

National Case Studies Manual

Parkinsonia

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 Natural Heritage Trust
Helping Communities Help Australia

 Queensland Government
Natural Resources, Mines and Energy

 National Prickle Bush
Management Group

 Northern Territory Government
Supporting the Territory's Future and Progress



NSW DEPARTMENT OF
PRIMARY INDUSTRIES



Department of Agriculture
Government of Western Australia



Parkinsonia

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Approaches to the management of parkinsonia (*Parkinsonia aculeata*) in Australia

September 2004



Natural Heritage Trust
Helping Communities Helping Australia



Queensland Government
Natural Resources, Mines and Energy



CSIRO



National Prickly Bush
Management Group



Department of Agriculture
Government of Western Australia



NSW DEPARTMENT OF
PRIMARY INDUSTRIES



Northern Territory Government
Department of Lands, Planning and Infrastructure

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Note: Owing to machinery of government changes in Queensland, the former Department of Natural Resources became the Department of Natural Resources and Mines in 2001. In early 2004 it became the Department of Natural Resources, Mines and Energy. This name will be used throughout this publication.

Foreword

Parkinsonia is one of Australia's worst weeds. It already infests nearly a million hectares and threatens the agricultural and environmental value of over three-quarters of the Australian mainland.

This manual provides a timely review of our existing knowledge of parkinsonia management, in addition to presenting a variety of case studies drawn from the geographic range of the weed.

While knowledge gaps still exist, much can be learnt from the experience of those who have grappled with the challenge of combating this weed. The achievements of these people provide both inspiration and a realistic appreciation of the challenges involved.

The National Prickle Bush Management Group recognises that it is only through the combined efforts, diligence and commitment of all affected landholders, community and catchment groups, agencies and others that we will effectively gain ground on this weed.

I recommend this manual to all landholders affected by parkinsonia and suggest that those at risk of parkinsonia invasion make good use of the combined knowledge and experience contained in this book.

Further, I commend all those who have been responsible, both directly and indirectly, for its production.



Louise Moloney
Chairperson
National Prickle Bush Management Group

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Introduction

Parkinsonia—a weed of national significance

Parkinsonia (*Parkinsonia aculeata*) is an exotic plant that has been recognised as a weed of national significance (WONS) because of its invasiveness and its ecological, economic and social impacts.

Parkinsonia can form dense, and often impenetrable, thorny thickets along watercourses, bore drains, floodplains and grasslands. This makes land inaccessible for people and animals, restricts stock access to drinking water, decreases the amount of pasture available, and excludes native vegetation. It can also make mustering virtually impossible. Some infestations in the Gulf of Carpentaria region and the Fitzroy catchment in central Queensland are now up to several kilometres across.

Flood-prone country is particularly susceptible to invasion by parkinsonia. Dense infestations in these areas can destroy wildlife habitat, provide a harbour for feral animals such as pigs, contribute to soil erosion, and exclude native plants and animals.

Introduced to Australia in the late nineteenth century, parkinsonia is now present on almost one million hectares of the Australian mainland. Yet this is only a small fraction of the total area at risk of invasion.

The national vision—Parkinsonia is confined and its impact reduced to a minimum.

A national approach

To tackle the current and potential threat of parkinsonia, in 2001 a national strategy was launched with the following vision:

Parkinsonia is confined and its impact reduced to a minimum.

The strategy, based largely upon national management zones, aims to deliver four desired outcomes:

1. Parkinsonia management is coordinated and maintained at a national level.
2. Zone A infestations (containment zone) are reduced.
3. Zone B infestations (active control zone) are minimised.
4. Zone C infestations (eradication zone) are eradicated and new introductions of parkinsonia are prevented.

The strategy, documented in the national WONS Parkinsonia Strategic Plan, is being led by the National Prickle Bush Management Group (NPBMG). Comprised of agency and community representatives across Australia, the group is responsible for overseeing and monitoring the implementation of the national strategies for three weeds of national significance: parkinsonia, mesquite and prickly acacia.

In the period 2001–04, the Commonwealth Government provided funding for addressing weeds of national significance through the National Weeds Program (Natural Heritage Trust). This funding has been available to community groups for strategic control activities for parkinsonia and the development of best practice methodologies. Some of the case studies included in the manual have referred to this funding.

Use of this manual

Although research into parkinsonia ecology and management commenced in the 1980s, most data available to scientists are relatively new, and still incomplete. However, our efforts to date have provided a preliminary information base that is of use to all land managers working against this weed.

This manual incorporates a summary of our present understanding of parkinsonia ecology and management. This technical information is supported by a variety of case studies

drawn from areas that represent the Australian geographic range of this weed.

This manual is intended to present the combined experience and expertise of many landholders, community groups, agency staff and others who have been and still are tackling the parkinsonia problem. It represents an opportunity for land managers to further equip themselves with the skills and knowledge to achieve their individual and collective goals.



Nathan March

Members of the National Prickle Bush Management Group at a meeting in Karratha, WA. From left to right: Nathan March (National Coordinator, Department of Natural Resources, Mines and Energy, Qld), Noel Wilson (Department of Agriculture, WA), Dr Rieks van Klinken (CSIRO), Dr Shane Campbell (Department of Natural Resources, Mines and Energy, Qld), Louise Moloney (Chairperson), David Barton (Pilbara Mesquite Management Committee), Phil Maher (Department of Natural Resources, Mines and Energy, Qld), Peter Gray (Department of Agriculture, NSW), Damian Collopy (Department of Agriculture, WA) and Alice Beilby (Department of Infrastructure, Planning and Environment, NT). Absent: Nora Brandli (Desert Channels Queensland) and Jenny White (Australian Agricultural Company)



Nathan March

▲ Parkinsonia is an invasive weed causing ecological, economic and social impacts

Parkinsonia— ecology and threat



Section 1

Section 1

Parkinsonia— ecology and threat

Michele Deveze and Nathan March with Rieks van Klinken

Description

Parkinsonia is a many branched, spreading shrub or small tree with a deep taproot and an extensive surface root system. While it can grow up to 10 metres high, it usually grows to between 2 and 8 metres. Young parkinsonia plants are usually single thorny stems, and typically continue growing as a single-trunked plant. Stem damage can result in a multi-stemmed bushy plant.

Young plants have a pale to dark green hairless stem that gets darker and rougher with age. Its slender zig-zag branches are pale to dark green, hairless and photosynthetic, and armed with very sharp, 7–12 mm long spines growing from the leaf nodes. Its distinctive leaves are pale green and have a short, spine-tipped stalk. The leaf branches are 20–40 cm in length and flattened, with small, oblong leaflets up to 3 mm long arranged along each edge.

The fragrant flowers are up to 20 mm in diameter, five-petalled, and predominantly yellow. The top petal either has orange spots or turns completely orange. Each flower grows on a long, slender, drooping stalk arising from leaf joints in groups of 8 to 12. The seeds are oval, hard, olive green to brown, 8–15 mm long and 3–4 mm wide. They are typically produced in 5–10 cm long, pencil-like, light brown leathery pods, which are constricted between the 1 to 3 seeds they usually contain. Pods can, however, contain up to 9 seeds.

Parkinsonia is most likely to be mistaken for other thorny shrubs and trees such as

prickly acacia (*Acacia nilotica*), mesquite (*Prosopis* spp.) and mimosa bush or needlebush (*Acacia farnesiana*). Prickly acacia and mesquite are also weeds of national significance.

To differentiate parkinsonia from other prickly bushes, look for tiny oblong leaflets on a flattened leaf stalk; the other species have fernlike or pinnate leaves.



Nathan March

▲ Parkinsonia infestation



Nathan March

▲ Plant form



Nathan March

▲ Pods



Nathan March

▲ Leaves



Nathan March

▲ Flowers



Nathan March

▶ Young plants characteristically have single thorny stems



Distinguishing between the 'prickle bushes'

Parkinsonia may be confused with other prickly bushes such as mesquite (*Prosopis* spp.), prickly acacia (*Acacia nilotica*), mimosa bush (*acacia farnesiana*) and mimosa (*Mimosa pigra*). These plants, with the exception of mimosa bush, are also weeds of national significance.

It is possible to tell the difference between the prickly bushes by examining the flowers and pods. If neither of these is available, they can be distinguished by their tree shape, leaves, bark or branches. However, as this can be difficult, a local weeds officer should be consulted.

The major differences between the prickly bushes are listed in Table 1.

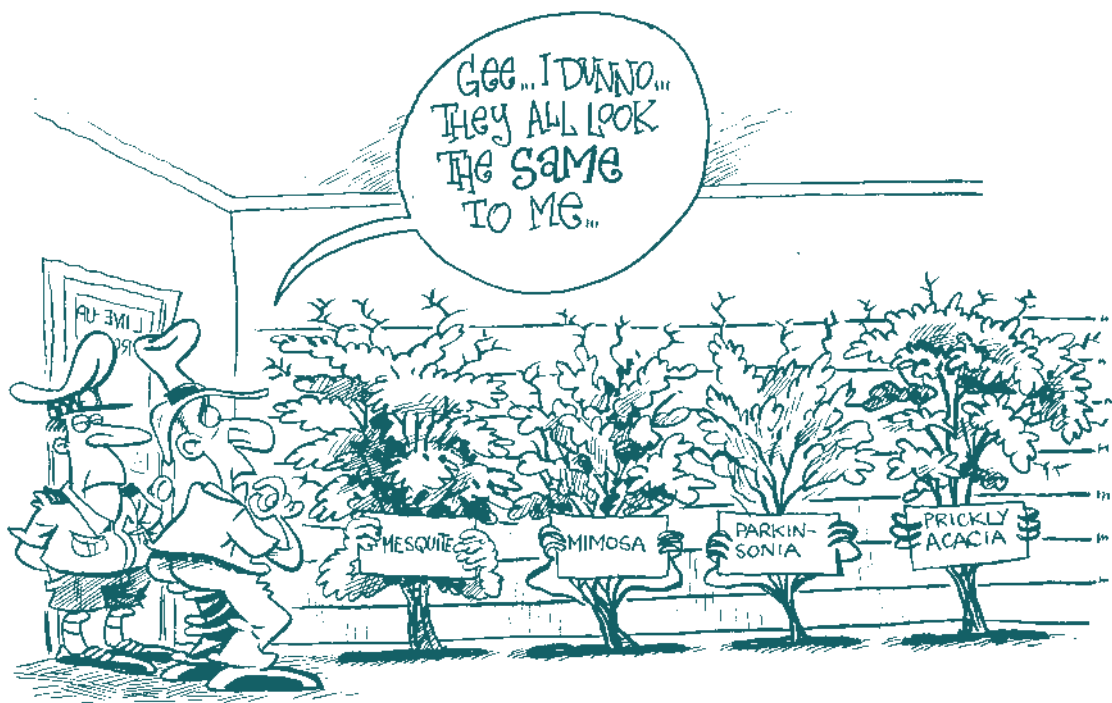




Table 1 Differences between prickle bushes

	Mesquite <i>Prosopis</i> spp.	Prickly acacia <i>Acacia nilotica</i>	Parkinsonia <i>Parkinsonia aculeata</i>	Mimosa <i>Mimosa pigra</i>	Mimosa bush <i>Acacia farnesiana</i>
Pod shape	Up to 20 cm long; slight constrictions between seeds; straight or slightly curved	Up to 23 cm long; constrictions between seeds	Up to 10 cm long; thin constrictions between seeds; straight	3–8 cm long; one-seeded, bristled segments, which fall away from the pod leaving a skeletal outline	Cigar-shaped; up to 6 cm long; slightly curved
Pod colour, hairiness	Straw-coloured, sometimes purple; no hairs	Blue-grey; fine hairs	Straw-coloured; no hairs	Brown when mature; covered with dense bristles	Brown to black; no hairs
Flowers	Cylindrical, greenish-yellow spike, 5–8 cm long	Ball-shaped, golden yellow, about 1 cm across	Five petals, mainly yellow, one with an orange spot	Round, fluffy, pink or mauve balls, 1–2 cm across	Ball-shaped, golden yellow, about 1 cm across
Leaves	Fernlike; 1–4 pairs; often with a gap between leaves	Fernlike; 4–10 pairs; often overlapping	Long, flattened leaf stalk with tiny oblong leaflets along each side	Central leaf stalk prickly; 20–25 cm long. Each leaf contains about 15 opposite segments, 5 cm long and divided into pairs of leaflets that fold up when touched or injured	Fernlike; 2–4 pairs; with a gap between leaves
Leaflets	6–18 pairs	10–25 pairs			8–18 pairs





















Table 1 Differences between prickle bushes (continued)

	Mesquite <i>Prosopis</i> spp.	Prickly acacia <i>Acacia nilotica</i>	Parkinsonia <i>Parkinsonia aculeata</i>	Mimosa <i>Mimosa pigra</i>	Mimosa bush <i>Acacia farnesiana</i>
Tree shape	Variable—either a multi-stemmed shrub to 5 m, or a spreading tree to 15 m	Spreading tree to 10 m	Small tree or shrub usually to 5 m	Multi-branched shrub to 5 m	Usually rounded shrub to 3 m
Bark	Rough, grey; smooth dark red or green on small branches	Tinge of orange and/or green on saplings; dark and rough on mature trees	Smooth and green; straw-coloured and lightly textured at base of older trees	Stems green at first; becoming woody; initially covered with thick hairs	Grey, with prominent white spots
Branch shape	Zigzagged	More or less straight	Slightly zigzagged	More or less straight	Zigzagged





Different features of the prickly bushes

Mesquite	Prickly acacia	Parkinsonia	Mimosa	Mimosa bush
				
				
				
				





Life cycle

Parkinsonia is fast growing and can flower as early as the summer of its second year of growth. Although most flowering occurs in spring or summer, it can occur opportunistically at any time of the year.

Parkinsonia produces large numbers of seed pods and seeds. Most pods mature in early to late summer and fall from the tree where they decay away, leaving the seeds behind. Parkinsonia seeds have a thick and extremely hard coat and can remain viable in the soil for many years before responding to favourable conditions and germinating. Seeds require wet soil conditions for several days to stimulate germination. Mass germination events may occur following rainfall, and will result in dense thorny thickets if not rapidly controlled.



Nathan March

▲ Pods are easily spread by the movement of water

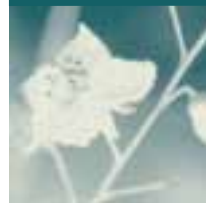
Habitat and distribution

Parkinsonia is native to Central America, northern South America, the Caribbean and tropical southern United States. It was introduced to Australia in the late nineteenth century as an ornamental plant and as a shade tree for planting around bores, dams and homesteads. Parkinsonia is adapted to growing under an extremely wide range of climatic and soil conditions but is most frequently found around creeks, river levees, bores and dams, and on black soil plains. Once parkinsonia plants are established, they withstand heat and drought well.

Parkinsonia pods float and seed can therefore be easily spread by water, particularly during floods. Seeds can also be spread in mud sticking to machinery, animals and footwear. The pods are relatively unpalatable to domestic, wild and feral animals, although these animals have been known to eat and disperse seeds, especially in drought conditions when more palatable foods are limited. There is little doubt that parkinsonia will continue to spread along watercourses, bore drains and floodplains, as well as adjoining areas throughout the sub-humid, semi-arid and arid environments of north Australia.

Parkinsonia seeds have a thick and extremely hard coat and can remain viable in the soil for many years





Parkinsonia currently infests approximately 1 million ha of land, and is established (mainly along watercourses) in thickets throughout northern Australia. This includes the Pilbara and Kimberley in Western Australia, and much of the Northern Territory and Queensland. Isolated occurrences also occur in South Australia and New South Wales.

Parkinsonia has the potential to invade more than three quarters of mainland Australia

Parkinsonia has the potential to invade more than three quarters of mainland Australia including the Gulf region, Channel Country, Mitchell Grass Downs, Lake Eyre Basin, western New South Wales, northern South Australia, Barkly Tablelands and the Kimberley and Pilbara. Special effort is being made to prevent the weed's spread into Cape York, the Lake Eyre and Murray–Darling basins in Queensland, and the blue-bush swamps of the Barkly Tablelands.

Parkinsonia pods float so seed can easily be spread by water

Figure 1 Distribution of parkinsonia in Australia, 2003

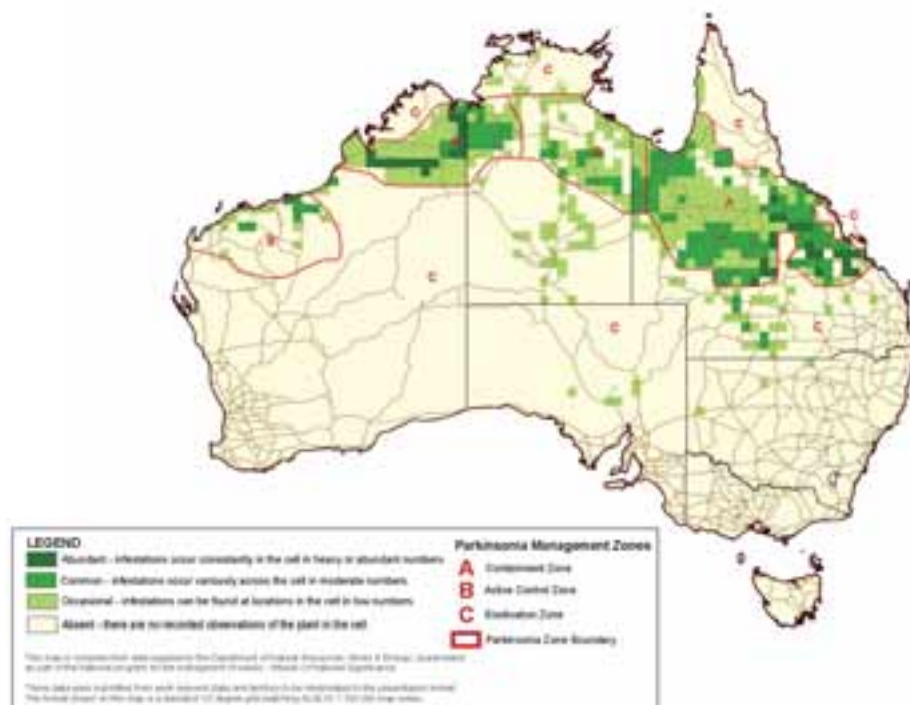
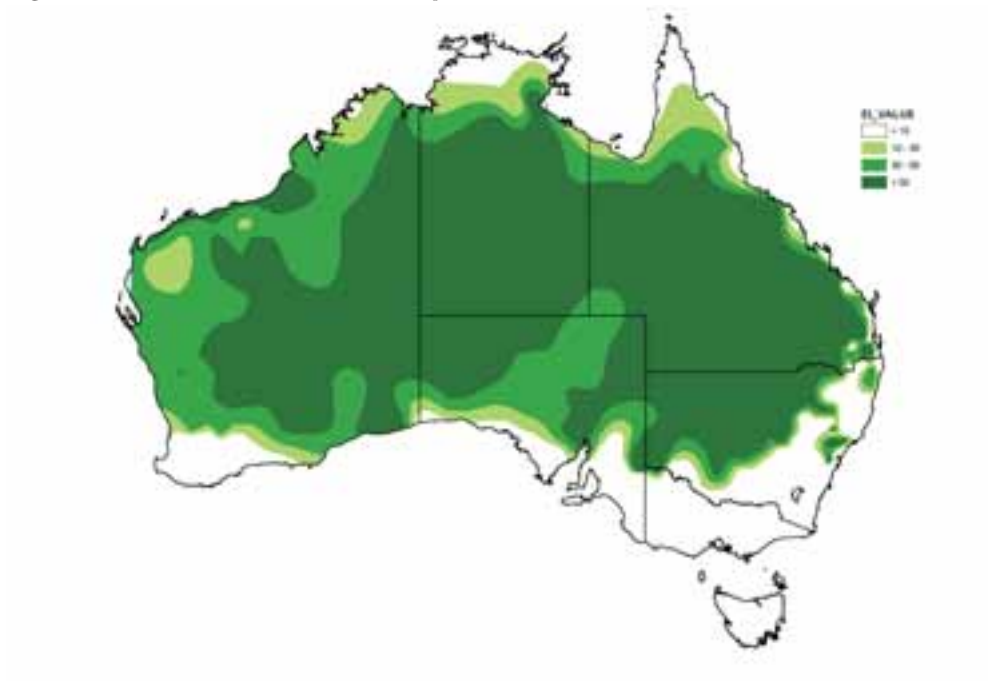




Figure 2 Potential distribution of parkinsonia in Australia



Data is splined from a CLIMEX Climate Prediction. EI = Ecoclimatic Index. EI<10 Potential for permanent population very low, EI>50 potential for permanent population very high.



Managing parkinsonia



Section 2

Managing parkinsonia

Michele Deveze and Nathan March

Evolution of management strategies

By 1906 parkinsonia was already considered a weed in parts of Queensland, especially along the Fitzroy River. By 1972 it had taken a firm hold in the Darwin area and in the Victoria River and Gulf districts.

Although parkinsonia is already widespread in Australia, invasion is still mostly in the early stage of thicket formation. Consequently, the total loss of pastoral production and environmental values due to parkinsonia infestation is still small. Most of the direct costs associated with parkinsonia are related to control work, and expenditures of up to \$5000 per annum on individual properties are beginning to occur, with 46 per cent of all landholders in the major areas of infestation spending money on parkinsonia control (Vitelli 1995).

The first formal recommendation for parkinsonia's control came in the 1950s: basal bark spraying using 2,4,5-T in diesel (ARMCANZ & ANZECCFM 2001). This became the standard method of control in infested areas on properties and government reserves until the herbicide's demise in the early 1990s. In addition to this, some landholders utilised fire and mechanical control.

As the problem became more serious, a combined research effort began in the early 1980s, with three state or territory government departments—the Department of Natural Resources, Mines and Energy,

Queensland; the Department of Agriculture, Western Australia; and the Northern Territory's Department of Primary Industries and Fisheries—looking into herbicide and biological control methods. This resulted in the release of three biological control agents and the registration of further herbicides for parkinsonia control.

In 1999 parkinsonia was recognised as one of Australia's 20 worst weeds, and a portion of significant National Heritage Trust (NHT), funding for the years 2001–03 has supported the development of a highly successful and collaborative research effort between state and territory departments, CSIRO and the Cooperative Research Centre for Australian Weed Management.

A major focus of the research is to predict the likely impact of parkinsonia in different regions and habitats throughout Australia if no control work is undertaken, and to develop integrated management methods (including the use of biological control, fire, machinery, herbicides and improved on-farm management) to minimise its spread and impact. It is expected that management strategies will need to be tailored for different landscapes around Australia. Research findings will be presented in future parkinsonia management publications.



Developing a weed control plan

Developing an overall plan for weed management on your property can save you time and money as well as helping you achieve other desired outcomes.

A realistic view of the impact of parkinsonia on overall property management is a necessary first step if planning is to be effective. Developing and implementing an achievable plan will reduce the impact of parkinsonia on a property's primary resources.

Although the control of parkinsonia is the primary focus of this manual, the same management principles can be applied to other weeds on a property. Ideally, all weed management should be included in the same plan, and a weed management plan should be integrated into the overall property management plan. It is recommended that a weed control plan has at least a 5–10 year time frame and is reviewed annually.

A range of planning processes is available for this purpose. The following is a suggested control and eradication management plan involving six steps. More detailed information about individual treatment methods is presented in Section 3.



Nathan March

▲ Peter Klem, Winton Shire Council, reviews a parkinsonia management plan





Suggested planning steps

Step 1: Define and prioritise the problem areas

The easiest way to identify problem areas is by using a map of the property.

- On the map, outline all natural features, improvements and property boundaries; then indicate areas of parkinsonia and other weeds, noting the size and density of each infestation.
- Prioritise the areas for control at both the property level and a paddock-by-paddock level—keeping in mind features outside your property such as seed sources, seed dispersal routes or vulnerable areas.
- Consider what legal or ethical responsibilities you may have (e.g. the threat of parkinsonia to neighbouring properties).
- Consider relevant local government, catchment or regional priorities and plans.

- The property map can be an aerial map, a satellite image or a hand-drawn map. Remember that the more accurate and current the map, the more precise the estimates and calculation of the control costs will be, and the easier it will be to track the long-term effectiveness of control programs.
- Separate transparent overlays are useful when developing the plan. Use one overlay to map property improvements, one for vegetation types and natural features, and one for weed infestations. The use of different overlays can make each section of the map easier to interpret and will also help determine management options, such as the placement of fences or fire containment lines.

Step 2: Determine the control options

- Identify the resources that are already available or affordable, such as spray equipment, machinery and labour.
- Determine the control methods required to address all phases of the control program—initial, follow-up and ongoing monitoring.
- Identify the most appropriate management strategies to control the parkinsonia infestation in each situation. Figure 3 (in Section 3) is a guide to the cost-efficiency of different techniques in relation to the infestation size. Table 3 provides an

indication of the suitability of treatment method in relation to infestation density. Usually, a combination of methods is necessary to complete the job effectively. Refer to sections 3 and 7 of this manual.

- To help prevent infestations from spreading, control efforts should initially focus on isolated and strategic outbreaks of parkinsonia. Start with the easiest section to control and then gradually work towards the thicker patches.





Step 3: Develop a financial plan

- Estimate costs of the management strategies and control options for each priority.
- Compare the costs of control against other property management priorities to make sure that the chosen control methods are viable options.
- Integrate control costs into short-term and long-term property budgets.
- Check to see if there are any financial incentives available to assist with control programs.
- All costs should be considered when developing a financial plan, including the hourly running costs of machinery and labour. If necessary, seek advice from local government or departmental weeds officers before committing a large amount of funds.
- Ensure that future costs are adequately considered. A common pitfall is to underestimate the amount of ongoing control required.

Step 4: Schedule activities for weed control

Parkinsonia control needs to be a regular part of property management.

- When developing a plan, take into consideration that after initial treatment, monitoring and follow-up control will also be necessary. Ensure that any treated areas are followed up within a year.
- Consider the effectiveness of control methods at different times throughout the year and balance this with the time available for weed control.
- Try to integrate weed control with other property management activities. For example, it may be suitable to combine a routine burn with the control of parkinsonia.
- Schedule all weed control activities for the year.

Step 5: Monitor progress

As an integral part of any control program, monitoring will show what has happened after treatment; it will identify areas of regrowth and indicate where follow-up is required.

- Use the map of the property as a baseline record of the problem before any control work has commenced.
- On the map, show previously treated areas and any new ones.
- Take several photographs at the same point over time, to show the changes resulting from the control effort.
- Document control costs and resource requirements.
- Incorporate monitoring activities into the yearly timetable.

Step 6: Follow up what was started

Follow-up control is crucial. No one control method for parkinsonia gives 100 per cent kill rate and some level of regrowth is almost guaranteed.

- Identify areas from the monitoring sites where follow-up is needed as a result of regrowth or seed germination.





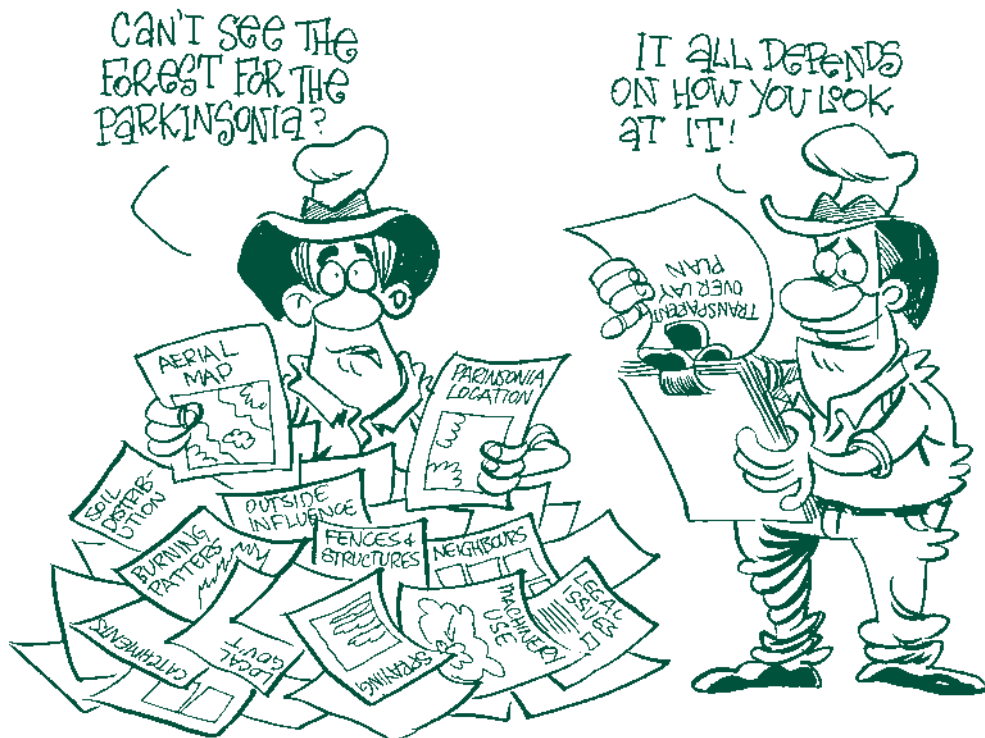
Helpful tips

There is no 'quick fix' solution to parkinsonia management, so the development of a parkinsonia management plan and a commitment to that plan is essential for the long-term effectiveness of your efforts.

Any control plan is useless without implementation. If, because of the size of the problem or lack of experience, it is difficult to start the planning process, it is advisable to gain professional advice and/or start on a smaller scale.

While the plan must be structured, it should be flexible enough to allow for changes brought about by uncontrollable external influences such as drought or fluctuating commodity prices.

It is critical to review the plan annually to assess the effectiveness and efficiency of the control options and strategies implemented.



Parkinsonia control



Section 3

Parkinsonia control

*Michele Deveze, John McKenzie, Rieks van Klinken
and Shane Campbell*

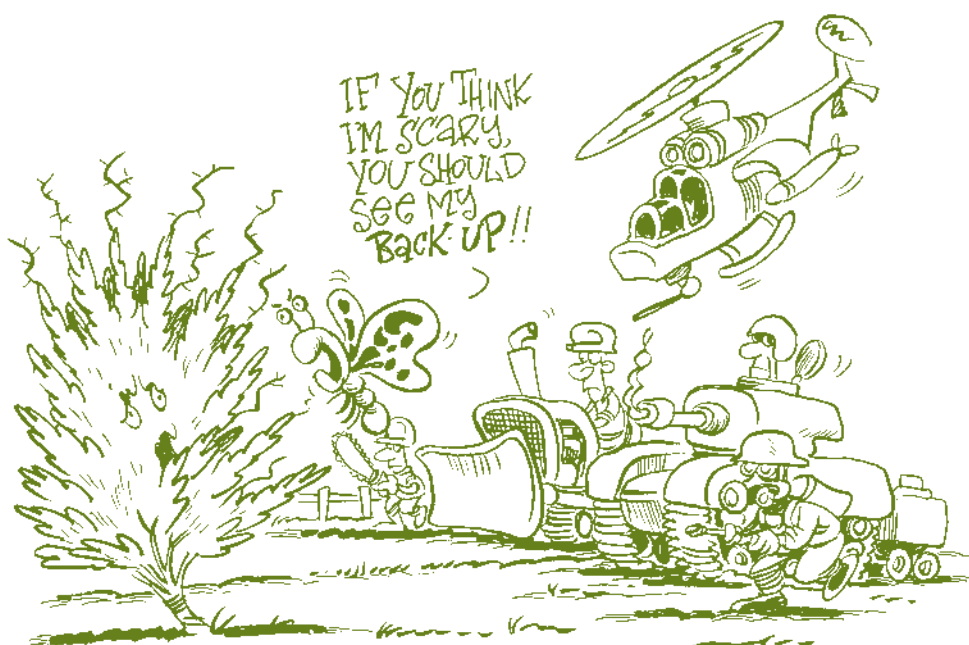
Although isolated trees or small clumps of parkinsonia may appear not to be a threat to the environment or an impediment to land management, individual plants will be the origin of future large infestations. Controlling parkinsonia before it takes hold is the most cost-effective approach to management.

A range of tools and techniques is available for parkinsonia management though at this stage there is no one method or 'best practice' for effectively managing extensive infestations. The most suitable control method may depend on the season, the type of country and extent of infestation, the identified environmental or economic risks, and the resources available. The combination, timing, intensity and frequency of treatments will also influence the effectiveness of the

control program. No matter what control method is used, new recruits will appear for many years after initial control, and it will always be necessary to undertake several follow-up treatments on regrowth.

Although some of the research is incomplete and inconclusive, anecdotal evidence and preliminary findings suggest that the following methods can be considered for controlling parkinsonia:

1. herbicide control
2. mechanical control
3. fire
4. grazing management systems
5. native organisms
6. introduced biological control agents
7. integrated management techniques.



Control methods

1 Herbicide control

Table 2 lists the herbicides registered for the control of parkinsonia. Chemical control measures always need to be followed up as some trees may be missed in the first treatment, and re-growth can occur from stumps or seeds.

- **Aerial application.** Application of herbicides, either liquid or granular, can be done by helicopter or fixed-wing aircraft fitted with purpose-built applicators. This technique is useful for dense, strategic infestations but consideration should be given to the proximity of water bodies, areas of native or desirable vegetation, and environmentally sensitive areas.



John McKenzie

▲ Application of a foliar herbicide using a helicopter

- **Foliar (overall) spraying.** Spraying the foliage and green stems of parkinsonia is a very effective control method for the treatment of actively growing seedlings up to 1.5–2 m tall. Leaves and stems should be sprayed to the point of run-off, and for best results a wetting agent must be used. The choice of application equipment depends upon the size, height, density and extent of the infestation.

For isolated or scattered situations, manual hand-held or back-pack spray units may be sufficient. As the density and size of the infestation to be treated increases, the use of four-wheel motorbike, four-wheel drive or tractor-mounted PTO, hydraulically or independently operated spray units with extension hoses will be more appropriate.



John McKenzie

▲ Herbicide application using a plane



- **Basal bark spraying.** Plants can be killed by applying herbicide mixed with diesel to their trunks or stems. For stems of up to 5 cm diameter, carefully spray completely around base of plant from ground level to between knee and hip height. To increase susceptibility, plants should be actively growing.

The trunk may need to be cleared of grass and the stem should be dry before spraying. Because parkinsonia-infested areas are often subject to flooding, care is also needed to ensure that mud and flood debris does not prevent spray reaching the bark.



- ▲ Andrew Burrows (NRM&E land protection officer) basal bark spraying a parkinsonia plant



- ▲ Chris Moloney of Bibil using a chainsaw for cut stump application of herbicide

- **Cut stump application.** Cut stems off less than 15 cm above ground level with a brush-cutter, chainsaw, brush hook or axe. Immediately swab or spray the cut surface and remaining stem with herbicide mixture. This process can be performed at any time of year.



- **Soil application.** Parkinsonia can be controlled by spot gun or granular herbicide treatments. Both soil-applied herbicides registered for use on parkinsonia (tebuthiuron and hexazinone) also have a residual affect with the potential to control seedling recruitment. Herbicides are sold as either granular or spot spray formulations. Place doses close to tree trunk—either with spot gun on clear bare ground; underground with ground injector; or evenly under the canopy and close to the trunk using a granular applicator. Herbicides should be applied to dry soil and will require rain before the chemical is taken up by plants. Do not use soil-applied herbicides within 100 m of watercourses. As well, do not use near desirable trees or shrubs or in areas where their roots may extend, or where the chemical may be washed into contact with their roots.

Table 2 lists which registered herbicides are appropriate to use with the above techniques as well as other relevant information.



John McKenzie

- ▲ Soil-applied herbicides will kill mature plants as well as having a residual affect. Hexazinone was the chemical used at this site near Rockhampton, Queensland



Table 2 Registered herbicides for parkinsonia control: product and application information

Application method	Active chemical constituents	Product names	Registered states	Rate	Optimum stage and time	Comments
Aerial	tebuthiuron	Graslan	Qld and NT	10–15 kg/ha	Apply prior to seasonal rainfall. Use a higher rate on dense growth or heavy soils.	Normally applicable to areas larger than 100 ha. Consult Dow Agrosience prior to application (phone: 1800 700 096).
Aerial (helicopter only)	triclopyr + picloram	Grazon DS, Grass-up, Triclozon, Trichloram, Tri-Pick, Picker	Qld and NT	3 L/ha	Seedlings 1–2 m tall or 12–24 months old. Avoid dry conditions, stressed plants or pod-bearing plants. Thoroughly wet foliage.	Apply oil-based wetting agent at 1 L/hectare.
Foliar (overall spray)	triclopyr + picloram	Grazon DS, Grass-up, Triclozon, Trichloram, Tri-Pick, Picker	Qld, NT and WA	350 mL per 100 L water	Plants to 2 m tall. Avoid dry conditions, stressed plants or pod-bearing plants. Thoroughly wet foliage.	Wet plant thoroughly. Use oil-based wetting agent.
Basal bark	triclopyr + picloram	Access	All states	1 L per 60 L diesel	Seedlings less than 2 m tall, or up to 5 cm diameter and actively growing.	Do not treat wet stems.
Cut stump	triclopyr + picloram	Access	All states	1 L per 60 L diesel	Throughout year.	Cut close to ground level and treat <i>immediately</i> .
Soil	tebuthiuron	Graslan	Qld and NT	10–15 kg/ha 1–1.5 g/m ²	Throughout year. Best applied to dry soil before rain. Needs moisture to activate herbicide.	Refer to label for critical comments.



Table 2 Registered herbicides for parkinsonia control: product and application information (continued)

Application method	Active chemical constituents	Product names	Registered states	Rate	Optimum stage and time	Comments
Soil: spot spray (individual tree)	hexazinone	Hexazinone Bobcat® SL	Qld, NSW, ACT and WA	4 mL/spot, 1 spot for each bush or tree	Bushes or trees up to 5 m tall.	Best when trees in active growth, and either soil is moist or rainfall will follow.
		Velpar® L	Qld, NSW and WA		Shrubs/trees up to 5 m tall. Throughout year. Needs moisture to activate herbicide.	
Soil: spot spray (grid pattern)	hexazinone	Bobcat® SL	Qld, NSW, ACT and WA	1 mL per spot to 1 m tall		
		Velpar® L	Qld, NSW and WA	4 mL per spot to 5 m tall		

Notes

1. Minor 'off label' permits have been obtained for specific uses in all states. For more information, refer to your local government pest management officer or state agricultural or primary industries department.
2. Prior to using herbicides, carefully read and follow all label directions and special restrictions that may apply (e.g. application distances from recognised watercourses and remnant vegetation). Do not use soil-applied herbicides within a distance of 2–3 times the height of desirable trees. Use must be in accordance with the state and/or local government native vegetation legislation.





2 Mechanical control

Mechanical options include clearing infestations by grubbing, stick raking, blade ploughing, chain pulling or using a cutter bar. Research and anecdotal evidence indicates that mechanical clearing is most effective when the roots of plants are removed or sheared off below the bud zone (20–30 cm below ground level). This decreases the potential for post-clearing regrowth. Best results are achieved when the plants are stressed, which generally coincides with the dry season. The exception is blade ploughing which still has good results when there is some soil moisture.

For small plants, hand-pulling or grubbing with a mattock can be effective. For scattered infestations, a backhoe or tractor fitted with a front-mounted blade may be used to remove individual plants.

Initial clearing by stick raking or blade ploughing is an effective way to reduce the standing volume of parkinsonia and increase its susceptibility to other forms of treatment. Preliminary results suggest that correct use of



John McKenzie

▲ Rear-mounted blade plough

a blade plough results in very high parkinsonia mortality (application of these techniques are further discussed in Section 7, 'Technical updates').

However, it is probable that the physical disturbance of soil associated with clearing creates an ideal seed bed, resulting in increased seed germination and necessitating mechanical or herbicide follow-up control.

To minimise the risk of soil erosion, heavy mechanical work must be restricted to reasonably level areas away from watercourses. In most states and territories tree-clearing permits will need to be obtained if there is a risk that native vegetation will be affected by control techniques.

▼ Front-mounted blade plough (Ellrott design)



John McKenzie

▼ Dozer pushing



John McKenzie

3 Fire

The effect of fire on parkinsonia appears to be variable and will depend on fire intensity and season. Fire has been observed to destroy seedlings if sufficient fuel load is present, and in some circumstances mortality of adult plants has been reported.

However, the use of fire is frequently limited by lack of fuel load, social or cultural constraints, the safety risks of late dry-season burns, the desire to conserve valuable livestock fodder, and concern about non-target environmental effects, particularly in wetlands and riparian habitats.



John McKenzie

▲ The Department of Natural Resources, Mines and Energy is continuing its assessment of fire through trials



John McKenzie

▲ Sufficient fuel is required for an effective fire

Other important factors to consider with fire include:

- What is the desired outcome?
- When is the best time for this fire?
- What is the seasonal weather outlook? Check the Southern Oscillation Index.
- What fuel load is required? Note that fire intensity increases with fuel load.
- Will fencing be needed to manage pre- and post-fire grazing?
- Is it possible that non-target vegetation may be killed? Ensure that you comply with government vegetation management legislation.
- What safety precautions (e.g. fire breaks) need to be taken? The risk of wildfire can continue for some days after a controlled fire.
- When will follow-up operations be required?

It is also important to notify neighbours and obtain a permit from a fire warden before burning.

Further discussion on the potential use of fire for parkinsonia management is provided in Section 7, 'Technical updates'.



4 Grazing management systems

Although cattle browse on parkinsonia foliage and repeated physical damage and defoliation may cause the death of juvenile and small adult trees, there is currently no clear data available regarding the relationship between the grazing of cattle in infested areas and parkinsonia dispersal or mortality. Under normal grazing conditions, cattle will generally select other species for browsing so parkinsonia control due to cattle grazing seems to be minimal.

By contrast, camels browse on parkinsonia shoots, flowers and pods, and since only around 8 per cent of the seed is viable after passing through camels, such grazing drastically reduces soil seed bank levels. Several landholders in recent times have incorporated camels as a parkinsonia control option (J McKenzie, pers. comm., August 2003).

Heavy native pasture cover is likely to compete with parkinsonia seedlings for light and moisture, thus limiting parkinsonia germination and survival. However, it is not yet known whether these competitive effects will be strong enough to affect existing parkinsonia populations. Grass will also provide fuel for control using fire.

Physical damage of wetlands by livestock and pigs is likely to result in ideal habitats for parkinsonia recruitment. These areas are already at high risk of parkinsonia infestation because the seed is transported by floodwaters and parkinsonia favours seasonally wet environments. It has been suggested that fencing might be beneficial under those circumstances.



John McKenzie

▲ Camels will browse on parkinsonia foliage, flowers and pods



5 Native organisms

In Australia, parkinsonia is relatively free from attack by native insects or diseases. The most damaging is the giant termite (*Mastotermes darwiniensis*) which is capable of killing mature plants, although the plant's root systems may survive and send up fresh suckers (R van Klinken, pers. comm., July 2003). Other species that have been observed on parkinsonia include seven species of stem-sucking bugs; stem borers in trunks of large trees; two pod and seed feeders; two species of grasshoppers; and a case moth caterpillar that chews leaves. The combined impact of all of these insects on the plant is likely to be negligible (R van Klinken, pers. comm., July 2003).

Heavy coccid (mealybug) infestations have been reported in the Victoria River district where they have caused distortion of growth tips (R van Klinken, pers. comm., July 2003). Most observed plants were infected throughout the year. The impact of the coccids has not been quantified but plant growth is likely to be reduced. Probably they have most effect on plants that are already stressed.

Widespread dieback of parkinsonia has been observed in many parts of Australia, although the cause has not yet been determined. Plant diseases are one possibility.



Marie Vitelli

▲ Damage to a parkinsonia plant caused by the giant termite (*Mastotermes darwiniensis*)



6 Introduced biological control agents

Biological control is the process of introducing natural enemies of exotic weeds or other pests to reduce their growth, reproductive capacity or life expectancy.

Three species of insects have been introduced into Australia as biological control agents against parkinsonia: the parkinsonia seed beetles *Penthobruchus germani* (first released from Argentina in 1995) and *Mimosastes ulkei* (first released from the USA in 1993), and the leaf bug *Rhinacloa callicrates* (first released from the USA in 1989). Only *Penthobruchus* has become widely established.



▲ *Penthobruchus germani*



Marie Vitelli

▲ *Rhinacloa callicrates*

Existing biological control agents may not be having a significant impact on parkinsonia survival and reproduction in most parts of Australia. In addition, because of the wide range of environments and land management systems that are infested with parkinsonia, it is unlikely that individual biological control agents will be equally effective throughout parkinsonia's distribution.

CSIRO Entomology is currently conducting surveys for potential new biological control agents in Central America. Further information regarding the biological control of parkinsonia is provided in Section 7, 'Technical updates'.

Catherine Lockett



7 Integrated management techniques

A range of different parkinsonia management techniques is available to land managers. The underlying principle of integrated pest management is that the choice, sequence and timing of selected treatments is intended to enhance and build on the attributes and outcomes of each, and to complement routine property management.

Because of the complexity of developing an integrated management program it is recommended that landholders define their management proposal in an overall property weed management plan. Initially, the characteristics of the infestation must be identified and the capabilities, shortcomings and probable outcomes of different control methods need to be understood.

To begin a weed management project for parkinsonia, begin by dividing the property into areas of scattered, medium and dense infestation, and prioritise those infestations that are in the vicinity of watercourses and floodplains. Develop a long-term control plan, treating each identified site with the appropriate control methods.

Using a series of control methods, in which each enhances the performance of the next planned operation, and the activities fit in with routine property management, will give the best overall results in cost-effective parkinsonia management.

A more detailed explanation of the development of whole farm weed management plans is provided in Section 2. Further discussion of integrated management is included in Section 7, 'Technical updates'.

Selecting the most appropriate control method

The following table and figure provide a range of information about the effectiveness of selected control methods. Table 3 rates the suitability of selected control methods in relation to different densities of infestation.





Table 3 Suitability ratings for parkinsonia control methods relative to densities of infestation

Control method	Density of initial infestation			Seedling growth
	Low density (<small><250 plants/ha</small>)	Medium density (<small>250–1000 plants/ha</small>)	High density (<small>>1000 plants/ha</small>)	
Herbicides				
Foliar (aerial application):	✓	✓✓	✓✓✓	✓✓ (if high density seedling regeneration occurs)
Foliar (overall spray)	✓✓	✓✓	✓	✓✓✓
Basal bark spraying	✓✓✓	✓✓	✓	✓
Cut stump application	✓✓✓	✓✓	✓	✓
Soil-applied herbicides: tebuthiuron	✓✓✓ (hand applied)	✓✓	✓✓✓ (aerial application)	✓✓
Soil-applied herbicides: hexazinone	✓✓✓	✓✓	✓	✓✓
Mechanical means				
Grubbing (tractor pushing)	✓✓✓	✓		
Grubbing (dozer pushing)	✓	✓✓	✓✓	
Blade ploughing		✓✓	✓✓✓	✓✓ (if high density seedling regeneration occurs)
Front-mounted blade plough (Ellrott design)	✓✓	✓✓✓	✓✓✓	✓✓ (if high density seedling regeneration occurs)
Stick raking	✓	✓✓	✓✓	
Double-chain pulling			✓	
Fire				
Fire	✓✓	✓✓	✓✓	✓✓ (variable depending on timing and plant condition)

Notes

- 1 Suitability ratings are based on consideration of control effectiveness, efficiency and practicality, as follows: very good (✓✓✓), moderate (✓✓), low (✓).
- 2 Before applying herbicide and mechanical control methods, seek information on state and/or local government native vegetation legislation and guidelines.
- 3 Fire research is still in progress to determine the most effective fire regimes.



Parkinsonia density standards

Nathan March and Andrew Burrows

Low density <250 plants/ha



20 plants/ha



100 plants/ha

Medium density 250–1000 plants/ha



250 plants/ha



600 plants/ha

High density >1000 plants/ha



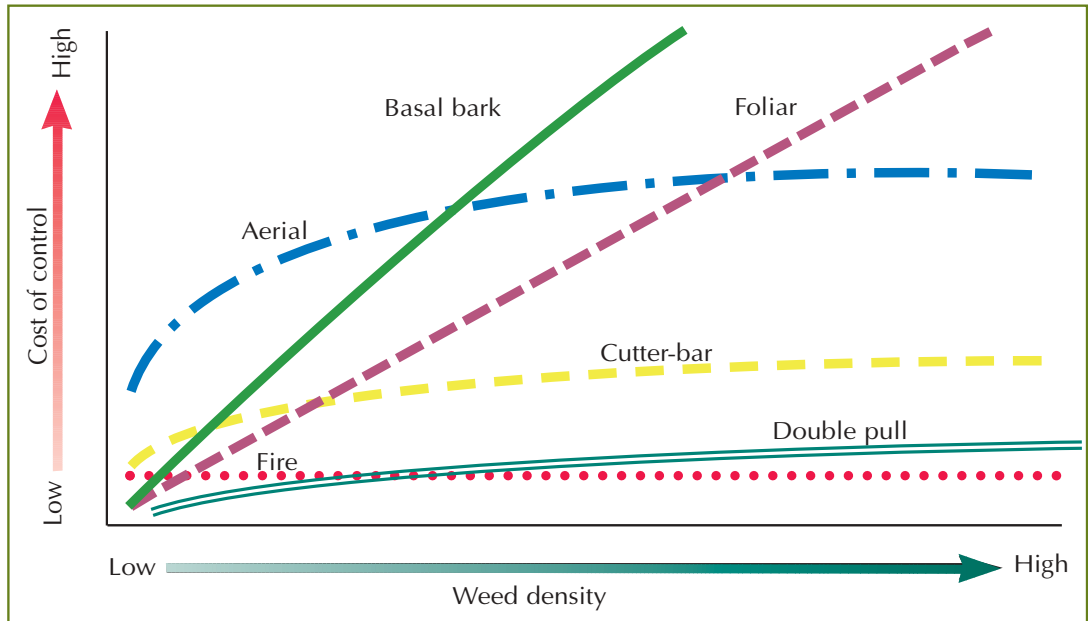
1000 plants/ha



3000 plants/ha



Figure 3 Cost comparison of parkinsonia control techniques



Case studies— property management approaches

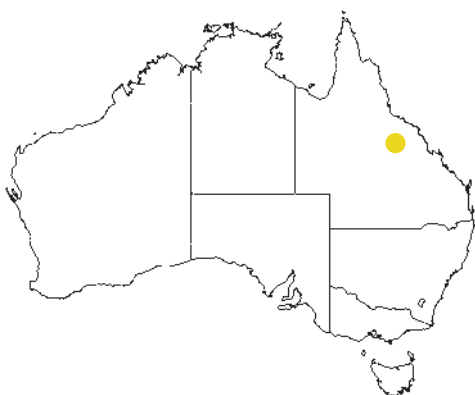


Section 4

Case studies—property management approaches

Integrating proven and innovative techniques

Michele Deveze with John and Ronda Lyons



Background

John and Ronda Lyons of Wambiana, near Charters Towers, are the third generation to have worked and developed the property on the eastern highlands in north Queensland since John's grandfather bought the property in 1912. John sees the family as 'long-term residents' wishing to be 'good custodians'.

Wambiana lies within the Campaspe River catchment which feeds runoff into the Burdekin River, the major watercourse of the area. It is open savannah poplar gum and carbeen grassland interspersed with brigalow and gidgee scrub. These grow on undulating to flat country, river channels and floodplains, comprising alluvial, cracking clay and duplex yellow earth soils. The property carries about 3000 head of Brahman cattle on its 22 300 ha. John and Ronda also conduct an educational tourism enterprise offering 'outback experience' to school children.

'What we failed to recognise was that the parkinsonia was laying the foundation for an explosion'

The parkinsonia threat

John remembers parkinsonia being on Wambiana for the past 50 years but until 10 to 15 years ago there was only a scattering of plants.

'What we failed to recognise was that the parkinsonia was laying the foundation for an explosion—we thought it was just a couple more plants coming.'

Within about three years, the infestation went from a fairly scattered to a dense stand of parkinsonia, and it continued spreading along watercourses at an alarming rate. Unfortunately, its spread coincided with the drought. The country was bare and brown, yet the parkinsonia thrived. Friends and neighbours made the same observations—they could see that parkinsonia was quickly overtaking rubber vine as their 'number one woody weed problem'.

As the parkinsonia spread, it shaded out the grass on the best soils, reducing grazing capacity. Finally, the Lyons realised they had a problem which threatened their base resources—the soil and grass production.

Experience with control methods

Herbicide treatment

The first control method used against parkinsonia was Graslan.



‘We had a good result. We used to be able to buy a container that would measure the appropriate dose of Graslan, we’d throw it on top of the canopy so that it came down in the area of dripline.’

Three men went on horseback—which meant that all types of terrain could be covered—followed by one on a four-wheel motorbike with a supply of Graslan. John remembers that it was fairly costly in labour but the results were very good.

Grazing management

Their next move was less successful.

‘In our innocence, we locked up the paddocks with parky to spell them and all the seedlings got away—what a mess! What we didn’t know then was that cattle readily eat parkinsonia seedlings and young trees, thus ending their life cycle.’

With hindsight, John considers that simply spelling from grazing at the end of the dry period lets grass recover but unfortunately also allows the parkinsonia seeds to germinate and flourish unchecked.

The Lyons then employed a contractor to spray the parkinsonia. There was a good kill but seedlings came up afterwards. Realising their earlier mistake, they put cattle in, and observed how cattle can kill seedlings off.

According to John, ‘As the drought continued, cattle would eat leaves off waist high or smaller plants eating whole stems up to finger diameter. They ate all the leaves off and started eating down the stem’. The damage was sufficient to kill many of the plants.

Mechanical control

Despite some success in control, John and Ronda were very concerned that the parkinsonia was growing on their best soils, and they were still struggling to find a practical way to manage the problem.

‘Make a start—even if you start at the wrong end, this will begin the learning process’

Next, they bought a brush-cutter with a circular saw blade attached. Though John had seen a demonstration of a brush-cutter that also administered herbicide, he preferred to pay two men, one using the brush-cutter and another with a knapsack putting poison on the stumps.

As John says: ‘Whatever you do has to be successful. The dearest thing is getting the herbicide and the men to the plant. Once we had that, we weren’t going to let the plants survive!’

They used Access at 1:60 most of the time with very good results. However, they still had seedlings coming through, unlike their experience with Graslan which also killed seedlings as they germinated.

Experience with camels

Until this point, they had only been working on scattered patches and had avoided tackling the worst patch, which was about one kilometre by half a kilometre and quite dense—‘you could pick your way through it but you couldn’t ride a horse through it with ease...some places you couldn’t ride through at all’. They still felt they were ‘getting nowhere’ with their parkinsonia problem.





Michelle Devezze

▲ John and Ronda Lyons are pleased with the impact of camels on parkinsonia on their property

Hearing that camels would eat 'anything with a spike on it' and that parkinsonia was their preferred diet, the Lyons decided to sell \$25 000 worth of breeders and invest it into camels and produce camels instead of cattle as there was a good market for camels.

'The camels cost about \$450 each in October 1999, and a Brahman cow sold for around the same price. Both produce progeny but cattle don't have the capacity to do what camels can in terms of weed control.'

Camels are a little slower than cattle to breed, with a gestation period of 15 months (compared to the cow's nine months). Camels have a lifespan of about 50 years, will have their first calf at about three or four years, and will keep breeding up to about 35 years.

John finds that working with camels is a little different to working with cattle. Although they are herd animals with a herd mentality, they nevertheless have 'minds of their own' and require more patience and a little more psychology when handling them—'they are a smart animal, they'll test you, but we've had minimum trouble with them'.

The feeding habits of camels are very damaging to parkinsonia. They pull the branches down, breaking and weakening

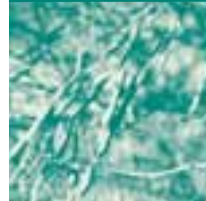
them, and making them more susceptible to biocontrol insects like borers. Since they also keep it defoliated, there is very little flowering or seeding. If they do seed, 'very few of the seedlings see the light of day as they are a delicacy to camels'.

Research by scientists from the Tropical Weeds Research Centre on parkinsonia seed spread by camels has demonstrated that only 8 per cent of seed passed through camels in a viable state. In any case, the risk of spread is considered minor because camel browsing prevents pod production in the first place. John Lyons also believes there is considerable anecdotal evidence that very little seed germinates after it goes through a camel—'there is evidence that the seed is damaged as it passes through the camel's rumen'.

John considers that getting the camels was the best thing that they have done in their battle with parkinsonia.

'Not only do they pay for themselves by saving wages and herbicide, but they work night and day for you.'

However, the Lyons feel that they do not yet have enough camels. Currently (2004), they have 70 cows and 23 calves (running 40 cows to one bull and 30 cows with a young bull) and hope to build up the herd to 200. They have observed that the camels work as a herd, all attacking a tree or group of trees together, and they want to maintain a high density of camels to encourage this activity. When they have 200, they'll run 50 in a mob over four paddocks.



John wants to have enough camels for each paddock where parkinsonia is a problem to 'keep the parky leafless, flowerless and seedless'. At present, he has to keep rotating the camels through paddocks: 'we're not getting on top of it because it's too long in between moves'. Some rotation may still be needed with 200 camels, but managing the process will be much easier.

The Lyons are very satisfied with the camel experiment, saying that friends and neighbours also agree that the camels are doing an excellent job. However, he advises caution in selecting stock for purchase. He paid \$450 each for quiet camels in 1999, although feral camels could have been bought for \$180 each. He is aware that many people have had trouble in handling feral camels.

John plans to keep the camels indefinitely, partly to cover initial costs. Nevertheless, he doesn't depend solely on the camels for parkinsonia control. He still uses herbicide when he wants instant results, such as cleaning up his best buffel grass paddocks that are used for fattening bullocks.

Fire and mechanical control

The Lyons have also tried burning the parkinsonia with fire, saying that 'a moist fire after rain, when the grass is green—a steamy slow cool fire—will give an amazingly good kill. And good grass came back afterwards as well'.

'A hot fire definitely didn't have the same results. A hot fire when the grass is dry is also more expensive because you need breaks and people and equipment. Fire after rain with a lot of green grass is so much cheaper.'

On another occasion, John used a bulldozer to push most of the parkinsonia into a pile, sprayed the regrowth plants, and then let the cattle in when the seeds germinated. He felt that this was not very successful: it was expensive and didn't get rid of the weed, though it did reduce the parkinsonia in size, which made it easier to spray next time.

Long-term approach

With parkinsonia both upstream and downstream from Wambiana, the Lyons' local catchment group has been a source of healthy peer pressure—'no one wants to get left behind'.

'At meetings landholders discuss what's not working and what does—people can adopt better methods instantly without having to go through all the experimentation. The group is a great energiser.'

At times, the Lyons have been able to use government programs to tackle their parkinsonia problem. For John, the big advantage with programs that provide labour is not only that it gives unemployed people a chance of work. It also enables the Lyons to undertake weed control at the most effective time rather than simply when they can fit it in. It's the critical difference between an organised program and a 'hit and miss' approach.

'Our catchment group is a great energiser—no-one wants to be left behind'





Key learnings

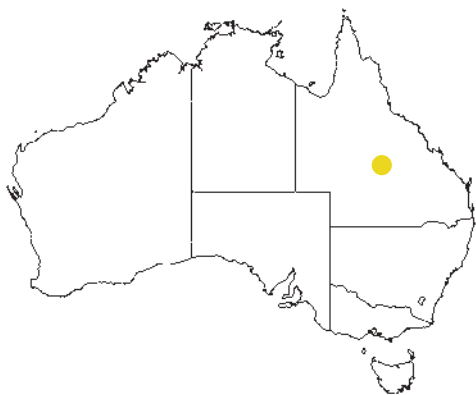
John feels the important lessons he has learned from his battle with parkinsonia are:

1. Make a start—even if you start at the wrong end this will begin the learning process. Do something to get on top of parkinsonia before it gets on top of you.
2. Don't destock in an attempt to beat parkinsonia, and don't spell country for too long—get the cattle back in before the parkinsonia seedlings are knee high.
3. Herbicide control has limitations including the relative cost and the need to commit labour to that job when it may be required elsewhere.
4. Ad hoc herbicide application is not effective—without continuity you don't get the full benefit of your investment.
5. Effective management of parkinsonia requires a combination of all treatments—camels, chemical, mechanical, fire, biological.



Using mechanical means to control parkinsonia

Michele Deveze with Ann and David Hay



Background

Ann and David Hay have two properties near Aramac in the Mitchell grass country of western Queensland. Myross is about 11 000 ha and carries around 700 cattle breeders. It's half black soil–Mitchell grass downs and half buffel–spinifex country.

The parkinsonia threat

The main parkinsonia infestation was a patch of about 32 ha that was so thick that it created problems for mustering. An initial attempt to use basal spraying had to be abandoned—'it was so thick it was physically impossible to work in'.



Michele Deveze



Michele Deveze

▲ Stick raking

Experience with control

Mechanical and biocontrol

Ann and David decided to try mechanical control, using a bulldozer.

'We put the dozer into the parky—it was October 2002, and very dry. We have found with past experience with dozer work that we get better results when it's dry. No soil moisture means the plants don't shoot straight away, and many die because they are so stressed and knocked around by the dozer. With basal spraying it's the opposite—you need the moisture.'

The Hays used a D6 with a 6-metre stick rake with a 3-metre cutter bar on the back to use on thick patches of smaller plants, but comment that the size of machine will depend on the kind of country. On the whole they are pleased with the result.

'Grass returned after the parkinsonia was removed'

- ◀ Mechanically clearing the parkinsonia created easy access for follow-up control



‘It’s worked pretty well, though at the time we didn’t know if it was the right thing to do. We managed to pop a fair number of the roots out. But parky doesn’t seem to like being broken off either—if it’s broken and splintered it seems to die. So far it looks pretty good—we haven’t had much rain since, although we had four inches four months later.’

They were worried that a huge number of seedlings would come up after the rain—‘parky’s got a really big seed bank and it could come back worse than ever’. It has not become as thick as they thought it might, though there has been some regeneration and shooting from broken stumps, and some parkinsonia left among the gum trees in the cattle camps.

The *Penthorbruchus* beetle has also been present on the parkinsonia and the Hays feel it may have helped: ‘If you open a seed pod most of the seed has holes in it, so maybe the majority won’t come up’.

The importance of continuity

The Hays have also done three days of follow-up spraying, using three 44-gallon drums of Access and diesel. They emphasise the importance of follow-up control.

‘You can’t just think that the dozer will do it and that will be it—you must follow it up or it’ll be a big mess again’



Michèle Devezze

▲ Ann Hay inspecting parkinsonia on Myross

‘You can’t just think that the dozer will do it and that will be it—you must follow it up or it’ll be a big mess again. The dozer cost \$2000 (20 hours at \$100 per hour) so we’re not going to spend that sort of money to make a mess of it and have it come back, and maybe even worse.’

Reviewing their approach

Ann feels that if they hadn’t been able to get into the parkinsonia with machinery first they mightn’t have been able to finish the job, or at least would not have done as much.

‘Physically and financially it would have been impossible to spray or basal it, and the good thing was that when we did the follow-up we didn’t have to bend our backs.’

They were also pleased that grass returned after the parkinsonia was removed—‘under big parky all the goodness is sucked out of the ground’.





Michele Deweze

▲ Working progressively through the parkinsonia

Cost-effectiveness issues

The Hays are happy with their decisions on control methods.

‘We could work out how much it cost per acre but we don’t usually worry about that—you either do the job or you don’t. You can nearly see by eye if you’re getting value for money. If you get a good operator you’ll get good value for money.

‘Just speaking financially: Access costs about \$600 per 10-litre drum and the dozing cost about \$2000. So that’s only three or four drums of Access, and that doesn’t include the diesel (600 L per 10 L of Access). Spraying this patch would take a lot more than three or four drums of Access, plus the labour it would require.’

‘It only took a couple of days with the dozer, and three people doing follow-up, and now we’ve pretty well got it all knocked over.’

They are also using camels for woody weed control. The camels have better access with the big parkinsonia trees gone so now they can eat any seedlings that come up.

Long-term approach

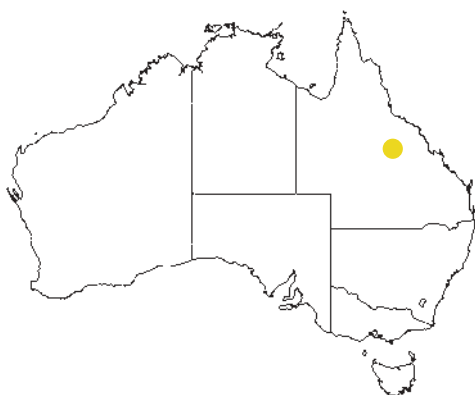
Ann and David are determined to get rid of parkinsonia on their properties, saying it’s hard to understand when people have a small infestation and don’t do anything about it. They are resigned to parkinsonia control being a long-term project but feel they are ahead of it now.

‘But we will never be able to ignore it. With rain, the amount of seed that washes in from upstream sources means that there’s always seedlings coming up here.’

‘If we hadn’t been able to get into the parkinsonia with machinery first, we may not have got the job done or at least not as much done’

Gaining ground on parkinsonia

Michele Deveze with Kate and Lock Harrington



Background

Ashton and Curragilla are adjoining properties situated 50 km south of Prairie in north Queensland. The properties are managed as one. In all there are 44 500 ha with a stock route running through it. The country is mixed—black soil with sand ridges, gidgee scrub on the east, and spinifex to the west.

Most of the parkinsonia on the properties is on the stock route, along Tower Hill Creek and tributaries. The Harringtons don't consider it a big infestation, saying it has no impact on their property stocking rates. However, they want to keep their country clean, and have been attempting to control it for some years.

'Certainly, the funding has kick-started a lot of people'



Michele Deveze

▲ A mix of Access and diesel has killed parkinsonia without affecting surrounding vegetation

Experience with control

Contract spraying with Access

Their first large-scale attempt at control was undertaken in 2003. Encouraged by the WONS funding, they hired contractors to spray the parkinsonia along the creek, using Access and diesel. Between 7 and 10 men spent 31/2 days on the job.

'In the long run the contractors did a lot more than we could have managed at the time'

The Harringtons have somewhat mixed feelings about the result. They were pleased with what was done but aware they will need to go back for the seedlings on a yearly basis.



Michelle Devezze

▲ Graslan was applied to this area with good results

In their experience, one of the problems involved with using contractors is that the contractor may know what he is doing but the workmen are usually inexperienced. Consequently, they missed both rubber vine and parthenium, though they had been asked to watch for these weeds whilst spraying the parkinsonia. However, in the long run the Harringtons felt the contractors did a lot more than they could have managed at the time, as they were hand feeding and carting water.

They also thought the guaranteed 80 per cent kill was difficult to assess, but acknowledged that back-up spraying would be necessary in any case, because of the longevity of the seed in the ground. Yearly spraying is now part of their ongoing property management.

Ongoing spraying

While the Harringtons have used Access and diesel, they have also found Graslan to be a good tool for continuing, small-scale control undertaken along with normal station work routines.

Given the availability of a second round of funding, they plan to continue the spraying on a more informal basis, rather than using the contractors again. Spray packs can be borrowed from the local Landcare group.

Value of the funding

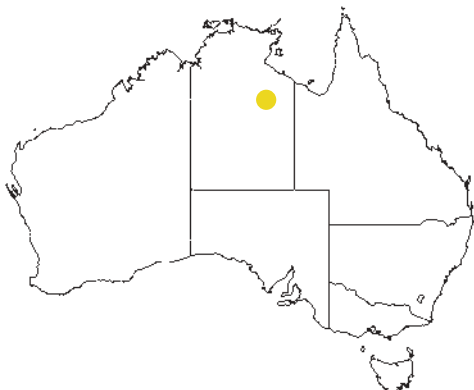
The Harringtons acknowledge that while the WONS funding is only a fraction of the actual cost of control spraying, it has been a big help and a 'kick start' for a lot of people for parkinsonia control. Since a lot of follow-up will be needed to control seedlings, they hope the funding will continue into future years.

'We'll be at it for years—it's just part of property management'



From pretty to pest

Ed Conway with Louise Martin



Background

In 1928 George Darcy (Senior) took up a small garden lease in the Gulf district of the Northern Territory, and over many years Mallapunyah was extended to a pastoral lease of 434 900 ha. The lease is a mix of reasonably heavily timbered areas with a grassland understorey and spinifex-covered hill country giving way to well grassed black soil plains. The lease is owned and managed by the Darcy family with the assistance of station labour.

The parkinsonia threat

It is known that parkinsonia was taken to the head of the Kilgour River and the McArthur River catchment in 1930 and planted on Mallapunyah Station. There is a strong possibility that the plant was obtained from the Borroloolua Police Station, as a photo taken pre-1930 shows a mature parkinsonia plant growing in front of the station.

As a small child Bob Darcy remembers being asked to water the parkinsonia tree planted

at the homestead. Now, over 60 years later, the family spends their time trying to control this weed.

Bob Darcy's partner, Louise Martin, explained that Baraba Paddock (along the watercourses where the McArthur River heads) has been the worst affected.

'However, it has now appeared over most of the station, mostly as scattered or isolated specimens. The thicker areas are up gullies in Baraba Paddock. Some have seemed to die naturally this year though there are still new plants coming through.'

Experience with control

Louise comments that it is impossible to put a monetary figure on control measures. Before the last ten years, the parkinsonia had been treated solely by mechanical means—'grubbed out with an axe or pulled out using a chain on a Toyota'.

However, over the last ten years at least \$18 000 has been spent on Graslan and other control measures. While these measures have been effective, they are aware that they won't ever get rid of every plant.

'Without some biological control like a beetle or grub it cannot be eradicated, as some bushes are never seen except while riding past during mustering.'

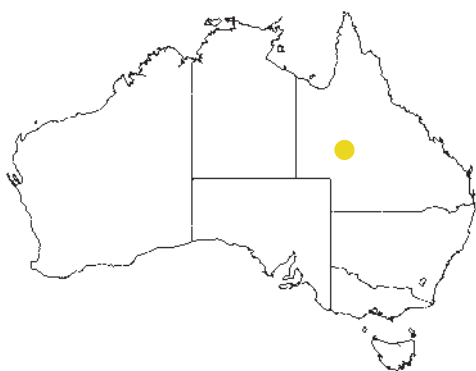
'Without some biological control like a beetle or grub it cannot be eradicated, as some bushes are never seen except while riding past during mustering'





Using mechanical control to advantage

Michele Deveze and Peter Klem with John and Philippa Whitehead



Background

Mentone, which belongs to the Whitehead family, is about 24 km east of Corfield township in central western Queensland. Sandy and Sach Whitehead with their son John and daughter-in-law Philippa run it as a family cattle breeding and fattening partnership. It is mostly undulating vine scrub and whitewood, with black soil downs and corkwood wattle and coolibah along the creeks.



Entriken family

- ▲ A historical photo of the Sesbania homestead with parkinsonia planted around it

The parkinsonia threat

Parkinsonia has been on Mentone for a long time, having been in the area since the turn of the century. In fact, historical photos show parkinsonia planted along the driveway of the old Sesbania homestead. The weed grows mainly along creek lines, dam banks and dam backwaters. On Mentone it is thick only in a couple of places in IO Creek.

The Whiteheads had noticed that the parkinsonia was dying off, possibly because of the prolonged drought. While in their observation parkinsonia seems to have a short life span, John maintains that it always seems to come back thicker after wet spells or after a decent wet season.

According to John, 'They don't seem to have a very long life span but five seem to come back to take the place of one dead tree'.

Sandy Whitehead has been running Mentone since 1940 and doesn't see parkinsonia as a great problem. To him, its main impact on Mentone is that it restricts movement for mustering, burr spraying and fencing, yet comments: 'cattle do eat parkinsonia so it does provide a source of fodder'.

The direct benefits of the control on Mentone have been that creek lines are more accessible and mustering is easier



Experience with control

Basal bark spraying (Access and diesel)

Because funding made treating parkinsonia achievable, John and Philippa started control early in April 2002, and they are keen to try to eradicate parkinsonia while it is still at a controllable level. Trees at all stages of growth were basal bark sprayed using Access and diesel at the rate of 60 L of diesel to 1 L of Access. It was fairly hot when the work was done but it meant that the trees were treated when they were taking in moisture and actively growing.

They used three people to basal bark creek lines, one person with hand-operated backpack sprayers on each side of the creek. The third drove the vehicle and with a hand-held spray bottle did outlying trees away from the creek, working on small areas in between shifting the vehicle.

John explained that trees were sprayed to about half a metre up the trunk and great pains were taken to make sure that the trunk was sprayed all the way around.

‘We made sure that trees with rough bark were wet to the point of the herbicide running down the bark into the ground.’

As far as he is concerned there is no reason to use a dye in the herbicide because ‘a basal barked tree is obvious even on the next day’. The Whiteheads found that smooth-barked or smaller trees proved easier to kill. The large rougher barked trees required a lot of herbicide mixture and took a long time to do, and they did not have a good kill rate with them.

‘Now we are on top of a problem that had nearly got us beaten and we are getting rid of a noxious pest’

Mechanical control

The Whiteheads have also tried mechanical control methods for parkinsonia. A loader was purchased, mainly to clean out silt tanks and de-silt dams when they are dry. However, with the treatment of prickly trees as a secondary function for the loader, they feel it is a useful machine to have.

For John, the advantage of using the loader is that only one person is required to make it work efficiently whereas a few people are needed in basal bark spraying. It is also much easier to control larger trees with a machine than by using herbicides, which then allows people to walk through and basal bark smaller trees that cannot be tackled with the loader. Overall, this approach involves using a lot less Access.

In areas of thick infestations and bigger trees, a much better kill rate is expected than if they had used herbicide. Where there were massive numbers of smaller trees they were sheared off at ground level.

‘We are expecting a massive regrowth problem but it will be accessible for overall spraying’, said John.

‘But re-growth doesn’t seem to be a problem on Mentone—just a dribble of herbicide on a tree will run right around the stem and kill it easily.’





John uses a 115 hp Hitachi LX100 with a 1.8 metre bucket, and finds that parkinsonia trees are easy to push and lift out. His method of treating individual trees is to have the bucket about 30 centimetres (or 12 inches) off the ground, push the tree, lift it with hydraulics until all the roots are out, and dump it away from the loose soil and the hole. One can then 'back off to approach the next tree'. On Mentone they think that basal bark spraying has achieved a 90 per cent kill, and mechanical treatment where everything is properly dug out has achieved about 100 per cent.

John considers that with a machine he can do much more parkinsonia control in a given time, making eradication more achievable. And controlling prickly trees with a loader is 'almost like a day off, with the radio and air conditioner on high'!

The benefits

John feels that they have the prickly trees under control and they are 'mentally on top' of the problem. The direct benefits of the control on Mentone have been that creek lines are more accessible and mustering is easier. He also comments on how much the funding helped in stirring them to action.

'It made us think about taking it on. Now we feel happier—we are on top of a problem that had nearly got us beaten and we are getting rid of a noxious pest.'

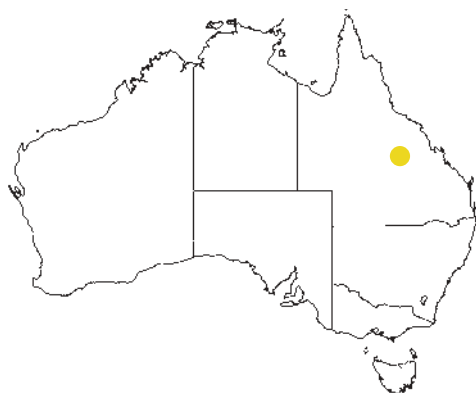
They are keen to try to eradicate parkinsonia while it is still at a controllable level





Clearing the way for mustering on Swanlea

Michele Deveze and Louise Moloney with Bob and Lesley Marshall



Background

The 10 900 ha property belonging to Bob and Lesley Marshall, Swanlea, is located north of Aramac in the Desert Uplands of central west Queensland and has been owned by Bob and Lesley Marshall for 30 years. Until 1973 it was grazed by sheep, but in that year cattle became the sole enterprise.

Following the treatment of all plants, their activity has been purely a maintenance program

The parkinsonia threat

Before 1974, Swanlea had only a few isolated parkinsonia trees. In that year, one of the few times that Lake Galilee actually joined completely across, the prevailing winds brought the floating parkinsonia seed pods across from adjoining stations.

By 1976 parkinsonia was everywhere. The country most affected was the gidgee country improved with buffel grass. The whole area was covered with scattered plants but the weed was heaviest in the drainage systems. There were also heavy infestations on the lake frontage, especially on the shoreline.

According to Bob, by 1991 mustering cattle was a problem as visibility was poor and cattle were using the parkinsonia to their advantage. Cattle were even hard to hold on water after being blocked up. In that year, the Marshalls 'bit the bullet' and decided to tackle it.

Experience with control

Basal bark spraying over several years

The Marshalls started with basal bark spraying, focusing on the areas around the dams. The next year, 1992, they did about six weeks spraying in the growing season, January to March, using Swissmex® knapsacks. Focusing on the drainage areas, they carried out basal barking on seedlings. They also used cut stump control on bigger plants and dragged them away in order to clear the regrowth. Where it was really thick they used long-handled secateurs and cut stump control in order to be sure of addressing all plants.

The following year, 1993, was a complete drought, with insufficient rain to graze the pulled country or the lake. The parkinsonia plants didn't even flower. As a result of the dry conditions the basal bark spraying was ineffective.





In 1994 they spent about five weeks using basal bark spraying and re-treating the areas they had done as seedlings. They also expanded into other areas. They achieved only about 70 per cent kill and had to re-treat some of it. By this time cattle had started using parkinsonia at the podding stage as a fodder resource and the gidgee country was showing lots of scattered plants.

In 1995 they used a bike and controlled all the scattered plants, and re-treated the drainage areas. About three weeks was spent in 1996 to kill all known remaining plants in the area. By this time Access had been registered for the control of parkinsonia. The Marshalls found this 100 per cent effective. As well, it could be used at any time of the year.

‘Cattle mustering is back to how it should be, and ringers and horses have no blood and cuts from thorns’

Continuing maintenance

Following the treatment of all plants, their activity has been purely a maintenance program. Currently, it takes about a week for one person to check all areas, and each year their control program uses about 2 L of Access.

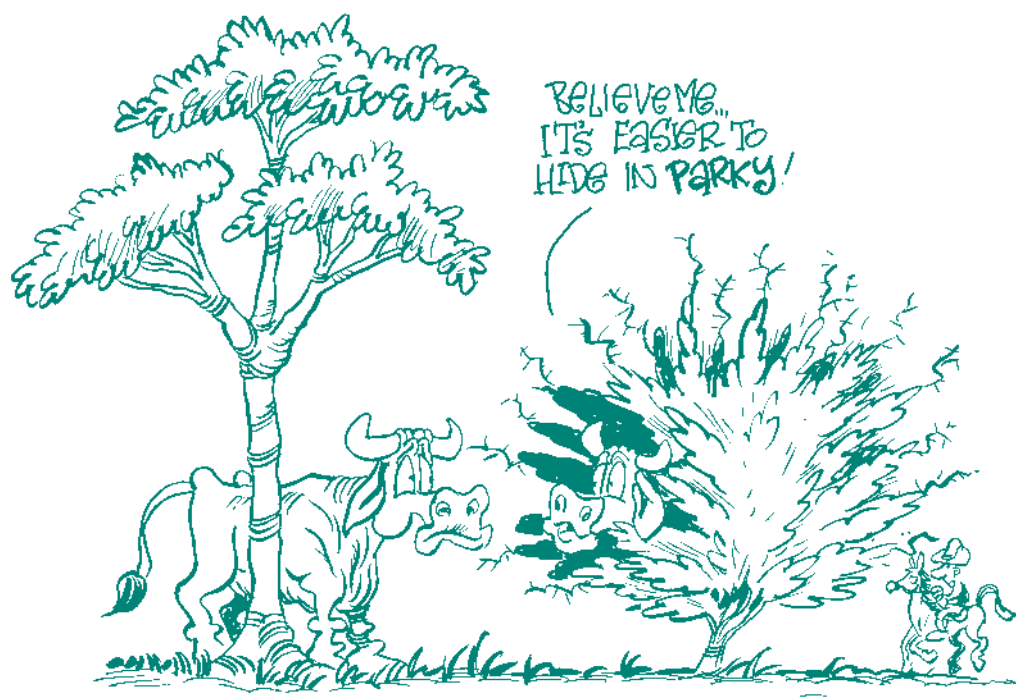
‘While mustering we may see odd plants in the buffel country, and we will go back later and treat them. In the heavy seedbed areas we had noticed a lot of black cockatoos feeding there in season, and as a result the seedling problem has not been as great as I was expecting’, said Bob.

The benefits

According to Bob, ‘Cattle mustering is back to how it should be, and ringers and horses have no blood and cuts from thorns. It’s a fair bit of effort and sweat, with the cost of herbicide and diesel quite high, but a well worthwhile project. I don’t know why we left it so long before starting.’

‘I don’t know why we left it so long before starting’





Case studies— community initiatives

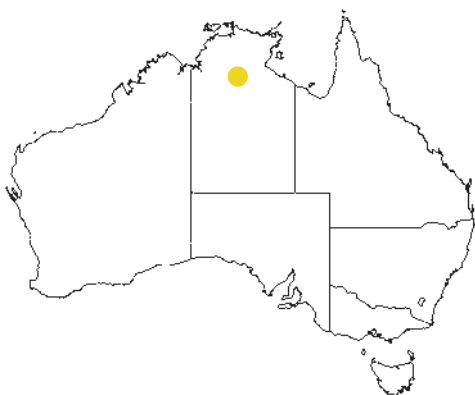


Section 5

Case studies— community initiatives

Parkinsonia control in the Never-Never

Alice Beilby with Elsey station—Jilkmingan community,
Northern Territory



Nathan March

▲ The Roper River which runs through
Elsey station

Background

Elsey station was one of the first pastoral leases taken up in the Northern Territory and was stocked with cattle in 1882. The station was made famous by the book *We of the Never-Never* written by Jeannie Gunn about her experiences living in the Northern Territory.

The parkinsonia threat

The Jilkmingan community has been involved in controlling parkinsonia since they purchased the property in 1991. Several control projects have been carried out over the years with the participation of Landcare, Green Corp teams and Community Development and Employment (CDEP), as well as assistance through weeds of national significance (WONS) funding.



Nathan March

◆ Isolated parkinsonia plant on Elsey station



According to Billy Fulton of Elsey station, many of the weed problems on the station coincided with the arrival of the Brahman cattle in the 1960s.

'I remember when they brought in the first load of Brahman cattle. We started to see weeds coming up in the area after they arrived.'

Experience with control

The Roper River Landcare Group were actively involved in the breeding of *Penthobruchus germaini* insects, a biological control agent for parkinsonia. The project commenced in 1995 and insects were successfully spread throughout the Roper River catchment. Some *Penthobruchus* insects have been found in parkinsonia plants on Elsey station.

During 2003 a joint project commenced between Elsey station and the Jilkmingan community for the control of parkinsonia, supported by WONS funding through the federal government. Weed management officers from the Northern Territory Department of Infrastructure, Planning and Environment have also provided assistance. The traditional owners are confident that they are slowly reducing the spread of parkinsonia on the station. The main control method used has been basal bark spraying using Access and diesel.

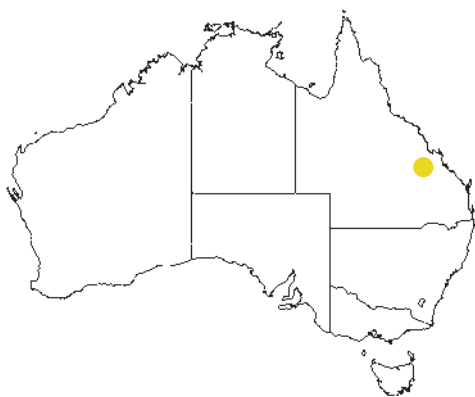
Station manager Max Gorringer is also actively involved in parkinsonia control, with assistance from station staff employed for the mustering season.

The traditional owners are confident that they are slowly reducing the spread of parkinsonia on the station



Coordinating government support to fight parkinsonia

Michele Deveze with Nev Mills and Rob Black



Background

A scheme to rid the lower Fitzroy River in central Queensland of parkinsonia was initiated by Nev Mills, who owns Melrose station at Morinish, 70 km from Rockhampton. The scheme was set in motion in 1994, when government drought relief funding became available. Through the Drought Landcare Program monies were available to be spent on the land for initiatives that would help improve sustainability.



▲ Trainees participating in a DEET new work program provided manpower for a parkinsonia control project on the Fitzroy River

Nev was keen to initiate parkinsonia control, and saw the drought funding as a possible opportunity. He and Dave Akers, the local Land Protection officer of the then Department of Natural Resources, completed the application. It was approved and they received about \$50 000.

At the time that Nev Mills was setting up the parkinsonia program for the Fitzroy River, Rob Black was working with Fitzroy Shire Council as a weeds officer. He describes a joint approach where Morinish Landcare Group received drought funding, and Fitzroy Shire Council submitted a project to the federal Department of Employment Education and Training (DEET) to provide the six months labour under a new work opportunities program.

'In terms of how it all meshed it was fantastic. The two projects really complemented each other, and so did the various fundings—drought money came from Morinish Landcare, Landcare funding provided the herbicide and diesel, and DEET provided the manpower for the basal barking.'

Preparation for the project

Nev explained that he developed a database of all the properties with river frontage. The Fitzroy and Livingstone shires drew up a map of the Fitzroy River and listed all landholder names, and the river was divided into five sections.

'We were basal barking with Access—I don't know if it was a 100 per cent kill but it's got to be pretty close'



▲ Parkinsonia prior to control



▲ The parkinsonia was successfully killed

'I sent a pamphlet to the 70 landholders to see if they were interested. We had meetings and they all became involved, discussing how we were going to go about this project and what level of participation was expected from the landholders. It provided some public education and gave us some publicity.'

There was sufficient money to employ seven long-term unemployed people and a supervisor. There was also enough to rent a four-wheel drive troop carrier, hire a trailer, and buy spraying gear and knapsacks.

Carrying out the control

They started at Yarra which was almost the top of the section of river covered by the project. Nev remembers 'Rob Black, myself and the men, nine of us in all, wielding basal barking gear...The day that we started was hot and with the overalls, gloves and masks I thought, this won't work, but they stuck it out. We were basal barking with Access—I don't know if it was a 100 per cent kill but it had to be pretty close.'

None of the men hired had done basal bark spraying before but as they went on they became quite competent. Overall, there was a good retention rate: 'we can put that down to the supervisor, an old council ganger, who knew how to handle men'.

Rob explained that the DEET new work opportunities program combined on-ground experience with a significant component of accredited training. This meant the men could not work continuously, but 'when they did work they did really well'.

'The trainees were a pretty good bunch of people—the participation level was up to 70–80 per cent for the life of the project, which is pretty good.'

Nev speaks glowingly of the cooperation between all parties involved in the project.

'Fitzroy Shire Council offered to do all the paper work, and gave us the use of a tank for diesel and a shed for storing the herbicide and gear. The state government people also gave a lot of assistance—it was an example of the three tiers of government working together.'

Working with landholders

It was stipulated that if the landholders wanted their parkinsonia treated they would provide access to the river and work with the men. To limit the time that the group worked on a property, the work was contained to upper and lower banks. Rob explained that eight or ten people covered the river bank in a swathe of 10–50 m wide.

Overall, of the 170 km of river covered by the project, 70 km of river length was actually treated, and all properties that requested help received it. All 70 landholders participating in the scheme were very satisfied.

'I always say that when you've sprayed your first weed you're halfway there!'



▲ Basal bark spraying

Follow-up

After the project was finished some money was left for publicity.

'We organised a bus trip and invited everyone who we felt could further these types of schemes in the future. We also invited our local TV station. We had a full bus load and went out through Dalma which is known for rubber vine, then to a heavily infested section of river that had been treated.'

The post-project stage has had some disappointing aspects. While all participants had agreed to do follow-up treatment on the areas treated, the actual implementation has been somewhat patchy, even though herbicide for follow-up treatment was distributed to people in the scheme.



Key learnings

1. **Long-term approach.** In retrospect, the main aspect of the project that Nev would change was the timeframe. He explains: 'It's a long-term project, not just a one-off thing, you need commitment from the landholders to keep up the work or a backup team to come back the next year, and some way to enforce it'.
2. **Participation.** From the experience, Nev's advice is: 'Get all your landholders on side, and make sure that you have good PR and public involvement—a good overseer is indispensable, someone that understands men and can make the most of them'.
3. **Ongoing monitoring.** Rob adds that he would also like 'to establish monitoring plots to be able to quantify the effectiveness of the project'.
4. **Government cooperation.** Overall, Nev feels the project was a great success: 'it's the beginning of getting action all along the river—in particular, I want to emphasise the terrific example of three tiers of government working to achieve a desired outcome'.
5. **Individual initiative.** Rather than waiting around for something to be organised in an area, Nev urges people to start up a project themselves.

'All this talk about top down—it sounds good but it just doesn't work! I say, if you're keen to work on it you should get going on it. If you've got parkinsonia, you've bred 90 per cent of it yourself—and if you get rid of yours or you're getting on top of it, you've made a start.'

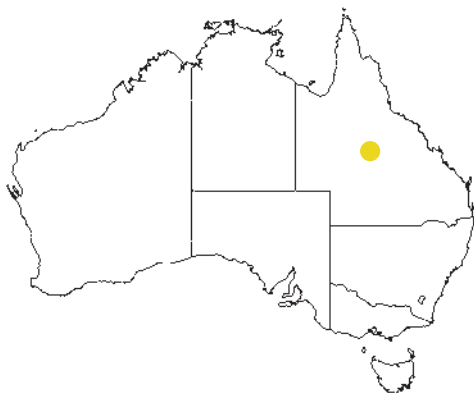
'I always say that when you've sprayed your first weed you're halfway there!'

'It was an example of the three tiers of government working together'



A catchment approach to parkinsonia management

Michele Deveze and Nora Brandli with
Peter Klem and Shane Rogers



Background

Lake Eyre Basin is a very defined and strategic area for the control of parkinsonia. About 770 000 sq. km or 66 per cent of the basin is either clean of parkinsonia or contains only scattered and isolated infestations. The remainder (390 000 sq. km) contains localised areas of dense infestations, usually restricted to streamlines and watering points.

Following extensive community consultation, weed management has been identified as one of the major issues facing the area. This has led to the formation of the Cross-Catchments Weeds Initiative (CCWI), which integrates state, shire and board (SA) approaches to weed management. The aim of the initiative is to reduce, eradicate and prevent weed infestations within the Cooper Creek and Georgina/Diamantina catchments, using collaborative partnerships between stakeholders.

‘One major issue is the common perception that parkinsonia is not a problem because “it’s always been here and hasn’t changed much”’

The CCWI recognised that containment and reduction of parkinsonia within the upper sections of the Cooper and Georgina/Diamantina catchments, where dense infestations occur, was urgent, and a successful application was made for Natural Heritage Trust NWP (National Weeds Program) funding to support the implementation of parkinsonia management projects developed by communities or land managers. This became known as the Lake Eyre Basin Cross-Catchment Weeds Initiative Parkinsonia Project (LEB Project).



- ▶ Alun Hoggett, of Desert Channels Queensland, developing a Lake Eyre Basin parkinsonia distribution map

Nora Brandli



About the project

Landholder issues

Nora Brandli of the Coopers Creek Catchment Committee is very aware of the importance of people's attitudes to weed management.

'One major issue is the perception that parkinsonia is not a problem because "it's always been here and hasn't changed much".'

Another concern raised by many people was that in some cases, chemicals that had been given out ended up just stored in the shed. To avoid this, it was suggested that participating landholders should be reimbursed for chemical used only after agreed milestones were reached.

Planning the project

The basin was divided into 'Area A' (with isolated and sparse parkinsonia infestations) and 'Area B' (with relatively dense infestations). The aim of the LEB Project was to eradicate existing parkinsonia infestations in Area A; and to eradicate existing smaller, isolated infestations, reduce large infestations, and prevent further spread in Area B.

▼ Infestations of parkinsonia in the Blackall area



Damian Byrne

Five 'sub-components' were identified within the project: on-ground works, surveying, education and awareness, linkages to other WONS projects, and monitoring and evaluation.

Lake Eyre Basin parkinsonia project: main components

On-ground works

Landowners were invited to submit proposals for parkinsonia control projects. Successful applicants received reimbursement for agreed activities when milestones had been reached. Project assessment criteria included:

- Consistency of the project with the national parkinsonia strategic plan and local shire council or board pest management plans.
- Strategic importance of the project in relation to local government pest management plans, catchment strategic plans for both the Cooper and the Georgina/Diamantina catchments, each of the state pest management plans, and the national parkinsonia strategic plan.
- Inclusion of a five-year integrated property pest management strategy with clearly defined milestones, outcomes and ongoing follow-up activities.
- Annual property inspections and monitoring of follow-up control.
- Involvement of a group or partnership of land managers.
- Dollar-for-dollar cost sharing only provided on a reimbursement basis.

'Landholders are more aware of the impact of their weed management on others in their catchment group'



‘The project has made landholders aware of parkinsonia—now it is a priority in their yearly plans’

Surveying and mapping

Aerial surveying was needed to accurately identify areas of infestation and information about parkinsonia spread. In particular they wanted to find how far along the Cooper Creek parkinsonia had travelled, and whether it had gone past Windorah to South Australia. All survey data was recorded on a geographic information system (GIS).

Education and awareness

This part included the use of written material to assist with identification; treatment methods and spread prevention strategies; the development of adaptive management trial sites; and the organising of field days at these sites.

Linkages to other WONS projects

Because parkinsonia is often found with other weeds of national significance, land managers were encouraged to develop proposals that would maximise the use and efficiency of management activities and resources.

Monitoring and evaluation

Participants were required to report on the effectiveness of their projects.

‘The old timers firmly believed that parkinsonia would only live for a certain time then die off’



Nathan March

▲ Parkinsonia are often present on bore drains in western Queensland

Managing the project

A steering group which included shire rural lands officers and NRM&E land protection officers was formed to oversee the assessment and coordination for Area A and Area B. A meeting was held to develop a project assessment criteria matrix; establish consistent monitoring, evaluating and reporting procedures; and identify specific areas for aerial and ground surveying. Overall consistency was provided through the CCWI Working Group.

Strengths of the project

1. The strategic control of parkinsonia on a catchment and sub-catchment basis.
2. The ownership of the project at a local level.
3. The participation of, and commitment from, shire rural lands officers and NRM&E land protection officers.
4. The requirement that milestones were reached before funding was provided.
5. The involvement of stakeholder representation in the development of the overall project.



Perspectives from shire rural lands officers

Organisational aspects

Shire rural lands officers (SRLOs) played a pivotal role in this project according to Nora: 'We could not have achieved the real on-ground outcomes or landholder commitment without the SRLOs' contribution'.

Meetings were held with existing Landcare groups and landholders in a local catchment area to explain the concepts and conditions of applying for WONS funding. Individual work programs, budgets and maps of group members had to be combined in a single application, which also included property pest management plans.

A template was developed to cover the information needed from individual landholders, and likewise a spreadsheet where this information was collated. This in turn was linked to a replica of the budget page of the application forms. This structure allowed for changes to be made quickly and accurately.

According to Peter Klem (Winton SRLO), 'At the height of this activity, Craig Magnusson, the land protection officer from Longreach, the catchment coordinator and I were doing two group applications a day'.

For Peter, a key benefit of the project was the opportunity to meet landholders in the shire and find out the layout of properties. He has made it a priority to compile as much information as possible so that if more funding becomes available the information

will be readily available. It also allowed him to gather a large number of individual property pest management plans, which is a requirement of the Winton Shire Council Rural Land Management Plan.

Experience with control methods

Shane Rogers (Flinders SRLO) reported that all the work in his area was done with Access and that parkinsonia sprayed before March died off quite quickly compared to that sprayed after March, which took 'a good three or four months' to die. In some circumstances the trees that were closer to, or in the creeks, died much quicker than the outlying infestations.

'An average 90 per cent kill rate was achieved, and this was during a very dry year.'

New awareness

The project gave Peter the opportunity to provide information on best practice treatment methods and registered herbicides for parkinsonia control, and to impress on landholders the fact that parkinsonia spreads very rapidly in water—an issue of great concern to communities downstream of the Winton Shire, including in South Australia.

'The funding could not have come at a better time—parkinsonia was getting to the stage where it was out of control'





‘It also encouraged individual landholders to think about the impact of their weed management on other landholders in their catchment group.’

Shane explains that his own attitudes have also changed. Until he started on the project, he did not actually see parkinsonia as being a very high priority weed.

‘The old timers firmly believed that parkinsonia would only live for a certain time then die off, but I have learnt that this is definitely not the case. This does happen in some areas, but the seed bank is still there and you find that new plants are always coming up and spreading.’

‘Parky is slowly spreading and becoming a pest—mainly along creek systems and lower lying flats. One thing that does interest me is why parky tends to have areas where it grows madly and other areas where it doesn’t. It may have something to do with the soil types and season.’

Evaluating the project

Shane was very pleased with the way the project worked in his area.

‘Overall, the project has been a big success with all landholders making a big commitment. I think the funding couldn’t have come at a better time because parkinsonia was getting to the stage where it was going to be out of control and a very costly pest to get rid of.’

‘Although it wasn’t a major concern to most landholders, it has made them aware of the parkinsonia. Now it is a priority in their yearly plans.’

Peter considers that the project worked very well considering that it occurred in ‘one of the longest times in history with no rain, followed up by a year with only patchy rain—and all the associated problems of dry years such as the increased workload of landholders, the stress of dealing with poor and dying stock, and drastically reduced income’.

In hindsight Peter suggests that the project would be enhanced by more training in applying for funding; more time to complete applications (even if most people tend to leave them to the last minute anyway); and a definite post-funding plan.

Nora, Peter and Shane all agree that through this project many landholders have been given more than money—they have been given heart to tackle their parkinsonia. This is probably the most important aspect of the project.

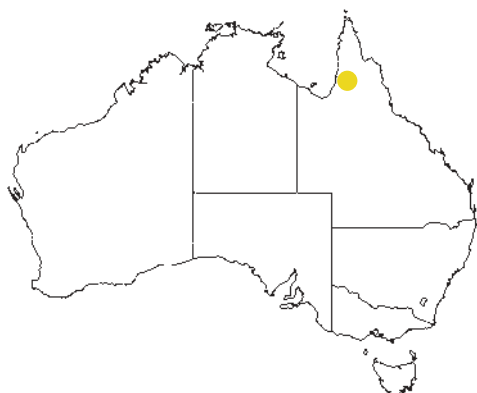
‘Through this project landholders have been given more than money—they have been given heart to tackle their parkinsonia’





Community weed control

Michele Deveze with Peter James, Dianne Ward and Cathy Waldron



Background

Cape York Peninsula is in the eradication zone of the national strategy for parkinsonia. Parkinsonia is a weed of national significance, with the potential to invade the watercourses and floodplains of much of the lower rainfall areas of the peninsula. Currently, there are four known outbreaks in the peninsula, all occurring on the floodplains of the west coast: on Rutland Plains Station, Kowanyama Deed of Grant in Trust (DOGIT) lands, Pormpuraaw DOGIT north of Balurga Creek, and the homelands south of Aurukun township.

'Parkinsonia could explode overnight on the marine plains and the watercourses'

Experience at Rutland Plains station

In early September, 2000, the Cape York Weeds and Feral Animal Project (CYWAFAP), a Natural Heritage Trust-funded project established in 1999, was contacted by Rutland Plains station with a request for assistance with control of parkinsonia. A survey was conducted and the infestation mapped using on-ground GPS recording and final desktop fill-ins. A training program on control techniques for station staff was conducted on site at Rutland Plains and the control work was carried out using basal bark spraying with Access mixed with diesel at 1:60.

The herbicide, application canisters, and weed crew of two were supplied by CYWAFAP and the property provided diesel and extra labour. In 2001 and 2002 follow-up control was carried out by CYWAFAP in conjunction with the property owner, with CYWAFAP again supplying the herbicide and application canisters, and the property providing diesel and extra labour. For these exercises the property also provided a helicopter to transport station staff to control scattered plants in outlying areas.

The area of infestation of most concern to the property owner was quite familiar to him because he regularly flew over the area while mustering in the property helicopter. Each year the treatment program was done on new areas, and only large mature plants were treated.



Evaluating the control program

Mark Upham, the current manager of Rutland Plains, considers that the project was effective as a whole though some regeneration has occurred beneath collapsed mature plants.

Mark plans to continue control work in slack times on the station, though acknowledges that normal station priorities often dictate the timing of spraying, which can limit its effectiveness.

‘The reality up here is that after the wet, as soon as you can move, you’re out there mustering—it comes down to the almighty dollar. When we *can* allocate manpower, it’s possibly the wrong time of the year to spray.’

Mark considers that parkinsonia is not severely impacting on the property at present—it’s not to a stage where there are areas that can’t be mustered. But he is aware that ‘it could explode overnight’ on the marine plains and the watercourses.

‘We want to keep on top of it so we are putting in a concerted effort again in 2004’.

Parkinsonia has the potential to invade the watercourses and floodplains of much of the lower rainfall areas of the peninsula.

Experience at Pormpuraaw community

In 1999 staff from CYWAFAP attended Pormpuraaw to treat (with basal bark spraying using Access mixed with diesel at 1:60) and map an area of parkinsonia that had been reported north of the community, as well as undertake a training program. In October of 2000 an extended area was mapped and remaining mature trees treated. Some treatment was also carried out on seedling plants in areas that had been treated in the previous year.

Follow-up treatment was carried out at Pormpuraaw in 2001 and 2002 by rangers from the newly founded Pormpuraaw Land and Sea Management Centre using herbicide and backpack spray units provided by CYWAFAP.



▲ Nerida Holznagel and Russell Graham (CYWAFAP) controlling parkinsonia on Pormpuraw

CYWAFAP



Another treatment was carried out after one of the Pormpuraaw steering committee members had noticed parkinsonia on his country

Rick Van Veen, coordinator at the Land and Sea Centre between April 2002 and April 2003, reported that another treatment was carried out after one of the Pormpuraaw steering committee members had noticed parkinsonia on his country.

In October 2003, the then Land and Sea Centre coordinator at Pormpuraaw, Marty Glancy and rangers re-mapped the parkinsonia infestations on Pormpuraaw land.

According to Marty, parkinsonia is one of the rangers' biggest concerns. He has arranged for the main CYWAFAP weeds supervisor to come out to Pormpuraaw to give them more training, and provide overall input on how best to tackle the parkinsonia in the area.



CYWAFAP

▲ Established parkinsonia infestations on Pormpuraw demonstrate the potential threat of this weed to Cape York





Future priorities for Cape York Peninsula

In January 2004 the Cape York Weeds and Feral Animal Program that evolved from the Cape York Weeds and Feral Animal Project submitted a proposal for a devolved grant under the National Weeds Program (prickly acacia and parkinsonia). This is a joint project between the Land and Sea Management Centre rangers and the Cape York Weeds and Feral Animals Program, with the following aims:

- Control and reduce infestations of parkinsonia on the west coast floodplain areas of Aurukun, Kowanyama and Pormpuraaw.
- Survey and map parkinsonia areas for the purpose of evaluation and monitoring.
- Provide capacity-building opportunities for Indigenous land and sea rangers through the delivery of on-the-job training during the control exercise—to enable them to be able to carry out future follow-up and control work on their homelands.

- Increase community education and awareness of the detrimental impacts of parkinsonia to their homelands.
- Fulfil the objectives of the draft Pormpuraaw Pest Management Plan and Kowanyama Pest Management Plan in accordance with the draft Cape York Pest Management Strategy.

Notification was received in March 2004 that the grant application was successful. Work will commence around June when the marine plains become accessible.

We want to keep on top of it so we are putting in a concerted effort'



▲ Greg Halbert (CYWAFAP) controlling isolated parkinsonia outbreaks on Rutland Plains

CYWAFAP

Case studies—industry and government initiatives

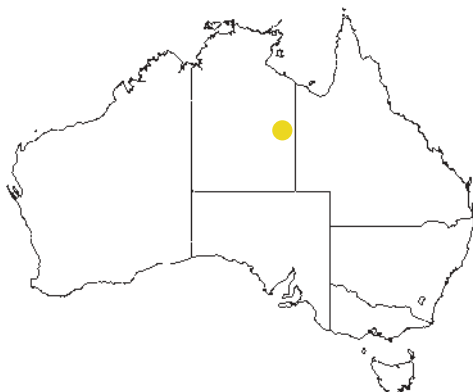


Section 6

Case studies—industry and government initiatives

Pastoral companies collaborate in battle against parkinsonia

Michele Deveze, Delphine Bentley, Jenny White and Ted Callanan



Background

The North Australian Pastoral Company (NAPCO), Stanbroke Pastoral Company and Australian Agricultural Company (AACo) have joined forces in an attempt to effectively control and manage parkinsonia on the Barkly Tablelands in the Northern Territory.

In the past, the station managers involved have made an extensive effort to combat parkinsonia, with somewhat mixed results. However, in recent years positive catchment-wide results are evolving through coordinated planning combined with on-ground projects.

The Playford River waterholes and wetlands support a diverse array of bird and aquatic life, making parkinsonia control crucial

Their effort has also been recently supported by the Barkly Landcare and Conservation Association (BLCA) and the Lake Eyre Basin Coordinating Group, and financed in two separate NHT-funded projects.

More recently, the companies have joined forces in two parkinsonia projects on the Playford River and the Upper Rankin River catchments covering a total area of 64 334 sq. km.

The parkinsonia threat

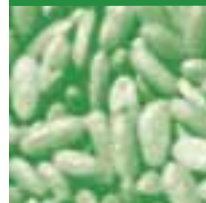
At present, parkinsonia is not a major problem in these catchments. However, it is spreading along watercourses and adjacent floodout country, which is causing small but noticeable disturbances to wetland habitats and landscape biodiversity.

The Playford River in particular has waterholes and wetlands of significant ecological value. These areas support a diverse array of bird and aquatic life, making parkinsonia control especially important.

The external support and funding is a fundamental factor in motivating these groups to work together

Strategic support for collaboration

These pastoral companies have formed alliances with many other groups in the bid to combat weed problems across northern Australia. Clearly, however, the external support and funding is a fundamental factor in motivating these groups to work together to carry out weed control and management activities in a coordinated manner.



It is imperative for government agencies to maintain external support in the form of funding initiatives (e.g. LEB Cross-Catchments Weed Initiative) and extension to ensure that more groups coordinate to work on common natural resource issues.

It is important to time control with other property management objectives and be able to manage the treated areas appropriately afterwards

Experience with control methods

Control options and treatments varied according to circumstances. Due to the vast expanses of land to cover, stations have opted to use contract weed sprayers for the dense, large populations of parkinsonia, whereas station staff have been used to undertake the majority of control activities for less dense infestations.

Herbicide treatments were mostly applied through the basal bark spraying control technique (Access and diesel at 1:60 ratio). Some isolated plants away from watercourses have been treated with Graslan or Velpar®.

Most control activities were coordinated in a strategic way as part of a combined cooperative effort. A weed contractor was used and they worked progressively across each of the properties. This ensured that there were minimal temporal or spatial gaps in treatment activities, again maximising the effectiveness of the program.

Using Access means that spraying can be carried out at any time during the year, which makes timing of control measures easier to balance with other property management objectives.

Though it is more effective to spray when plants are actively growing, most seem to die eventually if sprayed properly (i.e. around the entire circumference of the stem). Spraying in winter can be easier as there is less grass cover to interfere with spraying.

Graslan and other soil-applied herbicides require sufficient rainfall to be effective, although previous experience has noted plants dying several years after the herbicide was applied. Overall, it is important to time control with other property management objectives and be able to manage the treated areas appropriately afterwards—for example, through follow-up treatments and spelling.

Contract weed sprayers appear to be the most cost-effective and efficient operators for optimum results. They may appear expensive, but a good team will do the job well, with over 95 per cent kill rates. Area calculations are confusing, but the 225 km of the frontage/floodout type country of the Playford River and similarly for the Rankin River (not including tributaries) have been treated during the past couple of years.





Management and education

Recovery of treated sites has occurred naturally through careful grazing management, and a number of projects to re-fence watercourses have been initiated to continue effective weed control over the long term.

Consideration was given to introducing biological control agents but it was discovered that parkinsonia beetles (*Penthobruchus germanini*) were already present. However, a small number of beetles were also released as a demonstration. It is quite difficult to maintain effective populations of biological agents on the Barkly Tablelands due to the scattered nature of plant populations. Extreme seasonal conditions also affect biological control agents.

As part of an NHT-funded project an area of approximately four sq. km has been fenced off, enclosing the Playford River Waterhole on the Tablelands Highway. Being beside the highway, this site is an important demonstration site for the region. Visitors to the region as well as locals can view the results, in terms of both weed death and increase in wildlife to the area, of the work that has been done. Stations are continually investigating similar projects to improve management of the Playford and Rankin catchments, through spelling, burning, and relocation of fences and watering points.

Costs

The cost is dependent solely on how widespread the populations are. Based on weed contractor rates, an estimated average cost is about \$500 per person per day (plus GST). This figure includes the cost of

the Access and diesel mix, and assumes that each person can spray approximately 2.3 L of Access and 138 L diesel per day.

The overall costs associated with weed control in these two projects can be summarised as follows:

- cost of weed control/adult equivalent: \$0.71/AE
- cost of weed control/total project area: \$0.03/ha.

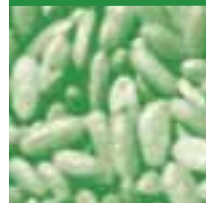
However, the effort against parkinsonia is not complete. Follow-up will be an ongoing activity on these stations, perhaps indefinitely, particularly if these large areas are to be maintained in a near clean state.

Practical benefits from the collaboration

This company-to-company collaboration has achieved a number of practical benefits including:

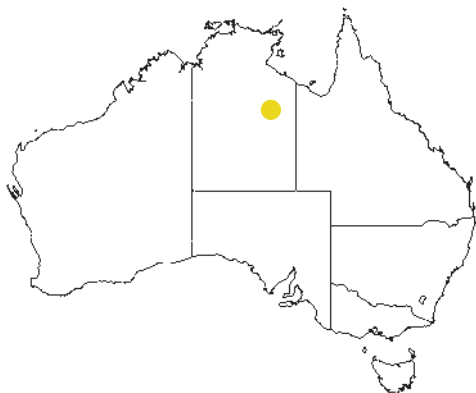
- a successful ongoing parkinsonia control program
- natural revegetation of treated locations on watercourses
- protection and regeneration of wetland habitats and biodiversity
- a high level of cooperation between neighbouring properties, pastoral companies, Northern Territory government agency staff, and catchment/Landcare groups (i.e. Barkly Landcare Conservation Association and Lake Eyre Basin Coordinating Group)
- increased awareness of other complementary land management approaches (such as fencing and relocation of water points).
- improved water quality as a result of the increase in ground cover along watercourses.





Protecting the Barkly Tablelands

Jonathan Peart



Background

The Barkly Tablelands region extends from Barrow Creek to Dunmarra and to the Queensland border, and includes the lower half of the Gulf country. It covers an area of 194 000 sq. km which is divided into 45 pastoral leases, reserves and Aboriginal land. The country is typically black soil plains primarily supporting Mitchell and Flinders grasses.

The parkinsonia threat

Parkinsonia is the most common weed of the Barkly and Gulf regions. Parkinsonia outbreaks in the Barkly Tablelands range from single plants to large impenetrable infestations, and all properties have recorded some parkinsonia.

'It's great that other property managers have been able to see real evidence of parky control'

Cooperative control efforts

Over the past 15 years control measures on parkinsonia have been undertaken on most properties, restricting the spread of and containing infestations. Parkinsonia control programs have been set up on all properties with assistance from the Northern Territory's Department of Infrastructure, Planning and Environment, and individual land managers continue to carry out annual weed control activities.

The Northern Territory government in conjunction with CSIRO has been involved in the distribution of a biological control agent, the seed-eating beetle (*Penthobruchus germani*), for the containment of parkinsonia throughout the Northern Territory. Following an initial release in the late 1980s and early 1990s, there is evidence of migration of the beetle across large distances—up to 40 km—over the Barkly. There are control sites on Banka Banka station where data on the success of the agent is still being gathered. Information regarding the growth and development of the trees and seed viability is being processed by CSIRO in Darwin.



Nathan March

- ▶ Former DIPE officer John McMahon inspecting treated parkinsonia on the Barkly Tableland





Experience with control measures

The most effective control measure to date has been herbicide. Application of Access and diesel using basal bark spraying is the most common practice. Graslan, a granulated, residual herbicide, has also been used with good results in moist areas that are not associated with watercourses, such as those around bores and turkey's nests, as well as for the control of isolated outbreaks.

Joint arrangements

Joint pastoral, departmental and NHT-funded projects have been and are being carried out in areas across the Barkly. In 2001 a major project on the Playford River was initiated with the granting of \$33 400. The catchment area extends for approximately 235 km, with some areas up 3 km wide, from the headwaters on Mittiebah station, through Alexandria station and Alroy Downs before draining into Lake Sylvester on Brunette Downs.

A weed control contractor was engaged to assist station-based control practices, and a team of twelve contractors, carrying out basal bark spraying, treated plants along the entire watercourse. Further extensive control and containment activities have been undertaken in 2002–03 with further work to be carried out in 2004. Signage outlining participants and the activities being carried out has been erected near the bridge crossing the Playford River at the Alroy Downs homestead.

Promoting awareness

According to John Stafford, President of the Barkly Landcare and Conservation Association, 'It's great that other property managers have been able to see real evidence of parky control (at the area near the Playford Bridge). They can actually see the trees dying and see the benefits of undertaking control work'.

Following the original control work carried out on the Playford River, quite a number of station-based control activities have been generated. Another catchment-oriented control program is beginning on the properties associated with Tarrabool Lake on Anthony Lagoon station.

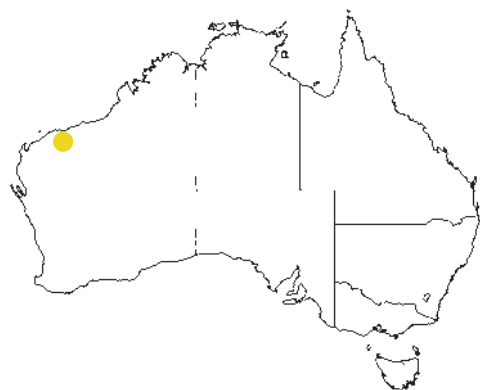
'They can actually see the trees dying and see the benefits of undertaking control work'





Using fire in the Pilbara

Michele Devezze and Peter Kendrick



Background

The Millstream–Chichester National Park is on the Fortescue River in the Chichester Ranges, about 100 km south of Karratha in the Pilbara. The Fortescue River terrain is broad river valley and floodout country, which narrows to about 500 m or less where it passes through the Chichester escarpment. The river valley ranges from fine red alluvium to coarse shingle and bedrock, and is primarily used as rangeland, national park or Aboriginal land.

‘The basal spraying technique works OK but needs constant revisiting to remove new seedlings’

The parkinsonia threat

Dr Peter Kendrick, regional ecologist for the Pilbara region of Western Australia’s Department of Conservation and Land Management (CALM), describes the parkinsonia infestation in the Millstream–Chichester National Park as ‘very dense thickets following the river, extending about 100 km from Millstream to Mardie’.

He is unsure about the origins of the infestation but suspects that because pastoralism was the only significant western land use in the country for about 100 years, it may have been associated with that industry.

Experience with control

Due to the extreme roughness of the terrain and the difficulty in accessing the area of river between the Pannawonica rail bridge and the north-west coastal highway, there is very poor vehicle access for much of the infestation. Staff from Yalleen, a neighbouring cattle station, have accessed the area to control parkinsonia on horseback, but this is limited in what it can achieve.

Consequently, parkinsonia control has been inadequate to date.

Around 1999 CALM started an intensive program to try to control parkinsonia and stop its spread in the Millstream–Chichester National Park. Every three months, at all times of the year, parkinsonia is basal bark sprayed with 2 per cent Garlon 600¹ in diesel. The lower half metre of the trunk of any plants over a centimetre diameter is covered with the mix.

During the same operation any plants less than a centimetre in diameter are hand weeded. Peter comments that ‘the basal spraying technique works OK but needs constant revisiting to remove new seedlings, as well as checking and searching for other thickets which are missed in the dense riverine vegetation’. He says that the advantages of hand weeding are that it minimises the use of herbicide in wetlands, and that ‘if there are only a few plants it’s easier than spraying’.

¹ Western Australia has an off-label permit, valid until the end of 2010, for the use of this herbicide





Occasionally, areas to be sprayed are pre-treated by burning as they have found that burning improves access for control. They are restricted to burning when fuel is sufficient to carry fire throughout the thicket—about once every two to three years—although if the fuel can carry it and other values are not damaged, they may burn annually.

Peter said that they accidentally discovered, when a relatively cool burn ‘totally wiped out some parky plants’, that fire could be an effective management tool for parkinsonia. They have not yet deliberately used fire on parkinsonia but intend trying it in some large thickets. He has noticed that while cool fires do destroy many plants, they also appear to encourage seed germination, and thinks therefore that hot fires may destroy more seed on the ground than cool fires.

However, he also believes the uniform germination of seed following a fire can be exploited, as it makes control of those plants easy to plan and manage. Another advantage of burning is that it clears away the debris resulting from previous spraying programs.

They have found that burning improves access for control

► Parkinsonia seedling emergence after fire

Longer term approach

Peter believes that a combination of burning and spraying is working well for them. However, in the future he would like to better coordinate burning and spraying by using small localised fires on particular targets.

The biggest problem in parkinsonia management in that area is the lack of easy access for ground-based management: ‘without biological control we cannot hope to control the parky in the river country between Millstream and Mardie’.

Fire could be an effective management tool for parkinsonia



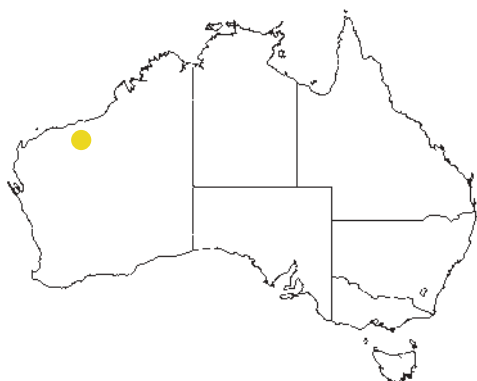
Nathan March





The De Grey River Parkinsonia Group

Michele Deveze and Rob Parr



The parkinsonia threat

Parkinsonia exists on many river systems in the Pilbara region of Western Australia including the Ashburton, Robe, Fortescue, Maitland, Harding and De Grey rivers. It is thought that the parkinsonia invasion probably originated from escapees from those planted around homesteads.



Nathan March

Under the Western Australian *Agriculture and Related Resources Act 1976*, leaseholders are obliged to control declared plants and animals on their leases. As such, the various leaseholders (both private and government) along these river systems are faced with a daunting task. Parkinsonia has invaded prime river frontage country and although these infestations are generally light/medium in density, they are extremely widespread and occasionally very dense.

Experience with control

Weeds and feral animals do not respect lease boundaries and in the case of weeds on river systems it is essential that a whole-of-catchment approach is adopted in order to achieve high quality outcomes. In other words, dedicated and persistent control downstream of a major infestation will amount to little if the potential for re-infestation from upstream is not dealt with.

With this in mind the De Grey River Parkinsonia Group was formed by the East Pilbara Regional Advisory Committee on 7 July 1989. It was an attempt to coordinate, and be supplementary to, subsidised spraying operations carried out on an individual basis by lessees in the catchment area.

A catchment-wide approach is essential where weeds are present in river systems

- ◀ Noel Wilson beside a parkinsonia plant growing within the Maitland River banks





The group consisted of pastoralists from Warrawagine, Pardoo, De Grey, and Yarrie and Muccan stations. The nearest towns to these properties are Marble Bar and Port Hedland. The process involved engaging the services of a contract spraying team and nominating a coordinator to oversee the running of the group. The finance for the group came from Western Australia's Declared Plant and Animal Control Trust Fund. This fund is created by the combination of rates raised on pastoral leases being matched by the government on a dollar-for-dollar basis.

Today, almost 15 years later, the group that began in 1989 is still operating. The original methods of approaching and dealing with the problems have changed somewhat but the 'whole of catchment' approach has remained consistent. Whereas a lot of the initial work was done on horseback and on foot, the present trend is to map the infestation via

helicopter and follow up with control in vehicles and on all-terrain vehicles (ATVs) using GPS equipment. One thing that has not changed is the tedious and difficult nature of the actual spraying programs.

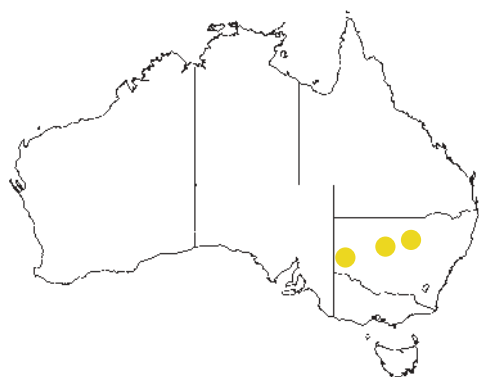
Last year, 2003, was the first year in which a team was not contracted to do the river to supplement the control exercised by the pastoralists themselves. This was not because the group was not keen to get the work done but rather a reflection of the shortage of competent available teams. Efforts are being made through various rural media outlets in Western Australia and Queensland to source contractors capable of carrying out these challenging weed control programs which are often in very remote locations under extremely trying conditions.

Weeds and feral animals do not respect lease boundaries



Parkinsonia—awareness and eradication in New South Wales

Nathan March



The parkinsonia threat

Until 2003 there were only two known occurrences of parkinsonia in New South Wales. These were limited to clumps of individual plants in the Broken Hill District. A further occurrence was found in 2003 on the Narran River in north-west New South Wales by Department of Natural Resources and Mines (Queensland) officer Darren Moor while holidaying at a relative's property. This chance discovery was further investigated by Nathan March (currently National Coordinator, Department of Natural Resources, Mines and Energy (Queensland) and Don MacKenzie of Bourke Shire Council in August 2003.

Small but established infestations were found growing on properties adjacent to where the original plant was discovered



Nathan March

▲ Nathan March inspecting an infestation on the banks of the Narran River

Small but established infestations were found growing in association with the Narran River on properties adjacent to where the original plant was discovered. The infestation contained both mature plants and seedlings with many plants overhanging the river bank. The presence of parkinsonia in this area was immediately recognised as a major threat to the environmentally significant Narran Lake.

▼ An isolated parkinsonia plant in the Broken Hill area



Nathan March



Experience with control

A control program is currently being led by Ian Kelly, Weeds Officer, Castlereagh–Macquarie County Council. To date this has included intensive surveys, awareness activities (particularly field days involving landholders in the area), and strategic control activities using Access and diesel.

Ian's surveys of the area have revealed parkinsonia infestations totalling 250 ha with over 20 km of the Narran River affected. The source of the infestation is likely to be a 'botanical garden' established at Yerambah, an original but now abandoned homestead site upstream of the core infestations.

In September 2003 a further occurrence of parkinsonia was found by Don MacKenzie at

an abandoned homestead in Bourke Shire. While this infestation was limited to 'about a dozen plants', it also threatened to spread via its proximity to the Warrego River.

NSW Agriculture aims to work with local government and community stakeholders to eradicate all known parkinsonia infestations from the state. It also seeks to increase the capacity for finding new infestations through awareness programs, identification training and surveys.

Control has included intensive surveys, awareness activities and strategic control activities using Access and diesel



Rieks van Klinken

- ▲ Don MacKenzie (Weeds/Vegetation Officer, Bourke Shire Council) inspects a parkinsonia plant adjacent to the Narran River. The plant had been unsuccessfully cut with an axe and was re-growing from the base.

Technical updates



Section 7

Technical updates

Principles of biocontrol

Michele Deveze

Biological control is the process of introducing natural enemies of exotic weeds or other pests to reduce their growth, reproductive capacity or life expectancy.

Establishment of a biological control program is lengthy and expensive because all potential agents must undergo testing against target and non-target plants under quarantine in Australia. This detailed testing is done to ensure that they will not attack native flora or economically important plants when they are released in Australia.

If quarantine testing in Australia indicates that the agent is definitely host specific, scientists make an application to the Australian Quarantine Information Service (AQIS) for approval to release the agent. Approved

agents are then mass-reared to produce large numbers of individuals that can be distributed throughout the range of the weed in Australia. Because these agents are introduced without their parasites and diseases, and often into vacant ecological niches, their population can reach very high levels and thereby result in very effective biological control.

There can be great variation in the time required for biological agents to build up in population and have a noticeable effect on the plant that they were introduced to control. Some agents can have a visible effect on weeds within a year or two of introduction whereas others may be present for more than ten years before having a noticeable effect. There is also a percentage that will not be able to adapt to the environmental conditions of their new habitat and will fail to establish.



▲ Entomological quarantine building in Brisbane

Rieks van Klinken

Research and development of *Penthobruchus*

Catherine Lockett

The Australian Agricultural Council approved *Parkinsonia aculeata* as a target for biological control in Australia in 1983, and investigations began with a joint project between the Queensland, West Australian and Northern Territory governments. Between 1983 and 1987, biological control research aimed at finding natural enemies of parkinsonia was undertaken in the southern United States and northern Mexico.

Twelve insect species were identified as potential biological control agents because of the damage they caused. The two with greatest potential were *Mimosestes ulkei*, a seed-feeding beetle and *Rhinacloa callicrates*, a sap-sucking bug. A third insect, the seed beetle, *Penthobruchus germani*, was later collected in Argentina. All three were brought to Australia for host specificity testing under strict quarantine.

In 1994 approval was obtained for the release of *Penthobruchus*. It is a small brown beetle, about 6 mm long, with large hind legs and black mottling on its wings. Individuals can live for up to two months but usually only live for about five weeks. The females lay up to 350 eggs each on parkinsonia pods, and after the eggs hatch the larvae tunnel into the seeds. The larvae will spend their entire development period in one seed and effectively destroy that seed.

- *Penthobruchus germani* eggs laid on a parkinsonia seed pod



Nathan March

- ▲ Field release of biological control agent *Penthobruchus germani* at Neumayer Valley, near Burketown



Catherine Lockett

- ▲ The hole in the seed was made by the emerging *Penthobruchus germani* beetle



Catherine Lockett



In early 1995 mass rearing of *Penthobruchus* started at the Tropical Weeds Research Centre (Charters Towers) and the Alan Fletcher Research Station (Brisbane) of the then Department of Natural Resources. More than 240 000 insects were released at over 125 sites including Winton, Rockhampton, Ayr, Cloncurry, Burketown, Normanton, Townsville, Georgetown and Charters Towers in Queensland. In the Northern Territory over 44 000 beetles were released. *Penthobruchus* has now been introduced to all major parkinsonia infestations in Queensland and has also been spread widely in the Northern Territory.

In the field the presence of *Penthobruchus* is indicated by white eggs under a pale membrane against the darker background of the pods. Round holes in the pods indicate that beetles have emerged.

Initial surveys in north and central Queensland showed that although there is a large variation in the success of the insects, *Penthobruchus* had in some cases destroyed up to 99 per cent of seeds over a season. Recent, ongoing research by CSIRO, however, has shown that although egg densities can be very high, seed mortalities are sometimes low and unlikely to significantly reduce parkinsonia populations in many parts of Australia. The main reason for low seed mortalities appears to be high parasitism of beetle eggs by native wasps.

Existing biological control agents alone will not control parkinsonia. They are just one of the control options that can be incorporated into integrated management practices.





Parkinsonia modelling

Michele Devezé with Riëks van Klinken

Models can help scientists and land managers assess the potential outcomes of a range of management options on a particular weed population, and determine which process will be the most cost effective. Models are commonly built on computers, and involve the computer performing a number of complex mathematical functions based on the interaction of known characteristics, or parameters, of the pest species.

Modellers feed into the computer model descriptive data about the pest species and its ecology, the range of environments that the species inhabits, the interaction between the species and environmental conditions, and the effect of different control methods on the survival of the species as a plant or a population.

When the modeller is satisfied that the model accurately represents the weed, its ecology


and its responses to external stimuli, scenarios can be developed and the 'virtual weed' subjected to a range of 'virtual treatments' under different conditions. To confirm the predictions of the model and develop best practice methodology, the scientist will then replicate in the field the scenarios that performed best, and conduct formal assessments on their outcomes.

A parkinsonia modelling working group was established in 2000, consisting of state and federal government agencies including CSIRO, NRM&E and the Department of Primary Industries and Fisheries (Queensland), the Department of Primary Industries and Fisheries (Northern Territory), and the Department of Agriculture (Western Australia). At the inauguration of the modelling workgroup, little research had been conducted in Australia on parkinsonia and little information on its biology and ecology was available.

▼ The parkinsonia modelling working group visiting the Leura field site near Rockhampton, Queensland



Riëks van Klinken



The working group's aims were to identify and address the current research gaps in parkinsonia biology, management techniques and potential biological control agents, and to devise a best practice management strategy for the weed as a part of the weeds of national significance parkinsonia strategic plan. The specific objective of building a parkinsonia model was to create a tool with which to design and evaluate a parkinsonia best management practice strategy that could be tailored for specific conditions around Australia. This would include looking at combinations of mechanical control, herbicide control, fire and biological control agents. The model will also provide an educational and predictive tool for managers, landholders and new employees.

Three workshops have already been held. Outcomes of these included gaining a clearer understanding of the parkinsonia lifecycle and the processes that affect parkinsonia growth, mortality and reproduction, as well as a clearer definition of the kind of data required to build a population dynamics model for parkinsonia.

The parkinsonia model working group have described the prototype model as 'almost operational' and are anticipating its practical use and further refinement in the near future. They commented that an incidental and unexpected outcome of developing the model was that background research designed to refine and define plant parameters has also provided indications of initial best practice management techniques.



Integrated parkinsonia management

Michelle Deveze with John McKenzie

In 2001 John McKenzie, rangelands weeds officer at the Tropical Weed Research Centre, Charters Towers, commenced a parkinsonia trial at Leura, near Duaringa in central Queensland. The Leura site was chosen because almost all of the 133 ha of the trial site were infested with parkinsonia, at an average density of 2200 plants per hectare.

The trial aimed to test the effectiveness of a range of parkinsonia control methods including herbicide, mechanical and fire. Factors assessed by the trial included plant mortality, regeneration, recruitment, soil seed bank changes, and grass response after each treatment.

The trial consisted of ten different treatment plots and a non-treated plot (known as a control plot). All plots were replicated three times.

The ten treatments were:

- Herbicide
 - Grazon DS (aerial application to the foliage)
 - Graslan (aerial application to the soil)
 - Velpar® L (soil application)
 - Access + diesel (basal bark technique)
- Mechanical
 - stick raking
 - blade ploughing
 - Ellrott ploughing
 - bulldozing
 - double pulling
- Fire

This trial at Leura has a four-year life span with final assessments scheduled for 2005.

John reports that preliminary indications are encouraging, though cautions that one should not jump to conclusions until a complete data set from the experiment is gathered. By the end of the trial he expects to be able to make a good comparison between these treatments with respect to their respective effectiveness in controlling parkinsonia. Existing results indicate, however, that each treatment is effective in controlling this weed, with individual circumstances dictating the 'best' situation in which to apply a particular treatment.

Herbicide treatment

Basal bark spraying is good for control in riparian areas and for isolated plants. Other application techniques using Grazon DS, Velpar® L and Graslan appear quite effective and relatively cheap, but to minimise damage to non-target vegetation their use should be restricted to areas away from watercourses and where there is minimal non-target vegetation.





John McKenzie

▲ Parkinsonia plants at the Leura trial site before treatment



John McKenzie

▲ After treatment with foliar herbicide (Grazon DS)



John McKenzie

▲ Before treatment



John McKenzie

▲ After treatment with soil-applied herbicide (Graslan)



Mechanical methods

The main benefit of mechanical methods is that they reduce the size of parkinsonia, encouraging grass to grow and compete with the weed. The result is that the area is more open and provides easier access for stock. Similarly, parkinsonia that has been pushed into stacks can be burned. By contrast, parkinsonia trees that have been killed by basal bark or foliar spraying remain as standing dead trees for around a year.

John recommends that the Ellrott plough and the conventional blade plough be used for thick infestations away from watercourses—‘they’ll kill almost all adult parkinsonia present’. At this stage of the experiment it is not possible to predict the level of recruitment from seed. Perhaps because of the presence and activity of the seed-boring beetle (*Penthobruchus*) at the site, it will not be significant.



John McKenzie

▲ Before treatment



John McKenzie

▲ After treatment by mechanical means (Ellrott ploughing)



John McKenzie

▲ Before treatment



John McKenzie

▲ After treatment by mechanical means (bulldozing)



Bulldozing, stick raking and double pulling are rated as similar in effectiveness. Initial results indicate a mortality ranging from 24 per cent for double pulling to 43 per cent for stick raking. However, John again warned that the overall costs of each would finally depend on the recruitment level after each treatment: 'it is still too early in the experiment, and environmental variables over the next few years will affect the results'.

'Follow-up treatments will be dependent on seedling density: it may be basal barking, soil-applied herbicide, foliar spraying, aerial spraying or mechanical control.'

John regards the experiment as very valuable because it is trialing a range of treatments at the one site.

Conditions such as climate, land usages, vegetation, fire properties and relative palatability of parkinsonia to cattle can be very different in other parts of Australia, so results and recommendations will not necessarily apply universally. Other research, including ecological work throughout Australia and the development of a computer management model, is therefore aimed at working out how management methods are likely to work best under other conditions.



Getting the most out of your basal spraying program

John McKenzie and Michele Deveze

Your basal spraying technique can make all the difference to the success of your spraying program. If you do not spray the weeds properly, your kill rate will probably be decreased and your follow-up work will take more time and herbicide. Making sure of a few simple points can mean the difference between a successful day's work and a waste of time.



Nev Mills

▲ Basal bark spraying

These include the following:

- Ensure that the herbicide that you're using is registered for the purpose.
- Use clean diesel.
- Mix at the right rate (see 'Herbicide use and mixing' page 92).
- Mix only the amount you will be using for the day.
- Ensure that the herbicide is thoroughly mixed through the diesel.
- Ensure that the stem is clean from grass, debris, mud and moisture.
- Spray at about 45 degrees to the stem to minimise splash-off.
- Use less rather than more pressure.
- To increase the flow rate, increase the apertures of the spray piece rather than increasing pressure.
- Ensure that complete circumference of the plant stem is covered with mix.
- The larger the diameter of the stem, and the taller the plant, the higher up the stem should be sprayed. As a general rule parkinsonia plants up to 50 mm basal diameter should be sprayed from the ground up to knee height. Plants bigger than this should be basal bark sprayed from the ground up to hip height.
- Although basal bark spraying will work throughout the year, the best time for treatment is when plants are actively growing and the soil moisture is good.



New Mills

▲ Before treatment



New Mills

▲ Basal bark spraying can be an effective tool in controlling parkinsonia





Herbicide use and mixing

Michele Devezé

How you mix your herbicides can make the difference between whether a weed control program is a success or a failure. If the mix is not strong enough your kill rate will be reduced, meaning that you will probably need to return and do some or most of the job again. If your herbicide mix is too strong, it may affect the way that the herbicide works by killing the outside cells, stopping it from being absorbed into the plant's sap system. At the very least, using a mix that is too strong will cost you more than is necessary. Table 4 contains a guide to the volume of chemical or concentrate required, when using different tank sizes, to make up the desired ratio of mixture.

The main points are as follows:

- **Read the label and have a MSDS sheet on hand when applying herbicide.**
 - Material safety data sheets can be obtained from the herbicide distributor and supplier, or online.
- **Observe all recommended safety precautions.**
 - Wear gloves, aprons and face/eye protection for mixing.
 - Wear overalls, gloves and eye protection for spraying.
 - Wash hands after mixing and using herbicide, and before smoking or eating.
- **Mix up only the amount that is required for the day.**
 - Measure herbicides and diesel/water using calibrated containers.
 - Use a wetting agent or other additive if recommended.
 - Fill the tank to about two thirds full, add the herbicide concentrate, and then continue filling the tank.
- **Make sure the herbicide is thoroughly mixed into the water or diesel.**
 - Do not use bare hands for mixing wettable powders or granules (of any herbicide).
 - Use a paddle or mechanical agitator to keep the solution in suspension for foliar herbicides.
- **Dispose of unused mixed herbicide and used containers in a lawful and responsible manner.**



Table 4 Volume of herbicide concentrate added to differently sized tanks to achieve specific mix ratios

Mix ratio	Tank volume (litres)							
	1	2	5	10	50	100	200	500
	1:40 0.025 L (25 ml)	0.05 L (50 ml)	0.125 L (125 ml)	0.25 L (250 ml)	1.25 L (1250 ml)	2.5 L (2500 ml)	5 L (5000 ml)	12.5 L (12 500 ml)
	1:50 0.02 L (20 ml)	0.04 L (40 ml)	0.1 L (100 ml)	0.2 L (200 ml)	1 L (1000 ml)	2 L (2000 ml)	4 L (4000 ml)	10 L (10 000 ml)
	1:60 0.017 L (17 ml)	0.033 L (33 ml)	0.083 L (83 ml)	0.167 L (167 ml)	0.833 L (833 ml)	1.667 L (1667 ml)	3.333 L (3333 ml)	8.333 L (8333 ml)
	1:100 0.01 L (10 ml)	0.02 L (20 ml)	0.05 L (50 ml)	0.1 L (100 ml)	0.5 L (500 ml)	1 L (1000 ml)	2 L (2000 ml)	5 L (5000 ml)
	1:200 0.005 L (5 ml)	0.01 L (10 ml)	0.025 L (25 ml)	0.05 L (50 ml)	0.25 L (250 ml)	0.5 L (500 ml)	1 L (1000 ml)	2.5 L (2500 ml)
	1:300 0.003 L (3 ml)	0.007 L (7 ml)	0.017 L (17 ml)	0.033 L (33 ml)	0.167 L (167 ml)	0.333 L (333 ml)	0.667 L (667 ml)	1.667 L (1667 ml)
Concentrate volume								

Can you fight parkinsonia with fire?

John McKenzie, Shane Campbell and Tony Grice

People are asking if parkinsonia can be controlled with a planned burning program. At this stage scientists at the Tropical Weeds Research Centre (TWRC) in Charters Towers, north Queensland, are not sure. However, along with CSIRO they are researching the effects of fire on parkinsonia infestations.

John McKenzie, rangeland weeds officer at TWRC says that he has heard from landholders that burning gives mixed results. In some areas there has been virtually no mortality following what appeared to be fairly intense fires, whereas some—but by no means all—cooler low-intensity fires, lit during breaks in the wet season, resulted in fairly good kill rates.

CSIRO scientist Dr Tony Grice monitored survival of parkinsonia following a dry season fire in the Charters Towers region. He found that 50 per cent of plants of a range of size-classes were killed even though the fire was of relatively low intensity.

Current research is examining the responses of parkinsonia to different seasons and intensities of fire in order to identify burning regimes that will cause maximum parkinsonia mortality. The research is being undertaken at Fletchervale, which is located near Charters Towers and has a fairly dense infestation of parkinsonia growing on an alluvial basalt soil.

- ▶ A fire trial underway at Fletchervale, near Charters Towers, Queensland



John McKenzie

- ▶ Scientists of NRM&E's Tropical Weed Research Centre are continuing fire trials in collaboration with CSIRO



John McKenzie



This experiment should give us a sound understanding of how differently sized plants handle fire, how fires affect parkinsonia density, and whether fires kill seeds in or on the soil. Researchers are recording the characteristics of each experimental fire, and the condition of plants at the time of burning, so that reliable recommendations can be made to landholders.

The effects of intensity are being evaluated through comparisons between fast moving head-fires (burning with the wind) and slow moving back-fires (burning into the wind). Four different seasonal burns are being studied: early dry season, late dry season, early wet season and mid wet season.

John said that preliminary results suggested that the seeds sitting on the soil surface might be damaged by fire, and that in some treatments already implemented, a number of plants appear to be dead or dying.

This research is in its early stages and recommendations will be published as results become available. It will then be possible to determine what role fire has to play in parkinsonia management, either as a stand-alone treatment or as a component of an integrated approach.



Seed viability and dormancy

Rieks van Klinken

Parkinsonia seeds can remain dormant for long periods, and the resulting long-lived seed banks can be a real problem for control. For seeds to lose dormancy and germinate, the very tough, hard seed coat needs to be damaged, or weakened sufficiently to let water in.

Many different factors can result in loss of seed dormancy. Moisture, heat (bare soil temperatures frequently heat up over 40°C), and damage (e.g. from insects) are probably particularly important. These conditions will differ depending on climatic conditions, ground cover, depth in soil, levels of inundation and other factors. A proportion of seeds (often about 10 per cent) are never dormant.

To properly predict the long-term outcome of different control techniques, it is valuable to know not only the size of existing seed banks but what proportion of the seeds are actually viable, and what proportion of those are dormant and therefore likely to remain in the soil well beyond the next major rainfall event.

CSIRO and the Northern Territory's Department of Infrastructure, Planning and Environment (DIPE) have recently developed a standard test for determining whether or not seeds are viable and dormant. To determine dormancy levels, seeds are placed in water at 20°C for four days; those that have not swelled up (imbibed) after that period are considered to be dormant.



Rieks van Klinken

▲ Dormant parkinsonia seed

To determine viability, seeds are soaked until they are fully imbibed, and then placed on paper and kept moist at 20–30°C until they either germinate (i.e. are viable) or rot. The seed coat of dormant seeds needs to be damaged (with sandpaper) before their viability is determined in the germination test.

These tests are currently being used in conjunction with Australia-wide studies aimed at determining seed density and distribution in the soil as well as seed bank longevity under different climates, habitats, ground covers and soil depths.



Rieks van Klinken

- ▲ A seed burial experiment in Darwin is examining the effect of depth, shade cover, burial time, and soil temperature and moisture on parkinsonia seed longevity



Rieks van Klinken

- ▲ Seed burial packets. Each packet contains 50 seeds and is buried for later retrieval



Do feral pigs spread parkinsonia?

Ben Lynes

The Tropical Weeds Research Centre (TWRC), wanted to find out if feral pigs might account for some of the spread of parkinsonia seed.

Based on a feeding trial, TWRC reported that the pigs did not appear to like to eat parkinsonia seed. Even when the seeds were coated with molasses, they only ate 35 per cent of the pods. Mostly they just licked the molasses off.

Of the small amount of seed that they did eat, it took from three to eight days for the seeds to pass through their digestive system; of these, 50 per cent remained viable and capable of germinating.

However, based on the feeding trial it appears that parkinsonia is not a preferred food source and consequently feral pigs may not be major dispersers of parkinsonia seed.



Ben Lynes

▲ Feral pigs do not seem to eat parkinsonia seed

Do I really need a tree clearing permit to clear weeds?

Michele Deveze and Ann Doak

Weed control should aim to avoid or minimise damage to non-target native vegetation. However when controlling parkinsonia, land managers may choose to use methods that involve the clearing of adjacent or interspersed native vegetation, particularly in heavily infested areas. In these cases, the clearing of the native vegetation may require a permit.

In addition, landholders may use methods of weed control that result in incidental damage to native vegetation. In these cases, the damage to the native vegetation is considered to be clearing, and may also require a permit.

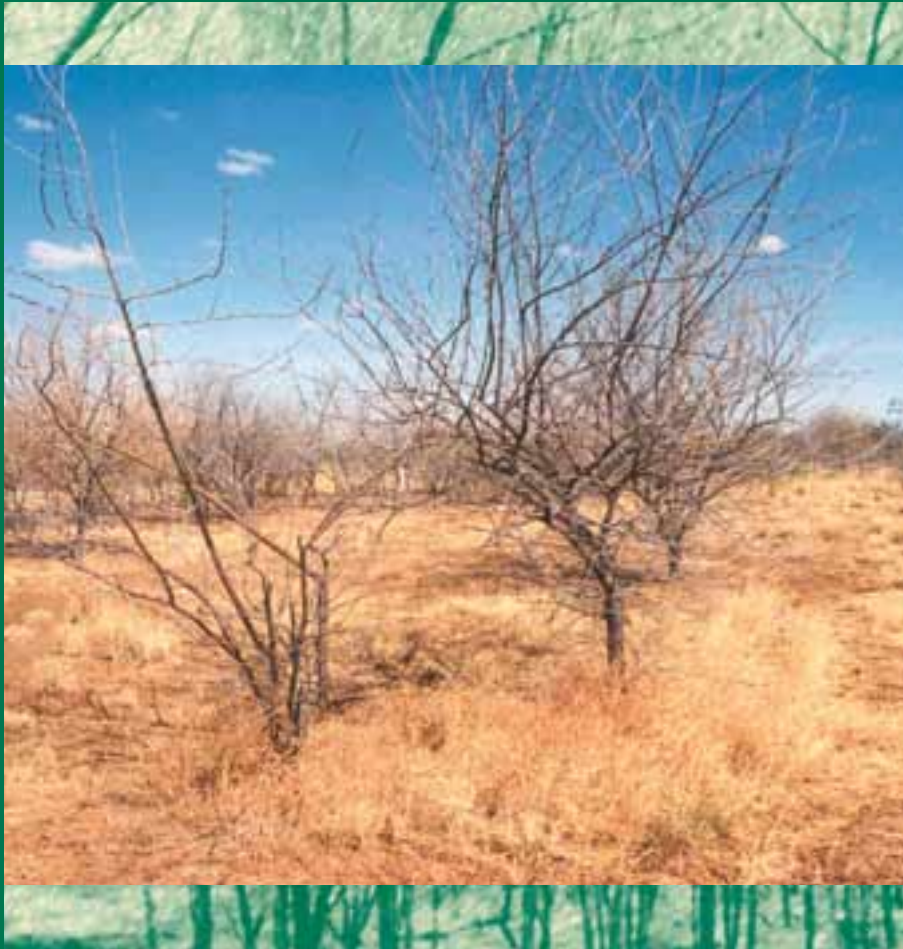
If using control methods such as mechanical, fire or herbicides, there may be a risk that native vegetation could be affected. If a proposed weed control program may result (intentionally or accidentally) in the clearing or death of native vegetation, it is essential to comply with the relevant state and/or local government native vegetation legislation. So check this before starting work.

▼ Clearing of parkinsonia working around native vegetation



Michele Deveze

Further information



Section 8

Further information

Declaration details in Australia

The following information regarding the declaration of parkinsonia in Australian states and territories has been extracted from the respective government web sites.

Australian Capital Territory

Currently not declared.

New South Wales

Declared noxious, category W1, in the following control areas: Bourke, Brewarrina, Broken Hill, Central Darling, Cobar, Unincorporated area of Western Division. This means that the presence of this weed on land must be notified to the local control authority and the weed must be fully and continuously suppressed and destroyed.

Northern Territory

Declared noxious, category B. Growth and spread to be controlled.

Queensland

Declared weed, Class 2. Must be controlled. Ban on sale, introduction and use.

South Australia

Proclaimed plant. Notifiable throughout the state. Plant must be destroyed.

Tasmania

Currently not declared.

Victoria

Currently not declared.

Western Australia

Declared plant categories: P1, P2 & P4

- P1—prohibits movement
- P2—aim is to eradicate infestation
- P4—aim is to prevent infestation spreading beyond existing boundaries of infestation

Locations

Both Categories P1 and P4 apply to the municipal districts of Ashburton, Carnarvon, Coolgardie, Cue, Dundas, East Pilbara, Exmouth, the City of Kalgoorlie–Boulder, Leonora, Laverton, Meekatharra, Menzies, Mt Magnet, Murchison, Ngaanyatjaraku, Port Hedland, Roebourne, Sandstone, Shark Bay, Upper Gascoyne, Wiluna and Yalgoo.

Both Categories P1 and P4 apply to the municipal districts of Broome, Derby-West Kimberley, Halls Creek and Wyndham-East Kimberley.



Contacts

In the first instance, enquiries about declared weeds should be referred to your relevant local

government or shire council. Weed information sheets are available from state and territory government agencies and from their web sites.

Table 5 State, territory and general contacts

Organisation/department	Contact details
New South Wales	
Department of Primary Industries	Tel: 1800 680 244 to report 'Notifiable weeds' class W1 Web site: www.dpi.nsw.gov.au
Department of Infrastructure, Planning and Natural Resources	Web site: www.dipnr.nsw.gov.au
Northern Territory	
Department of Infrastructure, Planning and Environment	Tel: 08 8962 4491 or 08 8973 8107 Web site: www.ipe.nt.gov.au
Queensland	
Department of Natural Resources, Mines and Energy	Tel: 1800 803 788 Web site: www.nrme.qld.gov.au
South Australia	
Department of Primary Industries and Resources	Tel: 08 8226 0222 Web site: www.pir.sa.gov.au
Western Australia	
Department of Agriculture	Email: enquiries@agric.wa.gov.au Web site: www.agric.wa.gov.au
General	
CSIRO	Tel: 1300 363 400 Email: enquiries@csiro.au Web site: www.csiro.gov.au
CSIRO Entomology	Email: entomology-enquiries@csiro.au Web site: www.ento.csiro.au
Weeds Australia	Web site: www.weeds.org.au
Weeds CRC	Tel: 08 8303 6590 Email: crcweeds@adelaide.edu.au Web site: www.weeds.crc.org.au



References and further information

Further information may be gained from the following publications and products.

Vitelli, JS 1995, *Parkinsonia*, in *Exotic weeds and their control in north west Queensland*, ed. N March, Department of Lands, Brisbane, pp. 34–35.

Agriculture & Resource Management Council of Australia & New Zealand, Australian & New Zealand Environment and Conservation Council and Forestry Ministers (ARMCANZ & ANZECCFM) 2001, *Weeds of national significance: Parkinsonia* (*Parkinsonia aculeata*) *Strategic Plan*, National Weeds Strategy Executive Committee, Launceston.

Department of Natural Resources and Mines 2002, *Parkinsonia ... is a threat*, brochure, Department of Natural Resources and Mines, Brisbane.

Department of Natural Resources and Mines 2003, *Help stop the spread of prickly bushes*, poster, Department of Natural Resources and Mines, Brisbane.

Department of Natural Resources and Mines 2003, *What prickly bush is that?* poster, Department of Natural Resources and Mines, Brisbane.

