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# Distribution maps of stinking passionflower (*Passiflora foetida*) at Danggu (Geikie Gorge) National Park

Report

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#### Cover photographs

Front cover: Stinking passionflower (*Passiflora foetida*) covering the banks of the Fitzroy River at Danggu (Geikie Gorge) National Park. Photo: Ruchira Somaweera, CSIRO.

Back cover: Stinking passionflower (*Passiflora foetida*) at Danggu National Park overtopping *Pragmites karka*, a native grass that is habitat for the purple-crowned fairy-wren. Photo: Bruce Webber, CSIRO.

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## Acronyms

<b>AGL</b> .....	above ground level
<b>CSIRO</b> .....	Commonwealth Scientific and Industrial Research Organisation
<b>DAWE</b> .....	Department of Agriculture, Water and the Environment
<b>DBCA</b> .....	Department of Biodiversity, Conservation and Attractions
<b>GSD</b> .....	ground sampling distance
<b>NESP</b> .....	National Environmental Science Program
<b>RGB</b> .....	red green blue
<b>RPAS</b> .....	remotely piloted aircraft systems (drones)

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# 1. Introduction

Stinking passionflower (*Passiflora foetida* L., Passifloraceae) is a threatening weed in the Kimberley and Pilbara regions of Western Australia. Some of its worst impacts are seen in riparian environments, where year-round access to water allows for long growing and reproductive seasons. One of the locations where these threats are most abundant is along the Fitzroy River in Danggu (Geikie Gorge) National Park (Figure 1). Danggu is included in the West Kimberley National Heritage place. The park has outstanding heritage value to the nation under National Heritage Criterion (e). Specifically, the place has outstanding heritage value to the nation because of the place's importance in exhibiting aesthetic characteristics valued by a community or cultural group. The West Kimberley National Heritage listing Gazette notice notes "*Particular aesthetic characteristics of Geikie Gorge Conservation Park and Geikie Gorge National Park valued by the Australian community include Geikie Gorge (Danggu), its colourful gorge cliffs and sculptured rock formations carved by water through an ancient limestone reef, the lush riverine vegetation along the gorge, the fossil decoration on the gorge walls and the deep permanent waters.*" The impacts of stinking passionflower at Danggu include the following threats:

## 1.1 Cultural and social values

Danggu (i.e. Geikie Gorge Conservation Park and Geikie Gorge National Park) have outstanding heritage value to the nation under criterion (e) for their aesthetic characteristics valued by the Australian community. Stinking passionflower is particularly conspicuous as a component of the vegetation community in this region due to its visual contrast with native vegetation. Across the floodplain, but particularly concentrated near the river, it overtops vegetation (including trees), sand banks and rock structures in large extensive mats. This impact significantly reduces visual amenity, which has implications for regions with high levels of tourist visitation, particularly those who are there to appreciate the lush riverine vegetation and gorge walls. The vine also physically impedes access to the river for cultural activities, including the visitation of significant areas, and accessing the river for fishing and other culturally significant activities.

## 1.2 Economic values

In areas where tourism values and visitation rates are high, significant resources are spent undertaking manual removal of the vine as a temporary control measure. These efforts are to mitigate as best possible the visual amenity impacts of the weed on the natural aesthetic values of Danggu. However, due to the high growth rates and dense seed bank, the vine re-establishes its cover within a matter of months following manual control, representing a significant and never-ending management burden for local land managers. As such, the need to suppress the worst infestations of the weed at Danggu is an ongoing challenge with no respite and no ability to keep the weed suppressed for any length of time.

## 1.3 Environmental values

The vine represents a threat to both flora and fauna. It is possible that the impact of stinking passionflower on native vegetation could be high. However, it is logistically extremely difficult to obtain a clear and meaningful insight into the pathways and level of impact on vegetation



in a relatively short time through extensive plot manipulation and maintenance experiments in the remote sites where it dominates. However, extensive vine overtopping of existing vegetation has been documented to act as an anchor on large trees during floods, increasing their chance of being uprooted. The weed biomass has also been observed taking fires high into tree crowns, causing the cadjeput (paper barks; *Melaleuca leucadendra* and *M. argentea*) to ‘explode’ during burns due to an increased fire intensity. At the ground level, the weed overtops riverbanks and low shrubs, suppressing growth and preventing regeneration of native plants if it is not removed during floods. This same overtopping of riverbanks also threatens the breeding of Australian freshwater crocodiles (*Crocodylus johnstoni*) through a reduction in suitable nesting sites and alteration of nest temperatures via microclimatic modification during incubation (Somaweera et al. 2019). Continued dominance of the riverbank vegetation by the weed could also have an indirect impact on the purple-crowned fairy wren (*Malurus coronatus*), which relies on native grasses (e.g. *Phragmites karka*) for suitable habitat (Greatwich and Somaweera 2017).

## 1.4 Project scope

The Commonwealth Science and Industrial Research Organisation (CSIRO) and the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA) are currently undertaking a project conducting a weed management assessment for stinking passionflower, including understanding impacts of this weed on vegetation and fauna within the riparian zone of the Danggu (Geikie Gorge) National Park. Despite the broad range of impacts that stinking passionflower has on ecosystem values, the scope of this project was focused primarily on impacts and conservation management implications for the Australian freshwater crocodile. Impacts on other values were noted in a qualitative way where possible and practical. To support the other impact-focused outputs of the project, here we document the extent of the stinking passionflower distribution in the Park based on the field surveys undertaken during the lifespan of the NESP project’s field component (mid 2016 to mid 2019).



## 2. Methodology

The distribution and abundance of stinking passionflower is known to be influenced by seasonal climate (including moisture availability) via growth rate and reproductive output/recruitment, and removal of the vine due to management programs (manual removal), flooding (the vine is stripped from the banks and vegetation, sometimes including the roots), and fire (fire can both remove above ground biomass and kill the vine and/or the seedbank if it is sufficiently intense). All of these variables can have significantly different impacts within and between years. As such, stinking passionflower at the Park was documented in three different ways, providing insight at variable scales while cross-referencing data streams to ensure consistency:

### 2.1 Field surveys

The presence and absence of the vine was mapped during field visits using a combination of handheld GPS devices, annotated aerial maps and written records.

### 2.2 Drone (RPAS) surveys

Site level mapping was undertaken by aerial RPAS surveys with a DJI Phantom 4 Pro RPAS (20 Mp camera with an f/2.8-f/11 24mm lens). Optical (visible RGB) data were generated at 90 m AGL with images overlapped by >75% front overlap and >70% side overlap. This approach produced orthomosaic maps at a Ground Sampling Distance (GSD) resolution of 1.70 cm per square pixel. All RPAS work was performed under CASA ReOC 0781(Rev2).

### 2.3 Aerial and satellite imagery

We sourced aerial and satellite imagery from Google Earth spanning the years 1985 to 2019 and Copernicus Sentinel-2 system from 2015 to 2019 focusing in particular on seasons where we did not have insight from field or drone survey data. Stinking passionflower is a very distinct bright green colour and stands out against the native vegetation, making discrimination a relatively straight forward task. Mapping of areas of infestation was done manually by digital image annotation.

Across all data sources, regions of the park where stinking passionflower was identified were classified into three classes – consistently absent, occasional, consistently present – across the period of observation. Data were collated for spatial manipulation and analysis in ArcMap (Esri, V10.8.1).



Figure 1. Location of Danggu (Geikie Gorge) National Park.

### 3. Results

We found that between 2016 and 2019, the distribution of stinking passionflower across the park was highly variable. Patches of vine that were consistently present across the observation period covered an area of 7.2 ha. Large and particularly dense patches of consistent vine cover were generally found on the more protected areas of the sand banks close to the rivers edge, while smaller strips of consistent vine cover were located at the base of cliffs and in other areas close to the river where there is a higher likelihood of good moisture availability during the dry season (Figure 2 and Figure 3). Vine cover was also more consistent in riparian areas where there was light tree cover. Patches of vine that were abundant when present yet occasional over time (i.e. showing variation between seasons and years) occupied 23.7 ha in the region of observation. These patches were more likely to be located on sand banks in areas of high flow velocity during flooding events, areas that are known to be included in manual control programs, or areas where there was evidence of fire events during the observation period (Figure 3).



Figure 2. Stinking passionflower (*Passiflora foetida*) at Danggu National Park on the banks of the Fitzroy River (a) overtopping suitable freshwater crocodile nesting habitat and (b) the native grass *Phragmites karka*, habitat for the purple-crowned fairy wren (*Malurus coronatus*). Photos: Bruce Webber.

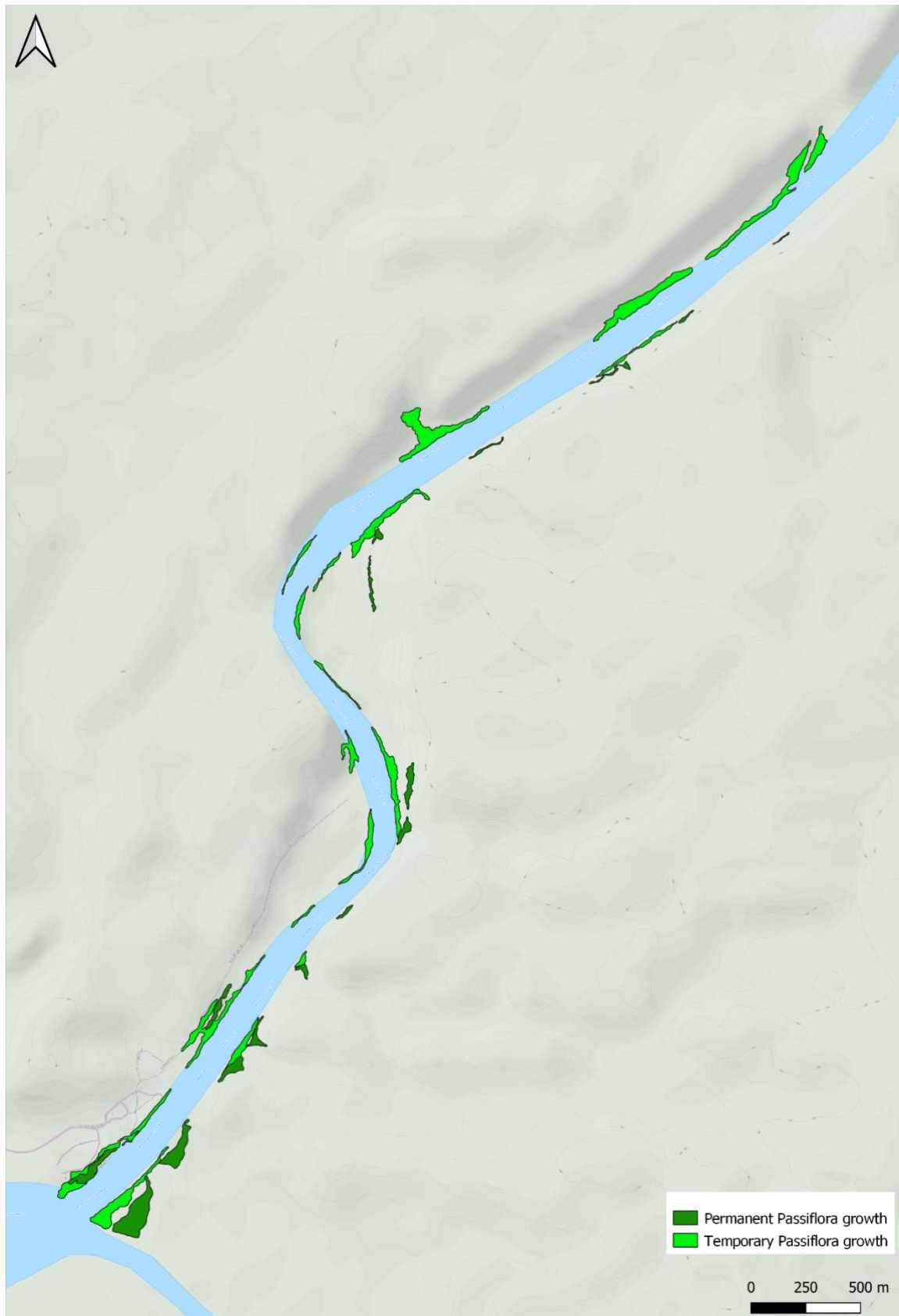


Figure 3. Stinking passionflower at Danggu National Park between 2016 and 2019 separated into areas where the vine was consistently present (dark green), occasional (light green) or consistently absent (unshaded).



## 4. Discussion and conclusions

Here we have shown that stinking passionflower has a variable but persistent presence at Danggu (Geikie Gorge) National Park throughout the riparian vegetation, with significant coverage in some years. While there is considerable variation between the coverage of the vine between years in some areas, this variation is not closely related to management actions, but is rather the outcome of flooding severity and intervals between flooding events. While the physical removal of stinking passionflower by water during high velocity flooding events may appear to be a positive outcome for native biodiversity, this interpretation requires more careful consideration. If the vine biomass was considerable during the flooding event, it may well have acted as an anchor to also remove native vegetation that it was climbing on. Moreover, if there is a greater propensity for floods to remove the vine, relative to native vegetation, then regular flooding events in areas where the vine dominates native vegetation may also be associated with greater subsequent riverbank erosion risk.

With regard to impacts on freshwater crocodiles, during the observation period there was always suitable substrate open and accessible for crocodile nesting. This result was driven by the random removal of riverbank vine cover during flooding in areas with substrate suitable for crocodile nesting sites. However, nesting site availability could change if there were more sequential low-flow years without flooding, allowing the vine to proliferate. Such a scenario would also allow for the stinking passionflower plants to get larger, with deeper, more stable root systems, decreasing the likelihood that entire plants would be removed by a flooding event. These interactions are documented in greater detail in other outputs from this work, including in regard to management outcomes and conservation implications.

Lastly, we recognise that our observation period is relatively short for such a dynamic ecosystem, and caution should be exercised when drawing wider conclusions from the findings. For example, local knowledge indicates that the large persistent area of stinking passionflower on the eastern bank is thought to be a relevant recent feature in the landscape. Previously this area consisted of open sandbank and was known as a reliable crocodile nesting location.

Management programs for the park should look to carefully monitor stinking passionflower cover along the riverbank. In regard to mitigating impacts on freshwater crocodiles, this survey work should be focused on areas where crocodile nesting has been observed in recent years. If sequential years of no flooding results in higher vine cover with larger vines, active control beyond the areas frequented by tourists (i.e. where manual control is confined to currently) should be considered. Impacts on other environmental, social, cultural and economic values were beyond the scope of this report but are discussed at a higher level in other outputs from this work. In summary, given the significant impacts the weed has on other ecosystem characters, there needs to be a pragmatic balance between undertaking resource intensive manual weed control with short-term impact around high value assets, and not wasting resources on short lived efforts in the mitigation of these weed threats.

In the long term, a biological control solution for stinking passionflower is the only feasible and effective way to reduce biomass across the park and beyond in a consistent, enduring way. A program between CSIRO and DBCA to develop a biological control solution for stinking passionflower is already underway. Danggu would represent a high value landscape in which to consider agent release, should a suitable agent be identified.

## References

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