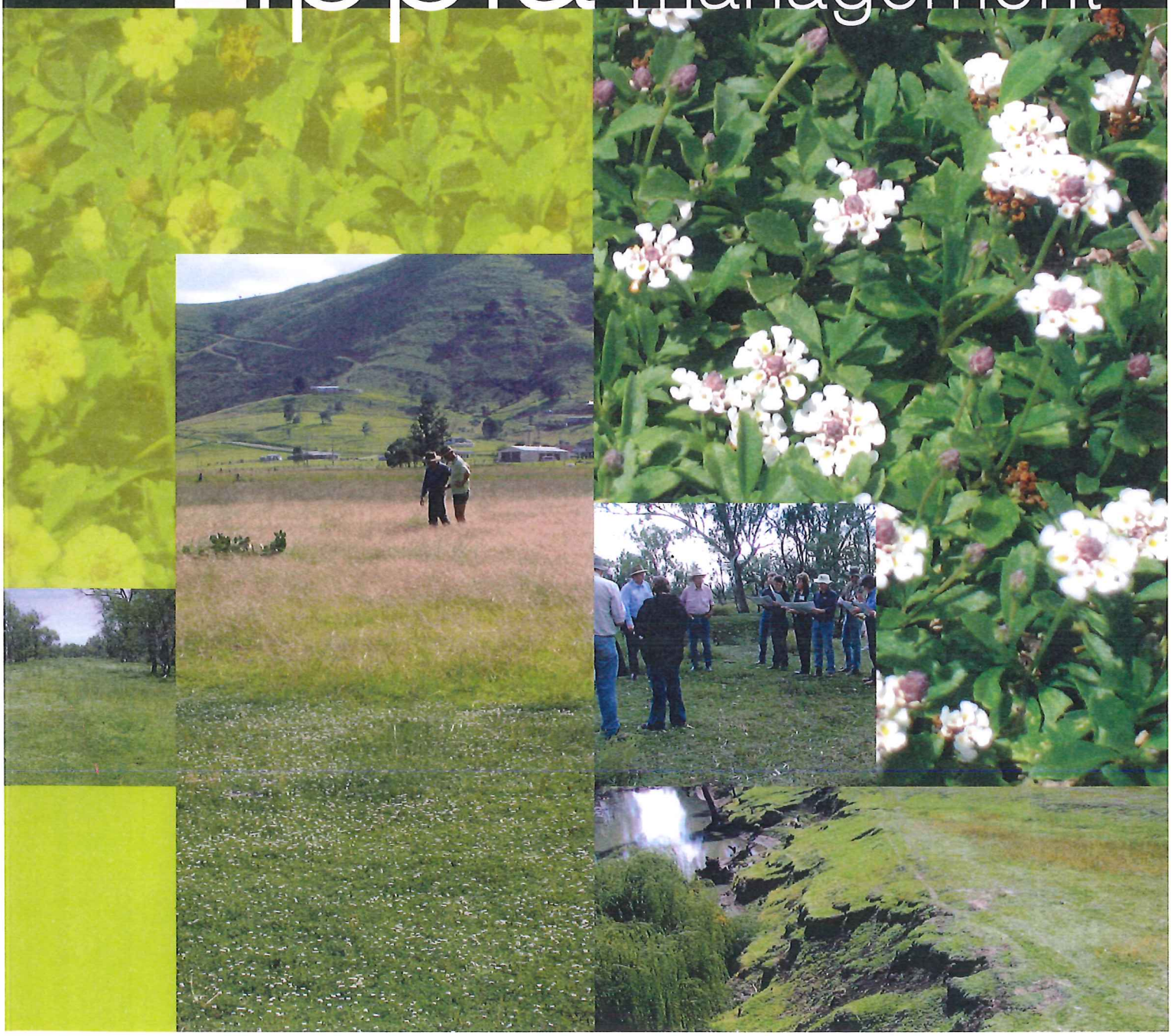
Challenges, opportunities and strategies

Lippia *Phyla canescens* management



national lippia working group

Australian Government

Challenges, opportunities and strategies

July 2008

Lippia management

Phyla canescens

NSW DEPARTMENT OF PRIMARY INDUSTRIES

Australian Government

swift NRM Finding community solutions to NRM challenges

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Principal author: Peter Crawford
Project managers: Janet Barker and Rodney Kerr
Graphic design by Jo Glasheen, The View Concepts
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A comprehensive mapping and survey project entitled "Lippia Management in the Macquarie Marshes and Gwydir Wetlands" was undertaken as a parallel process to this manual. The report contains additional case studies specific to these significant wetlands.

For copies of this report contact:

Central West CMA, NSW.
Phone (02) 6881 3400
Email shona.whitfield@cma.nsw.gov.au

Border Rivers Gwydir CMA
Phone (02) 6728 8020
Email liz.savage@cma.nsw.gov.au

Foreword

Lippia (Phyla canescens) infests 5,300,000 hectares of the Murray-Darling Basin at an annual cost of $1.8 billion to the environment, and conservatively costs grazing industries $38 million per annum in lost production. Lippia is generally considered an invasive weed of floodplains however, if seasonal conditions are suitable, lippia can adapt to almost any area. A weed of this magnitude can not be overlooked in the Australian agricultural and environmental landscapes.

The National Lippia Working Group (NLWG) formed in July 2002 in response to grave concerns of the rapid spread of lippia and its serious effects on the grazing industry and sensitive riparian, wetland and floodplain environments. The working group brings together landholders, representatives of state government agencies, local government, environmental and landcare groups, research bodies and industry groups. The working group and its members have been pivotal in raising the awareness of lippia in the wider community and raising the profile of lippia as a weed of national importance.

The activities of the working group include field days, national forums, research gatherings and activities to gain access to funding for lippia research and extension. The members of the working group are effectively volunteers who work closely together to utilise their skills to find solutions to the problem that is lippia.

It has been a privilege to be chair of the National Lippia Work Group and work with a team of dedicated and inspirational professionals who give freely of their time. The National Lippia Working Group formally recognises those who make a significant contribution to the community's awareness and knowledge of lippia. David Illing, Mic Julien, Rieks van Klinken, John Duggin and Wal Whalley, Greg Mills and Andrew Storrie have been invaluable contributors to this manual.

This manual collates historical work on lippia as well as ongoing activities of landholders and the research community. While projects such as biological control have many years to run and may or may not produce a satisfactory outcome, the National Lippia Working Group believes there are management options that can be trialled. It is the aim of this manual to bring together these management opportunities.

While there is no magic solution to lippia, the National Working Group is confident that with dedication to various management strategies some real progress in the fight against this very invasive weed can be achieved.

I trust readers of this manual recognise the insidious threat of lippia and that this manual will assist them in their fight against this most significant weed.

Tony Woods

Chairman

National Lippia Working Group

Contents

Acknowledgements

This project was directed by the National Lippia Working Group Steering Committee
John Duggin, University of New England, Armidale NSW
Greg Mills, Moree, NSW
Liz Savage, Border Rivers Gwydir Catchment Management Authority, Moree, NSW
Andrew Schweitzer, Namoi Catchment Management Authority, Tamworth, NSW
Phillip Spark, Ecological Consultant, Tamworth, NSW
Andrew Storrie, NSW Department of Primary Industries, Tamworth, NSW
Associate Professor Wal Whalley, University of New England, Armidale NSW
Tony Woods, Landholder & Chair of the National Lippia Working Group, Boggabilla, NSW

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The Western Catchment Management Authority

Other contributors to the manual:
Graham Charles, Research Agronomist, NSW Department of Primary Industries and Cotton Catchment Communities CRC, Narrabri NSW
Dr. Judi Earl, Agricultural Information and Monitoring Services, Guyra NSW
Dr. Mohammad Fatemi, University of New England, Armidale NSW
Andrew Hull, Catchment Coordinator (Projects), Western CMA, Bourke NSW
David Illing, Pasture Consultant (retired), Bribie Island Qld
Dr Mic Julien, CSIRO, France
Mike Lucy, Extension Agronomist, Queensland Department of Primary Industries and Fisheries, Toowoomba Qld
Matt McDonald, PhD student, University of New England, Armidale NSW
Sarah Moles, WWF Australia, Allora Queensland
Darcy Murray, Catchment Field Officer, Fitzroy River Coastal Catchments, Rockhampton Qld
Dr. Jodi Price, University of New England, Armidale NSW
Kate Reardon-Smith, PhD student, University of Southern Queensland
Andrew Storrie, Technical Specialist (Weeds), NSW Department of Primary Industries and CRC Australian Weed Management
Frank Taylor, Research and Development Officer, Nufarm, Toowoomba Qld
Dr Rieks van Klinken, CSIRO, Indooroopilly Qld
Rob Welsh, Resource Management Specialist, NSW Department of Primary Industries and Cotton Catchment Communities CRC, Narrabri NSW
Shona Whitfield, Catchment Officer Wetlands, Central West Catchment Management Authority, Dubbo NSW

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Vanessa Alsemgeest (SEQ Water Corporation),Doug Andrews, David and Rhonda Ballin, Phil and Shirley Ballin, Charles and Gillian Bellfield, Bill and Liz Caffery, Donald, Patsy and Liz Cameron, Peter and Janelle Cleary, John and Cathy Cowley, Richard and Janet Doyle, Denis and Stacey Franks, Jack and Julia Gooderham, John and Sam Hickson, Ray Jones (Ranger, Macquarie Marshes Nature Reserve), David and Stacey Lindsay, Trevor, Lois and Daryl Martin, Vic Melbourne, James and Susie Milson, Bill, Marcia and Angus Moore, Phil and Pat Norrie, Kate Reardon-Smith and Wambo Shire Council, Bruce and Jen Southeron, John, Robyn and Andrew Watson, John, Liz and Monty Wood, and Tony, Sally and Robert Woods

Introduction – Lippia, scourge of the floodplains

Lippia, *Phyla canescens*, is one of more than 28,000 foreign plants known to be introduced to Australia in the last 200 years. Lippia was deliberately introduced in the 1920s as a garden or ornamental species but due to its amazing survival abilities has spread along the floodplains of central and southern Queensland, New South Wales, and into Victoria. It has now been recorded in all states and territories of Australia.

Lippias introduction to Australia has become a source of great concern to farmers, conservationists and infrastructure managers alike as it threatens some of the nation's most productive agricultural land and richest sources of genetic biodiversity (found in wetlands and watercourse ecosystems where lippia is very prevalent).

Lippia is a significant threat in many areas of the Murray-Darling Basin, impacting on the productiveness of the land and is detrimental to the health of our pastures, soils, native vegetation and biodiversity, especially in floodplain and riparian areas.

Lippia is a dense, mat-forming plant that colonises bare ground. Although it is spread mainly by flood events, it is also believed to be spread by birds, animals and vehicles, making controlling its spread a difficult challenge to address.

Today, the cost of lippia to the livestock grazing industries of the Murray-Darling Basin alone, is conservatively estimated to be $38 million per annum in lost production. These costs do not take into account its impacts on threatened native species, increased erosion or reduced water quality. Management of this weed is becoming increasingly important to all those affected by lippia.

The momentum behind this manual

Lippia has been recognised as a problem in Australia since the early 1950s. Concern was originally raised in the Condamine catchment of Queensland and lippia has since spread to impact on land managers in other parts of Queensland, New South Wales and Victoria, due to its rapid spread by floods. Significant research work was instigated in the 1980s and 1990s to begin developing solutions.

In 2002, the National Lippia Working Group (NLWG) formed to raise the profile of the weed. It was felt that lippia had long been overlooked as a priority weed for research and funding. This group has fostered a coordinated and cross-border approach to lippia management. The result is a number of new research initiatives, extensive information gathering and lobbying to have lippia recognised as a national priority.

Through the production of this manual, the National Lippia Working Group aims to bring together current knowledge and the extensive work that is now underway in Australia and overseas to provide management solutions for lippia. It is not intended as a book of solutions, but as a reference point for the best information available at the time of collation.

The National Lippia Working Group recognises that landholders often prefer to observe how their peers deal with a problem. With this in mind, a large section of this manual is devoted to case studies of landholders experiencing varying degrees of success dealing with lippia. Anyone with a lippia problem may learn something from these case studies to assist them in making positive control decisions.

Whilst the majority of the work profiled in this manual comes from the northern Murray-Darling Basin, the recommendations are intended to be considered nationally.

(Photo by G. M

Lippia in flower

Section 1

Distribution, threats and impacts of lippia in Australia

Distribution, threats and impacts

Fact File

- There are two species of lippia present in Australia – *Phyla canescens* and *Phyla nodiflora*
- *Phyla canescens* is the species responsible for widespread environmental and economic impacts in Australia, mainly in the Murray-Darling Basin
- *Phyla nodiflora* seems to be restricted to sub-tropical and tropical regions and is not considered to be a threat at this stage
- *Phyla canescens* is often sold in nurseries, advertised as *Phyla nodiflora*
- The major environmental impacts from lippia are massive slumping and erosion of creek and river banks and the replacement of native perennial species with a monoculture of lippia, thereby reducing biodiversity
- Water flow, domestic and native animals, vehicles and machinery all contribute to the spread of lippia
- Lippia has the potential to infest floodplain areas of all river systems in southern Australia, not just the Murray-Darling Basin
- Climate change could have the effect of assisting the spread of lippia beyond its current range due to the potential for an increase in extreme rainfall and flood events
- Lippia is not a declared weed in any state, although it is declared a Control Class 4 noxious weed in some NSW local government areas

Physical characteristics of Lippia

Lippia is a member of the *Phyla* genus, which is, in turn, a member of the family *Verbenaceae*. This family includes several other important weeds such as Lantana and Maynes Pest.

There are two *Phyla* species present in Australia, *Phyla nodiflora* and Phyla canescens. It is *P. canescens* that is the major problem in Australia. There are no indications that *P. nodiflora* will become a probelmatic plant, therefore because of the current serious environmental and economic impacts associated with *P. canescens*, this manual will concentrate on this species.

Lippia is a prostrate perrenial broadleaf herb and has many branched stems, sometimes up to one metre in length. The plant has the ability to send down roots at nodes along the stems, and when well established Lippia can form a dense mat of groundcover.

The distinctive features of *P canescans*

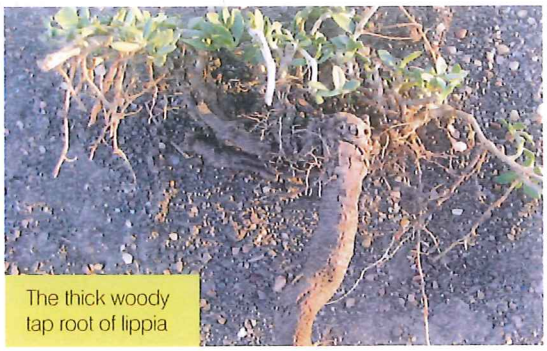
(Photo by Greg M

Lippia has the ability to become the total groundcover in an area

(photo by Judi E

Lippia has a very thick central taproot with fibrous secondary roots. The taproot has the ability to reach deep moisture reserves, and because of this ability a dense stand of lippia can dry out the soil to a depth of several metres.

The two lippia species *P. nodiflora* and *P. canescens* are very similar in some respects, but there are fundamental differences that are very obvious when comparing the two species. There are also differences in the environmental requirements of each species, and this contributes to *P. canescens* being the major threat that it is.



The thick woody tap root of lippia

(Photo by John Duggin)

Species	General description	Leaf	Flower	Soil and climate preferences
P. canescens	Very prostrate, forms a dense groundcover	1 – 3 cm, blunt serrated edge towards the tip, tapering to a short stem	Tubular, occur in clusters forming a round head when mature, 1 – 1.5 mm in diameter. Flowers white, cream, pinkish or lilac	Heavy clay soils to lighter clays and sandy soils, temperate to sub-tropical areas
P. nodiflora	Tends to be a more erect plant but can still form a fairly dense groundcover	2 – 4 cm, slightly hairy leaves that are sharply toothed on the upper margin	Oblong or cylindrical flower spike, flowers 9 –25 mm long x 6 – 8 mm in diameter, white, pink or purple	Light sandy soils, sub-tropical to tropical areas

Table 1: Comparison of features for *Phyla nodiflora* and *Phyla canescens*

The variations of *P. canescens* (left) compared with *P. nodiflora* (right)

(Photo by Gio Fichera, CSIRO)

P. canescens labelled as *P. nodiflora* on sale at a nursery in Bendigo, Victoria

(Photo by Matt Macdonald)

Lippia was, and still is, promoted widely as a groundcover and low maintenance lawn species by nurseries. Some nurseries are still marketing lippia, claiming it to be *P. nodiflora*, but in fact it has been identified as *P. canescens* in most cases. This is probably due to ignorance rather than deliberate misrepresentation.

The photo (above right) was taken at a nursery in Bendigo, Victoria in January 2008 and it has been positively identified as being *P. canescens*, although labelled as *P. nodiflora*.

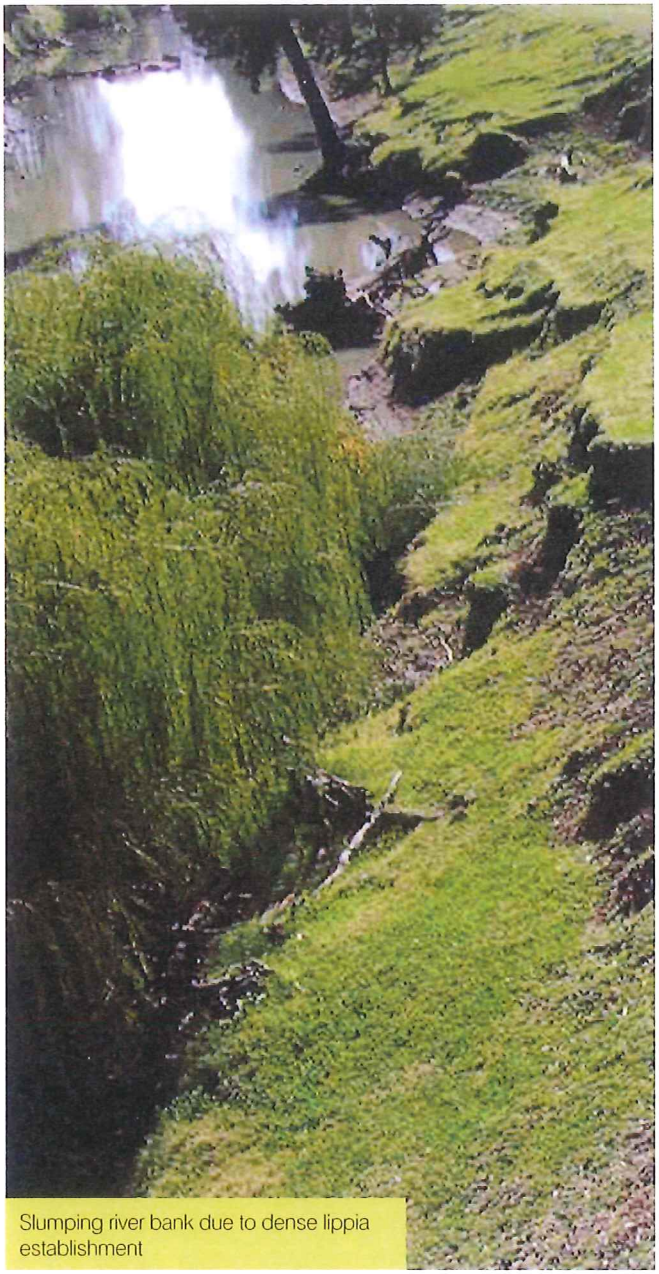
Environmental and economic impacts of lippia

Lippia has infested an area of more than 5.3 million hectares throughout the Murray-Darling Basin. Lippia is also present in other major catchments throughout Australia, however the extent has not yet been quantified. The cost to the grazing industry in the Murray-Darling Basin alone is conservatively estimated to be $38 million per annum. The average reduction in stocking rates attributed to lippia has been surveyed to be 55%, with 100% destocking reported by some landholders due to severe lippia infestation in grazing paddocks[1].

The loss of environmental services due to lippia is estimated to be $1.8 billion per annum. These losses are estimated in terms of the loss of biodiversity and perennial vegetation, increased rates of erosion and reduction in water quality. The primary threat from lippia lies in its direct impact on groundcover in floodplain communities. The spread of lippia has significantly impacted and continues to threaten biodiversity throughout the Murray-Darling Basin. A significant number of listed threatened species are restricted to environments where lippia tends to predominate.

Lippia was introduced in some areas as a soil stabiliser. It was thought that the root biomass and dense foliage would provide a barrier to streambank erosion, but the opposite is true. Because of its massive taproot system, lippia has the ability to draw moisture from very deep in the soil profile. Instead of streambanks being stabilised, they slump and collapse as a result of the soil being dried out to several metres.

[1] Source - The distribution and impacts of Lippia (Phyla canescens) in the Murray-Darling Basin, Judi Earl (2003)



Slumping river bank due to dense lippia establishment

(Photo by Judi Earl)

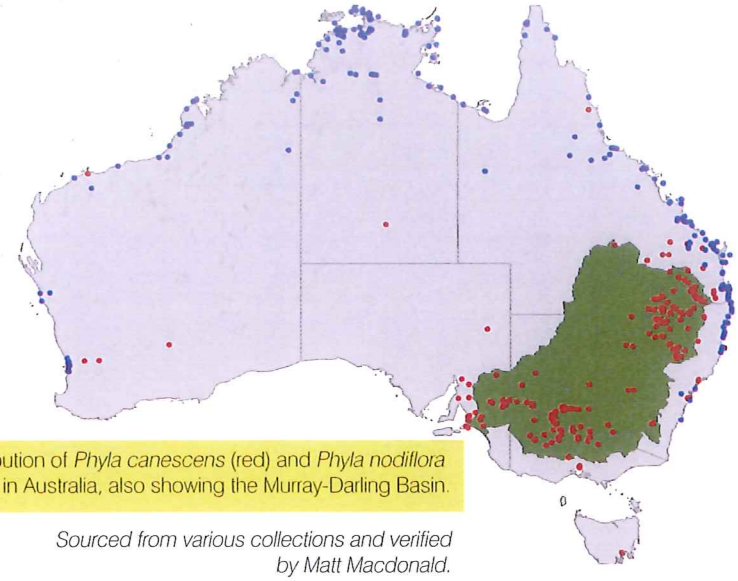
Close-up of lippia drying and cracking the soil, leading to slumping

(Photo by Greg Mills)

Current and potential distribution of lippia in Australia

P. canescens has been present in Australia since at least the 1920s. University of New England researchers[2] have extensively researched the distribution of both species of lippia throughout Australia. The following map shows the current estimated distribution of *P. canescens* and *P. nodiflora* across all states. This work has built on previous studies of lippia distribution carried out by A. A. Munir[3] in 1993.

[2] See Appendix 2 for researchers details – Ref no. 6
[3] See Appendix 1 – References



Distribution of *Phyla canescens* (red) and *Phyla nodiflora* (blue) in Australia, also showing the Murray-Darling Basin.

Sourced from various collections and verified by Matt Macdonald.

The Murray-Darling Basin in Queensland, New South Wales, Victoria and South Australia is the region most affected by the distribution of *P. canescens* in Australia. Lippia is also present in the Burnett region in Queensland, the lower Hunter Valley in New South Wales, and small areas in South Australia and Western Australia.

P. canescens can also be found in lawns and gardens in many towns across Australia, including Kununurra, Karratha, Blackall, Townsville, Brisbane, Mareeba and Alice Springs, with naturalisation observed in Mareeba and Townsville.

P. nodiflora seems to be restricted to the tropical areas of northern Australia and coastal areas in eastern states and Western Australia.

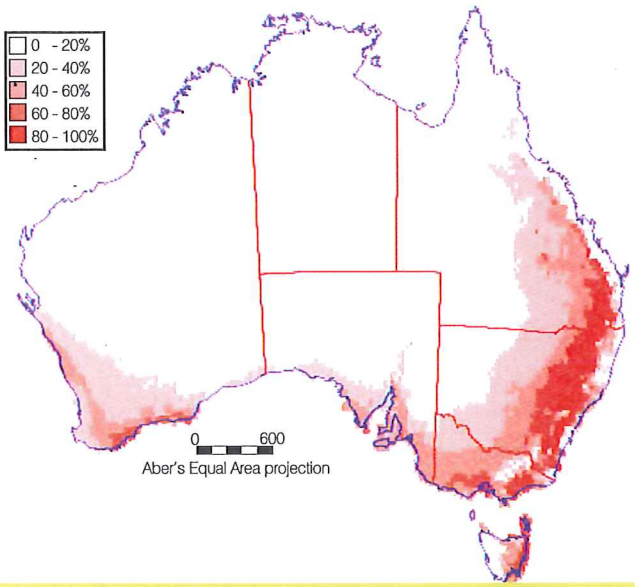
In June 2007, a CSIRO report was issued regarding the management of lippia and its potential response to the effects of climate change in the Murray-Darling Basin. The report was sponsored by the Australian Greenhouse Office.

Most climate change models predict a tendency towards drier and warmer seasonal averages for the Murray-Darling Basin. However, increases in high-rainfall events and consequent extreme flood events have also been predicted for the Basin, despite overall decreases in mean annual rainfall amounts. Due to the longevity of seed in the seedbank (see Section 2), a lippia population explosion is likely following such an extreme flood event.

A predicted increase in temperatures and lower rainfall may cause more frequent droughts, leading to an increase in areas of bare ground available for lippia to colonise following rainfall.

CLIMEX models indicated that even in sub-optimal drought conditions, lippia continues to pose a threat due to its ability to undergo population explosions from the seedbank. Therefore, reducing seed numbers would be desirable as this would decrease the potential of lippia to rapidly regenerate when optimal environmental conditions arise. This may be possible in the future through the introduction of biological agents that have an effect on seed set.

The following map indicates the potential of lippia to spread under the impact of climate change, with large areas outside the Murray-Darling Basin also being identified as suitable for lippia infestation.



The potential distribution of Phyla canescens in Australia by 2030 under a high global warming scenario, where 0% is climatically unsuitable for lippia and 100% is ideal.

(map by Kate Stokes, CSIRO)

Legal status of Lippia in Australia

Each Australian state has different noxious weed legislation. In Queensland, the State can declare a plant to be a Class 1, 2 or 3 weed. These plants are targeted for control because they have, or could have, serious economic, environmental or social impacts. Lippia is not on the declared list in Queensland although Queensland Shire Councils may locally declare a plant as noxious in their area.

In NSW plants may be declared noxious by the Minister for Primary Industries. Lippia is declared a Control Class 4 noxious weed in several local control authority (LCA) areas (Gunnedah Shire Council, Liverpool Plains Shire Council, Moree Plains Shire Council and Tamworth Regional Council).

Being declared a Class 4 weed means that there are legal requirements regarding lippia in these LCA areas, which are:

'The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority, and the plant may not be sold, propagated or knowingly distributed.'

These councils appear to be the only authorities who have taken steps to ban the sale of lippia, which is still continuing in many other areas of Australia.

There is no mention of *P. canescens* on Victorian, South Australian or Western Australian government websites which indicates either ignorance or lack of concern about the potential for *P. canescens* to become established over wide areas of these states.

Lippia is found in the streets and gardens of many towns in eastern Australia

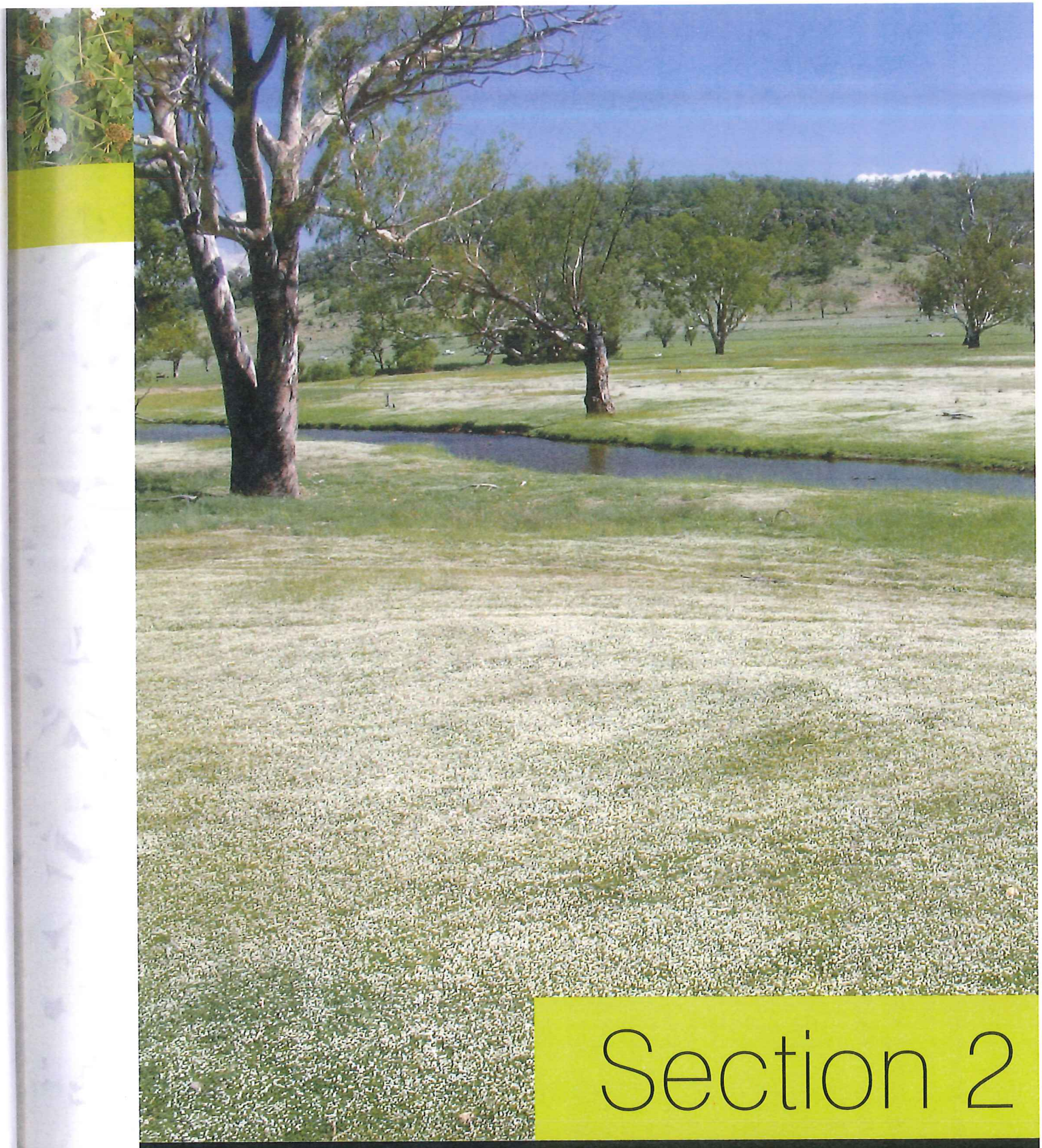
(Photo by P. Crawford)

Only Queensland and New South Wales government agencies have published fact sheets on lippia.

Landholders are reminded that as lippia mostly occurs in environmentally sensitive, riparian and floodplain areas they should always refer to the relevant legislation for activities in these zones for their state, especially regulations concerning allowable weed control activities in these areas. Landholders will need to refer to vegetation management, threatened species protection, pesticide and environmental legislation for the Commonwealth and for their state.

There is a list of Commonwealth and state legislation in Appendix 2.

WWF Australia has submitted a nomination to the federal government that lippia be listed as a *Key Threatening Process* under the Environmental Protection and Biodiversity Act. The nomination is still under consideration.



Section 2

Biology, ecology and genetics of lippia

Biology and ecology of lippia

Fact File

- Research has identified three conditions that need to be present for lippia to germinate:
  - o there needs to be fluctuating temperatures;
  - o there needs to be light; and
  - o the seed needs to be covered by free water for a period of time
- Lippia seed is likely to be viable in the ground for many years
- Lippia seeds can germinate directly from sheep faeces, indicating another potential method of spread

How lippia reproduces

Lippia has the ability to reproduce both vegetatively and from seed. Fragments of lippia stem will also readily take root in moist soil.

Fragments and seed can be spread by vehicles, machinery and animals but the majority of lippia spread is clearly related to flood events. A period of significant rainfall and flooding will likely result in an explosion in lippia population, especially on ground left bare by drought and overgrazing.

Viability of lippia seed

Research[4] has indicated that lippia seed remains viable for many years (probably well over ten years). Combined with a seed bank of up to 10,000 seeds per square metre and a germination rate of approximately 50%, it is likely that a huge reserve of viable seed will be present in the soil for many years.

Conclusions from this research indicate that even with good management practices in place, once lippia is established it will never be totally eliminated.

[4] See Appendix 2 for researchers details – Ref nos. 4, 6, 9

Flood induced recruitment

Research[5] has shown that for lippia seeds to germinate they must be covered by free water for a period of time. This fact was reinforced from observations of a single flood event after 200 millimetres of rain at Wee Waa, New South Wales in 2005.

Three transects (monitoring lines) were set up at right angles to a 150 metre section of a billabong on the Namoi River floodplain and measurements were taken from three zones:

Zone 1	the area of spike-sedges immediately adjacent to the billabong.
Zone 2	from the upper edge of the spike-sedges to the flood strand-line (upper limit of the flood).
Zone 3	the area above the upper flood limit (not under water at any time during the flood event, even though thoroughly wet from 200 millimetres of rainfall).

[5] See Appendix 2 for researchers details – Ref nos. 4, 6, 9

Samples were taken at one metre intervals (with a twenty-five centimetre quadrat) through the three zones and the lippia present was recorded. The lippia found was from three categories:

- Seedlings – small plants with cotyledons
- Fragments – small pieces of stem that had taken root
- Adult lippia – well established individual plants

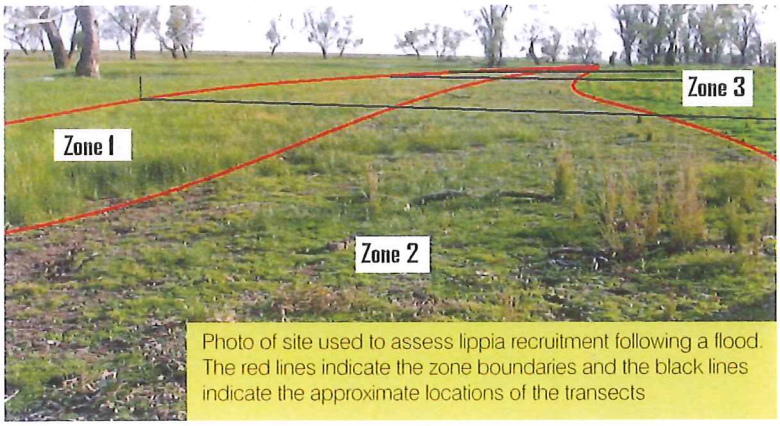


Photo of site used to assess lippia recruitment following a flood. The red lines indicate the zone boundaries and the black lines indicate the approximate locations of the transects

(Photo by M. Macdonald)

The major findings of this study were:

- with the exception of three seedlings, all recruits were recorded below the flood strand-line;
- zone 2 contained the highest number of adult plants (33 per m^2) and recruits (40 per m^2 for seedlings and 34 per m^2 for fragments); and
- adult plants were found at a density of only 3 per m^2 in Zone 1, indicating a restricted ability for lippia to persist in this zone.

This study has shown that although it is important that lippia has the ability to spread from fragments, germinating seeds could be the major lippia recruitment process. There are limitations to the germination of seedlings, particularly the need to be covered by water. This indicates that management actions immediately following a flood could be very important to reduce the spread of lippia.

The observation at this site of thirteen lippia seeds germinating directly from sheep faeces is the first time this has been found in research and this may have management implications for properties carrying sheep.

It should be emphasised that lippia is not confined to floodplains, with reported instances of lippia appearing in higher country. It is probable that seed could be carried to these areas by livestock and/or birds. The free water necessary for germination in these cases could simply be lippia seed being covered by water in a cattle hoofprint, wheel rut or other similar depression. Any place where water may sit for a week or more is a potential site for lippia recruitment.

Germination response to temperature and light

University of New England researchers[6] carried out experiments to measure the germination response of lippia seeds to a range of constant and fluctuating temperatures as well as a response to light. The seed used was collected from established lippia infestations at Boggabri and the Gwydir River watercourse at Moree, both in New South Wales.

The findings of these experiments were:

- germination was significantly lower for temperatures at or below 15°C, and at or higher than 45°C;
- germination was significantly reduced when the daily temperature fluctuated by less than 10°C; and
- where the temperature fluctuated by 10°C or more, germination was significantly increased.

The seeds were also subjected to alternating light and darkness. Where there were fluctuating temperatures, but constant darkness, no seeds germinated.

The need for light and fluctuating temperatures for germination is common to a number of aquatic, semi-aquatic and floodplain plants that germinate prolifically following floods.

[6] See Appendix 2 for researchers details – Ref nos. 4, 6, 9

Genetic diversity of lippia

Fact File

- The level of genetic diversity of any weed affects the difficulty or otherwise of selecting a successful biological control for that weed
- Some populations in Australia are showing very high levels of genetic diversity, whilst other areas are showing very little genetic diversity
- The genetics of lippia found in Australia leads researchers to conclude that lippia appears to have been sourced mainly from South America

Research by the University of New England[7] has identified genetic markers to enable the tracking of sites where particular populations of lippia in Australia may have been sourced. This will enable researchers to identify whether lippia in Australia has come from a range of sources, or from just one source. The early results from the project indicate that some populations in Australia are showing very high levels of genetic diversity, whilst other areas are showing very little genetic diversity.

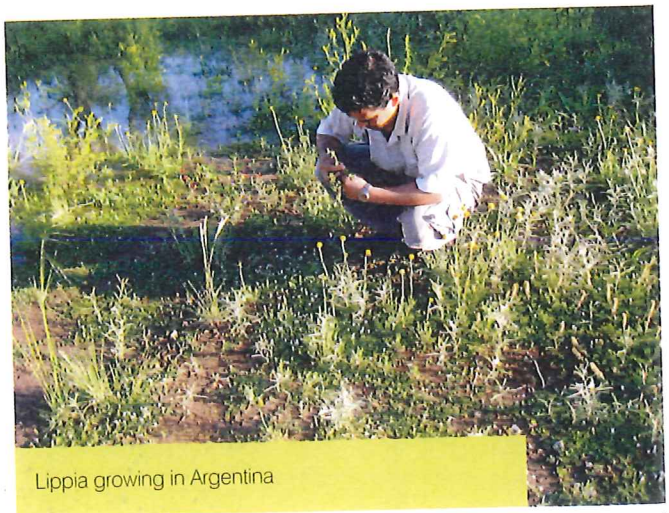
CSIRO researchers[8] are conducting comparative growth studies, utilising lippia material collected from a range of populations from the plant's native range in Argentina and from its invasive ranges in Australia and France. These studies aim to determine the variation within and between populations and countries.

The level of variation could have implications for future management. It has been determined that there are morphological and physiological differences in the invaded ranges (such as in Australia) compared to the native range. Results so far indicate that Australian populations have an enhanced vigour of sexual reproduction, producing more flowers (thus potentially more seeds) than native populations in Argentina.

These studies will be crucial for the development of management strategies, including biological control. However, the introduction of any biological control agent for lippia is likely to be some years away. In the meantime land managers will need to concentrate on other management options to control the weed.

Phyla nodiflora showing sharply toothed leaves

(Photo by M. Julien)



Lippia growing in Argentina

(Photo by M. Julien)

[7] See Appendix 2 for researchers details – Ref nos. 3, 4
[8] See Appendix 2 for researchers details – Ref nos. 8, 11

Allelopathic effects of lippia

Fact File

- Allelopathy is the effect of toxins from a particular plant impacting on the germination, growth or health of other plant species in the immediate vicinity
- Research and anecdotal evidence suggests that lippia may have some allelopathic effect on the germination of some plant species

Anecdotal evidence has indicated that lippia may have an allelopathic effect on other plant species. There has been much debate over whether lippia does have an actual allelopathic effect or whether germination of other species is inhibited by competition for moisture, light and space.

An experiment was conducted by The University of Sydney[9] in 2006 to research whether lippia is allelopathic to other plants. The experiment involved the extraction of solutions of lippia leaf, stem and root plant tissues, at various concentrations, and observing whether the germination of sorghum, radish, lettuce, subclover, oats and ryegrass seeds was affected.

The experiment showed that extracts of lippia stems and leaves had a minor inhibiting effect on the germination of all species tested, except sorghum. However it should be noted that the concentrations used in this experiment are probably not typical of those found under field conditions.

[9] See Appendix 2 for researchers details – Ref no. 2

Subclover seeds germinated in different concentrations of lippia residue.
Figure A demonstrates 100% germination in the control (H^2O) compared to 50% in 12g/100ml H^2O of lippia residue and 0% germination in 50g/100ml H^2O lippia residue in figures B and C respectively.

(Source - Allelopathic effect of lippia on germinating seeds, Andrew T Daley, University of Sydney, Sydney NSW 2006)

Conclusions

- As lippia residue concentration increased, the time to germination and final percentage germination decreased for most plant species tested;
- Germination percentages of legumes are significantly reduced by low concentrations of lippia residue (12 to 30 g/100 mL H^2O); and
- It is not recommended that legumes be planted shortly after cultivation of lippia infested pastures

The relevance of these results to lippia management is doubtful for two reasons:

1	Grazing trials have shown that native pasture species in lippia infested areas actually increase under a destocked regime (see management section).
2	If planting pasture is being planned, it is usually a good practice to fallow country for several months prior to planting to control weeds and store soil moisture. This would allow sufficient time to reduce the risk of any possible allelopathic effects, if the lippia was controlled at the beginning of the fallow.

Section 3

environmentally sensitive areas

Fact File

- A major issue with the management of lippia is that it is mainly found in environmentally sensitive areas such as wetlands, riparian zones and floodplains, therefore restricting management or control options
- There are strict rules and regulations limiting the types of activities that can be carried out in environmentally sensitive areas – seek advice and relevant permissions before acting! Refer to the reference table in Appendix 2 for legislation in your state
- Consider all possible environmental impacts of lippia control work at the local or property level, and consider potential downstream impacts

Lippia generally occurs in floodplains and watercourses. Many of the areas that are infested with lippia are in environmentally sensitive areas, such as the wetlands in the Gwydir River watercourse and Macquarie Marshes. Therefore great care needs to be taken in the management of lippia in these areas.

Each state has a range of environmental and vegetation legislation that should be consulted by landholders prior to undertaking any lippia control work in environmentally sensitive areas. Each state also has a range of agencies that should also be contacted if control work is to be carried out in these areas. The agencies in your local area may include:

- Commonwealth Department of Environment;
- your local or regional catchment management authority;
- your state environmental, natural resources or conservation agency;
- your local Department of Primary Industries or Agriculture; or
- your local shire council, or local control authority.

There are generally strict rules and regulations as to the type of work that can be carried out in environmentally sensitive areas, especially if there is a regionally endangered ecosystem present in the area. This is particularly important when considering cultivation of sensitive areas for the establishment of an introduced pasture species.

The use of herbicides to control lippia in areas of high lippia density will most likely be less damaging to the environment than cultivation, especially if the country has never been cultivated previously.

In some cases, there may be a greater environmental impact from control activities than the impact of the lippia. Landholders should consider all of the potential environmental impacts and possible legal liabilities before commencing lippia control activities in environmentally sensitive areas.

In many areas close to waterways or streams, restoring and managing the existing native pasture may be the best option for lippia management. The use of planned grazing management with the application of higher stock density for shorter periods of time will encourage the persistence of desirable native pasture components in areas that are not currently monopolised by lippia.

Every situation will be different and landholders will need to assess all the management options for these areas before committing to any lippia control strategy.

Extreme care is necessary with lippia control in environmentally sensitive areas

(Photo by M. Julien)

The impact of grazing practices on lippia management

Fact File

- Lippia is generally not a good competitor and contrary to common belief lippia has problems invading vigorous stands of native perennial pasture
- If there is good groundcover present, conditions are generally unfavourable for the survival of lippia recruits, both from seed and fragments
- All perennial pastures need periods of rest to survive hard times, and/or de-stocking to maintain the root biomass which is also a valuable tool for reducing the lippia population
- Even the best pastures do have spaces between grass tussocks so there is always the potential for lippia invasion
- 30% lippia cover is a big problem if the other 70% is bare ground, but 30% lippia cover is not a big problem if the other 70% is productive perennial pasture

The distribution and impacts of Lippia (Phyla canescens) in the Murray-Darling Basin, was the report on a study carried out by Dr Judi Earl for the Lippia Working Group in 2003. This study was a comprehensive analysis of lippia for the entire Murray-Darling Basin and the first to identify that inappropriate grazing practices are a major contributing factor in the spread of lippia. Contrary to the popular belief that lippia chokes out native species, there is increasing evidence that set stocking or continuous grazing promotes lippia abundance, as desirable species are gradually being removed, leaving ideal conditions for the spread of lippia.

In April 2003, Dr. Earl observed that lippia occupied 25-35% groundcover at all sites monitored for the study. The average area of bare ground at these sites was greater than 50% and was attributed to drought conditions and overstocking. In the absence of other species, lippia is very opportunistic and in the event of a major flood event following an extreme drought there is a potential for a massive increase in lippia infestation in areas where there is bare ground.

Lippia comprises about 15% cover in this overgrazed pasture west of Moree, NSW

(Photo by Judi Earl)

In most grazed floodplain pastures, individual paddocks are commonly stocked at a low density for extended periods of time (up to six months). Under such a grazing regime the most desirable (palatable) species experience frequent defoliation and only partial rest. Continual frequent defoliation of perennial grasses results in a significant reduction of root biomass and density and significantly restricts the plants ability to access moisture and nutrients.

In addition, the perennial native grass species of the floodplain are well adapted to regular cycles and periods of inundation. These wet and dry cycles have been significantly altered with the changed water regimes associated with river regulation. Weakened by environmental changes combined with continual exposure to livestock and frequent defoliation, the competitive ability of these grasses has been progressively diminished and ultimately has led to their decline in floodplain pastures.

The bare ground created following the decline in perennial grass populations is highly susceptible to occupation by exotic species. Over the period of the study it was observed that lippia was not present at locations that supported dense stands of perennial grasses; the boundary of the stand presents a barrier to invasion by lippia.

Vigorous, well managed native pastures may effectively compete with lippia

(Photo by Judi Earl)

Individual pasture plants need to be provided with adequate periods of time to recover from each grazing event to allow regeneration of root reserves to enhance their ability to persist during periods of moisture stress. Landholders employing a rotational method of grazing management have indicated that they have effectively restricted the spread of lippia over time. Other graziers who have experienced increasing lippia invasion and have not adjusted their stocking practices in affected paddocks have experienced a continuing increase in lippia infestation.

Grazing management trials

Researchers at the University of New England[10] are conducting a project in the Macquarie Marshes and the Gwydir River watercourse wetlands involving the placement of small (4 m^2) moveable exclosure cages on a fixed and rotational basis, providing rest at different times of the year. The trials are being carried out on two sites in each of the wetland areas – a dry site (infrequently flooded) and a wet site (flooded annually through environmental releases from Copeton and Burrendong Dams).

The trials are looking at five grazing management regimes:

[10] See Appendix 2 for researchers details – Ref nos. 4, 7

1	Continuous rest (CR)
2	Continuous grazing (CG)
3	Rest period 1 – December, January, February, March (R1)
4	Rest period 2 – April, May, June, July (R2)
5	Rest period 3 – August, September, October, November (R3)

Grazing exclosure cages in lippia infested grazing country in the Macquarie Marshes

(Photo by Jodi Price)

The three rest periods are being used to establish the potential for various plant species to recover at different times of the year.

After one year the initial results are very encouraging, with plant species other than lippia increasing in numbers in all of the trial plots in the rested plots. The early data from these trials indicates that lippia biomass can be reduced with increased groundcover from other species, supporting anecdotal evidence from other researchers and graziers.

The trials also indicate that a good cover of vegetative growth inhibits the spread of lippia after a flood event, both from seed and plant fragments. This could be a key factor in the management of lippia in floodplain and wetland situations.

The University of New England and CSIRO have commenced similar trials at Goondiwindi on the Macintyre River floodplain (in association with the Queensland Murray Darling Committee) and at Wivenhoe and Somerset Dams in the Brisbane and Stanley River catchments (in association with SEQ Water Corporation).

Managing lippia by restoring and encouraging vigorous and healthy perennial pastures

Fact File

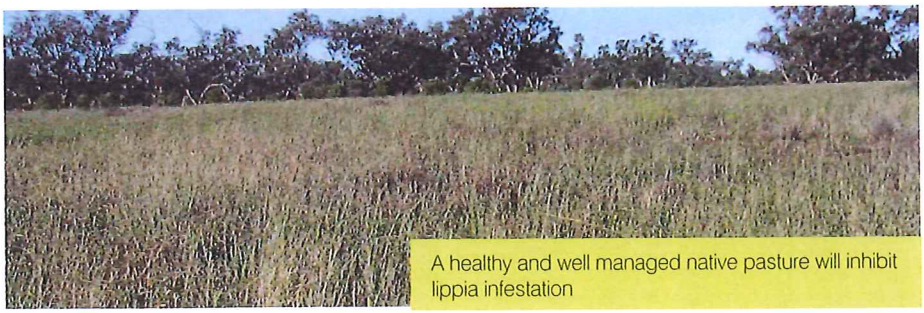
- A healthy and well managed native perennial pasture will effectively resist lippia invasion. Lippia has problems invading vigorous stands of pasture
- Depending on the closeness to environmentally sensitive areas and existing pasture species, a perennial native pasture may be the most desirable option for lippia control
- If considering a sown pasture for lippia management, take care to select the appropriate pasture species for your area
- Weed control is critical for a sown pasture but care needs to be taken regarding massive soil loss if a flood occurs before the pasture is well established. A no-till approach using herbicides for weed control may be more appropriate than cultivation in some cases
- Always allow sown pastures to set seed at least once before grazing
- Pereniality and strategic long rest periods are the key factors in pasture management, whether native or introduced

A strong competitive pasture is vital for long-term lippia control and simply de-stocking or reducing the stocking rate on lippia infested country may not be enough for long-term control in some instances. The pasture may need to be rejuvenated or re-established.

Encouragement and management of existing perennial native pastures has been demonstrated to successfully assist with lippia management and control. Promoting the revival of the pasture may require an initial treatment with herbicide or cultivation where it is acceptable and practical. However, the tendency of lippia to dominate riparian and floodplain areas adjacent to rivers would make cultivation an inappropriate practice for many of these situations.

While annual cropping provides the potential to generate income in the short term, the practice of cultivating areas adjacent to waterways, either for annual cropping or introduced pasture establishment, creates a huge potential for erosion during flood events. Apart from the environmental concerns, it may also be illegal in some areas.

Therefore, it would be prudent to consider management actions to promote the revival of the native pasture species as a first step, before any actions are taken to rip it out and replace it.



A healthy and well managed native pasture will inhibit lippia infestation

(Photo by J. Earl)

Establishing a sown pasture

In some areas, it may be desirable to re-establish pastures with introduced pasture species following chemical or mechanical control of lippia in grazing areas. Introduced pastures can be very difficult to establish, unless some basic rules are followed.

1	Preparation – the soil preparation for an introduced pasture should be similar to preparation for a grain crop. That is, it needs to be weed free (lippia controlled), there needs to be a good seed bed and there should be good soil moisture.
2	Timing – in most areas, the optimum time for planting introduced pastures is in late summer to early autumn. However, as this may not always be the best time as far as rainfall is concerned, it may be more appropriate to plant in late spring to early summer. The critical factor is a weed free environment.
3	Management – it is crucial that introduced pastures be allowed to establish completely and set seed at least once before any grazing takes place.

The best introduced pastures are generally those consisting of a mix of species. Two or more grasses with a suitable legume make up a very good pasture. The species used will depend on the region and the following table suggests species for southern and northern areas in the Murray-Darling Basin.

Landholders wishing to establish a legume such as a medic or clover would be best advised to leave the legume out of the initial pasture mix in case there is a need for herbicide application for lippia control in the grass pasture in the first year or so. When the grass species have become well established it would then be a good time to broadcast the legume seed onto the pasture, providing seasonal conditions are suitable.

Region	Species	Varieties	Planting rate	Comments
Southern New South Wales and Victoria	Phalaris	Holdfast, Atlas PG, Sirolan, Sirosa	2 – 3 kgs/ha	Phalaris is only moderately drought tolerant, and is unlikely to persist in western floodplain areas with less than 400 mm of rainfall.
	Persian clover	Nitro Plus, Prolific,	2 – 3 kgs/ha	Have performed well on floodplains west of Forbes. Tolerant of waterlogging.
	Balansa clover	Paradana, Frontier	2 – 3 kgs/ha	Not as productive in spring as Persian clovers, but useful in a mix. Tolerant of waterlogging.
Northern New South Wales and southern Queensland	Panic	Bambatsi	3 – 4 kgs/ha	Bambatsi is very suitable for heavy floodplain soils and tolerant of several weeks of inundation during a flood.
	Bluegrass	Floren	3 – 4 kgs/ha	Has the ability to form a thick pasture, leaves a thick layer of mulch on the ground. Very palatable, but not tolerant of extremely dry conditions.
	Burr medic	Naturalised		Very dependant on seasonal conditions for germination and spread.
	Vetch	Woolly pod	1 – 2 kgs/ha	Very suitable for floodplain conditions.

Table 2: Recommended introduced pasture species for floodplain areas

(NSW Agriculture Agfact P7.6.52, 1st edition, 2001)

A healthy and well managed mixed species introduced *(Photo by P. Crawford)*

Managing lippia with herbicides

Fact File

- Herbicides should be used as part of an overall management plan that includes vigorous pastures and good grazing management
- Two applications of 2,4-D, two months apart, give the best control of lippia in pastures
- Only spray when lippia is fresh and actively growing
- In many areas where lippia occurs, it may be impossible to use a boomspray. It may be worthwhile to consider a boomless sprayer for these areas
- Carefully follow the directions on the label and permits

Lippia's ability to spread, both vegetatively and by seeds, to tolerate waterlogging and drought, and to compete with other plants, allows it to overcome short-term setbacks from single herbicide applications. While herbicides are an important component of lippia management, when used alone they will provide only short-term suppression of lippia.

Long-term lippia management is best obtained through an integrated approach involving herbicides, grazing management and, in some cases, pasture re-establishment.

Application with a boomspray is the most common method of applying herbicides for lippia control. However in many areas where lippia occurs, it may be impossible to use a boomspray. Spot spraying may be appropriate for smaller areas, but can be very time consuming and at times inefficient. For areas difficult to access with a boomspray and too large for spot spraying, it may be worthwhile to consider using a boomless sprayer for applying the herbicide. Again, check the label for appropriate application methods.

Lippia in cropping country

Lippia is easily controlled by cultivation under drying soil conditions. However, with the increasing adoption of zero tillage cropping systems, there is a potential for lippia to become a problem in cropping systems. In fact there is anecdotal evidence from work being carried out by landholders in the Central West catchment management area of New South Wales that this is already happening.

There are permits for lippia control in fallows in NSW (PER10917) and Queensland (PER10540) which are outlined in the following table.

NSW PER10917		Queensland PER10540	
Herbicide	Rate per ha.	Herbicide	Rate per ha.
Glyphosate (450 g/L) + 2,4-D ipa (300 g/L) or 2,4-D ipa (475 g/L) + crop oil	2.6 to 5.4 L glyphosate + 1.8 L or 1.4 L 2,4-D + 1 % crop oil	Glyphosate (450 g/L) + 2,4-D ipa (225 g/L) + crop oil	2.6 to 5.4 L glyphosate + 2.4 L 2,4-D + 1 % crop oil
Glyphosate (450 g/L) + metsulfuron (600 g/kg) + crop oil	2.6 to 5.4 L glyphosate + 15 to 30 g metsulfuron + 1 % crop oil	Glyphosate (450 g/L) + metsulfuron (600 g/kg) + crop oil	2.6 to 5.4 L glyphosate + 15 to 30 g metsulfuron + 1 % crop oil
Glyphosate (450 g/L) + 2,4-D ipa (300 g/L) or 2,4-D ipa (475 g/L) + metsulfuron (600 g/kg) + crop oil	2.4 to 5.4 L glyphosate + 1.8 or 1.4 L 2,4-D + 15 to 30 g metsulfuron + 1% crop oil	Glyphosate (450 g/L) + 2,4-D ipa (225 g/L) + metsulfuron (600 g/kg) + crop oil	2.4 to 5.4 L glyphosate + 2.4 L 2,4-D + 15 to 30 g metsulfuron + 1% crop oil

Table 3: Herbicides permitted to be used under permit for lippia control in fallow situations

Notes on permits:

- Apply when lippia is actively growing, preferably early flowering with good soil moisture
- Do not apply immediately after rain or if rain is forecast within four days of the proposed application
- Only use Roundup® Biactive, Nufarm Weedmaster® 360, or equivalent formulations within 20 metres of a waterway
- Only use the isopropyl amine (ipa) salt formulation of 2,4-D when tank-mixing with glyphosate as the DMA salt formulation reduces the effectiveness of glyphosate
- 2,4-D formulations for fallow control of lippia all 2,4-D ipa are allowed in NSW, and 225 g/L ipa 2,4-D in Queensland
- Permit No. PER10917 for New South Wales and Permit No. PER10540 for Queensland both expire 31 July 2013

Lippia in pasture and non-crop areas

Non-crop and pasture areas can include environmentally sensitive areas such as riparian zones and wetlands. Great care should be taken when using herbicides in these areas to prevent off-target movement of these herbicides.

Agricrop Lantana® 600 (dichlorprop) is the only herbicide registered for lippia control in pasture and non-crop areas.

Permits are in place for the use of 2,4-D amine for lippia control in these areas in both New South Wales and Queensland.

Situation	Herbicide	Rate (/ha)	Registration or permit
Non-crop, rights of way	Agricrop Lantana® 600	5 L in a minimum of 100 L water	Registered in Qld & NSW
Pasture	2,4-D amine (625 g/L) + crop oil	1.7 to 3.1 L + 1% crop oil	NSW Permit PER10917
Pasture	2,4-D amine (500 g/L) + crop oil	2 to 4 L + 1% crop oil	Queensland permit PER10450

Table 4: Herbicides for lippia control in pasture and non-crop areas

Notes on permits:

- Do not use in areas where desirable broadleaf species such as clover or medics are present
- Lippia must be actively growing under good soil moisture
- Apply when lippia is in fresh condition and mid-flower
- Do not apply in dry conditions
- Only use a maximum of two applications per growing season
- 2,4-D formulation for lippia control on pastoral land allowed under the permits is 625 g/L 2,4-D in New South Wales and 500 g/L 2,4-D in Queensland
- Permit No. PER10917 for New South Wales and Permit No. PER10540 for Queensland both expire 31 July 2013

Herbicide trials on lippia

There have been a number of herbicide trials carried out since the 1960s investigating the control of lippia. They have found that a single application of herbicide in one season allows re-infestation by the surviving plants, even if over 95% control was initially achieved from one application.

Recent research has shown the need for two consecutive herbicide applications in the one season to give high levels of control. The timing of the applications should be early summer and then late summer-early autumn. The lippia should be actively growing otherwise the level of control will be low.

In a trial at 'Limebon', near Goondiwindi, Queensland, Amicide® 625 (2,4-D amine) was used in a split application experiment and compared with Agricrop Lantana® 600 (dichlorprop).

The results of these trials are outlined in the table below.

Plot	Herbicide and rate		% lippia groundcover			Cost per hectare		
	Application 1 (T1) (5/03/2004)	Application 2 (T2) (12/05/2004)	All plots 68 days after T1	Single appn. 201 days after T1	Double appn. 133 days after T2	1st appn. (T1)	2nd appn. (T2)	Total cost
1	3 L Agricrop Lantana® 600	2 L Nufarm Amicide® 625 + 1% Supercharge®	15%	37%	0%	$36	$22	$58
2	5 L Agricrop Lantana® 600	2 L Nufarm Amicide® 625 + 1% Supercharge®	4%	10%	0%	$61	$22	$83
3	3 L Agricrop Lantana® 600 + 1% Supercharge®	2 L Nufarm Amicide® 625 + 1% Supercharge®	3%	12%	0%	$44	$22	$66
4	2 L Nufarm Amicide® 625	2 L Nufarm Amicide® 625 + 1% Supercharge®	15%	13%	0%	$14	$22	$36
5	4 L Nufarm Amicide® 625	2 L Nufarm Amicide® 625 + 1% Supercharge®	6%	0%	0%	$29	$22	$51
6	2 L Nufarm Amicide® 625 + 1% Supercharge	2 L Nufarm Amicide® 625 + 1% Supercharge®	3%	7%	0%	$22	$22	$44
Control	No 1st application (T1)	2 L Nufarm Amicide® 625 + 1% Supercharge®	100%	100%	52%	NA	$22	$22

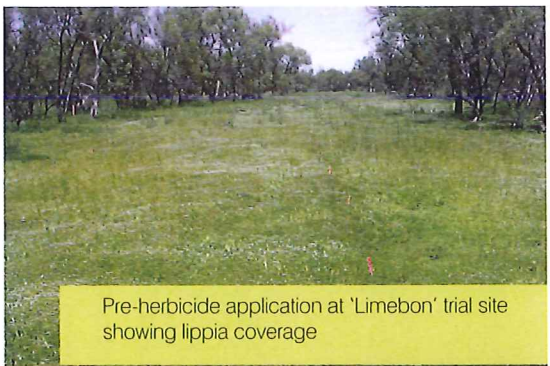
Table 5: Effect of single applications of dichlorprop and 2,4-D and/or a second application of 2,4-D on lippia groundcover, Goondiwindi, March 2004.

This trial shows that single applications of either herbicide do not give 100% control of lippia and that a second application is required to control the survivors of the first application. Two applications of herbicide, 68 days apart, gave 100% control of lippia.

The most cost-effective treatment was two applications of Amicide® 625 at a rate of 2 L/ha.

Trial details:

- All plots were divided in two, with half the plot receiving a second application 68 days after the first application
- Untreated control plot received an application of Nufarm Amicide® 625 + Supercharge at the same time as the second treatment for other plots
- Nufarm Amicide® 625 contains 625 g/L 2,4-D amine salts DMA/DEA
- Agricrop Lantana® 600 contains 600g/L dichlorprop
- Costs are based on prices in April 2008; Nufarm Amicide® 625 $7.20/L; Agricrop Lantana® $12.10/L; Supercharge® $7.50/L



Pre-herbicide application at 'Limebon' trial site showing lippia coverage

Forty-seven days after the second application of 2,4-D. The weeds present are not lippia. Plots that did not receive the follow up application had lippia reinfestation

(Photos by Frank Taylor)

Managing lippia in cotton and other irrigated agriculture

Fact File

- Lippia is not generally considered a problem in cotton cultivation paddocks but is considered a serious issue for irrigation infrastructure
- Environmentally sensitive areas such as riparian zones are generally associated with irrigation areas, and as such pose additional problems for irrigators managing lippia

The Cotton Catchment Communities CRC has long been proactive in researching and promoting lippia management as some of the heaviest lippia infestations occur in prominent cotton growing regions. While lippia is not a problem in the crop itself, the very fact that cotton farms are located along riparian zones where lippia occurs indicates the potential for a serious lippia problem for irrigators.

Lippia's ability to destabilise and erode soil structures poses a threat to irrigation infrastructure such as dams, channels, ditches and drains. Large infestations of lippia will replace other taller plants, allowing more rapid water run-off during storm events. This can increase the rate of overland water flow, leading to erosion and soil movement, directly impacting on irrigated agriculture adjacent to waterways. Particular care must be taken to ensure that lippia doesn't establish on irrigation structures as its presence can lead to the failure of these structures.

Lippia growing on an irrigation channel

(Photo by P. Crawford)

To date, lippia has not caused severe problems for the cotton industry or other irrigated crops. Nevertheless flooding regimes are constantly changing and irrigators are warned to keep an eye out for lippia.

Biological control of lippia

Fact File

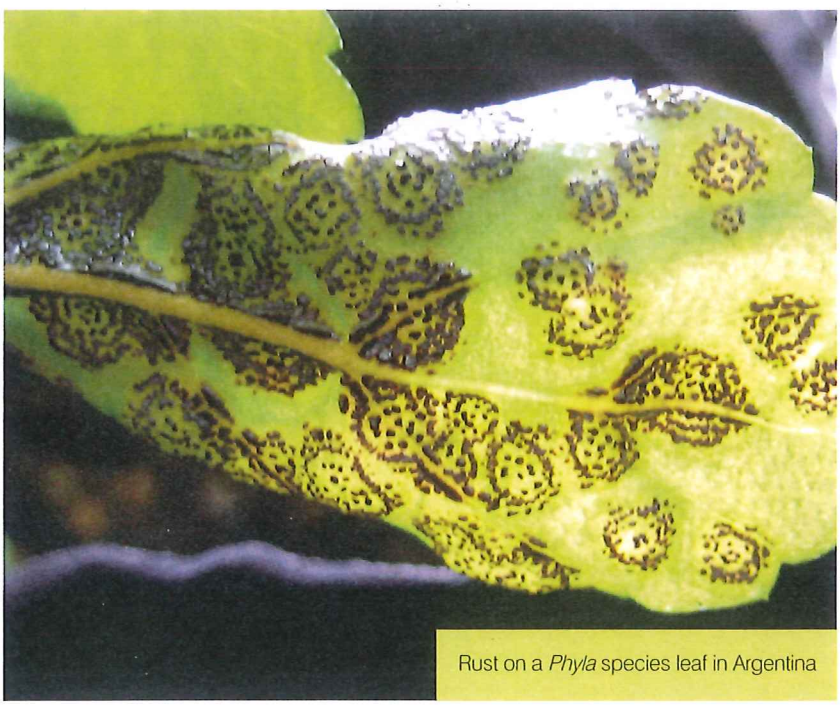
- Over 35 insects, mites and fungi natural enemies have been found attacking lippia in its native range (South America)
- Many biological control agents are highly specific to a particular weed species or genetic variants of a species, making it more difficult to identify an agent to cover the wide range of variants
- The release of biological control agents will not solve the problem on its own. An integrated lippia management strategy will need to be implemented for successful control
- Release of potential biological control agents in Australia is still several years away

The long lead time to implement biological control and the lack of alternative control measures for environmentally sensitive areas means a biological control programme is required as quickly as possible. With funding from diverse sources, CSIRO[11] has engaged researchers in Argentina to begin surveys for insects and pathogens in the native range of lippia in 2005.

The surveys and associated work will:

- identify the native range of *P. canescans*;
- determine whether *P. nodiflora* is native to Australia;
- determine the natural enemies (insects and pathogens) of lippia and related species; and
- identify and prioritise which of those natural enemies might be useful for biological control

[11] See Appendix 2 for researchers details – Ref nos. 1, 5, 8



Rust on a *Phyla* species leaf in Argentina

(Photo by M. Julien)

Surveys have determined that lippia occurs in all provinces of Argentina, and twenty-one insect and mite species, with possible potential for biocontrol, have been found on lippia throughout the country. Detailed studies have begun on one of these species, a flea-beetle called *Kuschelina bergi*. This beetle was found on *P. canescens* in the Pampas (wet and dry grasslands) and it feeds on the leaves of lippia.

Very little is known yet about the other insect and mite species and researchers are waiting for taxonomists to advise if they are known to science and have names, or if they are new and so need to be described and named. At this stage, none have been collected in sufficient numbers to attempt to rear them in the laboratory.

More than fifteen fungi have been found associated with lippia and related species. Some are secondary invaders that only attack diseased tissue and therefore are of no interest. However, some of the fungi are clearly pathogenic and can cause disease in healthy plant tissue. Others have unknown pathology, and no disease has been identified on any plant associated with these fungi.

One pathogen is a rust that was found in the field on *P. reptans* (a related phyla species), and is being cultured in the lab.

This rust has successfully infected *P. canescens* under lab conditions in Argentina.

The survey work in South America will continue until researchers have thoroughly searched the lippia plants in different seasons and years for potential agents and fungi. Once imported into Australia the fungi will be tested against a range of plant species to be sure that they will not pose a threat to the Australian environment and will only attack the target weed. Researchers predict that the first agents will be released in Australia by around 2012.

Researchers in Australia[12] are also investigating the suggestion from some quarters that *P. nodiflora* could be a native rather than an exotic or introduced plant.

If the plant has become naturalised, rather than proven to be native, there would not be any issues with using a biological control agent that attacks both species. However, if *P. nodiflora* is found to be a native plant species, then the problem arises that if a biological control agent is found that attacks both species it might not be allowed to be used. CSIRO researchers have found *P. nodiflora* in areas of Australia that are quite isolated, indicating that it could have been there before European settlement which would make *P. nodiflora* a native species.

[12] See Appendix 2 for researchers details – Ref nos. 3, 8, 11

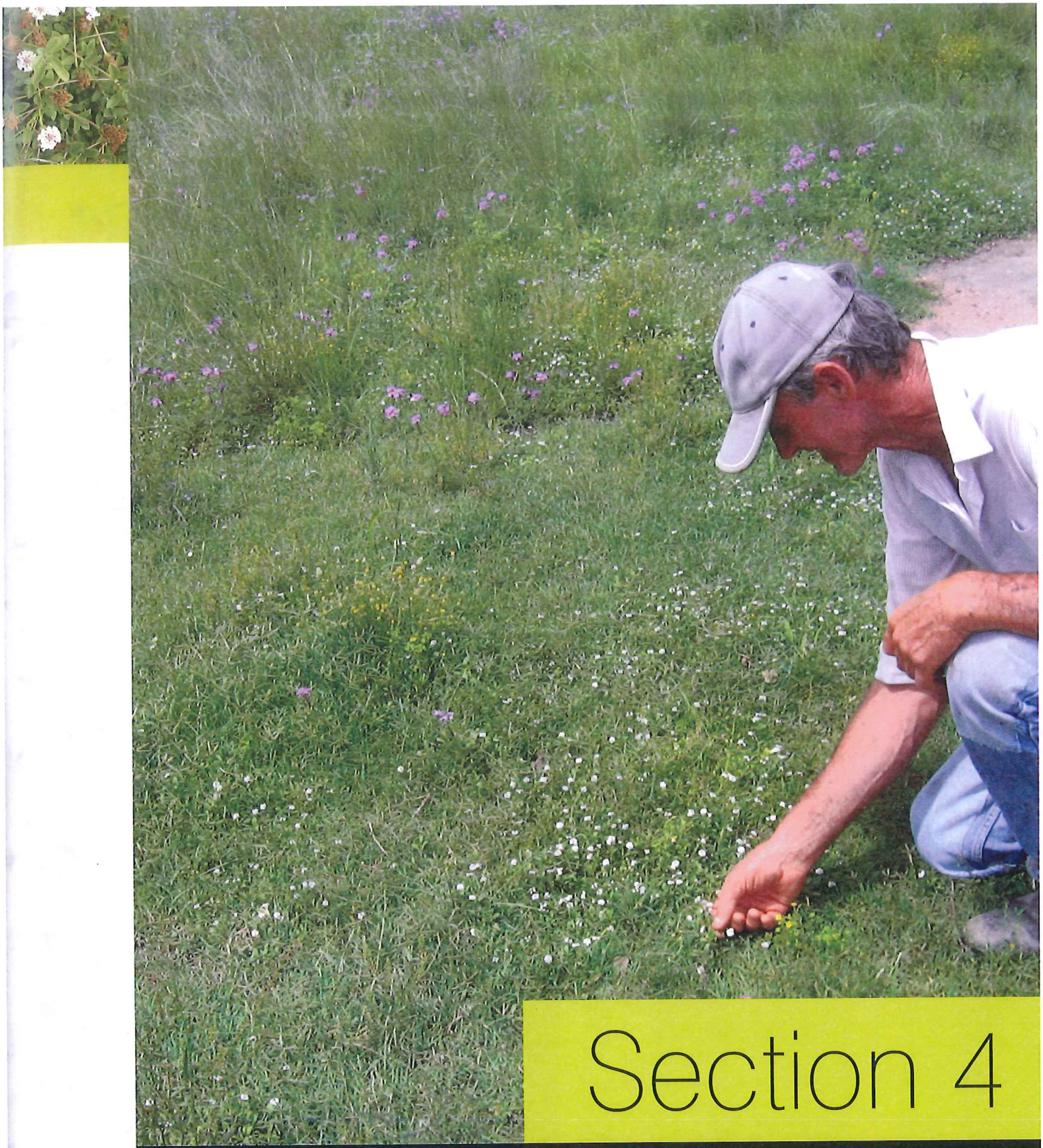
Much more work will need to be completed to unequivocally prove or disprove this theory.

A plant with several (or many) sub-species or genetic variations poses many more problems for biological control than a plant arising from a single source, and with less genetic diversity. Because invaded populations in Australia display high genetic diversity and a mixed gene pool from different native populations, effective control may require introductions of diverse enemies with wide regional origin.

The project is also comparing South American plants with Australian plants because the original source of the weed was from South America. A vast amount of material is being sourced from around the world to compare the DNA of all the variants.

The studies have also shown the need for more diverse sampling of lippia in the native range to discover the origin of the Australian populations. This work is in progress. Indications from this intercontinental comparative study conclude that:

- lippia has the capacity for rapid evolution. Whether this will impart resilience to lippia populations in the invasive ranges remains to be seen; and
- agents focusing on reducing reproductive capacity (both seeds and vegetative propagules) will be necessary to inhibit this plant.



Section 4

Case studies

Case study disclaimer –

The landholder case studies on the following pages have been chosen because they represent a variety of landuses and land types where lippia can be a problem. The case studies are in placed in a geographical-location order from north to south, rather than in any order of importance.

Please note the following important points regarding these case studies:

1. The National Lippia Working Group does not necessarily encourage or endorse the management actions outlined in these case studies. The management actions being used by case study landholders may or may not be recommended practices. Therefore landholders considering lippia management actions in their area should check the appropriateness or otherwise of particular actions for their circumstances.
2. Landholders considering lippia management actions in environmentally sensitive areas such as wetlands, riparian zones or floodplains should contact the relevant authorities prior to taking action. This especially applies with landholders considering actions that require vegetation removal or cultivation.

Case studies

Denis and Stacy Franks, 'Gavial Station', Rockhampton Qld.

Floodplain areas are where most landholders are experiencing difficulties managing lippia

(Photo by P. Crawford)

PROPERTY DETAILS

Location: 10km south of Rockhampton on the Southern Fitzroy floodplain

Catchment: Gavial Creek, Fitzroy River

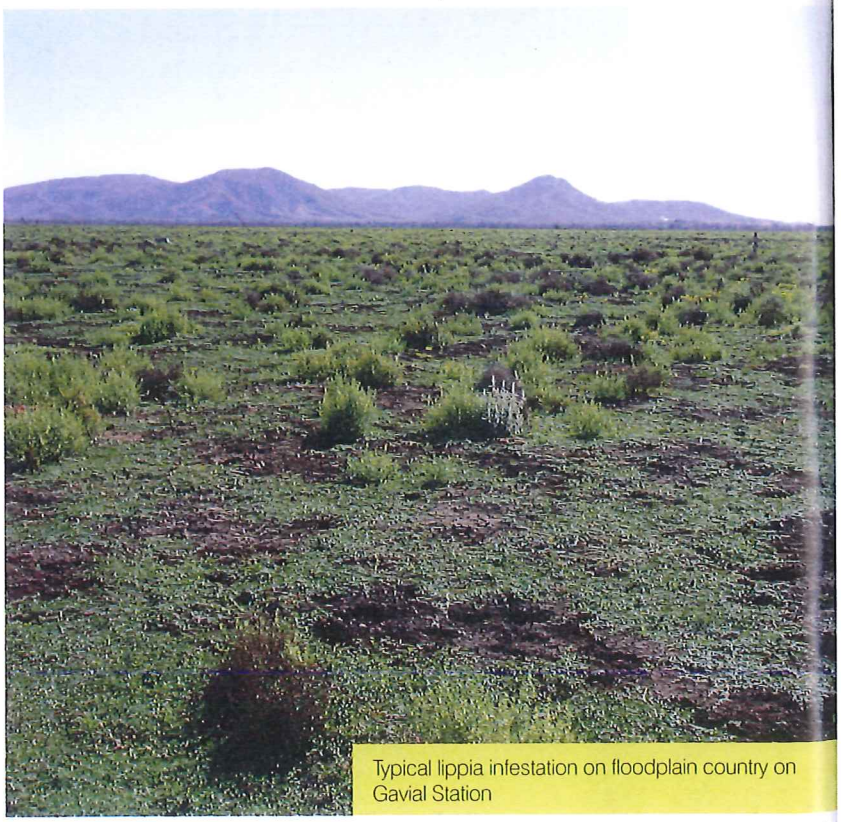
Property area: 1,800 hectares

Main enterprises: Beef cattle grazing with crop share-farming

Where lippia is a problem: Floodplain country

General information and lippia infestation

The Franks purchased 'Gavial Station' in 2004 and lippia was dominant at this time. Lippia is believed to have become established after the 1991 floods which inundated the property. At the time of purchase, about 85% of the property was heavily infested with lippia. Lippia was dominant on all low-lying flood prone parts of the property and where water ponded for prolonged periods.



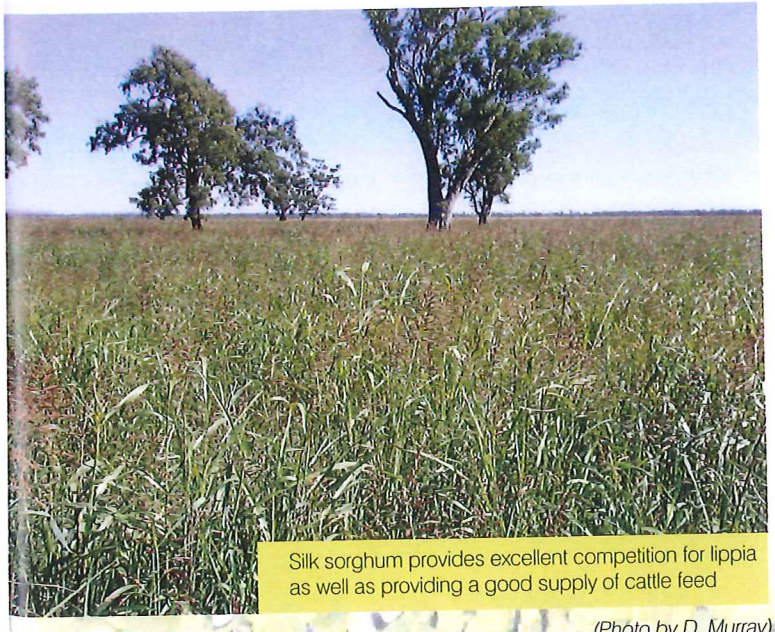
Typical lippia infestation on floodplain country on Gavial Station

(Photo by D. Murray)

In areas where lippia was dominant it contributed up to 90% of the groundcover present. The Franks believe that overgrazing by the previous owners had removed all of the desirable competitive species from the pasture system, allowing the lippia to invade.

Planting corn on previously lippia infested country on Gavial Station

(Photo by D. Murray)



Silk sorghum provides excellent competition for lippia as well as providing a good supply of cattle feed

(Photo by D. Murray)

Methods of lippia management

Five pondage banks have been lowered or removed from 'Gavial Station' to reduce the area affected by prolonged water pondage. Areas where lippia is most dominant have been leased for farming.

Full cultivation and pre and post emergent herbicide treatments have been used to reduce lippia infestations. Herbicides used for fallow weed control include a combination of knock down herbicides at recommended rates. Starane was used in the post emergent herbicide application with very good results. Crops have included wheat, corn, forage and grain sorghum.

Pasture monitoring following the first winter cropping cycle indicated a 50% reduction in lippia frequency.

In areas less suitable for cropping, direct pasture replacement has occurred. Prior to reseeding, paddocks were ploughed twice (no herbicides were applied). Cultivation was targeted for periods when the lippia was stressed from low soil moisture levels. Pasture species planted include Rhodes grass, Floren bluegrass and Silk sorghum. In areas subject to pasture restoration, 100% groundcover has been restored. Close to 0% lippia re-establishment has occurred in these areas.

Future control options

Cropping is to continue until the frequency of lippia is reduced to 0%. Pasture species are to be re-established in cropping areas. The property is to be monitored regularly for lippia re-establishment and immediately treated with selective herbicides if this occurs. Stocking rates are to be monitored to ensure regenerated and existing pasture is not overutilised and a long term pasture cover of 80% is maintained for a considerable length of time.

Case studies

David and Rhonda Ballin, 'Daisybank', Kingaroy Qld.

PROPERTY DETAILS

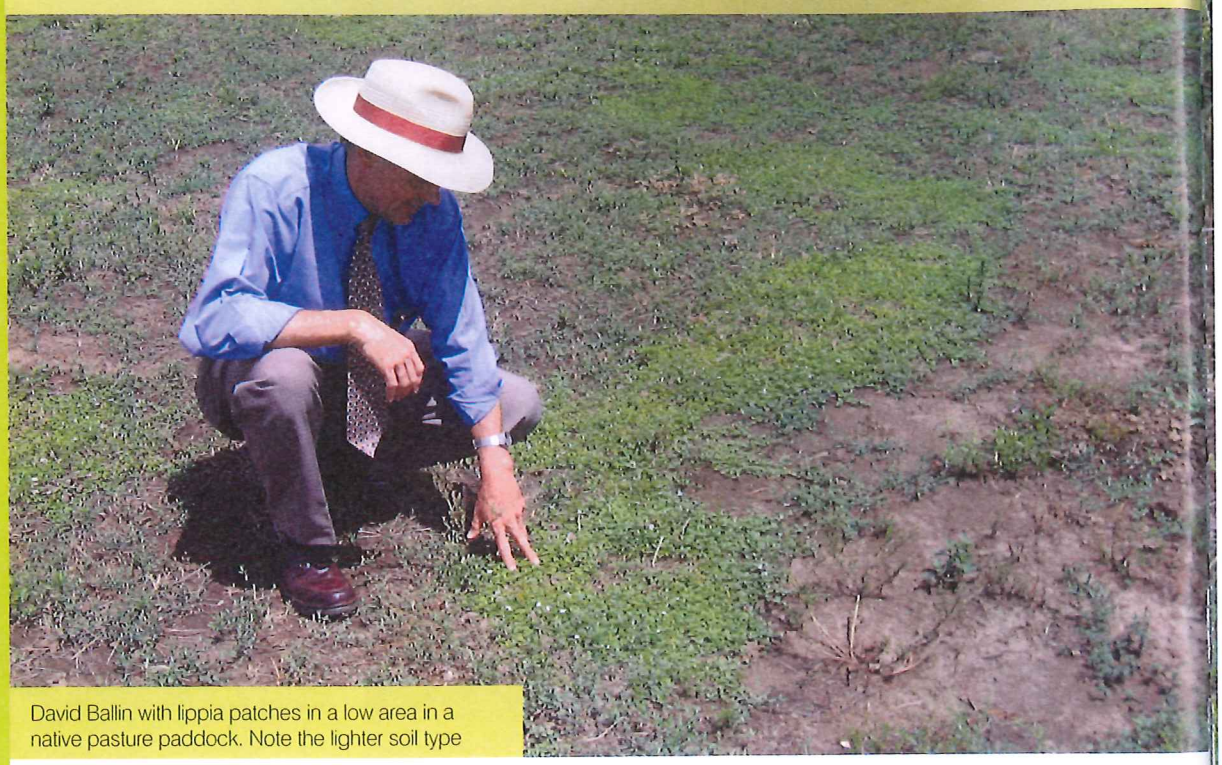
Location: 5 kms west of Kingaroy, southern Queensland

Catchment: Stuart River, Burnett River catchment

Property area: 140 hectares

Main enterprises: Beef cattle, forage crops for cattle (9 hectares of cultivated creek flats)

Where lippia is a problem: Pasture and cropping paddocks



David Ballin with lippia patches in a low area in a native pasture paddock. Note the lighter soil type

(Photo by P. Crawford)

General information and lippia infestation

David is the Principal of Kingaroy State High School, and he and his wife Rhonda bought the property in 1997 after deciding to settle for the long-term in Kingaroy. They first noticed small patches of lippia in about 2001. The property is situated immediately downstream of the town of Kingaroy, so there is a regular flow of water in the Stuart River from storm runoff and treated water from the sewerage treatment plant. It is likely that the lippia has escaped from lawns and verges in Kingaroy.

Due to an ongoing control programme, there are only small isolated patches of lippia on the property. The riparian area of the river itself does not appear to have lippia established, at least on David and Rhonda's section of the river anyway. The riparian area is not grazed, and has a good cover of native grasses and vegetation that would make it difficult for lippia to establish.

A large dam has small patches of lippia around the banks, immediately below the high water level. David sprays these patches on a regular basis, but the seed bank must be high enough to encourage germination after water covers this zone.

Small areas of lippia are present around the edges of a dam

(Photo by P. Crawford)

Methods of lippia management

David spends much of his school holiday time walking the property with a knapsack sprayer looking for lippia patches. He uses Amicide® 625 2,4-D and is getting good results. David considers that he is managing to keep the lippia under control, but he emphasises the importance of an ongoing management programme. Once lippia is established, control of it must be incorporated into the overall property management programme.

Future control options

David thinks he has lippia more or less under control and it is not a problem as far as productivity is concerned. He realises that the control programme will need to be ongoing, especially as up-stream neighbours appear to be doing little or nothing to control the lippia on their properties.

Case studies

Phil and Shirley Ballin, 'Camden', Nanango Qld.

PROPERTY DETAILS

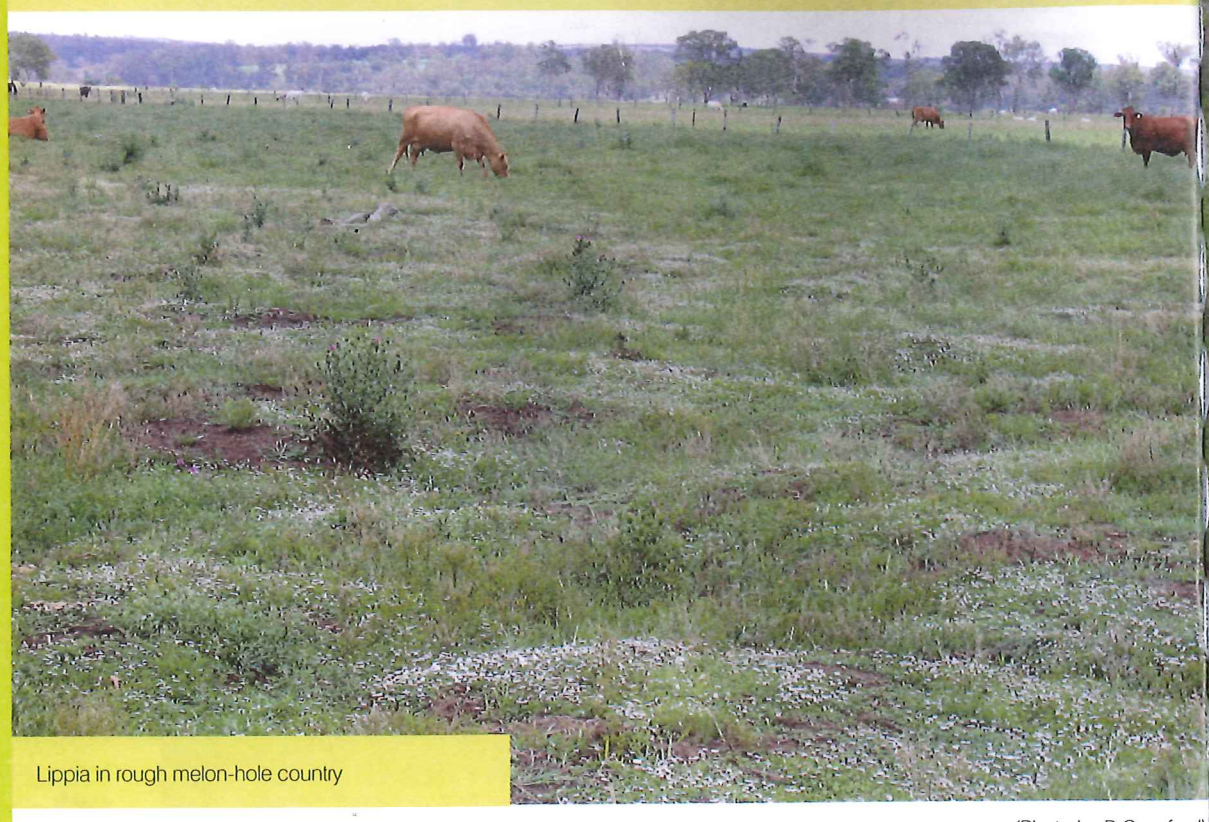
Location: 4 kms west of Nanango, southern Queensland

Catchment: Barkers and Meandu Creeks, Burnett River catchment

Property area: 200 hectares

Main enterprises: Beef cattle, lucerne hay production (40 hectares of cultivated creek flats)

Where lippia is a problem: Pasture paddocks, lucerne paddocks



Lippia in rough melon-hole country

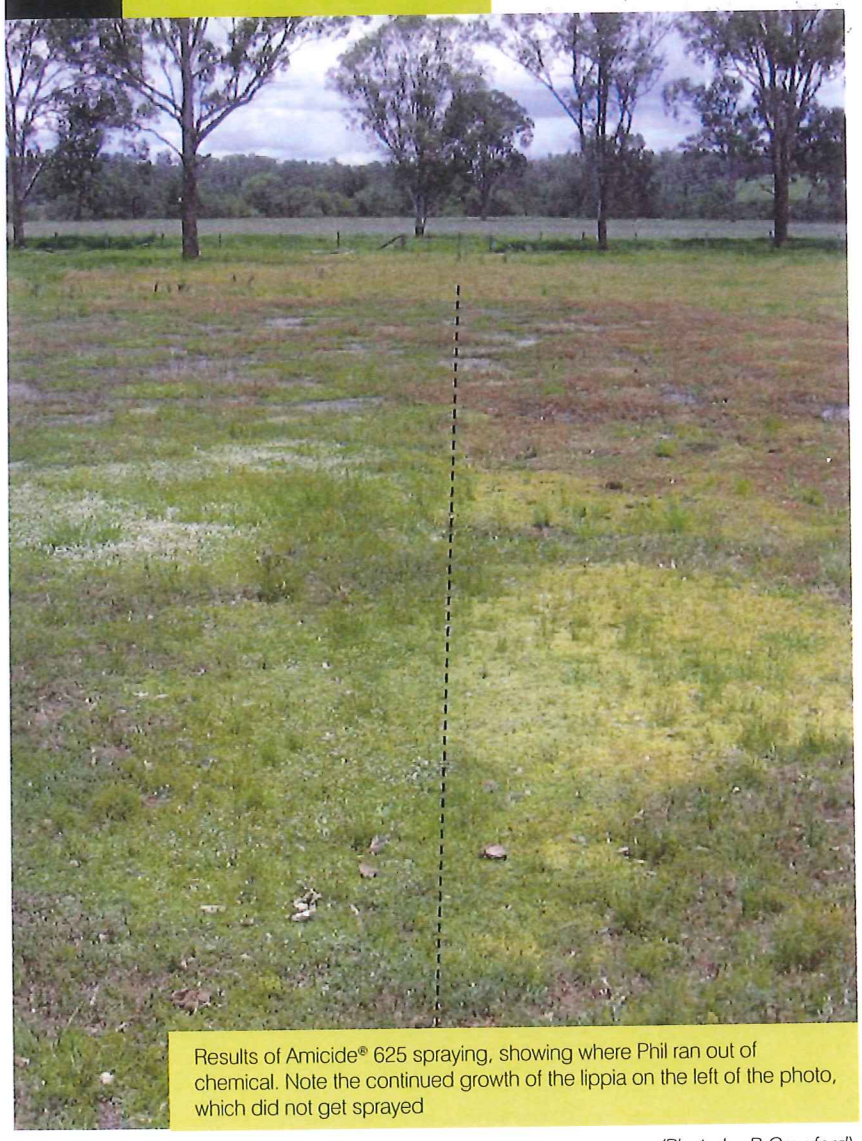
(Photo by P. Crawford)

General information and lippia infestation

The majority of the property is floodplain country, and can be covered by up to thirty centimetres of water during a major flood. Phil first noticed lippia starting to spread in the early to mid 1970s on the lower floodplain country, and then into some naturally rough melon-hole country higher up. Lippia has also become established in patches in lighter sandy country above the floodplain.

There are now lippia patches over approximately seventy hectares, and it has appeared in a lucerne paddock that was sown only two years ago. This is a particular worry, not only from the lippia management perspective, but the potential for spreading lippia in hay could be a serious risk.

The creeks and watercourses all have some lippia present and the control options are limited due to environmental considerations.



Results of Amicide® 625 spraying, showing where Phil ran out of chemical. Note the continued growth of the lippia on the left of the photo, which did not get sprayed

(Photo by P. Crawford)

Phil Ballin in an excellent stand of Bambatsi panic

(Photo by P. Crawford)

Methods of lippia management

Phil has been using a boomspray to apply herbicide to areas of lippia for several years. He first used Agricrop Lantana® 600, but in recent years he has been using Amicide® 625 2,4-D as it is much cheaper, and he is getting good results. He has also been spot-spraying with 2,4-D along fencelines and in pasture paddocks.

The melon-hole country is particularly difficult to spray due to the extremely rough surface. Phil boomsprayed the paddock in 2006, but due to the subsequent very dry conditions, he could not follow-up with a second hit. However, a 100% lippia coverage was reduced to 50%, and he plans a double hit on the paddock in the following summer, which he is confident will result in close to a 100% kill.

Phil is not keen on ploughing out good grass, so at this stage he is relying on chemical control to manage the lippia.

Future control options

Phil believes that his spraying programme is working and he has the lippia under control. Lippia will always be present on the farm, but Phil is confident that with follow-up spraying every year he can keep on top of it.

Phil has some excellent Bambatsi pasture and he is very happy with this grass's ability to compete with lippia. However the lucerne country is a concern. It may mean that lucerne will need to be ploughed out and replaced every two to four years to keep the lippia under control.

Case studies

Bill and Liz Caffery, 'Ashdale', Nanango Qld.

PROPERTY DETAILS

Location: Booie Road, 8 kms north of Nanango, southern Queensland

Catchment: Barkers Creek, Burnett River catchment

Property area: 400 hectares

Main enterprises: Beef cattle, grain and fodder crops (40 hectares cultivated creek flats)

Where lippia is a problem: Riparian areas of creeks, adjoining pasture paddocks

Bill Caffery checking for lippia patches in a treated pasture paddock

(Photo by P. Crawford)

General information and lippia infestation

Bill first noticed lippia growing on the property around 1985 to 1990. It appears to have come from an area adjoining the town of Nanango called the Town Swamp. Landholders say that this swamp is full of lippia and it probably started when local residents planted lippia for lawn in the 1950s and 1960s.

The extent of the lippia on 'Ashdale' is generally confined to the pasture paddocks that adjoin Barkers Creek. However the creek itself has heavy infestations along the banks.

The banks of Barkers Creek are being infested by lippia and that is a concern for Bill Caffery

(Photo by P. Crawford)

Methods of lippia management

Bill has been spraying lippia for several years. Spraying is completed with a boomspray using Agricrop Lantana® 600. The herbicide is applied at recommended rates in very high volumes of water at high pressures to ensure the lippia plants are thoroughly wet.

The control is generally good and Bill says that if he hadn't started his spraying programme, much of his pasture country would now be a sea of white lippia flowers. Instead, there are only small patches left and Bill recognises the need to regularly follow-up and be vigilant. His lippia control programme is now an accepted part of overall property management.

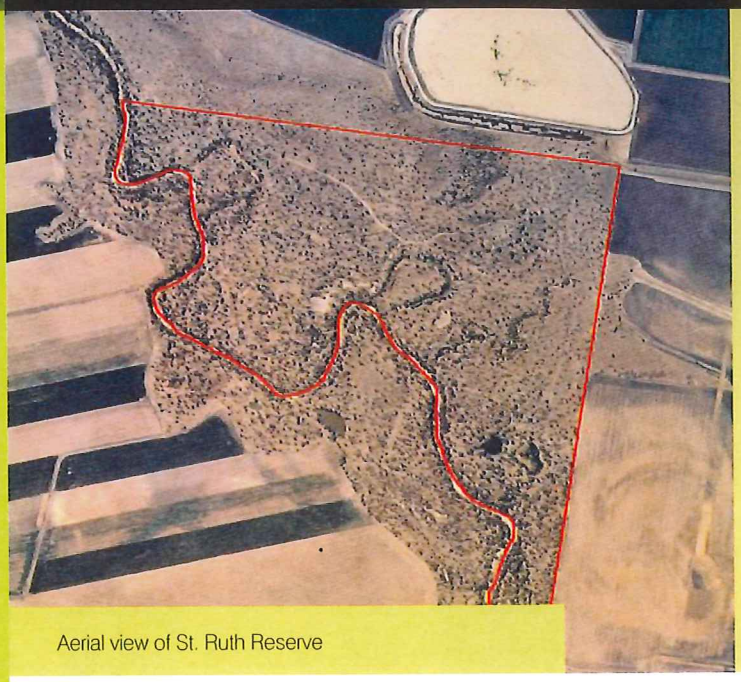
Future control options

Bill will continue to use herbicides as an on-going programme to control the lippia but he may try 2,4-D rather than the Agricrop Lantana® 600, due to the product being quite a bit cheaper. There will probably be more spot-spraying rather than total coverage as the patches get smaller.

The creek is a concern for Bill as it is difficult to access, and because none of his upstream neighbours are doing anything to control lippia, he feels it would be a waste of time trying to manage the lippia in the creek at this stage.

Case studies

Wambo Shire Council, St. Ruth's Reserve, Dalby Qld.



Aerial view of St. Ruth Reserve

(Map by Craig Hunter)

PROPERTY DETAILS

Location: 10 kilometres south of Dalby, southern Queensland

Catchment: Condamine River

Property area: 150 hectares

Main enterprises: Nature reserve, research site

Where lippia is a problem: Environmental reserve, river riparian zone

General information and lippia infestation

St. Ruth's Reserve is a State owned reserve on the Condamine River approximately 10 km south of Dalby. It is well timbered with river red gums (*Eucalyptus camaldulensis*), Queensland blue gums/forest red gum (*Eucalyptus tereticornis*), poplar box (*Eucalyptus populnea*), *Acacia salicina* and *Acacia stenophylla* being the dominant species.

The area was formerly held under a grazing lease and was used to graze cattle. By the late 1990s the reserve was becoming heavily degraded with gully and riverbank erosion and eucalypt dieback. The groundcover was dominated by lippia, and pasture productivity and environmental values were poor.

In 1999, the Queensland Department of Natural Resources and Water (DNRW) responded to the condition of the area by revoking the grazing lease and reclassifying the area as a state recreational reserve with Wambo Shire Council appointed as trustee. Since then, the site has not been grazed and observations have been made regarding the natural rate of regeneration.

Five years after the cessation of grazing, the condition of the property has improved. Many native grass species have regenerated and provide good groundcover. Natural regeneration of the Queensland blue gums, poplar box and acacias has also occurred.

The top photo (1999) shows the mass of lippia groundcover prior to destocking. The bottom photo was taken in 2004, 5 years after destocking. The main species is Queensland Bluegrass

(Photos by Craig Hunter)

Future control options

In 2001 DNRW carried out a range of small scale trials to determine useful management strategies for the area. These trials involved the use of fire, weed control and revegetation. Craig Hunter, Land Protection Officer based in Dalby, regularly monitors the site and believes the native grasses and trees will continue to re-establish and increase in density, but that lippia will always be present to some degree.

DNRW plans to keep the area as a state owned reserve available for use as a study site for universities and other research bodies. Kate Reardon-Smith, a PhD student at the University of Southern Queensland, has also been monitoring the reserve for several years. Kate agrees that despite the ongoing persistence of lippia across the reserve, native grass and herb species are recovering and, in some cases appear to be out-competing lippia, especially under the drier conditions of recent years.

Kate's research trials investigate lippia's response to a range of management activities (including simulated grazing). Results from these trials confirm lippia's ability to respond rapidly to a reduction in competition under favourable moisture conditions and therefore the importance of retaining good groundcover through conservative grazing management practices.

Early results indicate that if grazing was introduced back into the site today lippia could quickly regain dominance unless stocking regimes and pasture response were carefully monitored.

In a second study Kate has found that the abundance of lippia is much higher below the tree canopy. Lippia under trees appears to be in much better condition with greener, thicker leaves and greater root density, and has greater reproductive success, with a higher density of flowers. These areas appear to offer a form of refuge, enabling lippia to survive drought and frost conditions and from which it may then spread when conditions beyond the canopy improve.

Controlling the lippia at this site has not yet attracted a specific action plan beyond allowing for regeneration of native grasses in the absence of grazing pressure. Craig Hunter believes that if the site was left to manage itself it could take a very long time (at least 10-15 years) for the lippia to reduce, based on its current rate of displacement. Craig also believes that while lippia continues as an understorey, the removal of grazing alone may not be the answer. He maintains that integrated management by using other methods, such as herbicides and fire, may be required.

Kate largely agrees with Craig Hunter's assessment. There is a growing recognition that lack of fire in woodlands may be an important factor in the eucalypt dieback story. However, this requires further investigation both in terms of its impact on tree condition and on groundcover composition.
The response of lippia to burning is currently unknown, and a reduction of groundcover could enhance lippia regeneration at least in the short term.

Kate also suggests that the targeted use of herbicides in refuge areas (e.g. under trees and low-lying areas) would be an appropriate (strategic and cost-effective) management option in riparian areas. However, Kate warns that the risk to trees needs to be considered. A study of eucalypt dieback on the Liverpool Plains has shown a detrimental effect due to low concentrations of herbicide drift.

St. Ruth's reserve provides a valuable site at which to trial management options for both the management of lippia-infested grassy ecosystems and improvement of woodland health, and its on-going retention for these purposes, is to be applauded.

Case studies

SEQ Water Corporation, Lake Somerset, Kilcoy Qld.

PROPERTY DETAILS

Location: Leaseholder property, Somerset Dam, Kilcoy, south-east Queensland

Catchment: Stanley River

Property area: Lease area 27 hectares

Main enterprises: Beef cattle grazing.

Where lippia is a problem: Area immediately below full water level, spreading to the adjacent land above full water level

General information and lippia infestation

Large areas of land around Lake Somerset have been invaded by lippia, posing a potential threat to water quality in the lake and also to the sustainability of grazing enterprises in the catchment. In a drinking water catchment there are limited options for controlling weeds, particularly in waterways entering the lake and on the land that is exposed as the lake recedes. One of the preferred methods of control is to use a selective herbicide that breaks down quickly in the environment and has a low toxicity to fish and other aquatic life.

The water level in the dam varies considerably over time. Water couch, an excellent pasture species, is usually present below full water level and the grass spreads onto land exposed by falling water levels. Because it is such good cattle feed the cattle tend to concentrate on the areas below full water level, and grazing pressure (as well as the drought) has resulted in many bare areas ideal for lippia establishment.

The property involved in this trial has about 50% of the lease area infested by lippia, ranging from 25% to 100% groundcover.

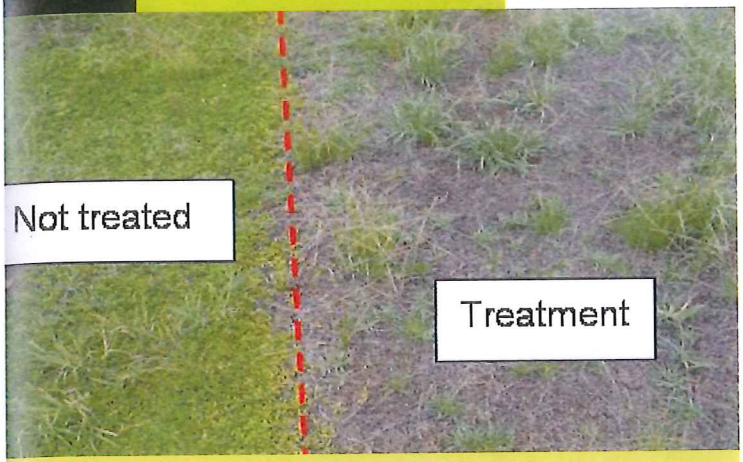
Methods of lippia management

An area of 0.75 hectares was sprayed twice with Agricrop Lantana® 600 and rotationally grazed to maximise pasture recovery. The paddock was grazed according to available feed throughout the observation period (and leading up to it)

The calculation of cost includes only the cost of the herbicide. To employ a contractor or factor in fuel and labour costs would therefore increase the overall cost of the treatment.

Application date	Herbicide rate	Cost
Early March 2007	6.7 L/ha Agricrop Lantana® 600	$81.07 per hectare
Late June 2007	6.7 L/ha Agricrop Lantana® 600	$81.07 per hectare
Total cost		$162.14

Table 6: Agricrop Lantana® 600 application timing, rate and cost (cost based on Agricrop Lantana® 600 price at April 2008 of $12.10 per litre)



Comparison of the treated and non-treated areas taken on 27 March 2000

(Photo by V. Alsemgeest)

Comparison of the treated and non-treated areas in December 2007, with insets showing a close-up of each area

(Photo by V. Alsemgeest)

Application 1 (March 2007)

The first treatment was applied after significant rainfall (20 mm) in March 2007. An extended period (three months) of dry conditions followed, which may have assisted in achieving such dramatic results so quickly. There was very little regrowth of lippia following the first treatment until good rainfall in June. The lippia responded vigorously to the winter rainfall during this period and as a result another treatment of Agricrop Lantana® 600 was applied.

Application 2 (June 2007)

The second application achieved a very good kill (estimated at over 90%), but the most dramatic change was the significant increase in grass species. When the treatment was observed in early December (2007), Windmill grass (*Chloris spp*) was the dominant grass post-treatment, but there were also significant areas of Rhodes grass (*Chloris gayana*) on the treated area. Very little lippia was present in the area treated in December, whereas lippia in the untreated area had not changed significantly since January 2007.

Future control options

The challenge will be to apply this strategy on other properties to see if similar results can be achieved. SEQ Water Corporation will also be monitoring this site into the future to see how effective the treatment was over the longer term (three years).

Grazing management has an impact on managing weed populations and this is especially true in the case of lippia. SEQ Water Corporation personnel have observed that continuous grazing systems seem to promote the spread of lippia considerably more than rotational grazing systems, where rest periods enable grass pastures to recover.

SEQ Water Corporation is engaged in a property management planning programme for the leaseholders, and field days and workshops are also held to encourage leaseholders to better manage their leasehold land.

Case studies

Donald, Patsy and Liz Cameron, 'Tullaville', Moonie Qld.

PROPERTY DETAILS

Location: 12 kms west of Moonie, southern Queensland

Catchment: Bendee Creek, Moonie River catchment

Property area: 2,400 hectares, with 1,200 hectares of cultivation for grain production

Main enterprises: Beef cattle, grain production, lucerne

Where lippia is a problem: Melon-hole country in grazing paddocks

Patsy Cameron checking a patch of lippia at the edge of a melon hole

(Photo by P. Crawford)

General information and lippia infestation

Donald and Patsy Cameron bought the property early in 2006. They first noticed lippia in patches around the house dam and waterway, and have since found small areas around melon-holes in a 220 hectare Bambatsi paddock. There are also small patches of lippia in a lucerne paddock. The infestation is not heavy at this stage, but there is concern that the lippia will spread.

The property is not floodplain country, so it is likely that the lippia has been brought in by birds such as ducks. It is also possible that stock may have spread the lippia from the house dam to the grazing paddocks in mud on their hooves.

Melon-hole country poses unique problems insofar as lippia management

(Photo by P. Crawford)

Methods of lippia management

At this stage, the Camerons have not taken any control measures because the drought conditions have ensured the lippia has remained confined to small areas. They are closely monitoring the patches and considering options for control as seasonal conditions improve.

Future control options

Patsy will start a spot spraying programme with Amicide® 625 following good rains in spring and summer of 2007. She and Donald are also considering changing their grazing regime to encourage more vigorous pasture growth in an effort to restrict the spread of lippia.

Due to the very small areas of lippia on the property, it is probable that the weed will be eradicated completely over a few years, with close monitoring and spot spraying.

Case studies

John and Cathy Cowley, 'Lentara', Clifton Qld.

PROPERTY DETAILS

Location: 10 kms west of Allora, southern Queensland

Catchment: Dalrymple Creek, Condamine River catchment

Property area: 180 hectares (all grazing), 260 hectares leased (130 hectares cropping, 130 hectares grazing)

Main enterprises: Beef cattle, cereal grain production

Where lippia is a problem: Swampy country on floodplain areas

John Cowley in a magnificent stand of Bambatsi in a previously lippia infested paddock

(Photo by P. Crawford)

General information and lippia infestation

John first noticed lippia in swampy areas and watercourses around 1993, mainly in small patches. One 20 hectare swampy block became 100% covered with lippia and after seeking advice from local pasture consultant David Illing, John decided to plough this paddock and plant an introduced pasture.

Cattle with plenty of feed for a couple of months

(Photo by P. Crawford)

Future control options

The Bambatsi has seeded well and will be monitored over the next few years for any lippia that may establish in the paddock. Other areas of the property will be monitored for lippia, and it is possible that other small areas may be considered for pasture establishment.

John says that it is ironic that without the drought he would not have been able to get this paddock growing good pasture, and this would apply to all areas where lippia is established on swampy ground.

Methods of lippia management

Normally the 20 hectare paddock would be too wet for machinery access, but the ongoing drought actually assisted, leaving the paddock dry enough to plough. The paddock was worked twice with a Sundercut disc plough in October 2004 to kill the lippia.

The pasture seed (a mix of Silk sorghum, Bambatsi and Floren Bluegrass) was aerially broadcast on the paddock on Christmas Eve 2004, before a predicted rain event. However, the rain didn't eventuate and only small areas of Silk sorghum germinated in lighter soil around the edges of the paddock.

The paddock remained destocked from October 2004. During the summer of 2005-06 there were storm rains and a flood event that covered the paddock with water. Bambatsi and some Floren started to appear, but also quite a lot of lippia. John sprayed the paddock twice with Amicide® 625 2,4-D at two litres per hectare over the summer and achieved a very good kill. However, the pasture was still very sparse.

After good rain and another flood in October 2006, John sprayed with 2,4-D (at two litres per hectare) and slashed the paddock. This helped to thicken the Bambatsi. At this stage, there was still not much Floren established, but the Bambatsi was starting to thicken up.

The paddock was grazed lightly from January 2007 until July 2007, during severe drought conditions. Following good rain and further flooding during the spring and early summer of 2007-08, the pasture started to establish, and there is now a very good cover of grass. The paddock was flooded four times during this period, and this has helped considerably with further pasture establishment. John introduced cattle back into the paddock in January 2008 after the grass had seeded.

There is still very little Floren, and being so palatable the cattle eat it first. There is virtually no lippia now, and it would be very unlikely for lippia to re-establish due to the thick grass and good groundcover. John is very careful with his grazing management and is committed to maintaining good groundcover at all times.

Case studies

James and Susie Milson, 'Alfalfa', Leyburn Qld.

PROPERTY DETAILS

Location: 15 kms north of Leyburn, southern Queensland

Catchment: Canal Creek, Condamine River catchment

Property area: 1,600 hectares, 800 hectares cultivation

Main enterprises: Beef cattle, sheep (fat lambs), grain and cotton production (dryland)

Where lippia is a problem: Pasture paddocks, riparian areas

James Milson checking a lippia patch in a Bambatsi paddock

(Photo by P. Crawford)

General information and lippia infestation

James and Susie Milson purchased the property in 1998 and lippia was evident at the time of purchase. Lippia is present on all country that is not cultivated, and the lippia coverage ranges from 1% to 50%. The worst lippia areas are on the heavier soils, however it is becoming established on the lighter country as well. There are some good paddocks of Bambatsi (planted around 1997), and James thinks the pasture is better now than it was when they purchased the property.

James Milson is concerned with lippia encroaching on the Bambatsi

(Photo by P. Crawford)

Future control options

James is considering ploughing strips (2.5 to three metres wide) just to level the ground enough to enable a ground spray rig to be used. This would make chemical application much cheaper and more efficient.

By missing a year of spraying, James believes they have got behind in lippia control, hence spraying should be completed every year. The recommendation of a double hit will also need to be considered, especially in wetter years.

Methods of lippia management

James has been using aerial applications of Amicide® 625 as the main lippia control method. The country that is being treated is very rough due to the Bambatsi and Floren bluegrass planted on the floodplain areas. These grasses tend to be very clumpy and tussocky, especially the Floren, making it almost impossible to use a ground rig. The country is generally lightly timbered, making aerial applications possible.

James has only sprayed the lippia three times so far, missing 2006 due to the drought. He has sprayed twice in autumn, and once in the spring. James has observed that the best results have been from a late autumn application, which contradicts most advice. James thinks it may have something to do with the lippia starting to become dormant for winter, possibly taking more sap and therefore more chemical down to the roots.

The application rate is 2.5 L/ha, costing around $30 per hectare (including application cost). With approximately 400 hectares being treated, it is a very expensive operation, but James believes that he has no other option except to see his grazing country lose productivity very quickly. James has not used Agricrop Lantana® 600 as he considers it to be too costly over an area this size.

James has ploughed some country to control lippia, growing a couple of crops of barley before letting it revert to grass. This country will probably be planted to Bambatsi because James doesn't think the local native grasses will be competitive enough with lippia.

James considers Floren to be a fantastic grass, as it is very palatable and is a good lippia competitor due to its extreme drying effect on the soil. The problem is that soils where Floren is growing become so dry and fractured that James has lost lambs down the cracks. Floren country is very difficult to muster, due to the tussocky nature of the grass and the cracks in the soil. Therefore the pasture of preference for James is Bambatsi.

James says that the only problem with Bambatsi is that it does not like long periods of flooding. A few days to a week of inundation is okay, but some parts of the property may be under water for three to four weeks during some floods, which can have a detrimental effect on Bambatsi.

Case studies

Peter and Janelle Cleary, 'Springlea' Warwick Qld.

PROPERTY DETAILS

Location: 25 kms west of Warwick, southern Queensland

Catchment: Greymare, Thanes and Lagoon Creeks, Condamine River catchment

Property area: 2,000 hectares

Main enterprises: Beef cattle, sheep, lucerne hay production, fodder crops

Where lippia is a problem: Pasture paddocks, floodplain areas

Peter Cleary with lippia in a waterway

(Photo by P. Crawford)

General information and lippia infestation

The Cleary's property is wholly contained within a catchment area covering a series of connecting blocks that run from the top of a hill down to the Condamine River floodplain. The property has primarily native pasture with a few small areas of introduced pasture.

Peter has observed lippia in the area for about twenty years and believes it was first carried onto his property by ducks and water birds, and then spread by cattle, farm machinery and floodwaters. Lippia now grows on all of the Cleary's blocks, and is even present on the higher sandy soil areas. It is most prolific on the two lower blocks with richer and heavier clay soils.

While it has only been a serious problem on his property for the past five years, other landholders in the area have had land severely affected by lippia for more than ten years, with stocking rates significantly reduced.

Cut-off line showing where Peter ran out of chemical. Inset – one month after spraying, showing dead lippia

(Photo by P. Crawford)

Future control options

With his systematic approach of focusing on the top of the catchment first and then working down, Peter hopes to eventually rid his property of lippia. This will not be an easy process and will require persistence, but Peter believes the effort is worth it.

Peter will consider setting up a grazing exclusion area of a half a hectare or so in order to observe the effect of stock removal on the return of grasses following spraying.

Methods of lippia management

Peter relies on herbicides to control lippia. He has sprayed in a systematic approach working in conjunction with his neighbours, focusing spraying at the top of the catchment first and then working down.

Peter boomsprays heavily infested areas of lippia and spot sprays smaller patches using a council Quick-spray unit with an eighty metre hose and automatic reel. The main chemical Peter has used in the past has been Agricrop Lantana® 600, but he has recently changed to Amicide® 625 2,4-D, due to it being much cheaper.

Peter believes it is important to spray when the lippia first starts growing after spring and summer rains, and observes that the chemical is most effective when lippia is actively growing. Peter also believes it is very important to really saturate the lippia when spraying and to wait until clovers and legumes have dropped seed before spraying, otherwise these species could be killed off.

After several years of spraying Peter has largely eradicated lippia on his upper blocks, where he has been concentrating his effort. He has also been spraying in some of the lower paddocks to prevent lippia becoming too strongly established.

Case studies

Trevor, Lois and Daryl Martin , 'Marrakai', Goondiwindi Qld.

PROPERTY DETAILS

Location: Wyaga district, 50 kms north-east of Goondiwindi, southern Queensland

Catchment: Tin Hut Creek and Coomoran Creek, Weir River catchment

Property area: 3,188 hectares, 1,000 hectares cultivation

Main enterprises: Beef cattle, dryland grain production

Where lippia is a problem: Melon-holes in pasture paddocks, and around stock water dams

Lippia established in light sandy country

(Photo by P. Crawford)

General information and lippia infestation

Trevor first noticed lippia around 2002, but it was not recognised as a problem at the time. 'Marrakai' is not a floodplain property so the lippia did not arrive in floodwaters. It is likely that the weed was carried in by birds (such as ducks) to melon-holes when filled with water. The weed has since spread around dams, probably carried by either stock or birds.

Trevor has noticed that the lippia has defied current thinking that it prefers heavy soils. It is growing in light sandy-loam box country near dams. Even the melon-hole country is lighter than the soil types where lippia is normally found.

The cultivation country also has melon-holes, but lippia is not a problem because in most years the melon-holes can be cultivated. This situation may well change with a return to wet seasons or an increased use of zero-tillage in the cropping operation.

The top photo shows lippia around the edge of a melon-hole showing the water couch encroaching from the centre of the hole (December 2004). The bottom photo shows the same melon-hole with very little lippia present (March 2006)

(Photos by T. Martin)

Trevor Martin with Renee Stephenson (QMDC) looking for lippia seedlings at the monitored melo-hole in December 2007

(Photo by P. Crawford)

Methods of lippia management

Chemical control of lippia in melon-hole country has been deemed too expensive and impractical, due to the large number of holes and the rough and uneven nature of the paddocks. The only way chemical could be applied is by air, and as lippia is only present in small areas around the melon-holes the wastage and expense would be unacceptable.

For several years, Trevor has observed the establishment of water couch (*Paspalum distichum*) in several melon-holes. He is not clear how this grass came to be on the property but it is excellent cattle feed and is very well adapted to survival in melon-holes. It will tolerate total inundation for lengthy periods but it will not spread outside of the wet area of the melon-holes.

It is appearing that the water couch is an excellent competitor with lippia and where lippia has been present in melon-holes prior to the water couch becoming established it is now only surviving on the edges of the melon-holes. The severe drought conditions of 2007 have caused much of the water couch to die out, the first time that Trevor has seen this occur. Good spring rainfall has resulted in some seedling establishment and Trevor is fairly confident that the water couch will return to its previous lush condition.

Trevor is trying to spread the water couch around the lippia infested melon-holes as seasons and time permits. He is closely monitoring the progress of his trials and keeps photographic records for monitoring purposes.

The Martins have established an exclusion area where four melon-holes have been fenced off and the area monitored to compare any improvement in species composition between grazed and ungrazed melon-holes infested with lippia. The main species are native pasture grasses, Bambatsi panic and Purple pigeon grass. Due to the ongoing severe drought, results are unclear at this stage but the trial will continue for several years.

Future control options

Trevor will continue to spread water couch into melon-holes, concentrating on those that have lippia present. The lippia areas around the dams pose a problem, with the only option being chemical control. At this stage, these infestations are not causing too much loss of production, as only small patches are presently appearing however, ongoing monitoring will be undertaken.

Case studies

John, Liz and Monty Wood, 'Taraba', Toobeah Qld.

PROPERTY DETAILS

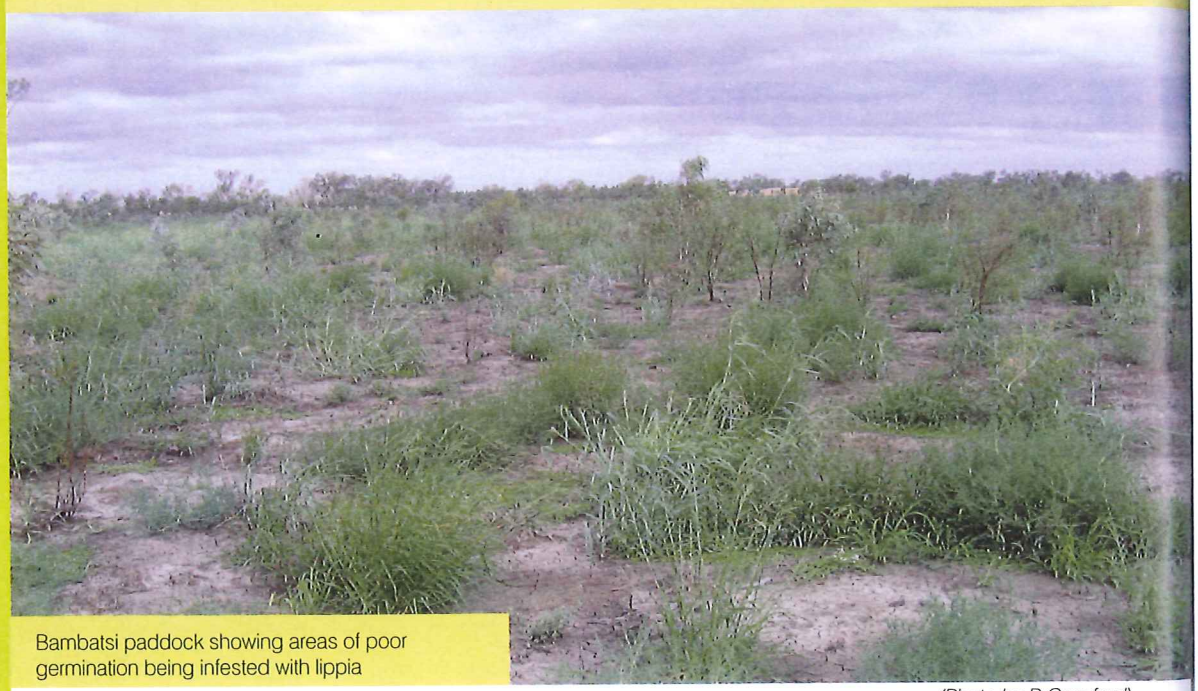
Location: 30 kms south-west of Toobeah, southern Queensland

Catchment: Coomonga Creek and Mamonga Creek, Macintyre River catchment

Property area: 4,400 hectares, with 1,030 hectares of dryland cropping and 1,060 hectares of irrigation

Main enterprises: Beef cattle, cotton, irrigated and dryland grain production

Where lippia is a problem: Floodplain grazing country, riparian areas



Bambatsi paddock showing areas of poor germination being infested with lippia

(Photo by P. Crawford)

General information and lippia infestation

John and Liz Wood bought 'Taraba' in 1968 as undeveloped land. The property is located on the banks of the Macintyre River and the entire property is inundated during large floods.

Over the ensuing years they developed half the land for cropping, with wheat, cotton, sorghum, barley and faba beans being grown, leaving the remainder for grazing. The soil types are mainly heavy black clays.

When the Woods first moved onto the property there was one lower more open paddock on the floodplain heavily infested with lippia. Over the years, it has spread and is now present over almost the entire property, with lippia occuring at a high density across 1,500 hectares of the property, including grassland, woodland and riparian zones. Areas of heavily flooded and swampier country are the most affected with some areas currently dominated by 100% lippia cover.

The increasing presence of lippia in paddocks on the floodplain after flooding events was reflected in reduced stocking capacities. Liz says that under their present grazing regime the native pastures are not able to out-compete lippia. Lippia has effectively displaced many of the native grasses present at 'Taraba', resulting in a decline in production.

Good stands of Bambatsi have reached equilibrium with lippia

(Photo by P. Crawford)

Methods of lippia management

John and Liz first started planting introduced pastures in 1972 to increase productivity. However, from the late 1980s onwards it became obvious that further pasture introduction was necessary for the sole purpose of managing lippia. The area of introduced pasture is now approximatey 800 hectares in eight grazing paddocks. Plantings have taken place when conditions have been favourable, the most recent in 2006.

The introduced pasture paddocks have been planted exclusively with Bambatsi, as this species suits the natural conditions of the property, provides good feed, and is capable of competing with lippia. About half of this country has a good Bambatsi cover, with some areas having a less than desirable establishment rate.

John believes that 'equilibrium' eventually develops between lippia and Bambatsi, the time taken depending on the establishment success of the grass. John defines this equilibrium situation as one where there is a good cover of Bambatsi, but with lippia persisting between grass tussocks.

Liz as grazing manager is happy with the stocking rate achieved in these equilibrium type situations. She believes that, once established, the Bambatsi can live quite contently with the lippia without seriously affecting stocking rates.

Paddocks that were sown straight to pasture have generally had a poorer strike rate and were quickly re-infested with lippia. The most successful pasture establishment has been in paddocks that were first cropped before being sown to Bambatsi. These paddocks had a good strike rate and reached the equilibrium stage relatively quickly

John believes this is for several reasons, including:

- competition has been reduced;
- crop stubble protects the topsoil from harsh weather conditions and aids in water infiltration;
- the build-up in soil moisture favours seedling establishment; and
- cropping develops the soil into a better seed bed.

Future control options

John has trialled spraying with Amicide® 625 and Agricrop Lantana® 600 after sowing pasture seed, but follow-up treatment was prevented because of the dry conditions.

John and Liz intend to move to a rotational grazing system in the next few years. This will be another tool for improved management of lippia infested pastures. They believe that apart from the production benefits rotational grazing will lead to a reduction in the incidence of woody weeds and weeds in general.

The riparian areas along the creek banks are a concern as the areas are well timbered and the environmental impacts of chemical control in these areas could be high. The creek banks are generally higher than the surrounding country which results in water flowing out from the creek rather than into it in time of flood. Fencing of creek banks would be problematic, as a major flood would inundate most of the fences every time.

There is no evidence of bank slumping and both John and Liz are of the opinion that with minimal stock pressure on the banks, combined with a good vegetation cover, bank slumping will not occur here however they continue to closely monitor this situation for any deterioration.

Case studies

Richard and Janet Doyle, 'Malgarai', Boggabilla NSW

PROPERTY DETAILS

Location: 7 kilometres south-east of Boggabilla, north-west New South Wales

Catchment: Whalan Creek, Macintyre River catchment

Property area: 3,237 hectares

Main enterprises: Mixed cropping and beef cattle grazing

Where lippia is a problem: Floodplain grazing country

Patches of Lippia in native pasture country on the floodplain

(Photo by P. Crawford)

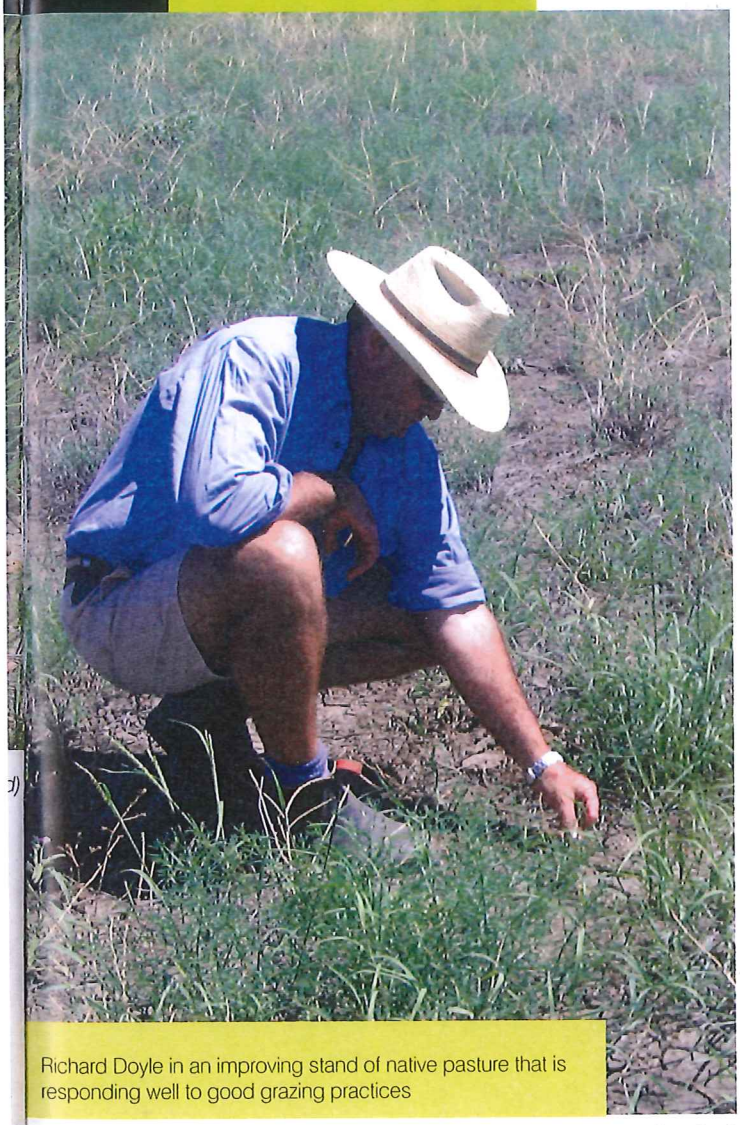
General information and lippia infestation

'Malgarai' is split into two blocks – the house block of 485 hectares is situated on the southern bank of the Macintyre River, with the other block of 2,750 hectares straddling Whalan Creek (with 14 kilometres frontage) to the south. Approximately 1,468 hectares of the property is cropped for grain (with some forage crops), with 1,356 hectares of native pasture, 263 hectares of introduced pasture, 255 hectares of remnant grassy woodland, and 93 hectares of riparian zone and remnant eucalypt woodland.

The southern side of Whalan Creek is grazing only, and it is this country that has had a major lippia problem which probably started after a major flood in the early 1980s.

Richard and Janet have introduced some innovative concepts to managing Malgarai, with the main emphasis being on grazing management. The Doyles are implementing a cell grazing system for all their grazing country. This began in 2003, mainly as a means of improving production and sustainability but it is becoming increasingly apparent that cell grazing is assisting with the control of lippia.

There have been two major flood events since the cell grazing system was introduced and, although floods in general favour lippia spread, the Doyles are keen to point out that floods also favour the native floodplain grass species on the property, including Warrego summer grass and curly windmill grass, as well as sedges and Nardoo.



Richard Doyle in an improving stand of native pasture that is responding well to good grazing practices

(Photo by P. Crawford)

Methods of lippia management

Grazing management is the only lippia control measure being used on Malgarai and, at this stage, the Doyles are very happy with the results. Initially, the cell grazing system was introduced for production reasons but the system is proving to be very effective in controlling lippia.

On the grazing floodplain country there are species returning that Richard and Janet haven't seen for years, including Mitchell grass, curly windmill, Warrego summer grass, windmill grasses (*Chloris spp.*), sedges and Nardoo. There are also areas of weeds but these seem to be reducing as the grasses return. Prior to the introduction of cell grazing much of the floodplain grazing country was a solid mat of lippia, especially in the grassy woodlands and riparian areas.

What is it that makes cell grazing such an effective system, especially for lippia control? It could be that a large number of cattle in small paddocks for a short time (up to 1,000 head on 30 hectares, for as little as half a day) has an impact in stimulating faster pasture growth and, at the same time, breaking up the lippia groundcover. It could be the competition from the healthier grasses or a shading effect that is restricting lippia competition. Whatever the case, the system seems to be working.

There is still lippia evident throughout the grazing country but it is not present to the extent of being a major problem. The lippia seems to be doing best around the base of trees, and this is probably due to these areas not having good grass cover.

Future control options

Richard and Janet plan to continually improve their grazing management system, with further subdivision and establishment of more water points. There may also be areas where species such as Bambatsi may be introduced to further improve lippia control, as well as for production outcomes.

Recently Richard and Janet began trialling pasture cropping as a means of improving the production on the older native pasture country. Pasture cropping may be a very useful tool for lippia control in future years as it accelerates the increase in groundcover, perhaps reducing the opportunity for lippia establishment as well as contributing to the shading effect. They are very excited about the pasture cropping concept and will continue to experiment and trial different species under this system.

Case studies

John and Sam Hickson, 'Eural', Boomi NSW

PROPERTY DETAILS

Location: 7 kms south of Boomi, north-west New South Wales

Catchment: Whalan Creek, Macintyre River catchment

Property area: 8,100 hectares

Main enterprises: Merino sheep for wool production, beef cattle production (breeding and store fattening), grain production

Where lippia is a problem: Floodplain grazing country.

John Hickson in a healthy stand of Bambatsi

(Photo by P. Crawford)

General information and lippia infestation

'Eural' has a significant area of land on the Whalan Creek floodplain and this country has had an increasing lippia invasion for more than ten years. However, this has been managed through a conservative stocking rate and rotational grazing system, with the aim to leave a good level of groundcover at all times. John has observed that lippia is not a good competitor with a vigorous and well maintained pasture.

John and Sam bought the adjoining block 'Broxburn' in 2000, which is on the Whalan Creek floodplain. This block had been cleared many years ago, with approximately 480 hectares that hadn't been farmed for some years. This previously farmed area was virtually 100% lippia when purchased. With grazing being the main enterprise on 'Eural', it was necessary to plan for some serious lippia management on this block.

John has been involved in grazing management training through Resource Consulting Services, and this has assisted him to implement a more sustainable grazing system. John and Sam are in the process of implementing a time-controlled grazing system, with major changes to paddock sizes and increased stock watering points. At present, the original lippia paddock has been split up from one large 360 hectare paddock to smaller paddocks averaging around 60 hectares in size.

The Hicksons sold all their cattle early in 2007 in order to give their pastures a rest from the drought but have maintained approximately half their sheep flock. Following good rains in the spring of 2007, they are looking to partially re-enter the cattle market.

A close-up of the dense Bambatsi groundcover, which is contributing to lippia control

(Photo by P. Crawford)

Methods of lippia management

Cultivation, improved pasture establishment and grazing management are the methods of lippia control that are working very well on 'Eural'. With the grazing country on the new block virtually 100% lippia, the only viable option for control was cultivation.

Of the 480 hectares of lippia infested country on the new block, 320 hectares was ploughed with the aim of growing one or two crops and then planting back to pasture. A crop of wheat was planted in 2005 but a flood in July wiped out about half the crop. This country was planted down to pasture in October 2005 and good spring rainfall ensured an excellent germination.

The other half of the paddock was harvested and planted to pasture in February 2006. A very dry autumn and winter resulted in a very patchy germination but John hopes there will be an ongoing establishment with improved seasonal conditions from spring 2007.

The grass species planted have been Bambatsi panic and Floren bluegrass, with the Bambatsi by far the most dominant species.

Future control options

John and Sam will continue to subdivide more of their grazing paddocks into smaller sizes and, with the artesian bore capping and piping programme progressing in their area, they will have a much improved access to water which will enable the establishment of more watering points.

At this stage, no chemical has been used for lippia control but John may consider spraying lippia in laneways and tracks used by stock to reduce the potential for further spread.

John is very happy at this stage about the effectiveness of the introduced pasture in controlling lippia. Where there is good pasture establishment and good groundcover the lippia is not competing. He is confident of long-term control through pasture establishment and good grazing management.

Case studies

Tony, Sally and Robert Woods, 'Limebon', Tulloona NSW

PROPERTY DETAILS

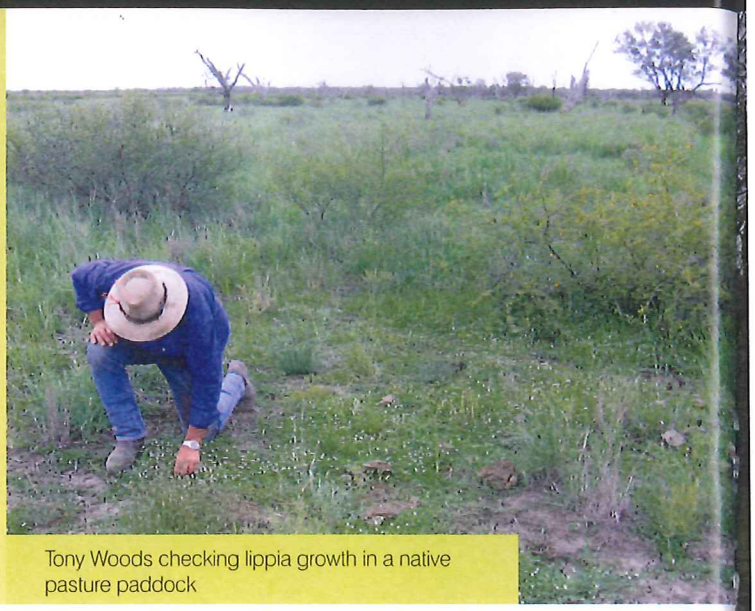
Location: Tulloona, 70 kilometres north of Moree, north-west New South Wales

Catchment: Whalan Creek and Croppa Creek, Macintyre River catchment

Property area: 4,865 hectares

Main enterprises: Beef cattle and grain production

Where Lippia is a problem: Floodplain grazing country, creek riparian zones



Tony Woods checking lippia growth in a native pasture paddock

(Photo by P. Crawford)

General information and lippia infestation

'Limebon' is predominantly floodplain and, in large floods such as those that occurred in 1996 and 1998, the whole property is inundated. Small patches of lippia were first recognised on the property a number of years ago and presented no significant problem prior to 1996. The density and extent of the lippia population across the property increased markedly following widespread flooding in 1996 and 1998. Recent floods, such as in February 2006, have contributed to widening the extent of the lippia infestation.

During wet periods, cattle spread lippia seed around the grazing country with the mud on their hooves. The conditions for lippia seed germination are perfect following a flood, so the regular flooding regime of the property is ideal for increased lippia spread.

In the past, 1,215 hectares were sown under crops and 3,650 hectares of predominantly native grassland were used as grazing land. Currently, 2,840 hectares are cropped and 2,025 hectares remain for grazing. Lippia affects the total area of the remaining grazing land to varying degrees, with approximately 1,620 hectares having more than 50% lippia cover.

The traditional stocking rate was one cow and calf unit per 4 - 4.5 hectares (4.2 DSE/ha equivalent) utilising crop stubble for grazing post harvest and until 1996 the property regularly ran 600 cows. The current stocking rate is now one cow and calf unit per 10 hectares (1.8 DSE/ha equivalent) with a total mob of 300 cows. The 50% reduction in stocking rate across the property is due solely to lippia invasion.

In addition to lippia, the Woods are experiencing an increase in Mimosa bush (*Acacia farnesiana*) infestation throughout the whole property. Mimosa bush is even appearing in cultivation paddocks as the zero-till farming system used on 'Limebon' allows the weed to become established due to the cessation of cultivation.

The effect of lippia on the banks and riparian zone of Croppa Creek itself is a cause of concern for the Woods family and other landholders in the area. Lippia has caused creek banks to slump, due to the drying out effect, causing the soil to crack and fall apart. This is leading to an increase in erosion and turbidity.

Black wattle country infested with lippia on the left, compared with the cultivated and very productive country in the same paddock on the right

(Photo by P. Crawford)

Methods of lippia management

The main lippia control measure on 'Limebon' has been cultivation. A 1,620 hectare grazing paddock on an area of flood country on Croppa Creek would consistently grow clover which would fatten 700 head of cattle in a good season however lippia spread to 100% coverage, making this country useless for grazing. Since being cultivated for crops, the paddock has been returned to a very productive state and with current high grain prices it is unlikely to be returned to pasture, at least in the near future.

Future control options

The area of native pastures being slowly overtaken by lippia is a serious cause of concern for Tony Woods. The drought has reduced the effects of lippia to some degree. However Tony is concerned that a return to good seasons could see the lippia out-compete the native grasses. He doesn't believe that the native grass species are capable of out-competing the lippia on the floodplain, even with very careful grazing management.

Although Tony is supportive of cell grazing systems, he believes that such a system would be very difficult to manage on a floodplain. Apart from the massive damage following a flood to the huge amount of fencing that would be needed for cell grazing on a property of this size, the other problem is where to relocate the cattle during a flood. There is generally not much warning prior to a flood event, which would make moving stock very problematic. With the present grazing system and large paddocks, stock generally have access to high ground during a flood.

Although Tony believes that cell grazing could be a valuable tool for lippia control, there would need to be much research and planning prior to establishing such a system on the property.

It is likely that there will be some chemical control work on lippia carried out on 'Limebon' in future years, depending on the availability and cost-effectiveness of chemicals. There will need to be more research on chemical control, especially as currently there are no registered chemicals (except under permit) for lippia control in pastures in New South Wales.

Case studies

Jack and Julia Gooderham, 'Myling' and 'Sefton', Tulloona NSW

PROPERTY DETAILS

Location: Tulloona, 70 kilometres north of Moree, north-west New South Wales

Catchment: Croppa Creek, Macintyre River catchment

Property area: 2,025 hectares

Main enterprises: Beef cattle and grain production

Where lippia is a problem: Floodplain grazing country, creek riparian areas

Jack Gooderham with a lippia patch in a Bambatsi pasture

(Photo by P. Crawford)

General information and lippia infestation

The properties are located on the floodplain adjacent to Croppa Creek. Of the total area, 80% has been cultivated for cropping or introduced pastures. Jack has been gradually putting floodplain country back to pasture, mainly for erosion control, as the soil type is very prone to erosion from flood events.

There was no evidence of lippia in the area until about 1992. In the initial stages, lippia was transported onto the property via table drains. Lippia now occurs to varying degrees across the whole property. Ducks and probably cattle have spread it to higher ground and it establishes easily where water lays but it does not need water to survive.

Traditional stocking rates were one beast to two hectares on introduced pasture and one beast to 2.8 hectares on native pastures. Since the invasion of lippia, stocking rates have been reduced to one beast to four hectares on the majority of the area, and as much as one beast to 12 hectares on badly affected paddocks.

This paddock previously had a magnificent stand of Floren bluegrass which has now all but disappeared

(Photo by P. Crawford)

Methods of lippia management

Although Jack has experimented with some chemical control, planting introduced pastures is the major lippia control measure and, at this stage, Jack is extremely happy with the results. If native grasses regenerate, as they appear to be doing in some areas, Jack is quite happy to see them but he considers that most of the main natives are not robust enough to compete with lippia to the degree that species such as Bambatsi panic will.

The pasture species used include Bambatsi, Purple pigeon grass, Floren bluegrass and medics such as barrel and snail. Jack says it is important to include medics wherever possible to feed the grasses. The floodplain paddocks have been split up into smaller paddocks and a cell grazing system has been implemented.

Jack's method of pasture establishment does not always involve ploughing. In fact, Jack's philosophy is one of working with the natural system as much as possible and this means leaving organic matter and fine soil particles on top of the ground to assist with the germination of pasture seeds. Jack considers that by ploughing these are all buried, making it much harder to get pasture seeds established.

Jack's method is to spray out the lippia (and other groundcover) in summer, leaving the stubble and organic matter on the surface during winter. New pasture is then seeded (using a fertiliser spreader, air-seeder or aeroplane) in early spring to maximise its exposure to rainfall. Jack allows the grasses to establish and set seed before grazing. Jack says that you have to be prepared to have those pastures out of commission (not grazed) for two years.

Newly seeded pastures are sprayed to control lippia regrowth two to three times each year for the first few years until the grasses have established, using 2,4-D amine and a wetting agent.

Floren bluegrass planted on its own has not been a successful species on this property, although in a mix it is more successful. One paddock on the northern side of the creek was planted to a straight Floren pasture in 2004. For the first year after establishment, the Floren was a superb pasture and Jack has figures to show better weight gains than cattle grazing on oats. However, most of the Floren died during the drought, exposing a poor drought tolerance trait of this species.

Future control options

Jack and Julia will continue to manage their floodplain country under introduced pastures for the long term. The cell grazing system will be further developed and fine-tuned with more subdivision fencing and water points established.

Jack is considering using their zero-till summer crop planter to establish grasses, with the only ground disturbance being from the coulter. The seed will be dropped onto the coulter groove, and the following presswheel will lightly press the seed into moist soil.

Case studies

Bruce and Jen Southeron, 'Old Dromana', Moree NSW

PROPERTY DETAILS

Location: 70 kms west of Moree, on the Gwydir River watercourse

Catchment: Gwydir River

Property area: 4,300 hectares

Main enterprises: Beef cattle production, some cropping for forage crops

Where lippia is a problem: Watercourse and floodplain grazing country, Ramsar wetlands

Bruce Southeron with lippia patch on the watercourse

(Photo by P. Crawford)

General information and lippia infestation

'Old Dromana' is located on the floodplain of the Gwydir River and the majority of the area is subject to inundation. The Gwydir River actually ends as a defined channel about half a kilometre inside the eastern boundary of the Ramsar wetland site on 'Old Dromana' and from this point the river (when it floods) spreads out onto the broad plains of the Gwydir River watercourse. Over 90% of the area of 'Old Dromana' is located in the watercourse.

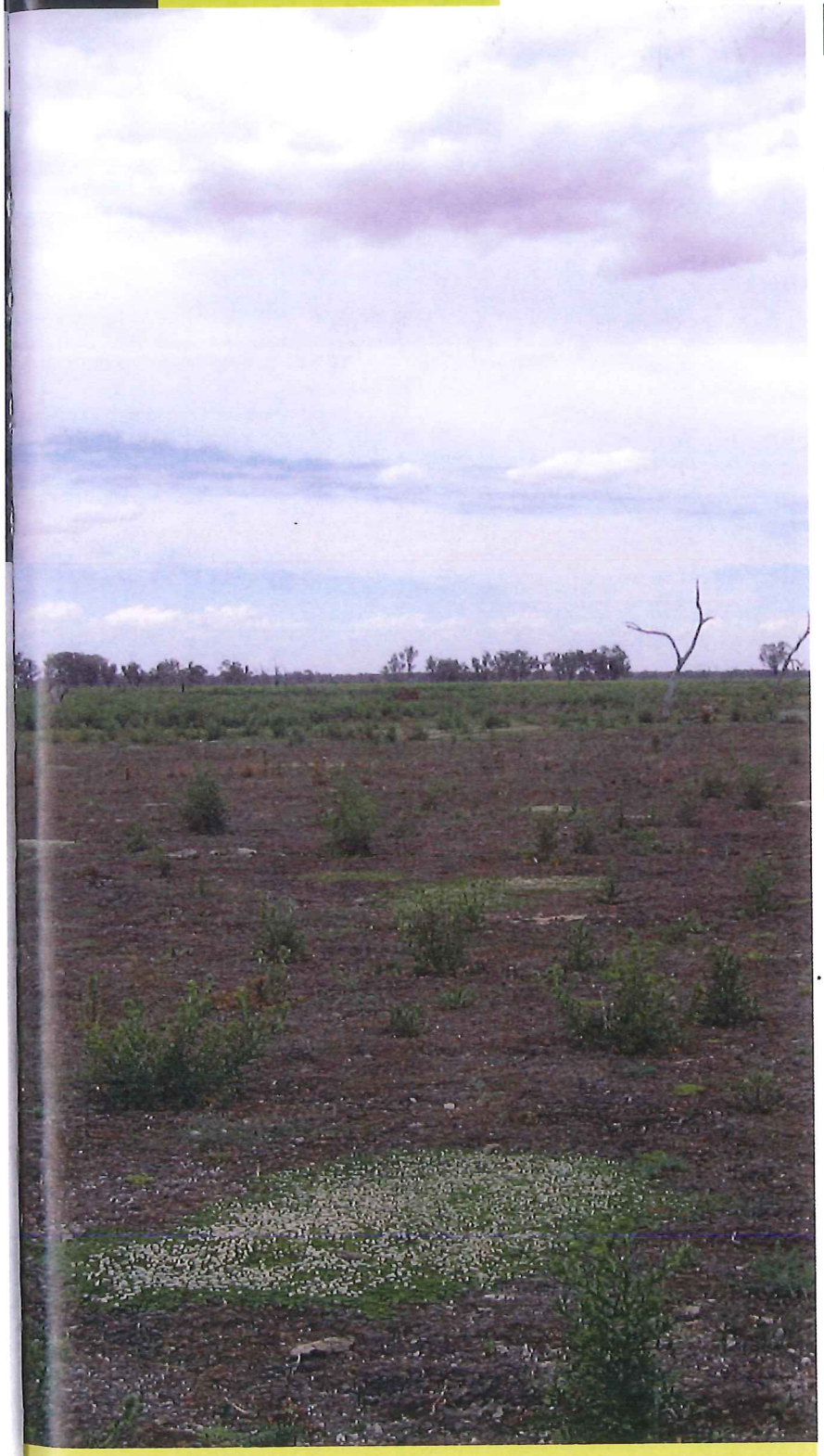
Prior to the construction of Copeton Dam in the late 1970s, regular flooding was a feature of the watercourse country. Bruce says that a good flood that lasted several weeks would provide enough soil moisture for twelve months feed supply. Since the expansion of the cotton industry over the last twenty-five years, floods have been far less frequent and short lived. This has resulted in the loss of the majority of the property floodplain grasses such as Bull couch, as these grasses need regular flooding for their survival.

A 600 hectare Ramsar wetland site is located on the property, the largest privately held Ramsar wetland of national significance in New South Wales, and 75% of this area is now covered by lippia. Where there were once thousands of birds breeding in the wetlands, the numbers now could be counted in the tens. Bruce is adamant that this has been caused more by over allocation of water for irrigation than by drought. Bruce and Jen are both keen naturalists and Jen is the membership and publicity officer for the New South Wales Bird Atlassers Inc.

Club rush (*Bolboschoenus sp.*) once covered over 4,000 hectares, the largest area of this plant in New South Wales. This area has been reduced to less than 80 hectares due to lack of flooding.

Lippia is present over 80% of the property in densities ranging from 10% to 90% cover. The worst lippia infestation is on the watercourse or floodplain country, although the weed has spread to some higher areas of the property.

Previous stocking rates have been up to 2,400 to 2,500 head of cattle. Between 1998 and 2002, the breeding herd was reduced from 1,000 to 700 cows. Currently, numbers on the property are down to 600 head. A conservative estimate of the cost of lippia to the profit margin on the property is at least $200,000 - $300,000 per year.



General view of the watercourse country with lippia patches in the foreground

(Photo by P. Crawford)

Methods of lippia management

Prior to the last five years, the distribution and spread of lippia was contained by using conservative stocking rates. The decline of the floodplain grasses has reduced the property carrying capacity dramatically and the resultant takeover by lippia has made this country now more or less useless.

About 30% of the property has been cultivated for lippia suppression, with mainly forage crops grown to support the cattle enterprise. Approximately 200 hectares of this country was planted with Bambatsi panic in 2004 and timely rainfall resulted in an excellent germination. The Bambatsi is competing well with the lippia and Bruce considers this species to be the most productive grass.

Future control options

Bruce considers that they have no alternative than to cultivate the floodplain area as a means of controlling the lippia. Before they can proceed with this plan they need to receive the authority to do so which involves an assessment of existing groundcover and vegetation. There is no tree cover on this area but the fact that there are dead trees with hollows suitable for bird breeding and habitat may restrict the ploughing of this area.

The plan is to crop the country with forage crops for two or three years and then plant the area to Bambatsi panic. Bruce believes that the native grasses will be too slow to re-establish and the species present will not compete with lippia as well as Bambatsi does.

Case studies

David and Stacey Lindsay, 'Roblyn', Warialda NSW

PROPERTY DETAILS

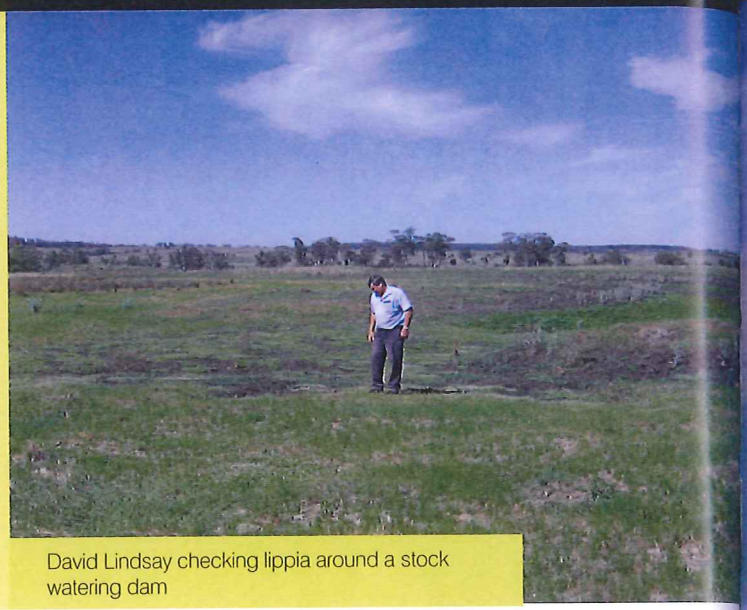
Location: 15 kilometres west of Warialda, northern New South Wales

Catchment: Mosquito Creek, Gwydir River catchment

Property area: 730 hectares

Main enterprises: Beef cattle production

Where lippia is a problem: Floodplain grazing country, creek riparian zone, contour banks and waterways on higher country



David Lindsay checking lippia around a stock watering dam

(Photo by P. Crawford)

General information and lippia infestation

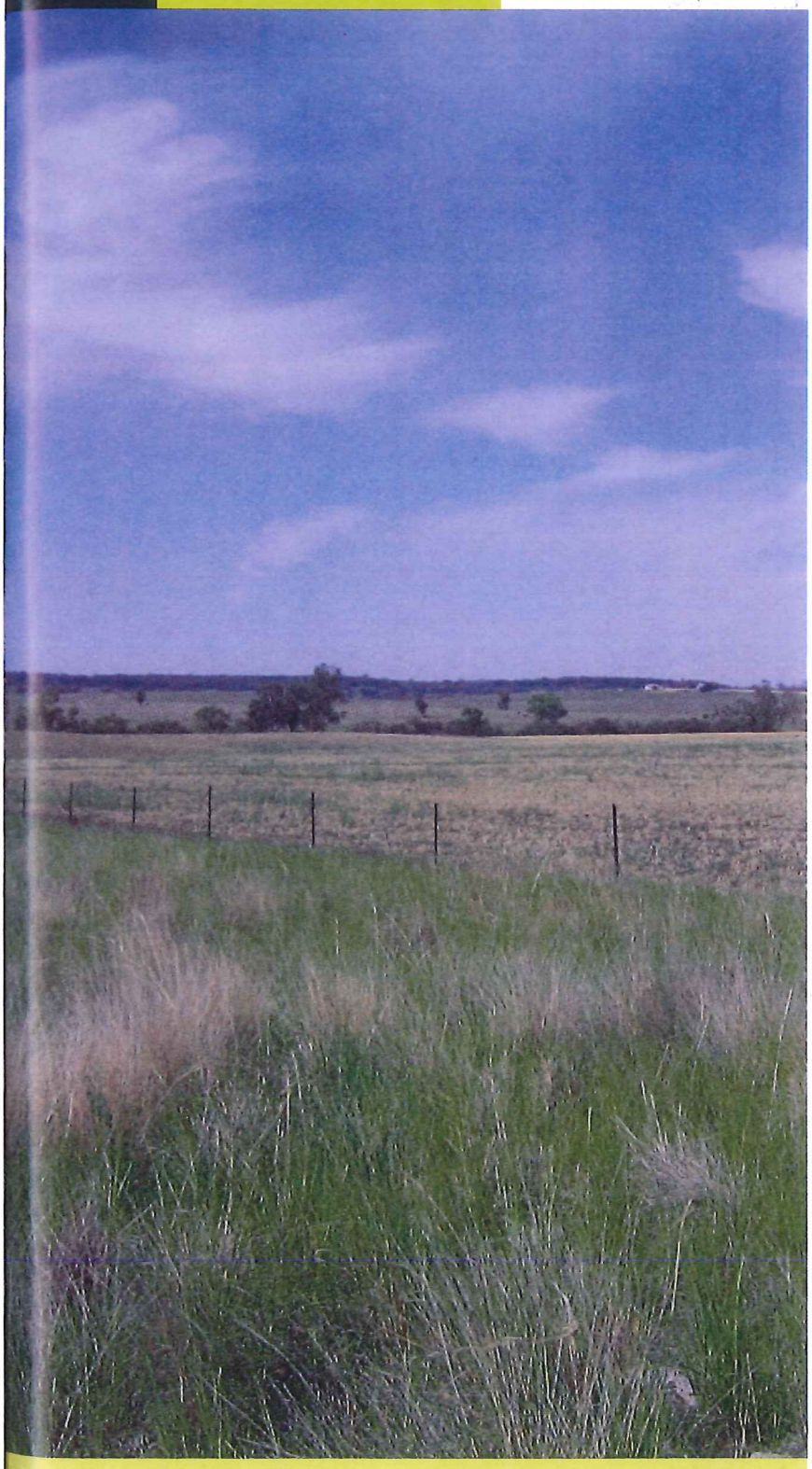
The area around Mosquito Creek is predominantly undulating low hills. David Lindsay thinks lippia probably first appeared after a major flood in the 1970s. During a twelve month period from 1999 to 2000 six floods were recorded, contributing significantly to the expansion of lippia on the property. Over the last five years, the infested area on 'Roblyn' has increased significantly and lippia is now encroaching into gullies and watercourses away from the creek

Currently, more than 50% of the property has scattered lippia present and the total land area covered by lippia is approximately 5% of the property. An eight hectare area of the property has 100% lippia cover present. All dams and contour banks are covered with lippia, as well as small depressions in hillsides.

David uses a rotational grazing system to manage the pastures on the property and considers that the stocking rate is fairly conservative. The property is subdivided into twenty paddocks, with the cows occupying the larger paddocks and weaners and steers run in the smaller paddocks.

It is interesting to note that one particular area of grass near the creek is rarely grazed by the cattle as they tend to graze some higher, lighter country in the paddock where the grasses are presumably more palatable. This lower area has some good quality pasture but no lippia present and this is probably due to the under-grazing. David considers that this could indicate that grazing management practices do play an important role in the spread and control of lippia.

Traditionally, the only country cultivated on the property has been in selected paddocks where forage crops, such as oats, are grown for winter feed. In recent years, David has had to plough other paddocks, just for lippia control. One former grass paddock close to the creek was virtually 100% lippia so this paddock is now used to grow oats or other forage crops for the cattle.



The paddock in the rear has been cultivated to control lippia. David Lindsay is thinking he may have to cultivate the paddock in the foreground for the same reason

(Photo by P. Crawford)

Methods of lippia management

Apart from conservative grazing management, cultivation is the main method of lippia control. With conservative stocking, the property is well grassed at all times and this assists in the suppression of lippia. The decision to cultivate areas of native pasture was solely based on the suppression of lippia and the ability to generate income from the land. David has carried out some limited chemical control, without much success.

Some of the higher country has been planted with Bambatsi and this country does not have any lippia present, indicating that the vigorous growing habit of this species makes it very effective for lippia control.

Future control options

David and Stacey consider that the only options for lippia in the future will be to cultivate more areas of low-lying grass country and plant back to an introduced pasture species, such as Bambatsi panic. In the meantime, David may carry out some chemical control work based on the information arising from lippia chemical control trials.

Case studies

Charles and Gillian Belfield, 'Kialami', Armidale NSW

PROPERTY DETAILS

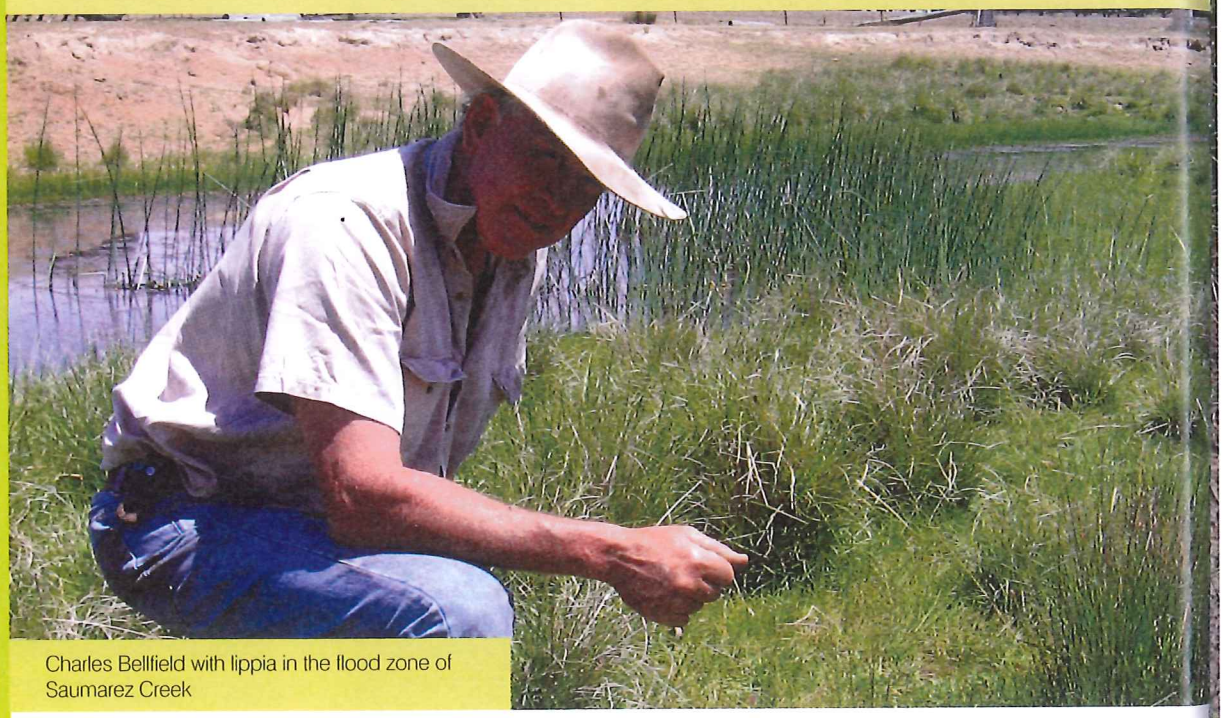
Location: 15 kilometres west of Armidale, northern New South Wales

Catchment: Saumarez Creek, Macleay River catchment

Property area: 2,600 hectares

Main enterprises: Beef cattle, merino sheep, grain production and horticulture

Where lippia is a problem: Riparian areas of creeks and watercourses, irrigation drains



Charles Bellfield with lippia in the flood zone of Saumarez Creek

(Photo by P. Crawford)

General information and lippia infestation

Charles Belfield and his family own and manage a grazing property fifteen kilometres west of Armidale in northern New South Wales. Saumarez Creek flows through the property and Charles harvests floodwater into a large dam for irrigation of fodder and grain crops. The property is situated on the eastern side of the Great Dividing Range and is located at the very top of the Macleay River catchment.

The family also operates a contract harvesting business and Charles works on several properties in north-west New South Wales each year.

In 2002, Charles noticed a new weed that had appeared in irrigation drains on the property. The weed had also shown up on several sites on the creek. The weed was identified as lippia. At this stage the weed is not widespread however Charles is concerned about its presence and the potential for spread further downstream in the Macleay catchment. It is unclear how the weed was established here but Charles suspects it could have come to the property either on a header or vehicle returning from lippia infested properties further west.

(Photo by G Mills)

Methods of lippia management

Charles has carried out some chemical application around the irrigation drains using mainly knockdown herbicides for general weed control. The effect of these chemicals on the lippia has been negligible and this is backed up by chemical trials for lippia control.

The potential for the impact of chemicals on the riparian ecosystem has limited control work on the creek infestations.

Future control options

The weed will probably not be an ongoing problem on the irrigation drains. These drains are basically low-fall contour banks on cultivation paddocks with PVC pipe outlets for irrigation water to flow through onto the lower bay. Control of lippia here could be a combination of chemical application, cultivation or conservative stocking.

There has not been much research carried out on lippia outside the Murray-Darling Basin so the fact that lippia is present at the very top of the Macleay catchment is a concern. It is very likely that the weed is present in other areas of the catchment but at this stage it has not been raised as a serious issue.

If lessons are to be learned from the Murray-Darling experience, it is important that authorities take the threat of lippia seriously and move to research its distribution before it takes hold.

Case studies

Bill, Marcia and Angus Moore, 'Nowley', Burren Junction NSW

PROPERTY DETAILS

Location: 70 kilometres west of Narrabri, north-west New South Wales

Catchment: Pian Creek, ephemeral un-named watercourses, Namoi River catchment

Property area: 6,227 hectares

Main enterprises: Grain, cotton and beef cattle production

Where lippia is a problem: Floodplain grazing country, irrigation channels and water storage infrastructure

Coolibah regrowth on 'Nowley'

(Photo by P. Crawford)

General information and lippia infestation

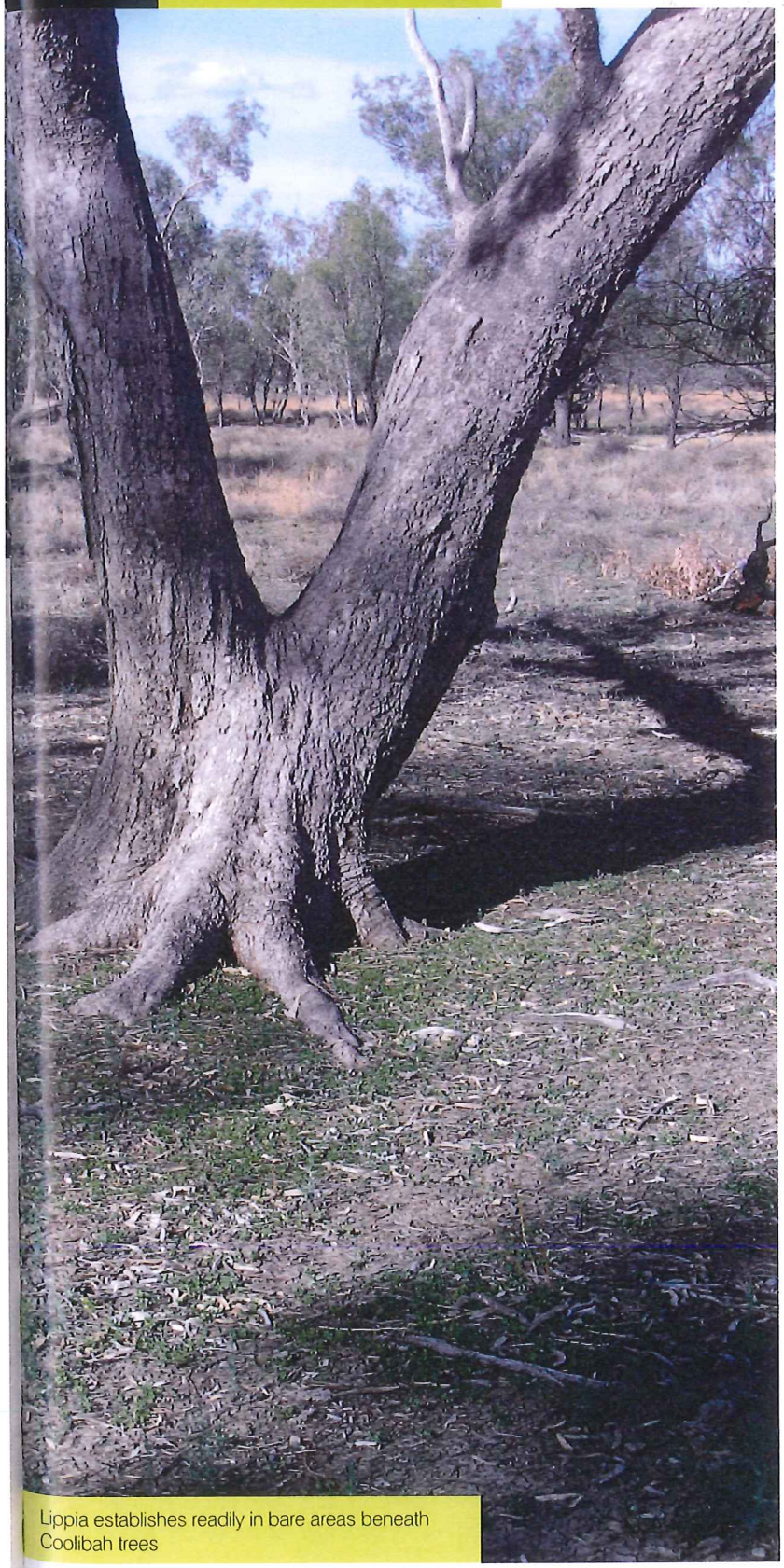
'Nowley' is predominantly flat grassland and Coolibah woodland plain. The property was historically a mixed sheep and cattle farm, with 8,000 to 10,000 sheep run in the past. Currently 6,000 sheep are run, a 40% reduction from the potential stocking rate. Cotton has been added to the enterprise mix with 405 hectares being developed for irrigation in an effort to maintain production from this area of land. Irrigation water is harvested from overland flows as well as being provided from a bore.

In large floods, 80% of the property is inundated. Water flows in a broad front from the Namoi River (approximately 35 kilometres from the property) in times of major floods. Coolibah regrowth became a significant land management issue following floods in the early 1970s and paddocks were subsequently grazed more heavily than previously in an attempt to manage the rapid regrowth.

The regrowth of the Coolibah is now so dense that where there was once a good cover of native grasses, the soil is basically bare in most places, leaving the area wide open for lippia invasion. Under the NSW Native Vegetation Act, Coolibah is listed as an endangered ecosystem, and therefore cannot be cleared.

Lippia was first observed on the property following the widespread flooding in 1998 and subsequent localised flooding over the months that followed. At that time, lippia was present on more than 200 hectares, predominantly in low-lying melon-holes.

The density of lippia has increased markedly since 2000. It is prolific across an area of 810 hectares of heavily flooded country, which is thick with Coolibah regrowth and therefore cannot be controlled with the use of herbicides because the area is not accessible with machinery.



Lippia establishes readily in bare areas beneath Coolibah trees

(Photo by P. Crawford)

Methods of lippia management

In the initial stages, a knockdown herbicide was applied without any effect. The difficulty of accessing the areas of Coolibah regrowth makes effective lippia control with herbicides impossible in this country.

The Narrabri Rural Lands Protection Board carried out some trial work in 2005 on the travelling stock route adjoining the property. Small areas (0.5 to one hectare) were cleared of trees and the regrowth was sprayed in the cleared areas when it appeared. Bill has observed a return of native grasses in these blocks, as well as some lippia. However the grasses appear to be competing well with the lippia.

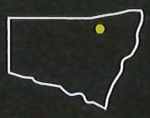
Future control options

If the Coolibah country could be accessed with conventional spraying equipment, Bill would definitely be implementing a lippia control programme using herbicides. However, the areas able to be accessed are only very small so a spraying programme would not be very successful.

The Moores are interested in cell grazing concepts and could introduce this grazing management system in the near future, both for production outcomes and lippia control.

Case studies

Vic Melbourne, 'Yarral', Wee Waa NSW



PROPERTY DETAILS

Location: 30 kilometres west of Narrabri, north-west New South Wales

Catchment: Namoi River

Property area: 8,100 hectares

Main enterprises: Grain, cotton and beef cattle production

Where lippia is a problem: Floodplain grazing country, river riparian zone

Floodplain country that has been ploughed and cropped and now returning to native pasture

(Photo by P. Crawford

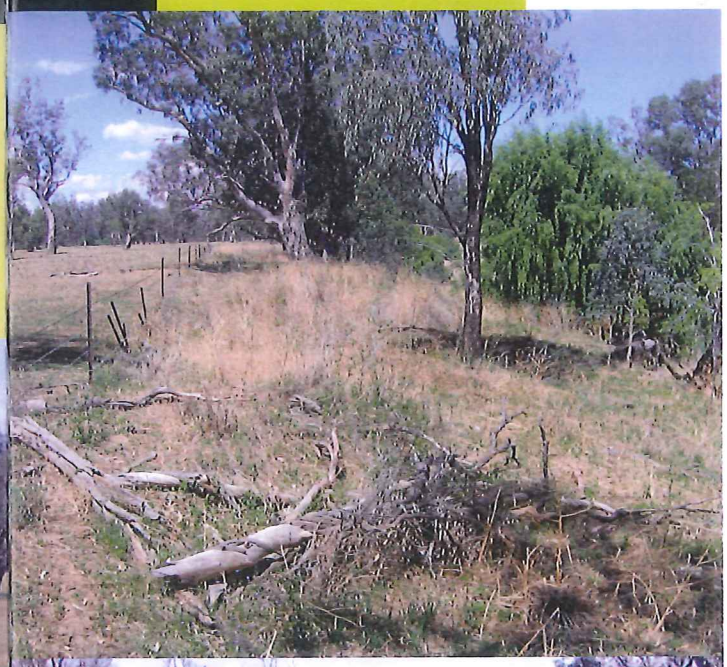
General information and lippia infestation

'Yarral' is located on the floodplain of the Namoi River. There is 1,620 hectares of grazing land, including 1,000 hectares of river country. The total area of grazing country is affected by overland flow from watercourses.

Each paddock is stocked to match pasture growth rates using a rotational grazing system. The property usually runs 800 to 900 head of cattle at a stocking rate of one cow and calf unit to 0.8 hectares.

Lippia was first observed on the property following the flood in 1998. Approximately 600 to 800 hectares is now covered with about 60% lippia. In drainage areas, pasture plants are dying out due to the combined effects of drought and lippia and in these areas lippia now provides 100% of the groundcover. Some areas of the property have recorded a 75% reduction in stocking rates.

Vic fenced off the entire length of river frontage (25 kilometres) in 1995 to prevent stock access to the river. Due to the very good grass cover and native tree cover on his side of the river there is very little lippia. This can be contrasted with the bank on the other side of the river, which has not been fenced and where cattle have continuous access to the river. Here lippia is very abundant and there is evidence of bank slumping and erosion. When the river is very low the cattle can move across to Vic's side, but this does not happen very often.



Comparisons between the fenced river bank on Vic Melbourne's side (no lippia) with the unfenced bank directly across the river. Uncontrolled cattle access has resulted in increased lippia, leading to bank slumping

(Photo by P. Crawford)

Methods of lippia management

After poor control with various knockdown herbicides, Vic decided that farming the country to suppress the weed was the best option.

A 73 hectare paddock of native pasture that was heavily infested with lippia has been cultivated to control lippia in accessible and badly affected areas. The paddock was farmed up to about 1995 but was left to return to grass. Under the NSW Native Vegetation Act, authority to plough the paddock needed to be granted. The authority to cultivate is based on the percentage cover of non-native species, in this case over 70%.

After a couple of years of cropping to oats for grazing, the paddock is being left to return to a native grass pasture. The only lippia remaining is around the base of the trees and in some low-lying areas unable to be cultivated.

Vic says there needs to be a minimum of two years of cropping before allowing the paddock to revert back to grass. There seems to be a very good seed bank of the native grasses, which regenerate readily when cultivation ceases.

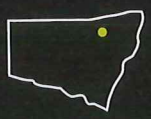
Future control options

Vic will continue to plough other grazing paddocks as it becomes necessary. This control option is reasonably expensive to carry out, especially when there is a significant amount of flood debris that needs to be cleared beforehand. These costs are recouped over a couple of years by the increased productivity of the country and compared with chemical control is still reasonably cheap. Being so close to the river also limits chemical control for environmental reasons.

Vic believes that the native species present are good enough to compete with the lippia and is not planning to plant any introduced pasture species at this stage.

Case studies

Phil and Pat Norrie, 'Mollee', Wee Waa NSW



PROPERTY DETAILS

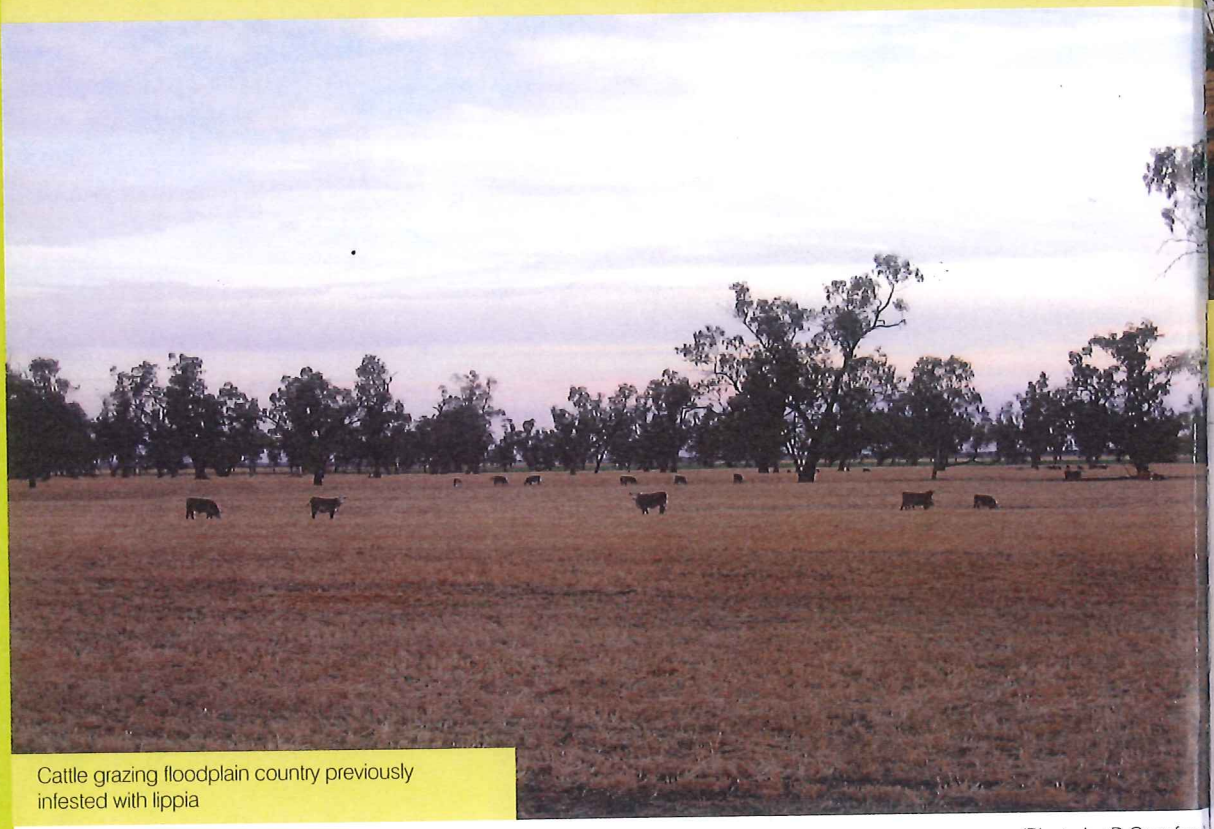
Location: Narrabri, north-west New South Wales

Catchment: Namoi River

Property area: 1,270 hectares

Main enterprises: Grain, cotton and beef cattle production

Where lippia is a problem: Floodplain grazing country, river riparian zone



Cattle grazing floodplain country previously infested with lippia

(Photo by P. Crawford

General information and lippia infestation

'Mollee' is located on the floodplain on the southern side of the Namoi River. The main enterprises of the property are cropping and beef cattle grazing. Approximately 25% of the property is grazed, with the remainder cropped. There are 474 hectares under flood irrigation, 267 hectares for dryland farming and 95 hectares with irrigation support.

Lippia was first observed on the property in the mid 1990s and became a significant issue following the 1998 flood when 10 to 20% cover of lippia appeared. Following the 2000 flood, the lippia cover increased to around 50% and lippia now covers 70% of the grazing area (300 hectares). Across a large part of this area, lippia provides 100% of the groundcover. Lippia is not present on land that is above the level of floodwaters.

The Namoi River frontage of the property has been fenced to restrict stock access and as a result of the absence of continuous grazing, lippia has not really taken hold in the riparian area.

Lippia controlled by cultivation compared with lippia infested country on the left. Note the difference in tree health

(Photo by P. Crawford)

Methods of lippia management

Cultivation was determined as the only viable option to suppress lippia on the river flats where it had become the dominant species and in 2002 cultivation for dry land farming was initiated on a 200 hectare paddock of lippia affected river flats. Of the 200 hectares, 140 hectares has been cultivated with the remaining 60 hectares being left for wildlife corridors and habitat areas.

The cultivated area of the river flats is now used for annual cropping. Due to the high risk of soil loss associated with floods, a summer/winter crop rotation is implemented to maintain stubble cover. A zero-tillage farming system also assists in this regard.

The New South Wales Native Vegetation Act only allows cultivation of previously uncultivated country if the groundcover consists of less than 50% of native species and only if clearing of trees is not necessary. In the Norrie's case, the assessment revealed that the native species present ranged between 0% and 17% and the medium tree density could be accommodated by the farming machinery. The low percentage of native species has enabled the Norries to proceed to develop this country for cropping.

A very interesting observation has been the spectacular recovery of the trees. Prior to cultivation, with lippia cover up to 100%, the trees were in a very poor condition and looking stressed. This condition can still be seen on the adjoining property where the groundcover is mainly lippia.

The improvement in the health of the trees may be due to the lippia and its soil drying capability or it could be from improved moisture infiltration from the cropping system used. Whatever the case, the positive benefits of the lippia removal are very obvious in this case.

The country will be double cropped where moisture is available and sown using zero-tillage methods. The cropping rotation is forage sorghum in the summer (for hay or grazing) and barley in the winter. Soil conditions after grazing may require conventional cultivation methods in some instances.

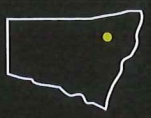
Phil and Pat are unsure at this stage whether to keep cropping the paddock or return it to pasture. Current high grain prices are enabling the costs of development to be recouped.

Future control options

The cultivated river flat country may be returned to pasture in future years, depending on the economics of grazing versus farming. Because the main area of lippia infested country is now under control, future work will basically involve monitoring the situation and carrying on with the current property activities.

Case studies

John, Robyn and Andrew Watson, 'Kilmarnock', Boggabri NSW



PROPERTY DETAILS

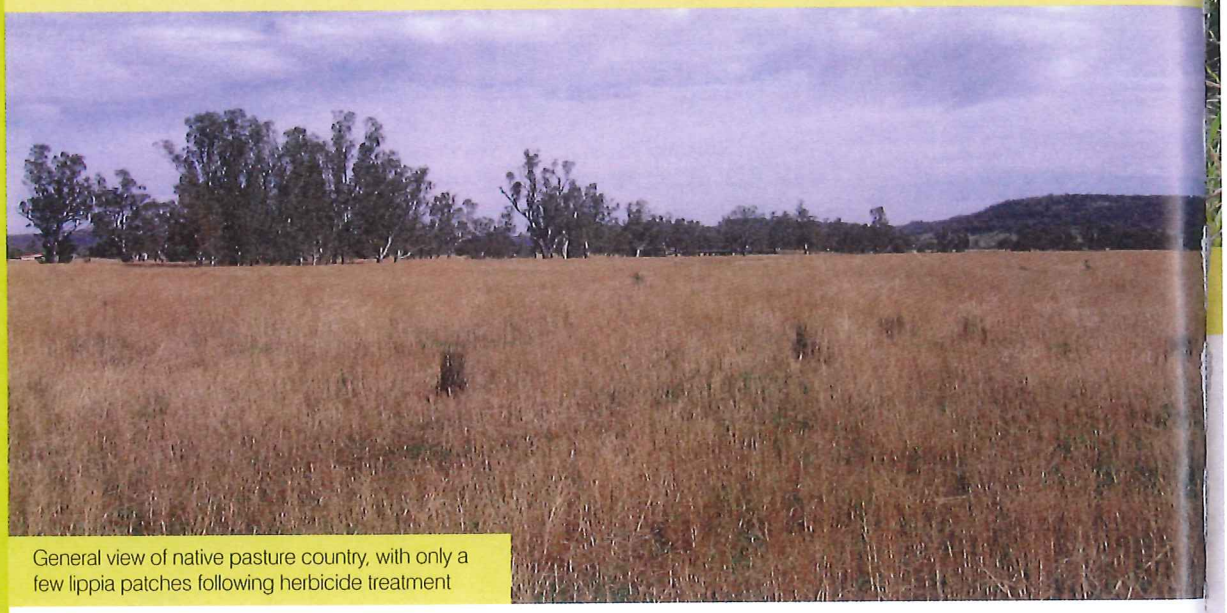
Location: Boggabri, north-west New South Wales

Catchment: Namoi River

Property area: 1,500 hectares, plus leased country

Main enterprises: Grain, cotton and beef cattle production

Where lippia is a problem: Floodplain grazing country, river riparian zone



General view of native pasture country, with only a few lippia patches following herbicide treatment

(Photo by P. Crawford)

General information and lippia infestation

The property is located on the floodplain of the Namoi River, five kilometres from the town of Boggabri. Approximately 50% of the property is cropped and beef cattle graze a mix of native and introduced pastures, predominantly Bambatsi panic. Native pastures dominate on the river country and the higher ground has been sown to Bambatsi. The Watsons are very impressed with the competitive ability of Bambatsi, if a good establishment is achieved.

The historical stocking rate is 300 cows but this is currently down to 100 due primarily to drought. The average stocking rate on the unfertilised native pastures of the floodplain was 3.7 DSE per hectare. Grazing management is on a rotational basis, with all grass paddocks having lengthy rest periods after stocking.

Lippia was first noticed in the region after floods in the mid 1970s. Lippia occurs commonly in flood runners (low-lying waterways or channels) and is increasing in incidence across the floodplain, as well as on higher ground. Lippia has a relatively patchy distribution across the property as a result of the management programme. It is estimated that the total area of lippia on the property is approximately 80 hectares.

The riparian strip of the river has been fenced to exclude livestock and a tree regeneration programme has been initiated. The dominant grass species in this strip is the highly palatable Queensland blue grass. Immediately outside the fenced area in the grazed pasture, there is a lower percentage cover of blue grass and here lippia occurs frequently.

Small patches of lippia are apparent throughout both introduced and native pasture country

(Photo by P. Crawford)

Methods of lippia management

A very intensive chemical control programme is the main factor that has prevented lippia spreading across a wider area of the property. A concentrated effort is made to suppress lippia in flood runners and depressions where it predominates. Flood runners are sprayed regularly with 2,4 D and more recently with Agricrop Lantana® 600. Robyn has a quad-runner set up with a spot sprayer and regularly carries out a planned spraying regime when the lippia is most susceptible.

The spraying programme has been successful but is only just keeping ahead of the lippia. The drought hasn't helped as lippia needs to be actively growing and fresh for good results so the spraying windows have not been very regular over the last few years. The country that has been sprayed on a regular basis does not have a severe lippia problem. The weed is present but there is also plenty of grass. Repeat sprays are usually necessary two to three times per year.

In the first year 30 hectares were sprayed and in 2005 approximately 80 hectares were sprayed at an average chemical cost of $30/ha. This constant concentrated effort at suppressing patches of lippia where they occur has reduced the rate of spread across the property however lippia continues to spread into continuously grazed pastures on the floodplain and higher ground.

John has also carried out some boomspraying in selected areas, although the proximity of the river prevents the use of chemical in immediately adjacent paddocks. One of these paddocks has been ploughed to control the lippia and is currently being cropped to wheat or oats for the cattle. The paddock was ploughed many years ago but allowed to return to native pasture which over time was taken over by lippia. The paddock will probably be planted down to Bambatsi over the next couple of years.

In the fenced riparian area, grasses are slashed annually to reduce competition for newly planted trees. Where grasses have been slashed regularly and 100% groundcover has been retained the presence of lippia is minimal, suggesting that maintaining a healthy groundcover and vigorous perennial grasses is an effective method to restrict the establishment of lippia.

Future control options

John is considering that they may have to plough up some of the river country to completely eradicate the weed, but this could pose some serious soil erosion risks if a flood occurs prior to the re-establishment of pasture.

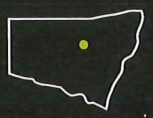
John is interested in the cell grazing concept and it is possible that this type of system could be introduced in future years nevertheless an intensive farming programme may limit the adoption of cell grazing due to the time commitments needed to implement it.

The farming country is managed with a minimum-till system but as the family move to a complete zero-till operation it is possible for lippia to start to encroach on the cultivation country. If this occurs it may be necessary to introduce strategic cultivations as part of the system.

Ongoing chemical control will depend on the availability of suitable products, which at the moment are only available through a permit that expires in mid 2008.

Case studies

Doug Andrews, 'Messines', Warren NSW



PROPERTY DETAILS

Location: 80 kms north of Warren, central west NSW

Catchment: Macquarie River

Property area: 2,200 hectares

Main enterprises: Beef cattle, grain production and cropping for cattle

Where Lippia is a problem: In flood country in the Gum Cowal of The Macquarie Marshes

Heavy (100% cover) lippia infestation in typical timbered country

(Photo by T. Woods)

General information and lippia infestation

Lippia was first noticed eighteen years ago on 'Messines'. Presently an area of 500 hectares of the flood country of the Gum Cowal varies from moderate to heavy infestations of lippia.

With the construction of Burrendong Dam in 1967, the resulting changed water flows have had an impact on the extent of lippia in the Macquarie River valley. The regularity and volume of flooding has been severely decreased with the irrigation industry taking a large percentage of the water. Land that was regularly flooded in years gone by now only receives a minimal environmental flow on an irregular basis. This has resulted in the original water couch and rushes dying out and lippia infesting the bared areas.

Lippia will not compete with water couch if there is a sufficient flooding regime in place. Where lippia has become dominant on the flood country, the carrying capacity has been reduced by 80% or more.

Lagoon area that has received more regular flooding, showing a heavy cover of water couch, and virtually no lippia

(Photo by T. Woods)

Methods of lippia management

There are very few management options in the mainly heavily timbered environmentally sensitive areas of the property, which is situated in part of the Macquarie Marshes. Herbicide control is basically the only method being used but this is not possible in inaccessable country.

Close-up of heavy lippia infestation

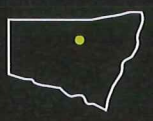
(Photo by T. Woods)

Future control options

Some small areas may be able to be sprayed with herbicide on the edge of the marsh country where there is scattered timber only.

Case studies

Macquarie Marshes Nature Reserve, Warren NSW



PROPERTY DETAILS

Location: Situated between Warren and Carinda, central west NSW.

Catchment: Macquarie River

Property area: 22,000 hectares

Main enterprises: Nature Reserve – environmental and biodiversity conservation

Where lippia is a problem: Across the whole reserve

This area was once all water couch and rushes. Since regular flooding ceased, these species have died out and replaced with lippia and a range of other weeds. This country has not been grazed since 1979

(Photo by T. Woods)

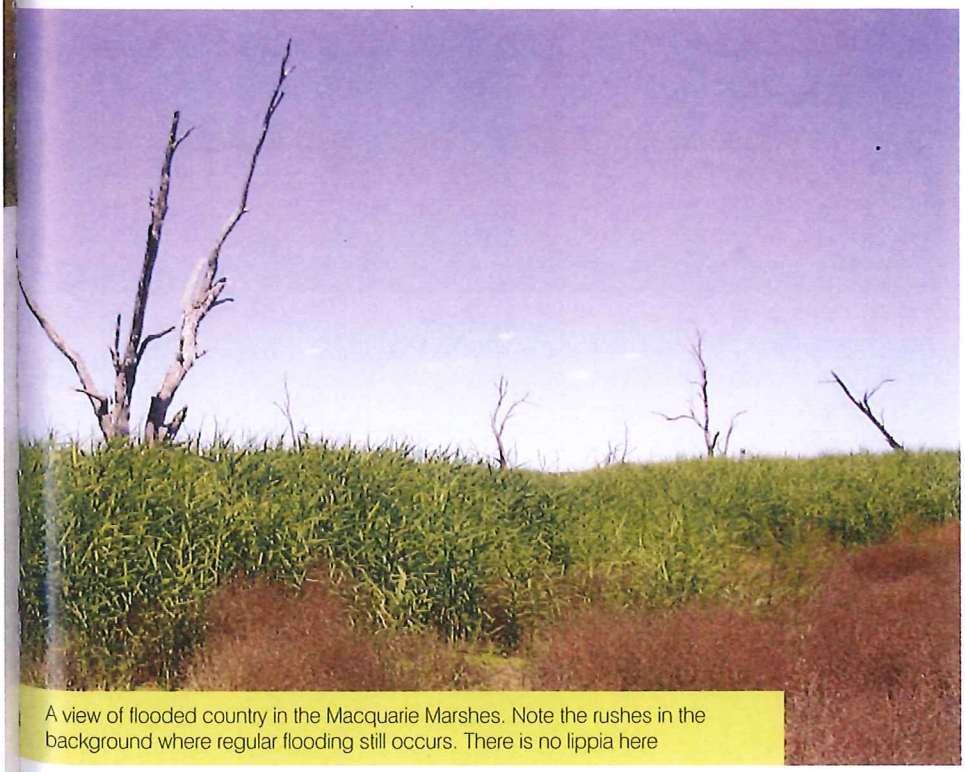
General information and lippia infestation

Lippia was first noticed on the reserve in the mid 1980s, which coincided with an increase in the extraction of water for irrigation. The extent of the infestation is approximately 12,000 hectares, or over half of the entire reserve area.

Ranger, Ray Jones (NSW National Parks and Wildlife) believes that the problem will increase as the marsh continues to dry because the only method of control available at present is by flooding. The flooding regime has been affected by both extraction and prolonged drought conditions.

Ranger, Ray Jones at what is left of the Macquarie River. The river once spread out over many thousands of hectares. Note the 100% lippia cover

(Photo by T. Woods)



A view of flooded country in the Macquarie Marshes. Note the rushes in the background where regular flooding still occurs. There is no lippia here

(Photo by T. Woods)

Methods of lippia management

The only method available is flooding when water is available. The water flooding regime has decreased significantly since the river was regulated and this method is only available opportunistically. When flooding takes place, the natural vegetation successfully competes with the lippia and increased populations of water birds are found, as they are dependent on water couch and other natural vegetation for feed areas. Without flooding lippia continues to spread.

Future control options

It is hoped that strategies being introduced such as RiverBank and the buying back of water for the environment will see an increase in flooding in areas such as the Macquarie Marshes and thus a decrease in the spread of invasive weeds like lippia. The control of lippia by chemicals is very limited in wetlands due to the environmental concerns. The only way forward for the reserve is to increase water availability.

Appendix 1 – references

Much of the material in this manual has been sourced from a range of existing research documents, reports and management fact sheets. The National Lippia Working Group would like to acknowledge the contributors of these publications.

Authors unknown (2004), *Lippia,* Qld. Department of Natural Resources and Water factsheet
Authors unknown (2006), *Lippia, a weed of national importance, information factsheet,* National Lippia Working Group
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Daley A.T. et al. (2006), *Phytotoxic effects of Lippia* (research paper)
Dellow J.J. et al. (2001), *Lippia,* NSW DPI AgFact
Earl J. (2001), *The distribution and impacts of Lippia (Phyla canescens) in the Murray-Darling Basin, final report,* Murray-Darling Basin Commission
Julien M. et al. (2007), *Biological control of lippia: native range surveys for plant pathogens,* CSIRO
Leigh C. and Walton C.S. (2004), *Lippia in Queensland, Qld.* Department of Natural Resources and Water
Lucy M. et al. (1995) *Lippia. A review of its economic and environmental impact on floodplain ecosystems in the Murray-Darling Basin,* Qld. Department of Primary Industries and Fisheries
Martin P. (2003), *Killing us softly – Australia's green stalkers,* CRC for Australian Weed Management
Munir A.A. (1993), *A taxonomic revision of the genus Phyla Lour in Australia,* Journal of the Adelaide Botanical Gardens
Stokes K. et al. (2007), *Evaluating potential responses and management of Lippia in the MDB under climate change and developing methodologies for assessing climate change effects on riparian weeds,* CSIRO
van Klinken R. (2005), *Report of the 1st Australian Lippia research workshop,* UNE Armidale

Appendix 2 – current research activities

Ref No	Name	Organisation	Research Activities	Date for Completion
1	Celine Clech-Goods	CSIRO, Brisbane	Is a PhD student investigating how soil nutrients and herbivores influence the growth and competitive ability of lippia. Her project includes a comparison between the native (Argentina) and exotic ranges (Australia).	2009
2	Andrew Daley	University of Sydney	Has conducted experiments to determine the presence or otherwise of an allelopathic effect from lippia	2006
3	Dr. Mohammad Fatemi	University of New England	Conducting research into the genetic diversity and variability of the lippia population in Australia. Dr. Fatemi's work will be crucial to the future development of biological controls for lippia.	2011
4	Associate Professor Caroline Gross	University of New England	Coordinating several research projects with Post Doctorate Fellows at the University of New England at Armidale, New South Wales. Associate Prof Gross is also conducting research into pollination, to establish whether Lippia needs insects for crosspollination or whether flowers can set seed automatically.	On-going
5	Mic Julien	CSIRO European Laboratory, France	Co-leader of the CSIRO Lippia Project with Rieks van Klinken. Leader of the research in South America seeking insect and pathogen biological control agents. Conducts research with Dr Xu and Mohammed Fatemi on the comparisons of growth and genetics of lippia between the native range (Argentina) and the introduced ranges (Australia and France). Supervisor for PhD student Matt Macdonald.	On-going
6	Matt Macdonald	University of New England	Conducting a three year project looking at the reproductive ecology and distribution of lippia throughout Australia. Most of Matt's research work is being carried out in wetland and floodplain areas in the northern New South Wales sections of the Murray-Darling Basin.	2008
7	Dr. Jodi Price	University of New England	Conducting a three year research project to investigate the potential for strategic grazing and in particular, seasonal rests to encourage more competition from favourable species. The project is being carried out on four sites in the internationally significant Gwydir and Macquarie Marshes wetlands, both of which have been infested by lippia to the extent that substantial destocking has been necessary, making grazing on the properties unviable.	2010

Ref No	Name	Organisation	Research Activities	Date for Completion
Case Study	Kathryn Reardon-Smith	University of Southern Qld.	Conducting a three year research project looking at riparian woodland community condition along a floodplain section of the Upper Condamine River, southern Queensland. Lippia can be a major invasive weed within these communities and this research looks at the functional role of lippia in the ecology of these woodlands and in response to prevailing disturbance regimes.	2009
8	Dr Rieks van Klinken	CSIRO, Brisbane	Leads the CSIRO Tropical Invasive Plants Team in Brisbane, is co-leader of the CSIRO Lippia Project with Mic Julien and leader of the collaborative lippia project within the Weed CRC. Dr Rieks van Klinken manages a range of projects on the ecology and management (including biological control) of lippia.	On-going
9	Associate Professor Wal Whalley	University of New England	Professor Whalley has been closely involved with the National Lippia Working Group Steering Committee for several years and has been closely involved with grazing management trials in the Gwydir and Macquarie Marshes wetlands. Professor Whalley is supervising Matt Macdonald and is a co-investigator with Assoc. Prof Gross and Dr Jodi Price for the grazing trials.	On-going
10	Andrew White	CSIRO, Brisbane	Assisting in research funded by SEQ Water on lippia ecology and management around Wivenhoe and Somerset Dams in south-east Queensland. It includes supporting collaborative research with Chenqyuan Xu, Jodi Price and Alice Yeates.	2010
11	Dr Chengyuan (Stephen) Xu	CSIRO, Brisbane	Conducting a three-year project into the eco-physiology, ecology, evolution and management of lippia with Dr Rieks van Klinken and Mr Mic Julien. An important aim of this research is to help select and evaluate effective biological control agents.	2009
12	Alice Yeates	CSIRO, Brisbane	Is a PhD student examining the relationship between disturbance and weed invasions. One aspect of her PhD is a study on the effect of flood, grazing and herbicide use (broad-spectrum and dicot-specific) on lippia. Field sites are near Goondiwindi and at Somerset Dam.	2009

Appendix 3 – legislation

Legislation	Summary
Australian Government *Environment Protection and Biodiversity Conservation Act 1999* www.environment.gov.au/epbc/	The objectives of the EPBC Act are to: • provide for the protection of the environment, especially matters of national environmental significance • conserve Australian biodiversity • provide a streamlined national environmental assessment and approvals process • enhance the protection and management of important natural and cultural places • control the international movement of plants and animals (wildlife), wildlife specimens and products made or derived from wildlife • promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources The seven matters of national environmental significance to which the EPBC Act applies are: • world heritage sites • national heritage places • wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed) • nationally threatened species and ecological communities • migratory species • Commonwealth marine areas • nuclear actions
Queensland Government *Vegetation Management Act 1999* www.nrw.qld.gov.au/vegetation	The Vegetation Management Act 1999 regulates the clearing of native vegetation in Queensland. The Act sets down the rules and regulations that guide what clearing can be done, and how it must be done to meet the requirements of the law. It regulates clearing of remnant vegetation on freehold land, and of remnant and some non-remnant vegetation on state tenures.
Queensland Government *Environmental Protection Act 1994* www.epa.qld.gov.au	Places a "duty of care" responsibility on all persons in relation to activities that may have an environmental impact. The act also has provision for overseeing of various licences and permits required for certain activities

Legislation	Summary
Queensland Government *Land Protection (Pest and Stock Route Management) Act 2002 and the Land Protection (Pest and Stock Route Management) Regulation 2003.* www.dpi.qld.gov.au/cps/rde/dpi/hs.xsl/4790_7652_ENA_HTML.htm	The Department of Primary Industries and Fisheries is responsible for the administration of the Land Protection *(Pest and Stock Route Management) Act 2002* and the Land Protection (Pest and Stock Route Management) Regulation 2003. The Act provides for pest management in Queensland by: • establishing the principles of pest management for land • providing pest management planning through the development of pest management strategies and pest management guidelines • declaring animals and plants to be declared pests • restricting the introduction, keeping or sale of declared pests • preventing the spread of declared pests in the state, including, for example, preventing their spread by human activity • establishing responsibilities for pest management • building and maintaining fences to prevent declared pest animals moving from one part of the state to another • establishing the Land Protection Council to give advice and make recommendations to the Minister about managing pests • providing for the establishment of pest operational boards • monitoring, surveying and controlling pests.
NSW Government *Native Vegetation Act 2003* www.nativevegetation.nsw.gov.au	This Act regulates the clearing of native vegetation on all land in NSW, except for excluded land listed in Schedule 1 of the Act. The Act outlines what landowners can and cannot do in clearing native vegetation. The Act repealed the Native Vegetation Conservation Act 1997. The objects of this Act are: • to provide for, encourage and promote the management of native vegetation on a regional basis in the social, economic and environmental interests of the State, and • to prevent broadscale clearing unless it improves or maintains environmental outcomes, and • to protect native vegetation of high conservation value having regard to its contribution to such matters as water quality, biodiversity, or the prevention of salinity or land degradation, and • to improve the condition of existing native vegetation, particularly where it has high conservation value, and • to encourage the revegetation of land, and the rehabilitation of land, with appropriate native vegetation, in accordance with the principles of ecologically sustainable development.
NSW Government *Noxious Weeds Act 1993* www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/legislation	The objects of this Act are as follows: (a) to reduce the negative impact of weeds on the economy, community and environment of this State by establishing control mechanisms to: (i) prevent the establishment in this State of significant new weeds, and (ii) restrict the spread in this State of existing significant weeds, and (iii) reduce the area in this State of existing significant weeds, (b) to provide for the monitoring of and reporting on the effectiveness of the management of weeds in this State.

Legislation	Summary
NSW Government *Pesticides Act 1999* www.environment.nsw.gov.au/legislation	It is an offence under the Act: • to use a pesticide in a manner that injures or is likely to injure another person (section 10); • to use a pesticide in a manner that damages or is likely to damage any property of another person (section 10); • to use a pesticide in a manner that harms any non-target animal or plant, or harms any animal or plant if there is no approved label or permit for the pesticide (section 11); • to wilfully or negligently use a pesticide in a manner that causes material harm to threatened species or protected animals (section 9); • to possess or use an unregistered pesticide without a permit (sections 12 and 13); • to fail to read an approved label or permit before using a registered pesticide (section 14); • to use a registered pesticide contrary to the approved label (section 15); • to keep registered pesticides in a container without an approved label (section 16); • to possess or use a restricted pesticide without being authorised by a certificate of competency or a pesticide control order (section 17). The Act provides that certain pesticides may only be used by a person who has obtained a certificate of competence authorising such use. There are also provisions to regulate foodstuffs that contain prohibited residues of pesticides, and to prescribe methods of controlling the application of pesticides from aircraft (with the EPA being required to licence pilots and aircraft operators that conduct aerial spraying).
NSW Government *Threatened Species Conservation Act 1995* www.environment.nsw.gov.au/legislation	This is an Act to provide for the conservation of threatened species, populations and ecological communities of animals and plants (although the Act does not generally apply to fish). The Act sets out a number of specific objects relating to the conservation of biological diversity and the promotion of ecologically sustainable development. . The Act sets up a Scientific Committee, whose functions include: • identifying and classifying (as endangered, critically endangered or vulnerable) the species, populations and ecological communities with which it is concerned, and • identify key threatening processes that may threaten the survival of those species, populations and ecological communities. The Act inserts offences into the *National Parks and Wildlife Act 1974* relating to harming (of listed threatened species, populations and ecological communities, being animals) and picking (of listed threatened species, populations and ecological communities, being plants), buying, selling or possessing of threatened species or populations (being animals or plants) and damaging of critical and other habitat. The Act also provides for the declaration and mapping of habitats that are critical to the survival of those identified threatened species, populations and ecological communities that are classified as endangered (critical habitats).

Legislation	Summary
Victoria Government *Environment Protection Act 1970* www.epa.vic.gov.au	The *Environment Protection Act 1970* is Victoria's primary environment protection legislation, with a basic philosophy of preventing pollution and environmental damage by setting environmental quality objectives and establishing programs to meet them.
Victoria Government *Pollution of Waters by Oils and Noxious Substances Act 1986* www.epa.vic.gov.au	The purpose of the *Pollution of Waters by Oils and Noxious Substances Act 1986* is to protect the sea and other waters from pollution by oil and noxious substances (POWBONS). This Act also implements the Marpol Convention; the International Convention for the Prevention of Pollution from Ships 1973.
Victoria Government *Planning and Environment Act 1987* www.dpi.vic.gov.au	Since 1989, people wanting to clear native vegetation must have a planning permit from their local Council, where the landholding is greater than 0.4 hectares. Exemptions from this requirement for a permit apply for some activities. These native vegetation retention controls are in Clause 52.17 of the Victorian Planning Provisions, under the *Planning and Environment Act 1987.* Local laws and overlays may also apply to the land in question. These have additional controls and requirements and may override some exemptions. Such overlays may include: • Vegetation Protection • Environmental Significance • Significant Landscape • Erosion Management • Salinity Management • Schedule to a Heritage Overlay.
Victoria Government *Catchment and Land Protection Act 1994* www.legislation.vic.gov.au	Purposes of the Act • To set up a framework for the integrated management and protection of catchments • To encourage community participation in the management of land and water resources • To set up a system of controls on noxious weeds and pest animals • To repeal and amend certain Acts concerning catchment and land management
South Australia Government *The Native Vegetation Act 1991*	An Act to provide incentives and assistance to landowners in relation to the preservation and enhancement of native vegetation; to control the clearance of native vegetation; and for other purposes. The Native Vegetation Act ensures that areas of high conservation value are protected and that minor clearance is subject to a thorough assessment process. As such, the Act curtails particular forms of development in favour of biodiversity. A person must not clear native vegetation except where the Act permits such clearance under regulations or with the approval of the Native Vegetation Council. Broad scale clearance in South Australia is prohibited under any circumstances. The Act also protects smaller areas of native vegetation including isolated trees.

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Border Rivers-Gwydir CATCHMENT MANAGEMENT AUTHORITY

Namoi CMA CATCHMENT MANAGEMENT AUTH