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Invasive *Passiflora foetida* in the Kimberley and Pilbara: understanding the threat and exploring solutions

Phase 1 summary document

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For:

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Mount Gibson Iron

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Copyright and disclaimer

Important disclaimer

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Previous reports

This report builds on the content previously outlined in the following interim reports:

Webber BL, Yeoh, PB and Scott JK (2013) Invasive *Passiflora foetida* in the Kimberley and Pilbara: understanding the threat and exploring solutions. Interim 12 month report. CSIRO, Australia.

Webber BL, Yeoh, PB and Scott JK (2013) Invasive *Passiflora foetida* in the Kimberley and Pilbara: understanding the threat and exploring solutions. Mount Gibson Iron summary update. CSIRO, Australia.

Please note that this document is not the final report for this first phase of research.

Background context

• Stinking passionflower (*Passiflora foetida* L., Passifloraceae) is a herbaceous vine from south and central America that is now widely introduced into many tropical regions of the world. In many of these regions the plant is a weed of concern. The first known record in Australia dates from 1892 (Queensland), while the first record from Western Australia was from near Derby in 1921.

• In the Dysosmia section of *Passiflora*, to which *P. foetida* belongs, species-level delimitation remains somewhat controversial, with no molecular phylogeny to date. This contrasts with a robust taxonomic understanding at the sub-genus level.

• Pre-project consultation and prioritisation ranked *P. foetida* as one of the most significant problem weeds in the north west of Australia. Currently, it is listed under the EPBC Act as being amongst the main weed threats to the monsoon vine thickets of the Dampier Peninsula. Its biological traits and widespread distribution implies that it is likely to be a threat to other vine thickets in the Kimberley. The weed also affects key areas of high conservation value across the north west, and is found as far south as Sharks Bay.

• A significant impediment for implementing more effective weed management strategies for *P. foetida* is that very little is known about its biology and life history, particularly in areas where it has been introduced.

• Current control methods advise hand-pulling or herbicide application, often in combination. These control methods, however, are costly (particularly in remote areas), labour intensive, and amount to little more than window dressing with minimal impact on long-term control.

Insight highlights to date

• Phase 1 research (2012-2014) has focused on study sites at three locations with contrasting ecosystems: Kununurra and Koolan Island in the Kimberley and Millstream National Park in the Pilbara. Sampling is tracking differences within and between years to account for considerable precipitation variability.

• Observations from across the invasion area suggest a recent trend toward invasions in more intact vegetation, with initial presence not necessarily associated with large scale disturbance. This may imply that we are seeing the end of an initial 'lag phase' as the *P. foetida* invasion transitions into a period of rapid expansion.

• Biological traits identified thus far that are likely to increase the threat represented by *P. foetida* include:

- *Reproduction*: (a) no limitation on dispersal and extremely high reproductive output (e.g. > 350 units [flowers or fruits] per m^2 on the ground and > 3000 units in a single overtopped tree canopy); (b) a life cycle of less than 3 months; and (c) fruit production year round in the right conditions.

- *Establishment and growth*: (d) seedling survivorship through the first year of greater than 95%; (e) very large mature plants with crown diameters > 40 mm; (f) the ability to build up dense vegetation smothering mats (greater than 50 cm thick and > 1 km of stem length in 1 m^2) within a single season; and (g) the ability to over-top trees in excess of 14 m tall, with *P. foetida* biomass in a single tree canopy representing > 30 kg dry weight (up to 85% as dead highly flammable material).

- *Ecosystem interactions*: (h) a notable absence of damage due to native herbivore or pathogen load; (i) the ability to not only enhance fire intensity, particularly canopy fires, but survive fires via canopy-stored seed and below-ground crowns; (j) rapid post-fire regeneration to further suppress native vegetation; and (k) a far greater tolerance of low soil moisture than initially expected.

• It appears at least six factors may have a significant influence on *P. foetida* establishment, growth and reproduction dynamics: (1) initial disturbance, (2) timing of germination, (3) nutrient availability, (4) seasonal precipitation and local soil moisture, (5) wet season standing water, and (6) local fire history.

• Significant variation in observations between study sites suggests that without careful consideration of local context and identification of relevant factors driving or limiting invasion, management and control plans are likely to remain ineffective.

Management implications

• The threat that *P. foetida* represents to the north west of Australia is diverse in its nature and targets:

- *Tourism values*: the weed is becoming increasingly common in areas of high tourism value in the W.A. parks and reserves system (e.g. Purnululu, Geikie Gorge, Mirima, Mitchell Plateau, Lake Argyle). The visual impact is high due to tree overtopping and the formation of thick and vast vine mats over the ground and understorey. While inefficient and costly manual control is used for short-term control at times of high visitation at some sites, the spread of *P. foetida* into new areas is proving impossible to keep up with.

- *Mine site rehabilitation*: the weed favours disturbed areas and is a strong competitor for the increased available resources (e.g. light, disturbed soil) in restoration areas. With dispersal a non-limiting factor, *P. foetida* is likely to quickly colonise restoration areas and threaten the long term presence of any restored native vegetation via overtopping and smothering via vine mats.

- *Agroforestry*: the Ord River irrigation scheme is the location of the world's primary source of sandalwood oil from *Santalum album*. The manual control of *P. foetida*, to prevent it from overtopping trees in sandalwood plantations, represents an ongoing and considerable annual cost to these operations over the many growing seasons required to reach harvest size.

- *Native flora*: overtopping tree canopies can lead to tree death as well as increased fuel load to raise the likelihood and intensity of tree canopy fires. In the vine thickets, this fire regime modification can lead to a gradual reduction in the area of vine thickets via damage to the thicket edge. Mats of *P. foetida* growing on the ground and on shrubs results in a complete absence of other vegetation, with likely impacts on native seed banks should the vine mat be able to persist.

- *Native fauna*: the vine is reducing available nesting space for freshwater crocodiles on Lake Argyle, where suitable nesting space is already limited due to substrate suitability. Recent high flood levels may have exacerbated the problem. Emerging between-year patterns suggest that this impact may be minimised, but not eliminated, by manipulating lake water levels in the wet season.

• We have been unable to identify any barriers to nominating *P. foetida* as a candidate for biological control. Trial plantations of commercial passionfruit using *P. foetida* as a root stock have been largely unsuccessful and the weed has been abandoned as an option in favour of an alternative *Passiflora* species.

Future directions

Project framework

Phase 1 (2012-2014)	Phase 2 (2014-2017)	Phase 3 (2017-2019)	Phase 4 (2019-2021)
- Characterise core life history traits (e.g. growth, reproduction, ecology). - Identify invasion drivers and limitations. - Develop an understanding of threats and impacts. - Model the potential range of the weed.	- Quantify limiting factors for invasion. - Molecular studies of introduced genotypes and biogeographical variation. - Quantification of threats posed. - Application for biocontrol program. - Native range scoping for biological agent short listing.	- Agent testing for suitability, including fitness and specificity. - Quantify limiting factors for invasion. - Quantification of threats posed. - Application for agent approval.	- Field trials of approved agents. - Agent breeding programs. - Agent release programs. - Post-agent introduction characterisation of weed life history traits.

- NB: While this broad outline represents a most likely framework for working towards the project endpoint, unanticipated future developments may bring forward or delay aspects of later phases.

Project funding

• Phase 1 research (24 months, Jul 2012 to Jun 2014) will be completed via a c. $310K budget, representing investment of $155K from the Department of Parks and Wildlife (including funds from Mount Gibson Mining) and and $155K from CSIRO.

• Preliminary costing for Phase 2 research (36 months, Jul 2014 to Jun 2017) suggests an additional c. $150K per annum is required, over and above CSIRO financial support and in-kind logistical support from the Department of Parks and Wildlife and Mount Gibson Iron.

Imminent research activities & deadlines

• *30th Jun 2014*: Phase 1 final report submitted / Phase 1 funding finishes

Depending on available funds:

• *25th Aug 2014*: Pre-nesting survey for 2014 crocodile nesting season

• *17th Nov 2014*: Post-nesting survey for 2014 crocodile nesting season / pre-wet season survey for invasion dynamics transects

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