DEPARTMENT OF **ENVIRONMENT AND NATURAL RESOURCES**

Parkinsonia Biological Control

Monitoring parkinsonia health to better document impacts of management

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BACKGROUND

Parkinsonia

Parkinsonia (*Parkinsonia aculeata*) is a thorny tree from the Americas that negatively impacts production and the environment by forming thickets, replacing desirable vegetation and impeding mustering and access.

Climatically, it is most suited to semi-arid and semi-humid regions in northern Australia; dense infestations generally only occur on seasonally flooded areas (especially black soils), riparian fringes and watercourses, around water infrastructure ("turkey nests") and on the edges of freshwater wetlands.

Brief history in Australia

- Deliberately introduced and spread from the 1860s, first as an ornamental, and later for shade, windbreaks and land rehabiliation.
- First recognised as a potential threat in parts of Queensland from 1906.
- Population expanded during the 1970s and 1980s.
- Research programs into parkinsonia biological, chemical and other control methods began in the early 1980s (van Klinken *et al.* 2009).
- Three biocontrol agents were released in the 1990s, one of which established (a seed-feeding bruchid) (Julien *et al.* 2012).
- A naturally occurring dieback has been observed in parkinsonia stands for at least 50 years. In the last 10 years, parkinsonia dieback has become more noticeable – on occasion associated with the death of whole stands of adult trees.
- Declared a Weed of National Significance in 1999.

Biological Control Agents — UU and UU2

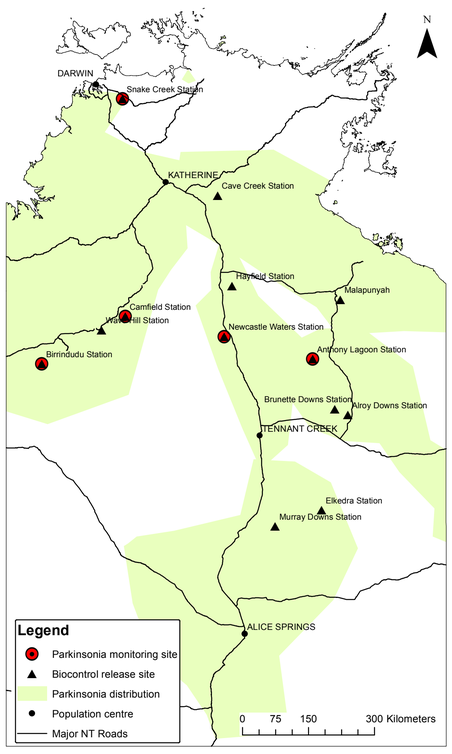
Since 2013, the CSIRO and the NT and Queensland Governments have been rearing and releasing two new parkinsonia biocontrol agents, the moths UU and UU2 (*Eueupithecia cisplatensis* and *Eueupithecia vollonoides*).

The long term aim of the program is to reduce the health of parkinsonia plants so that stands are less vigorous and produce less seed, thereby reducing the cost and difficulty of control using other methods,

UU Larva on parkinsonia leaf

UU Pupae and moth

Parkinsonia monitoring and biocontrol release sites in the NT



STEPS IN A BIOLOGICAL CONTROL PROGRAM

STEP 1
Research potential agents in the native range to determine whether they are likely to be (1) host-specific and (2) capable of impacting the target.

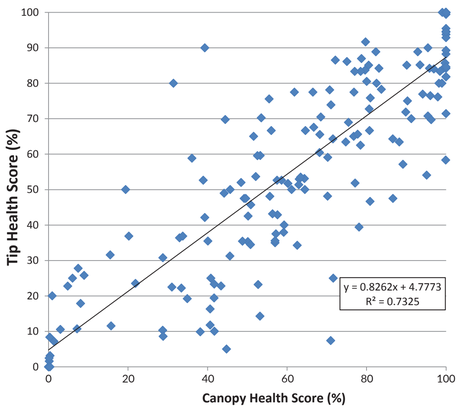
STEP 2
Moths undergo host testing to ensure that they only eat the target plant, then application is made to allow their release (Heard 2011).

STEP 3
Rear and release the parkinsonia moths to establish healthy wild populations of both species, with the aim that they become widespread across the range of the target plant, parkinsonia.

STEP 4
Monitor the establishment of the moths using a simple method to estimate their density. The two species of moth are difficult to distinguish in the field.

STEP 5
Monitor any change in the health of the parkinsonia plants over time, and with the agent monitoring data, draw informed conclusions about the level of impact from the moths and/or other causes.

Canopy Health Score and Tip Health Score are weakly positively correlated (R^2 = 0.7325)



MONITORING AND EVALUATION

Monitoring sites

The NT Weed Management Branch has established five parkinsonia monitoring sites in five different regions of the Northern Territory. The UU moths are monitored at these sites, as well as at other release sites.

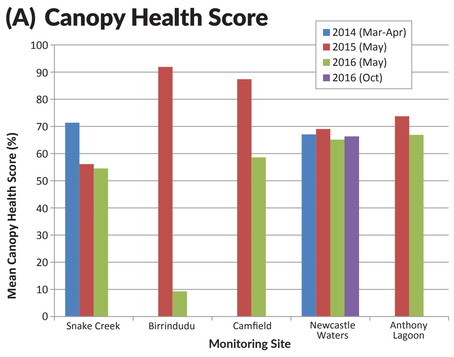
Aim of monitoring

To inform conclusions about the level of impact of the UU moths on parkinsonia.

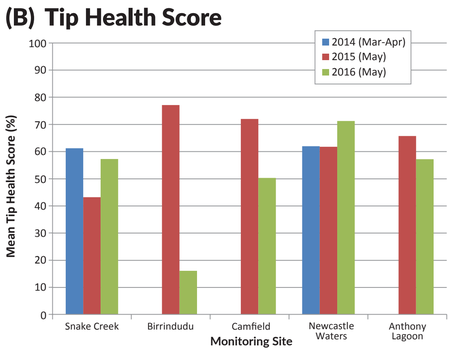
Why do all this monitoring?

Land managers often ask the question, are the moths working? By using data from specific locations before and after the release of agents, we can use evidence to help answer this difficult question.

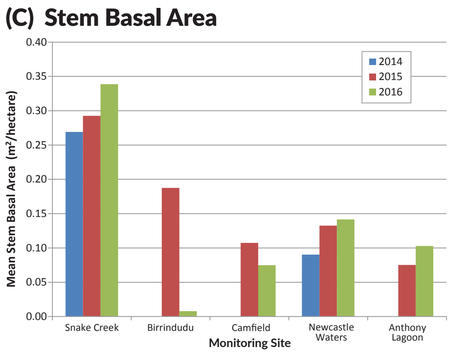
(A) Canopy Health Score



(B) Tip Health Score

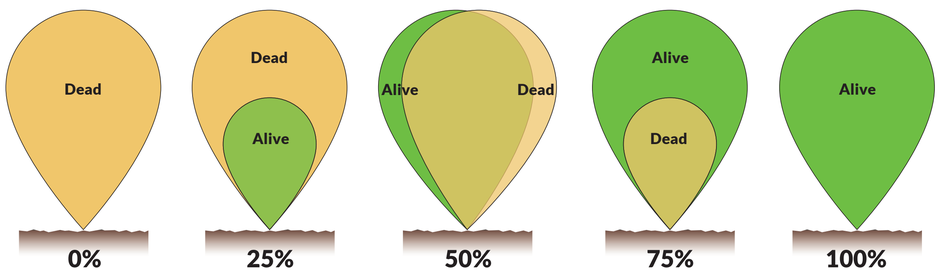


(C) Stem Basal Area



Change over time at five monitoring sites for (A) mean Canopy Health Score; (B) mean Tip Health Score; and (C) mean Basal Area. All values are the mean from 15 adult plants (>1.5 m height) randomly sampled from the population and remeasured in subsequent years. Any plants that die are replaced with new randomly sampled alive plants to control for age effects. Note that the Birrundudu site was burnt in 2016, and there was significant evidence of grazing by cattle at the Camfield site.

HOW WE MEASURE THE CANOPY HEALTH SCORE



Schematic of alive and dead canopy volumes. This measure works on the principle that if the alive and dead canopy have equal volume, then the plant has a Canopy Health Score of 50%. The score ranges from 0% (completely dead) – 100% (completely healthy). The Canopy Health Score is calculated using the formula: Alive canopy volume/Alive canopy volume + Dead canopy volume.

IS THE HEALTH OF PARKINSONIA PLANTS CHANGING?

Methods

Each monitoring site is one hectare (100 x 100 m). Using a 100 cell grid, we surveyed the grid for presence/absence of parkinsonia plants in 3 size classes (adult (>1.5 m), juvenile (0.2–1.5 m), seedling (<0.2 m). This allowed us to first randomly select cells with adult parkinsonia, and then to randomly select an adult plant from each cell. We sampled 15 adult plants to represent the population and measured variables to represent plant health, substituting new plants in the following year from the same population for any dead individuals to maintain the integrity of the methodology and control for age effects.

Plant Health Variables

On the basis of previous work on assessing the health of mimosa (*Mimosa pigra*), we measured plant health in three ways,

Tip Health Score (% stem tips alive from the total sample)

The observer assesses tips of the plant (at least 50 cm long) and counts the number alive and number dead. The observer aims to assess at least 20 stems from the plant, sampling across the whole canopy, although sometimes less than 20 stems are available to count.

Canopy Health Score (Alive Canopy Volume / Alive Canopy Volume + Dead Canopy Volume)

To measure canopy volume, the observer measures the length, width and height of the living and dead canopy.

Volume is calculated using a formula for an ellipsoid (a 3D ellipse). To avoid small dead twigs on otherwise healthy stems being counted, dead matter had to be at least 50 cm long to be considered.

Stem Basal Area (total stem area calculated from stem diameter measured with calipers)

Basal area is a standard forestry measurement to measure plant size, and can be related to total biomass. To be consistent with previous work (Grice *et al.* 2002), we measured it at 20 cm above the ground.

Another method that has been used to measure plant health is:

Plant Health Class (e.g. from 1–10).

Plant Health Classes have been used in previous monitoring work on parkinsonia and mimosa (e. g. Galea 2009). We chose to use continuous rather than class based measures to (1) avoid observer bias; and (2) to meet the requirements of statistical analysis.

Challenges

Assessing whether or not plants are actually changing in health is difficult. Some of the challenges include:

- Plants vary in their health within a stand.
- Some methods are prone to observer bias (subjective).
- Plant health varies in time naturally (with the wet and dry seasons and with plant age).
- Plant health varies in space with region, habitat and other factors.

Comparison of four different methods of assessing plant health

METHOD	STRENGTHS	WEAKNESSES
Canopy Health Score (%)	• Highly observer independent • Repeatable • Continuous measure	• Time consuming • Requires good sampling method to represent population
Tip Health Score (% alive)	• Quick and easy to do • Can be done across a population if necessary	• Prone to a degree of observer and/or measurement error
Stem basal area (m^2)	• Highly observer independent • Repeatable • Continuous measure	• Prone to age effects • Not reliable for tracking change in health over time
***Plant health Class (1-10)** *This method was not used in the present study, but is included here for the purpose of comparison	• Quick and easy to do • Can be done across a population if necessary • Definition of classes can be tailored to purpose	• Coarse measurement due to use of classes • Prone to observer bias • Data has limited utility for statistical analysis

Results

- Two sites were significantly disturbed and had reduced scores for all three measures of plant health. The Birrindudu site was burnt, and the Camfield site was heavily grazed by cattle during the period.
- Stem basal area increased over time for the three undisturbed sites.
- The other two measures, Canopy Health Score and Tip Health Score showed both small increases and decreases.
- Canopy Health Score and Tip Health Score are weakly positively correlated (R^2=0.7325).

HOW ARE THE UU MOTHS GOING IN THE WILD?

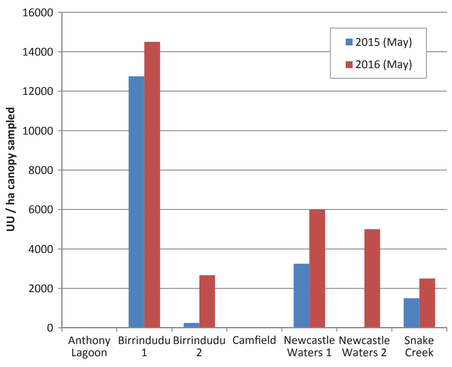
Method

Sample the canopy by beating healthy plants with a club above a standard size drop sheet and counting the number of UU larvae detected on the sheet. Calculate the density of larvae per hectare canopy.

Results

- Density of UU moths is strongly affected by season, so results at different times of the year may not be comparable.
- Moths increase in abundance during the wet season, and reduce to such low densities that they may be undetectable during the late dry season.
- Comparing the same monitoring sites at the same time of year (May), there has been an increase in the density of UU moths (2015–16) across the three sites where it has established from 2015-2016 indicating healthy, established populations at these sites. The UU moths have been unable to establish at two sites.

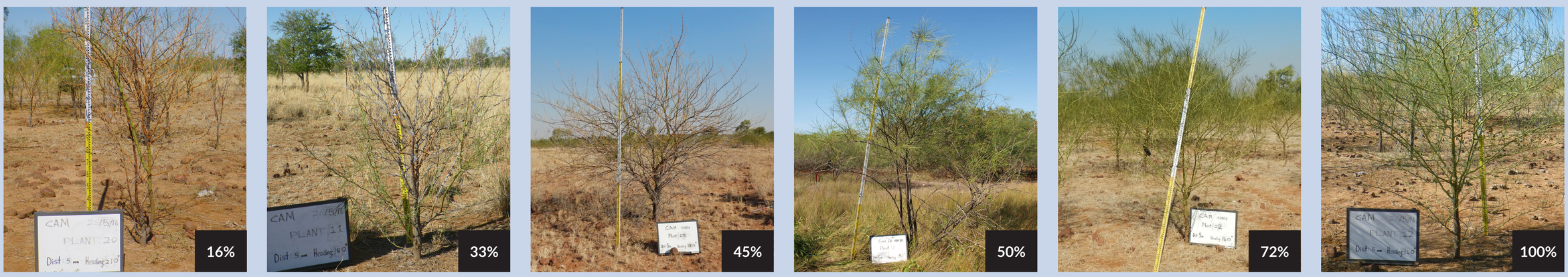
UU per hectare parkinsonia canopy



Conclusions

- Of the methods used to assess plant health, Canopy Health Score was preferred because it is (1) sensitive to changes in both alive and dead canopy, (2) continuous data, (3) observer independent.
- Tip Health Score was considered to be more prone to observer bias from field observations, although it has some advantages over Canopy Health Score. Developing this method in the future may provide useful, for assessing plant health in weed infestations.
- Stem Basal Area is not a useful measure of plant health because it relies on the living part of the plant only and does not use the dead or dying part of the plant, although it may allow useful comparisons between sites and regions.
- Adult parkinsonia plants are highly susceptible to heavy grazing and fire.
- The health of parkinsonia plants appears stable at the present time at the three less disturbed sites.
- The UU moths are increasing in abundance in areas where they have been able to establish, but are mostly at densities below that required to significantly impact parkinsonia plants.
- Consequently, any input that UU and UU2 are having on parkinsonia is limited at the present time.
- The density and distribution of UU and UU2 are anticipated to continue to increase over the coming 2016/17 wet season.

EXAMPLES OF PARKINSONIA PLANTS WITH VARYING CANOPY HEALTH SCORES



Acknowledgements

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