Managing invasive native scrub to rehabilitate native pastures and open woodlands

A Best Management Practice Guide for the Central West and Western Regions

Acknowledgements:

This is a revised version of a resource that was produced through the INS Research Program for the information of the wider community and Catchment Management Authority (CMA) (now Local Land Services (LLS)) staff. Information contained within is based on reviewed historical works, current research, expert opinion and landholder experience.

This program was coordinated by the Central West and Western CMAs in collaboration with the NSW Department of Environment, Climate Change and Water (DECCW); CSIRO; Geoff Cunningham Natural Resource Consultants; Industry & Investment NSW; GHD; Namoi CMA; the University of New England (UNE) and the landholder community.

The INS Research Program Advisory Group consisted of:

- Dr Denis Saunders AM (Chair) (Landscape ecologist)
- Angus Atkinson (Landholder)
- Andrew Mosely (Landholder)
- Phil Norman (Queensland Department of Natural Resources and Water)
- Peter Weston (Landholder).

The INS Research Program Management Team consisted of:

- Carolyn Raine (Chair) (Central West CMA)
- Dr Sue Briggs (CSIRO)
- Gary Howling (DECCW)
- Russell Grant (Western CMA)
- Dr Brian Wilson (DECCW).

The following individuals have also provided input into sections of this resource: Claire Bergin, Rod Campbell, Dr Veronica Doerr, Brian Dohnt, Susan Drane, Peter Droulers, Daryl Green, Dr Ron Hacker, Scott Hosking, Peter Jessop, Dr Anne Kerle, Karen Kneipp, James Leigo, Dr Nick Reid, Dr Matt Tighe, Paul Theakston and Ray Thompson.

Thanks also to the following landholders for their assistance in preparing case studies contained in this resource: David Betts, Tony Falkenhagan, Barry Francisco, Kevin Mitchell, Cr Wally Mitchell, Ken Norman, Terry Pitkin and The Zell Family.

Disclaimer:

Local Land Services has published this management guide in good faith, exercising all due care and attention. Local Land Services does not accept responsibility for any inaccurate or incomplete information supplied by third parties.

No representation is made about the accuracy, completeness or suitability of the information in this publication for any particular purpose. Local Land Services shall not be liable for any damage which may occur to any person or organisation taking action or not on the basis of this publication.

This manual is subject to revision without notice and it is up to the reader to ensure that the latest version is being used. Readers should seek appropriate advice when applying the information to their specific needs.

Users of this guide may be required to obtain approvals from government agencies for activities referred to in this management guide. Readers should seek appropriate legal and other expert advice on whether any approval is required under any legislation for any activity referred to in this management guide.

© State of NSW, Local Land Services (2014).

Published by:

Central West Local Land Services
PO Box 2105 Dubbo NSW 2830
Ph (02) 6881 3400
admin.centralwestlls.nsw.gov.au
www.centralwest.lls.nsw.gov.au

Western Local Land Services
PO Box 302 COBAR NSW 2835
Ph 1300 795 299 or 026836 1575
admin.western@lls.nsw.gov.au
western.lls.nsw.gov.au

Editorial services: Bloom Communication
Cover page image taken at 'Wilgadale', Hermidale. Photographer Rod Campbell.

ISBN 978-0-7313-3437-7 [Hardcopy] [or] ISBN 978-0-7313-3438-4 [electronic]

December 2014

Contents

Foreword

The complex issue of invasive native scrub (INS) has a long history in central west and western NSW.

Since the 1800s widespread thickening and encroachment of woody vegetation has had major impacts on farm viability and the natural environment.

Experience has shown there is no simple solution to the management of INS. Despite considerable research and management practice in relation to INS, there are still gaps in our knowledge of why some species behave as INS and the most effective methods for their control. However, we do have enough knowledge resulting from research and drawing on practical experience of many land managers to assist those undertaking INS management. Since their formation in 2004, Catchment Management Authorities (CMAs) have taken a critical role in examining the problems posed by INS and its management in order to develop cost-effective approaches to management for beneficial economic, social and environmental outcomes.

The Central West and Western CMAs have played a leading part by instigating and coordinating the INS research program. This program was undertaken to increase our knowledge of this serious issue and distil available research and management results to provide support for those managing areas affected by INS.

The INS program was undertaken in partnership with the Department of Environment, Climate Change and Water, a range of research organisations and the landholder community.

This manual is the synthesis of the results of scientific research and practical knowledge gained by many landholders who have been managing INS. It is a comprehensive reference for strategic management of INS and for practical decisions relating to managing INS at the paddock and farm scales.

We believe this guide is practical, useful and contains the best available information on management of INS. Obviously it can be improved as more information becomes available and we would welcome any feedback that could lead to its improvement.

Tom Gavel
Chair, Central West Catchment Management Authority

Rory Treweeke
Chair, Western Catchment Management Authority

Dr Denis Saunders, AM
Chair, Invasive Native Scrub Research Program

Introduction

Invasive native scrub (INS) is a serious issue affecting large areas of central and western NSW, and rangelands elsewhere. The encroaching and dense regeneration of native trees and shrubs impacts on farm production, communities and the environment.

This 'road map' outlines the principles, processes and techniques used to manage INS and restore affected landscapes into a healthy mosaic.

This resource is the product of a collaborative research program on INS. This work was undertaken across the central west and western regions of NSW to help us better understand the principles and practices of managing INS.

This resource presents findings from this program and draws on up-to-date scientific research, landholder experience and previously published information.

In addition, the road map also provides access to detailed scientific reports, historical publications and hands-on resources to give a comprehensive background for INS management.

Please note however that this resource is not property specific and provides only one source of information to help landholders, Local Land Services and others manage INS. Readers should seek appropriate advice when applying this information to their specific needs.

In this section:

An introduction to invasive native scrub

What is invasive native scrub?

Native vegetation in New South Wales has significantly changed since European settlement. Much of the State has been cleared, while in other areas the shrub and/or tree densities have increased. This thickening is often referred to as invasive native scrub (INS).

INS has been observed in rangelands around the world. The cause of this change in western and central NSW is attributed to a complex combination of seasonal and management factors.

Some of the major causes include inappropriate grazing management, altered fire regimes and the impacts of feral animals. INS can result in environmental, production and social problems.

Note: For a legal definition of INS refer to the relevant legislation.

Top: Dense bimble box regeneration
Bottom: Locked cypress pine

What is the issue?

Before European settlement, western and central NSW was most likely a mosaic of open grasslands, open woodlands and areas of thicker scrub. Changes in fire and grazing patterns combined with rainfall patterns have increased INS in some regions.

INS competes for resources (i.e. light, water, nutrients) and can reduce or exclude the growth of other plant species, particularly native perennial grasses.

Widespread INS reduces habitat diversity and soils in INS sites can be crusted and hard setting. The reduction in groundcover can increase soil erosion and can be made worse when combined with high total grazing pressure.

Most INS species are unpalatable to stock. INS limits pasture production and stock carrying capacity. Thick stands of trees and shrubs present difficulties for stock management. Dense INS reduces paddock visibility and can restrict access to parts of a property. This makes mustering time consuming, labour intensive and costly. Dense INS also harbours feral animals such as foxes, cats and pigs. With poor vehicle access, controlling these pests is more difficult.

However, INS species are native to NSW and provide shade and shelter for livestock, habitat for a wide variety of native plants and animals, and connections for the movement of wildlife across the landscape.

Effective INS management produces mosaic landscapes with native pastures, open woodlands and denser areas for social, environmental and economic benefits.

Managing INS in NSW

INS can be managed successfully to restore this mosaic of native vegetation. However one treatment is unlikely to achieve this. There are many examples across western NSW where one-off blade ploughing or other treatments have worsened the problem.

A successful INS management program needs integrated and ongoing treatments, and incorporates pasture establishment, appropriate grazing management, infrastructure (e.g. fencing) and monitoring.

Under the *Native Vegetation Act 2003*, Local Land Services is responsible for assisting land managers with on-ground management of native vegetation, including INS. Before undertaking any INS management activity, landholders need to contact their Local Land Services office for relevant advice and information on what restrictions may apply.

Above and below: Examples of treated INS to restore a mosaic environment and perennial pastures.

References and resources

This information has been drawn from the following sources:

Border Rivers-Gwydir Catchment Management Authority. *Invasive Native Species*.

NSW Office of Environment and Heritage (formerly the Department of Environment, Climate Change and Water. Native vegetation management information sheets, publications and reports. Available at http://www.environment.nsw.gov.au/vegetation/publications.htm

Harland, R (ed). (1993), *Managing for woody weed control in Western NSW*. Woody Weeds Task Force, Dubbo. pp 28-31.

Fundamentals of managing invasive native scrub

The aim of managing invasive native scrub (INS) is to create a healthy and productive environment. The long-term goal of management should be the re-establishment and maintenance of stable perennial pastures in a healthy and balanced environment.

When planning an INS management program, the following should be taken into account.

1. Take a tactical approach

There is no silver bullet to INS management and a long-term approach is essential to reduce the risk of failure.

Planning is needed beyond the initial treatment event to make sure elements such as total grazing pressure, follow-up treatments, monitoring and other ongoing tasks are considered and costed in the initial budget.

You should realistically assess your capacity for ongoing management of treated areas. Over-extending yourself in the initial treatment of INS and failing to follow-up can lead to a worse INS problem and wasted investment.

Climate variability should also be considered, so allow for a margin to allow for the risk of bad seasons.

2. Make INS management part of farm planning

A whole of property approach is essential. Management decisions should not be made in isolation, but with consideration of the property plan and the need for sustainable production. INS management must be a core element of farm planning systems in affected landscapes. INS treatment needs to be scheduled and implemented throughout the year to be effective.

Regular monitoring should also be carried out to ensure that follow-up work is done as needed. It is important to remain vigilant for recruitment events, INS regrowth and seedling establishment.

3. Adopt an integrated approach

Each INS management option has advantages and disadvantages. For effective control of INS seedling growth and INS generally, an integrated strategy is needed. Such a strategy uses a range of control techniques to maximise the strong points of individual techniques and minimise their shortcomings, achieving more than a single technique alone.

For example, heavy goat grazing may control hopbush, but if used alone may damage groundcover and lead to an increase in unpalatable INS species such as turpentine.

4. Know your INS species

Different INS species have different responses to treatment. It is important to correctly identify INS species to ensure that an INS problem is not made worse by inappropriate management. For example, pine and hopbush can be managed through burning, but turpentine is less susceptible to fire.

Top: 'Woody weeds' comprising predominately turpentine and budda
Bottom: INS sites can often have hard setting, crusted and eroded soils.

5. Keep open areas open

Keeping open areas open is the easiest and most cost-effective way in which to manage INS, and so should be a priority. Perennial groundcover and production loss is greatest at the earlier stages of INS encroachment. This means that managers must monitor for encroachment and treat INS seedlings early. Where there is no open country, priority areas for INS management should be holding paddocks, stock laneways, fencelines and around watering points. Ultimately, the best country on your property must be treated, not the worst.

Landholders should be aware of conditions suitable for INS recruitment events (i.e. subsequent wet summers) and monitor for seedling encroachment.

6. Achieve a balanced environment

An INS management program should restore a mosaic of different vegetation types to the landscape. A balance of native pastures, open woodlands, and open and denser INS areas provide greater habitat diversity and biodiversity than one vegetation type alone.

7. Manage grazing pressure and groundcover

Management of total grazing pressure is essential for long-term INS control. The management of total grazing pressures (i.e. feral, native and domestic animals) and appropriate resting periods are required to promote good native groundcover and vigorous growth of native pasture.

Sustainable grazing is the major preventative technique to maintain country in an open condition. A vigorous perennial pasture can compete with emerging shrub seedlings for moisture, nutrients and light, and help limit encroachment.

Appropriate grazing pressure will also help develop fuel loads for management burns if needed, and allow for quick recovery.

Improving native groundcover also improves soil processes and health, meaning more resilient and productive landscapes.

To improve and maintain good native groundcover, appropriate grazing regimes, infrastructure (e.g. fencing, water point control) and feral animal control are paramount.

Coolabah acting invasively

References and resources

Information in this resource has been drawn from a number of sources, including the following publications:

Ayers, D, Melville G, Szigethy-Gyula, J, Read, D, Rees, R and Atkinson, A (2001), Woody weeds and biodiversity in western New South Wales. WEST 2000.

Doerr, VAJ, Doerr, ED, McIntyre, S, Howling, G, Stol J, Davies, M, Drew, A, Warren, G and Moore, D. (2009), Managing INS landscapes for improved ecosystem health. Report prepared for the Central West Catchment Management Authority.

Tatnell, B (1993), Integrated woody weed management strategies. In Harland, R (ed). Managing for woody weed control in western NSW. Woody Weeds Task Force, Dubbo. pp 6–8.

WEST 2000. Perennial pasture management plan for woody weed control.

Invasive native scrub in western and central NSW: a brief history

The causes of invasive native scrub

A range of factors are thought to have led to the widespread establishment of invasive native scrub (INS) across western NSW. These include grazing pressure from domestic, feral and native herbivores, the widespread suppression of fire (both wildfire and Aboriginal management burning) and climate change.

Grazing pressure from feral herbivores (in particular, goats) has been a driving force in the emergence of INS. Kangaroo numbers have also increased since the introduction of more reliable water sources in the landscape, adding to total grazing pressure.

The role of the rabbit in INS emergence is debated. In large numbers rabbits can substantially add to total grazing pressure and remove groundcover competition to INS establishment. However, many landholders believe they played a role in controlling INS seedlings (particularly cypress pine) and that their decline due to myxomatosis in the 1950 led to further INS emergence.

The impact of total grazing pressure on INS areas is seen is several ways – herbivores preferring to eat herbage over most shrub species, the reduction of fuel for fires, soil degradation and seed dispersal. Stock management also means natural movements of native animals away from depleted areas are prevented by fencing.

The impact of European settlement changed fire regimes from Aboriginal mosaic-burning practices to fire suppression. Fire regimes have changes in terms of frequency, extent and intensity.

Subsequent wet years also suit INS recruitment, with a number of periods of above-average rainfall leading to widespread INS germination events and establishment.

The role of climate change and increased levels of atmospheric carbon dioxide have also been implicated in woody thickening.

Overall it is unlikely that any one of these factors is the sole cause of vegetation change. Rather, it is the combination of these factors and the interaction with local conditions that have had led to the prevalence of INS.

Early days of European settlement

Before European settlement, western NSW was most likely a mosaic of open grasslands, open woodlands and patches of thicker scrub.

The introduction of grazing stock, rabbits and provision of watering points from the 1860s significantly increased total grazing pressure. Along with the suppression of fire and heavy rainfall events, the vegetation changed from a mixture of trees, palatable grasses and shrubs (with denser areas) to more widespread areas of denser trees and mostly unpalatable shrubs in some regions.

Records indicate significant scrub growth in the 1880s and 1890s, most likely as a result of high rainfall and intensive stocking in this period. The increase in shrubs was noted by travellers in the region in the mid-1800s.

Top: Early western NSW is thought to have been more mosaic in nature than today.

Bottom: INS was recognised as an issue for early pastoralists in the Western Division. (Photo: A. Campbell. Backcountry squatter A.D. (1892). National Library of Australia, 8488440)

1900-1950

The growing problem of invasive native scrub (INS) was formally recognised in 1900 when the NSW Government appointed a Royal Commission to examine the condition of crown tenants in the Western Division of NSW.

The Royal Commission report, released in 1901, identified seven principal factors that were thought to have led to the widespread depression and general decline in profitability of the pastoral industry in the Western Division of NSW. These were:

- frequent periods of drought
- ongoing financial cost of rabbit control
- overstocking
- loss of topsoil through vegetation loss
- spread of non-edible shrubs
- decline in prices of pastoral products
- insufficient property size for profitable farming.

The 40 years following the Royal Commission were very dry on average. A major bushfire in 1921-22 destroyed much of the scrub regrowth from the 1880s and 1890s.

1950s-1970s

A prolonged period of above-average rainfall in the early 1950s resulted in extensive INS regrowth, although the extent wasn't appreciated until grasses, which had grown tall in the years of high rainfall, were grazed in the dry conditions of 1957. Increased stocking also led to reduced groundcover, and hence reduced competition for INS seedlings.

Good rainfall in 1962, 1968, 1969 and 1973-76 resulted in more periods of INS regeneration and dense regeneration. Bushfires in the 1970s had little effect on the dense INS. Although they were hot fires, there was insufficient fuel to carry a fire through the woody shrubs. At this time rabbits and kangaroos were also abundant, increasing total grazing pressure and removing the grass growth.

In 1968, an interdepartmental committee was established to investigate and report on the problem of scrub and timber regrowth as it affected parts of the Western Division of NSW and the Cobar-Byrock district in particular.

1980s-1990s

There was a general thickening of INS in response to higher rainfall in both the early 1980s and late 1990s. Erosion due to lack of groundcover in areas with dense INS growth was a problem.

High total grazing pressure coupled with wet years provided conditions suited to widespread INS establishment.

The high wool prices of the late 1980s saw many landholders start or expand INS management programs, however when the wool prices fell many of these programs were abandoned.

In 1988 the Woody Weeds Taskforce was established. The Taskforce coordinated efforts by industry and government to publicise the urgency of the INS problem and helped landholders to adopt available treatments.

2000s

The INS problem continues today. Lower rainfall, fluctuating kangaroo numbers and high feral goat numbers are some of the factors resulting in increased dense scrub and trees in parts of central and western NSW. Burning is often not a viable management option for thick, established INS, with no grass fuel to carry fires in mature stands.

References and resources

This information has been drawn from the following sources:

Hassall & Associates, Briggs, S and Norman, P (2006), *Documenting the science behind the invasive native scrub tool*. Report prepared for the Central West Catchment Management Authority. Available at **http://archive.lls.nsw.gov.au/__data/assets/pdf_file/0003/496002/archive-documenting-the-science-behind-the-invasive-native-scrub-tool.pd**

Kerle, A (2009), *Managing rangeland vegetation with fire: a literature review and recommendations*. Report prepared for the Western Catchment Management Authority.

WEST 2000. *Perennial pasture management plan for woody weed control.*

Research to improve invasive native scrub management

About the Invasive Native Scrub Research Program

In 2006, the Central West and Western Catchment Management Authorities (CMAs) commenced a research program to better understand and improve management of invasive native scrub (INS), in collaboration with the NSW Department of Environment, Climate Change and Water (DECCW) and other partners.

This collaborative research program gave us a better understanding of how to manage INS, including overall management principles and techniques that work under specific circumstances.

Project partners included:

- CSIRO
- Geoff Cunningham Natural Resource Consultants
- GHD
- Namoi CMA
- NSW Department of Environment, Climate Change and Water (DECCW)
- Industry and Investment NSW
- University of New England (UNE).

This work was made possible through the support of the landholder community, research partners, DECCW, the Australian Government and the CMAs.

Brief summaries of the individual research projects and their key findings follow. Further information is provided in later sections of this publication.

INS management and soil

Soils in INS areas are often different from soils of non-INS areas. Soils in INS areas often lack permanent groundcover, allowing water run-off and poor infiltration. This can result in eroded, crusted or hard-setting soils. Soils in INS areas have lower herbage cover, reducing the livestock carrying capacity of land.

The UNE undertook two projects in the INS research program to investigate relationships between INS and soil.

The first project set out to identify relationships between INS and soil erosion and provide guidelines for managing INS and soil erosion.

The study found significant differences in run-off between INS and long-established pasture and open woodland, but not between INS and recently established pasture. There were no significant differences in sediment production between INS and the other vegetation states (recently established pasture, long-established pasture, open woodland).

There were significant differences in run-off and sediment production between the types of vegetation patches (e.g. bare, vegetated and densely vegetated) within the vegetation states.

Top: A grazing exclusion cage at a soil function study site
Bottom: Gully erosion site

The second project looked at soil health and function and found that, when compared with soils in open woodlands, soils in INS areas:

- have less herbage cover (groundcover)
- are harder crusting
- are more acidic
- have less carbon and lower biomass of soil microbes.

Soils in INS areas had significantly less herbage cover and were significantly more acidic than soils in pasture and open woodlands.

These projects developed a series of best management principles (BMPs) for improving soil health. These BMPs are:

- reduce bare soil to less than 30%
- increase herbage production and litter retention
- reduce/limit compaction
- increase pH
- increase water and carbon retention
- reduce the potential for high velocity surface run-off of water.

Further information on these BMPs and their practical implications is contained later in the management planning and principles section of this resource.

The erosion study's rainfall simulator in action.

Using fire to manage INS

Research suggests that changed fire regimes (particularly the decline in the incidence of fire) since European settlement is a factor contributing to woody thickening, and that burning may be useful for managing INS.

While fire has not been readily adopted as an INS treatment in western or central NSW it is becoming more attractive as the cost of other treatments rises. Improved control of grazing pressure through total grazing pressure fencing and water-point management opens the option to burn when seasonal conditions permit.

Burning emerging hopbush

The Western CMA investigated the factors that influence landholders' attitudes to fire and through this work, management guides, case studies and other resources were developed to help landholders use fire to manage INS.

The fire project also included a comprehensive review of literature by ecologist Dr Anne Kerle to better understand how to use fire in pastoral systems for both environmental and production values.

These two projects highlighted the need for landholders to:

- focus INS management activities on seedling regrowth and sparse shrub establishment
- create conditions to encourage grass growth; a fire strategy is ineffective without an appropriate grazing management strategy
- choose appropriate timing for management burns
- undertake long-term planning for successful INS management.

An important conclusion from this work is that ineffective treatment of INS can be worse than no treatment at all.

Further information on fire management is contained in the techniques section of this resource.

Landholder experience in managing INS

Landholders hold a significant and valuable bank of knowledge about managing INS. A project was undertaken by natural resource consultant Geoff Cunningham to record information from landholders in the Cobar Peneplain area who have experience in managing the impacts of INS. The work documented management techniques and their effectiveness under a range of conditions and vegetation types.

The landholders' responses illustrate the variety of management techniques that have been used to remove, manage and prevent the spread of INS. Some of these techniques have been successful while others have failed or have resulted in INS becoming a more serious problem.

Most landholders recognised that total grazing pressure is essential to the implementation of a successful INS control program. Many used a variety of methods to control INS which they regarded as a temporary means to 'buy time' while they fence and water their land to control total grazing pressure.

Information from this research is incorporated throughout this resource. The *Listening to the managers* report is also available in full (see references and resources).

Birds and INS

A CSIRO project examined the role that different types of habitat in INS landscapes play in supporting native birdlife.

The research found that 'open' scrub had more species of birds than open agricultural areas and 'closed' scrub. Overall bird diversity was greatest when the landscape contained a range of vegetation types.

A willie wagtail in open scrub.

This research led to a number of management recommendations including:

- plan landscapes to encourage a mosaic and support wildlife movement before treating INS
- manage for a balance of open agricultural areas (with and without trees), open scrub and thicker scrub
- manage for native perennial grasses in open scrub as well as in treated paddocks.

Further information about mosaics, biodiversity and INS landscapes is in the management principles and planning section of this resource.

Short-term cropping to manage INS

Managing INS with short-term cropping

In many situations, cropping is the only economically viable means of treating INS and regenerating native perennial grasses. However, there was little documented evidence of its effectiveness (or otherwise), and little information about how to best manage the transition from crop to regenerated grassland.

A project conducted by Industry & Investment NSW (formerly the Department of Primary Industries) to evaluate the benefits of opportunistic cropping in restoring native perennial grasslands in the Western Catchment found that:

- treating INS provides an opportunity for native perennial grasses to establish. However, in the absence of measures that encourage their persistence many paddocks revert to INS
- good stands of native perennial grasses established in some paddocks within a year of cropping after treating INS

- an adequate soil seed bank of the major native perennial grasses is available in many parts of the Cobar Peneplain for re-establishment of native grasslands when the required environmental conditions (rainfall and removal of competition from shrubs) are met
- rotationally grazed paddocks had more native perennial grasses than set stocked paddocks.

The study concluded that cropping every few years with minimul soil disturbance (e.g. pasture cropping) may assist in keeping paddocks free from INS.

Further information from this research is in the management principles and planning section of this resource.

White cypress pine acting invasively

Management of white cypress pine on the North West Slopes

Soil and climate conditions in the North West Slopes of NSW are particularly favourable for the germination and re-establishment of white cypress pine.

A UNE research project looked at soils under single scattered pine trees and soils in away from trees, and found that soil under the trees had higher soil carbon, available phosphorous and pH (i.e. they were less acidic) than soil away from the trees. This pattern was strongly related to the amount of litter on the ground – the more litter, the better the soil.

The project also compared soil under dense stands of cypress pine trees with soil under single, scattered trees, and soil in the paddock away from pine trees.

Soil under dense stands of cypress pine trees was the lowest in nutrients and the most acidic, with soil under single, scattered trees the highest in nutrients and least acid. The reasons for this were thought to be related to competition between the dense trees and groundcover for light, water and nutrients - eventually the dense trees out compete the groundcover vegetation.

The result is that there is very little groundcover to 'catch' the nutrient-rich tree litter and hold it in place, and so the litter is lost from the site. As the dense trees in the stand compete with each other for progressively less and less soil nutrients, they drop even less litter, exacerbating the problem.

Classifying and mapping INS

A project to identify and map INS on the Cobar Peneplain was undertaken to help understand the extent of INS within their regions. The information has been used by LLS staff to help plan landholder extension programs and identify the extent of INS in the region.

Coolabah and black box

Coolabah and black box often regenerate prolifically on the Darling riverine plains after flooding events.

A UNE research project examined this vegetation community to determine options for managing this type of INS that enhance the biodiversity and production values of the affected areas. The results from this work are being analysed.

References and resources

Further information on these projects and their results can be found in the following papers and reports:

Alemseged, Y (2009), *Evaluating opportunistic cropping for control of INS and restoration of native perennial grasslands in western NSW*. Industry & Investment NSW.

Cunningham, G (2008), *Listening to the Managers.* Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Doerr, VAJ, Doerr, ED, McIntyre, S, Howling, G, Stol, J, Davies, M, Drew, A, Warren, G and Moore, D. (2009), *Managing INS landscapes for improved ecosystem health*. Report prepared for the Central West Catchment Management Authority.

Kerle, A (2009), *Managing rangeland vegetation with fire: a literature review and recommendations.* Report prepared for the Western Catchment Management Authority.

McHenry, M (2009), *Management of white cypress pine on the North Western Slopes*. University of New England.

Tighe, M, Reid, N, Wilson, B and Briggs, SV (2009), Invasive native scrub and soil condition in semi-arid south-eastern Australia. *Agriculture, Ecosystems and Environment*, 132, 212–222.

Flowering punty bush

Management principles and planning

Controlling invasive native scrub (INS) is central to land management in western and central NSW. Prevention and intervention by landholders is often needed to maintain a balanced mosaic of open pastures, woodlands and denser areas.

The cost of time, fuel, labour and/or machinery however means that INS treatment can be an expensive exercise.

Furthermore the cost of inappropriate treatment or no ongoing management strategy can be higher still, with landholders citing examples of INS becoming denser and more widespread due to ineffective management.

It is important then to approach INS management in a strategic and integrated manner. This section outlines the principles that landholders should consider when developing their INS management strategy.

Landholders should also be familiar with the legislative environment surrounding INS management and talk to Local Land Services staff early in the planning stage.

In this section:

Planning integrated invasive native scrub management

An integrated strategy for managing invasive native scrub (INS) links together a range of treatments to capitalise on the advantages and minimise the disadvantages of the individual methods. This approach achieves results that cannot be reached by a single method alone.

An integrated management strategy is not simply about trying different control methods but rather developing a well-planned program of treatment and ongoing management to achieve a desired landscape.

Your regional Local Land Service (LLS) can provide information about best practice in your area and can advise on how to manage INS within current legislative guidelines. The following points outline the on-farm planning needed to create and implement an effective INS management strategy.

1. Map INS areas

Draw a property map that shows INS affected areas for each paddock. Local Land Services can provide a baseline for the map.

2. Identify the degree of INS on your property

On your map identify:

- open paddocks without INS
- areas with isolated INS
- areas with scattered INS
- areas of dense INS.

When mapping, it is desirable to estimate the shrub densities so that the costs of control can be determined. The species of shrub should be also recorded as each responds differently to the various treatments.

Likewise the age structure of the shrub population should also be noted – are the shrubs all young, mixed ages, all mature, mostly seedlings? These factors have an important bearing on the likely success of the various treatment methods.

3. Evaluate treatment methods

Treatment options should be viewed as components or tools of an INS control program. The program should be flexible enough to accommodate unforeseen circumstances such as changes in prices and seasons. Several treatment methods may be required. For instance, dense INS may require mechanical thinning to allow pastures to grow and become fuel for a management burn.

Different stages of INS encroachment and INS species should be recorded and mapped as part of your planning.

4. List priorities

The next step is to outline priority areas for treatment. Areas that may be priorities based on cost of treatment and production benefit are (highest to lowest):

1. open paddocks with emerging INS – monitor for signs of INS encroachment and treat when small (i.e. less than 50 cm)
2. scattered shrubs and small clumps of INS
3. moderate densities of INS
4. dense areas of INS.

Some properties have reached the stage where there is virtually no open country left. Landholders in this situation should still place priority on where INS should be managed.

Examples of high priority areas may include:

- around watering points
- holding paddocks
- stock laneways
- fence lines
- around buildings
- country with greatest production potential after treatment.

5. Prepare a post-treatment management strategy

INS management is not one-off, and post-treatment management is essential for rehabilitating INS into perennial native pastures and open woodlands.

A post-treatment management strategy is paramount for successful rehabilitation of native groundcover. The strategy should include:

- re-establishing native perennial grasses and other native groundcover
- controlling total grazing pressure
- providing alternative grazing for domestic stock during treatment of the area
- follow-up treatments
- the future grazing regime for the treated area
- monitoring the treated area in a practical way.

LLS and other local extension staff can provide advice on these aspects of post-treatment management in addition to the material contained in this resource.

6. Cost and schedule your program

By undertaking a detailed costing of each priority, it is possible to schedule the INS treatment program to fit in with the yearly budget and best time for treatment. Erratic or unpredictable rainfall must be considered and planned for.

INS management work needs to be integrated into property management. Treating INS to create a mosaic environment and managing further encroachment is fundamental to maintaining healthy and productive land in western NSW.

References and resources

Information in this resource has been drawn from a number of sources, including the following publications:

Tatnell, B (1993), Integrated woody weed management strategies. In Harland, R. (ed). *Managing for woody weed control in Western NSW*. Woody Weeds Task Force. pp 6-8.

WEST 2000. *Perennial pasture management plan for woody weed control.*

Woody Weed Task Force. *Code of Practice for the Management and Prevention of Scrub Dominated Landscapes* - Draft Management Guidelines.

Invasive native scrub seedling management

A priority for invasive native scrub (INS) management is to keep open areas open.

Land managers with areas of INS encroachment should look for seedling growth of INS species and consider how they will respond. Seedlings of INS species can be difficult to see in the pasture. Often landholders do not notice them until they get 'their eye in', and then they are everywhere.

If seedlings are emerging, then landholders should consider their management options in controlling this growth, particularly to stop encroachment into open country.

There is a window of opportunity to effectively manage this growth. Generally landholders need to control seedlings within two years – before the plants develop a woody base. After that, control is harder and typically involves more expensive management options.

Seasonal conditions for INS recruitment

Widespread germination of many INS species occurs after prolonged rain, with moderate temperatures, high humidity and low evaporation. These conditions occur only periodically, so widespread germination of INS is an episodic event.

Conditions affecting seedling survival are of greater importance than conditions for germination in influencing large-scale encroachment. Seedling survival and establishment are dependent on conditions in the seasons immediately following germination, particularly the first summer.

If a wet summer follows a major germination event then large numbers of seedlings often survive. If the first summer is dry then survival depends on competition from other vegetation. Without follow-up rain during summer, hopbush seedlings in vigorous stands of the grass woollybutt, for example, do not survive. If grasses are absent, however, more than 80% of these seedlings are likely to survive the first summer.

Summer-growing perennial grasses can provide competition to suppress shrub seedlings when the first summer after germination is dry.

Herbage that grows in winter does little to suppress seedlings following an autumn germination; although herbage can reduce the amount of water available for the seedlings in the following summer.

A variety of INS seedlings establishing - pine (top), turpentine and bimble box (middle) and yarran (bottom).

INS seedling identification

It is important that landholders are able to recognise seedlings of INS species to help alert them to seedling germination and establishment, and take appropriate action.

In good seasons INS seedlings can be easily overlooked among the growth of grass and herbage. In the past, many graziers have been surprised when what they considered to be a good paddock of grass suddenly became a young pine forest as the seedlings were exposed by subsequent grazing.

Early recognition of seedlings and subsequent monitoring of their growth allows early intervention techniques to be applied before they reach a stage where they can no longer be removed cheaply.

INS species can best be controlled when they are less than 50 cm high. Therefore timely identification and appropriate management are critical to suppress encroachment.

Also the decline of pasture production due to woody encroachment is highest at low levels of shrub cover. This is another reason to remain vigilant to the establishment of INS seedlings.

Opportunities to manage INS are rare so must not be wasted.

Managing INS seedling growth

INS management programs which concentrate on seedlings should wait until after the first summer following emergence, as a dry summer can kill most seedlings. If seedlings are not killed by a dry summer, landholders should implement a management program as soon as possible, as the plants are far easier to control at the seedling stage.

Encroachment of INS can be controlled by careful management. INS can be most economically treated at an early stage when shrubs are small or at low densities. Seedling management may involve a range of treatments, integrated to provide the best INS management for the area and circumstances.

Some areas will be more suited to control by burning, others to grazing or herbicides. Landholder should consider the range of management options available and choose appropriate treatments.

References and resources

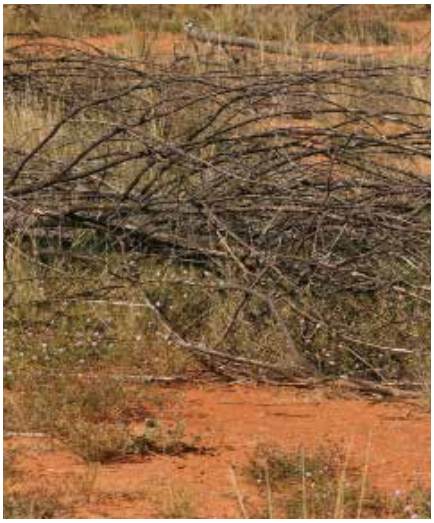
Information in this resource has been drawn a number of sources, including the following publications:

Harland, R (ed.) (1993), Managing for woody weed control in western NSW. Woody Weeds Task Force, Dubbo.

Jacobs, S (ed.) (1989), *A graziers' guide to bimble box-pine country of western New South Wales*. Soil Conservation Service of NSW.

Scriven, R (ed.) (1989), *A graziers' guide to belah-bluebush country of western New South Wales*. Soil Conservation Service of NSW.

Improving soil health



Soils need careful management

The Cobar Peneplain has ancient soils that have been weathering for millions of years. They are hard setting, and often have low amounts of organic matter and carbon, low nutrient levels and moderate water infiltration capacity. This means careful ongoing management is essential for healthy functional soils.

Healthy soils are essential to productive and sustainable agricultural systems. Groundcover, pasture production, livestock carrying capacity, water infiltration, erosion and other processes are all driven or regulated by overall soil condition.

Soils in invasive native scrub areas have low herbage cover

Soils under invasive native scrub (INS) are often different from soils in non-INS areas. They have lower herbaceous groundcover, which reduces livestock carrying capacity, lowers the production potential of land, and reduces habitat diversity.

INS can both be a cause and result of degraded soils. Through competition for resources (e.g. water, nutrients, sunlight) and a lack of litter recycling, INS may impede the functioning of the soil. Bare and eroded soils will have little perennial groundcover to compete with the establishment of INS species when seasonal conditions suits INS recruitment.

Research undertaken by the University of New England on soil function shows us that when compared with soils in open woodlands, soils in INS areas:

- have less herbage cover
- are harder crusting
- are more acidic
- have less carbon and lower biomass of soil microbes.

Soils in INS areas often lack seed banks of grasses and forbs, and herbage cannot compete with shrubs for water.

Improving soil condition through groundcover management

Improving aspects of soil health following INS management depends on encouraging groundcover.

Patchy groundcover is characteristic of the Cobar Peneplain and other rangeland areas. High levels of total groundcover may be difficult to achieve. However the patchiness can be managed to improve soil health.

Run-off and sediment production (erosion) are greatest from long bare areas up and down slopes. Slowing water velocity in these large bare areas will help in the establishment of patches of groundcover, reducing erosion risk. Waterspreading is one example of this.

Small bare areas can help maintain patches of denser groundcover. If they are upslope of grassy patches, they provide run-off and nutrients to these areas.

Landholders should aim to keep bare soil to less than 30% of ground area by improving pasture cover. In addition to pasture cover, fallen timber and leaf litter can help achieve this goal.

Top: Soils under INS often have less herbage cover, are harder crusting, are more acidic and have less carbon and lower soil microbe biomass than soils from non-INS areas.

Middle and bottom: Fallen timber, branches and leaf litter can be managed along with pasture to help keep the ground less than 30% bare.

Management tips for soil health

Traditional cultivation such as disc ploughing often leads to a 'plough pan' about 10 cm below the soil surface. This compaction reduces water infiltration, water retention and herbage production. Alternative cultivation practices such as minimum or no tillage will help prevent this.

Soil pH is low under INS. As soil pH decreases, many nutrients become less available to plants. This limits herbage production and groundcover. Therefore managing country with INS should include soil pH testing. This will give an indication of nutrient availability and turnover, as well as limitations to plant growth that are not related to water. In areas that have previously been managed for INS and groundcover establishment has been difficult, soil pH should be examined in conjunction with managing run off. If soil pH in these areas appears to be a limiting factor in pasture establishment, agronomic approaches to ameliorating soil acidity should be considered.

Managing country with INS should include pH and responding appropriately. The cause of acidic soil under INS is not known yet, but short-term management to counter acidic soils may aid in improving groundcover.

Grazing management is vital in managing groundcover. Grazing pressure from feral, native and domestic animals needs to be considered when managing the total grazing pressure on an area for native pasture establishment.

References and resources

Information in this resource has been drawn from the following publication:

Tighe, M, Reid, N, Wilson, B and Briggs, SV (2009), Invasive native scrub and soil condition in semi-arid south-eastern Australia. *Agriculture, Ecosystems and Environment*, 132, 212–222.

The potential for run-off (white arrows) under INS due to low groundcover, compared with the effect of groundcover (with interspersed patches of herbage and bare soil) on breaking up flow in managed INS country.

Mosaics in the landscape

Mosaic landscapes occur when patches of different vegetation types or vegetation states (such as grasslands, woodlands and shrublands) exist together.

Generally these different vegetation types are actually different states of the same ecosystem. For example, under certain conditions grasslands can become shrublands, and shrublands can become woodlands.

All vegetation types may make unique and important contributions to the biological diversity and ecological health of any invasive native scrub (INS) affected landscape.

Invasive native scrub landscapes as mosaics

Western and central west NSW is a mosaic landscape that has been influenced and altered by human activities.

The relative amount of each vegetation type in the landscape has changed over time, and some vegetation types have been altered.

Various categories of vegetation states on the Cobar Peneplain can be defined. One group of states can be defined as follows:

1. Pasture with no trees – The ground layer is used for agricultural production and/or grazing and there are just a few widely scattered trees or no trees at all. The ground layer is often perennial native pasture that is occasionally cropped and thus may be in a pasture phase or a crop phase.

2. Pasture with trees – Open woodland, sometimes scattered trees, where the ground layer is used for agricultural production and/or grazing as above.

3. Open scrub – Open shrubland or shrubby woodland (shrubs with a scattered overstorey of trees), where clusters of trees and/or shrubs are evident but are distinctly separated by open ground which may have a grassy ground layer.

4. Closed scrub – Dense shrubland and/or shrubby woodland, where the tree and shrub cover is more uniform, without obvious open areas. Dense regeneration of some tree species, like white cypress pine, falls into this vegetation type.

5. Open woodland – Woodland in which there is an overstorey of trees with a sparse to open shrub layer, often with a groundcover of perennial native pasture.

The variation and patterns of these five vegetation types in INS-affected landscapes arise from a combination of soil characteristics, and disturbances across time and space.

Examples of the five main vegetation types in INS affected landscapes from top to bottom: (a) Pasture no trees, (b) Pasture with trees, (c) Open scrub, (d) Closed scrub and (e) Open woodland. Photos: Veronica Doerr

The ground cuckoo-shrike is one of the most striking and easily observed of the bird species that live in grasslands.

Scrublands are particularly high in insect-eating birds, like the tiny yellow-rumped thornbill (middle) and the much larger white-bellied cuckoo-shrike (bottom).

Disturbance makes the mosaic

Natural mosaic landscapes most commonly occur in arid and semi-arid areas, where changes from one successional stage to the next happen following disturbance.

The most common natural types of disturbance are fire, grazing by native species, and unpredictable pulses of rainfall and nutrients (for example, when flooding of a dry creek bed brings nutrients into the surrounding flooded land).

Because these disturbances tend to occur patchily through the landscape, there are patches of the different successional stages. Humans can also create mosaic landscapes by adding new vegetation types and disturbances to the mix, for example by cropping, grazing with livestock or introducing feral grazing animals like goats.

Sometimes, the specific way in which the vegetation types are combined may increase or decrease the biodiversity and long-term sustainability of the landscape.

Managing for mosaic landscapes

The first step in managing a property as a mosaic landscape is to plan how INS should be managed to achieve the mosaic landscape. Mosaic landscapes usually include two or more:

- pasture areas (possibly with some cropping) with no trees
- pasture areas (with some cropping) with scattered trees (sometimes at density of open woodland)
- open scrubland that has clumps of shrubs with open areas in between
- closed scrubland that lacks open areas
- open woodland with native groundcover and no cropping.

A mixture of vegetation types

All vegetation types may make unique and important contributions to the biological diversity and ecological health of INS-affected landscapes.

Research by CSIRO in INS affected landscapes has found that:

- each of the five vegetation states contained unique bird species (i.e. that were not in the other vegetation states)
- each vegetation state contained some species of conservation significance
- open scrubland had the highest number of bird species, followed by closed scrub.

While open scrubland and closed scrubland contained a greater diversity of birds, agricultural areas were still important to native species. Agricultural areas supported different birds than scrubland areas did, particularly species that usually live in native grasslands. For example, dense white cypress pine regrowth is habitat for the Gilbert's whistler, while the brown songlark prefers open areas.

This means that the healthiest landscapes are not those completely filled with scrub. Balance is needed to ensure a range of habitats is available.

The research suggests that two vegetation types may be slightly more important for native birds than the others:

1. Agricultural paddocks that contain plenty of scattered trees (similar to open woodland) are increasingly rare in the region, however they support several bird species that were rarely found in other vegetation types.
2. Open scrubland was found to support the greatest number of bird species, particularly where the open areas between clumps of shrubs still had a healthy grass layer.

Planning for a mosaic that contains both of these vegetation types (as well as some pasture areas with no trees and some closed scrubland) will help maintain a healthy ecosystem.

A good cover of native grasses and herbs will also provide important habitat, can reduce the establishment of INS seedlings through competition for resources and provide fuel for management burns.

While all vegetation types contribute to a healthy mosaic, there is some evidence that pasture areas with a reasonable density of scattered trees (top) and open scrublands with grassy spaces between clumps of shrubs and trees (bottom) are particularly important for birds.

An excellent cover of grasses provides good native pasture and good quality habitat for native grassland bird species.

References and resources

Information in this section was prepared by Veronica Doerr and Jacqui Stol, CSIRO Sustainable Ecosystems, based on the report:

Doerr, VAJ, Doerr, ED, McIntyre, S, Howling, G, Stol J, Davies, M, Drew, A, Warren, G and Moore, D. (2009), *Managing INS landscapes for improved ecosystem health*. Report prepared for the Central West Catchment Management Authority.

Cropping and grazing management

The spread of invasive native scrub (INS) is regarded as one of the major problems threatening the pastoral lands of western NSW.

Over the past 40 years several methods of controlling INS have been evaluated with varying degrees of success. One successful method has been mechanical clearing. However, the cost of mechanical clearing can be prohibitive under the economic reality of the area. Therefore, many landholders believe that opportunistic cropping is the only economically viable way of treating INS and regenerating native perennial grasses.

An Industry and Investment NSW and the Western Catchment Management Authority funded a project to evaluate the benefits of opportunistic cropping in the rehabilitation of native grasslands.

Through this work paddocks that had been cropped for 20–25 years were surveyed in the Western CMA (now Western Local Land Services) section of the Cobar Peneplain. Groundcover and botanical composition were measured and used to assess the response to clearing and cropping.

The surveyed paddocks were placed in four categories based on cropping history and grazing management:

1. paddocks with INS that were never cleared and cropped but were adjacent to cropped paddocks (not cleared)
2. paddocks that were last cropped 15 years or more (now with INS)
3. paddocks that were set stocked when not in crop
4. paddocks that were either rotationally or lightly grazed when not in crop.

The study found that there was less than 30% groundcover in paddocks under INS. This figure is the same under INS regrowth and under paddocks that were set stocked (see Figure 1). Perennial grass made up less than 8% of groundcover under INS, INS regrowth and set stocked paddocks.

However the groundcover was nearly 50% in post-cropping paddocks that were lightly/rotationally grazed. The difference in groundcover between lightly/rotationally grazed paddocks and the other three categories was due to an increase in perennial grasses (see Figure 1).

Low groundcover in paddocks with INS regrowth (top) and that were grazed heavily under set stocking (bottom)

The 2007-08 summer rainfall significantly contributed to the impressive establishment of the perennial grasses when paddocks were rotationally grazed. However, paddocks that were set stocked however had considerably less perennial groundcover before the rain and did not exhibit any increase in perennial grass establishment despite receiving the same amount of rainfall.

This project emphasised the need for producers to be actively involved in post-cropping management. It is not enough to clear and crop once, and then continue to graze paddocks as usual. As well as rotational grazing, it may be necessary to crop paddocks again with minimal soil disturbance. This can be done using pasture cropping – a farming system where a winter cereal is simultaneously grown with summer active native perennial grasses. Because of their differing growing seasons, it is believed that these species would maintain groundcover throughout the year.

Re-establishment of INS was observed in paddocks that were heavily grazed and devoid of groundcover. It can be safely surmised that had these paddocks had good perennial grass cover, shrub seedlings could have faced competition.

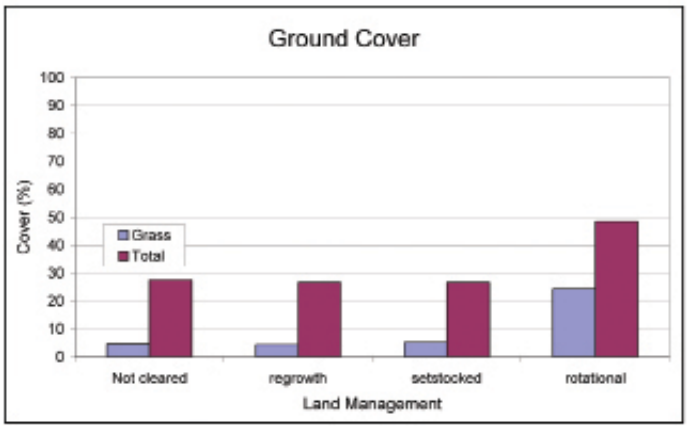


Figure 1: Total and perennial groundcover (%) under the four different land management categories.

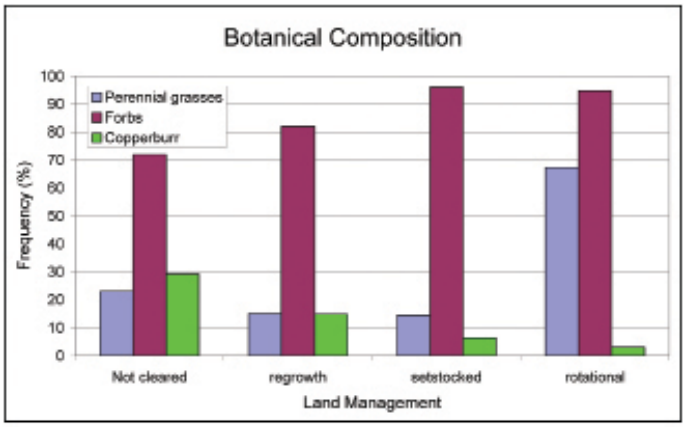


Figure 2: Frequency of the major pasture components that were significantly affected by land management

Photos of the same paddock taken in November 2007 (top) and March 2008 (bottom)

If the following seasons were to be wet, those shrub seedlings would establish and be harder to control without substantial expense.

The project also found that:

- forbs, perennial grasses and copperburr were the major species groups affected by cropping (see Figure 2)
- the frequency of less desirable species such as copperburr significant declined due to cropping and more so when paddocks were grazed rotationally
- the frequency of forbs increased by around 25% due to clearing and cropping, but was not affected by post-cropping grazing management
- standing dry matter increase from about 100kg/ha under INS (both uncleared and regrowth) to about 300 kg/ha in continuously grazed paddocks and to about 1100 kg/ha when paddocks were grazed rotationally
- rotationally grazed paddocks had higher organic carbon than the INS and regrowth INS paddocks.

Heavily grazed paddock with INS seedling growth after the 2007-08 summer rain

The dominant grasses in six paddocks spread over five properties included species such as mulga Mitchell, curly Mitchell grass, woollybutt, neverfail, panicum and digitaria. The presence of desirable perennial grasses that have not been observed for a long time was a revelation to landholders.

The results from this project indicate that cropping is a viable tool in controlling INS and restoring perennial grasslands, and that the major desirable native perennial grasses have seeds available in the soil seed pool waiting for the right conditions (both climatic and management) to germinate even after long periods of apparent absence.

Rotationally grazed post-cropping paddock that contained several of the desirable perennial grasses

References and resources

Information in this section has been drawn from a number of sources, including the following publications:

Alemseged, Y (2009), *Evaluating opportunistic cropping for control of INS and restoration of native perennial grasslands in western NSW*. Industry & Investment NSW

Alemseged, Y (2009). *Cropping helps control scrub and restore native grasslands*. Western Division Newsletter, number 126, pp. 24-25. Industry & Investment NSW.

Coolabah acting invasively

Identifying key invasive native scrub species

Over 40 native plant species are recognised as invasive native scrub (INS) in NSW. This section profiles 12 key species that occur in the Central West and Western Local Land Services regions.

This may change over time so please refer to your Local Land Service for an up-to-date listing.

In this section:

Bimble Box

Scientific name:	*Eucalyptus populnea* subsp. *bimbil* (Myrtaceae)
Also known as:	Poplar box

Description

Bimble box is a rapidly growing, medium-sized tree 8 to 20 m in height. It has light grey, flaky bark with dark green, round, glossy leaves. Flowers are whitish and occur in clusters of 4-7 in late summer. They develop into ovoid fruit 4-5 mm in diameter.

It is common throughout the hard red country in western NSW, particularly on the deeper soils of the plains and drainage lines. In the soft red country it is less common and tends to occur mainly along watercourses and in small drainage depressions or 'sinks'. Bimble box is associated with cypress pine, grey box or red box and mulga.

Growth

Bimble box establishes periodically following favourable climatic conditions.

Management notes

- Seedlings are generally unpalatable to livestock, but may be eaten during drought.

Early (top) and developed (middle) bimble box INS establishment

Bimble box regrowth

Mechanical

- Mechanical treatments, such as chaining, are often not effective as most trees sucker readily (the two- or three-trunked form of the tree is a relic of ringbarking in the late 1800s and early 1900s).
- A heavy-duty blade plough can control regrowth, although several deep ploughings are often necessary to gain good management.

Fire

- After a fire bimble box re-grows from suckers and seedlings. However, two successive autumn fires will control resprouters and seedling establishment.

Herbicide

- A number of chemical treatments have been documented as effective against bimble box.

Goats

- Goats can be used to control this species when plants are small. Care must be taken as overstocking may result in damage to the pasture.

Growth-locked bimble box INS

Multi-stemmed bimble box following ringbarking. Note the original ringbarked stem fallen to the left.

References and resources

Information in this resource has been drawn a number of sources, including the following publications.

Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Queensland Department of Natural Resources and Mines.

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Jacobs, S (ed.) (1988), *A graziers' guide to the bimble box-pine country of western New South Wales*. Soil Conservation Service of NSW.

Broad-leaf hopbush

Scientific name: *Dodonaea viscosa* subsp. *spatulata*
(Formerly *Dodonaea viscosa* var. *arborescens*)
(Sapindaceae)

Description

Broad-leaf hopbush is a tall, sticky, hairless, bushy shrub, 2-3 m high, with resinous stems covered with thin reddish bark. It flowers late winter-spring.

It is mainly found in the east of the NSW rangelands with isolated occurrences in the central west. It commonly occurs on shallow stony soils of hillslopes and ridges, and especially in disturbed areas along roads.

Growth

Broad-leaf hopbush regenerates mainly from seed and has very high seed production. Seed loads are dropped in late spring to early summer and germinate over a range of temperatures (16-22°C). Seed germination is also promoted by fire.

Rainfall that starts seedling growth is related to periods of high humidity and low evaporation (often occurring late autumn/winter). It is the following summer rainfall, temperatures and evaporation that decide the survival of seedlings.

Broad-leaf hopbush seedlings rapidly develop a dual root system – a substantial lateral root system reaching between 12-140 cm below the soil in mature plants, and a taproot to a depth of 120-140 cm when mature. The lateral system starts developing four to six weeks after germination and this rapidly increases during week 14 along with shoot development.

Shoots regenerate from the base of stems but not from roots.

Mature shrubs are drought hardy and will survive and grow throughout drought however, landholders in western NSW have observed that seedlings are killed by drought.

Broad-leaf hopbush seedlings establishing

Management notes

- May be heavily browsed by stock when there is little available herbage.
- Hopbush should be controlled before the end of winter or before its annual seed set, so the seed bank is not replenished.
- Waiting until the passing of the first summer after germination to implement control techniques will allow the heat and possibly a lack of rain during summer to kill off many seedlings.
- Minimising soil disturbance will allow growing pasture to compete with hopbush seedlings, reducing the ability of seedlings to emerge and establish.
- It has been found that although germination may be greatest on non-grassed areas, survival through the pre-summer period is greatest on grassed areas. This situation is reversed during autumn, with grass competing with germinating shrubs. It is critical in a management plan to allow a significant quantity of grass to remain over the summer period, as good competition may lead to a decrease in the establishment of hopbush seedlings.
- If hopbush is treated during a good season, the pasture will compete with regenerating stands and provide a decent fuel load for burning. Best results are achieved by resting pastures from grazing after treatment until grass has re-established.
- Landholders in western NSW have observed that broad-leaf hopbush is a relatively easy INS species to treat. It is easily removed by ploughing, water logging and fire.

Mechanical

- Mechanical methods of control provide high-cost short-term gain. However, hopbush readily re-establishes, requiring follow-up management.
- Chaining is likely to break off the tops of shrubs, leaving taproot and lateral roots intact and allowing the shrub to re-sprout.
- Blade ploughing may be effective as it severs the root system below the butt of the shrub, providing less chance for the shrub to re-shoot. Landholders in western NSW have observed that broad-leaf hopbush is easily removed by ploughing.
- Follow-up treatment (e.g. burning) must be considered to control regrowth and emerging seedlings promoted by soil disturbance.

Fire

- While mature shrubs can be resistant to fire, burning can eliminate or substantially reduce overall hopbush populations.
- Fire can promote seed germination, so follow-up fires (within five years) are usually necessary to eliminate establishing seedlings. Two successive autumn fires have been shown to control re-sprouting shrubs.
- Burning before hopbush seedlings reach maturity will ensure that the seed bank is not replenished.
- If a succession of fire treatments can be implemented, the effect could last for up to 30 years.

Goats

- Goat grazing has been used in western NSW to successfully control broad-leaf hopbush. Care must be taken as overstocking may result in damage to the pasture or an increase in less palatable species.

Broad-leaf hopbush (above and below)

Various immature broadleaf hopbush plants

References and resources

Information in this resource has been drawn from a number of sources, including the following publications.

Brooke, G and McWhirter, L (2006), *The glove box guide to plants of the NSW rangelands*. NSW Department of Primary Industries.

Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Queensland Department of Natural Resources and Mines.

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Harland, R (ed). (1993), *Managing for woody weed control in Western NSW*. Woody Weeds Task Force, Dubbo.

Jacobs, S (ed.) (1989), *A graziers' guide to bimble box-pine country of western New South Wales*. Soil Conservation Service of NSW.

Scriven, R (ed.) (1989) *A graziers' guide to belah-bluebush country of western New South Wales*. Soil Conservation Service of NSW.

Budda

Scientific name:	*Eremophila mitchellii* (Myoporaceae)
Also known as:	False sandalwood, sandalwood

Description

Budda is a shrub to about 3 m, or a tree to 9 m high with aromatic leaves and branchlets that are hairless or sparsely downy at the ends. Bark is rough, dark-brown to almost blackish, with a regular pattern of oblong segments. White or cream bell-shaped flowers occur mainly in spring, with a secondary flowering in autumn. An occasional flower may be seen at any time.

Budda grows on sandy loam and clay loam red earths, red brown earths and duplex soils, and is common beneath bimble box, white cypress pine, wilga, gidgee and leopardwood. It is found mainly in the east of the NSW rangelands, extending to Hillston in the south. It is less frequent in the west, occurring about as far west as White Cliffs.

Growth

Seed is the main mode of budda establishment however, it can regenerate from a swelling of the trunk just below the soil surface if damaged. Seedling establishment is encouraged by a lack of pasture competition, often typical of overgrazed areas. Budda develops a central trunk when young and has a lifespan of 50-100 years. Budda is drought-resistant and survives fire very well when mature, re-sprouting readily. It also recovers well after ringbarking or cutting.

Budda seedling

Management notes

- Overgrazing can reduce the vigour of perennial pastures, allowing budda seedlings to establish and to increase in abundance.
- Control of outlying shrubs before they seed (at approximately 0.75 m in height) is important in limiting encroachment over open areas.

Mechanical

- Chaining is not particularly effective due to the ability of budda to re-sprout. If budda is chained follow-up treatment is necessary.
- Blade ploughing is documented as being 95% effective at a depth of 20 cm however, it is an expensive treatment and is generally only considered viable for the treatment of specialised areas or smaller areas of dense INS.
- Stick raking is not as effective as blade ploughing but it is much more affordable, so it is a more viable option for treating large areas.
- Grubbing can be effective.
- Landholder experience in western NSW suggests following mechanical treatment with grazing by goats.

Fire

- Fire is an effective treatment for budda seedlings (before they develop a woody base).
- Following fire, budda may become dominant if it is able to establish in the sites vacated by other more fire-sensitive INS species, so mechanical treatments can be appropriate.
- Fire is also considered a useful follow-up treatment, and is often essential when controlling budda. Shrubs are most susceptible to two successive autumn fires with a reported 80% mortality.

Herbicide

- Herbicide treatments are more effective on younger plants. Higher applications are required on older plants and secondary chemical treatments are often necessary. Low dosage chemical rates are effective as a secondary treatment, especially as an autumn application, giving a 90-100% kill. The effectiveness of chemical treatments can be increased when applied in combination with other forms of treatment. The disturbance of plants in spring (via mechanical or fire treatments), followed by a secondary chemical treatment in autumn will result in high shrub mortality.

Goats/sheep

- Very heavy grazing by sheep or goats has in some cases been successful in reducing the density of budda. However, care must be taken as overstocking results in depletion of the pasture and therefore lack of competition for re-establishing budda and also lead to an increase in less palatable species.

Various budda plants

Budda in flower

Budda sprouting from roots

Mature budda

References and resources

Information in this resource has been drawn from a number of sources, including the following publications.

Brooke, G and McWhirter, L (2006), *The glove box guide to plants of the NSW rangelands*. NSW Department of Primary Industries.

Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Queensland Department of Natural Resources and Mines.

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Harland, R (ed). (1993), *Managing for woody weed control in Western NSW*. Woody Weeds Task Force, Dubbo.

Jacobs, S (ed.) (1989), *A graziers' guide to bimble box-pine country of western New South Wales*. Soil Conservation Service of NSW.

Scriven, R (ed.) (1989), *A graziers' guide to belah-bluebush country of western New South Wales*. Soil Conservation Service of NSW.

Green turkey bush

Scientific name:	*Eremophilia gilesii* (Myoporaceae)
Also known as:	Desert fuchsia

Green turkey bush

Description

Green turkey bush is a low, compact shrub, usually less than 1 m high. It has spreading, multi-stemmed branches, which are covered by alternate leaves that secrete a sticky resinous substance. Flowers are pale-blue to purple and a deeper blue, rarely white, and can occur any time of year but usually in winter-summer.

Green turkey bush is usually found in soft-hard mulga and sandplains.

Growth

Large germinations often occur after winter rainfalls.

Management notes

Mechanical

- Slashing, breaking up the soil, and severing the root system by ploughing, blade ploughing, chaining and stick raking have successfully controlled turkey bush.
- Chaining alone has not been reported to be very successful in reducing turkey bush populations however, when used in combination with burning, chaining has been reasonably successful. This is because the chaining reduces the initial shrub population enough to grow a grass fuel load to burn the established and germinating plants.
- Waterspreading has been successful in managing turkey bush as it encourages growth of grasses which compete with turkey bush seedlings. It is extremely effective when used in combination with fire, and also helps to maintain the integrity of the ecosystem.

Herbicides

- Herbicide treatments have been shown to be successful on green turkey bush, and are most effective if applied when plants are growing. This is when the chemical is most readily absorbed.

Fire

- Green turkey bush is extremely susceptible to fire, especially young seedlings.
- Burning should be carried out whenever the opportunity arises, however the best time to burn is during late winter to early spring, using a well-carrying fire.

References and resources

Information in this resource has been drawn from a number of sources, including the following publication:

Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Queensland Department of Natural Resources and Mines.

Mulga

Scientific name: *Acacia aneura* (Mimosaceae)

Description

Mulga is a tall shrub or small tree, to 8 m high, greyish-blue in colour. It has leaves of variable size and shape that are covered in minute downy hairs. Its bright yellow flowers may occur at any time of the year, usually following suitable rain.

Mulga is found mostly in sandplains, dunefields and rolling pediplain country with red earths, as well as mountain ranges with stony and skeletal soils. It sometimes occurs on areas with heavier soils that are subject to periodic flooding. Mulga is adapted to infertile, acidic soils. It is often associated with the native shrub green turkey bush (*Eremophila gilesii*).

Growth

Regeneration is episodic.

Management notes

- Mulga is regarded as one of the best western fodder trees, and is also valuable for the shade and shelter it provides. However, if behaving invasively it forms a dense, almost impenetrable scrub.
- The tree is relatively shallow-rooted, and in dense stands pasture growth is precluded or at least severely restricted.

Mechanical

- Chaining, selective pushing and blade ploughing have proven to be successful methods in opening up areas of thickened mulga.

Fire

- Mulga is extremely susceptible to fire, especially young seedlings.

Mulga seedling

Middle and top: Thick mulga INS

References and resources

Information in this resource has been drawn from a number of sources, including the following publications.

Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Queensland Department of Natural Resources and Mines.

Harland, R (ed). (1993), *Managing for woody weed control in Western NSW*. Woody Weeds Task Force, Dubbo.

Jacobs, S (ed.) (1989), *A graziers' guide to bimble box-pine country of western New South Wales*. Soil Conservation Service of NSW.

Scriven, R (ed.) (1989), *A graziers' guide to belah-bluebush country of western New South Wales*. Soil Conservation Service of NSW.

Narrow-leaf hopbush

Scientific name:	*Dodonaea viscosa* subsp. *angustissima* (Formerly *Dodonaea attenuata*) (Sapindaceae)

Description

Narrow-leaf hopbush is a spreading, slightly sticky shrub, usually 1-2 m high, although occasionally growing to 5 m. It is multi-stemmed and hairless except for the flowers, which occur mainly in spring/summer.

Narrow-leaf hopbush is widespread and common in the NSW rangelands and is found chiefly in deep sandy soils, particularly in disturbed areas, in a wide variety of vegetation types.

Growth

Narrow-leaf hopbush produces many seeds, but they survive only a few years in soil. Seed loads are dropped in late spring to early summer and germinate over a range of temperatures (16-22 °C). Major germination events follow prolonged rain periods. Seedlings are susceptible to drought and commonly die if their first summer is dry.

Management notes

- It is relatively unpalatable, with sheep browsing it only as a last resort. However, it is eaten by goats. Care must be taken with goat grazing as overstocking results in damage to the pasture.
- Management of outlying shrubs, particularly those less than 1 m tall (i.e. before they begin seeding) is important to limit encroachment over open areas.
- Hopbush should be controlled before the end of winter or before its annual seed set, so the seed bank is not replenished.
- Waiting until the passing of the first summer after germination to implement control techniques will allow the heat and possibly a lack of rain during summer to kill off many seedlings.
- Minimising soil disturbance will allow growing pasture to compete with hopbush seedlings, reducing the ability of seedlings to emerge and establish.

Narrow-leaf hopbush

- It has been found that although germination may be greatest on non-grassed areas, survival through the pre-summer period is greatest on grassed areas. This situation is reversed during autumn, with grass competing with germinating shrubs. It is critical in a management plan to allow a significant quantity of grass to remain over the summer period, as good competition may lead to a decrease in the establishment of hopbush seedlings.
- If hopbush is treated during a good season, the pasture will compete with regenerating stands and provide a decent fuel load for burning. Best results are achieved by resting pastures from grazing after treatment until grass has re-established.
- Landholders in western NSW have observed that narrow-leaf hopbush a relatively easy INS species to treat through fire. It is easily removed/ killed by water logging and fire, and is grazed by goats.

Mechanical

- Mechanical methods of control provide high-cost short-term gain. However hopbush readily re-establishes, requiring follow-up treatment.
- Chaining is likely to break off the tops of shrubs, leaving taproot and lateral roots intact and allowing the shrub to re-sprout.
- Blade ploughing may be effective as it severs the root system below the butt of the shrub, providing less chance for the shrub to re-shoot.
- Follow-up treatment (e.g. burning) must be considered to control regrowth and emerging seedlings promoted by soil disturbance.

Fire

- Fire kills seedlings and most adult plants, and can be used to manage encroachment of this shrub if there is sufficient grass fuel, particularly when the plants are young.
- Fire can promote seed germination, so follow-up fires (within five years) or alternative treatments (e.g. grazing) are usually necessary to eliminate establishing seedlings. Two successive autumn fires have been shown to control re-sprouting shrubs.
- Burning before hopbush seedlings reach maturity will ensure that the seed bank is not replenished.
- If a succession of fire treatments can be implemented, the effect could last for up to 30 years.
- Grazing management is important following fire. If large quantities of grass are allowed to remain during dry summer periods in competition with seedlings, the seedlings can become stressed and die.

Goats

- Narrow-leaf hopbush is eaten by goats and readily killed by heavy goat grazing especially under drought conditions. Grazing heavily enough to kill the shrub (i.e. complete defoliation) will also have a major effect on the grass layer but with reasonable seasons and rest it will regenerate if originally in reasonable condition. Care must be taken as overstocking may result in damage to the pasture or an increase in less palatable species.

Narrow-leaf hopbush seedling

References and resources

Information in this resource has been drawn from a number of sources, including the following publications.

Brooke, G and McWhirter, L (2006), *The glove box guide to plants of the NSW rangelands*. NSW Department of Primary Industries.

Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Queensland Department of Natural Resources and Mines.

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Harland, R (ed). (1993), *Managing for woody weed control in Western NSW*. Woody Weeds Task Force, Dubbo.

Jacobs, S (ed.) (1989), *A graziers' guide to bimble box-pine country of western New South Wales*. Soil Conservation Service of NSW.

Scriven, R (ed.) (1989), *A graziers' guide to belah-bluebush country of western New South Wales*. Soil Conservation Service of NSW.

Punty bush

Scientific name:	*Senna artemisioides* subsp. *filifolia* (Formerly *Cassia eremophila* var. *eremophila*) (Caesalpiniaceae)

Description

Punty bush is an erect shrub, 1-3 m high. It flowers mainly in late winter/spring. Punty bush resembles silver cassia but can be distinguished by the number of pairs of leaflets – punty bush has two pairs, while silver cassia has three or more

Punty bush is found throughout the NSW rangelands, mainly on red loam and sandy loam soils beneath mulga, bimble box, white cypress pine and red box. It is also sometimes found in undulating country and on rocky ridges and footslopes.

Punty bush has increased markedly in western NSW since European settlement, thickening and encroaching over extensive areas of grassland and open woodland.

Growth

Punty bush is a prolific seeder. Seed germinates after adequate rains at any time of the year. Because there are a lot of seeds in the soil, there is always a potential for replacement plants. It is a reasonably fast growing but short-lived (10 years or so) shrub.

Punty bush seedlings germinating

Flowering punty bush

Management notes

- Moderate susceptibility to fire, particularly juvenile plants however, some regeneration by re-sprouting and from seedlings may occur following fire. This will be a problem only if the seedlings survive their first summer.
- Seedling density can be reduced by a long period of heavy intermittent stocking with sheep. Use of goats at a moderate stocking rate can also be successful. Care must be taken as overstocking may result in damage to the pasture.

References and resources

Information in this resource has been drawn from a number of sources, including the following publications.

Brooke, G and McWhirter, L (2006), *The glove box guide to plants of the NSW rangelands*. NSW Department of Primary Industries.

Harland, R (ed). (1993), *Managing for woody weed control in Western NSW*. Woody Weeds Task Force, Dubbo.

Jacobs, S (ed.) (1989), *A graziers' guide to bimble box-pine country of western New South Wales*. Soil Conservation Service of NSW.

Scriven, R (ed.) (1989), *A graziers' guide to belah-bluebush country of western New South Wales*. Soil Conservation Service of NSW.

Silver cassia

Scientific name:	*Senna artemisioides notho* subsp. *artemisioides* (Formerly *Cassia artemisioides*) (Caesalpiniaceae)

Description

Silver cassia is a shrub 1-2 m high. It has whitish to grey-green leaves, usually with 4-6 pairs of leaflets, and flowers mainly in late winter/spring. Silver cassia resembles punty bush but can be distinguished by the number of pairs of leaflets – punty bush has two pairs, while silver cassia has three or more.

Silver cassia is found throughout the northern two-thirds of the NSW rangelands. It is less common in the east and generally absent from the floodplains in the north-east. Silver cassia grows in bimble box, red box and white cypress pine on level and undulating country with red earths; on sandplains with mulga, belah-rosewood and mallee; and on rocky ridge and footslope areas with currawang.

Flowering silver cassia

Growth

Silver cassia can seed prolifically after wet conditions. It is quick growing but relatively short-lived (about 10 years).

Management notes

- *Senna* species can become the dominant vegetation after clearing, suppressing pasture and groundcover.
- Silver cassia is rarely browsed. The pods may be eaten by sheep and goats.

Immature silver cassia

Mechanical

- Mechanical treatments (especially those which disturb the soil) are likely to result in re-sprouting and further germination of *Senna* species.
- Mechanical treatments may be used in combination with fire to encourage the growth of grass to be used as a fuel load.

Fire

- Prescribed burning during autumn is the most cost-effective method of *Senna* control. This involves burning the thickened area at least twice (more burns may be required) within a time period of 10 years.
- Although fire may promote the germination of the hard-coated *Senna* seeds, a follow-up burn will deplete the seed bank.
- Fire can promote suckering.

References and resources

Information in this resource has been drawn from a number of sources, including the following publications.

Brooke, G and McWhirter, L (2006), *The glove box guide to plants of the NSW rangelands*. NSW Department of Primary Industries.

Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Queensland Department of Natural Resources and Mines.

WEST 2000. *Perennial pasture management plan for woody weed control*.

Turpentine

Scientific name:	*Eremophila sturtii* (Myoporaceae)
Also known as:	Narrow-leaf emu bush

Description

Turpentine is a sticky, hairless shrub, 1-4 m high, with slender branches and dark grey finely fissured bark. It is generally multi-stemmed and has pink, bell-shaped flowers, mainly in spring although flowers may be present throughout the year. It has strong smelling leaves that are generally not browsed by stock.

Turpentine

Turpentine seedling

Resprouting turpentine

Turpentine can be found over much of the NSW rangelands, on sandy and loamy red earths in mallee, mulga and bimble box; solonized brown soils in belah-rosewood woodlands, with numerous other shrub species. It is not found on alluvial soils of any of the major floodplains.

The shrub may occur as widely scattered plants, in small colonies, or in dense infestations covering large areas.

Growth

Germination from seeds is episodic. Seedlings need a succession of wet summers to survive and reach maturity. Young plants grow slowly but a deep taproot appears early making even juvenile plants very drought resistant. Once established, the plants are long lived (at least 50 years and probably more than 100 years). Turpentine also regenerates rapidly from roots if disturbed.

Management notes

- Rarely grazed by any animal, even in times of acute feed shortage.
- It is one of the most difficult INS species to manage, with successful management of other species potentially leading to widespread turpentine infestation on a treatment site.
- Overgrazing can reduce the vigour of perennial pastures, allowing turpentine seedlings to establish and to increase in abundance.
- Control of outlying shrubs before they seed (at approximately 0.75 m in height) is important in limiting encroachment over open areas.

Mechanical

- Chaining is not particularly effective due to the ability of turpentine to re-sprout. If turpentine is chained follow-up treatment will be necessary.
- Blade ploughing is documented as being 95% effective at a depth of 20 cm however, it is an expensive treatment and is generally only considered viable for the treatment of specialised areas or smaller areas of dense INS. Landholder experience in western NSW notes that two ploughings will kill 90% of turpentine regeneration after treatment.
- Stick raking is not as effective as blade ploughing but it is much more affordable, so it can be a more viable option for treating large areas with appropriate follow-up.
- Grubbing can be effective however, it is important to recover the roots of turpentine once it has been lifted from the ground, to help prevent the plant from re-shooting.

Fire

- Fire is an effective treatment for turpentine seedlings (before they develop a woody base). However, only 10-20% of adult plants will be killed by a single fire (due largely to their resprouting ability). The conditions that favour seedling growth also favour grass growth, providing fuel for management burning. Fire is a useful follow-up treatment when controlling turpentine, and is often essential. Shrubs are most susceptible to two successive autumn fires with a reported 80% mortality.

Herbicide

- Herbicide treatments are more effective on younger plants. Higher applications are required on older plants and secondary chemical treatments are often necessary. Low dosage chemical rates are effective as a secondary treatment, especially as an autumn application, giving a 90-100% kill. The effectiveness of chemical treatments can be increased when applied in combination with other forms of treatment. The disturbance of plants in spring (via mechanical or fire treatments), followed by a secondary chemical treatment in autumn will result in high shrub mortality.

An example of turpentine's deep taproot

References and resources

Information in this resource has been drawn a number of sources, including the following publications.

Brooke, G and McWhirter, L (2006), *The glove box guide to plants of the NSW rangelands*. NSW Department of Primary Industries.

Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Queensland Department of Natural Resources and Mines.

Cunningham, G (2008), *Listening to the Managers.* Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Cunningham, GM, Mulham, WE, Milthorpe, PL and Leigh, JH (1992), *Plants of western New South Wales*. Melbourne: Inkata Press.

Harland, R (ed). (1993), *Managing for woody weed control in Western NSW*. Woody Weeds Task Force, Dubbo.

Jacobs, S (ed.) (1989), *A graziers' guide to bimble box-pine country of western New South Wales*. Soil Conservation Service of NSW.

Scriven, R (ed.) (1989), *A graziers' guide to belah-bluebush country of western New South Wales*. Soil Conservation Service of NSW.

WEST 2000. *Perennial pasture management plan for woody weed control.*

White cypress pine

Scientific name:	*Callitris glaucophylla* (Cupressaceae)
Also known as:	White cypress

Description

White cypress pine is a straight-trunked, medium-sized tree usually growing up to 20 m high. It has rough bark and needle-like aromatic green leaves, and woody cones that separate into six segments at the base to release hard-winged seeds.

White cypress pine generally occurs on sandy or loamy soils as they are well drained.

Growth

Regeneration from seed is often slow, but white cypress pine can survive for over 100 years.

White cypress pine can become 'locked'. When there is a major germination event, the trees slow their growth in response to competition for resources.

A growth-locked pine thicket

Management notes

- Fire is considered the best form of management for regenerating or young seedlings of white cypress pine, although trees of all sizes are usually killed by fire.
- Fire often gives close to a 100% control. The main factor determining survival after a fire is the intensity and duration of the fire at the base of the trunk.

White cypress pine seedlings

- In severely burnt areas seed production from any surviving trees may be negligible for up to seven years after the fire.
- In the absence of fire, white cypress pine may develop into very dense stands, with groundcover almost completely excluded.
- Maximising groundcover is an effective way of managing white cypress pine regeneration. Grazing must be planned carefully to ensure that groundcover is not reduced to a level at which more seeds can get to the ground and regenerate.
- Active management of locked up stands of white cypress pine is necessary to increase groundcover and litter under the trees, increasing soil health.
- Landholder experience in western NSW suggests white cypress pine can be controlled using mechanical treatment followed by goats, by fire and by cultivation. Periodic cultivation controls this species by removing/killing seedlings. Experience also suggests it takes a lot of grazing to kill this species once it gets higher.

References and resources

Information in this resource has been drawn from a number of sources, including the following publications.

Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Queensland Department of Natural Resources and Mines.

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Jacobs, S (ed.) (1989), *A graziers' guide to bimble box-pine country of western New South Wales*. Soil Conservation Service of NSW.

Wilga

Scientific name: *Geijera parviflora* (Rutaceae)

Description

Wilga is a medium-sized tree that grows to 9 m in height. It has a large, dense canopy, with pendulous branches that often reach ground level. The shiny, dark-green leaves have a prominent midrib and are dotted with oil glands. Small, white, 5-petalled flowers occur in winterspring. Wilga fruit are small (4-5 mm in diameter) and globular.

Wilga occurs throughout western NSW, except in the far north-west. It usually occurs on calcareous red clay loams and calcareous sandy soils. It is found scattered through belah-rosewood and bimble box woodlands, and can be dominant over smaller areas.

Growth

Wilga is usually found in mixed woodland communities, although it may also occur in dense local stands.

Management notes

- Can be a problem along fence lines, as seeds are spread in bird droppings
- Eaten by both sheep and goats
- Establishes in cleared areas
- Will grow in chained areas if a secondary treatment is not applied.

Left, top and above: Various stages of Wilga

References and resources

Information in this resource has been drawn a number of sources, including the following publications.

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Cunningham, GM, Mulham, WE, Milthorpe, PL and Leigh, JH (1992), *Plants of western New South Wales*. Melbourne: Inkata Press.

Yarran

Scientific name: *Acacia homalophylla* (Mimosaceae)

Description

Yarran is a small tree 7-10 m in height that often grows in thickets. It has yellowish-green leaves with 3 prominent veins. The leaves are often curved, and tipped with a small curved point. Pods are broad, thin-walled and slightly curved. Flowers are golden yellow in globular heads and occur in late winter/spring.

Yarran is common in the eastern half of western NSW. Although it can be found on many soils and among many types of vegetation, yarran mainly occurs on solonized brown soils growing with belah and rosewood, and red earths in bimble box communities.

Yarran foliage

Growth

Yarran regenerates periodically and suckers readily. It occurs as single trees, in small groups or in dense communities. It is multi-stemmed in its early growth stage, becoming single-trunked when it is about 2 m high. It develops into a bushy-topped tree similar to myall (*A. pendula*). Older trees have rough bark and wide-spreading branches.

Yarran thickening

Management notes

- Can be a problem along fence lines, as seeds are spread in bird droppings.
- Foliage is not readily eaten by stock, although it is highly palatable to goats and will be browsed by sheep and cattle in dry times.
- In western Queensland chaining has been used to control yarran, however other INS species (such as mulga and budda) establish in the treated areas unless an additional treatment (such as fire) is applied.

References and resources

Information in this resource has been drawn from a number of sources, including the following publications.

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Cunningham, GM, Mulham, WE, Milthorpe, PL and Leigh, JH (1992), *Plants of western New South Wales*. Melbourne: Inkata Press.

Noble, JC (1997), *The delicate and noxious scrub.* Canberra: CSIRO Division of Wildlife and Ecology.

Treating invasive native scrub

Successful invasive native scrub (INS) management programs are long-term and generally do not rely on one treatment method. A program that integrates a range of treatments and follow-up is most effective to control INS to rehabilitate native pastures and open woodlands.

In this section:

Invasive native scrub treatment options at a glance

Method	Advantage	Disadvantage
Management burning	• Cost effective over large areas • All species susceptible when young i.e. < 50 cm • Kills some mature shrubs and improves visibility • Pasture response may be rapid	• Infrequent opportunities because of seasonal/fuel condition requirements • Response depends on shrub species and size • The area may have to be destocked before the fire and will have to be destocked after the fire • Risk of erosion after fire
Blade ploughing	• Shrubs are removed • Pasture response may be rapid • Pasture can be sown at the same time • Can be done at any time	• Very high cost • Soil disturbance may stimulate INS seedling germination and requires follow-up treatment • Inadequate blade depth will make the problem worse • Risk of erosion
Chaining	• Large shrubs are removed • Pasture response may be rapid • Improved chance of management burn • Can be done at any time • Timber can be left on the ground to protect pasture regeneration	• High cost • Can stimulate INS seedling germination and regrowth • Essential follow-up is expensive • Can be non-selective • Risk of erosion
Double chaining	• Shrubs are removed • Improved pull out • Less regrowth to treat • Easier to introduce pasture • Timber can be left on the ground to protect pasture regeneration	• High cost • Material tends to ball up and reduced ability to burn • Small shrubs aren't removed • Risk of erosion
Crocodile seeding	• Low erosion • Seed bed created in pits • Pasture response may be rapid • Cheap knock down of mature bushes • May stimulate sufficient fuel growth for fire	• Temporary knock down • Stimulates regrowth • Very low kill of shrubs
Stick raking	• Shrubs are removed • Pasture response may be rapid • Reduce rabbit harbour	• High cost • Stimulate regrowth • Will not kill sprouting species (turpentine)
Manual grubbing	• Low cost • Plant specific • Can be done by any family member • Bushes killed • Useful for areas of scattered shrubs	• Only plants under 50 cm can be treated • Slow

Mechanical grubbing or 3 point linkage cutter bar/ blade plough	• Low cost • Plant specific • Bushes killed • Useful for areas of scattered shrubs • Timber can be left on the ground to protect pasture regeneration	• Plants over 1 m need to be pushed over then grubbed on both sides from the centre of the plant • Grubbing is not raking. It is a specialised piece of equipment.
Cultivation/ cropping	• Shrubs are removed • Pasture response is rapid • Cash crop to recoup initial costs • Possibility of using a sharefarmer to minimise risk • Stubble retention aids pasture establishment • Ploughing destroys INS roots	• High cost • Erosion/decline in soil structure • Risk of crop failure • Without fertiliser soil fertility drops rapidly, although high soil fertility may limit recruitment of native perennial grasses.
Pasture and grazing management	• Minimal soil/wind erosion • Increased animal production • Increased opportunity for management burns • Increased drought preparedness • Reduced INS seedling survival	• Pasture management and perennial groundcover will help limit INS establishment but alone will not prevent it, depending on the season.
Goats	• Reduced total grazing pressure with better fences if managed correctly • Suited to dense stands of edible species, e.g. hopbush, punty bush and mulga	• Not all species are eaten by goats and may lead to increase in unpalatable INS • Very likely to damage pasture, especially perennial groundcover, and soil • Needs long rest periods afterwards • Fencing costs are very high
Herbicide	• Minimal erosion risk • Effective on all species • Chemicals are very specific • Does not require specialised equipment • Dead standing shrubs may protect pasture regeneration	• High cost and labour intensive • Loss of some pasture • Loss of non-target species • Effectiveness linked to regrowth and plants actively growing • Response depends on shrub species and size

References and resources

Information in this resource has been drawn from:

Tatnell, B (1993), Integrated woody weed management strategies. In Harland, R, (ed). *Managing for woody weed control in Western NSW*. Woody Weeds Task Force. pp 6-8.

WEST 2000. *Perennial pasture management plan for woody weed control.*

Blade ploughing

Why use blade ploughing to manage INS?

Blade ploughing uses a flat blade set below the soil surface pushed or dragged by a tractor or bulldozer to destroy the root structure of heavy INS. For treating relatively small areas of INS blade ploughing has been shown to be an effective INS treatment if done correctly and appropriate follow-up performed.

When blade ploughing sprouting INS species, such as turpentine, it is essential that the blade be at least 30 cm below ground. When treating non-sprouting species (seeders) such as hopbush, a large germination of plants will occur and it is essential that the seedlings be controlled. Likewise any regrowth of sprouting species will need to be managed.

While results have been variable for sprouting INS species, the treatment results in an initial high mortality of mature shrubs for non-sprouting INS species, and has been shown to be an effective method of controlling mature INS in the western region of NSW.

Any area blade ploughed should be destocked until after the grasses have established and preferably set seed.

An example of a blade plough set-up

This site was blade ploughed with little follow-up, demonstrating the need for ongoing management.

Best application

Blade ploughing is effective for treating INS species that re-shoot from the base (e.g. budda) and non-sprouting species (e.g. narrow-leaf hopbush).

While undertaking blade ploughing in dry soil will achieve the highest mortality, it is best undertaken when the soil is moist and clods evenly. In this way, the soil is not too hard so suitable penetration and speed of operation can be achieved, while minimising the possibility of wind erosion.

It is best performed in sandy/loamy soil. Soil in dense INS areas may be low in grass seed. While grass seed may become available from movements across the landscape, new seed may need to be introduced.

It is essential a strong healthy grass be established in the treated area to complete with any new seedling and act as a fuel for a fire if needed.

Limitations

- Extremely expensive
- Causes major disturbance to the soil and is an erosion hazard
- Return to stable pasture can take some time
- Follow-up treatment will be necessary
- Not effective in soils with a shallow hard pan or which set hard as they hinder penetration and do not allow the plough to operate at an effective depth (although in some cases these soils can be effectively ploughed when moist).

Where does blade ploughing fit in to an INS management plan?

This treatment is best suited to high value areas and isolated stands.

To achieve good results blade ploughing should be combined with grazing management and other techniques as part of an integrated management program.

Operational notes

Depth

Blade ploughing is effective at any depth for species that do not readily re-sprout, e.g. narrow-leaf hopbush.

To minimise regeneration of re-sprouting species (e.g. budda and turpentine) shrubs should be cut off below the first lateral roots. A minimum depth of 30 cm (12 inches) should be maintained for these species. Ploughing at the appropriate depth can achieve greater than 90% mortality. Where correct depth has not been maintained, mortality of less than 70% can be expected.

An example of a blade plough with a seeder attached

Plough model

With a number of blade plough models on the market, choice of model is an important consideration. For effective and cost-efficient blade ploughing the model should:

- be able to maintain correct depth
- be able to plough through target species without damage or being jolted sideways
- have good trash flow
- be matched to the tractor.

Site blade ploughed for INS treatment (left) with adjacent untreated INS

Site blade ploughed for INS treatment

Pasture establishment

Limited options are currently available to landholders wishing to sow pastures in conjunction with blade ploughing however, seed boxes can be fitted to ploughs to enable a one-pass operation.

Because blade ploughing has a very high mortality rate for existing INS plants, rehabilitation of the treatment site will be faster if nucleus areas of perennial pasture species are left unploughed. Shrubs on these areas could be targeted with a different option such as herbicide.

Management of grazing pressure after ploughing is essential to enable establishment of natural or sown pastures.

It is essential a perennial pasture be established within two years of treatment.

Landholder experience

Blade ploughing was used to remove dense patches of larger saplings on the property. Whole paddocks were not treated – only densely invaded areas. After the blade ploughing, any invading INS seedlings were spot sprayed with herbicide on a regular basis.

Blade ploughing had an immediate significant impact on budda, turpentine and hopbush shrubs on the Cobar Peneplain, however in the absence of any further treatment INS was once again a major problem within eight and a half years.

References and resources

Information in this resource has been drawn from a number of sources, including the following publications:

Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Qld Department of Natural Resources and Mines.

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Harland, R (1993), Blade ploughing for woody weed control. In Harland, R (ed). *Managing for woody weed control in Western NSW*. Woody Weeds Task Force. pp 16-18.

WEST 2000. *Perennial pasture management plan for woody weed control*.

Chaining

Why use chaining to manage INS?

Chaining is one of the most widely used of the mechanical INS control measures. It involves dragging a thick heavy chain between two tractors or bulldozers to pull down thick INS.

Chaining can be performed using a single chain or by hocking two chains together, one behind the other. An area can also be treated twice by dragging the chain one way and then dragging it over the same area in the opposite direction.

Chaining is a relatively cheap first treatment and does not significantly disturb soil or destroy existing pasture compared with more intensive treatments. Fallen timber provides the added advantage of a protected environment for grass and herbage seeds to establish.

The chained timber can provide an excellent source of fuel in the years following chaining. The fuel can be used in a follow-up burn to control regrowth and whipstick pine that was missed in the chaining. When burning, leaving chained scrub in situ will help distribute nutrients and reduce acidity across the site rather than concentrate nutrients in windrows.

Livestock management can be improved after chaining by putting in stock access tracks.

Chaining is also a way to enable browse to be brought into reach of grazing goats.

Chaining can be a suitable way to treat:

- large shrubs
- land to be used for cultivation
- mature hopbush on grazing land.

It can also be used as an initial treatment to improve the effectiveness of other treatments such as grazing and burning.

Sites chained both ways for INS treatment with high broadleaf hopbush mortality and good groundcover response. Note post treatment hopbush germination.

Limitations

- Chaining does not kill many smaller (< 2 m) shrubs and slender saplings, particularly white cypress pine, which often bend under the chain and then remain in place with little or no setback to growth.
- Not suitable for use in dry soil and/or in areas where an erosion hazard would be created.
- Low mortality of some species (e.g. *Eremophia* spp., *Cassia* spp.)
- Difficult to be selective
- There can be a considerable impact on livestock management, with mustering made very difficult and logs on the ground restricting access
- The fallen timber can harbour rabbits and foxes
- There will be significant regrowth if the area isn't chained both ways.

Large areas of INS in the Western Division have been chained with no follow-up performed, and many of these areas are now worse than they were before chaining.

Where does chaining fit in to an INS management plan?

Chaining is generally viewed as a short-term strategy. When used alone it has a poor success rate, as much INS re-sprouts or re-establishes after treatment. Additional treatments are necessary to increase success.

Many landholders use crocodiles to introduce pasture seed into chain-treated areas. In most areas there is a fast pasture response.

Chain used for INS treatment

A site chained for INS treatment with good groundcover response

Operational notes

Initial treatment

Chaining should be carried out while soil is moist to maximise effectiveness. The bole of the shrub needs to be thick enough so that it does not bend over and spring back up after the chain passes over or snap off without pulling the roots from the ground. Two-way chaining maximises mortality of shrubs from the initial treatment.

There is generally a high mortality rate among taller INS species and individual plants. However, their death reduces competition for the shrub layer that often re-sprouts or establishes as seedlings on the land disturbed by the chaining process.

Follow-up treatment

A secondary treatment needs to be applied within a relatively short time after chaining, otherwise scrub will regenerate from root suckers and/or seed to form a stand as dense, if not more so, than before the treatment.

Chaining cannot be repeated for several years after the initial chaining treatment, as the regrowth will not be high enough for chaining to be effective.

Re-sprouting species

Successful chaining of re-sprouting species, such as turpentine and budda, may require the paddock be used for cereals or sown pastures.

Landholder experience

Chaining can increase native perennial pasture production for up to five years after treatment (as a consequence of removal of competition, soil disturbance and greater rainfall infiltration). Without follow-up treatment, pasture production decreases after five years as INS re-grows, and after about 10 years there is reduced pasture production once again.

One estimate of the impact of chaining on sheep carrying capacity in the Cobar Peneplain was that carrying capacity changed from one sheep to 16 hectares to one sheep to four hectares for a period of about five years after chaining, and then carrying capacity decreased.

References and resources

Information in this resource has been drawn from a number of sources, including the following publications:

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Harland, R and Kelly, S (1993), Chaining for woody weed control. In Harland, R. (ed). *Managing for woody weed control in Western NSW*. Woody Weeds Task Force. pp 26-27.

WEST 2000. *Perennial pasture management plan for woody weed control*.

Crocodile seeding

Using crocodile seeding to manage INS

Crocodile seeding involves pulling an offset drum with shovel-like teeth over INS. It knocks down shrubs while introducing seed.

Traditionally a crocodile is used to increase water infiltration to encourage grass growth.

Limitations

- Temporary knock down of shrubs
- Very low mortality rates
- Can stimulate regrowth

Where does use of a crocodile seeder fit in to an INS management plan?

Even though it can have a low mortality rate of INS species, a crocodile seeder can give grasses a chance to establish in the short-term for a follow-up management burn.

Operational notes

Crocodile seeders are best used to introduce seed into areas without perennial grasses or an existing seed bank. This should be done when soil is moist to encourage native grasses establishing.

Landholder experience

Some landholders intend to knock down mature INS bushes, introduce seed, keep grazing stock off the area, burn in autumn and then treat any regrowth with chemicals.

Examples of crocodile seeders used for INS treatment

References and resources

Information in this resource has been drawn from a number of sources, including the following publications:

Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Queensland Department of Natural Resources and Mines.

WEST 2000. *Perennial pasture management plan for woody weed control.*

Cultivation and short-term cropping

Using cultivation and cropping to manage INS

Cultivation with cropping is an economical way to manage INS regrowth and restore native pastures, following treatment of the INS.

With appropriate grazing regimes, perennial groundcover establishes after INS treatment, cultivation and cropping. This provides forage for stock and fauna habitat. Cropping increases groundcover, allowing perennial native groundcover species to re-establish and can increase soil nitrogen. It also can allow gullied areas to be filled and sheet-eroded areas to become productive.

Ploughing destroys the root structure of re-sprouting INS species, meaning less regrowth.

Conservation farming practices such stubble retention help create an environment that traps grass seed and resources, and provide shelter for native pastures to establish. Research and landholder experience has shown that short-term cropping is a successful tool in restoring native perennial pastures only when appropriate post-cropping grazing management is employed. If paddocks are heavily grazed after cropping and devoid of groundcover, INS establishment is likely following wet years.

Short-term cropping for INS management

Limitations

The areas suitable to cultivation and cropping are limited to those with adequate rainfall. If rainfall is unreliable crops may not succeed. Rainfall in the Western Division is very unreliable, therefore there is a higher chance of crop failure. Also soil/land capability and slope will be a limiting factor.

If INS regrowth is still present after the first year, the area may need to be cropped for a second time to control this regrowth.

Soils that have a tendency to set hard or contain shallow pans should generally be excluded from ploughing operations.

Where does cropping fit in to an INS management plan?

Appropriate pasture and grazing management is essential to establish and improve native perennial pastures following cropping. INS will re-establish on heavily grazed land without healthy perennial groundcover.

Landholder experience

Initial removal of INS

Landholder experience in western NSW shows there are a number of ways to approach cultivation and short-term cropping. Specific landholders' approaches have included:

- Chaining/bulldozing INS on previously ringbarked country with INS between standing trees. Leave for six months to two years (up to 10 years if necessary) for fuel to develop and to obtain the benefit of grazing. Burn to reduce the amount of timber on the ground that has to be moved, then stick rake the remaining timber into windrows. Burn, stick rake, burn then level the ground surface and plough. Sow a crop of oats, triticale or barley.
- On some properties the treated area was not burned prior to pushing timber into the windrow.
- On some properties the period between initial chaining/bulldozing and burning was extended to allow a good bank of native seed to develop in the soil.
- If seedlings and suckers were not a problem, the first ploughing was deferred to obtain more value from the established pasture.
- The area being treated can be chained more than once to obtain benefit from native pastures before proceeding to ploughing and sowing.
- On one floodplain property the INS was treated by using a very heavy offset disc plough followed by stick raking, burning, ploughing and sowing.

Some landholders expressed concern about using disc ploughs to prepare the ground for the initial crop on the basis of its aggressive impact on soil structure and others now use to minimum tillage and direct drilling wherever possible – particularly drilling into stubble during the cropping phase.

Rotations

Many landholders aim to employ long rotations, and different combinations of INS treatment, sowing and pasture grazing have been implemented successfully. Decisions on rotation length and when to crop vary between regions and properties, but should consider:

- seasonal conditions
- market prices
- INS species present (e.g. re-sprouting or not) and degree of INS regrowth
- labour and machinery availability
- grazing and pasture management goals.

References and resources

Information in this resource has been drawn from a number of sources, including the following publications:

Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Queensland Department of Natural Resources and Mines.

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

WEST 2000. *Perennial pasture management plan for woody weed control*.

Dorper and Damara sheep

Using Dorper or Damara sheep to manage INS?

Dorper and Damara sheep are hardy meat sheep from South Africa that are suited to Australia's rangelands.

Both Dorpers and Damaras graze and browse a wide range of feed (pastures, shrubs and trees, including some INS species) so can be run on INS-affected grazing country. This allows INS to be treated and used as a productive resource, and the sheep control germinating and establishing INS seedlings.

Other advantages of running these breeds include:

- increased carrying capacity
- reduced cost of inputs with no shearing required (Dorpers)
- earlier turnoff of meat sheep.

Left and right: Dorper sheep can be used in an INS control program.

Limitations

Dorpers and Damaras only eat some INS species and can make an INS problem worse if stocked in such a manner that they just remove the palatable INS species (e.g. hopbush and mulga). If grazing is not managed correctly, budda and turpentine can establish. Turpentine establishment is especially enhanced when sheep remove all the plants competing for nutrients and moisture.

The sheep only graze up to sheep grazing height.

Heavy grazing is required to treat woody scrub using these breeds of sheep and this may result in long-term damage to perennial pastures unless an adequate period of rest is allowed after treatment.

Where do Dorper and Damara sheep fit in to an INS management plan?

Dorpers and Damaras can control emerging INS seedlings and regrowth, as well as browse to control established INS.

They can be useful where INS is dense so other options are unsuitable, e.g. where low levels of groundcover prevent burning opportunities, or where mechanical or chemical treatments are not cost-effective.

The sheep can open dense areas at relatively low cost. They browse scattered shrubs before denser patches. In opening up denser patches, pasture growth is encouraged and other treatments may be able to be used (i.e. fire).

As Dorpers and Damaras can only browse INS up to a certain height they have little significant impact in areas with tall INS. Chaining when the sheep have eaten most of the available browse is a good follow-up treatment. This controls the INS, and allows the full value of the INS resource to be obtained.

Operational notes

Secure fencing and provision of an adequate permanent water supply are essential if using Dorper or Damara sheep to control INS.

Without appropriate management, grazing by these sheep (as with all livestock) can lead to long-term land degradation as a consequence of their impact on groundcover.

Landholder experiences with Dorper and Dorper cross sheep (Dorper/Merino, Damara) suggests that the sheep only graze and browse INS when a good groundcover pasture is also available, so they are ideally run on a mix of open pasture country and INS.

References and resources

Information in this resource has been drawn from a number of sources, including the following publications:

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Damara Sheep Breeders Society of Australia Inc. **http://www.damaras.com.au/**

Dorper Sheep Society of Australia Inc. **http://www.dorper.com.au/**

Fire

Using fire to manage INS?

Management burning is the most effective overall method of managing INS seedling outbreaks and can also be used to reduce INS density in more mature stands. Management burning has the added advantage of minimising wildfire risks by reducing fuel loads.

Fire is most effective (up to 100% mortality) if used during the first two years after an INS germination event when seedlings are less than 30 cm high. Follow-up is often needed to control further germination.

In high grass years when INS is most likely to germinate, back-burning can provide better kill rates if enough fuel is available to carry a back-burn.

Experience has shown that white cypress pine, green turkey bush, mulga, narrow and broad-leaf hopbush, and punty bush are most easily killed by fire

Management burning in action

Limitations

Thick INS will not burn alone – there must be sufficient fuel underneath to carry a fire for a successful management burn. Waiting for adequate fuel to build up means that the opportunity to burn may be infrequent.

Building up fuel for an effective management burn and regenerating pasture post-burn may mean destocking the treatment area before and after the fire. This is not always practical, particularly on smaller properties.

Fire also enhances the germination of many INS species, so follow-up treatment is necessary.

Where does fire fit in to an INS management plan?

Landholder experience has shown that while good initial mortality rates of a number of INS species are achieved by burning, in many cases INS re-established. A one-off burn alone is not an effective tool to control INS, so follow-up treatments must be used.

Some landholders have used burning to buy time in an area encroached by INS to allow the establishment of appropriate watering facilities and fencing to allow control of total grazing pressure.

Operational notes

All appropriate fire permits must be obtained and adhered to.

Fuel load

A good body of fuel is necessary for a successful management burn, although the amount varies with type of plant, e.g. more fuel is required if grass is coarse (like wire grass) than if it is fine and compact (like spear grass).

Every leaf on the bush must be scorched to give a maximum death rate. Thus the fire must be intense enough to achieve this objective without running the risk of burning outside the planned area. Scorch height, however, is not the same as flame height. Leaves will be scorched to above the flame height by the radiant heat of the fire.

A successful burn across the desired area will be enhanced if there is a continuous layer of fuel over the paddock.

Experience has shown that grass makes the best fuel. Generally 900 to 1200 kg/ha of dry grass growing up to 30 cm high will ensure an adequate scorch height of invasive native scrub up to 3 m high. However, in semi-arid woodlands most grass grows in tussocks (clumps) and these must be close enough together, or have enough litter between them to ensure that the fire will carry across the paddock.

Fuel levels need only be sufficient to give the desired scorch height and allow for prompt and effective lighting up.

While seasonal condition is a large driver of pasture growth, grazing management is crucial to ensure that there will be enough fuel for burning. Grazing pressure from domestic, feral and native species reduces the frequency of burning opportunities, so managing total grazing pressure is an important preparation activity.

A McArthur Grassland Fire Spread Meter is a useful tool in planning a management burn.

INS response

Mortality varies between INS species. Research has shown mortality of 20-30% for established turpentine and budda, and 70-100% for hopbush, punty bush and cypress pine.

Mortality also depends on:

- the age of the INS being treated – older shrubs are more tolerant of fire than younger plants
- the density of the INS – dense INS often does not have enough fuel under it for an effective burn.

Burns in more open country with scattered juvenile INS are more successful than burns in areas where INS is dense.

Firebreaks

The type of firebreaks necessary in a particular situation depend on many factors. These include the type of fuel, the expected fire intensity, the amount of dead plant material that has been deposited in the windrow of the firebreak by the grader, the amount of labour and equipment available on the day of the burn and the management burning experience of the personnel involved.

When constructing firebreaks, it is important to guard against a build-up of excessive dead plant material in the graded windrow. If there is a build-up of plant materials such as dead shrubs, the burning leaves and embers may spot across the breaks during back-burning operations. If the windrow is to be turned into the paddock it is much safer to burn the windrows at night, well before the management burn. Preference would be to grade the windrow to the fence or away from the burn side.

In most situations, constructed breaks should be strengthened by back-burning on the burn day. Firebreaks can often be made by taking advantage of natural breaks such as clay pans, water courses or densely scrubbed areas without grass or ground fuel. Tidy breaks around fences protect them from fire and give better vehicle access for checking them and observing livestock.

In the Western Division there are guidelines for the construction of firebreaks. For further details please check with your Local Land Services office.

Before and after management burning

Equipment

When conducting management burns it is essential to check that all equipment is fully serviceable. All machinery should be tested several days before the burn to allow time for repairs.

Each mobile unit should carry a water tank and pump and be equipped with a UHF radio. Each unit should be individually identified and carry a map of the burn area with clearly identifiable positions marked on it, particularly the points where water is available and safety zones. Remember, a visiting neighbour who is helping with the burn will not know the paddock as well as the owner does.

If possible, each watering point should have its own pump for filling the units' water tanks.

For a full list of equipment you may require, contact your local Rural Fire Service (RFS) Captain or major centre. Instruments to measure wind speed, temperature and relative humidity are necessary and may also be obtained from the RFS. These measurements, together with a Grassland Fire Danger Meter, can predict fire intensity and rate of spread. Knowledge of these factors is vital for making sound decisions on lighting and managing the burn.

A very useful piece of equipment at a management burn is a grader; this can be quickly brought in for assistance if necessary.

Planning your burn – one to two years before burn

- ☐ Consider upgrading fencing to manage total grazing pressure from kangaroos and goats.
- ☐ Planning grazing management is essential. Destock the area to be burnt and make sure there is plenty of feed elsewhere to feed stock. Reducing overall stock numbers may be required.
- ☐ Check INS type to be burnt against fuel loads. For example, is there going to be enough fuel to burn 1m high cypress pine?
- ☐ Determine if any other treatment methods need to be used; any one method may not work on its own. Dozing/chaining may be required to flatten INS prior to burning.
- ☐ Herbicide treatment may be required if fuel loads are patchy and burning doesn't eliminate all seedlings.
- ☐ Determine the season that best suits the requirements. Autumn and spring burns are desirable.
- ☐ Establish photo points for monitoring of pasture and INS.
- ☐ Check with Local Land Services, Western Lands and other relevant authorities on permits and approvals that are required before burning can commence.
- ☐ Establish a check list so you can keep track of actions taken or other works required.

Planning your burn – months before burn

- ☐ Monitor fuel loads. Make sure you have enough grass and ground litter (900 to 1200 kg/ha) to carry a fire.
- ☐ A burn plan should be drawn up so people can understand what you intend to do and so others, like your neighbours, understand what may be required of them.
- ☐ Firebreaks should be constructed, not just around the burn area; other paddocks close by should have firebreaks as well. These breaks should also protect environmentally sensitive areas, riparian zones, and Aboriginal and historical sites.
- ☐ Identify what equipment may be required and where to obtain equipment, like a McArthur Grassland Fire Danger Meter or perhaps a quick-fill pump from the RFS.
- ☐ Check that all fire fighting equipment and vehicles are in working order.
- ☐ Are there adequate watering points close to the burn? Tankers may be required.
- ☐ Will there be enough people to assist on the day and possibly to patrol for several days after?
- ☐ Ensure knowledge of weather patterns for time of burn. Check Bureau of Meteorology (BoM) and other internet resources.
- ☐ Obtain a permit to burn (if in the fire danger period) and notify your neighbours and RFS of the approximate date you wish to burn.
- ☐ RFS Brigade captains should encourage as many members as possible to attend. INS burns are a good opportunity to gain skills and knowledge.
- ☐ A grader is a valuable piece of machinery to have on site for the day of the burn, so make arrangements for one to be on hand.
- ☐ Make sure you have appropriate cover – third-party, personal and property insurance.
- ☐ Identify and map your property (large aerial, land-sat, mud map), including:
  - *Assets* - buildings, structures
  - *Vegetation types* - INS areas, grazing areas (winter, summer)
  - *Environmentally sensitive areas* – threatened plants and animals or communities, historical or Aboriginal sites, etc
  - *Asset protection zones* - fire exclusion areas, safety areas
  - *Strategic firebreaks* - main tracks, roads, graded fence lines, rocky out crops
  - *Future and past burn areas*
  - *Any important features* on your neighbour's property (water, protected area).

Planning your burn – day of burn

The decision to burn or not has to be made on the day.

- ☐ Check weather conditions and BoM for the forecast of your area.
- ☐ Check firebreaks and equipment, and that water tanks are full.
- ☐ A briefing must be conducted with all personnel involved in the burn.
- ☐ Determine UHF radio channel and other forms of communications.
- ☐ Explain the lighting pattern to those involved.
- ☐ Maps must be supplied to all involved in the burn (map should have water points, control lines, radio channel, weather forecast, etc).
- ☐ If people are to be responsible for a designated area or role, others should be notified – e.g. western sector of fire (Bob), pump operator (Steve), grader driver (Dave).

Remember, visitors to your property will need to know your property like you do – the names of paddocks, tanks, landmarks and features could be confusing if things don't go right.

After burn

- ☐ Patrolling of the fire ground is essential, especially if there are heavy fuel loads near the fire edge. These should be extinguished if possible.
- ☐ Also, check for hollow trees on the fire edge that may have caught alight. Patrolling may have to continue for several days if weather conditions stay hot and windy.
- ☐ Check the interior of the burnt area to see if the burn was successful. You may need to light unburnt areas to kill all INS seedlings.

Year after burn

- ☐ Continue to monitor site for groundcover, plant species and density. The established photo points will be valuable for this.
- ☐ If rain has occurred shortly after the burn and grasses are returning quickly, short-term grazing could encourage plant growth, but make sure stock are removed before seed set. Leaving adequate groundcover will also help in preventing the survival of germinating INS seedlings.
- ☐ Monitoring should continue for germination of INS for several years, especially if a good wet season has followed the burn.
- ☐ Depending on INS species, grazing by goats may be beneficial (e.g. hopbush), but allow for grasses to re-establish first. Spot treatment with herbicides will also be beneficial for small outbreaks.

Post-burn management

Regenerating perennial grasses compete with emerging INS seedlings for moisture. Until the regeneration of protective groundcover occurs, burnt areas are particularly susceptible to wind and water erosion. Post-burn grazing management is important to let grasses re-establish.

The burnt areas should not be grazed by domestic stock until the predominant perennial pastures at the site have reached maturity and set seed at least once.

References and resources

Information in this resource has been drawn from a number of sources, including the following publications:

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Jessop, P (2009). *Management burning of invasive native scrub: Principles*. Industry & Investment NSW. **http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0010/276652/Management-burning-of-invasive-native-scrub-principles.pdf**

Jessop, P (2009). M*anagement burning of invasive native scrub: techniques*. Industry & Investment NSW. **http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/276660/Management-burning-of-invasive-native-scrub-techniques.pdf**

O'Shea, R (1993). *Management options – Fire*. In Harland, R. (ed). Managing for woody weed control in Western NSW. Woody Weeds Task Force. pp 37–38.

WEST 2000. *Perennial pasture management plan for woody weed control*.

Goats

Using goats to manage INS?

Goats can remove extensive amounts of foliage of palatable INS species under heavy grazing conditions. Where this kills shrubs, INS density is reduced. Where shrubs are not killed, the reduction in foliage can open the INS enough to allow pasture growth. Stocking goats to manage INS has the potential to yield income from animal products. However, optimal stocking rates for INS control may not result in a saleable product.

Management of goat grazing can also support a feral goat control program. There are a number of resources available to landholders to humanely control feral goats and these should guide any control program.

Goats regularly eat hopbush, mulga and cypress pine, although hopbush tends to be more heavily browsed as pasture levels decline. Mortality of hopbush is up to 90% after two or three years of heavy goat stocking. Mulga and pine are more resilient to repeated defoliation so mortality rates are much lower (e.g. 30% for mulga).

In western NSW goats have been recorded as eating emu bush, wattles and bimble box seedlings with some effect. Goats will occasionally eat punty bush and silver cassia.

Goats are effective in controlling whipstick pine. Larger mature goats can break off pine whilst pulling the plant down to graze the top of the young tree.

For adequate INS control it is essential that there is adequate fencing and water around the area to be treated.

Left and right: Goats will browse a number of INS species.

Limitations

Goats do not graze INS exclusively and they remove perennial grasses. Heavy grazing is required to kill woody scrub and this may result in long-term damage to perennial pastures unless an adequate period of rest is allowed after treatment. Total grazing pressure management and appropriate seasonal conditions are needed to recover pastures.

Goats only effectively control species that they find palatable (e.g. hopbush and mulga). Goats do not readily eat turpentine and budda. The density of unpalatable species can increase and become a huge problem as goats browse out the competing species.

The reproduction of turpentine (especially) can be enhanced by goats as they remove competition (both groundcover and woody vegetation) for nutrients and moisture.

Where do goats fit in to an INS management plan?

Goats are not appropriate in all situations, and for best results they should be integrated with other management options.

Goats may be useful where INS is dense and other options are unsuitable, e.g. where low pasture levels restrict burning opportunities, or where mechanical or chemical treatments are not cost-effective.

Goats will open dense areas at relatively low cost. They browse scattered shrubs before denser patches. In opening up denser patches pasture growth will be encouraged and other treatments may be able to be used (i.e. fire).

As goats can only browse INS up to a certain height they have little significant impact in areas with tall INS. Chaining when goats have eaten most of the available browse is a good follow-up treatment. This controls the INS, and allows the full value of the INS resource to be obtained.

Operational notes

Goat breed

Herds of goats used to control INS generally comprise trapped feral goats. The flock quality can be upgraded by introducing Boer bucks or selecting for characteristics to produce a better line.

Stocking strategies

Continuous pressure will result in the highest INS mortality. Strategies that give the shrubs a chance to recover will reduce mortality.

Sheep and cattle are often removed from the paddock during goat stocking. Some landholders add a small number of goats to their sheep flocks as part of their INS management strategy.

Goats have also been stocked at high levels for short periods in a 'crash grazing' strategy.

A 'deferred grazing' strategy involves resting the paddock from goat grazing at certain times of the year (e.g. after the first significant rain).

Another strategy is to stock goats in paddocks with INS and low pasture levels. In this situation goats have a more rapid impact on INS because they are immediately forced to consume large amounts of browse. Shorter stocking periods are required, so income forgone through not stocking sheep and cattle is reduced.

Goats can have a detrimental effect on groundcover if grazing is not managed correctly.

Effect of goat browsing on young pine

Stocking rate

Stocking rate depends on the amount of palatable browse and pasture levels in the paddock. When determining an appropriate stocking rate remember:

- There is a trade-off between a stocking rate that is most effective for INS control, and one that gives maximum goat production.
- Heavy stocking rates quickly reduce INS, but with greater risks of pasture loss, soil erosion and goat welfare.

Managing total grazing pressure

Good fencing is essential to manage total grazing pressure.

Electric fencing is becoming more widely used in western NSW. Electric fences need to be set up properly. If incorrectly set up, faults will short-out the fence and it will be ineffective.

In some instances fencing that allows feral goats to enter the paddock has been used to increase flock size. However, this fencing also allows kangaroos into the paddock, increasing total grazing pressure.

Overgrazing can damage pastures and lead to bare soil, and subsequent erosion and production problems. Soil and vegetation condition need to be carefully monitored, and goat numbers adjusted as necessary. Well fenced 'goat' paddocks allow strategic management of goats for paddock spelling.

Two critical times for pasture management are after rain and after goat stocking. Stocking levels should allow pasture to seed, and a period of spelling should follow goat stocking to allow pastures to re-establish and seed.

The left of the fenceline demonstrates goat impact on bimble box seedlings, pine seedlings and groundcover.

References and resources

Information in this resource has been drawn a number of sources, including the following publications:

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Harland, R (ed). (1993), *Managing for woody weed control in Western NSW*. Woody Weeds Task Force, Dubbo.

Jacobs, S (ed.) (1989), *A graziers' guide to bimble box-pine country of western New South Wales*. Soil Conservation Service of NSW.

Muir, S (1993), Woody weed management using goats. In Harland, R. (ed). *Managing for woody weed control in Western NSW*. Woody Weeds Task Force. pp 32-36.

Saunders, G, Sharp, T (2005), *Model code of practice for the humane control of feral goats*. NSW Department of Primary Industries

Scriven, R (ed.) (1989), *A graziers' guide to belah-bluebush country of western New South Wales*. Soil Conservation Service of NSW.

WEST 2000. *Perennial pasture management plan for woody weed control*.

Grubbing

Why use grubbing to manage INS?

Grubbing is a mechanical treatment where INS shrubs are uprooted using a 'grubber' attached to a tractor.

Grubbers have a relatively low horsepower requirement and can be a cost effective method of INS control.

Grubbing gives instant results and can be used at any time with minimal erosion risks. It does not kill non-target species, and the operator can easily see the treated area.

Grubbing is effective against all species but particularly those that re-sprout at the base (e.g. budda, turpentine, hopbush).

Limitations

Grubbing is very slow and difficult to use in dense stands of INS where access may be a problem.

Where does grubbing fit in to an INS management plan?

Grubbing is best used in light to medium density stands of INS where little time is spent driving between shrubs, and the density is not so great that there is a constant danger of staking tyres. Grubbing is also a useful treatment for areas of scattered INS shrubs.

Operational notes

Equipment

A number of models of grubber are available. A front-mounted grubber consists of a horizontal double-bladed steel cutting edge mounted on two steel uprights, which in turn are attached to a front-end loader equipped with hydraulics. The hydraulics allow the cutting block to rotate, assisting the uprooting of shrubs.

Operation

The grubber is driven into the ground at the base of the shrub and 'grubs' it out using the upward motion of the front-end loader and rotation action provided by the hydraulic ram. If the front-mounted grubber can cut in both directions, it also has the ability to remove shrubs from beneath trees.

Operation is easier when the soil is moist following rain. Little effort is required for shrubs less than 2 m in height.

References and resources

Information in this resource has been drawn from a number of sources, including the following publications:

March, N and O'Leary, C (1993), Mechanical grubbing for woody weed control. In Harland, R. (ed). *Managing for woody weed control in Western NSW*. Woody Weeds Task Force. pp 23-25.

WEST 2000. *Perennial pasture management plan for woody weed control*.

An example of a front-mounted grubbing unit

Herbicides

Using herbicides to manage INS?

Controlling INS species with herbicides allows effective management without large machinery, labour or risk of damage to other property. Herbicides are less disruptive to the soil than other techniques, and application can be carefully directed to target plants. The cover provided by dead INS has benefits for soil protection and grass establishment.

It is most economical to treat early stages of INS encroachment in order to maintain open pastures. When INS shrubs and trees are small, the return on money invested in treatment is quicker and the groundcover of a large area can be maintained.

If applying to the leaf or soil, herbicides should be used when the shrub or tree is actively growing and not moisture stressed.

Limitations

Herbicides may not be economical on dense stands.

Always read the label and use according to manufacturer's instructions.

Where do herbicides fit in to an INS management plan?

Herbicides are best used:

- to maintain open areas and contain the spread of dense clumps (by treating outliers)
- where it is impossible to use fire or mechanical methods, as using herbicide does not require destocking and pasture loss is minimal compared to fire or mechanical methods
- to initially treat coppicing or re-sprouting species, or as a follow-up after other methods
- to treat regrowth.

Coolabah treated through stem injection

Operational notes

Which herbicide?

Your local herbicide agent, Local Land Services officers and neighbours are able to advise which herbicide will work best on your property.

How herbicides work

Many popular herbicide products work by interrupting photosynthesis, causing shrubs to lose their leaves and exhaust root reserves. Control is gradual and is characterised by intermittent growth and die back. It may take the herbicide up to 18 months to kill the shrub. Herbicides work more quickly when the shrub is actively taking up moisture.

Application methods

Soil application involves a residual herbicide being placed on soil near the base of the shrub. Chemical is carried down into the soil by the first effective rainfall after application. Most of the herbicide is absorbed through the lateral roots just outside the drip line. The herbicide should be placed just outside the drip zone so that the leaf canopy does not interfere with rainfall and movement of herbicide into the ground. Over-application should be avoided as it can result in bare areas devoid of vegetation. Also, soil application should not be used on sandy soils as the herbicide may leach off-site and kill non-target species. This is particularly important when using water-soluble products.

Stem injection or cut stump application uses small amounts of chemical by applying it directly into the sap. This method does not depend on soil moisture to carry the chemical into the plant. It is, however, a labour intensive method and may not be feasible for species that are multi-stemmed such as turpentine.

Basal bark application involves mixing herbicide with diesel and applying it to the stem of the plant in a band at the base of the stem using a knapsack and drench gun. The herbicide is absorbed through the bark, effectively ringbarking the shrub.

With ***leaf application*** the herbicide is absorbed through the leaves and transported to the plant roots. The chemical is only absorbed under good growing conditions and is not effective when moisture stressed. A 'wetter' is sometimes mixed with the herbicide to help chemicals penetrate a waxy leaf. Full coverage of the plant is necessary for an adequate control. This is often hard to achieve for plant that is taller than the operator. Good results have been achieved on young regrowth.

Application timing

Timing of application when using stem injection is important for good control. Contrary to popular belief, autumn rather than spring is a better time for stem injection for the control of coolabah and bimble box.

Autumn applications of soil-applied chemicals have been reported as most successful. This coincides with the higher chance of rain and movement of carbohydrates from the roots to the leaves prior to a stage of dormancy in winter.

Leaf application can be restricted during the hotter months of the year as chemical uptake by the plant is poor. It is much cheaper to control a few shrubs than to wait until they are very thick and a major problem. Groundcover and productivity begin to decline quickly at greater than 20–30 shrubs per hectare.

Application rate

Much lower rates of chemical are required for stem injection in comparison to leaf and basal bark applications.

When treating regrowth use the label rate for the original height of the shrub and not the size of the regrowth. Label rates based on the size of the regrowth will not be enough when small regrowth is grown from old, large root systems.

Turpentine treated through herbicides

Landholder experience

An INS area was blade ploughed in 1990 and then left without any further treatment until mid-1998. By this time turpentine, budda and hopbushes had regrown and the shrub population (excluding any trees that were present or that had established) was between 43 and 812 per hectare, with spacing of 15 m to 3-4 m between plants.

In mid-1998 the site was treated with a number of herbicide compounds in a trial. The herbicides had a variable impact with most apparent kills after four months of 90-95%, although some were only 20-50%. Hopbushes were generally poorly affected by any of the treatments.

Six months after the herbicide applications the site was showing a considerable amount of re-shooting by the previously apparently dead shrubs. No further treatment was applied and by 2007 the treated areas was again overrun by INS.

References and resources

Information in this resource has been drawn from a number of sources, including the following publications:

Barclay, R (1993), Chemical control of woody weeds in the Western Division. In Harland, R (ed). *Managing for woody weed control in Western NSW*. Woody Weeds Task Force. pp 28-31.

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

WEST 2000. *Perennial pasture management plan for woody weed control*.

Pasture management

Using pasture management to manage INS?

Vigorous perennial pastures can compete with emerging INS seedlings for moisture, nutrient and light, and help control their widespread establishment. In healthy stands of perennial grass, INS seedlings are unlikely to survive normal to dry summers for the first or second season after they germinate. Effective grazing management is critical to establishing healthy pastures.

Limitations

Although critical components of an INS management program, pasture and grazing management alone will not control encroaching INS.

Where does pasture and grazing management fit in to an INS management plan?

Well-managed pastures can out compete INS seedlings, reducing (but not eliminating) the need for other INS treatment options. Grazing management is an important component of pasture management as it:

- ensures adequate levels of groundcover for good soil health and to control erosion
- allows the accumulation of fuel for a management burn if burning
- minimises the time that ground remains bare after a burn if burning
- allows the regeneration of diverse and productive pastures following INS treatment.

Operational notes

INS recruitment

INS seedlings can have high survival rates in wet summers regardless of pasture competition. Under these conditions other INS management activities may need to be carried out.

Post-treatment grazing

Post-treatment grazing pressure needs to be managed to allow desirable 'soft' native grasses to re-establish. Achieving a diversity of native grasses and herbage needs careful management of stock and control of feral and native animal grazing pressure.

Maintaining perennial groundcover can limit INS establishment

Seeding

It is important to rest paddocks when grasses are seeding so the seed bank can be replenished.

Reintroduction of native pasture seed, preferably harvested from local stands, may allow faster re-establishment of groundcover.

Stocking rates

Stocking rates should be driven by a strategic purpose and plan, allowing key perennial species to remain vigorous and ensure their frequency in the pasture does not decline.

This is particularly important during favourable seasons to allow depleted populations of perennial grasses to re-establish naturally. Research has shown that conservative grazing is a key factor in preventing INS encroachment.

Managing total grazing pressure

Total grazing pressure has to be kept low enough to allow native grasses to regenerate. This can be achieved through careful placement of watering points and fencing, and by spelling paddocks.

In addition to livestock, grazing pressure from native and feral animals needs to be factored in to grazing management plans. Feral goats, kangaroos and rabbits can account for up to half of the grazing pressure on land in western NSW.

Feral goats may add substantially to the total grazing pressure. If managed as domestic livestock, goats graze in a similar manner to sheep and impact on groundcover. They will, however, browse a wider range of plants. Feral goats should be controlled by cooperative and coordinated programs.

Kangaroo grazing is more difficult to control. Water points in spelled paddocks should be kept free of kangaroo access. These paddocks should be kept under surveillance and kangaroo harvesters used if there is evidence of a build-up.

Controlling rabbits is an important part of overall pasture management and needs to be planned to make efficient use of available resources.

References and resources

Information in this resource has been drawn from a number of sources, including the following publications:

Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Queensland Department of Natural Resources and Mines.

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Hacker, R, Beange, L, Casburn, G, Curran, G, Gray, P and Warner, J (2005), *Best management grazing practices for extensive grazing enterprises*. NSW Department of Primary Industries.

Harland, R (ed). (1993), *Managing for woody weed control in Western NSW*. Woody Weeds Task Force, Dubbo.

Jacobs, S (ed.) (1989), *A graziers' guide to bimble box-pine country of western New South Wales*. Soil Conservation Service of NSW.

Scriven, R (ed.) (1989), *A graziers' guide to belah-bluebush country of western New South Wales*. Soil Conservation Service of NSW.

WEST 2000. *Perennial pasture management plan for woody weed control*.

Stick raking

Using stick raking to manage INS?

Stick raking uses a clawed instrument attached to a tractor or bulldozer to break off young shrubs and 'rake' them into piles.

Timber can be left on the ground to provide shelter for establishing groundcover.

The roughened soil surface can also collect seed, debris and other resources to encourage establishment of perennial native pastures.

The position of the cutter bar on the stick rake is important for the species to be controlled. A cutter bar on the bottom of the stick rake can give good results on some species such as pine but poor results on budda. If budda is cut off at ground level it will re-shoot.

For effective control, budda needs to be broken off below ground level. This can be achieved with moderate success by positioning a bar approximately 15 cm from the bottom of the rake. The stick rake will then pull and lift the plant from the ground.

Stick raking can be selective to avoid non-target trees and species.

An example of a wide stick rake

Whipstick pine remaining after the site was stick raked

An example of a stick rake suitable for budda

A site stick raked for INS treatment

Limitations

Lower-growing saplings, seedlings and shrubs are difficult to treat.

Re-sprouting species (e.g. budda and turpentine) are difficult to control with stick raking as they rapidly re-sprout. Bimble box root suckers can occur post-stick raking.

Stick raking is only viable if regularly followed up with further treatments.

Where does stick raking fit in to an INS management plan?

Stick raking is sometimes combined with ploughing to prevent sucker regeneration.

A crocodile seeder is also sometimes used increase infiltration, roughen the soil surface and re-introduce grass seed following stick raking.

References and resources

Information in this resource has been drawn from a number of sources, including the following publications:

Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Queensland Department of Natural Resources and Mines.

WEST 2000. *Perennial pasture management plan for woody weed control*.

Waterspreading

Using waterspreading to manage INS?

Waterspreading is a land management technique used to evenly disperse water flows over relatively level land, away from drainage lines. By reducing the energy of the water flow, soil erosion is reduced and water infiltration increased. Increased water infiltration suits native grasses and herbage.

Waterspreading is not an INS control tool in itself however, it can be used to establish healthy perennial pastures after INS treatment in appropriate landscapes (i.e. less than 3% slope).

Waterspreading spreads water that would otherwise form narrow drainage lines. These drainage lines can be gully eroded and the areas that shed the water are subject to sheet erosion.

Limitations

Waterspreading may lead to seed of INS species being spread in flood events.

Top and bottom: Waterspreading banks on a site previously treated for INS

Where does waterspreading fit in to an INS management plan?

Waterspreading helps promote pasture establishment in land where other treatments have removed INS.

Established perennial pastures will help control INS establishment.

Operational notes

Waterspreading is suitable for landscapes with gentle slopes (i.e. less than 3%).

Water is channelled away from the drainage line by a series of diversion banks that change into spreader banks away from the flow line. The spreader banks have gaps that allow water to flow slowly into a shallow level channel. As the channel fills, water slowly flows out over the land surface. Excess water returns to the flow line. Depending on the system design the water may flow on or be re-spread.

Correct design and construction is essential to avoid problems such as:

- scouring in channels and gaps
- erosion at bank ends
- bank breaching during high flows
- sediment build-up
- overflows.

It is important that banks and channels aren't too big – too much water is stored in big channels. Smaller channels allow more water to flow over the paddocks.

References and resources

Information in this resource has been drawn from a number of sources, including the following publication:

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Ongoing management

Invasive native scrub (INS) management is an ongoing process, rather than a one-off event. To achieve lasting results, conditions need to be created that maintain mosaic landscapes, and sites need to be monitored for follow-up action to treat INS as needed.

In this section:

- Ongoing invasive native scrub management
- Native grasses
- Grazing management
- Monitoring

Ongoing invasive native scrub management

Management of invasive native scrub (INS) is an ongoing process. A single treatment is not adequate to keep INS under control. Ongoing management involves:

- re-establishment of native perennial grasses
- total grazing pressure management (including preparation of alternative grazing for domestic stock and determination of a suitable grazing regime for the treated area)
- appropriate follow-up treatment
- practical monitoring of the treatment area.

Re-establishment of native perennial grasses

Native perennial grasses and other native groundcover plants are adapted to our extreme weather conditions, often providing groundcover and fodder all year round. Providing fodder and groundcover is particularly important during the hot, dry summer months. Many species can grow in low quality soils, respond quickly to low and inconsistent rainfall, and use available moisture more efficiently than introduced species. They can also help the soil to soak up the available water, reduce soil erosion and stop weeds from invading.

Total grazing pressure management

Overgrazing by domestic, native and/or feral animals hampers or prevents the re-establishment of native perennial grasses. This in turn will limit the success and benefits of any INS treatment.

Domestic animals can be controlled with adequate planning to ensure alternative grazing areas. Feral and native animals are often more difficult to control. Establishing fencing and restricting access to watering points can aid in the control of total grazing pressure. Programs can be implemented to manage feral animals such as rabbits and goats.

Follow-up treatment

Many INS management techniques require follow-up treatment to be successful. The timing, frequency and type of follow-up treatment depend on the site conditions. Some of the factors that need to be considered are seasonal conditions, species of INS and cost. The amount of available fuel is also a major consideration for the use of fire.

Monitoring

Monitoring the outcomes of treatments used to control INS is a valuable exercise. The results provide information about which treatments are successful or unsuccessful, and for post-treatment management. Monitoring after wet years will allow detection of germination of shrubs, so early control can be implemented.

Monitoring can be as simple as using photo points or may involve a more detailed assessment of the site using transects or other vegetation and soil surface assessment methods.

As a minimum for monitoring landholders should:

- establish a photo point prior to INS treatment
- photograph the site to show the results of the treatment over time and comparison with non-treated areas
- photograph non-INS vegetation (where present) in the vicinity of the photo point at the time the photos are taken
- record rainfall
- record stock movements for the paddock/s in which the site/s are located
- record other management actions.

Top and bottom: These sites were previously treated for INS, but without appropriate follow-up are again thick scrub.

Photo points

The location of the photo point should be permanently recorded, as should the procedure for taking the photo, to ensure consistency through time. Having the previous photo assists with ensuring the new photo is taken in the same manner.

Photos should be taken at consistent intervals and also following events at the site, such as after rainfall.

The plant species in the immediate vicinity of the photo point should also be recorded.

Photo points such as this provide a consistent reference for visual comparison.

Recording of rainfall

A rain gauge should be set up close to the site, and the rainfall measured and recorded on a regular basis. If this is not practical the rainfall should be recorded at the nearest location to the site.

Documenting management actions

To provide useful records, landholders should record the following pre and post-treatment of INS (as a minimum):

- stock in and out of the paddock/s in which the site/s are located
- follow-up works to control regrowth of INS
- other management actions (e.g. kangaroo culling, new water points, goat harvesting)
- general comments and observations (e.g. wildfires, floods, dry spells).

It would also be a useful exercise to record changes in fauna before an after INS treatment.

While biodiversity surveys are often complex, simply keeping a diary of fauna observations and general observations of the landscape will help land managers understand the effect of management actions. For example, the diary could include a checklist of the region's declining bird species.

References and resources

Information in this resource has been drawn from:

Woody Weeds Task Force. *Code of Practice for the Management and Prevention of Scrub Dominated Landscapes* - Draft Management Guidelines.

Native grasses

Native grasses, especially perennial species, form an important component of pastures, native grasslands, and woodland and forest groundcover. They are a valuable grazing resource and component of biodiversity in the region, as well as providing food and habitat for native animals.

Why are native grasses important?

Improved production capacity

Well-managed native pastures generally grow better under conditions of low nutrient inputs and low rainfall than introduced pastures, with little maintenance needed in the longer term if they are grazed strategically. Within a few weeks of rain, native grasses can thrive and produce seeds for further growth.

Reduced weed invasion

Weeds find it difficult to invade areas of well-managed, healthy native grasses. On the other hand, if native grasses are overgrazed then weeds can become a big threat.

Summer feed and soil protection

Many native pastures are summer growing perennials and can grow well into the hot summer months and provide soil protection and livestock fodder. Maintaining good groundcover is essential to control soil erosion. The fibrous root system of native perennial grasses helps to bind the soil together and protect the precious topsoil from wind and water erosion.

Left and above: Native grasses are a valuable grazing resource and offer many benefits.

Annual grasses

Native annual grasses (grasses that complete their lifecycle within a year) can be a high quality source of forage for livestock across the catchment. Annuals grow from seed when conditions are favourable. This usually requires several days of moist conditions, which is most likely to occur when evaporation rates are low. Annual grasses produce a bulk of growth before setting large numbers of seeds and then dying off.

Perennial grasses

Perennial grasses (species that live for two or more years) form the bulk of any healthy native pasture. They provide a number of valuable functions that are not, or only partially, provided by annual grasses. Perennials:

- use more water than annuals due to their larger and deeper root systems, thereby reducing deep drainage, nitrate losses and acidification rates.
- have extensive root systems that allow them to persist from year to year.
- reduce soil erosion by providing year-round groundcover. This is especially important in late summer and autumn when summer annuals have finished, but winter annuals haven't begun.
- are more adapted to surviving droughts and respond more quickly after breaking rains.
- provide effective weed competition as they efficiently use light, water and nutrients year-round. Again, this can be especially important in late summer and autumn when many weeds germinate.
- provide forage in response to small rainfall events that are too small to allow annuals to germinate and grow.

Perennials grow from buds in the crown of the plant or from seed. When regrowing from buds they have an advantage over annuals as their root system is already in place. However, if the crown of the plant is damaged by overstocking or protracted drought the perennial needs to regenerate from seed. In this situation, perennials are at a disadvantage when compared with more vigorously growing annuals.

Some perennials tend to behave as annuals under severe drought conditions, e.g. windmill grass (*Chloris truncata*) and spear grass (*Austrostipa* species). In these situations, such short-lived perennials tend to expend a greater proportion of their energy producing seed than other more long-lived perennials.

Within a pasture system, perennials can usually be identified by being difficult to pull out of the ground. This is because they produce tillers from persistent crowns, which are strongly rooted to the soil. Annuals, however, do not form a persistent well-rooted crown and are generally easier to pull out.

Native pastures

Native pastures consist of a mix of native grasses and other native herbs and shrubs. Even healthy, relatively undisturbed native pastures also commonly have a mix of introduced species, such as annual and perennial grasses, medics, clovers and herbs. This wide range of species in native pastures ensures that there are always some species capable of responding to seasonal and site conditions.

When perennial grasses are grazed too short, the leaf area is reduced and plants need to rely on energy stores to regrow. The harder plants are grazed, the more that leaf area and energy stores are reduced. As plants increasingly rely on energy stores to regrow, the recovery time needed between grazing increases and overall production declines. It is important that total grazing pressure is managed to establish and maintain healthy native perennial pastures.

Resources and references

Information in this resource has been drawn from:

Central West Catchment Management Authority (2008), *Perennial pastures on the Central West Plains – a best practice management guide for the Central West Catchment*. Central West Catchment Management Authority.

Woody Weeds Task Force. *Code of Practice for the Management and Prevention of Scrub Dominated Landscapes - Draft Management Guidelines*.

Other useful references include:

Central West Catchment Management Authority (2008), *Common native grasses of the Central West Catchment – a best practice management guide for the Central West Catchment*. Central West Catchment Management Authority.

Casburn, G, Strong, A, Hacker, R, and Clipperton, S (2006), *Restoration of degraded grazing country in the semi-arid areas of NSW*, Primefact 225. NSW Department of Primary Industries.

Grazing management

Grazing management refers to the management of the frequency (how often) and the intensity (how heavily) of livestock grazing on pastures.

Resting pastures

Perennial pastures are most vulnerable during establishment and during drought. Inappropriate grazing at these times has adverse impacts on persistence. Resting of perennial pastures is important to allow plants to recover from grazing in both their above ground growth and root reserves.

Strategic resting can also be important in allowing plants to seed and regenerate. Provided there are no other limiting factors with soil chemistry and drought conditions, a grazing animal can be used as a powerful and cost-effective tool to improve perennial pastures through the modification of botanical composition and feed quality.

The value of rest in perennial pasture grazing systems cannot be emphasised enough. Grazing systems that mimic natural herd grazing, that is, short intense graze periods followed by long periods of rest and recovery, favour the persistence and regeneration of perennial species.

Providing rest allows the plants to use root reserve energy to regrow after defoliation. The combination of severe grazing and insufficient recovery results in poor recovery and eventual plant death. Managers practicing time-controlled grazing observe that the health and plant diversity of pastures improves as desirable native perennial species find their way back into the system.

Species knowledge

Knowledge of how individual pasture plants respond to grazing is essential to manage pastures for persistence and production. For example, wallaby grass (*Austrodanthonia caespitosa*) responds well to light grazing, but eventually dies under heavy grazing pressure.

In contrast, neverfail (*Eragrostis setifolia*) tolerates heavy grazing pressure for long periods before it is severely affected. Native semi-arid species have generally evolved in the absence of highly fertile soils and most grow well without fertiliser application, in contrast to introduced species such as lucerne, which requires regular applications of phosphorous.

General principles of grazing management

Pasture composition is dynamic, fluctuating within and between years according to seasonal conditions, soil health and grazing management. Successful grazing management means you control what the stock eat and ultimately maintain perennial pastures by:

- maintaining adequate groundcover of perennials to help reduce soil salinity, acidity and invasion of undesirable or weedy species

Successful grazing management means controlling what stock eat and maintaining perennial pasture.

- matching groundcover and the amount of pasture mass to the environment and seasonal conditions, e.g. prevention of soil loss from erosion due to high intensity rainfalls in summer storms
- managing pastures for longevity by resting for recovery, seeding and recruitment of new plants
- optimising pasture growth and maximising feed quality
- matching stock feed requirements to seasonal growth rates such as low pasture growth in winter and large spring flushes
- using higher stocking rates where possible for short periods to limit selective grazing of the better species, reduce patch grazing and increase overall pasture use.

In the semi-arid rangelands successful grazing management also requires:

- placing watering points no more than 1.6 km from where livestock are grazing. As a general guide, sheep graze a radius of 1.6 km out from water in average seasons. To get the best return from a new water point, maximise the area of productive country accessible to stock grazing from it. When watering points are located next to a fence, natural barrier (e.g. range) or in a paddock corner, the total area available for grazing from that water point is reduced and grazing pressure is concentrated. Piping water to a trough away from the fence or barrier reduces disturbance, as well as increasing the area that can be grazed and the number of stock that can be carried.

- locating watering points in less productive areas to ensure better pasture use. If a watering point is located in the most productive pasture, production can be lost due to trampling and overgrazing in the 'sacrifice' area close to the trough. Locating the trough in less productive areas can ensure better pasture use.
- identifying the most important and palatable perennial grasses and leaving 70% of these plants (approximately 50% of the grass height) when stock are moved to another paddock. These species show the earliest signs of overgrazing.
- recognising and allowing for the total grazing pressure from domestic and non-domestic animals (such as kangaroos, goats and rabbits) when determining appropriate stocking rates, grazing periods and grazing intervals.

Types of grazing systems

There are many different forms of grazing management systems. Some of the more common are:

Continuous stocking

This system allows animals to graze with a high degree of selectivity as the pastures rarely, if ever, receive a spell from grazing. Continuous selection of preferred species may lead to elimination of desirable species and patch grazing/poor utilisation. Depending on stocking rates, this system may result in poor groundcover through continuous grazing pressure and dominance of less palatable or weedy species.

Set stocking

Often used to describe continuous stocking, but more appropriately it is a term used to refer to a specific grazing period when stock are not moved. The bigger the paddock and the lower the stocking density the more selective the animals can be, which places pressure on desirable species. The set stocking of pastures for extended periods (say up to three months) may not necessarily be detrimental to the pasture (depending on the type of pasture, seasonal conditions and plant growth phases).

Rotational grazing

This term refers to the system where a period of grazing is followed by a period of rest. The rest period or rotation length is generally influenced by pasture growth rate and may vary from days to weeks and sometimes months.

There is a wide variation in the number of paddocks in a rotational grazing system, hence the wide variation in graze period and rest period. The minimum number is usually four paddocks per mob and may be as high as 30 or more in intensive rotational systems, e.g. cell or time-controlled grazing systems have a short intense grazing period (say 3 to 10 days) with a long recovery period (30 to more than 75 days).

The speed of rotation is determined by pasture growth rates. Stocking rates are also matched to seasonal conditions and pasture growth rates.

Time-controlled grazing

This grazing system is a rotational grazing system by definition with the length of graze period and recovery period determined by the pasture growth rates and the number of paddocks used in the rotation. The system pays particular attention to the amount of material left on pasture plants to allow for better recovery during the rest period.

The graze period in a time-controlled grazing system is usually short and intense with long recovery periods. Stock densities may be high, often in excess of 100 dry sheep equivalents (DSE) per hectare. The critical management decision to move the stock is made based on the state of the pasture and how much plant material the manager wishes to retain before moving the stock. As a consequence of management being based around plant growth rates, the rate of rotation is likely to speed up during periods of faster pasture growth rates and slow down to allow for more rest during slower growth periods.

These systems need to allow for flexibility and include elements of strategic grazing, such as letting pastures go to seed or grazing to manage undesirable plant components. This grazing system relies on a high number of subdivisions in the rotation to allow the manager to have a greater control on overall grazing effectiveness and the length of the graze and recovery periods. Matching stocking rate to carrying capacity is critical to the success of this system.

Tactical or strategic grazing

This grazing system is ideal for semi-arid rangeland environments where set management recipes are difficult to maintain. It is a flexible management system which sets a management objective for a paddock, implements a strategy and monitors the results, to achieve a desired outcome. Tactics used in one year or paddock may not be applicable in another year.

Implementing tactical grazing management

Tactical grazing has four steps:

1. Setting a management objective
2. Determining a strategy
3. Implementing the strategy
4. Monitoring the results

Setting an objective

Since paddocks are the basic management units on pastoral properties, a management objective has to be set for each paddock. However, decisions made for each paddock need to be integrated with the rest of the property because stocking decisions affecting one paddock will have consequences for the stocking policy applied to others.

Broadly there are two possible management objectives:

- *Maintenance* – desirable if the main pasture type is already close to its potential for long-term animal production, or is in a condition from which it is unlikely to be able to change readily in response to grazing management.
- *Restoration* – appropriate if the pasture is not close to its potential long-term productivity but has the capacity to respond to management.

Determining the management objective is not always easy, and objectives may change with time as regeneration is achieved or seasonal conditions provide opportunities not previously expected.

When setting management objectives carefully consider what is desirable in terms of sustainable animal production, and what is feasible within biological and economic constraints.

For example, in an environment of highly variable rainfall, pastures containing a variety of palatable perennial grasses and palatable shrubs are the best for reliable animal production. Where there are still vigorous stands of these plants, the management objective would be to maintain the pasture in its present state. Where sparse populations remain, and the soil surface is not severely eroded, restoration of a vigorous perennial pasture would be an appropriate management objective. Where perennial grasses have been completely removed, it may no longer be feasible to restore a perennial pasture. In these circumstances, the objective should be to maintain annual pasture production and so prevent soil erosion.

Whether the pasture is close to its long-term productivity will determine management objectives.

Determining a strategy

Once the management objective for each paddock has been determined, a broad strategy to achieve that objective can be determined, and paddocks can be ranked in order of priority for particular management options, e.g. management burning or spelling.

Any strategy for maintaining or promoting productive native grassland must ensure that:

- the vigour of desirable perennial grasses is maintained or improved. This will require moderate overall levels of grazing, early responses to developing drought conditions and adequate opportunities for pasture spelling after drought or fire
- periodic opportunities are provided for these desirable plants to set seed
- shrub seedlings or established shrubs are suppressed, as required, by management burns or other means.

In severely degraded areas, where the return to a perennial grassland is not feasible (other than by cultivation and re-seeding), strategies to prevent soil erosion need to involve an early response to dry conditions to ensure that stock numbers are closely matched to feed availability and that the minimum amount of vegetation cover essential for landscape stability is maintained.

Implementing the strategy

Just as seasonal conditions vary widely and continuously, so the actual management required to implement the principles contained in the strategy will also vary continuously. Strategies may include:

- changing stocking density at critical times
- resting at critical times, e.g. after drought conditions or other stresses
- allowing thin perennial pastures to seed down and regenerate
- allowing newly sown pastures to set seed in year 1 and year 2
- using different types of stock. Sheep and cattle have different grazing habits and dietary preferences. Sheep tend to graze closer to the ground and can be highly selective, while cattle are less selective and are better able to utilise tall pasture growth. Goats are also being successfully used to control various weed species in pastures, as well as INS species
- using different classes of stock. Wethers or dry cows can be used to eat less palatable species or lower quality feed without penalty compared to young or lactating stock
- uniformly grazing undesirable annual species during flowering or early seed growth to reduce seed production for the following growth period, i.e. annual grasses such as barley grass.

Management will need to respond to changing conditions, on a day-to-day basis as seasonal opportunities allow, in order to implement the strategy. This continuous response, guided by a well thought-out strategy, is the essence of tactical management. For the grazier to respond in this way, the important components of the strategy must be monitored with sufficient precision and frequency to allow timely management decisions.

Monitoring the results

Tactical management requires regular monitoring of pastures so that factors such as stocking rates, stock distribution and management burns can be altered or implemented at the appropriate times. Simple observations at one or a few key sites within each paddock can provide much of the information necessary to allow tactical management to proceed. Important observations include:

- the degree of grazing of the desirable perennial grasses
- seeding of desirable grasses
- times when shrubs germinate
- shrub growth
- available forage
- amount of groundcover.

Monitoring will allow progress towards the management objectives to be judged and the objectives to be changed as required.

Key points

- Identify pasture species and understand how they respond to grazing pressure.
- Manage for the pasture species you want rather than those you don't want.
- Know and visually recognise pasture species and how they respond to grazing pressure.
- Be flexible with grazing management from season to season and year to year.
- Graze to maintain more than 40% groundcover.
- Match animal requirements to seasonal pasture availability.
- Repeated or continuous defoliation when perennials are under stress may lead to their death.
- Total grazing pressure by livestock and other animals impacting on the pasture resource must be accounted for when deciding on a stocking rate.

References and resources

Information in this resource has been drawn a number of sources, including the following publications.

Central West Catchment Management Authority (2008), *Perennial pastures on the Central West Plains – a best practice management guide for the Central West Catchment*. Central West Catchment Management Authority.

Hacker, R (1993), Grazing management and woody weed control in the semi-arid woodlands. In Harland, R (ed). *Managing for woody weed control in Western NSW*. Woody Weeds Task Force. Pp 9-15.

Hacker, R, Beange, L, Casburn, G, Curran, G, Gray, P and Warner, J (2005), *Best management grazing practices for extensive grazing enterprises*. NSW Department of Primary Industries.

Other useful references include:

Campbell, T and Hacker, R (2002), *The glove box guide to tactical grazing management for the semi-arid woodlands*. NSW Agriculture.

Cunningham, GM, Mulham, WE, Milthorpe, PL and Leigh, LH (1992), *Plants of western New South Wales*, Inkata Press.

Monitoring

Monitoring is an important component of INS management and keeping good records is important to inform ongoing INS management decisions. Landholders need to be aware of the changes that are occurring on their property and adapt their management accordingly and early enough to prevent or minimise INS re-establishment. Monitoring the following can be useful:

- rangeland pasture condition
- groundcover and species composition
- pasture quantity and quality
- carrying capacity
- soil
- grazing charts.

Rangeland pasture condition

Where grazing is based on native pastures, 'pasture condition' or 'range condition' describes the health of the plant and soil resource. The condition of the resource has important implications for animal production and ecosystem function. This is influenced by total grazing pressure from domestic, native and feral animals. The condition can be ranked as 'good', 'fair' or 'poor'.

Good

Pastures are stable and at close to their productive potential. There is an excellent diversity and cover of annual and perennial plant species for that pasture type, with plants of varying ages. Plant and litter cover protects the soil from wind and water erosion in all but exceptionally bad seasons and following fire.

Fair

Pastures are productive, but below their productive potential. Soil is sometimes actively eroding and can rapidly deteriorate to poor condition. Unpalatable plants may also have established. Productivity remains high in good seasons but is markedly reduced in dry seasons. Reduced plant cover increases the susceptibility to soil erosion in most seasons and there is evidence of moderate erosion on susceptible land types.

Poor

Pastures have severely reduced productivity, particularly during dry periods. They require a very long period of spelling to improve condition, or mechanical intervention such as erosion control earthworks or in some cases reseeding. Poor pastures are dominated by annual, ephemeral or unpalatable perennial species. There is little or no regeneration of desirable perennial plants, productivity is impaired and the seasonal response is poor. Soils are unstable and susceptible to erosion in all seasons and past erosion leaves the site susceptible to further soil movement if grazed.

Groundcover and species composition

Groundcover is any material on or near the soil surface that protects the soil against the erosive action of raindrops, overland flow and wind. Percentage groundcover is the converse of percent bare ground. Plant material either alive or dead is the most important form of groundcover. Other materials such as stones, branches, cryptogams (lichens, algae and fungi) and dung have no grazing value, but can help control erosion in some circumstances.

Where soil is left unprotected, up to 100 t/ha of valuable topsoil can be lost in a year (1 mm depth of soil cover over one hectare weighs around 10 tonnes) and will not be replaced. Groundcover also directly affects plant production, as it helps water infiltrate into the soil and reduces soil moisture loss through evaporation. Bare ground also increases soil temperatures, overheating and killing beneficial microbes and slowing plant growth.

Bare soils lacking adequate groundcover (often as a result of poor grazing management) are also susceptible to surface crusting and compaction.

How much groundcover is enough?

At least 40% groundcover, and preferably up to 70%, is required in semi-arid environments to control erosion.

Measuring groundcover

Several different methods can be used to estimate groundcover. Groundcover levels will vary across a paddock so, representative areas must be selected.

A square such as this can help measure groundcover.

Visual assessment

A simple method involves using or visualising a square, say 0.5 m x 0.5 m (18" x 18") in front of your feet and look vertically into the pasture to estimate the percentage of the area that is covered with plant material and litter. Do this say ten times in a paddock and average out the results.

Step point method

This method determines changes in groundcover and species composition in pastures and involves making observations along a straight path at specified intervals and recording the type of groundcover.

Firstly, make a mark on the toe of each of your boots. Secondly, select a prominent feature such as a water tank or windmill that can be used as a bearing point. You then step for 100 equally spaced steps throughout the pasture along the fixed bearing or towards a landmark to ensure a straight line. At each step look at what the mark has hit on your boot, be it bare ground, litter, native annual vegetation, exotic annual, native perennial, non-native perennial vegetation or other. Record the results for each step.

Pointed stick method

This technique is undertaken using a 1 cm thick dowel about 30 cm long with pointed ends – or a nail can be driven into each end of the stick. It is randomly thrown across the paddock and the plants that are nearest the ends of the stick are recorded. The process is repeated 50-100 times throughout the paddock. Fifty observations of a double-ended stick will give you 100 observations (hits) and the cover can be calculated as a percentage. Assessing cover is best done in winter or early spring.

Pasture quantity and quality

Pasture quantity

Pasture quantity is herbage mass and it is usually expressed in kilograms of pasture dry matter per hectare (kg DM/ha). It is the total amount of pasture present, assuming a cut is taken at ground level and includes both green and dead components. Pasture quantity is influenced by the height and density of the pasture.

In the semi-arid rangelands as a general rule the amount of standing forage available for livestock is roughly one-fifth of the standing dry matter with the remainder being retained for or used by pasture maintenance, groundcover, termites and trampling.

Pasture standards showing standing dry matter kg/ha for the semi-arid woodlands are provided in *The glove box guide to tactical grazing management for the semi-arid woodlands* (Campbell and Hacker, 2002).

Pasture quality

Pasture quality refers to the digestibility, metabolisable energy and protein percentage of the pasture. Digestibility is expressed as a percentage. It provides a prediction of the proportion of the pasture consumed that is utilised by the animals. For example, if the digestibility of a pasture is 70%, then 70% of the feed consumed (on a dry matter basis) is utilised by the animal, with the remaining 30% excreted as faeces. Digestibility is a useful measure of pasture quality as it is directly and positively related to the energy content of the feed. Digestibility differs between species (legumes are higher than grasses), parts of the plant (leaves are higher than stems) and the stage of growth (young vegetative growth is higher than older rank pasture).

Measuring pasture quality and quantity is important component of monitoring.

Soil

Soil testing of rangelands can be used to monitor soil nutrient levels over time or to get a snapshot of the chemical properties of the soil in a paddock.

It is best done when the soil is moist in early spring or autumn. Avoid sampling in late spring when phosphorus, in particular, is mostly in the plant material. Always test prior to undertaking any new pasture development.

To ensure that the results of a soil test are accurate it is important to use a credible soil testing laboratory (that is preferably a National Association of Testing Authorities accredited laboratory) and to follow a few simple rules:

- Sample at the same time of the year for monitoring paddocks. Avoid sampling when soils are very wet or very dry. When testing for phosphorus, allow at least 6 months since the last fertiliser application.
- Sampling every 2-3 years is generally sufficient for monitoring purposes. Priority should be given to new pasture paddocks or those that are to be sown.
- When monitoring fertility over the farm, select a range of paddocks with different pasture, soil types, land classes and land management.
- Soil samples should be taken to a depth of 10 cm. Deeper soil cores may be necessary to investigate subsoil problems.
- For monitoring purposes, a permanently marked site or transect is preferred to general paddock sampling in a random or zigzag pattern.
- A minimum of at least 20 cores should be taken from each paddock, pasture type, soil type, land classes and land management. For example, if a paddock has an alluvial flat and a rocky hill, two separate soil tests will be needed.

Carrying capacity

Carrying capacity is a measure of a paddock or property's capacity to carry livestock. It is usually measured in dry sheep equivalents per hectare (DSE/ha). Carrying capacity of a property is largely influenced by the productivity of its pastures.

Management can influence carrying capacity through pasture species selection, strategic fertiliser use, weed control and grazing management.

Over time, monitoring the grazing use between paddocks enables comparisons to be made and provides an indication of paddock capabilities for animal production.

Total grazing pressure must be taken into account. For example, kangaroos, rabbits and feral goats will all add to total grazing pressure. Pigs do not generally compete directly with livestock for food except when pasture is limited but they do foul water and dig up roots.

Grazing charts

A number of grazing management courses promote the use of grazing charts. These are a valuable tool to help managers to monitor and predict grazing management decisions within their property.

They are commonly used in time-controlled grazing systems, where landholders have a large number of paddocks, i.e. 30 paddocks per mob, and are using high-intensity short-duration grazing with long recovery periods. They combine important detailed information regarding paddocks names, sizes, number of days grazed per paddock (down to DSE grazing days per hectare within each paddock), rainfall data, predicted stocking densities based on rainfall and growth rates, stock days per hectare in relation to rainfall, etc.

These charts can also be used to identify when certain management activities occur such as joining, lambing, weaning, shearing, holidays, etc, and then managers can plan where the stock are within the grazing system when these management activities occur.

Important information can be extracted from these charts that can help managers make calculated decisions on the level of production of certain paddocks. Importantly, they provide for predictions such as appropriate graze and recovery periods, and can identify when de-stocking strategies need to be implemented.

References and resources

This material was taken from the following publication:

Central West Catchment Management Authority (2008), *Perennial pastures on the Central West Plains – a best practice management guide for the Central West Catchment*. Central West Catchment Management Authority.

For more information on determining a grazing plan and strategy for pasture management in the semi-arid rangelands using the concept of tactical grazing see:

Campbell, T and Hacker, R (2002), *The glove box guide to tactical grazing management for the semi-arid woodlands*. NSW Agriculture.

Pointers from the paddock

Landholders have significant bank of knowledge in managing invasive native scrub (INS). This section profiles a number of landholders who are managing INS across a range of landscapes and through a range of techniques.

In this section:

Waterspreading and restoring native grasslands on 'Florida'

The history of 'Florida'

Located approximately 80 km west of Nyngan, 'Florida' was typical of many properties in the region.

Particularly since the 1950s, 'Florida' has experienced encroaching and thickening native scrub which has led to reduced carrying capacity, lower biodiversity and increased erosion.

Before European settlement the region was a mosaic of open grasslands with patches of scrub and open woodlands – now INS dominates the landscape.

In 1979 the then Western Lands Commissioner Dick Condon set up a 250 ha waterspreading trial on 'Florida' with landholders Kevin and Gwen Mitchell with the aims of restoring grasslands on the property, improving biodiversity, increasing carrying capacity and ensuring farm viability.

Since then, the Mitchells continued to manage INS and restore native grasslands through waterspreading and carrying out a range of management activities.

Ray Thompson from the Central West Catchment Management Authority (now Central West Local Land Services) worked with Kevin and Gwen to implement waterspreading systems and manage INS.

As 'Florida' is located across a CMA boundary, this work was supported by both the Central West and Western CMAs.

The improvements in groundcover, carrying capacity and biodiversity over this period were amazing.

Please note:

- Waterspreading is suitable for landscapes with gentle slopes. Correct design and construction is essential to avoid problems such as scouring in channels and gaps; erosion at bank ends; bank breaching during high flows; sediment build-up; and overflows.
- While every care has been in taken in preparing this document, the results are based on specific property experiences and people should take their own property situation into account when planning management activities.

For these reasons, seek appropriate advice before commencing any on-ground work.

Top: Central West CMA (now Central West Local Land Services) officer Ray Thompson (left) and 'Florida' owner Kevin Mitchell inspect one of the established native grasslands. This site was thick invasive scrub with nil carrying capacity 18 months beforehand.

Middle: Kevin standing in one of the waterspreading sills.

Bottom: A typical invasive native scrub site on 'Florida' – note the absence of groundcover, even after recent rainfall of 200 mm.

This case study shows the management decisions and ongoing practices that led to this transformation and demonstrates how farm productivity and environmental outcomes can go hand-in-hand.

Waterspreading to restore native grasslands

Rainfall events at 'Florida' need to be utilised carefully as it is in an area with an average of 375 mm per annum, with a lot of variability between years. Waterspreading helps the Mitchells use to use this resource wisely.

Waterspreading is a land management technique used to evenly spread and disperse rainwater flows over country with gentle slopes. The key advantage is that the energy of water flow is reduced, meaning almost no soil erosion and better water infiltration.

Waterspreading basically involves creating a series of small banks to direct water away from drainage lines to areas where it would normally not flow. Each bank has a series of gaps 100 m apart to allow water to flow through, fill a level sill on the low side of the bank and then flow out evenly across the ground. This means better infiltration to suit native grasses and herbage.

Waterspreading banks were initially constructed on 'Florida' through the Soil Conservation Service.

Yellow burr daisy – a pioneer plant

The INS management cycle on 'Florida'

After the original Soil Conservation Service trials of 1979-82, Kevin Mitchell continued to establish waterspreading sites and manage INS.

Throughout this period, he observed a distinct cycle in restoring native grasslands.

Turpentine regrowth following management

"Restoring a native grassland from a woody weed site is a long-term exercise and can take five to seven years, depending on the season and soil of the area," said Kevin.

"Firstly the invasive scrub area is thinned or cleared through chaining, raking and burning, followed by ploughing if necessary because of regeneration of turpentine and bimble box.

On 'Florida', Kevin didn't plough unless necessary, so as to avoid damage to soil structure.

"If it doesn't need ploughing I don't touch it. It's important not to plough when very dry and powdery; otherwise the paddock will turn to bulldust. Also, we don't plough when the soil is wet as moisture lets roots live and sucker. The ideal conditions is when the ground clods evenly and is not susceptible to wind erosion."

After this initial management, pioneer plants such as yellow burr daisy and galvanised burr establish.

"We leave these untouched as they provide some groundcover and will be replaced by native grasses and herbage after around two years. The pioneer plants then disappear as they don't like the competition.

"Scrub regrowth can be managed through ploughing, grubbing or spot spraying.

"I generally have to spray regrowth annually for the first few years and then every three years or so until the grasslands thicken and out-compete woody weed growth. In the first area developed in 1982, it takes me about half an hour to spot spray 250 hectares of scattered regrowth that periodically occurs, so follow-up spot herbicide treatment has some advantages.

Bimble box regrowth following management

"We have also used short-term cropping and stubble retention to control woody weed regrowth. This provides competition to scrub regrowth, retains soil moisture and shelters native grasses when establishing."

After the initial clearing Kevin used waterspreading to manage the flow of water over the paddock. This technique involves the construction of a series of banks. The banks have openings every 100 m which effectively allow rainwater to flow evenly across the ground's surface.

By slowing overland flows and spreading this water across areas other than drainage lines, rainfall can infiltrate the surface and support groundcover.

When an even water flow was established, Kevin managed scrub regrowth to allow native grasses to establish and dominate the site.

"Ongoing management of scrub regrowth is vital. Initially this must be done annually, then every couple of years until grasslands are established enough to restrict invasive scrub regrowth."

Post-treatment grazing pressure needed to be managed to allow desirable 'soft' native grasses to re-establish. Achieving a diversity of native grasses and herbage needs careful management of stock and control of feral animal grazing pressure.

"It's important not to flog it when establishing pastures. We found that heavy stocking can cause monocultures of spear grasses."

Results

Since Kevin and Gwen started managing invasive scrub and undertaking water spreading they saw dramatic improvements in productivity and biodiversity across the country.

"We now have such a diversity of desirable native grasses, with around 120 species of spring and summer grasses and approximately 40 species of autumn and winter herbage across the property," said Kevin.

A vegetation survey of the property revealed that a treated site had on average 35 times the dry weight of groundcover than an adjacent untreated INS site. The treated area was chained in 2002, and raked and waterspread in 2006.

"Endangered species like Major Mitchell cockatoos, superb parrots and others are returning to the region – we have sighted and documented 121 species of birds.

"Some are in abundance. I counted around 230 Major Mitchells in one flock recently. They were simply not there when it was all invasive scrub.

"The property is viable now too. Before INS removal and waterspreading began, invasive scrub meant our best stocking rate was one dry sheep to nine hectares. Now we can run one sheep to one hectare with very good lambing percentages and wool production.

"This is compared to the district average in open country of one sheep to two hectares."

Waterspreading and INS management also allowed the Mitchells to run a beef cattle enterprise.

Cattle in a paddock that was treated for INS and is now grassland – grazing management is an important part of native grassland regeneration

"Before it just wasn't possible to run cattle, but now we can run one head to nine hectares on waterspreading areas.

"When we started we thought we'd never see results in our lifetime, but looking back it is fantastic to see the restoration of the landscape.

"The difference between treated and INS sites is clear cut. For example, after eight inches of recent rain our grasslands are flourishing, but there is absolutely no groundcover on our scrub sites. The water can't penetrate the surface and just runs off."

According to Kevin, the banks are an asset of the property and a resource during dry times.

"The waterspreading system means native grasslands respond very well to heavy falls, but the real worth is during the hard times.

"It is the difference between having some groundcover or nothing at all during dry seasons."

The banks at 'Florida' are also quite robust.

"People have asked whether they wash away.

"Once they have pasture cover, water can flow over without any damage. There is no erosion on our treated areas because of the groundcover.

"They must be rolled to consolidate first though and we do this with a wheel tractor.

"We've received great encouragement from former Western Lands Commissioner Dick Condon and Ray Thompson from the Central West CMA in carrying out this work."

Both sides of the fence: adjacent INS and treated sites

The photos from 'Florida' demonstrate the results from waterspreading and INS treatment after 200 mm of rain in early 2008. The treated site has thick and diverse native grasses and herbage, while the adjacent INS has poor groundcover response.

Unmanaged INS

Treated INS site

Before and after comparison sites

The 'Florida' sites below show typical impacts of rain on treated and untreated sites. Photographs were taken in late 2006 and early 2008. There was a wet period immediately before the 2008 photos.

Site 1 – Managed for INS

The project monitoring site photos show the improvements due to waterspreading. The 2006 photograph was taken two weeks after clearing thick turpentine.

Site 1 - 2006

Site 1 - 2008

Site 2 – Managed for INS

These photos show improvements in a treated site. INS was removed from this site in 2006. The lower photo shows the second year of rehabilitation back to native pastures. This will take about five years.

Site 2 - 2006

Site 2 - 2008

Site 3 – Unmanaged INS (adjacent to Site 2)

This site is adjacent to Site 2. Over the same period there are still bare patches of soil, as well as low levels and diversity of native grass and herbage.

Site 3 - 2006

Site 3 - 2008

Key points from 'Florida'

1. Managing INS is a long-term commitment. Paddocks generally need five to seven years of ongoing management to establish dominant grasslands. With appropriate grazing they will then maintain groundcover

2. Follow-up management is vital. Bimble box suckering and woody weed regrowth need ongoing management otherwise INS will re-establish.

3. You don't have to do it all at once. INS management and waterspreading have taken place paddock by paddock on 'Florida' as resources have allowed since the 1970s.

4. Managing INS needs an integrated approach. A variety of management techniques are needed to manage and control INS.

5. Leave scattered trees and shelter belts of trees. Livestock need shade and shelter, and trees also provide native fauna habitat.

6. Don't flog it. Overgrazing can cause a spear grass monoculture or, worse, a bare paddock.

7. Plough when cloddy (not very dry or too wet) to control INS, and only if needed.

8. Don't make banks and channels too big if waterspreading. Too much water is stored in big channels, and smaller channels allow more water to flow over the paddocks.

9. Keep learning. According to Kevin and Gwen, managing INS is a cycle of continuous learning and improvement – they are still finding ways of doing things better.

Thanks to Kevin and Gwen Mitchell for their assistance in preparing this case study.

Chaining and burning to rehabilitate native pastures on 'Mirrabooka'

The history of 'Mirrabooka'

In a region dominated by thickening and encroaching INS, David Betts achieved production and environmental outcomes through a program of burning and scrub management.

Through treating INS and rehabilitating native pastures, David restored a mosaic environment of grasslands and grassy woodlands on his property 'Mirrabooka', 95km south of Cobar.

In 1998, David decided it was time to do something about the encroachment of white cypress pine on 'Mirrabooka'. Thick pine was spreading across his open areas and even after good rains, groundcover and carrying capacity were slowly decreasing as a result.

Evidence from previous wildfires convinced David that burning could be the answer to limiting this encroachment and keeping his open areas open.

After a number of successful burns, coupled with other INS treatments, David saw the return of thick native perennial pastures and groundcover.

Please note:

- A fire permit may be required from the Rural Fire Service (RFS) for management burns undertaken, particularly during the bushfire period (generally early October to late March).
- While every care has been in taken in preparing this document, the results are based on specific property experiences and people should take their own property situation into account when planning management activities.

For these reasons, seek appropriate advice before commencing any on-ground work.

Top: 'Mirrabooka' owner David Betts and Western CMA Fire Extension Officer Brian Dohnt in a paddock that was restored to native pastures through management burns.

Middle and Bottom: Fire is thought to have played an important role in maintaining open grassy plains before European settlement and can be an effective tool to manage INS.

This case study highlights the principles and management actions used by David, and demonstrates how farm profitability and environmental sustainability can go hand in hand.

Native grassland rehabilitation and INS treatment on 'Mirrabooka'

In a region known for the invasive behaviour of cypress pine and turpentine, David used burning in conjunction with a number of other INS treatment techniques to keep his open areas open and rehabilitate native grasslands.

Following a wildfire in 1984, David started to think about how he could be using fire to open up his country and increase his carrying capacity.

"My father was always burning, and after seeing the results of wildfires I started to think about using fire," he said.

"The wildfires seemed to keep the scrub in check and I wanted to be able to get the same results with management burns."

Unfortunately, competition from the encroaching pines meant there was not enough fuel (grass and herbage) to burn. David set about chaining the worst of his property to knock down the scrub. His plan was to burn at a later time when there was sufficient fuel.

Other than opportunistic crash grazing, David de-stocked the chained areas and then burnt in 2001.

"Some of the local RFS came out to help, which was great and gave people a chance to get experience with fire.

"We used drip torches and burnt in clumps. The grasses that had established, plus the timber on the ground and small whipstick pine missed by chaining, was enough to get a good burn.

"It was just enough to get the fire through the burn site and then die down."

While effective on pine, David found that not all INS species were controlled by fire.

"Fire knocks the pine, but not so much turpentine. We found we had to plough it out to control regrowth properly."

David also used stick raking on some of his chained areas as part of his management program.

"On some sites I stick raked the timber up in rows for burning – raking also roughs up the soil and encourages grasses to establish."

With established grasslands, David's focus shifted to controlling INS regrowth and keeping his native pastures open.

"Some INS sites on the property are too big to manage now, so I'm focusing on keeping my open areas open.

"I carry out small cool burns now to control regrowth – around 20 hectares at a time. Goats and sheep grazing will also be used to keep the regrowth down."

David also cultivated and cropped to kill the small seedlings that emerged and to re-establish some groundcover.

Two of the native perennial pastures on 'Mirrabooka' restored through burning.

This integrated program of short-term cropping, grazing management and an occasional fire (once every 5-10 years) should control any INS germination.

David in one of his restored grassy open woodlands, previously too thick with cypress pine to walk through.

Results

Seven years after the initial burns and 10 years after chaining, native grasses were well established on the burn areas.

"In the end we did it properly and I didn't realise at the time how well it worked. To see the little black stumps amongst the thick grasses now is incredible.

"Some of these areas were originally so thick with INS you couldn't walk through them," David said.

Through restoring native pastures, Mirrabooka's carrying capacity increased. Mustering was also far easier and quicker due to the reduced areas of wall-to-wall pine.

Areas are no longer dominated by one or two INS species – a wider range of habitat is available, improving the biodiversity of the property.

David's approach and management worked well. Through chaining and burning over a long time frame, he has spread his expenses over a number of years. The amount of lost production time was reduced.

'Mirrabooka' sites: INS and rehabilitated grasslands

Site 1 - Burnt in 2001

David had ample fuel for a burn in 2001 to control pine seedlings and smaller trees. Due to drought the site had limited groundcover for some years afterwards, but native pastures recovered after good summer rains.
Photo taken May 2008.

Site 2 - Area chained in 1998-99 and burnt in 2001

This area was chained, and then the pulled-down timber burnt in clumps. Chaining was undertaken selectively to leave larger trees.
Photo taken July 2008.

Site 3 - Chained in 1998-99 and burnt in 2001

This site was burnt, but some clumps of pine remained where there was insufficient fuel for the fire to scorch the juveniles or affect the larger timber.
Photo taken July 2008.

Site 4 - Country experiencing pine regrowth and in need of a management burn

If burnt at this stage, young pine can have up to a 100% mortality rate. Well-planned grazing management helps to generate sufficient fuel load.
Photo taken May 2008.

Site 5 - Area chained in 1998-99 and burnt in 2001

The site was previously dominated by cypress pine so thick in parts that you could not walk through it. Now the area is restored to a mix of open pasture and scattered trees selectively left from chaining. Photo taken July 2008.

Key points on burning

1. Total grazing pressure management is vital. Grazing pressure from feral, native and domestic animals must be controlled to allow fuel loads to develop and for native grasslands to establish after a burn.

2. Target seedlings and keep open areas open. INS species are most susceptible to treatment by fire when at the seedling stage. When INS is well established more expensive management techniques are needed.

3. Cool burns are better. Autumn and spring burns can effectively control INS. They present less risk to infrastructure and the environment than hot summer fires, which can also 'cook' the earth and limit grasses re-establishing.

4. Burning alone won't control INS. Management and follow-up burns, other treatments (e.g. chaining), infrastructure and grazing management all need to be integrated to successfully rehabilitate native grasslands.

5. Work with your local authorities. Experience counts with burning, so working with the RFS and Local Land Services on your burn will be a great advantage.

6. You don't have to do it all at once. David's initial chaining and burning program took place over a three-year period as conditions and finances suited.

7. Carefully plan your burn and have experience on hand.

Thanks to David for his assistance in preparing this case study.

Burning to rehabilitate native pastures on 'Norma Vale'

The history of 'Norma Vale'

Located 80 km south of Cobar, 'Norma Vale' sits in a region affected by thickening and encroaching invasive native scrub (INS).

'Norma Vale' owner Barry Francisco has a history tracing back four generations in the Cobar region and he advocates fire as a management tool to treat INS and restore native grasslands.

Barry first experienced the potential of burning for restoring native grasslands after a bushfire in the 1950s. After the fire swept through a section of his property, areas of thick scrub were transformed into rich and diverse native grasslands.

Since then he has observed the results of wildfires and management burns carried out over the years and is firm believer in the benefits of a burning program.

The work carried out to restore native grasslands on 'Norma Vale' improved the profitability and long-term sustainability of the property for generations to come.

Please note:

- A fire permit may be required from the Rural Fire Service (RFS) for management burns undertaken, particularly during the bushfire period (generally early October to late March).
- While every care has been in taken in preparing this document, the results are based on specific property experiences and people should take their own property situation into account when planning management activities.

For these reasons, seek appropriate advice before commencing any on-ground work.

Top: 'Norma Vale' owner Barry Francisco (left) and Western CMA Fire Extension Officer Brian Dohnt in a paddock previously burnt for INS control and pasture regeneration.

Middle and Bottom: If left untreated, emerging pine seedlings can soon establish and eventually develop into 'growth-locked' thickets that suppress pasture growth.

This case study highlights the principles and management actions of this work and demonstrates that farm profitability and environmental sustainability can go hand in hand.

Native grassland rehabilitation and INS management on 'Norma Vale'

Since seeing first-hand the effects of bushfires, Barry's eyes opened to the role that fire can play in a program to restore and maintain healthy native grasslands.

"While I could see the results from the '57 bushfire, it still took me a while to appreciate how I could be using fire on my property," said Barry.

"I first started carrying out follow-up burns after wildfires and have been managing my grasslands through burning for over 20 years now.

"I used to be afraid of burning but now it is the best way for me to manage my native pastures and keep the scrub in check," he said.

The results from management burns depend on the INS species in question.

Pine and hopbush were most susceptible to fire and Barry had success in controlling these species with burning. Other species can be harder to manage with a burn.

"I've found fire won't kill turpentine and spraying is needed as a follow-up. I also use spraying to control bimble box regrowth.

"Fire alone will only achieve so much."

INS species are most susceptible to burning when less than 50 cm tall, so regular monitoring and timely action is needed to keep open areas open.

There are also some practical points to be observed when burning. Good firebreaks are needed and be prepared to move stock quickly.

Total grazing pressure management is essential for developing a fuel load and allowing grasslands to re-establish on burnt areas.

Grazing management and exclusion were used on 'Norma Vale' to allow grasses to establish for a fuel load. Barry also used timber on the ground as fuel.

Grazing pressure comes from feral, native and domestic animals, so all of these should be managed in any program to rehabilitate native grasslands. Barry used two-barb fencing and has a feral animal control program for this reason.

"I pay particular attention to controlling ferals. You need to get feral goats off your pastures for burning to be effective. We set traps around the tanks to help with this.

"Pigs will damage drains and tanks so they go too."

Once native grasslands are established, water can be an issue. Better groundcover and infiltration means that run-off will be lower and planning is needed to avoid empty tanks. Barry usedhis roads and other bare areas as drains to make sure he had enough water.

After a burn galvanised burr can dominate, but this soon gives way to native perennial grasses, according to Barry.

"Galvanised burr will come but it is there to protect the soil until grasses develop. The diversity soon follows."

These two native pastures on 'Norma Vale' are the direct result of wildfires and management burning to control INS.

Barry inspecting one of the regenerating native grasslands.

Results

The return of native perennial pastures to 'Norma Vale' increased Barry's ability to carry stock and gave his property long-term sustainability.

"Burning keeps it profitable and the main thing for me is to pay the bills every month," he said.

"It has reduced farm inputs and lowered overheads. As a mechanism to control INS, it costs me virtually nothing."

The balance is there too.

"We don't get a thick body of crowfoot or spear grass anymore. We've got a diversity of grasses and heavy groundcover.

"We now only need 15 mm every few months or so to maintain stock."

"There is an active bird life on the property as a result of the mosaic landscape. The grasslands are established and trees are still there to give habitat diversity.

"I'm rapt in the country. It's healthy and I am proud of it."

'Norma Vale' sites: INS and rehabilitated grasslands

Site 1 - not affected by fire but evidence of ring-barking

Ringbarking was conducted in the late 1960s at this site. At the time of ringing, the larger trees in the background were seedlings hidden in the grass. Bushfires in 1975 and 1985 did not affect this area and cypress pine subsequently encroached into the open areas.

Site 2 - experienced two wildfires

This area was burnt during the 1975 and 1985 wildfires. It recovered very well to native pastures. Even though these results were from wildfires, the same effect can and will take place with controlled burning. Cool burns can control seedling pine.

Site 3 - experienced two wildfires

This area was also burnt during the 1975 and 1985 wildfires. The area recovered well with a nice scattering of mature trees and open grassland remaining.

Site 4 - experience wildfire in 1985

This site was burnt in a 1985 bushfire, and 23 years later the area is in need of another burn to eliminate the new germination of cypress pine (seen in background).

Barry on one of the pastures previously burnt. Grasses have recovered well and burnt pines can be seen in the background.

Key points on burning

1. Get experience and confidence. Barry has developed his burning experience and skills and has seen the benefits – profitability, viability, sustainability and diversity.

2. Total grazing pressure management is vital. Grazing pressure from feral, native and domestic animals must be controlled to allow fuel loads to develop and for native grasslands to establish after a burn.

3. Target seedlings. Cool autumn and spring burns can control INS seedlings. They present less risk to infrastructure and the environment than hot summer fires. Barry prefers to conduct autumn burns on 'Norma Vale' to establish groundcover before summer.

4. Burning alone won't control INS. Management and follow-up burns, other treatments (e.g. spraying), infrastructure, and grazing management all need to be integrated to successfully rehabilitate native grasslands.

5. A few trees are still needed. They carry out important farming functions (shade, wind shelter, etc) and are part of the environment.

6. You can't do anything without water. Rainfall run-off from established native grasslands is lower, so planning is needed to avoid empty tanks.

7. Carefully plan your burn and have experience on hand. Make good firebreaks.

Thanks to Barry for his assistance in preparing this case study.

Burning to manage INS encroachment at 'Gundabooka'

Western grazier Tony Falkenhagen of 'Gundabooka' station carried out a large-scale burning program during 2001 to help control invasive native scrub (INS) that was thickening over his property and affecting its groundcover and overall viability.

Turpentine in particular was establishing thickly on Tony's open pastures, leading to reduced perennial groundcover.

Tony carried out management burns over 4500 ha of 'Gundabooka' through the WEST 2000 Plus program. This work was done to see how burning could be carried out on a large scale to control emerging woody shrubs and trees.

"Much more of my property was open pastures 20 years ago – the scrub has thickened a lot since then. I didn't want to see this keep going and be left with no open land," said Tony.

"Burning was the best choice to control it because I had the fuel loads and was prepared to experiment with fire."

The experiences from this burning program are valuable to others considering a burning and INS management program.

Please note:

- A fire permit may be required from the Rural Fire Service (RFS) for management burns undertaken, particularly during the bushfire period (generally early October to late March).
- While every care has been in taken in preparing this document, the results are based on specific property experiences and people should take their own property situation into account when planning management activities.

For these reasons, seek appropriate advice before commencing any on-ground work.

Top: Tony on one of the burn sites.

Bottom: This 2005 photo shows the impact of the post-burn drought.

Importance of planning

The 'Gundabooka' burn demonstrated a number of important issues, according to former West 2000 Plus officer, Angus Atkinson.

"Tony recognised he had an INS issue long before West 2000 Plus existed and was using the best techniques available at the time to manage it," said Angus.

"He determined that INS encroachment had become too big a problem and he was never going to beat it by spraying individual plants establishing over nearly 4000 hectares.

"It was becoming uneconomical and labour intensive.

"Tony evaluated the scale of encroachment and options available.

"He saw the opportunity to experiment with fire and treat large areas of INS.

"He should be recognised for treating the problem effectively. 'Gundabooka' would be a very different landscape now if not for his effective management."

INS management at 'Gundabooka' highlights the importance of:

- early recognition of the natural resource management problem (i.e. encroaching turpentine)
- developing an INS management plan (treat open areas before dense stands)
- adopting the most cost-effective treatment technique, monitoring the results and then modifying/changing the technique if needed.

Carrying out the burn

The burn was conducted over two days with a number of people and vehicles present during and after the event.

"The actual burn did not take long at all. We did the largest block during the first day and then the smaller blocks took about another half day to burn," said Tony.

"I set up a firebreak beforehand with the grader. It was two blades wide and did a great job on containing the burn.

"My neighbours were all alerted and happy with the precautions we had in place.

"When we actually burnt, we had six people helping out and three vehicles with water. Two vehicles patrolled the perimeter during and after the burn to make sure it was well contained.

"I plan to burn again over the next few years, but will carry out the burning program piece by piece over smaller areas."

Series of photographs showing the INS mortality from the management burns

The burning program in action.

Managing regrowth

Tony managed regrowth on his burn sites and other open areas through spraying.

"I monitor my property on motorbike and spray any individual plants which works quite well.

"Spraying on bare ground underneath the plant's drip zone will get best results."

Managing total grazing pressure

Tony was conscious not to overgraze his grasses and herbage.

"I'm careful to maintain my perennial pastures. Having agistment cattle gives me more control over grazing pressure.

"Having not enough stock on is better than too many for maintaining groundcover.

"Pastures will catch water, grass seeds and other resources and respond quickly to rainfall. Bare ground won't."

In addition, Tony managed grazing pressure from feral animals.

"There aren't too many feral goats on the property, but I have traps set up around water tanks to keep them in check."

Results

The effects of drought meant that much of the burn area did not respond as quickly as hoped.

"There was not much rain for the two years after the burn so profitability fell in the short-term," said Tony.

"However grass butts responded well once the season improved and groundcover has now returned.

"Without the burn, turpentine and other invasive shrubs would have continued to spread. I would have lost much of my open country without some sort of intervention.

"The burning program stopped it getting any thicker."

The burn killed most of the juvenile turpentine and around half of the bigger plants.

"I followed up with spraying and the combination of fire and chemicals worked well to maintain my open areas.

"Some patches of INS did not have enough grass fuel underneath so did not burn as well."

Another site on 'Gundabooka' had a storm a few weeks before, so grass was greener and had more moisture. Fire did not burn as well on this site compared to some of the drier areas.

"One of the main things I would do differently is to burn smaller blocks over a longer time frame, rather than a large area at once. This would take a lot of the risk out of post-burn seasonal conditions."

Key points from 'Gundabooka'

1. Focus on keeping open areas open. Tony implemented his burning program during the early stages of encroachment for effective control of INS.

2. Prepare for the burn and have people on hand. Tony's burn was well planned and implemented and there were enough people on site to carry it out safely.

3. Manage groundcover and grazing pressure. Controlling feral goat numbers and managing stock numbers means that groundcover can establish before and after a management burn.

4. Smaller burns over a longer timeframe may reduce seasonal risk. The original burns took place over a large area. Smaller burn areas will reduce from seasonal conditions.

5. Plan your INS management and remain flexible. Tony was managing INS on 'Gundabooka' through spraying but changed his approach to burning when he realised the problem was too great to manage through spraying alone.

Thanks to Tony for his assistance in preparing this case study.

Thinning with herbicides on 'Bairnkine'

A thinning program on Walgett property 'Bairnkine' helped rehabilitate native pastures on areas previously thick with invasive native scrub (INS).

On 'Bairnkine', flooding events led to coolabah establishing en mass on parts of the property. These developed into thick stands of INS, marked by lack of groundcover and reduced diversity of native grass species.

Competition for light, water and other resources meant that trees remained stunted and would not readily grow to mature sizes without treatment such as thinning.

Landholders, the Zell family, undertook an INS thinning program to allow groundcover to establish. This also meant that selected trees could grow to provide better ecological and farm services.

Ken Norman, a consultant to the Zell family, coordinated the thinning program.

"With emerging INS, groundcover was decreasing, along with farm production," said Ken.

"Groundcover under the coolabah stands was very limited and species diversity reduced.

"The thinning program, coupled with changes to grazing management and supportive seasons, will mean a return of thick native perennial grasses."

Please note:

- When using herbicides always read the product label carefully before using and only use according to manufacturer's instructions.
- While every care has been in taken in preparing this document, the results are based on specific property experiences and people should take their own property situation into account when planning management activities.

For these reasons, seek appropriate advice before commencing any on-ground work.

Top: Ken Norman (right) with Western CMA Officer Brian Dohnt.

Middle and bottom: Adjacent areas demonstrating the affect of INS on perennial groundcover.

INS treatment

The herbicide thinning program was conducted in 2009. Undertaking the program during the warmer months meant sap in the trees was flowing more and poisoning was more effective.

The program of spot treatment was undertaken through an INS Property Vegetation Plan (PVP). Herbicides have the advantage of no disturbance to soil and groundcover.

"We undertook a thinning program over 570 hectares of the property to give native pastures a chance to establish," said Ken.

"In the thinning work we used stem injection as it is more selective. Spray drift in this situation could have hit large trees and non-target species.

"The team used Velpar ® mixed with water at a 2:1 ratio. Two cuts were made per tree and two millilitres injected per cut with good results.

"Costs per hectare varied depending on thickness and size of the scrub, but the overall thinning program cost around $96,000.

"Sixteen people were working at $200 per day over 18 days, meaning labour costs were around $63,000. Herbicides cost a total of $32,000."

Landholders should take into account ongoing management when costing a program. While poisoning on 'Bairnkine' had a high mortality rate, if the treatment was not carried out correctly areas will need re-treating.

Future germination events also need to be considered and managed. If treated early, costs will be much lower.

When using herbicides always read the product label carefully before using and only use according to manufacturer's instructions.

The foreground shows the impact of locked coolabah on perennial groundcover when compared to the open background.

Planning

Much planning went into INS and property management on 'Bairnkine'.

Through the PVP process, the extent of INS on 'Bairnkine' was mapped and its management planned.

Up to 80% of the extent of INS could ultimately be treated through a PVP. This amount can generally be treated all at once though poisoning and other low disturbance methods. Treatments that disturb the soil and groundcover are undertaken over a staged process to allow pastures to establish.

Property planning also saw nature corridors established along ridgelines for biodiversity benefits, such as providing connectivity for animal movement across the landscape.

Vegetation buffers were also established along warrambools (drainage depressions), as retaining native vegetation along water lines is important for filtering run-off, trapping nutrient and sediment, and preventing erosion.

Livestock will add grazing pressure to water troughs and other high traffic areas.

According to Ken, one thing they would do differently when setting up infrastructure for grazing is to take into account the grazing pressure livestock put around water troughs.

"When we put in the water system, we didn't consider the extra pressure that livestock contribute around water points," he said.

"Having them in a straight line meant that grazing was not spread across the paddock.

"In hindsight we would have been better staggering the position of water points to encourage livestock movement over a wider area."

Grazing management

Successful INS treatment depends on resting the site after treatment and appropriate ongoing grazing management for the re-establishment of native pastures.

Sites must be rested from grazing after treatment otherwise pastures will not easily establish. Seasonal conditions affect the resting length.

Ken and the Zell family saw first hand the benefits of improved grazing management and rotational grazing on their pasture areas and INS sites.

Previous set stocking had resulted in paddocks full of copper burr and other less desirable species, but now native grasses are re-establishing.

"I'd like to see curly Mitchell grass develop, but I am happy with the response seen to date. Given time it will come," said Ken.

Results

The chemical thinning program saw an increase in groundcover on the INS sites.

"Groundcover is still establishing under the coolabah we've thinned with herbicides, but it is a vast improvement on what was there before."

The whole property has benefited from better grazing management, with established pastures also much healthier now.

"Even the property's open pastures have better groundcover and are ready to respond to rainfall.

"Although there is more feed, the property is not carrying more stock. This means we can maintain better overall groundcover and livestock are healthier.

Key points from Bairnkine

1. **Plan and cost your INS management work before beginning.** The thinning program on 'Bairnkine' was well planned and achieved its set goals.

2. **Support INS treatment with appropriate grazing management and treat further encroachment.** Create an environment that will let native grasses grow, including managing INS seedling establishment.

3. **Rest treated sites to allow groundcover to establish.** Pastures need time to establish and this will vary depending on the season.

4. **Follow instructions and use correct technique to achieve a high mortality.** Follow-up work will be often needed but this can be minimised by doing it right the first time.

Thanks to Ken for his assistance in preparing this case study.

Controlling grazing pressure at 'Hermitage Plains'

Originally established as a soldier's settler block after World War II, 'Hermitage Plains' has since seen good years, intermittent floods and extended drought periods.

Thickening and encroaching invasive native scrub (INS) has also had its impact on carrying capacity, productivity and the property's natural resources over this time.

On 'Hermitage Plains' thick stands of cypress pine established on open areas and are a dominant figure on the landscape. Historical photographs from the 1920s show open pastures where the thick pine has since encroached.

Even now, open areas must be regularly monitored for pine seedling growth and treated to maintain a mosaic landscape and property viability.

Landholders Terry and Kerry Pitkin have been managing 'Hermitage Plains' now for 10 years and have undertaken a program to treat INS and help restore native perennial pastures.

This body of work will lead to improved productivity, reduce erosion and create a more balanced mosaic landscape.

This case study has been developed to highlight the management decisions and ongoing practices carried out by the Pitkins and the results to date.

Creating mosaics

Like other properties in the region, 'Hermitage Plains' has thick stands of cypress pine and bimble box encroaching on open grasslands and reducing the diversity of native vegetation and habitats.

Terry and Kerry implemented a program of INS treatment to restore native perennial pastures.

Through the Property Vegetation Planning (PVP) process, they were able to map the property and strategically plan areas of INS to be treated. Up to 80% of INS on a property could be treated through a PVP.

INS management work on 'Hermitage Plains' was supported through the NSW Farmers INS management pilot program.

A range of treatment techniques were used over the property to treat INS and maintain native perennial pastures and open woodlands.

Top: Terry with a recently treated site.

Middle: The benefits for native grasses of leaving timber on the ground.

Bottom: A thick INS stand on 'Hermitage Plains'.

Managing INS on 'Hermitage Plains'

When the Pitkins first started managing 'Hermitage Plains', around 60% of the 3800 ha property was covered in INS, severely limiting production. Over the 10 years they have managed the country with a number of different techniques to maintain their open areas and treat heavy INS.

According to Terry, their approach is a mixture of strategy and practicality.

"We have been using a satellite map and farm planning to decide which areas to approach first. This means we can focus on opening up our paddocks more and treating sections of INS piece by piece," said Terry.

"The sites we treat are generally chosen by where the machinery is at the time, but we do have a plan of which areas to manage."

The Pitkins set priority areas to treat.

"Some of our hilly areas are just too thick to deal with however, so we fenced those off to try to get some groundcover on them."

A range of INS treatment methods were used on 'Hermitage Plains'. Thick pine was initially pushed over with a dozer fitted with a stick rake or chained, then selectively left on the ground or raked in piles and burnt.

"Timber on the ground can be difficult to muster around, but has noticeable benefits in establishing groundcover – it gives protection for establishing grasses and herbage," said Terry.

"It also has a waterspreading effect by slowing the water's flow and trapping debris. This makes a better environment for grasses to establish and seed."

Roughing up the ground also helped create an environment suited to establishing pastures.

"We've found raking and ploughing can both help roughen the soil's surface and trap debris, seeds, water and other resources."

Pine seedlings were also been manually grubbed to keep open areas free from INS establishment.

"At times the whole family has been out pulling emerging pine growth in our open areas. It's a practical way for us to keep small pines from turning into thick scrub."

Total grazing pressure (TGP) was managed through subdivision fencing and fencing off dams to control access to water.

"By increasing stock rotations over smaller paddock units, we are able better maintain groundcover in good and bad times.

"TGP fencing also allows us to rest areas that have been treated. We'll rest an area six or seven months to allow pastures to establish before grazing.

"Selected dams are also fenced off to reduce access by feral animals and kangaroos. This has a positive impact in reducing overall grazing pressure."

A treated site previously thick with pine INS. This site was pushed and raked with a front-end loader.

This bimble box regrowth following treatment highlights the importance of follow-up management. This site was more open before treatment.

Results

Although INS management is an ongoing process, Terry has already seen the benefits of this work.

"Through strategically reducing the thick monocultures of INS and opening up the country, stock management is far easier and productivity has improved.

"When we first started managing the property, feral bulls would roam in and out of the scrub. They had grown wild and even attacked me occasionally.

"Our fencing system allows us to better control grazing pressure from ferals and natives, and better plan our stock grazing for healthier native pastures.

"Fortunately it means there are no more wild bulls either."

Increased perennial groundcover meant that water flow slowed and infiltrated better.

"The pastures allow better water infiltration and reduce erosion. Previously you could see rain water flooding off our INS sites and over the boundary fence – carrying our soil with it."

This had an overall positive impact on productivity and environmental outcomes, but also meant that less water could be collected in tanks.

One of the rehabilitating native pastures on 'Hermitage Plains'.

"Water infrastructure needs to be improved as your carrying capacity increases. As bare earth is reduced, run-off and the ability to collect water are too."

By treating widespread INS and creating areas of pastures and open woodlands, 'Hermitage Plains' now supports a wider range of plant and animal life.

The effect of pine INS on groundcover

Key points from 'Hermitage Plains'

1. Use a number of treatment methods. Each treatment mechanism has positives and drawbacks, so an integrated approach is more effective.

2. Plan your water infrastructure. As groundcover increases, water collection is reduced so planning and infrastructure improvements are needed.

3. Follow-up is needed. INS treatment is not one-off and ongoing management is needed.

4. Monitor and treat INS when small. Treatment is cheapest and most effective when INS is establishing and plants are small.

5. Control total grazing pressure (TGP). TGP fencing, controlling water point access and grazing management will all lead to better establishment of native perennial pastures.

6. Create an environment better suited to grasses. Selectively leaving timber on the ground and roughening the soil surface meant that debris, grass seed and other resources were trapped to encourage groundcover.

Thanks to Terry and Kerry for their assistance in preparing this case study.

Pulling mulga and encouraging groundcover at 'Landsdowne'

Louth local Wally Mitchell carried out a scrub-pulling program to feed his livestock over an extended drought.

Hand-in-hand with this, this program is managing invasive native scrub (INS), encouraging perennial pastures and improving his land.

On 'Landsdowne' thick stands of mulga, punty and harlequin fuchsia bush dominate areas, reducing groundcover and lowering the property's productivity.

Wally carried out a program of pulling thick mulga, controlling INS regrowth and restoring native perennial groundcover.

Through his Property Vegetation Plan (PVP), Wally was able to treat up to 80% of the extent of INS on his 12,500 ha property.

An active member of the Louth community, Wally has lived in the district for all his life and is still amazed by the cycles of nature.

"I recall my sister and I found a particularly striking wildflower near the Louth tennis courts during World War II," said Wally.

"I have only seen this plant a handful of times since over the last sixty years - all around the same site. This flower's seed has remained viable over this time, ready to go when the conditions are right.

"We've really been here for five minutes when you consider the scale of time and change of this land."

Pulling mulga and leaving timber on ground

Wally's mulga feeding program manages INS and improves groundcover on his property.

The original plan for developing 'Landsdowne' and managing INS was prepared for Wally by former Western Lands Commissioner, Dick Condon.

The program involved dividing his thick mulga sites into 150 to 200 ha blocks. As time and resources permitted, he knocked mulga down and left it on the ground.

Leaving the mulga branches and trunks where they fell had several benefits.

Top: Wally with his solar powered watering system.

Bottom: Diversity of native grasses has increased since the program began.

Firstly, they provided shelter for grasses to establish and seed. Animals could not eat the emerging groundcover and it was sheltered from extreme elements.

The material also slowed the water's flow and allowed better infiltration. It didn't matter which way the fallen mulga was facing – across or with the water's flow, it slowed down flow rates.

"I want to keep water on my property rather than see it run off. By slowing down the flow and establishing more groundcover, I can capture much more water than with bare ground."

The timber also trapped debris, grass seeds, dust and other resources. This was important to create an environment suited to grass establishment.

There are a few things to consider when pulling mulga, according to Wally.

"Timing is important. If the tree is seeding or has recently done so, then widespread germination may follow if stock trample seed into the ground.

"The other trick is to start pulling mulga on the higher country first. This suffers first in hard times and groundcover will be reduced.

"You must set a timetable to your mulga pulling program and keep to it. If fresh mulga browse is not available, sheep may start to eat the stems and fibrous parts of the plant which can kill the animal."

Controlling sprouting turpentine and punty bush

Monitoring is an important part of INS management at 'Landsdowne' and Wally paid particular attention to controlling encroaching turpentine and punty bush.

"I can ride through my treated areas with a spray gun to control emerging woody regrowth. The timber on the ground isn't a hindrance and the lanes I've established let me move around the property easily.

"If I can control sprouting turpentine and punty bush early, then widespread INS regrowth can be prevented.

"I am still trying different chemicals but find a sixty to one mix of diesel and Access ® is working well for hand spraying."

Managing total grazing pressure

Another key element of the property's management strategy was controlling water access to manage grazing pressure.

Controlling water points is an important tool in managing grazing pressure. Regardless of whether they are feral, native or domestic, animals can only graze close to water.

"I have a series of watering points on my larger blocks which I can turn on and off to move stock around. I find this works well in resting sections of land and managing grazing pressure.

"The solar powered water system is an important asset of my property."

Wally also gave particular attention to controlling feral goats.

"Regardless of goat prices, I want them off my property. They hammer grasses and vegetation, damaging what I have worked hard to establish.

"You can't overestimate the damage they cause to the environment and your productivity."

Feral goats are controlled to manage total grazing pressure.

A treated INS site starting to develop groundcover

A view to burn

Wally's plan was to pull the mulga down in blocks to allow grasses to establish. When mulga regrowth needed managing and there was a sufficient fuel load, he carried out a small-scale management burn.

"Sheep will not generally graze young mulga due to its waxy coating, so burning would be a suitable option for me.

"You don't need much fire to kill mulga, especially when it's young."

Results

Leaving the timber on the ground was beneficial in allowing grasses and herbage to establish.

"Many of the emerging grasses are quite new and strange to me. It is promising to see the diversity developing," said Wally.

"Controlling goats has helped this process and I have seen the results from limiting the damage they cause.

"My cattle have been in good condition throughout the drought. I am happy with how they are performing."

While agriculture can be a stressful industry, Wally remains focussed on what is important.

"I have no control over the weather or markets so I try not to worry about these. All I can do is manage and improve my country, and enjoy the process as I go."

Key points from 'Landsdowne'

1. Leave timber on the ground. This shelters grasses and herbage and helps them establish.

2. Manage total grazing pressure. Controlling feral goats and access to water points are two tools used by Wally to manage total grazing pressure on his property.

3. Planning is vital. 'Landsdowne' is managed according to a plan and this helps maintain a long-term view.

4. Use a number of management techniques in combination. Wally has opened up thick mulga stands with a modified D7 bulldozer and scrub-pulling attachment. He is also spraying to manage turpentine and punty bush and burns as needed.

5. Monitor open areas. Monitoring and early treatment of INS regrowth is important to keep open areas open.

6. Ongoing management is needed. Treating INS is not a one-off event and follow-up is needed.

Timber on the ground helps catch debris, seed and other resources.

Pulled mulga protects the native grasses while establishing.

Thanks to Wally for his assistance in preparing this case study.

References and resources

Reference to full reports, including archived reports

References and resources

Alemseged, Y (2009), *Evaluating opportunistic cropping for control of INS and restoration of native perennial grasslands in western NSW*. NSW Department of Primary Industries.

Alemseged, Y (2009), *Evaluating opportunistic cropping for control of INS and restoration of native perennial grasslands in western NSW*. Industry & Investment NSW

Alemseged, Y (2009). *Cropping helps control scrub and restore native grasslands*. Western Division Newsletter, number 126, pp. 24-25. Industry & Investment NSW.

Ayers, D, Melville G, Szigethy-Gyula, J, Read, D, Rees, R and Atkinson, A (2001), *Woody weeds and biodiversity in western New South Wales*. WEST 2000.

Barclay, R (1993), Chemical control of woody weeds in the Western Division. In Harland, R (ed). *Managing for woody weed control in Western NSW*. Woody Weeds Task Force. pp 28-31.

Border Rivers-Gwydir Catchment Management Authority. *Invasive Native Species*.

Brooke, G and McWhirter, L (2006), *The glove box guide to plants of the NSW rangelands*. NSW Department of Primary Industries.

Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Queensland Department of Natural Resources and Mines.

Campbell, T and Hacker, R (2002), *The glove box guide to tactical grazing management for the semi-arid woodlands*. NSW Agriculture.

Casburn, G, Strong, A, Hacker, R and Clipperton, S (2006), *Restoration of degraded grazing country in the semi-arid areas of NSW*, Primefact 225. NSW Department of Primary Industries.

Central West Catchment Management Authority (2008), *Perennial pastures on the Central West Plains – a best practice management guide for the Central West Catchment*. Central West Catchment Management Authority.

Central West Catchment Management Authority (2008), *Common native grasses of the Central West Catchment – a best practice management guide for the Central West Catchment*. Central West Catchment Management Authority.

Cunningham, G (2008), *Listening to the Managers*. Report on the invasive native scrub 'Landholder Knowledge' project prepared for the Central West and Western Catchment Management Authorities.

Cunningham, GM, Mulham, WE, Milthorpe, PL and Leigh, JH (1992), *Plants of western New South Wales*. Melbourne: Inkata Press.

Damara Sheep Breeders of Australia Inc. **http://www.damaras.com.au/**

Doerr, VAJ, Doerr, ED, McIntyre, S, Howling, G, Stol J, Davies, M, Drew, A, Warren, G and Moore, D. (2009), *Managing INS landscapes for improved ecosystem health*. Report prepared for the Central West Catchment Management Authority.

Dorper Sheep Society of Australia Inc. **http://www.dorper.com.au/**

Hacker, R (1993), Grazing management and woody weed control in the semi-arid woodlands. In Harland, R (ed). *Managing for woody weed control in Western NSW*. Woody Weeds Task Force. pp 9-15.

Hacker, R, Beange, L, Casburn, G, Curran, G, Gray, P and Warner, J (2005), *Best management grazing practices for extensive grazing enterprises*. NSW Department of Primary Industries.

Harland, R (ed). (1993), *Managing for woody weed control in Western NSW*. Woody Weeds Task Force, Dubbo.

Harland, R (1993), Blade ploughing for woody weed control. In Harland, R (ed). *Managing for woody weed control in Western NSW*. Woody Weeds Task Force. pp 16-18.

Harland, R and Kelly, S (1993), Chaining for woody weed control. In Harland, R. (ed). *Managing for woody weed control in Western NSW*. Woody Weeds Task Force. pp 26-27.

Hassall & Associates, Briggs, S and Norman, P (2006), *Documenting the science behind the invasive native scrub tool*. Report prepared for the Central West Catchment Management Authority.

Jacobs, S (ed.) (1989), *A graziers' guide to bimble box-pine country of western New South Wales*. Soil Conservation Service of NSW.

Jessop, P (2009). Management burning of invasive native scrub: Principles. Industry & Investment NSW. **http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0010/276652/Management-burning-of-invasive-native-scrub-principles.pdf**

Jessop, P (2009). Management burning of invasive native scrub: techniques. Industry & Investment NSW. **http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/276660/Management-burning-of-invasive-native-scrub-techniques.pdf**

Kerle, A (2009), *Managing rangeland vegetation with fire: a literature review and recommendations*. Report prepared for the Western Catchment Management Authority.

March, N and O'Leary, C (1993), Mechanical grubbing for woody weed control. In Harland, R. (ed). *Managing for woody weed control in Western NSW*. Woody Weeds Task Force. pp 23-25.

McHenry, M (2009), *Management of white cypress pine on the North Western Slopes*. University of New England.

Muir, S (1993), Woody weed management using goats. In Harland, R. (ed). *Managing for woody weed control in Western NSW*. Woody Weeds Task Force. pp 32-36.

Noble, JC (1997), *The delicate and noxious scrub.* Canberra: CSIRO Division of Wildlife and Ecology.

NSW Government (2005), *Native Vegetation Regulation 2005*. NSW Department of Natural Resources, Sydney. Available at **http://www.environment.nsw.gov.au/legislation/DECCRegulationsummaries.htm#native**

NSW Government (2005), *Native Vegetation Regulation 2005: Environmental Outcomes Assessment Methodology*. NSW Department of Natural Resources, Sydney, **http: //www.environment.nsw.gov.au/vegetation/eoam.htm**

NSW Government (2005), *How do I get a Property Vegetation Plan?* Info sheet 3. November 2005. Available at **http://www.environment.nsw.gov.au/vegetation/publications.htm**

NSW Government (2005), *Details about the new Native Vegetation Act 2003*. Info sheet 4. November 2005. Available at **http://www.environment.nsw.gov.au/vegetation/publications.htm**

NSW Government (2006), *Managing invasive native scrub*. Info sheet 9. November 2006. Available at **http://www.environment.nsw.gov.au/vegetation/publications.htm**

NSW Government (2006), *Native vegetation in the Western Division*. Info sheet 14. February 2006. Available at **http://www.environment.nsw.gov.au/vegetation/publications.htm**

O'Shea, R (1993), Management options - Fire. In Harland, R. (ed). *Managing for woody weed control in Western NSW*. Woody Weeds Task Force. pp 37-38.

Saunders, G, Sharp, T (2005), *Model code of practice for the humane control of feral goats*. NSW Department of Primary Industries.

Scriven, R (ed.) (1989), *A graziers' guide to belah-bluebush country of western New South Wales*. Soil Conservation Service of NSW.

Tatnell, B (1993), Integrated woody weed management strategies. In Harland, R (ed). *Managing for woody weed control in western NSW*. Woody Weeds Task Force, Dubbo. pp 6-8.

Tighe, M, Reid, N, Wilson, B and Briggs, SV (2009), Invasive native scrub and soil condition in semi-arid south-eastern Australia. *Agriculture, Ecosystems and Environment*, 132, 212–222.

WEST 2000. *Perennial pasture management plan for woody weed control*.

Woody Weed Task Force. *Code of Practice for the Management and Prevention of Scrub Dominated Landscapes* - Draft Management Guidelines.

Flowering wilga

Broad-leaf hopbush

About this publication

Information in this publication is based on outcomes of the invasive native scrub (INS) research program, previously published material and landholder experiences.

Originally published in May 2010, this resource has been updated to reflect changes in legislation and the formation of Local Land Services to replace Catchment Management Authorities (CMAs).

While the general principles will apply to all INS affected areas, much of the research program relates to the Cobar region. Unless a specific reference is given, readers outside this region should take caution applying this information.

The original INS Research Program that formed the basis of this publication was coordinated by the Central West and Western CMAs (now Local Land Services) in collaboration with the NSW Department of Environment, Climate Change and Water (now the NSW Office of Environment & Heritage), a range of research organisations and the landholder community.

The program was funded through the NSW and Commonwealth Governments.

For further detail on native pasture rehabilitation and INS management, please contact the Central West or Western Local Land Services offices.

Central West Local Land Services

1300 795 299 or 02 6881 3400

admin.centralwest@lls.nsw.gov.au

www.centralwest.lls.nsw.gov.au

Western Local Land Services

1300 795 299 or 02 6836 1575

admin.western@lls.nsw.gov.au

www.western.lls.nsw.gov.au

NSW GOVERNMENT Local Land Services

Australian Government