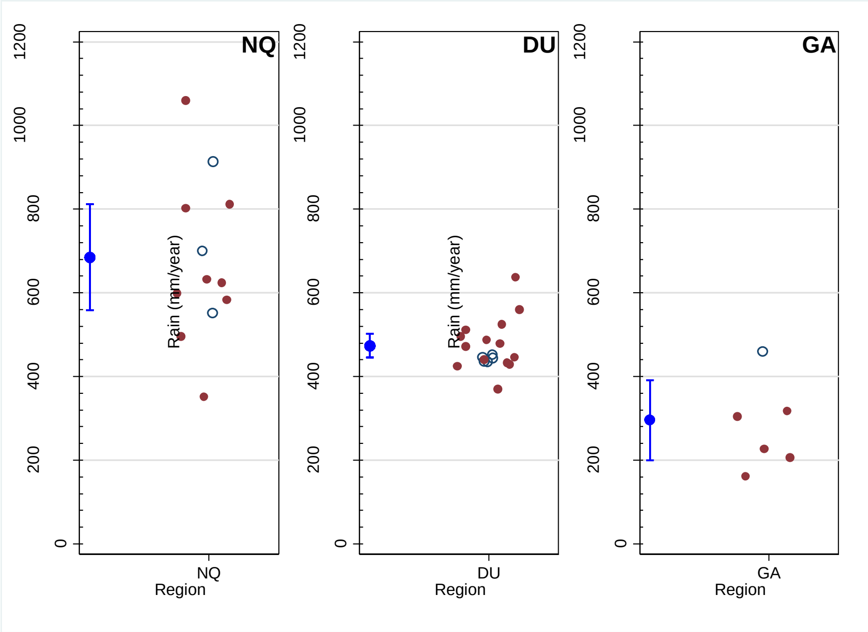


Figure 3: Summary plot of annual rainfall (mm/year) for three regions: NQ, DU and GA. Red coloured symbols denote affected properties, non-filled symbols denote unaffected properties, blue dot and lines show the mean and 95% confidence interval for annual rainfall in each region

The three regions were reasonably distinct on simple summary measures. The Georgina had the largest land areas and lowest rainfall, followed by the Desert Uplands and then north Queensland.

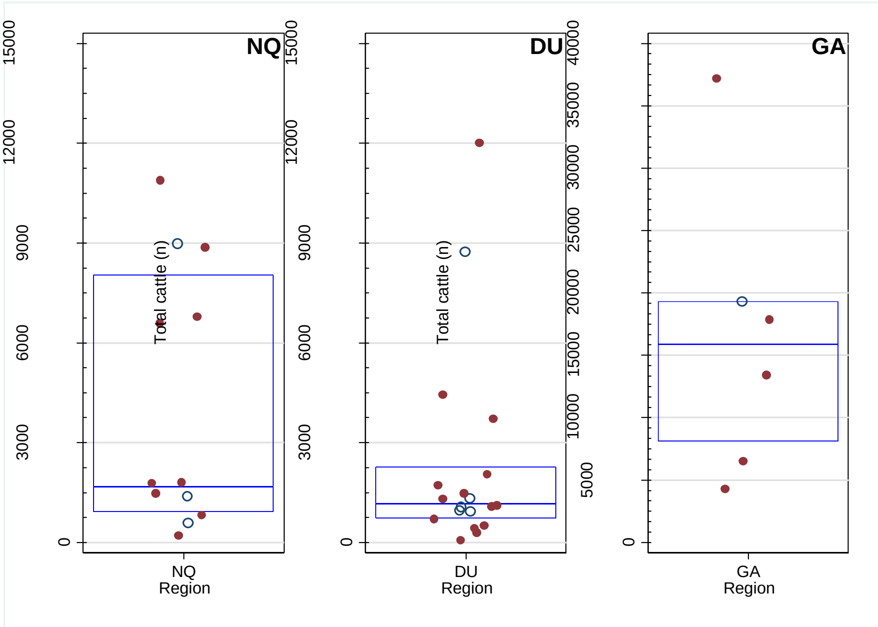


Figure 4: Summary plot of total cattle numbers for three regions: NQ, DU and GA. Red coloured symbols denote affected properties, non-filled symbols denote unaffected properties, blue box shows the interquartile range (25th to 75% percentile) with the line inside the blue box showing the median area

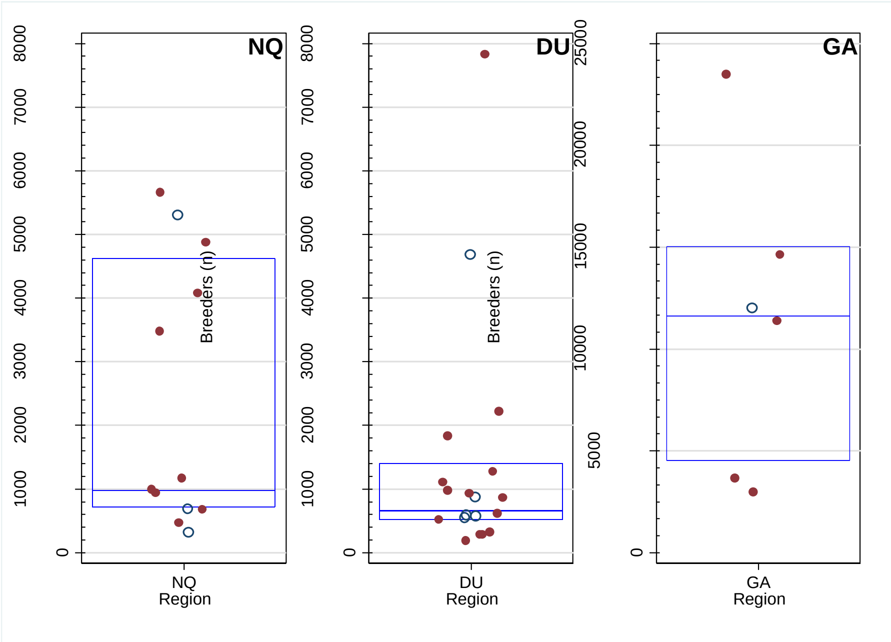


Figure 5: Summary plot of breeder numbers for three regions: NQ, DU and GA. Red coloured symbols denote affected properties, non-filled symbols denote unaffected properties, blue box shows the interquartile range (25th to 75% percentile) with the line inside the blue box showing the median area

There was considerable variation in breeder and total cattle numbers both within and between regions. The highest median numbers were in the Georgina. Median counts were fairly similar in the Desert Uplands and north Queensland but there was more variation in north Queensland. Each region had a small number of relatively large operations in terms of cattle and breeder numbers.

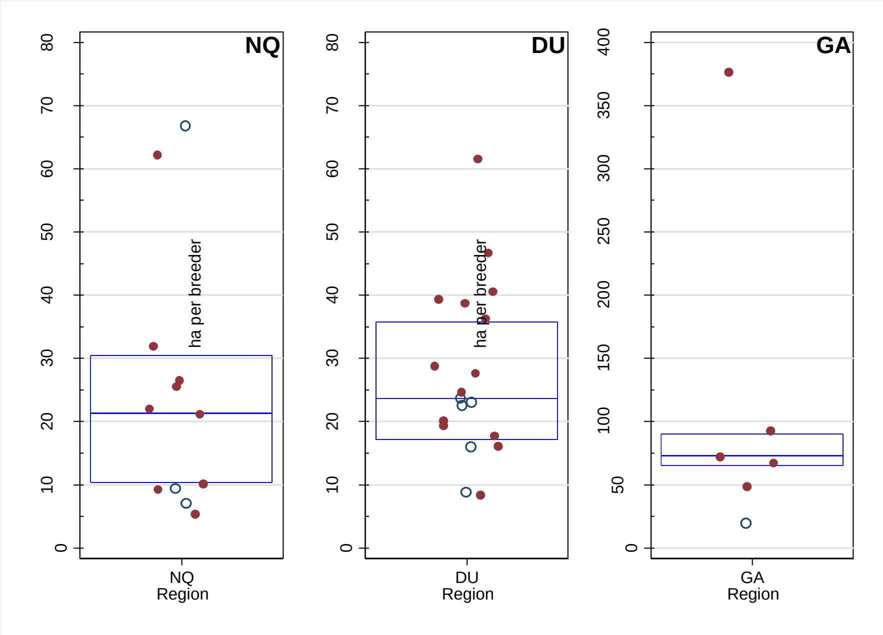


Figure 6: Summary plot of stocking rate in ha per breeder for three regions: NQ, DU and GA. Red coloured symbols denote affected properties, non-filled symbols denote unaffected properties, blue box shows the interquartile range (25th to 75% percentile) with the line inside the blue box showing the median area. Stocking rates were estimated using 2013 data

Median hectares per breeder was similar for Desert Uplands and north Queensland but was markedly higher for the Georgina region. This observation was consistent with larger land areas and lower rainfall for the Georgina region compared to the other two regions.

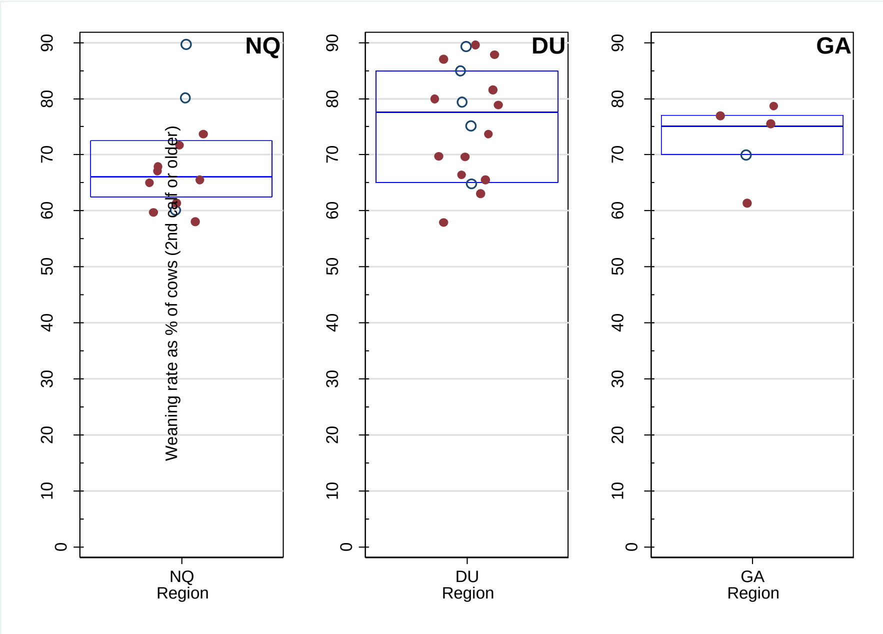


Figure 7: Summary plot of weaning rate in cows (% of breeders mated per year) for three regions: NQ, DU and GA. Red coloured symbols denote affected properties, non-filled symbols denote unaffected properties, blue box shows the interquartile range (25th to 75% percentile) with the line inside the blue box showing the median area

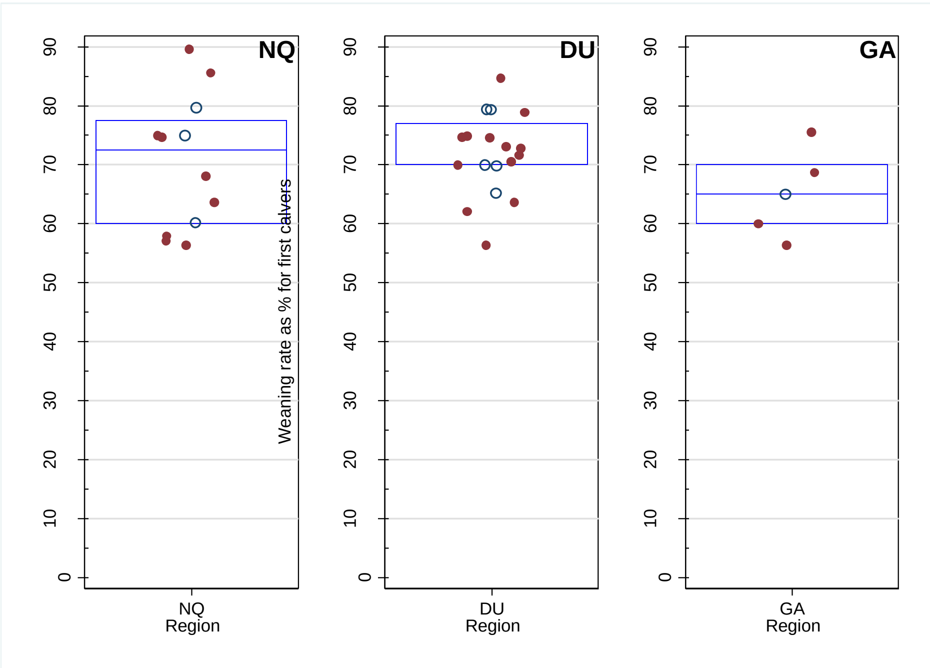


Figure 8: Summary plot of weaning rate in first calvers (% of heifers mated per year) for three regions: NQ, DU and GA. Red coloured symbols denote affected properties, non-filled symbols denote unaffected properties, blue box shows the interquartile range (25th to 75% percentile) with the line inside the blue box showing the median area

4.3 Cattle numbers potentially affected

4.3.1 Desert Uplands

The Desert Uplands is considered to be a distinct bioregion. Discussion with landholders, NRM personnel and departmental employees indicate that up to 50% of the Desert Uplands Bioregion is potentially affected by Heartleaf. The bush grows in varying densities and this proportion includes all country with the potential to have Heartleaf plants on it.

The total area within the Bioregion is 7.5 million hectares. The proportion of the area with potential to grow Heartleaf is estimated at 50% or 3.75 million hectares. The majority of cattle operations in the Desert Uplands are breeder operations selling young stock to a variety of markets. Numbers of breeders affected has been calculated using a stocking rate of 23.6 hectares per breeder.

4.3.2 North Queensland

Discussion with landholders, NRM personnel and departmental employees have identified that Heartleaf in North Queensland occurs primarily in the bioregion called the Einasleigh Uplands. The bush grows in varying densities and occurs in isolated patches as well as in larger areas.

The total area within the Bioregion is 11 million hectares. The proportion of the area with potential to grow Heartleaf is 40% or 4.4 million hectares. The majority of cattle operations in the affected North Queensland region are breeder operations selling young stock to a variety of markets. Numbers of breeders affected has been calculated using a stocking rate of 21.3 hectares per breeder.

4.3.3 Georgina Basin

The Georgina basin is affected with Georgina Gidgee to varying degrees. All properties in the region were contacted and an estimate of breeder numbers and total numbers of cattle affected was gathered through discussion with affected landholders. The Georgina cattle enterprises are a mixture of breeder operations and dry cattle or growing operations.

4.3.4 Total numbers

Total cattle numbers for the Desert Uplands and North Queensland have been estimated using an average breeder component of the herd as 60%. The Georgina region numbers are based on discussions with all affected landholders. The total numbers of cattle potentially affected in the three regions are presented below.

REGION	AREA AFFECTED	STOCKING RATE BREEDERS	NUMBERS BREEDERS	TOTAL NUMBERS
Desert Uplands	3.75 M ha	23.6ha/breeder	158,900	
North Queensland	4.40 M ha	21.3ha/breeder	206,600	
Total NQ & DU			365,500	609,167
Georgina	20.50 M ha		120,000	243,000
Total	28.65 M ha		485,500	852,167

Australian cattle numbers currently stand at 29.3 million so the number of cattle affected represents 2.9% of the total Australian herd.

4.4 Producer discussions

Discussions were held with landholders in the affected regions through a range of activities including telephone and email; small group workshops; and case study visits to selected producers. In addition a range of producer views and observations were derived from survey responses.

This section provides a summary of producer opinions gathered during the project. Findings are presented by region.

4.4.1.1 Desert Uplands and North Queensland

The Desert Uplands and North Queensland regions were dealt with together as they experience toxicity due to the same plant, Heartleaf Poison bush (*Gastrolobium grandiflorum*) and represent similar bioregions and similar cattle enterprises. The area affected in both these regions as presented in the following maps was determined through discussion with local landholders at workshops and during property visits.

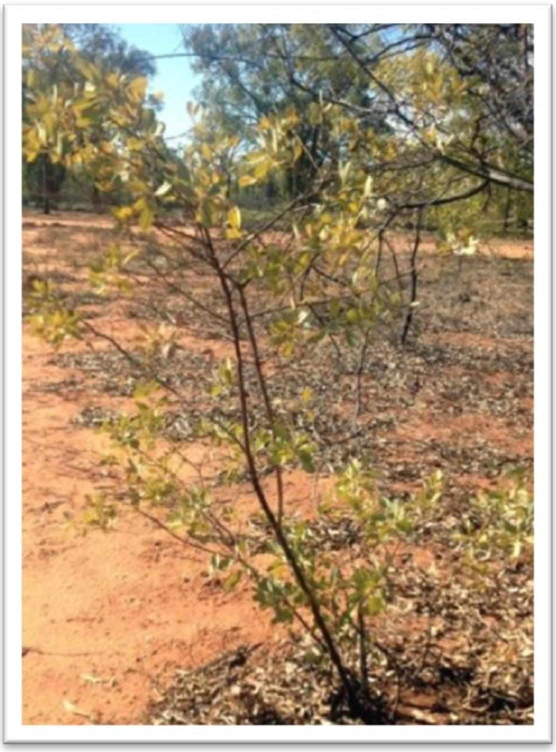
GENERAL DESCRIPTION

Affected and non-affected landholders were contacted by phone and a sample of these landholders filled in a detailed questionnaire. Small group workshops were held in the Torrens Creek, Aramac and Jericho regions and four properties were visited to form the basis of three case studies.

Fluoroacetate poisoning in the Desert Upland and North Queensland regions is caused by ingestion of the Heartleaf Poison bush (*Gastrolobium grandiflorum*). This plant has been causing problems since the area was first stocked in the 1860’s and a number of the landholders have been living with Heartleaf and its affects for many years. At the meetings and in discussion by telephone contact was made with landholders who have been living in the area for 3 generations. This represents a valuable store of accumulated knowledge and experience. In the past large parts of this affected area were utilised only as drought reserve and grazed with cattle or sheep when other surrounding country was very dry. Attempts have also been made in the past to grub the bush out of areas with teams of men. That approach is naturally prohibitively expensive in the current economic climate and it was largely ineffective in the long term in the past.

Landholder observations indicate that poisoning in these regions is primarily a problem with:

- introduced cattle
- cattle grazing recently burnt areas
- cattle grazing Heartleaf affected country after rain
- cattle which are stressed by movement.



Heartleaf poison bush (not grazed)

Heartleaf poison bush showing bulb

The density of the Heartleaf plant infestation varies considerably with some properties reporting that Heartleaf is scattered over the entire property and others speaking of areas of infestation and clean areas. Where possible and practical, landholders fence off the Heartleaf affected country and manage it differently to the clean country. This is however, not always possible and a number of landholders manage an infestation which covers their entire property.

There was variation in producer opinions on which parts of the plant might be most poisonous and whether there was variation in toxicity associated with different stages of growth, time of year or climatic or other events. Most producers agreed that the Heartleaf bush is most dangerous and poisonous when there is fresh growth after fire or after rain at the end of a dry time. After fire Heartleaf is generally the first green shoot to appear and it is a soft, green, highly palatable leaf. Cattlemen say they have two weeks in which to remove cattle after a fire before deaths start to occur. During dry times cattle do not seem to eat the bush and the leaves appear to be hard and dry, most probably unpalatable. It is however not known whether the toxicity of the plant varies during different growth phases. Most landholders agree that the issue varies every year and no two years are the same.

The reported overall death rates throughout the area are generally higher than in country close by without Heartleaf.

MANAGEMENT

Management of the problem follows a number of key principles throughout these regions, including:

- maintenance of a light stocking rate
- low stress handling of cattle at all times
- if cattle show signs of distress during moving or mustering leave them behind
- fencing off the Heartleaf affected country
- utilisation of Heartleaf infested country at the times when it is generally least toxic
- during the dry season
- during prolonged droughts
- avoidance of stocking Heartleaf country after a fire - for up to 6 to 8 months or until sufficient other forage is available
- cleaning out cattle before handling and trucking if they have been grazing in Heartleaf country by holding them in a clean area for at least 5 to 6 days
- ensuring cattle have good access to water and keeping distance between waters to a minimum. Ideas have changed on water placement and landholders are now putting waters in the Heartleaf country to reduce the distance cattle have to walk to water
- plant control or eradication in targeted areas.

Plant control or eradication is generally carried out where the Heartleaf occupies a small discrete area in an otherwise clean paddock, around waters or in holding paddocks and laneways. Eradication is time consuming and difficult as the plant is generally lightly scattered in quite dense bush. Finding it is a challenge and ensuring an area is clean is a time consuming process. Chemical control is used as is physical removal. The seeds appear to have a very long life and it requires constant vigilance to maintain a clean area. Germination appears to be stimulated by fire and any soil disturbance will result in germination of Heartleaf plants. Grubbing plants out can frequently stimulate germination.

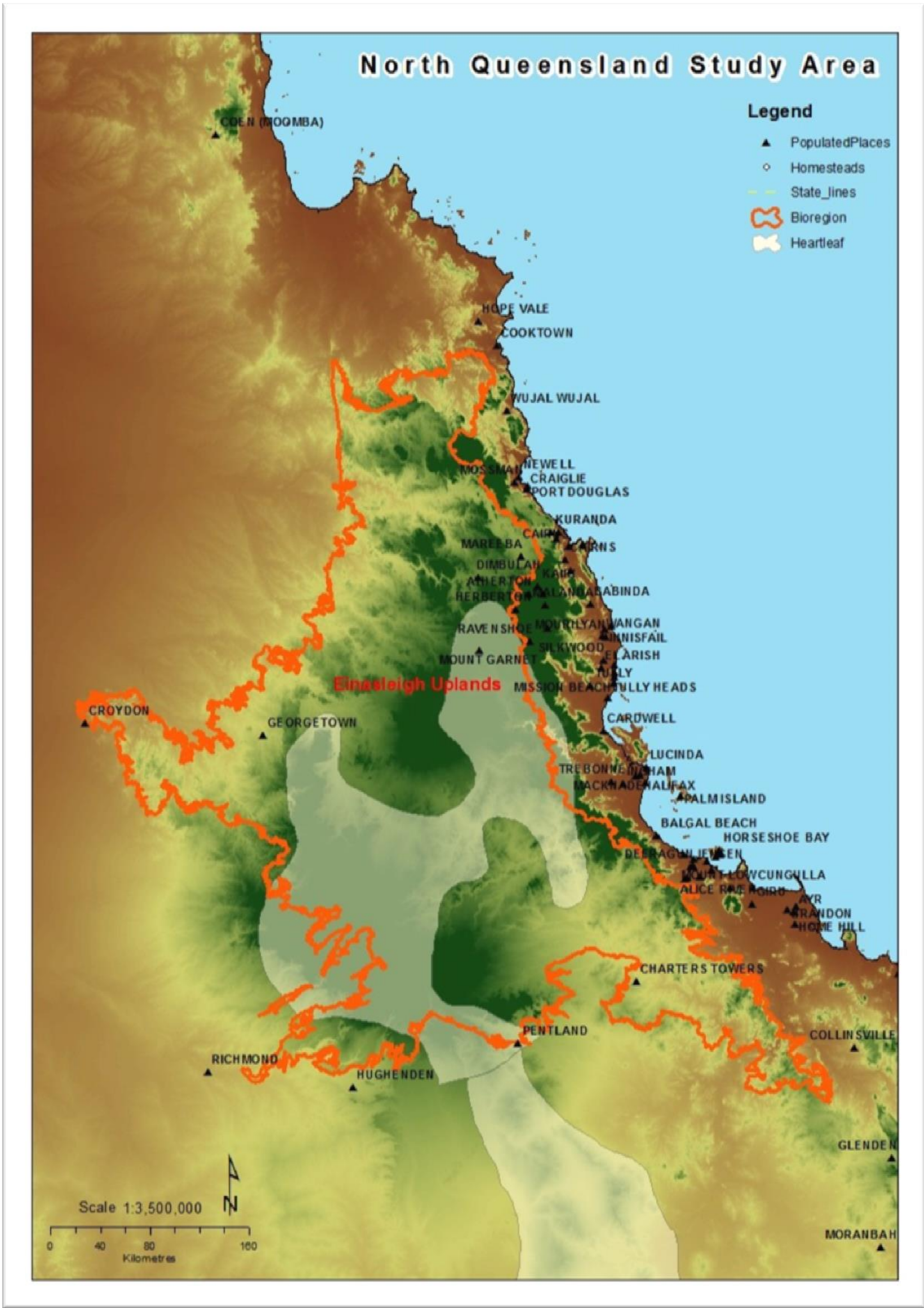
IMPACTS

Producers identified a number of areas where the problem results in costs to the enterprise, including:

- increased death rates
- plant eradication and control
- additional infrastructure in order to facilitate management of the problem
- additional handling of livestock
- opportunity costs associated with a lower stocking rate
- opportunity costs of not being able to effectively use fire as a management tool
- lack of flexibility in timing of stock handling
- lack of opportunities to take on agistment as people from outside the area are concerned about the possibility of Heartleaf poisoning.

Landholders in the Desert uplands and North Queensland are aware of the problem and generally have a good understanding of the issues. Landholders have described a higher death rate in Heartleaf affected country than in non affected country in the surveys and in discussion and are concerned about the cost of a higher death rate and the time and money spent attempting to control the plant and believe that without Heartleaf the country would be more productive and simpler to manage.

Desert Uplands – Area potentially affected by Heartleaf



North Queensland – Area potentially affected by Heartleaf

4.4.1.2 Georgina Basin

GENERAL DESCRIPTION

Within the Georgina Basin fluoroacetate toxicity is caused by ingestion of Georgina Gidgee (*Acacia georginae).* Poisoning problems have been reported since this country was first stocked in the 1880's and large losses of sheep and cattle have been reported over the years. Poisoning in this area presents a rather complex picture as cattle graze the plant preferentially and perform extremely well while grazing the Gidgee. The Georgina region has a reputation amongst cattlemen as sweet country and apparently Sir Sydney Kidman called Carandotta, which is in the centre of the Georgina basin, his best property.

Survey findings suggest that Gidgee poisoning in this area has been a problem for many years and land holders have been managing around it since the introduction of cattle to the Georgina Basin. The experience level of station owners/managers does vary, from six months to in excess of one hundred years nevertheless old diary entries and current reports remain consistent and the majority of stakeholders were more than willing to offer information on their individual situation. The density of Georgina Gidgee does vary amongst properties; from full infestation to small pockets easily controlled by fencing.

Although all property owners / managers suggested that cattle will die all year round from ingestion of Georgina Gidgee it is at the end of the dry season (July-August) through to the onset of the wet season that stock losses are at their highest. It appears that once the cattle are grazing primarily on Gidgee, deaths start to occur and will continue until a good fall of rain (>50mm). In addition losses would also increase if a small amount of rain was received (5mm – 40mm) as this would freshen the leaves but not provide enough moisture for grass growth. Once enough rain (>50mm) has fallen through the warmer months and pasture (grass and herbage) is established cattle will tend to alter their grazing patterns to target this forage and losses will decrease significantly until cattle start to graze on the plant again as conditions dry off, generally around July/August/September. However in a dry season when the wet season fails deaths will continue until good rain comes.

Landholders talk about 18 month periods without rain and a constant experience of cattle deaths during this period. Poisoning in this region during the period when cattle are grazing Gidgee will affect all classes of stock and stock in any condition, frequently fat cattle die and stock that have been living in the country for many years will die. Georgina Gidgee is predominately associated with very soft nutritious soil and cattle grazing in these areas are in forward store to fat condition. Even at the end of the dry season where pasture is in most cases dry and very low in protein cattle remain in good condition through grazing on trees and shrubs such as the Georgina Gidgee. Owners and managers have commented that they do save money on supplement costs in comparison with other parts of northern Australia.

Cattle are generally found dead close to waters and it is assumed death is sudden as sick cattle are seldom observed. Cattlemen say that some cattle show signs of being dazed or not fully aware of their surroundings when they are eating the tree.

Some areas of the properties affected appear to be more dangerous; however, the location of poisonings can change from year to year and within a year. Cattlemen have observed that cattle will preferentially graze one particular tree. It appears that cattle eat leaves, pods and flowers.

When the cattle are eating the tree deaths will occur if cattle are heated up by handling or mustering. Affected cattle become reluctant to move and if they are left behind when moving cattle, they will frequently recover.

Georgina gidgee

Cattle grazing Georgina gidgee

Landholders and cattle managers have learnt to manage the problem and to reduce the impacts of poisoning on their herd, however considerable losses do occur with a consistent death rate through the year while the cattle are eating the Gidgee and high death rates if cattle are handled or need to be moved for any reason.

Most cattle managers in the area vaccinate for botulism and very few supplement with phosphorous. Cattle were observed chewing bones by project team members and this is supported in discussion with land owners and managers This would suggest that Phosphorous deficiency is a problem.

MANAGEMENT

There appears to be two methods of managing poison Gidgee, depending on the level of infestation and these are:

1. Partial infestation of Georgina Gidgee with dense areas either fenced out or controlled through watering points. These properties are typically steer depots or the combination of both dry cattle and breeders. Management strategies for these operations include:
   a. Breeders are typically run outside the perimeter of this problem area as this is in the most cases the more marginal country; as mentioned above poison Gidgee normally grows in better soils.
   b. Dry cattle are moved into these ‘problem paddocks’ once significant rainfall has been received (>50mm within a week) and grasses are in full growth. Cattle are then moved out of this area in mid winter before the stock begins to target the poison Gidgee. There are risks involved with this and being late on this movement and either losing cattle in the paddock or during the movement.

   c. If fences are in poor condition or non-existent waters can be turned off and cattle shifted to prevent losses.
   d. Low stress cattle handling when working with cattle that have been grazing in poison paddocks.
2. Full infestation of Georgina Gidyee with the majority of the property affected. These properties are typically breeder operations with limited fences and stock divided up through placement of water. Management strategies for these operations include –
   a. Light stocking rate
   b. Muster cattle only once a year, typically before July/August. The majority of young stock are weaned, calves branded, sale cattle taken off and any other husbandry requirements attended to.
   c. In some cases water is turned off 1-3 days prior to mustering and stock are fed hay; this has found to help in walking cattle to yards as often this can be in excess of 20 kilometres.
   d. Low stress handling of cattle starting from mustering whereby the majority of cattle are trapped on water. Cattle are then walked quietly to the yards with any beast showing signs of fluoroacetate poisoning (staggers, slow walk, froth at the mouth) left behind. Process through the yards is also done quietly.
   e. If fences are in poor condition or non-existent waters can be turned off and cattle shifted to prevent losses

Management of the problem does incur costs and these costs are detailed in the financial analysis section of this report. As described by the landholders and managers these costs include –

- Reduced carrying capacity by 50-100%.
- Reduced weaning rates by 15-30%.
- Restricted management options on when and how to run stock; only one round of mustering, paddock utilisation and cattle handling techniques.
- Lost sales opportunities; for example the live export market will frequently jump over the wet season (from $1.80/kg to as much as $2.20/kg) and there might be cattle ideally suited to this market. However because of the poison Gidgee, handling these at this time would mean substantial losses.
- Welfare impacts – the ongoing death rate presents continuing animal and human welfare issues
- Emotional loss; the loss of fat cattle is depressing for any cattleman, be they a manager or a property owner.

Landholders believe that the Georgina basin is sweet and productive country with significant costs imposed by the elevated death rate and the lack of flexibility in timing of cattle handling. They believe that this country would be much more productive in terms of stocking rates and general usability if the Gidgee problem was eliminated. If the problem of fluoroacetate toxicity is removed and stocking rates are increased this may have an impact on land condition. Any stocking rate increase would require careful monitoring in terms of impact on land condition and long term sustainability.

5 Survey findings

5.1 Property level prevalence of fluoroacetate poisoning

Stage 1 survey results indicated that:

- 22 of 31 (71%) properties contacted in Desert Uplands and
- 11 of 17 (65%) in North Queensland and
- 16 0f 25 (64%) for Georgina for Stage1 indicated that they experienced impacts from FP poisoning.

These measures provide an estimate of property level prevalence of fluoroacetate poisoning within affected regions and indicate that within all three regions, the majority of properties will be affected at some level by fluoroacetate containing poisonous plants.

5.2 Findings from the stage 2 survey

5.2.1 Proportion of property affected

Table 2: Count of respondents by fluoroacetate status (area of property affected) and region. NQ=north Queensland, DU=Desert Uplands, GA=Georgina Basin

Fluoroacetate status	NQ	DU	GA
	n	n	n
None	3	5	1
0 to 10%	1	1	1
10 to 25%	3	6	1
25 to 50%	2	5	2
50 to 75%	2	2	4
>75%	1	0	1
Total	12	19	10

Of the 41 respondents to the stage 2 survey, there were five (Desert Uplands), three (north Queensland) and one (Georgina) that indicated that they had no fluoroacetate plants on their properties. Only one property from each region indicated that they had less than 10% of land area affected with FL-plants. Most properties had more than 10% and less than 75% of their land area affected and two properties had more than 75%.

For questions asking about fluoroacetate plant related information (impacts, distribution of plants, management etc), these nine respondents were not included in analyses. Questions relating to fluoroacetate plants were therefore addressed by a total of 32 respondents.

5.2.2 General impacts

Table 3: Summary of responses about impact of FL-plants. Respondents could select more than one response. For each row, the number of responses is presented as a count and as a percentage of the total number of respondents for that region. Limited to those respondents that indicated they do have FL-plants on their property

	NQ		DU		GA		Total	
Total count within each region	**9**		**14**		**9**		**32**	
	n	**% of total**	**n**	**% of total**	**n**	**% of total**	**n**	**% of total**
No adverse effects	1	11.1	0	0.0	0	0.0	1	3.1
Increased death rates	8	88.9	14	100.0	8	88.9	30	93.8
Reduced fertility (calving rate)	2	22.2	1	7.1	2	22.2	5	15.6
Reduced stocking rates	7	77.8	14	100.0	6	66.7	27	84.4
Reduced growth & turn-off weights	2	22.2	2	14.3	2	22.2	6	18.8
Increased management costs	8	88.9	12	85.7	6	66.7	26	81.3
Change in management timing	7	77.8	12	85.7	9	100.0	28	87.5

5.2.3 Plant distribution on affected properties

There was a clear association between plant and region. In the Georgina basin, all respondents indicated that the plant of concern was *Acacia georginae*, the Georgina gidgee. In north Queensland and the Desert Uplands, the plant of concern was *Gastrolobium grandiflorum*, commonly called heart-leaf poison bush, desert poison bush or wallflower poison bush.

Table 4: Summary of responses about distribution of FL-plants on affected properties. For each row, the number of responses are presented as a count and as a percentage of the total number of respondents for that region. Limited to those respondents that indicated they do have FL-plants on their property

	NQ		DU		GA		Total	
	9		14		9		32	
Density of plants	n	% of total	n	% of total	n	% of total	n	% of total
Scattered at low density across larger areas	3	33.3	6	42.9	1	11.1	10	31.3
Variable with some areas of high density plants	3	33.3	5	35.7	2	22.2	9	28.1
Mostly high density plants in affected areas	2	22.2	3	21.4	6	66.7	8	25.0

There was no clear pattern of distribution in any one region or across all regions.

5.2.4 Which plant stages are poisonous

Table 5: Summary of responses about which plant stages are poisonous on affected properties. For each row, the number of responses are presented as a count and as a percentage of the total number of respondents for that region. Limited to those respondents that indicated they do have FL-plants on their property

	NQ		DU		GA		Total	
	9		14		9		32	
Poisonous stage	n	% of total	n	% of total	n	% of total	n	% of total
Flowering and seed pod stage	6	66.7	4	28.6	9	100.0	15	46.9
Young growing plants	5	55.6	6	42.9	4	44.4	12	37.5
Fresh green growth	8	88.9	11	78.6	6	66.7	22	68.8
Dried plant material	0	0.0	0	0.0	4	44.4	2	6.3
Trunk or branches	1	11.1	2	14.3	1	11.1	4	12.5

There was variation in response about which plant stages were poisonous.

The most common response overall was fresh green growth.

In the Georgina, the flowering or seed pod stage was considered poisonous by all respondents, whereas there was less consistency in the other two regions about the flowering or pod stage.

Respondents were asked to indicate a time of year when poisonous plant stages might be more common. Most respondents indicated that poisonous stages may occur at any time of year depending on other conditions such as rain or fire.

A very small number of respondents indicated that poisoning may be more common in specific seasons including Spring (one each from DU, GA), Spring and Summer (one from GA), Summer (one from NQ), or Autumn and Winter (one from NQ).

5.2.5 Impact of land and climate events on poisoning risk

Respondents were asked to indicate whether various events (fire, rain, land clearing etc) would be likely to impact FL-plant poisoning risk.

Responses were graded according to the following scale:

- reduced risk of poisoning = -1
- no change in risk of poisoning = 0
- increased risk of poisoning = +1
- don't know = missing

Responses were then summed across each region. This meant that the larger a positive score, the more support there was for a positive association between the event and increased risk of poisoning.

Increasingly negative scores indicate protective events, associated with reduce poisoning risk and scores that are close to zero indicate events that may have little association with poisoning risk.

Table 6: Summary of responses about events and their influence on poisoning risk. The effect of an event on risk of poisoning was assessed as reducing risk (score of -1), having no effect on risk (score of 0) and increasing risk (score of +1). Scores from all respondents within a region were summed to produce overall scores for each event. n= number of responses for each event. Limited to those respondents that indicated they do have FL-plants on their property

Events	NQ		DU		GA		Combined	
	n	Score	n	Score	n	Score	n	Score
Land clearing or new fence lines	6	4	12	10	3	-1	21	13
Soil disruption	7	3	11	11	3	0	21	14
After a fire	8	8	14	14	5	2	27	23
Change of season: wet to dry	5	-2	11	0	4	3	20	-1
Change of season: dry to wet	7	5	13	10	4	-2	24	13
During drought when other feed is scarce	6	2	13	9	7	6	26	15
In a good year when other feed is available	5	-4	11	-8	6	-5	22	-16
After a flood	1	0	11	-2	4	-2	16	-3
Planted crop & heartleaf came up thickly under crop and caused deaths	0	0	1	1	0	0	1	1

The most consistent agreement across respondents was for the following conclusions for effects of land and climate events o plant poisoning risk:

- Increased risk of poisoning after a fire. Comments by respondents indicated that this was associated with fresh green growth that occurred after a fire.
- Reduced risk of poisoning in good years when other feed is available.
- Increased risk of poisoning in drought when other feed is scarce.
- Increased risk of poisoning after soil disruption; again associated with fresh green growth.
- Increased risk of poisoning associated with land clearing or new fence lines. This was mainly reported in NQ and DU and less so in GA, perhaps because fencing and land clearing may be less common in the GA region. Again comments indicated that this risk was associated with fresh green growth of FL-plants.
- Increased risk of poisoning when seasons changed from dry to wet; apparently associated with fresh green growth soon after rain.

- There was little clear evidence for a strong effect (either an increase or a reduction in poisoning risk) associated with change from wet to dry seasons or following a flood.
- One respondent indicated that they had experienced a specific problem when a crop was planted. The crop grew and was eaten without a problem but Heartleaf had grown as well and as the crop was eaten down, Heartleaf started to dominate and animals began to get poisoned.

5.2.6 Animal management factors and poisoning risk

Table 7: Summary of responses about livestock management factors and poisoning risk. The effect of each factor on risk of poisoning was assessed as reducing risk (score of -1), having no effect on risk (score of 0) and increasing risk (score of +1). Scores from all respondents within a region were summed to produce overall scores for each factor. n= number of responses for each factor. Limited to those respondents that indicated they do have FL-plants on their property

	NQ		DU		GA		Combined	
	n	Score	n	Score	n	Score	n	Score
Newly introduced cattle unfamiliar with the plant	8	8	14	13	6	3	28	24
Soon after cattle enter a paddock with poisonous plants (shorter time interval)	6	-4	12	5	7	6	25	7
Days or weeks after cattle enter a paddock with poisonous plants (longer time interval)	6	-1	10	3	3	3	19	5
When cattle are mustered or pushed too hard	8	8	14	13	9	9	31	30
When cattle are handled very gently and slowly	6	-5	9	-6	9	-5	24	-16
When cattle are yarded and held off feed and/or water	5	-3	9	-1	6	2	20	-2
When poison is bad shut off water & feed hay	0	0	0	0	0	0	0	0
When cattle are mustered by helicopter	1	1	0	0	0	0	1	1
Trap into clean paddock for 1 week to cool down/empty out	1	-1	0	0	0	0	1	-1
Any added stress or handling bad	1	1	2	2	0	0	3	3
50%+ of new deaths are found within sight of water	1	1	1	1	0	0	2	2
Cattle in paddock longer than planned due to season	0	0	1	1	0	0	1	1

The most consistent agreement was for the following:

- Increased risk of poisoning when new cattle that are unfamiliar with the plant are introduced into affected paddocks.
- Increased risk of poisoning when cattle are pushed too hard.
- Reduced risk of poisoning when cattle are handled very gently and slowly.

Other livestock management factors were not consistently described as protective or risky by respondents.

A small number of respondents indicated that most dead animals are found near water.

Another group of respondents indicated that holding animals in a yard or trap paddock to allow recovery from exposure before moving them longer distances is a useful risk reduction measure. A couple of respondents indicated that they believe that yarding animals with feed, but without water, for a period of time will reduce poisoning risk.

5.2.7 Contribution of fluoroacetate plants to mortalities

Properties were asked to indicate the contribution of FL-plants to mortalities in an average year for each class of cattle, using a four-point scale:

- 0 = No contribution
- 1= Cause of some deaths
- 2= Variable cause but important in some years
- 3= Major cause of death

Table 8: Average importance score by region to assess contribution of FL plants to mortality in a typical year. Responses limited to those properties that reported they had FL plants on their property

	NQ	DU	GA	Total
First calvers	1.9	1.8	2.1	1.9
All other cows	1.9	1.9	2.2	1.8
Calves up to weaning	1.1	1.1	1.2	1.2
Weaners	1.7	1.6	1.9	1.6
Steers	0.8	0.7	2.3	1.3
Bulls	2.1	1.1	2.3	1.7

In general, breeders and bulls appeared to be most likely to be affected by FL plant toxicity, followed by weaners and steers.

A small number of properties with FL plants indicated that they purposefully kept some classes of cattle out of FL-plant affected areas on their properties and this may explain part of the variability in impact of FL plants on classes of cattle.

Table 9: Average importance score by region to assess contribution of FL plants to mortality in the year when the highest mortality occurred during the previous decade. Responses limited to those properties that reported they had FL plants on their property

	NQ	DU	GA	Total
First calvers	2.3	1.3	2.0	1.8
All other cows	2.3	2.5	2.1	2.2
Calves up to weaning	0.4	0.5	2.0	0.9
Weaners	1.4	1.5	2.0	1.4
Steers	1.6	0.3	2.5	1.3
Bulls	2.4	2.0	2.4	2.2

Comparing the results of the two tables above provides information on producer opinions about the contribution of FL plants to mortality in an average year and in a high-mortality year.

In general, high-mortality years are associated with an increase in contribution of FL plants to mortality in breeders and bulls in all regions. In the Georgina the results suggest that FL plants are capable of making an important or major contribution to mortality in all classes of cattle.

When mortality was highest, most respondents reported rainfall to be drier than average or severely dry. There were a smaller number of respondents in other categories including one from DU indicating that conditions were very wet. Most respondents indicated that pasture conditions were poor in years when the highest mortality occurred.

These findings are consistent with low rainfall and poor pasture conditions contributing to elevated mortality risk.

5.2.8 Management options

Table 10: Count of responses by management strategy employed to combat FL-plant toxicity. Responses limited to those properties that reported they had FL plants on their property

	NQ		DU		GA		Total	
Count of respondents by region	**9**		**14**		**9**		**32**	
	n	**% of total**	**n**	**% of total**	**n**	**% of total**	**n**	**% of total**
Fenced off and never use for grazing	1	11.1	5	35.7	0	11.1	7	21.9
Fenced off and graze when risk is low	6	66.7	8	57.1	4	44.4	18	56.3
Management changes	6	66.7	6	42.9	9	100.0	21	65.6
Eradicate or remove plants from affected areas	3	33.3	11	78.6	0	0.0	14	43.8
No management changes	0	0.0	0	0.0	0	0.0	0	0.0

Different strategies appear to be employed in different regions.

In the Georgina (GA), all respondents indicated that they employ management changes and some have controlled grazing in risk areas. It seems possible that the large land areas and associated need to limit input costs may be influencing their decisions.

In contrast the DU region seems to involve people using the most different strategies.

Six properties from two regions indicated that they have fenced off land and never use it for grazing.

Table 11: Details of respondents indicating they fence off land and never use it for grazing. Responses limited to those properties that reported they had FL plants on their property.

Region	Prop_ID	Area fenced	Total area	%	km fence	km/100 ha	$/km
NQ	11	4500	22000	20.5	10	0.2	2000
DU	23	250	8800	2.8	15	6	2000
DU	25	2800	16500	17.0	15	0.5	2000
DU	26	1200	14545	8.3			
DU	31	16000	80900	19.8	100	0.6	1500
DU	32	4000	67000	6.0	100	2.5	2500

The fenced land ranged from 3% to 20% of the total land area of the property.

5.2.9 Impact on stocking rate

A number of approaches were used to explore associations between the proportion of property affected by FL-plants and measures of stocking rate. Stocking rate was measured either using ha per breeder or breeders per 100 ha. These two measures are alternative methods for expressing the same attribute and the choice of one measure or another was based on the visual appearance of the plots as a way of demonstrating possible associations.

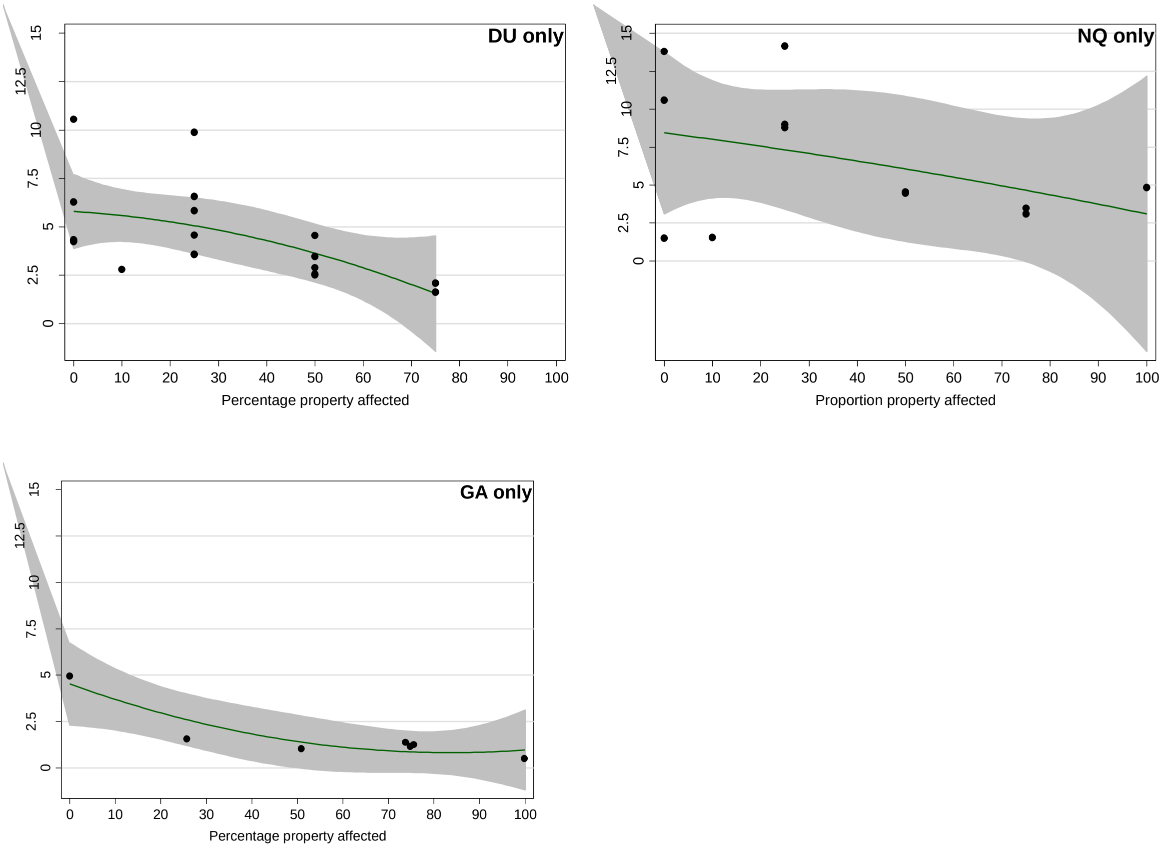


Figure 9: Scatter plots of percentage of property affected with FL-plants (X-axis) and stocking rate (breeders per 100 ha) for each region. Each plot shows a fitted quadratic line and the shaded area represents the 95% confidence interval around the fitted line

These plots provide evidence of an association between the proportion of property affected by FL-plants and stocking rate. In each of the three regions as a higher percentage of property is affected by FL-plants, the stocking rate (breeders per 100 ha) declines. The patterns appear to be best fitted with a quadratic relationship. The values are different for each region and the general pattern is quite similar between regions, allowing for small variations in the shape of the fitted lines. The wider confidence intervals in north Queensland reflect increased variability in responses from that region.

Caution is urged in interpreting these findings. The following figure shows a very clear association between rainfall and stocking density. As rainfall increases the number of ha required per breeder declines. Descriptive information presented earlier in this report shows the rainfall patterns in each region.

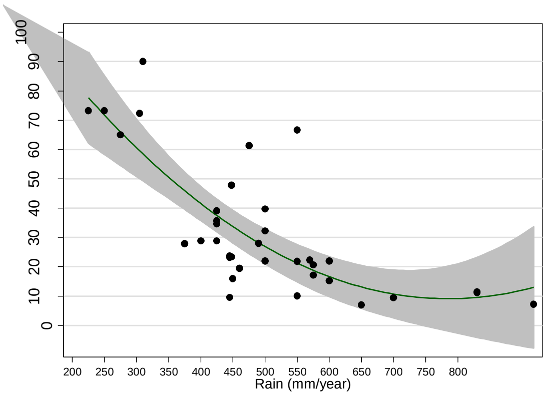


Figure 10: Scatter plot of ha per breeder vs annual rainfall with largest value of ha per breeder and of rainfall omitted. A quadratic fitted line is shown with the shaded area showing the 95% confidence interval region for the fitted line. Based on combined data from all properties. The two extreme values were omitted because they appeared to be outliers with respect to all other data points

It seems apparent that there may be confounding between rainfall, proportion of property affected with FL-plants and stocking rate and it is not possible to distinguish a clear and separate effect of FL-plants on stocking rate.

There was some suggestion of an association between rainfall and percentage of property affected by FL-plants was less clear (see following Figure). In NQ there appeared to be an association with lower rainfall areas tending to have higher percentage areas affected by FL-plants. The association was less clear in the other two regions, perhaps influenced in part by relatively little variation in annual rainfall in these two regions.

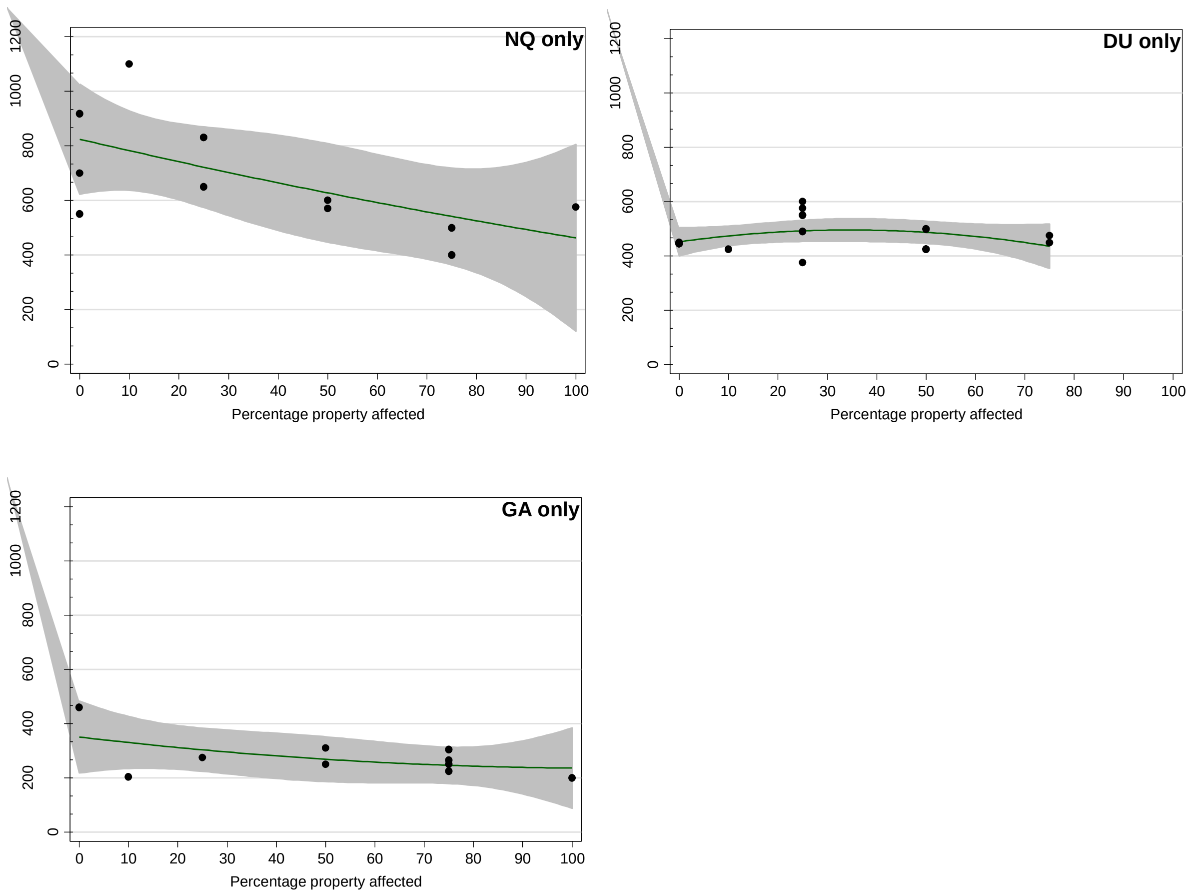


Figure 11: Scatter plot of percentage of property affected (X-axis) and annual rainfall (Y-axis) for each region. Each plot shows a fitted quadratic line and the shaded area represents the 95% confidence interval around the fitted line

A multivariable linear model was then fitted with breeders per 100 ha as the outcome and with fixed effects coding for percentage of property affected by FL-plants (0%, 1 to 25%, >25%), region and annual rainfall (mm per year). Marginal means for stocking density (breeders per 100 ha) were generated as predictions for each combination of region and FL-plant score. This produced an estimate of effect adjusted for effects of variable rainfall on stocking density.

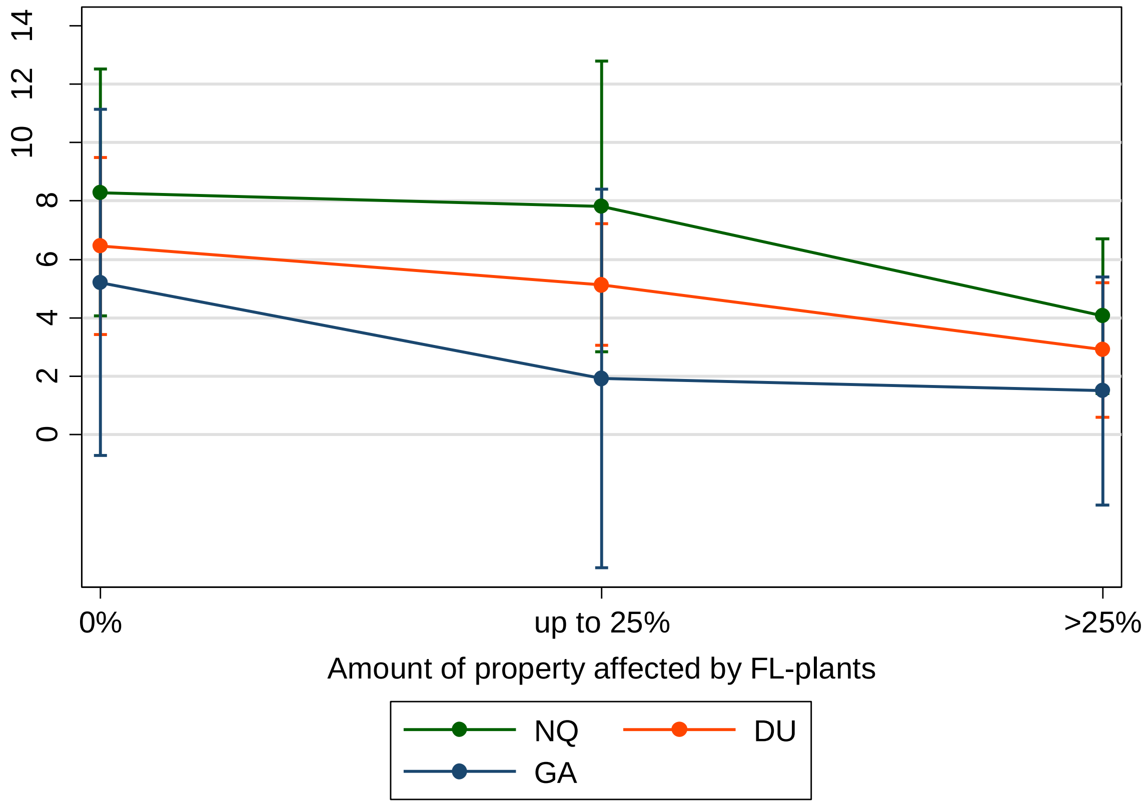


Figure 12: Marginal mean stocking density (breeders per 100 ha) by region and category of property affected by FL-plants. Bars represent 95% confidence interval. Derived from a multivariable model including region, category of property affected by FL-plants and rainfall

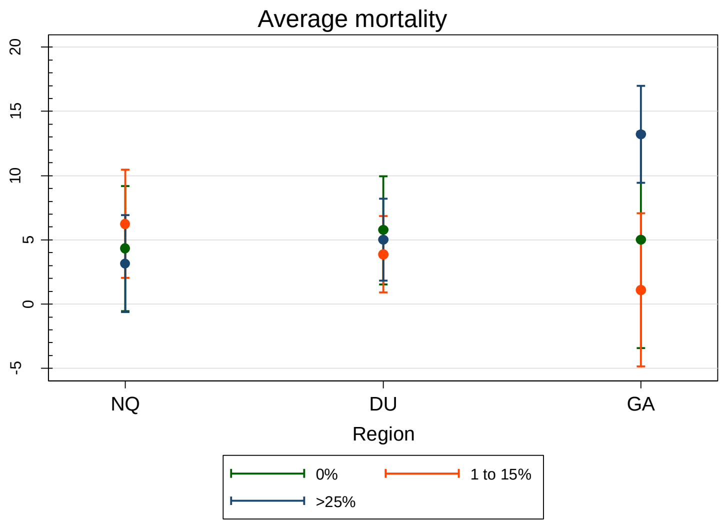
Figure 12 indicates that as the percentage of property affected by FL-plants moves from 0% (none of the property affected) to the highest level (>25%), the mean stocking density (breeders per 100 ha) is reduced by about half in each region. The actual impact is different in each region because of the different starting levels for stocking density.

Pairwise statistical comparisons of the means indicated that none of the differences were statistically significant (p>0.05) but two of the comparisons reported p-values that tended towards significance. In north Queensland and Desert Uplands, follow-up tests comparing the stocking density at the highest category of percentage of property affected by FL-plants to the stocking density for properties with no FL-plants reported p-values of 0.086 and 0.059, respectively. The difference in the Georgina was not significant (p=0.3) and this may reflect the lower starting value and relatively higher variation for stocking densities for properties in this region as reflected by the confidence interval bands.

These findings suggest that even adjusted for rainfall, as the percentage of property affected by FL-plants rises there is a progressive fall in stocking density and that worst affected properties may have a stocking density that is approximately half the stocking density for properties in the same region that are unaffected by FL-plants.

5.2.10 Impact on mortality risk

This section presents marginal means derived from multivariable linear regression models with fixed effects coding for region, proportion of property affected by FL-plants (coded as a three level categorical variable) and the interaction between these two fixed effects. Separate analyses were conducted for each livestock class: first calvers, adult cows, calves, weaners, steers and bulls. Within each livestock class separate analyses were conducted using mortality estimates for a typical year (reflecting background or average mortality), the highest mortality



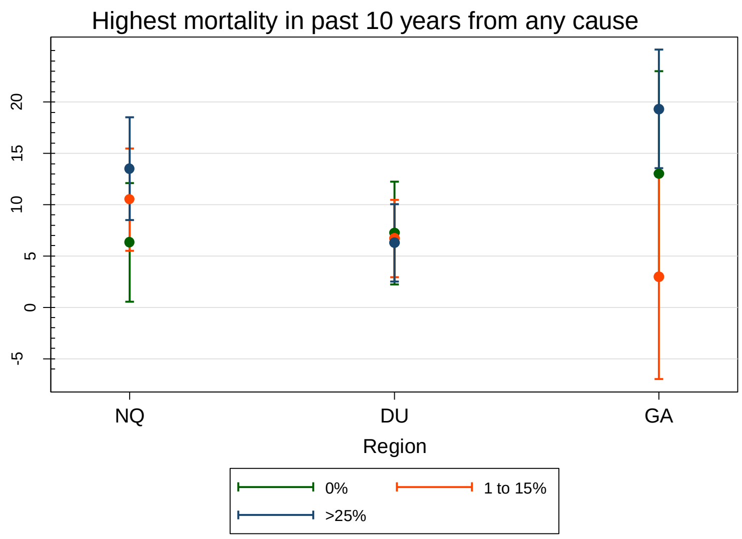


Figure 13: Marginal mean annual mortality % for first calving breeders, by category of FL-plant density and region. Derived from a regression model with fixed effects coding for region and fluoro-status. Bars represent 95% confidence intervals. Top plot presents estimates of average mortality and the bottom plot presents estimates from the highest annual mortality in the past 10 years from any cause

Pairwise t-tests were used to compare mortality percentage between the levels of FL-plant density within each region. There was no difference for any of these three comparisons in

NQ and DU (p>0.05). For the highest mortality estimate in the past ten years in GA, properties with >25% area affected by FL-plants had a significantly higher mortality than properties with no FL-plants (p=0.001).

The point estimates (coloured circles on the plots) provide an estimate of average expected mortality under the various conditions and may be used to derive estimates of the impact of FL-plants.

Additional plots were used to further explore an association between FL-plants and mortality in first calvers.

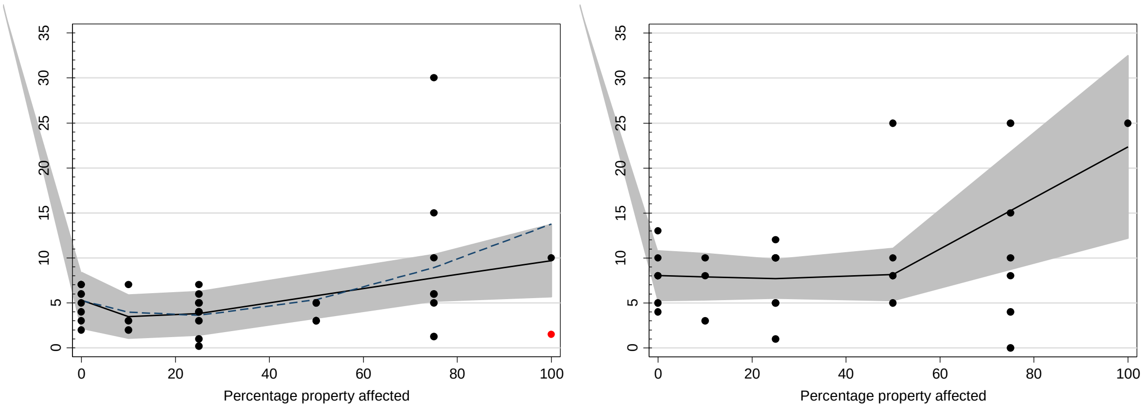


Figure 14: Scatterplot of all properties combined showing association between mortality in first calvers (annual %) in an average year against percentage of property affected by FL-plants. Solid line represents a fractional polynomial fitted line based on all data points and the shaded area is a 95% confidence interval for this line. The dotted line is a fr-poly fitted line to all points except the red circle point in the bottom right. The left most plot is from a typical year and right most plot represents the largest mortality in the past decade from any cause.

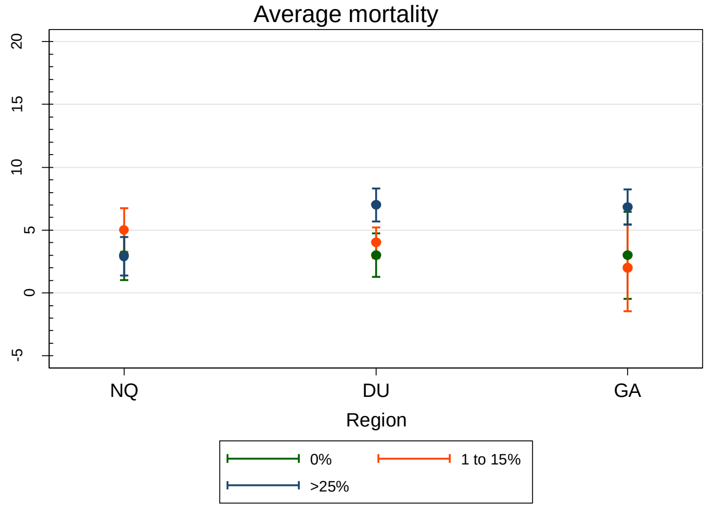
Figure 14 is a summary plot of first calver mortality against percentage of property affected by FL-plants.

The solid line is a fitted fractional polynomial line, fitted to all the data. A fractional polynomial fit provides a flexible fitted line that allows for non-linear fitting to data. The fitted solid line shows an initial steep rise in annual mortality when moving from no FL-plants to some and then a gradual and progressive rise as the percentage of area affected increases.

In the typical mortality data plot (on the left of Figure 13), there was one property with more than 75% of area affected, that had a relatively low mortality percentage despite having a high % area affected by FL-plants – indicated by the red circle in the bottom right corner of the plot. The category of >75% area affected is recorded in the data as 100%. This property has implemented specific management changes that according to the owner have reduced their breeder mortality risk to background levels.

As a type of sensitivity analysis, the red circle point was filtered and a fractional polynomial line was refitted and displayed as the dotted line (without any confidence interval). As expected the two fitted lines are very similar on the left side of the plot but at the right edge of the plot they diverge because the dotted line does not incorporate the red circle while the solid line does. If the red circle value can be assumed to be low only because of management intervention and if the upper dark circle at this same point on the x-axis were to be more representative of mortality without major intervention, then the dotted line may represent a more valid estimate of the change in mortality risk as the percentage of property affected rises.

The plots provide interesting results. The fitted lines show that average mortality in high mortality years is a few percentage points higher than average mortality in typical years (comparing the right plot to the left plot) and that as the percentage of property affected by FL-plants rises, the upward shift in mortality in a high mortality year becomes both very much more evident (higher estimates) and more variable (wider confidence band). The findings are considered to be consistent with an impact of FL-plants on mortality in both typical years and becoming more pronounced in high mortality years.



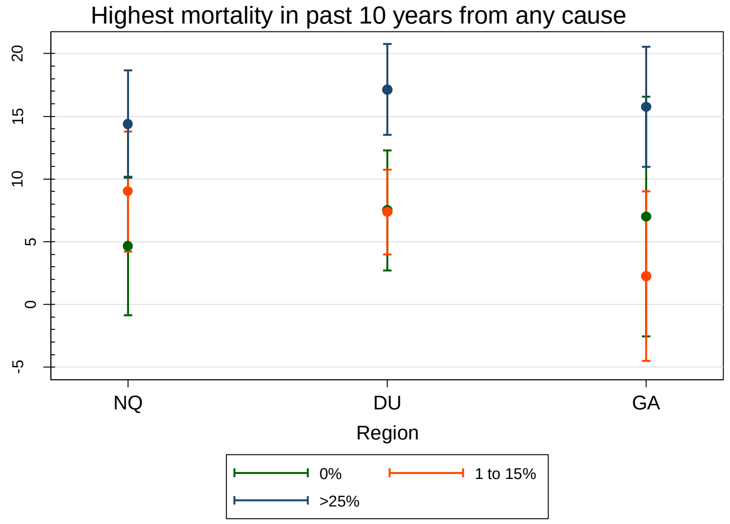


Figure 15: Marginal mean annual mortality % for cows, by category of FL-plant density and region. Derived from a regression model with fixed effects coding for region and fluoro-status. Bars represent 95% confidence intervals. Top plot presents estimates of average mortality and the bottom plot presents estimates from the highest annual mortality in the past 10 years from any cause.

Pairwise testing detected a number of significant comparisons. In an average mortality year (top plot), mortality for properties with >25% area affected by FL-plants was significantly higher than both other categories for DU and GA (p<0.05) but not for NQ (p>0.05). For the high mortality estimates, properties with >25% area affected by FL-plants had higher mortality in cows than unaffected properties in NQ and DU (p<0.05). In GA, properties with >25% area affected by FL-plants had higher mortality in cows than properties with 1 to 25% area affected by FL-plants (p<0.05). Other comparisons were not significant.

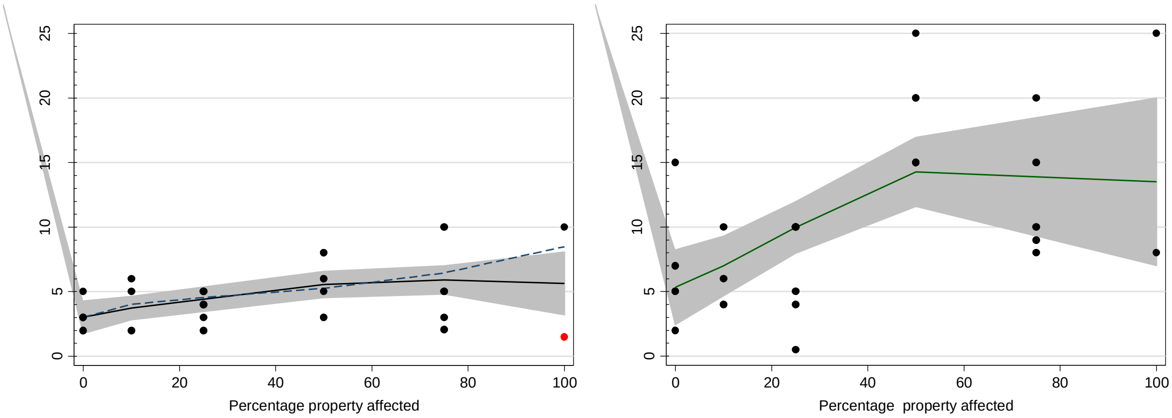


Figure 16: Scatterplot of all properties combined showing association between mortality in cows (annual %) in an average year against percentage of property affected by FL-plants. The solid line represents a fractional polynomial fitted line based on all data points and the shaded area is a 95% confidence interval for this line. The dotted line is a fractional polynomial fitted line to all points except the red circle point in the bottom right. Left most plot is from a typical year and right most plot represents the largest mortality in the past decade from any cause.

Figure 16 is a summary plot of adult breeder mortality against percentage of property affected by FL-plants.

The fitted solid line shows an initial steep rise in annual mortality when moving from no FL-plants to some and then a gradual and progressive rise as the percentage of area affected increases.

There was one property with more than 75% of area affected, that had the lowest reported breeder mortality percentage – indicated by the red circle in the bottom right corner of the plot. The category of >75% area affected is recorded in the data as 100%. This property has implemented specific management changes that according to the owner have reduced their breeder mortality risk to background levels.

As a type of sensitivity analysis, the red circle point was filtered and a fractional polynomial line was refitted and displayed as the dotted line (without any confidence interval). As expected the two fitted lines are very similar on the left side of the plot but at the right edge of the plot they diverge because the dotted line does not incorporate the red circle while the solid line does. If the red circle value can be assumed to be low only because of management intervention and if the upper dark circle at this same point on the x-axis were to be more representative of mortality without major intervention, then the dotted line may represent a more valid estimate of breeder mortality when >75% of the property is affected by FL-plants. Under this scenario, there is an initial steep rise in mortality as the percentage of property affected rises from 0 to 10%, then a plateau in mortality and finally another rise as the percentage of property affected rises above 50%.

The findings for older cows were very consistent with those described earlier for first calvers. The only difference is that there is a more pronounced early rise in mortality in high mortality years as the percentage of area affected by FL-plants rises and the effect then flattens out.

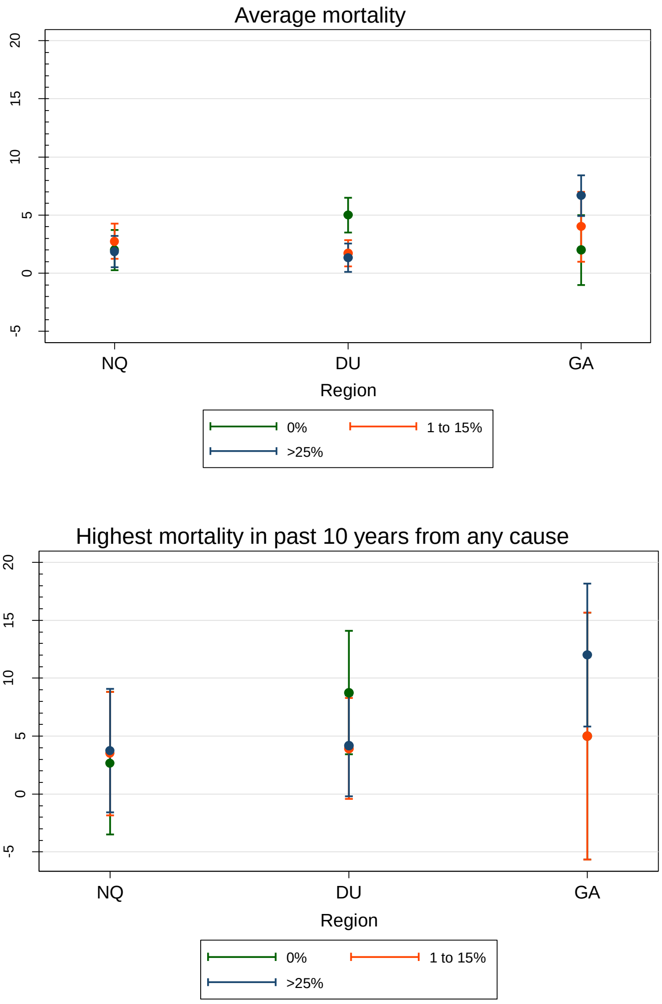


Figure 17: Marginal mean annual mortality % for calves at foot, by category of FL-plant density and region. Derived from a regression model with fixed effects coding for region and fluoro-status. Bars represent 95% confidence intervals. Top plot presents estimates of average mortality and the bottom plot presents estimates from the highest annual mortality in the past 10 years from any cause.

Pairwise t-tests were used to compare mortality percentage between the levels of area of property affected by FL-plants within each region.

For average mortality estimates properties with >25% area affected by FL-plants had higher calf mortality in DU and GA compared to properties with no FL-plants ($p<0.05$). Other comparisons were not significant.

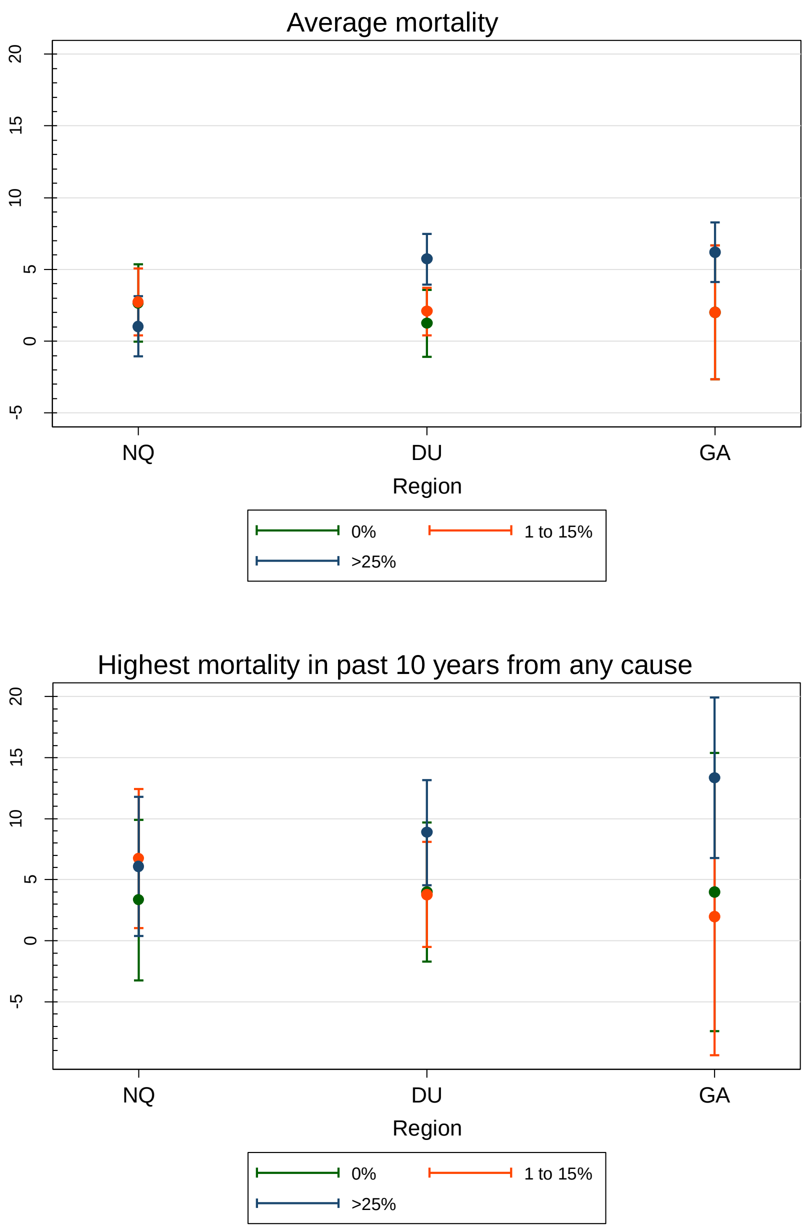
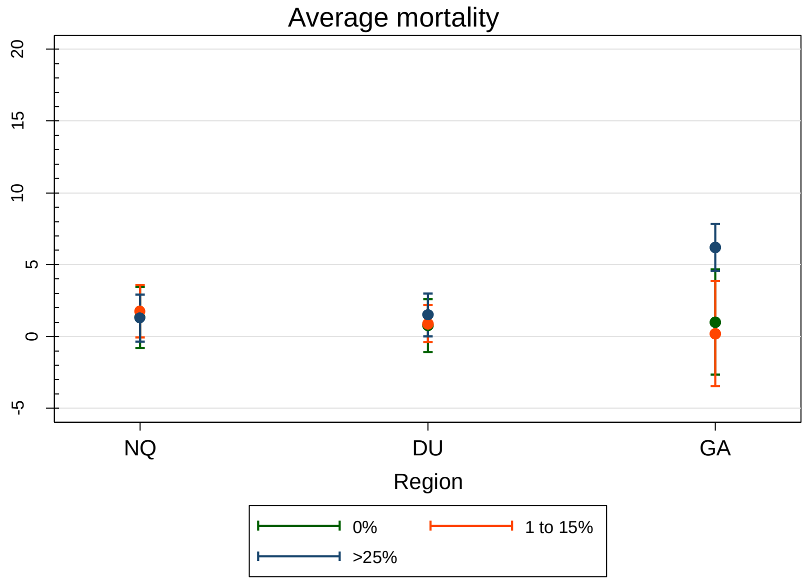


Figure 18: Marginal mean annual mortality % for weaners, by category of FL-plant density and region. Derived from a regression model with fixed effects coding for region and fluoro-status. Bars represent 95% confidence intervals. Top plot presents estimates of average mortality and the bottom plot presents estimates from the highest annual mortality in the past 10 years from any cause.

Pairwise t-tests were used to compare mortality percentage between the levels of area of property affected by FL-plants within each region.

For average mortality estimates properties with >25% area affected by FL-plants had higher weaner mortality in DU compared to properties with either no FL-plants or 1 to 25% of area affected ($p<0.05$). Other comparisons were not significant.



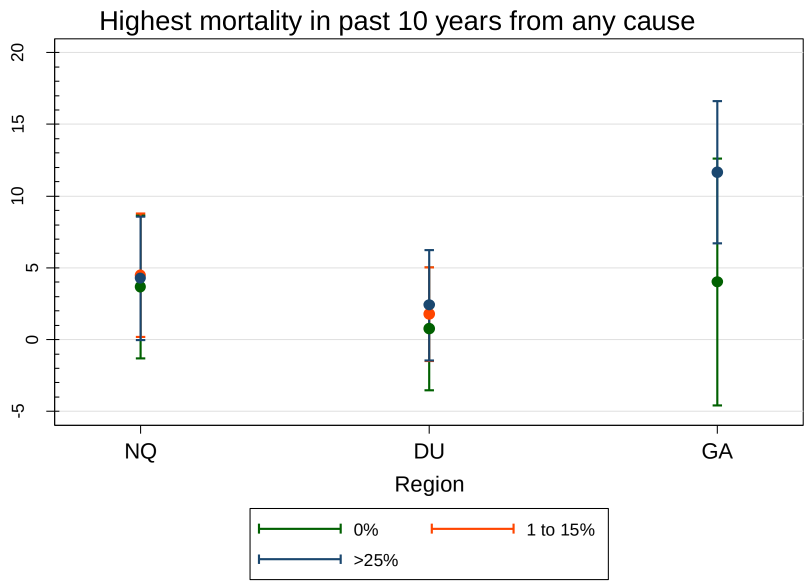


Figure 19: Marginal mean annual mortality % for steers, by category of FL-plant density and region. Derived from a regression model with fixed effects coding for region and fluoro-status. Bars represent 95% confidence intervals. Top plot presents estimates of average mortality and the bottom plot presents estimates from the highest annual mortality in the past 10 years from any cause.

Pairwise t-tests were used to compare mortality percentage between the levels of area of property affected by FL-plants within each region.

For average mortality estimates properties with >25% area affected by FL-plants had higher steer mortality in GA compared to properties with either no FL-plants or 1 to 25% of area affected ($p<0.05$). Other comparisons were not significant.

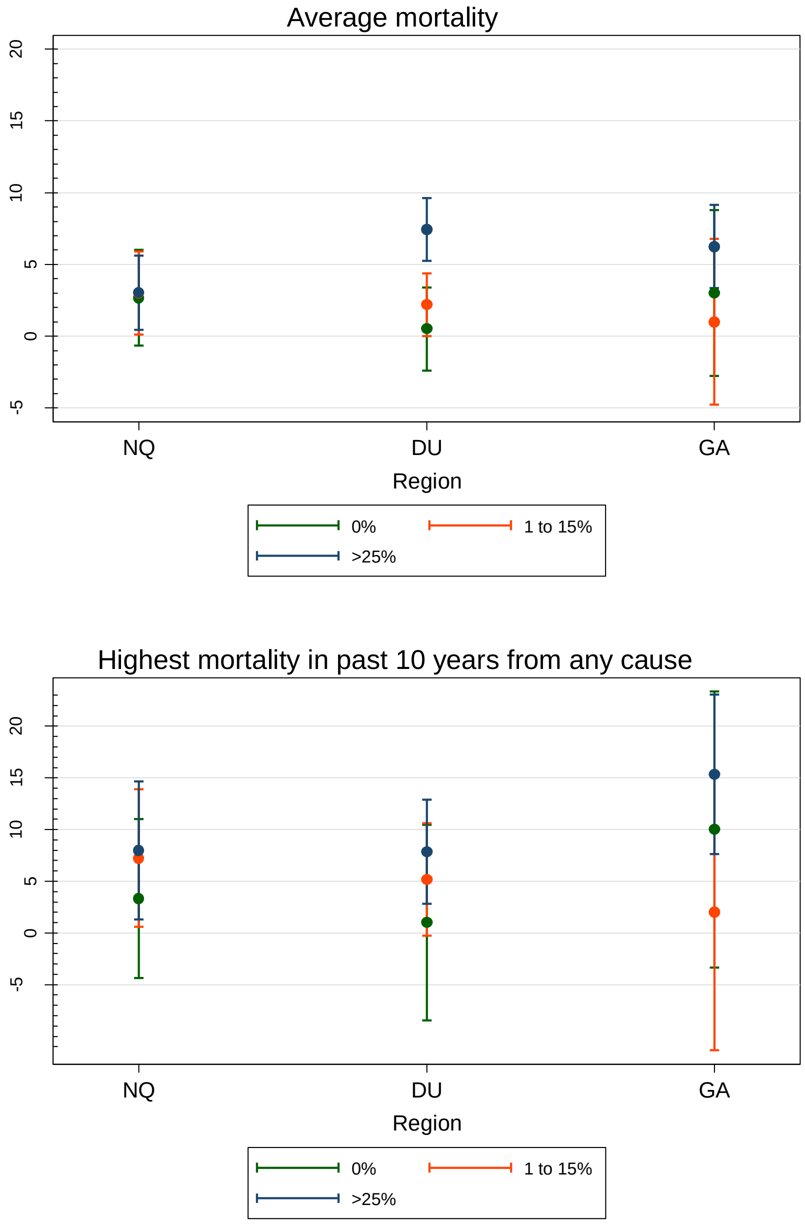


Figure 20: Marginal mean annual mortality % for bulls, by category of FL-plant density and region. Derived from a regression model with fixed effects coding for region and fluoro-status. Bars represent 95% confidence intervals. Top plot presents estimates of average mortality and the bottom plot presents estimates from the highest annual mortality in the past 10 years from any cause.

Pairwise t-tests were used to compare mortality percentage between the levels of area of property affected by FL-plants within each region.

For average mortality estimates properties with >25% area affected by FL-plants had higher bull mortality in DU compared to properties with either no FL-plants or 1 to 25% of area affected ($p<0.05$). Other comparisons were not significant.

5.2.11 Summary of survey findings

A random sample of producers from each region were selected from lists of producers developed by the project team and were contacted in stage 1 of the survey. Producers completing stage 2 surveys were derived largely from the stage 1 survey with a small number of additional producers being identified through industry consultation. An attempt was made to seek input from both affected and unaffected producers in each region. The number of producers completing stage 2 surveys met or exceeded the targets for each region. There were difficulties reaching target response rates in the Georgina Basin in particular and it was only possible to get a completed stage 2 survey from one producer who was unaffected by FL-plants despite stage 1 survey results suggesting that a reasonable proportion of properties in this region might be unaffected.

The main source of data for analyses conducted in this report was the stage 2 surveys. All data and information were provided willingly by producers. Our findings are considered to be representative of producers in these regions.

It is possible that some information provided by producers may be biased towards amplifying the adverse effects of FL-plants perhaps in an attempt to raise awareness of the issue and facilitate increased funding of RD&E towards mitigating the effects of FL-plants in affected areas. However, we explicitly sought and obtained survey responses from producers in the same regions whose properties were unaffected by FL-plants and compared information from these two sources to explore effects of FL-plants. In addition our experience in past survey projects with producers is that in general producers tend to under-estimate adverse measures such as mortality rates and over-estimate production measures such as weaning rates. Our survey derived estimates of weaning percentage were very consistent with those recently reported in the CashCow report (McGowan et al 2014) and mortality rates were consistent with measures reported in the recent Breeder Mortality report (Henderson et al 2013).

The surveys provided data and information as quantitative estimates and as a range of comments and anecdotal responses to questions. This section has concentrated on summary findings presented in aggregated form as counts and percentages of responses to various qualitative questions and as numeric estimates and plots derived from analyses applied to numeric estimates provided by respondents.

The findings suggest that in each of the three regions, a substantial proportion of cattle producers indicate that they are affected by FL-plants and that FL-toxicity is perceived to be an important cause of a range of adverse impacts, most notably increased mortality in livestock, reduced stocking rates and increased management requirements.

Producers reported a range of views about variation in toxicity of plants based on plant stage of growth, time of year, rainfall and other events.

All affected producers surveyed reported making management changes and adaptations as a result of the toxicity problems and a number of producers reported that parts of their properties are unused due to the presence of fluoroacetate containing plants.

Findings of analyses applied to numeric estimates were consistent with qualitative survey findings. There was evidence of increased mortality rates and reduced carrying capacity in properties that were most extensively affected with FL-plants. Our findings provide point estimates of mortality rates in different classes of cattle and under different conditions.

While there is uncertainty associated with these estimates and they are based on relatively small sample sizes, they are considered to be valid estimators of FL-plant effects in each of the three regions. Our findings suggest that in most classes of cattle there is an increased mortality from year to year on properties with higher percentages of land area affected by FL-plants and that these effects are exacerbated in years when mortality is high for any reason.

The survey findings relating to management impacts and changes were consistent with findings raised in workshops and case studies and are discussed in more detail in other parts of this report.

6 Economic analyses

6.1 Estimated economic cost of the impact of Fluoroacetate in grazing cattle

The following table presents a consolidated estimation of the current opportunity cost per annum of the impact of Fluoroacetate in grazing cattle in Northern Australia. The notes below the table provide an explanation of the source the data or the calculation used to derive the outcome presented.

Factors	Units	Notes	DU	NQ	GA	Total
Total Area of region	'000ha	1	7,500	11,000		
Proportion affected	%	2	50%	40%		
Area affected	'000ha	3	3,750	4,400		
Estimated Stocking rate	ha/hd	4	23.6	21.3		
Current Breeder Numbers exposed	head	5	158,900	206,600	120,000	485,500
Proportion of dry cattle	%	6	40%	40%	50%	
Total Estimated Numbers	head	7	264,833	344,300	240,000	849,133
Dry Cattle affected	head	8	105,933	137,700	120,000	363,633
Weaning rates						
With	%	9	75%	65%	76%	
Without	%	10	80%	80%	80%	
Adult Cow Death rates						
With	%	11	5.50%	5.00%	5.00%	
Without	%	12	3.00%	2.00%	3.00%	
Dry Cattle Death rates						
With	%	13	2.00%	2.25%	4.50%	
Without	%	14	2.00%	1.00%	1.50%	
Current turnoff	head	15	108,317	120,862	79,800	308,979
Potential turnoff	head	16	120,234	159,771	90,600	370,605
Increase in turnoff	head	17	11,918	38,909	10,800	61,627
Net Farm Gate value	$/head	18	748	748	640	
Opportunity Cost	$M	19	**8.91**	**29.10**	**6.91**	**44.93**

Notes:

1. Section 6.3 of this report.
2. Section 6.3 of this report.
3. Section 6.3 of this report.
4. Table 13, Sample data Breeders per ha by region and fluoroacetate status for DU and NQ.
5. Calculation of Note 3 / Note 4. Georgina region by survey data of all property owners in the region.
6. Estimated proportion of dry cattle in herds from survey data. Georgina has higher proportion due to the number of enterprises running larger numbers of steers through to bullocks and some ‘fattening only’ enterprises.
7. Note 5 divided by Note 6.
8. Difference between total herd numbers (Note 7) and total Breeder numbers (Note 5)
9. Sample data weaning rate in adult breeders by region and fluoroacetate status. (refer appendices)
10. Sample data weaning rate in adult breeders by region and fluoroacetate status. With the exception of the Georgina where the sample size for the Non fluoroacetate status is 1 and has recorded a value less than the properties with fluoroacetate. In this case I have adopted the same Without weaning rate as for DU and NQ. (refer appendices)
11. Sample data adult breeder mortality rates in an average year by region and fluoroacetate status. (refer appendices)
12. Sample data adult breeder mortality rates in an average year by region and fluoroacetate status. (refer appendices)
13. Sample data weaner and steer mortality in an average year by region and fluoroacetate status. (refer appendices)
14. Sample data weaner and steer mortality in an average year by region and fluoroacetate status. (refer appendices)
15. Note 5 x Note 7 minus Note 5 x Note 9 minus Note 8 x Note 14.
16. Note 5 x (1+Note 6) x Note 8 minus Note 5 x Note 9 minus Note 8 x Note 14.
17. Note 17 minus Note 16.

18. Net Farm Gate = Gross value per head less freight costs and MLA levies, see table below.

		NQ/DU	GA	
		$	$	Notes
Gross Value per head	$/head	783	700	1
Freight to market	$/head	30	55	2
Levies	$/head	5	5	3
Gross value all sales	$/head	748	640	4

1. Sourced from Northern Beef Report 2013 – Gross Value per head sold (all sales) – (NQ/DU North Queensland) and (GA Queensland West South West).
2. Sourced from Northern Beef Report 2013 – Total freight costs/head sold.
3. MLA levies per head sold.
4. Net Farm Gate value per head sold

19. Total economic costs per annum in $M.

6.2 Summary of economic analysis

The total direct losses attributed to fluoroacetate toxicity in the three regions is calculated at $45million and this cost is attributed to stock losses and associated productivity losses.

The impact of reduced carrying capacity on properties affected by fluoroacetate poisoning has not been incorporated into the economic costs calculated above. In the survey conducted, 85% of respondents indicated that reduced stocking rate was an impact of fluoroacetate poisoning. The extent of the reduced stocking rate was not quantified in the survey data. However the case study participants provided information on With and Without fluoroacetate impact estimates of carrying capacity. This is shown in the table below.

Region	Increased Carrying Capacity
Northern Queensland	11%
Desert Uplands	55%
Desert Uplands	67%
Georgina Basin	43%

Due to the small sample size and specific nature of the case studies, we have not attempted to extrapolate this data across the whole of the region economic cost calculations. However, a reduced stocking rate due to the impacts of fluoroacetate toxicity would contribute to the total opportunity cost.

6.3 Public/Private costs and benefits

At an enterprise scale, it could be argued that one of the largest costs associated with the operation of a cattle enterprise is the opportunity cost of the capital engaged in the enterprise. If we assume that purchasers of land in areas affected by Fluoroacetate poisoning are well enough informed to adjust the purchase price of the property due to the economic factors shown above, then land values will reflect the lower performance outcomes. Therefore a large part of the opportunity cost is ameliorated by an adjustment in land values in Fluoroacetate country.

Examining the benefit side of the equation, all levels of scale benefit from a reduction in the impacts of Fluoroacetate poisoning. At the enterprise scale, the landholder would be able to increase production and output. At the regional scale, regional communities benefit from increased regional production and the multiplier effect. At the national scale, with 2.9% of the herd affected, the nation benefits from an increase in the output of the cattle industry, and the flow-on effects in exports and taxation revenues.

7 Case studies

The case studies present information as supplied by landholders during property visits. Some case studies represent an amalgamation of information from a number of sources and are meant to be a representation of the problem and the impacts in that region.

7.1 Case Study A

Figure 21 North Qld typical Heartleaf country

7.1.1 Property details

LOCATION – North Queensland

SHIRE - Flinders

PROPERTY SIZE – 13,000 hectares

PROPORTION OF PROPERTY WITH HEARTLEAF – 95%

7.1.2 Herd details

Average number of breeders	650	
Cattle breed	Brahman crossed with Brangus and Charbray	
Primary market	Supply young cattle to the backgrounding industry	
Average weaning rate -		
1st calvers	85%	
adult cows	65%	
Average death rate -	Without Fluoroacetate impact	With Fluoroacetate impact
1st calvers	1.5%	5.0%
adult cows	1.5%	8.0%
calves	0.5%	0.5%
weaners	1.0%	1.0%
steers	0.0%	0.0%
bulls	1.0%	2.5%

7.1.3 Synopsis of Heartleaf situation and impact

Heartleaf grows all over this property and considerable losses have been suffered in the past. Large losses were associated with introduced cattle when the current owner first came to the property. Management and infrastructure changes have been introduced and losses have been considerably reduced. The owner of case study A considers that his death rate is now possibly lower than in many parts of the north because there is always something (forage, shrubs etc) to eat in this country.

The country does not vary considerably from a good time to a dry time, so as infrastructure development reduces the losses from Heartleaf it is becoming safe breeding country.

7.1.4 Management systems developed to deal with Heartleaf

Holding paddocks and laneways have been established with fencing and then have been cleared of Heartleaf. The holding paddocks are approximately 100 hectares. Heartleaf was cleared from these areas using a combination of grubbing out with a mattock and spraying with Access and diesel. The scrub is quite thick and a grid pattern was used to ensure all plants were removed in the first instance. The cleared areas are checked every year before use and new plants are grubbed out or sprayed. This is also done using a grid pattern to ensure the country is well covered and all plants are removed. Heartleaf is removed from around waters on a regular basis.

Cattle are mustered quietly into the holding paddocks generally after being trapped on water. Cattle are then held in the holding paddocks for 5 to 7 days depending on feed availability before being walked to the yards for handling, trucking etc. General consensus in the district is that cattle need to be held off Heartleaf for a minimum of 6 days to enable safe handling. Any cattle which are reluctant to walk or show early signs of Heartleaf toxicity are left behind when cattle are moved. Losses associated with mustering have been largely eliminated. All cattle, however, have to be double handled, as they are mustered once into holding paddocks until they are moved 5 to 7 days later.

Occasionally weaners will die just before weaning as they begin to forage and experiment and occasionally cows will die around calving time when nutritional demands are high.

Losses have been suffered with introduced stock, so the property owners have decided that they need to keep their breeders. This means in dry conditions such as at present a feeding regime is necessary. All breeders are being fed molasses and urea during the current drought.

The biggest danger is fire, as Heartleaf is most dangerous after fire. The Heartleaf is the first plant to recover from a fire and the fresh leaves are particularly poisonous and appear to be highly palatable. Because the whole property is covered with Heartleaf, fire cannot be used as a management tool until further subdivision has been completed.

The property owner aims to establish improved pastures such as Secca and Verano Stylo and Wynn Cassia to improve the quality and availability of forage. At the moment seed is added to the lick to spread seed over the country.

The property owner purchased the property in a relatively undeveloped state and is in the process of developing the property with the aim of achieving the best possible level of productivity given the constraints imposed by Heartleaf. He believes that the presence of Heartleaf has accelerated his development plan. Aspects of the development plan which have become essential because of Heartleaf are the construction of large holding paddocks.

7.1.5 Planned management strategies

- Construction of more holding paddocks, so that each paddock has a clean 100ha holding paddock attached to it.
- Subdivision of paddocks so that paddocks can be isolated and burnt
- Subdivision will also enable paddocks to be spelled with the aim of encouraging the establishment and spread of improved pasture species.
- Introduce pasture species such as Secca and Verano Stylo, Wynn Cassia etc to provide higher quality forage and an alternative to Heartleaf.

7.1.6 Summary of Heartleaf impacts

- Significant losses in introduced cattle
- Need to construct and clear holding paddocks and laneways
- Holding paddocks and laneways need to be checked and cleaned out before stocking

- Requirement for double handling of stock before trucking or any husbandry or management procedures
- Need to hold on to breeders in dry seasons
- Cannot introduce cattle
- Cannot use fire as a management tool

7.1.7 Costs associated with Heartleaf

ACTIVITY			
Fencing	$/klm	Kilometres	Cost
Current fencing	1500.00	6	$ 9,000
Proposed fencing – subdivision and holding paddocks	1500.00	33 water squares 4 holding paddocks	$ 49,500 $ 8,000 $ 18,000
Plant eradication	Days	Hectares	Cost
Initial labour	10	275	$ 3,000
Maintenance labour	1		$ 300
	$/ha	Hectares	Cost
Initial chemical cost	$10	275	$ 2,750
Maintenance chemical cost	$ 5	275	$ 1,375
Pasture establishment	$/ha	Hectares	Cost
			$2,500
Additional stock handling	Man days/year		Cost
	20		$ 5,000

7.1.8 What would you do if you didn't have Heartleaf?

The property owner of case study A considers that without Heartleaf he would possibly increase his carrying capacity a little, however the biggest change would come from an increase in productivity. He may be able to be more flexible with stocking rates as he would be able to sell breeders in a dry time and buy back in after rain. He may also be able to trade cattle in favourable seasons.

7.1.8.1 Productivity changes

	Current	Without Heartleaf
Weaning rate	66%	73%
Weaning weight	165 kg	175kg
Carrying capacity	20 ha/breeder	18 ha/breeder
Total breeder numbers	650	720

7.1.8.2 Opportunity costs

- unable to trade or introduce cattle
- unable to use fire
- must feed and maintain breeders during drought (losses in introduced cattle mean it is critical to maintain the homebred breeders)
- extra handling required in holding cattle for 5 to 7 days before handling/trucking etc
- need to build holding paddocks large enough to hold cattle for 5 to 6 days minimum
- time spent controlling Heartleaf

7.1.9 Economic costs of Heartleaf

The following table shows an economic analysis of the annual opportunity costs of Heartleaf on the case study property. The notes below the table provide explanation for any calculations.

Region		**North Queensland**		**Notes**
Shire		Flinders		
Property Size	ha	13,000		
Current number of breeders	head	650		
Current Stocking Rate	ha/breeder	20		
Proportion of the property with FL	%	95%		
		With	**Without**	
Potential Breeder numbers	head		720	
Increase in Breeder Numbers	%		11%	1
Weaning Rate	%	66%	73%	2
Adult Cow Death Rate	%	8%	2%	3
Heifers retained to cover cow deaths	head	52	11	4
Estimated Turnoff Numbers	head	377	515	5
Estimated Turnoff Value (per head farm gate)	$/hd	748	748	6
Net Farm Gate value of turnoff	$	281,996	385,070	7
Gross Value of lost productivity per annum	$	103,074		8
Additional Costs (per annum)				
Fencing	$	3,380		9
Waters	$	880		10
Labour	$	1,375		11
Chemical	$	5,300		12
Pasture establishment	$	2,500		13
Annual Management and Infrastructure Costs	$	13,435		14
Annual Management costs/breeder (potential)	$	19		15
Total Costs per annum	$	116,509		16
Annual Costs per ha	$	8.96		17
Annual Costs per Breeder area (potential)	$	161.82		18

Notes:

1. Calculated potential increase in breeder numbers based on information from the landowner.

2. Weaning rates from case study.

3. Adult cow death rates from case study.

4. Number of additional heifers required to be retained in the breeding herd annually to cover the adult cow death rate and maintain a steady state breeding herd. Note that this results in less sale animals per annum.

5. Estimated turnoff numbers equals breeder numbers x weaning rate – heifer retention. Note this represents ‘all turnoff’ which would include steers, heifers and cull cows.

6. Estimated turnoff value (per head farm gate) is calculated as follows.

		$	Notes
Gross Value per head	$/head	783	1
Freight to market	$/head	30	2
Levies	$/head	5	3
Net Farm Gate Value	$/head	748	4

   1. Sourced from Northern Beef Report 2013 – Gross Value per head sold (all sales) – Queensland Central North Region.
   2. Sourced from Northern Beef Report 2013 – Total freight costs/head sold.
   3. MLA levies per head sold.
   4. Net Farm Gate value per head sold

7. Net Farm Gate value of turnoff.

8. Difference in Net Farm Gate value of turnoff between the With Fluoroacetate and Without Fluoroacetate.

9. Annual fencing costs are based on the total fencing costs as per case study (5.1.7), divided by estimated economic life of fencing (25 years) to give an annual cost for the erection of additional fencing.

10. Annual cost of additional water infrastructure is the same methodology as Note 9 above and assumes a similar economic life of 25 years.

11. Labour costs are as per the Case Study table in 5.1.7.

12. Chemical costs are as per the Case Study table in 5.1.7.

13. Pasture establishment costs are as per the Case Study table in 5.1.7.

14. Annual management and infrastructure cost is the sum of 10, 11, 12 and 13.

15. Note 14 / potential number of breeders (720 head).

16. Total cost per annum is the sum of the opportunity loss of reduced sales and the increased management and infrastructure costs.

17. Note 16 / ha of the property.

18. Note 16 / potential number of breeders (720 head).

In the case of this case study property the annual opportunity cost of Heartleaf on the property is calculated at $116,509 or $8.96 per hectare.

7.2 Case Study B

Figure 22 North Qld - Yellow Jacket Heartleaf country

7.2.1 Property details

LOCATION – Desert Uplands/North Queensland

SHIRE - Flinders

PROPERTY SIZE – 30,000 hectares

PROPORTION OF PROPERTY WITH HEARTLEAF – 60%

7.2.2 Herd details

Average number of breeders	1000	
Cattle breed	Brahman cross	
Primary market	Supply young cattle to the backgrounding industry and some young cattle to the live export industry	
Average weaning rate -		
1st calvers	75%	
adult cows	60%	
Average death rate -	Without Fluoroacetate impact	With Fluoroacetate impact
1st calvers	1.2%	4.0%
adult cows	2.1%	10.0%
calves	1.8%	4.0%
weaners	1.2%	4.4%
steers	4.3%	10.0%
bulls	1.7%	10.0%

7.2.3 Synopsis of Heartleaf situation and impact

Heartleaf on this property grows on 60% of the area and the remainder is free of Heartleaf. The Heartleaf country is fenced separately and managed accordingly. The establishment of fencing and waters has facilitated more intensive grazing management and has enabled the Heartleaf country to be rotationally grazed during the growing season.

Losses occur in the Heartleaf country and on one occasion significant losses (30% of the mob) occurred after a fire in the Heartleaf country.

7.2.4 Management systems developed to deal with Heartleaf

The country with Heartleaf is fenced separately into large paddocks. Cattle largely graze the Heartleaf country during the dry season – April to October and graze the Heartleaf free country after first storms - October through to April. This means that the carrying capacity is limited to the number of cattle which can be grazed on the non Heartleaf country and in the past it has been difficult to spell the non Heartleaf country during the growing season.

The non Heartleaf country is fenced into 800 hectare paddocks and is grazed according to a rotational grazing system. This country is primarily used during the growing season. Calving occurs during this time and weaners are generally taken off before the cows return to the Heartleaf country in April/May.

In order to improve utilisation of all the country the property owner is now grazing the Heartleaf country during the growing season on a rotational basis. Half of the Heartleaf country (8,000ha) is subdivided into 1600ha paddocks. Cattle are rotated through these Heartleaf paddocks with the aim of moving them out of the paddock before they begin to eat the Heartleaf. The aim is to move them before they have grazed all the other palatable feed. This means in practice that cattle are moved through the Heartleaf paddocks after about a week of grazing. The waters are fenced to allow cattle to be moved to the next paddock by opening the relevant gate. This allows the non Heartleaf paddocks to have some rest during the growing season and enables additional use of the Heartleaf paddocks.

Rotational grazing provides a level of control and supervision of cattle that was not achievable before the system was introduced. The subdivisional fencing is electric fencing with two wires, a hot wire and an earth. The adoption of low stress stock handling principles has reduced stock losses due to mustering and handling. All stock handling is carried out when the cattle have been grazing in the non-Heartleaf country. When it starts to rain generally gates are opened and the cattle move quietly out of the Heartleaf country.

7.2.5 Planned management strategies

- Further subdivision of the Heartleaf country. One paddock in the Heartleaf country is approximately 10,000 hectares and would benefit from further subdivision – this means fencing and addition of water. The aim is to have a water radius of a maximum of two kilometres.
- Increase rotation through the Heartleaf country to ensure the better country will have reasonable spelling during the growing season
- Introduce pasture species such as Secca and Verano Stylo, Wynn Cassia etc to provide higher quality forage and an alternative to Heartleaf.

7.2.6 Summary of Heartleaf impacts

- Ongoing losses in the Heartleaf country
- Inadequate spelling of the non Heartleaf country during the growing season
- Need to subdivide and intensively manage the Heartleaf country
- Need to increase the number of water points throughout the Heartleaf country.

7.2.7 Costs associated with Heartleaf

ACTIVITY			
Fencing	$/klm	Kilometres	Cost
Current fencing	900.00	90	$ 81,000
Proposed fencing – subdivision and holding paddocks	1000.00	35	$ 35,000
Additional water points – 10klm poly pipe, 2 tanks and troughs			$ 32,000
Plant eradication	Days	Hectares	Cost
Labour	10/yr		$ 2,500
	$/ha	Hectares	Cost
Chemical cost	$ 40	50	$ 2,000
Pasture establishment	$/ha	ha	Cost
			$ 2,500

7.2.8 What would you do if you didn't have Heartleaf?

The property owner of case study B considers that without Heartleaf he would increase his carrying capacity and productivity. He is currently carrying a breeder to 17 hectares on his non-Heartleaf country and a breeder to 36 hectares on his Heartleaf country. His non Heartleaf country is better quality than the Heartleaf country.

Increased subdivision will enable him to increase the carrying capacity of the Heartleaf country through better control and increase the carrying capacity of the non-Heartleaf country through increased spelling during the growing season.

7.2.8.1 Productivity changes

	Current	**Without Heartleaf**
Weaning rate	60%	68%
Weaning weight	160	165
Carrying capacity – Heartleaf country	36 ha/breeder	24 ha/breeder
Carrying capacity – non Heartleaf country	17 ha /breeder	15 ha/breeder
Total breeder numbers	1,200	1,550

7.2.8.2 Opportunity costs

- restricted use of fire
- stocking rate limited to carrying capacity of clean country during the growing season
- time spent controlling Heartleaf

7.2.9 Economic costs of Heartleaf

The following table shows an economic analysis of the annual opportunity costs of Heartleaf on the case study property. The notes below the table provide explanation for any calculations.

Region		Desert Uplands		Notes
Shire		**Flinders**		
Property Size	ha	30,000		
Current number of breeders	head	1,000		
Current Stocking Rate	ha/head	30		
Proportion of the property with FL	%	60%		
		With	**Without**	
Potential Breeder numbers	head		1,800	
Increase in Breeder Numbers	%		80%	1
Weaning Rate	%	60%	68%	2
Adult Cow Death Rate	%	10%	2%	3
Heifers retained to cover cow deaths	head	100	38	4
Estimated Turnoff Numbers	head	500	1,186	5
Estimated Turnoff Value (per head farm gate)	$/hd	748	748	6
Net Farm Gate value of turnoff	$	374,000	887,278	7
Gross Value of lost productivity per annum	$	513,278		8
Additional Costs (per annum)				
Fencing	$	4,640		9
Waters	$	880		10
Labour	$	2,000		11
Chemical	$	1,250		12
Pasture establishment	$	2,500		13
Annual Management and Infrastructure Costs	$	11,270		14
Annual Management costs/breeder (potential)	$	6		15
Total Costs per annum	$	524,548		16
Annual Costs per ha	$	17.48		17
Annual Costs per Breeder area (potential)	$	291.42		18

Notes:

1. Calculated potential increase in breeder numbers based on information from the landowner.
2. Weaning rates from case study.
3. Adult cow death rates from case study.

4. Number of additional heifers required to be retained in the breeding herd annually to cover the adult cow death rate and maintain a steady state breeding herd. Note that this results in less sale animals per annum.

5. Estimated turnoff numbers equals breeder numbers x weaning rate – heifer retention. Note this represents 'all turnoff' which would include steers, heifers and cull cows.

6. Estimated turnoff value (per head farm gate) is calculated as follows.

		$	Notes
Gross Value per head	$/head	783	1
Freight to market	$/head	30	2
Levies	$/head	5	3
Net Farm Gate Value	$/head	748	4

   1. Sourced from Northern Beef Report 2013 – Gross Value per head sold (all sales) – Queensland Central North Region.

   2. Sourced from Northern Beef Report 2013 – Total freight costs/head sold.

   3. MLA levies per head sold.

   4. Net Farm Gate value per head sold

7. Net Farm Gate value of turnoff.

8. Difference in Net Farm Gate value of turnoff between the With Fluoroacetate and Without Fluoroacetate.

9. Annual fencing costs are based on the total fencing costs as per case study (5.2.7), divided by estimated economic life of fencing (25 years) to give an annual cost for the erection of additional fencing.

10. Annual cost of additional water infrastructure is the same methodology as Note 9 above and assumes a similar economic life of 25 years.

11. Labour costs are as per the Case Study table in 5.2.7.

12. Chemical costs are as per the Case Study table in 5.2.7.

13. Pasture establishment costs are as per the Case Study table in 5.2.7.

14. Annual management and infrastructure cost is the sum of 10, 11, 12 and 13.

15. Note 14 / potential number of breeders (1,800 head).

16. Total cost per annum is the sum of the opportunity loss of reduced sales and the increased management and infrastructure costs.

17. Note 16 / ha of the property.

18. Note 16 / potential number of breeders (1,800 head).

In the case of this case study property the annual opportunity cost of Heartleaf on the property is calculated at $524,548 or $17.48 per hectare.

7.3 Case Study C

Figure 23 Desert Uplands

7.3.1 Property details

LOCATION – Desert Uplands

SHIRE – Barcaldine Regional Council

PROPERTY SIZE – 40,000 hectares

PROPORTION OF PROPERTY WITH HEARTLEAF – 40%

7.3.2 Herd details

Average number of breeders	1200	
Cattle breed	Brahman cross	
Primary market	Supply young cattle to the backgrounding industry.	
Average weaning rate -		
1st calvers	75%	
adult cows	70%	
Average death rate -	Without Fluoroacetate impact	With Fluoroacetate impact
1st calvers	3%	8%
adult cows	6%	20%
calves	1%	8%
weaners	8%	15%
steers	3%	4%
bulls	10%	10%

7.3.3 Synopsis of Heartleaf situation and impact

Heartleaf occurs across discrete areas on this property. One area with a heavy infestation of Heartleaf is fenced off and not stocked and other areas with moderate Heartleaf infestation are fenced into larger paddocks. Approximately 50% of the paddocks have Heartleaf in them with about 20% of each of these paddocks affected.

Heartleaf management is broadly focussed on managing around the problem, timing mustering and movement of cattle and control of the plants in targeted areas.

Fires are a major problem as fire in the Heartleaf area of a paddock means that whole paddock has to be destocked and it cannot be grazed again until after the end of the next growing period or when there is sufficient other feed available to eliminate the need for stock to graze on fresh Heartleaf shoots. This takes an average of 6 to 8 months and longer in a dry season. The property has a number of neighbouring properties which have Heartleaf paddocks fenced off and not grazed.

They become a major fire hazard and regularly burn with wild fires. Where these paddocks adjoin Case Study C there can be major fire problems with loss of fencing and the need to destock paddocks that have Heartleaf in them and get burnt.

A higher death rate is attributed to Heartleaf throughout the year and grazing management and timing of husbandry procedures and management inputs is largely determined by the presence of Heartleaf. Breeder cattle are really only handled during the growing season

October to April when cattle are out of the Heartleaf country. This is when all branding and weaning is done. Time is spent finding and eradicating plants in targeted areas.

7.3.4 Management systems developed to deal with Heartleaf

The country most heavily infested with Heartleaf is fenced off and not stocked. The country with a moderate infestation is generally stocked with dry cows during the dry season (May to October). Calves are weaned in April/May and the cows are moved into the country containing Heartleaf. As the timing of calving approaches (October) cows are moved out of the Heartleaf country. Cattle movement out of the Heartleaf country is generally a matter of trapping cattle on water or opening gates between Heartleaf country and non Heartleaf country, so movement and mustering stress is kept to a minimum.

Cows calve in the non Heartleaf country so that at a time of maximum nutritional demand cows are not exposed to Heartleaf. Young cattle are weaned and sold to backgrounders or kept on the property to grow out before sale. Weaners are not run in the Heartleaf country. The cows go back into the Heartleaf country after weaning in April.

While ongoing losses are higher than in non Heartleaf country, the problem has been minimised with conservative stocking, provision of adequate waters, removal of some Heartleaf bushes and considerate stock handling.

The Heartleaf country is well watered so cattle don't have to walk more than one kilometre to water.

Some Heartleaf control is carried out around water, in pressure points and where there are discrete clumps in otherwise clean paddocks. Control consists of grubbing the plants out and spraying with access and diesel.

7.3.5 Planned management strategies

- Increase the number of waters and place waters in the Heartleaf country
- Further paddock subdivision to enable the currently fenced off area to be utilised
- Controlled burning using good firebreaks
- Introduce pasture species such as Secca and Verano Stylo, Wynn Cassia, Buffel Grass etc to provide higher quality forage and an alternative to Heartleaf.

7.3.6 Summary of Heartleaf impacts

- Ongoing losses in the Heartleaf country
- The non Heartleaf country does not get adequate spelling during the growing season
- Need to increase the number of water points throughout the Heartleaf country
- Fire becomes a major threat and the use of fire as a management tool is limited
- Time spent finding and eradicating Heartleaf from target areas

7.3.7 Costs associated with Heartleaf

ACTIVITY			
Fencing	$/klm	Kilometres	Cost
Proposed fencing – subdivision and holding paddocks	$ 2,000	10	$20,000
Additional water points – 7 klm pipe, 2 x tanks and 2 x troughs			$ 18,500
Plant eradication	Days	Hectares	Cost
Labour	7	250	$ 1,750
	$/ha	Hectares	Cost
Chemical cost	$ 30	250	$ 7,500
Pasture establishment	$/ha	Hectares	Cost
			$ 5,000

7.3.8 What would you do if you didn't have Heartleaf?

Increase stocking rate and productivity – improved grazing management and additional subdivision and waters would increase stocking rate and productivity.

Much of the country benefits from a fire, especially the Spinifex country. The ability to utilise fire as a management tool will considerably improve stocking rates and productivity. Further subdivision and the use of firebreaks will enable fire to be used regularly as a pasture management tool.

Finding and controlling Heartleaf takes time and without this time could be spent on more productive activities.

7.3.8.1 Productivity changes

	Current	Without Heartleaf
Weaning rate	65%	70%
Weaning weight	165	175
Carrying capacity – Heartleaf country	400ha/breeder	26ha/breeder
Carrying capacity – non Heartleaf country	20ha/breeder	16ha/breeder
Total breeder numbers	1,200	2,026

7.3.8.2 Opportunity costs

- restricted use of fire as a management tool
- the threat of fire from neighbouring properties

- the necessity to destock any paddocks which have Heartleaf in them which get accidently burnt
- time spent controlling Heartleaf
- inadequate spelling of Heartleaf free country
- lack of flexibility in timing of handling breeder cattle

7.3.9 Economic costs of Heartleaf

The following table shows an economic analysis of the annual opportunity costs of Heartleaf on the case study property. The notes below the table provide explanation for any calculations.

Region		**Desert Uplands**		**Notes**
Shire		**Barcaldine**		
Property Size	ha	40,000		
Current number of breeders	head	1,200		
Current Stocking Rate	ha/head	33		
Proportion of the property with FL	%	40%		
		With	**Without**	
Potential Breeder numbers	head		2,000	
Increase in Breeder Numbers	%		67%	1
Weaning Rate	%	65%	70%	2
Adult Cow Death Rate	%	20%	6%	3
Heifers retained to cover cow deaths	head	240	120	4
Estimated Turnoff Numbers	head	540	1,280	5
Estimated Turnoff Value (per head farm gate)	$/hd	748	748	6
Net Farm Gate value of turnoff	$	403,920	957,440	7
Gross Value of lost productivity per annum	$	553,520		8
Additional Costs (per annum)				
Fencing	$	800		9
Waters	$	740		10
Labour	$	1,750		11
Chemical	$	7,500		12
Pasture establishment	$	5,000		13
Annual Management and Infrastructure Costs	$	15,790		14
Annual Management costs/breeder (potential)	$	8		15
Total Costs per annum	$	569,310		16
Annual Costs per ha	$	14.23		17
Annual Costs per Breeder area (potential)	$	284.66		18

Notes:

1. Calculated potential increase in breeder numbers based on information from the landowner.

2. Weaning rates from case study.

3. Adult cow death rates from case study.

4. Number of additional heifers required to be retained in the breeding herd annually to cover the adult cow death rate and maintain a steady state breeding herd. Note that this results in less sale animals per annum.

5. Estimated turnoff numbers equals breeder numbers x weaning rate – heifer retention. Note this represents 'all turnoff' which would include steers, heifers and cull cows.

6. Estimated turnoff value (per head farm gate) is calculated as follows.

		$	**Notes**
Gross Value per head	$/head	783	1
Freight to market	$/head	30	2
Levies	$/head	5	3
Net Farm Gate Value	$/head	748	4

    1. Sourced from Northern Beef Report 2013 – Gross Value per head sold (all sales) – Queensland Central North Region.
    2. Sourced from Northern Beef Report 2013 – Total freight costs/head sold.
    3. MLA levies per head sold.
    4. Net Farm Gate value per head sold

7. Net Farm Gate value of turnoff.

8. Difference in Net Farm Gate value of turnoff between the With Fluoroacetate and Without Fluoroacetate.

9. Annual fencing costs are based on the total fencing costs as per case study (5.3.7), divided by estimated economic life of fencing (25 years) to give an annual cost for the erection of additional fencing.

10. Annual cost of additional water infrastructure is the same methodology as Note 9 above and assumes a similar economic life of 25 years.

11. Labour costs are as per the Case Study table in 5.3.7.

12. Chemical costs are as per the Case Study table in 5.3.7.

13. Pasture establishment costs are as per the Case Study table in 5.3.7.

14. Annual management and infrastructure costs is the sum of 10,11, 12 and 13.

15. Note 14 / potential number of breeders (2,000 head).

16. Total cost per annum is the sum of the opportunity loss of reduced sales and the increased management and infrastructure costs.

17. Note 16 / ha of the property.

18. Note 16 / potential number of breeders (2,000 head).

In the case of this case study property the annual opportunity cost of Heartleaf on the property is calculated at $569,310 or $14.23 per hectare.

Figure 24 Georgina Gidgee

7.4 Case Study D

7.4.1 Property details

LOCATION – Georgina Catchment

SHIRE – Boulia

PROPERTY SIZE – 550,000 hectares

PROPORTION OF PROPERTY WITH GEORGINA GIDGEE – >75%

7.4.2 Herd details

Average number of breeders	7,000	
Cattle breed	Brahman crossed with Brangus and Charbray	
Primary market	Live export, direct to abattoir	
Average weaning rate -		
1st calvers	60%	
adult cows	70%	
Average death rate -	Without Fluoroacetate impact	With Fluoroacetate impact
1st calvers	5%	12%
adult cows	5%	12%
calves	5%	10%
weaners	5%	10%
steers	5%	12%
bulls	5%	12%

It must be noted that the percentage deaths listed for cattle affected by Georgina Gidgee are on average; toxic years brought on my season can be between 20-30%.

7.4.3 Synopsis of poison Gidgee situation and impact

Georgina Gidgee grows over the vast majority of this property with significant losses suffered at certain times of the year. Georgina Gidgee grows on very nutritious soils and as a result cattle grazing theses areas are in fat to very fat condition. The death rate associated with the poisonous tree is dictated predominately by the season and the amount of grass and other fodder that grows over the wet season (to supply alternative feed options to the poison tree for cattle grazing).

In a ‘normal’ year, deaths caused by Georgina Gidgee begin in the latter months of the dry season and will continue at a significant rate until a fall of rain in excess of 50mm is received. Smaller falls have been found to increase the toxicity and or consumption of the plant as fresh leaves grow on the trees. The plant will ‘come into pod’ in late August and then proceed to flower and this can be the most fatal stage of the yearly cycle as cattle will favour these pods as they naturally graze.

Cattle don’t appear to become immune to the poison and in the majority of cases it appears that after drinking from a trough / dam the poison in their system becomes fatal. Although this property is used primarily for breeding if the tree were not to be poisonous the opportunity to consistently turn off fat dry cattle would exist.

7.4.4 Management systems developed to deal with Georgina Gidgee

Management options to reduce these losses are limited to when and how to handle cattle. Given the size of this property fencing is not an economical option and given the Gidgee tree grows over most of the property fencing off 'clean' areas is very difficult. Cattle on this property are only mustered once and this is normally completed through April, May and June depending on the preceding wet season. Cattle are normally trapped on water and quietly walked to the yards with any beast showing symptoms of Gidgee poisoning (wobbly on their feet, eyes rolled back, slow pace) immediately left behind. While walking stock it is important to not let them drink as the property owner believes this causes deaths in cattle.

Once arrived at the yards cattle are fed grassy hay and kept off water over night. Low stress cattle handling principles are applied while working cattle through the yards and although there are normally losses (2-10hd) associated with this process (mustering, processing, walking cattle back to the paddock) these are kept to a minimum by managing the stock quietly.

Reducing the distance cattle have to walk to water will enable cattle to spread out and graze more efficiently however there are substantial costs associated with installing new bores / dams. This property has increased watering points over the last decade and losses are still occurring.

Given the abundance of trees on this property and tree clearing legislation it would neither be possible nor economical to remove the Georgina Gidgee. Furthermore cattle fatten very well when eating the tree and therefore a solution to prevent these losses would have to involve consumption of the leaves by stock.

The property owner has suggested that neighbouring properties are hoping to trial 'clean holding paddocks', where by an area is fenced off and the trees totally removed. Cattle are then mustered and or trapped into these holding paddocks and spelled for a week before being processed through a set of yards. A similar system is used in the Desert Uplands with success, however the very low rainfall would make pasture establishment in these cleared areas more difficult.

7.4.5 Summary of Georgina Gidgee impacts

- Georgina Gidgee grows on quality country
- Significant losses in cattle especially through Spring and on to first storms
- Quiet handling of cattle paramount to reducing losses when mustering and processing
- Important to know the symptoms of a beast affected by Georgina Gidgee so as these can be dropped when moving cattle
- Small rain fall events increase the toxicity of the tree and or the consumption
- Cattle do very well in country where Georgina Gidgee grows
- All classes of cattle are affected
- Increased losses when the tree is in pod, nevertheless losses are always being incurred

7.4.6 Costs associated with Georgina Gidgee

The direct costs associated with Heartleaf are predominately the loss of cattle and given the numbers on this property these are substantial.

Total Number of Cattle	Death Rate	Number of Losses (hd)	Average Value ($/hd)	Total Losses ($)
7,000	5%	350	$600	$210,000
7,000	10%	700	$600	$420,000
7,000	20%	1,400	$600	$840,000
7,000	30%	2,100	$600	$1,260,000

7.4.7 What would you do if you didn't have Georgina Gidgee?

The property owner of this case study suggests that there would be endless opportunities if cattle were not fatally affected by the consumption of Georgina Gidgee. Assuming that cattle would perform as well as they currently do the property owner believes -

- 50-100% increase in carrying capacity
- Increased weaning rate by 10-20% by being able to complete a second round of mustering. Currently only able to do one round of mustering and therefore cows with calves on at this time are not weaned and unless greater than average rainfall is received a significant number of these cows will not go back in calf until after the following muster (in a year's time and once the weaner has been removed).
- Flexibility in time/technique of mustering and processing (e.g. could take advantage of historically high export prices through the wet season with good condition cattle that currently cannot be touched in fear of losses associated with Gidgee)
- Flexibility in type and timing of turn/sale cattle. For example –
    - Could run more dry cattle for slaughter or export
    - Could take advantage of historically high prices over the summer months (currently unable to due to the poison)
    - Could sell added weaners and dry cows with the two rounds of mustering
- Increased cash flow associated with less losses and increase sales
- Substantial increase in land value.

The following tables highlight possible increases in productivity if poison Gidgee was not present on this property –

Increased Breeder Numbers and Weaning Rate

The property owner believes that without fluoroacetate poisoning carrying capacity would increase by at least 50% and weaning rates by 10%.

	Breeder Number	Weaning Rate	Number of Weaners
Current situation	7,000	65%	4550
No Gidgee	10,500	75%	7875

This represents an increase of 3,325 weaners per year which could be either sold or retained in the herd.

Changes to sale program

Assuming the increased numbers listed above, without the poison Gidgee the property would be able to take advantage of a higher market through the summer months and sell cattle at a greater value. Also providing the property received average rainfall the stock would be heavier in weight and therefore increasing value as well.

	Breeder Number	Weaning Rate	Number of Weaners (sold)	$/hd	Total Weaner sales ($)	Dry Cow Sales (hd)	$/hd	Total Cow Sales ($)	Total Sales ($)
Current situation	7,000	65%	4550	$360	$1,638,000	210	$600	$126,000	$1,764,000
No Gidgee	10,500	75%	7875	$440	$3,465,000	315	$750	$236,250	$3,701,250

7.4.8 Economic costs of Georgina Gidgee

The following table shows an economic analysis of the annual opportunity costs of Heartleaf on the case study property. The notes below the table provide explanation for any calculations.

Region		**Georgina**		**Notes**
Shire		**Boulia**		
Property Size	ha	550,000		
Current number of breeders	head	7,000		
Current Stocking Rate	ha/head	79		
Proportion of the property with FL	%	75%		
		With	**Without**	
Potential Breeder numbers	head		10,000	
Increase in Breeder Numbers	%		43%	1
Weaning Rate	%	65%	75%	2
Adult Cow Death Rate	%	12%	5%	3
Heifers retained to cover cow deaths	head	840	500	4
Estimated Turnoff Numbers	head	3,710	7,000	5
Estimated Turnoff Value (per head farm gate)	$/hd	640	640	6
Net Farm Gate value of turnoff	$	2,374,400	4,480,000	7
Gross Value of lost productivity per annum	$	2,105,600		8
Additional Costs (per annum)				
Fencing	$			9
Waters	$			10
Labour	$			11
Chemical	$			12
Pasture establishment	$			13
Annual Management and Infrastructure Costs	$	60,000		14
Annual Management costs/breeder (potential)	$	6		15
Total Costs per annum	$	2,165,600		16
Annual Costs per ha	$	3.94		17
Annual Costs per Breeder area (potential)	$	216.56		18

Notes:

1. Calculated potential increase in breeder numbers based on information from the landowner.

2. Weaning rates from case study.

3. Adult cow death rates from case study.

4. Number of additional heifers required to be retained in the breeding herd annually to cover the adult cow death rate and maintain a steady state breeding herd. Note that this results in less sale animals per annum.

5. Estimated turnoff numbers equals breeder numbers x weaning rate – heifer retention. Note this represents 'all turnoff' which would include steers, heifers and cull cows.

6. Estimated turnoff value (per head farm gate) is calculated as follows.

		$	Notes
Gross Value per head	$/head	700	1
Freight to market	$/head	55	2
Levies	$/head	5	3
Gross value all sales	$/head	640	4

    1. Sourced from Northern Beef Report 2013 – Gross Value per head sold (all sales) – Queensland West South West.
    2. Sourced from Northern Beef Report 2013 – Total freight costs/head sold.
    3. MLA levies per head sold.
    4. Net Farm Gate value per head sold

7. Net Farm Gate value of turnoff.
8. Difference in Net Farm Gate value of turnoff between the With Fluoroacetate and Without Fluoroacetate.
9. Fencing costs not provided.
10. Water infrastructure costs not provided.
11. Labour costs not provided.
12. Chemical costs not provided.
13. Pasture establishment costs not provided.
14. Annual management costs estimated based on other case studies.
15. Note 14 / potential number of breeders (10,000 head).

16. Total cost per annum is the sum of the opportunity loss of reduced sales and the increased management and infrastructure costs.

17. Note 16 / ha of the property.

18. Note 16 / potential number of breeders (10,000 head).

In the case of this case study property the annual opportunity cost of Heartleaf on the property is calculated at $2,165,600 or $3.94 per hectare.

8 Conclusions

Fluoroacetate toxicity caused by ingestion of toxic plants is experienced in Australia, South Africa and parts of South America and has had an impact on beef cattle in Australia for over 180 years. Research conducted during the course of this project has revealed that fluoroacetate toxicity remains a significant problem in affected areas and is responsible for a considerable impact on the beef cattle industry in these areas and on a national scale.

During the conduct of this project team members held discussions with landholders, researchers, advisors and technical specialists during on property visits, regional workshops, individual meetings and the conduct of two surveys. Team members visited affected properties, witnessed the problem first hand, discussed management strategies and inspected infrastructure designed to ameliorate the problem. The data collected were analysed using statistical and economic analysis and the following conclusions have been drawn.

Toxicity is due to ingestion of native plants and is limited to specific areas in Queensland, the Northern Territory and Western Australia. The impact of fluoroacetate toxicity has real economic consequences in the Desert Uplands and North Queensland regions of Queensland and the Georgina Basin in Queensland and the Northern Territory. Toxicity in these areas is caused by two different plants – *Gastrolobium Grandiflorum (*Heartleaf Poison Bush) in the Desert Uplands and North Queensland and *Acacia Georginae* (Georgina Gidgee) in the Georgina Basin. The toxic element and the symptoms of poisoning are the same in both plants, however the country in which they grow and the conditions leading to stock poisoning are very different.

Survey findings suggest that in each of the three regions, a substantial proportion of cattle producers indicate that they are affected by fluoroacetate containing plants and that fluoroacetate toxicity is perceived to be an important cause of a range of adverse impacts.

Heartleaf Poison Bush grows in lighter country and is primarily a problem at specific times such as after fire, after rain, when handling stock and with introduced cattle. Heartleaf Poison Bush appears to be attractive to stock only at these particular times and is most probably grazed as a last resort. Georgina Gidgee grows in sweet country in an arid environment and causes poisoning and deaths every year when cattle graze the tree. Cattle in Georgina Gidgee country die without any apparent external stimulus during this period and also die when heated by handling during this time. Landholders have observed that Georgina Gidgee is an important component of the diet of cattle during the dry season in the Georgina Basin and believe it provides a high quality source of protein and energy.

While the toxic ingredient, the plants themselves and the areas in which they grow have been identified and described very little is known about the factors leading to ingestion and toxicity. One consistent result of the discussions and surveys conducted throughout this project is that the factors leading to toxicity and the experiences of toxicity in all affected regions are poorly understood, highly variable and different from year to year and from place to place.

Producers reported a range of views about variation in toxicity of plants based on plant stage of growth, time of year, rainfall and other events.

All affected producers surveyed reported making management changes and adaptations as a result of the toxicity problems and a number of producers reported that parts of their properties are unused due to the presence of fluoroacetate containing plants.

Increased mortality rates and reduced stocking rates are the most consistent and immediate impacts of fluoroacetate toxicity while restrictions on management options including mustering and selling times, costs of management strategies and reductions in productivity due to reduced reproductive rates also contribute to production and economic impacts.

It is estimated that Fluoroacetate toxicity has the potential to affect approximately 2.9% of the Australian herd and currently costs the industry $45 million due to increased death rates and associated productivity losses.

The impacts locally are highly significant with stock losses of over 20% recorded on individual properties and the potential for increased productivity reaching levels of 70 to 100% over a considerable land mass. The impact of a continued high mortality rate in all affected areas has economic, social, welfare and emotional impacts on the landholders, livestock managers and on the livestock.

8.1 Recommendations

Fluoroacetate toxicity is a complex problem. The one consistent result of the surveys and research conducted during this project is that knowledge of the plant, the environment in which it grows, the relationship between the plant and animals, soil, seasons and other environmental influences is incomplete.

The plant causing the problem is a native plant and it covers vast areas in inconsistent patterns. Any solution to the problem caused by ingestion of these plants will most likely revolve around dealing with the impact rather than addressing the cause. Removal of the plant is impractical and undesirable.

Recommendation 1: Identification, documentation, communication and implementation of regionally implemented best management practices.

Landholders throughout the affected regions hold a vast amount of knowledge with regard to the poisonous plants, the localities in which they are found and the effects of these plants on stock. Management strategies have been experimented with, implemented, adapted and adopted. Data on current management strategies have been collected during the conduct of this project and examples are presented in the case studies in this report. A process of building on the work already done to identify, evaluate, document, communicate and implement best management strategies would reduce the impact of fluoroacetate toxicity at a reasonable cost.

Recommendation 2: ***Research leading to a better understanding of the method of poisoning and the relationship between the plant and the animals.***

Very little is known about why particular animals die and research leading to a better understanding of the method of poisoning and the relationship between the plant and the animals is recommended. This research could cover topics such as –

- The levels of fluoroacetate in different parts of the plant at different times

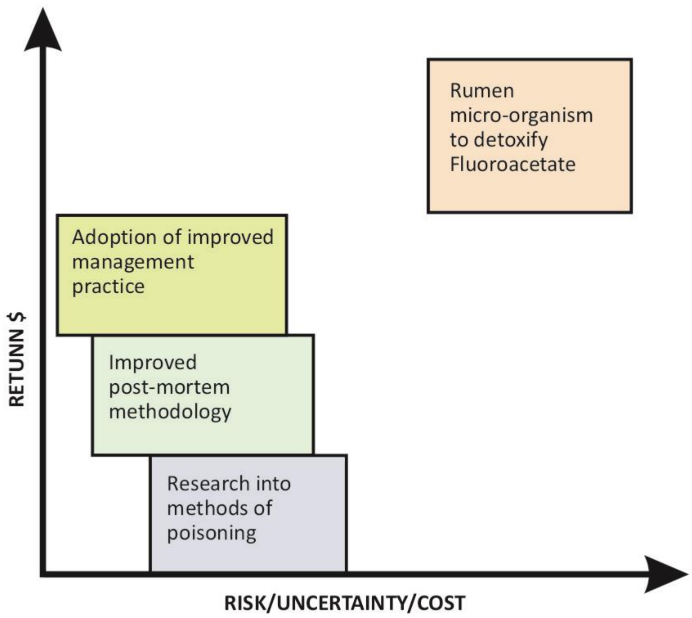
- The varying levels of fluoroacetate in the same plant at different times
- The varying levels of fluoroacetate in plants in different localities
- Plant factors which influence palatability
- Potential husbandry practices which may reduce the impact including husbandry methods practised in other countries

Recommendation 3: The development and communication of a post mortem methodology and a key identifying post mortem characteristics of fluoroacetate poisoning.

Throughout the conduct of this project landholders expressed a desire to be able to determine with some certainty whether or not an animal has died from fluoroacetate toxicity.

Recommendation 4: **Research is continued in the process of developing or discovering a rumen micro-organism which will detoxify fluoroacetate in the rumen and to examine the feasibility of the use of intra ruminal detoxification.**

The potential of detoxification of fluoroacetate in the rumen as mentioned in the report presents a practical possibility of addressing the problem. Research has been conducted in this area with documented results, however the research needs to be continued and expanded to locate a naturally occurring micro-organism or to utilise the previously developed micro-organism and to determine the feasibility of intra ruminal detoxification of fluoroacetate.



The recommendations shown above will have different risk/reward relationships, as demonstrated in the diagram below. For example, if a rumen micro-organism that detoxified fluoroacetate in the rumen were able to be developed or discovered, this may enable all the opportunity costs to be ameliorated, or the opportunity benefits to captured, however the outcome is uncertain and is likely to require reasonable research resources.

By comparison, adoption of proven management practices more broadly within the affected areas may be a relatively low cost, low risk method of capturing some of the opportunity benefits. Research into methods of poisoning and improved post mortem methodologies may be essential research tasks in terms of the longer term understanding of the problem; however the return for these activities may be relatively low.

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Appendix 1 Summary of anecdotal evidence of reduced stocking capacity

Anecdotal evidence of reduced stocking capacity where Fluoroacetate exists is summarised below in the verbatim comments from the survey data collected in relation to this project.

The Heartleaf that occurs on Strathburn and other places on the cape is generally in the rough range country. There is no water there and we don't put water into this country deliberately so the cattle don't utilise the country and don't graze the Heartleaf. Most places in the cape with Heartleaf are the same.

We generally keep stock out of the Heartleaf country during the growing season and only run dry breeders in there during the dry season – April to October.

If cattle are in the poison country it can take up to three months to clean them out to move them any distance or even to shift them to another paddock.

We have a little bit of Heartleaf scattered over the property. It is not fenced off.

We had a series of wet winters and weren't spelling the clean country- eventually put the cattle into the Heartleaf country and lost breeders.

18,000 acres of the property is largely unusable because of Heartleaf

Heartleaf plants scattered everywhere- have been located in Ironbark, Paperbark and Wattle timbers, on iron stone rises, open ironbark and lower slopes of the country.

It can grow in both poor and better country but the bulk is in the poorer souls, Yellowjacket and wattle type of country. Have seen some growing out in Iron bark and box country.

We estimate that 50% of our paddocks have Heartleaf and about 20% of each paddock is affected.

Our cattle are bush eaters & like flowering plants. I am always wary of Heartleaf after frost & avoid using country after fire.

Main problem is fresh green shoot after fire.

The most toxic phase is the fresh green shoots either after rain or after a fire.

The Heartleaf country was already fenced off. When using adjoining paddock we check every week or two to ensure cattle have not crawled through what is an old fence.

Generally the Heartleaf area is not stocked, there is little water there. Sometimes in a bad drought we will use it. Generally there is no poisoning then.

Don't use after Sept.

Cannot use after fire - extremely high death risk. Entire property fenced into clean paddocks (controlled) or dirty paddocks (poison bush too thick to control).

Paddocks that we have had previous biggest losses in we try to lessen the impact of grazing. When we see cattle vigorously chasing browse, we endeavour to move stock to a new paddock, if the season permits. No doubt we have Heartleaf plants that we have not located, so moving the stock does not always stop deaths.

We try not to use the land immediately after rain or fire as the poison is at its most potent at this stage.

Don't use it after fire. I like to spell country for 9 to 12 months after fire.

The country affected with Heartleaf is less productive because we cannot burn it.

Have them out by mid-August, horse mustering only, keeping a paddock spelled especially for this purpose.

We rotational graze with one mob of cattle moving weekly to a fresh paddock, similar applies to the Heartleaf country, only the paddocks are twice the size which means the yield is halved. We are also experimenting with grazing when the heart leaf is more potent during the wet by moving more frequently which is so far proving to be effective.

The way we manage our stock lines up with suggested practises for cattle management in Heartleaf country. E.g. increased waters for more efficient and effective pasture utilisation, low stress stock handling, mustering cattle from paddocks is tried to be lined up with pasture utilisation, rotations. We under-utilise the whole property in an effort to minimise the amount of browse cattle graze. The property could stock another 200 head of dry stock if Heartleaf was not an issue. As a family size operation we are balancing between lowering our stocking rate too much and being unviable, and increasing our stocking rate that could potentially increase our death %.

This country is not grazed in drought times or post bushfires as there is a much higher risk of cattle eating Heartleaf due to lack of other feed. We always stock it lightly in a normal season as there is a much lower risk of poisoning as cattle have plenty of space and don’t overgraze the paddock.

We would not use the country after rain or fire.

The Heartleaf country is generally stocked during the dry season with dry, newly weaned cows and we remove the cows just before they calve. We move them by opening gates and they walk out of the Heartleaf country.