Progress in the eradication of *Mikania micrantha* from Australia

Simon J. Brooks[1] and Mick Jeffery[2]
[1] Tropical Weeds Research Centre, Biosecurity Queensland, Department of Agriculture and Fisheries, PO Box 187, Charters Towers, Queensland 4820, Australia
[2] Biosecurity Queensland, Department of Agriculture and Fisheries, PO Box 20, South Johnstone, Queensland 4859, Australia.
(simon.brooks@daf.qld.gov.au)

Summary *Mikania micrantha* Kunth (Mikania vine) was first discovered near Mission Beach in north Queensland in 1998 and this species was included in the nationally cost-shared 'National Tropical Weeds Eradication Program' when it commenced in late 2003. The progress that is being made towards the eradication of this serious tropical weed is prompting decisions about the type and duration of program resources deployed to survey areas with continuous records of plant absence.

Issues still remain in detecting this vine amongst a backdrop of green vines and rainforest trees, the longevity of the seed soil seed bank and preventing the occasional reproductive relapse. Research and field observations have identified that control prior to July each year should prevent seed production, but canopy disturbance from cyclones increases emergence and growth rates.

Keywords Cyclones, tropics, declaring eradication.

INTRODUCTION

Mikania micrantha Kunth (Mikania vine) is a rampant, smothering tropical weed, readily capable of vegetative dispersal and seed dispersal by wind, water or machinery. It is one of the most serious weeds across tropical Asia, the Indian sub-continent and Pacific regions (Day *et al.* 2016). *Mikania micrantha* was first discovered near Mission Beach in north Queensland in 1998 and this species was included in the nationally cost-shared 'National Tropical Weeds Eradication Program' (NTWEP) when it commenced in late 2003. *Mikania micrantha* was also discovered near Forrest Beach, Ingham and Speewah, (Brooks *et al.* 2008) but most active infestations are near Mission Beach and Bingil Bay. This area also includes several of the multiple *Limnocharis flava* (L.) Buchenau and *Miconia calvescens* DC. infestations that are also targeted by this program. Single locations of *Miconia racemosa* (Aubl.) DC. and *Miconia nervosa* (Sm.) Triana are not located near any *M. micrantha* infestations. Program resources are managed across all the target species, so new discoveries and changes in search area and frequency of any target species can influence the resources available for all the species.

There has been a substantial period since details on the progress of the eradication of *M. micrantha* were published (Brooks *et al.* 2008). The eradication program is constantly changing (Jeffery and Brooks 2016) and many changes are only documented in internal reports or presentations. Therefore, an update on the progress of eradication of *M. micrantha* and the methods used to measure this progress are presented below.

ERADICATION REPORTING METHODS

Four times a year, field crews search buffer (polygon) areas at least 200 m around points known to have had at least one *M. micrantha* recorded. Additional surveys are conducted along creeks and rivers (Jeffery and Brooks 2016). Presence or absence is one of the parameters derived from field records for every known or new Global Positioning System (GPS) waypoint. Additional waypoints are added if plants are found more than 30 m away from previous points. For the purposes of program reporting waypoint records are aggregated into static one hectare cells (100 m × 100 m), generated as a 'grid layer' across the entire incursion. These cells are used in program reporting as 'management areas', they are not survey units. A new management area is added to the database if a new waypoint falls beyond the boundaries of a previously known management area.

Reporting of management areas commenced in 2010, previously a system based on infestation buffers was used (Brooks *et al.* 2008). Under the buffer system, infestations were different sizes and could expand and merge. To account for the merging of infestations, past annual status data had to be recalculated (Brooks 2017). The management area system means that eradication reporting is across a scale that is spatially consistent over time. Every six months point records are summarised to allocate a status of 'control' = plants present or 'monitoring' = plants absent for each management area. Management areas only enter a monitoring phase when absence data is

recorded in the last 2 × 6 month periods, this progression is via evidence of absence. The amount of time management areas have been in the monitoring phase is calculated as the time since last detection, which is rounded down to an annual value in years. If plants are recorded in a management area which is in the monitoring phase it relapses to a control phase, for at least 2 × 6 month periods.

In recent years, at the suggestion of external reviewers (Jeffery and Brooks 2016), the program has also started using the time since last reproduction as a measure of eradication progress. In cases where no seed production has been observed, the discovery date is used as a 'defacto' time since last seed production. The time since last seed production (or discovery) accrues annually unless there is a seed production event (reproductive escape) causing the management area to suffer a reproductive relapse. The last reproduction data is determined at the end of each financial year from a single date for each management area.

Both the last detection and last reproduction or discovery data are plotted as histograms for annual program reporting at the end of each financial year. While this data has the same sample size and appears similar (Tables 1 and 2) it was created via different processes and at different intervals, as described above.

ERADICATION PROGRESS

By December 2017 there were 89 management areas with at least one *M. micrantha* vine present once. Seventy five percent (67 of 89) of the management areas had progressed to a monitoring stage (plant absence for more than a year) (Figure 1, Table 1). All management areas near the towns of Ingham and Forrest Beach have been in a monitoring phase for three or more years. Since 2012, there has been a consistent decline in the percentage of management areas in the control phase (plants present) (Figure 1). When plants are encountered, they are effectively controlled with fluroxypyr or triclopyr based herbicides (Brooks and Setter 2014). Occasionally isolated vines or any in riparian areas may be physically controlled by field crews with care taken to remove and destroy all vegetative fragments.

Sixty seven of the 89 management areas have absence records for between 1 and 19 years (Table 1). The NTWEP considers management areas to be 'provisionally eradicated' after a monitoring phase (absence) of 5 years. No decline in the percentage of 'provisionally eradicated' management areas is a current milestone the program must meet and report against each financial year. With the exception of one management area where seed was kept dry by nursery plastic and germinated when it was disturbed, all relapses from the monitoring phase have been from one, two or three years since last detection.

Discovery The 2010 transition to reporting management areas allowed eradication progress to be documented for portions of larger infestations. Across the program this transition also caused a spike in the discovery of new management areas with finer scales of recording and reporting. However, this is less evident in the *M. micrantha* data (no new areas in 2010, Figure 1) where each infestation was reasonably well documented by waypoints prior to 2010, including discovery and control information dating back to 1998.

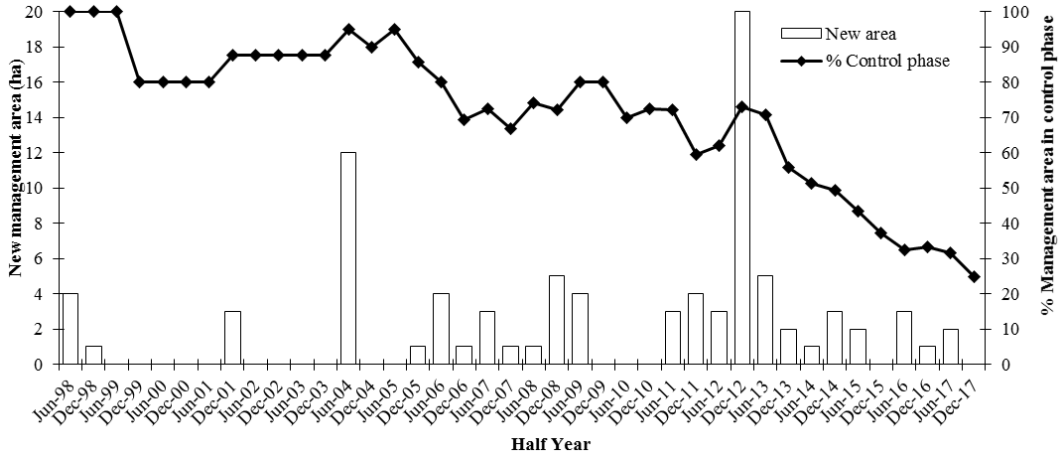

Figure 1. Discovery of new *M. micrantha* management areas (1 ha each) and the percentage of management areas with plants (control phase) at 6 monthly intervals.

Most of the new management areas recorded in August and September 2012 were in the Mission Beach area and are thought to have been the result from increased search effort north of currently known infestations. The passage of severe Tropical Cyclone Yasi over the area in early February 2011 may have also contributed as it created a much lighter environment for *M. micrantha* germination and seedling growth (see Brooks and Jeffery 2018, this proceedings).

The 14 new management areas discovered between September 2013 and May 2017 were all adjacent to previously known management areas. They are likely to be the result of local dispersal and emergence from the soil seed bank. There were no new management areas recorded in the six months to the end of December 2017. The discovery of new *M. micrantha* areas are more likely to be via on ground searches by trained weed officers, than as a result of public information and display specimens (Jeffery and Brooks 2016).

Reproductive relapses Only 45 of the 89 management areas have seeding plants recorded either on discovery or via reproductive relapses. Hence, the data in Table 2 is influenced by the discovery date of each management area. The five management areas in the zero years since last reproduction or discovery (Table 2) comprise of three newly discovered areas and two reproductive relapses in the 2016–2017 financial year. There were no reproductive relapses in 2015–2016, and the three areas shown in the one year line in Table 2 were new discoveries. Discoveries or reproductive relapses in 2012–2013 have resulted in a spike in the 4 year line (Table 2) after new management areas were following a crew scale up and cyclone Yasi. Research trials and field observations have identified that control prior to July each year should prevent seed production. However, there are still some reproductive escapes, or relapses; particularly leafless stems reaching several metres into lower parts of the tree canopy. Detecting this vine amongst a backdrop of green vines and rainforest trees and preventing the occasional reproductive relapse is a difficult task but has been aided by having a designated crew for the Mission Beach/Bingil Bay area and Ingham within the program. Across all infestations, field crews surveyed or resurveyed a gross total of 935 hectares in 2016–2017. Field crews have no choice but to record plants that have developed fractionally beyond flowering as seeding. Although undesirable, newly mature vines with intact seed heads have limited opportunities for the dispersal of viable seed, or for incorporation into the soil seed bank. The last local collection of mature seed suitable for seed research was in 2012.

Table 1. Summary of years since last plant was detected for 89 *M. micrantha* management areas as of December 2017, note years with 0 management areas are not shown (n = 89).

Years since last detection	Management areas (ha)
0	22
1	14
2	11
3	6
4	8
5	11
6	3
7	6
8	2
10	1
11	1
12	3
19	1

Table 2. Summary of years since last seeding plant was detected or the management area was discovered as of June 2017, note years with 0 management areas are not shown (n = 89).

Years since last seeding or discovery	Management areas (ha)
0	5
1	3
2	10
3	7
4	25
5	9
6	3
7	2
8	9
9	3
13	8
15	3
19	2

When the categories of years since last reproduction are split by whether the management areas are in control or monitoring phases (July 2017, data not shown), all of the control phase cells are in the six years since last reproduction category or less. Once management areas pass seven years since last reproduction, and multiple years continuous of absence are recorded, then confidence that the seed bank is exhausted increases.

FUTURE ISSUES

The positive trends in decline of the active areas, discovery and reproductive relapses show the overall progress made towards the eradication of this serious tropical weed. This progress is prompting discussion about the type and duration of program resources deployed to survey areas with continuous records of plant absence. Specifically considering the need to maintain a quarterly visit schedule, the possibility for transitional arrangements to local management for some areas and when to stop searching and declare areas eradicated. Decisions about these topics are likely to be based on multiple criteria including: the time since last reproduction; length of the recent monitoring phase; total recorded population or infested area; number of monitoring phase or reproductive relapses; and the data from the surrounding management areas. Importantly these criteria will include a spatial component as management areas rarely exist in isolation and are arbitrary divisions. Mature discoveries or reproductive relapses could influence the surrounding management areas within the dispersal buffer. As there is always uncertainty about the status of the soil seed bank, the use of multiple criteria may help manage the uncertainty and overcome any limitations of applying a single value for seed bank longevity in all situations. There are some indications from an ongoing buried seed packet trial (Brooks and Setter 2012) that seven years since last reproduction may be insufficient as one of criteria to declare management areas eradicated (S. Brooks unpubl. data). The 25 *M. micrantha* management areas with over seven years since last reproduction illustrated in Table 2 provide a sample to develop, test and refine these criteria.

Although plants are becoming increasingly rarer, the occasional reproductive relapse will suppress future progress. Eradication progress took a step back 15 months after cyclone Yasi, so there remains the potential for increased emergence and growth rates as a result of future cyclone(s).

The decreasing proportion of management areas in the control phase demonstrates that plants are effectively treated when found. Even allowing for new areas, there have been fewer active (control phase) areas each year for the past five years. Field crews should eventually face the possibility of searching for years and never seeing a naturalised vine. Despite the difficult working environment, substantial progress is being made towards the eradication of one of the most serious tropical weeds.

ACKNOWLEDGMENTS

The data presented has been collected by numerous dedicated field workers in the Four Tropical Weeds Program and stakeholder agencies (particularly Hinchinbrook Shire Council and Queensland Parks and Wildlife), who repeatedly and diligently survey tropical forests, disturbed vegetation margins and crocodile infested creeks for single green vines amongst a continuum of green vegetation.

REFERENCES

Brooks, S.J. (2017). What can I do with weed control data? Proceedings of the 14th Queensland Weed Symposium, ed. T. Sydes. pp. 119-25. (Queensland Weed Society, Brisbane).

Brooks, S.J., Panetta, F.D. and Galway, K.E. (2008). Progress towards the eradication of mikania vine (*Mikania micrantha*) and limnocharis (*Limnocharis flava*) in northern Australia. *Invasive Plant Science and Management* 1, 296-303.

Brooks, S.J. and Jeffery, M. (2018). The effects of cyclones on a tropical weed eradication program. Proceedings of the 21st Australasian Weeds Conference, 9–13 September, Sydney, New South Wales, eds S. Johnson, L. Weston, H. Wu and B. Auld, pp. 119-23. (Weed Society of NSW).

Brooks, S.J. and Setter, S.D. (2012). Soil seed bank longevity information for weed eradication target species. *Pakistan Journal of Weed Science Research* 18, 73-83.

Brooks, S.J. and Setter, S.D. (2014). Increased options for controlling mikania vine (*Mikania micrantha*) with foliar herbicides. Proceedings of the 19th Australasian Weeds Conference, ed. M. Baker, pp. 409-12. (Tasmanian Weed Society, Hobart).

Day, M.D., Clements, D.R., Gile, C., Senaratne, K.A.D., Shen, S., Weston, L.A. and Zhang, F. (2016). Biology and impacts of Pacific Islands invasive species. 13. *Mikania micrantha* Kunth (Asteraceae). *Pacific Science* 70, 257-85.

Jeffery, M. and Brooks, S.J. (2016). Eradication in the tropics: constantly changing and adapting. Proceedings of the 20th Australasian Weeds Conference, eds R. Randall, S. Lloyd and C. Borger, pp. 23-7. (Weeds Society of Western Australia, Perth).