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Understanding the distribution and status of Wimmera bottlebrush in the Wannon River catchment – 2016 Project Summary Report

By Lachlan Farrington

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For correspondence in relation to this report please contact:

Lachlan Farrington
Senior Wetland and Landscape Ecologist
Nature Glenelg Trust
MOB: 0401 208 717
Lachlan.farrington@natureglenelg.org.au

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EXECUTIVE SUMMARY

Remote and field based surveys of the Wannon River floodplain, immediately upstream of Brady and Gooseneck swamps, identified a number of previously unrecorded *Callistemon wimmerensis* stands. Previous documentation of the species at this site recognised it as probably the most important site across the species range, purely by weight of numbers of plants occurring. This current study has further increased this observation by recording an even greater number of plants. Observations derived during this study suggest that there could be up to 100,000 mature plants. Furthermore, the plants look to be healthy, in terms of canopy, and also show a range of size classes, suggesting regular recruitment events. Age classes have been associated with potential timing of recruitment and appear to correlate with both fire events and episodes of high riverine flow. The most recent evidence of recruitment (<1m juvenile plants) is likely to exhibit a response to wetland restoration trials undertaken in 2013 and 2014, providing support for the role of hydrological wetland restoration in mitigating against the effects of climate change and reduce rainfall, runoff and flow events.

1 Background and objectives

1.1 Project background

Callistemon wimmerensis was first described in 2004 from the MacKenzie River in the Wimmera region of north-western Victoria (Marriot and Carr, 2008). Since then it has also been recorded along the Glenelg and Wannon Rivers, on the western and eastern edge of the Grampians National Park respectively. The species is described as a rigidly erect, small tree growing to 10m high with steeply ascending branches and a narrow crown (Marriot and Carr, 2008). It is distinctly recognisable from the sympatric *Callistemon rugulosus* by both its more upright growth habit and distinctly pink or mauve flowers. Despite having a fragmented distribution, genetic analysis supports a conspecific status for specimens from four disjunct locations to the north, east and west of the Grampians National Park (Miller *et al.* 2011).

Hydrology is recognized as a key component for both species persistence and recruitment. Marriot (2010) observed approximately 30% mortality in MacKenzie River populations during an episode of zero environmental flows and prolonged rainfall deficiencies between 2005 and 2008, and subsequent mass recruitment of seedlings following a return of flows and winter-spring flooding (Marriot, 2010).

Of all the populations currently known, Gooseneck and Brady swamps, to the east of the Grampians National Park, host an overwhelming bulk of the species. Vegetation surveys undertaken by the Glenelg Hopkins CMA estimated approximately 5000 individuals occurring within this area. Further records now exist adjacent to this site and also downstream, along the Wannon River however the area is still yet to be exhaustively surveyed for all occurrences.

Recent hydrological restoration works at Gooseneck and Brady swamps by Nature Glenelg Trust have capacity to alter the hydrological regime of the areas occupied by *C. wimmerensis* in and around the site and thus an appreciation of the entire local distribution and the response of the species to these hydrological changes is warranted.

1.2 Objectives

The following sections outline methodology and results of remote sensing, field based validation and demographic modelling of the species in the Wannon River floodplain adjacent to and immediately upstream of Gooseneck and Brady swamps. The objectives of this assessment are to provide the following:

1) An estimate of area of occupancy of the species
2) A time based analysis of changes in area of occupancy
3) An assessment of demographic status (number of cohorts and status of recruitment) for individual stands across the local extent of the species.

2 Methods

The area of potential occupancy of *C. wimmerensis* in and around Gooseneck and Brady swamps (**Error! Reference source not found.**) is approximately 600 Ha. Not only is the area large, but it is also punctuated by areas of thick, impenetrable vegetation. As a consequence, records of *C. wimmerensis* are restricted to areas along the edge of woodlands and shrublands. Aerial and satellite imagery thus present as an ideal alternative for providing a more thorough indication of the extent of the species within the woodlands and floodplain thicket at the site where the Wannon river leaves the Grampians National park and spills onto the floodplain adjacent to Gooseneck and Brady swamps.

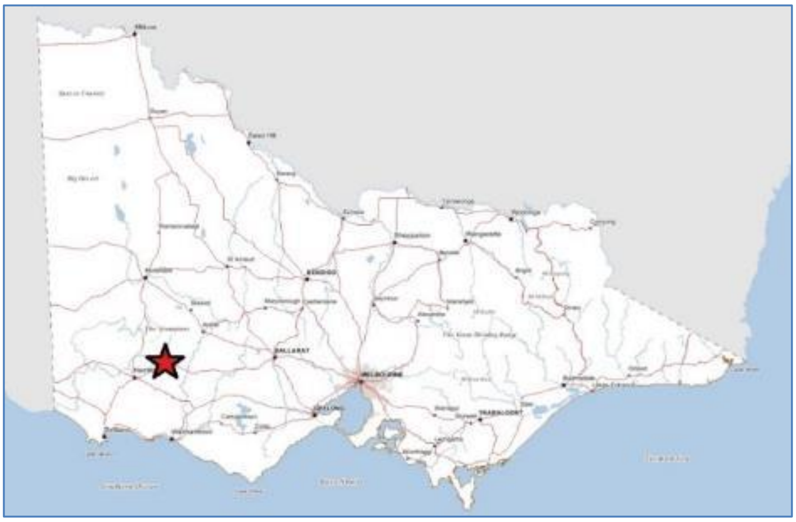

Figure 2.1: Location of study site in western Victoria

2.1 Remote sensing

Initial vegetation classification was undertaken using Landsat imagery collected in December 2015. While unlikely to provide sufficient resolution for differentiating individual trees and shrubs, this imagery was explored for suitability in classifying major vegetation components across the study areas. Segments which contained existing *C. wimmerensis* records were identified and all other segments with a similar grid code value were selected so as to create a polygon representing land within the study area of equal spectral characteristics to areas known to contain *C. wimmerensis*. The area defined by this segmentation process (Figure 2.2) formed the project mapping area and was subject to a more thorough field survey.

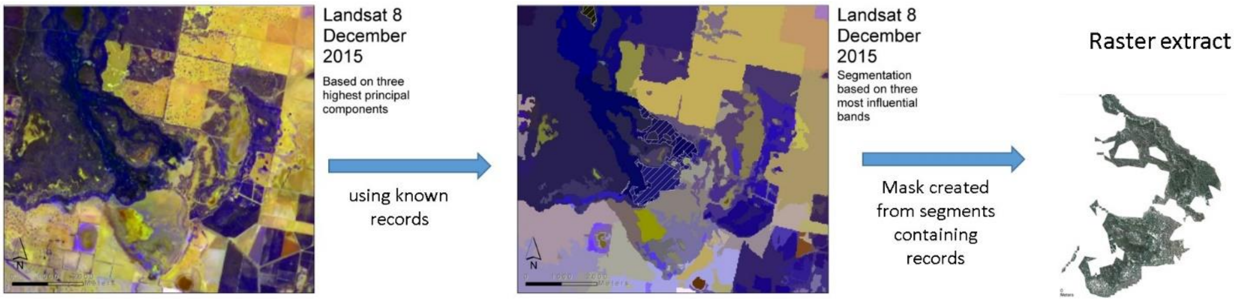

Figure 2.2 Workflow for reducing data to area of interest using segmentation of Landsat imagery and identifying segments known or considered likely to contain C. wimmerensis.

In order to refine areas for field surveys, a LiDAR dataset (collected in March 2015), was utilized to explore patterns of terrain positioning from a derived digital surface model. Slope and hillshade datasets were derived from the elevation data and a compound raster dataset created using surface elevation, slope and hillshade bands. An overlay of field-survey results revealed a pattern species occurrence in areas of mounding within and alongside the floodplain (Figure 2.3).

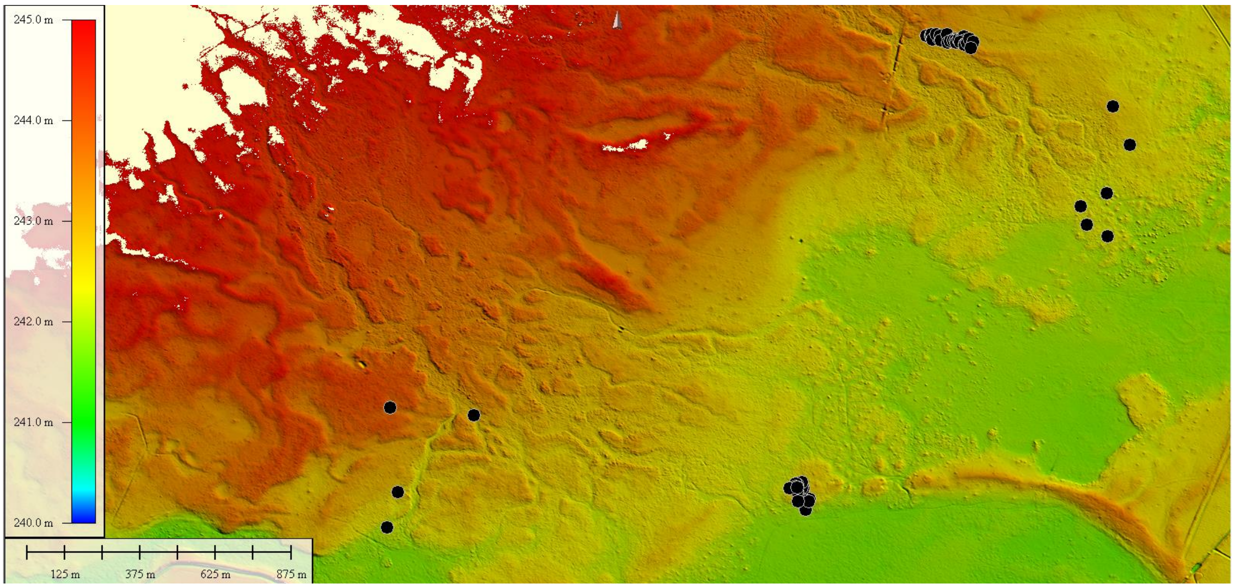

Figure 2.3 Pre-survey records of C. wimmerensis and digital surface model

2.2 Field surveys

Mapping of *C. wimmerensis* stands was undertaken in areas identified using remote sensing (as above). The following information was collected for each discrete cluster:

- GPS coordinate and edge path
- Representative photos
- Number of size classes (height categories)
- Estimated number of plants
- Evidence of juveniles (< 1.5m with no evidence of fruit)
- Overall canopy health and/or signs of deer rubbing and trampling

In some instances, it was not possible to totally circumnavigate a cluster and so the GPS path generated was used in conjunction with aerial mapping to best determine the likely extent of these clusters.

2.3 High resolution image and LiDAR based classification

In order to provide further classification within vegetation components, high resolution multispectral and panchromatic satellite imagery (Airbus Pleaides acquired in December 2015), and also high resolution aerial imagery (collected in March 2015) was analysed for likelihood of differentiation between tree species using *C. wimmerensis* colony locations identified during field surveys. One hundred training polygons were created for each of the following classes:

- *C. wimmerensis* canopy
- *Eucalyptus camaldulensis* canopy
- Bare ground
- Shadows

Image analysis was based on raw imagery and band symbolization following principal component analysis. Scatterplots revealed a high level of overlap between a priori classification group (class) spectral information indicating that image classification was unlikely to delineate classes based on the spectral information available.

An additional exploration of point cloud transects through field-observed stands revealed that large *C. wimmerensis* plants were readily identifiable from other tree types (Figure 2.4). Hence methodical manual visual analysis of cloud point transects was undertaken to assess the likelihood of *C. wimmerensis* occurring outside areas previously not explored during ground surveys. At present an algorithm for defining *C. wimmerensis* shape from point cloud data has not been developed although this remains a priority for future mapping work.

Figure 2.4: Example point cloud transect silhouettes and inferred likelihood of C. wimmerensis presence (green box – probable; yellow box – likely; red box – potentially but requires ground confirmation)

2.4 Historical imagery analysis

Historical aerial photos were obtained for four time intervals (1949, 1971, 1985, 2015) in order to identify potential areas of expansion or contraction. Given that image classification was not possible at the scale required, inferences were based on known occurrence sites (as identified using contemporary imagery and field mapping). Each of the mapped clusters was categorised as follows:

- Expanding (vegetation adjacent to 2016 mapped colonies increasing)
- Contracting (vegetation adjacent to 2016 mapped colonies increasing)
- Unchanged (vegetation adjacent to 2016 mapped colonies consistent over time)

3 Results

Landsat image classification delineated areas of likelihood for *C. wimmerensis* based on known occurrences of the species prior to detailed field surveys. These areas were typically confined to watercourses and adjacent banks and mounds of the floodplain area (Figure 2.3). An additional 21 additional stands were identified during ground-surveys targeting these areas, with a large increase in the mapped boundary of a previously known large adult stand. Incorporation of ground-based GPS points into image classification frameworks failed to provide any evidence of distinguishing spectral characteristics, suitable for determining *C. wimmerensis* from other tall shrub and tree species. Manual visualisation of cloudpoint transects was thus employed to determine the likelihood of *C. wimmerensis* presence in areas which were not explored during ground surveys. This analysis provided a higher level of confidence of the absence of *C. wimmerensis* in areas which were excluded (and agreement with field observations) in the initial landscape segmentation process. There was a predicted likelihood of presence in some areas which were not ground-truthed, within the search area. Hence the current assessment of the species distribution at this site is likely to have recorded a majority of the species extent although smaller, undocumented occurrences throughout the site are still likely. An overview of the areas of both ground confirmed and potential, non-ground-truthed occurrence is displayed in Figure 3.1.

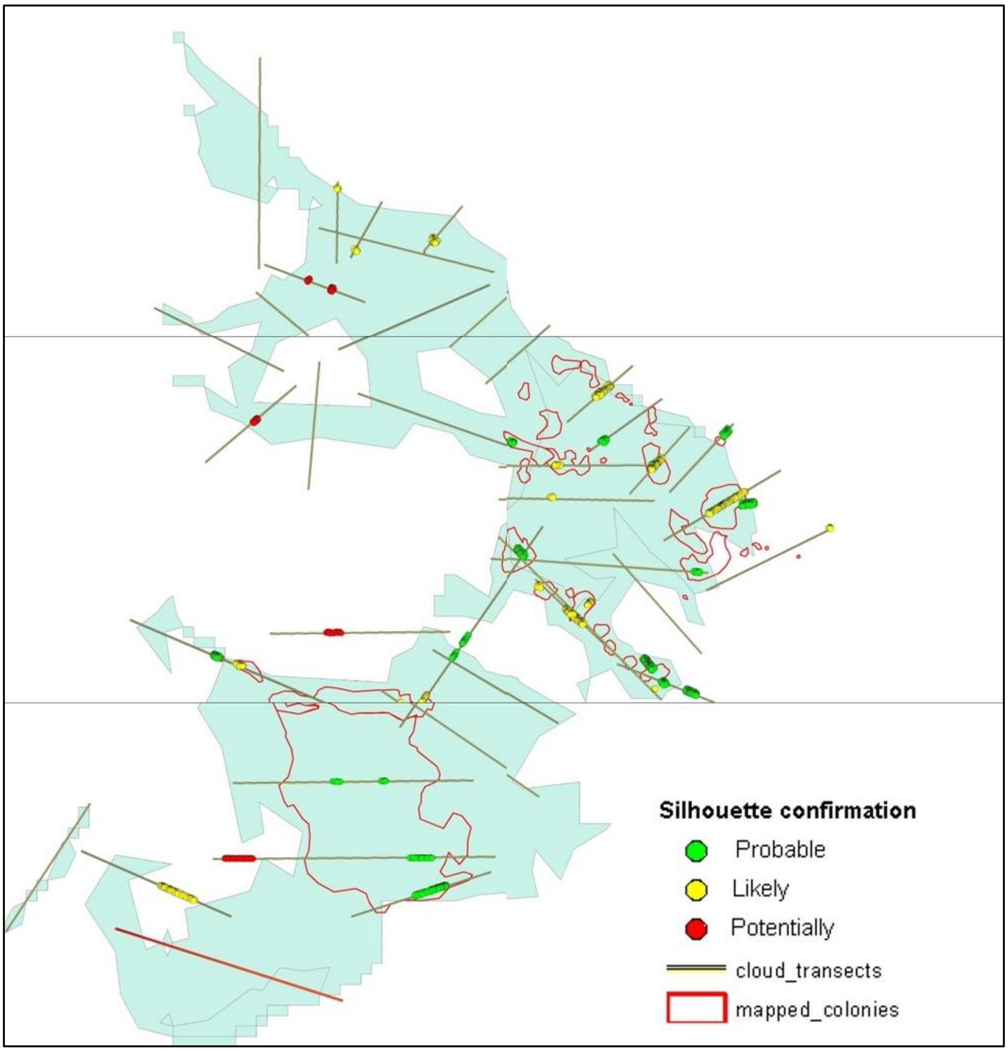

Figure 3.1: Mapped stands and point cloud inferred locations of C. wimmerensis across the study site.

The demographic status of each of the mapped colonies suggested that recruitment has been occurring within most colonies over the past decade. Some of the smaller, outlying stands show no signs of recent recruitment and are generally low in number (1 to 20 trees). Some young colonies were observed, suggesting species expansion into these areas of the past 10 to 20 years.

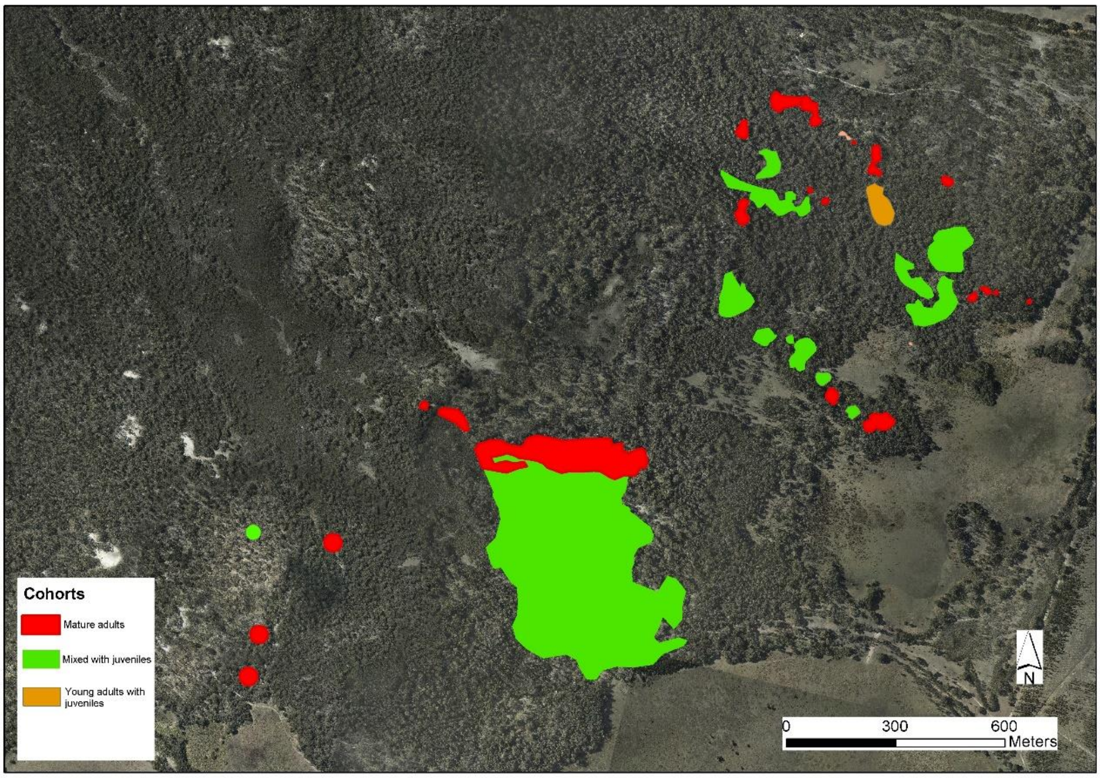

Figure 3.2 Range of age classes observed within mapped colonies.

Analysis of historical change in and around mapped colonies was achieved using a time set of imagery ranging from 1949 to 2015 (Figure 3.3). Based on changes in extent of vegetation in and around mapped colonies, all colonies were observed to be in areas where surrounding vegetation was either unchanged or had expanded, most overly the past 20 years (Figure 3.4). The largest mapped colony, at the southern edge of the study area, was deemed to be expanding given the high number of young adults and juveniles, and scarcity of larger (<4m) specimens observed throughout this zone.

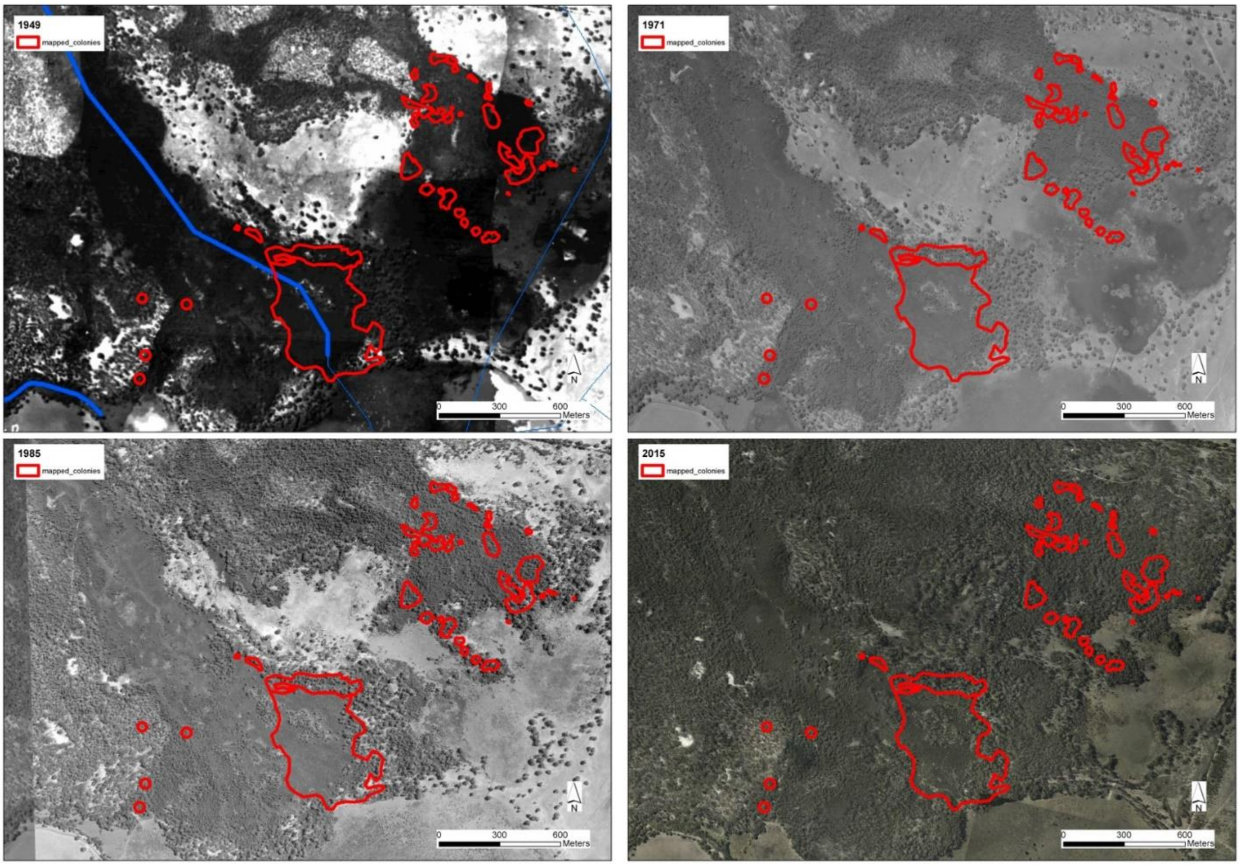

Figure 3.3: Historical and contemporary aerial imagery with 2016 mapped colony boundaries shown.

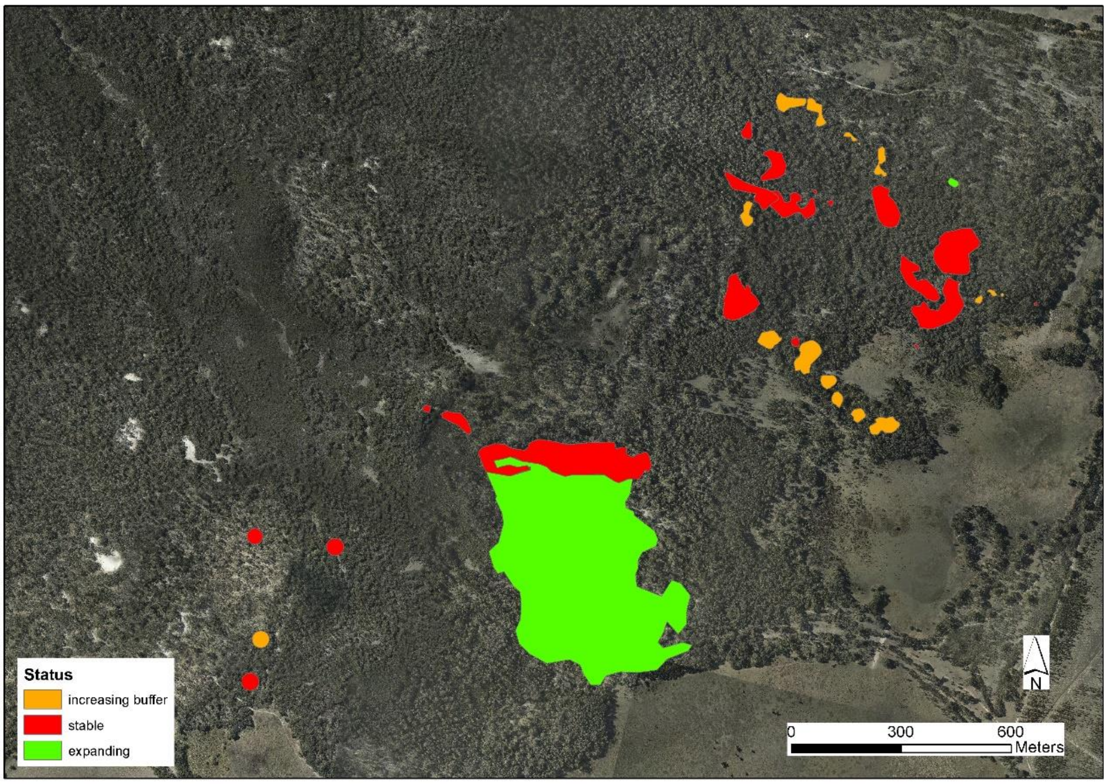

Figure 3.4: Status of vegetation change in and around colonies identified during the current study.

4 Discussion

The distribution of *C. wimmerensis* across the Wannon River floodplain adjacent to Brady and Gooseneck swamps constitutes the largest known geographical aggregation of the species across its entire range. Previous estimates put the population size at approximately 5000 although estimates from this study place it an order of magnitude higher (50,000 to 100,000). A majority of discrete clusters are fringed by younger adults and also juvenile species (<1m tall). Scattered low number aggregates (mainly adults) and larger colonies (100 to 1000) are distributed throughout the study area but all mapped specimens were in close proximity to defined channel banks and mounds across the floodplain. Typically, the largest trees were located at higher elevation points with the youngest specimens occurring at lower elevations and even within defined water courses (Figure 4.1). This may be due to the larger adults inhibiting germination through heavy shading or the fact that inundation extents have been declining in line with overall reductions in rainfall and also upstream water diversions.

Figure 4.1 Juvenile C. wimmerensis growing in the watercourse

The highest rate of regeneration was observed across approximately 20 Ha of floodplain at the southern edge of the study site. Interestingly, this site was burnt in 2000 and the large number of 3 to 4 m trees would suggest that mass-regeneration probably occurred following this fire. *Callistemon* and *Melaleuca* are canopy seed storing species and their fruit is usually opened in response to damage or fire (Kim *et al.* 2009). Marriot and Carr (2008) report that other *Callistemon* species show recruitment in response to fire and subsequent inundation. A summary of annual flow volumes, based on a gauge at Jimmy's Creek campsite (Figure 4.5), reveals that 2001 was a high flow year and so the coincidence of a high flow, following a fire, probably led to this large recruitment event. More recently, high flows and flooding were observed in 2011 and localised inundation of the Brady and Gooseneck swamp peripheral areas was observed following hydrological restoration trials undertaken in 2013 and 2014. The growth rate of *C. wimmerensis* has not been scientifically determined although they are anecdotally reported as slow growing relative to more common ornamental *Callistemon* species. Some of these ornamental species can grow up to 1m per year however research has shown that plant growth is effected by even moderate evaporative demand (Alvarez *et al.* 2011). Hence an estimate of 50cm per year once established would put the age of the young adult cohort in this area at 6 to 8 years and the smallest juveniles at between 1 and 2 years. Unless growth rates are even slower than contemporary evidence suggests, it is likely that the youngest cohorts in this section of the floodplain are in response to the hydrological restoration trials of 2013 and 2014. The 2 to 3m adult cohort likely reflects the 2011 floods and the 3-4m cohort probably represents the pioneering recruits which established post 2000 fire and 2001 flooding. Larger (8 -10m) and much older trees are located along higher ground on the eastern boundary.

Figure 4.2 Mixed cohorts and recent recruitment in the southern section of the study site.

A vast majority of colonies exhibited healthy canopies. It was only in areas where trees were large and dense that moderate canopy loss was evident (Figure 4.3). Some of these more mature stands also exhibited signs of tree damage, both probably due to natural attrition but also in response to damage by deer, as evidence by rub marks and adjacent hoof mark concentration. In the large area of younger individuals to the south of the study area, a number of trees exhibited epiphytic growth. This typically occurred on the higher trees in the area but whether this is related to stress is currently unknown.

Figure 4.3 Dense mature stand with signs of canopy decline.

Figure 4.4 Epiphytic growth on C. wimmerensis on the floodplain

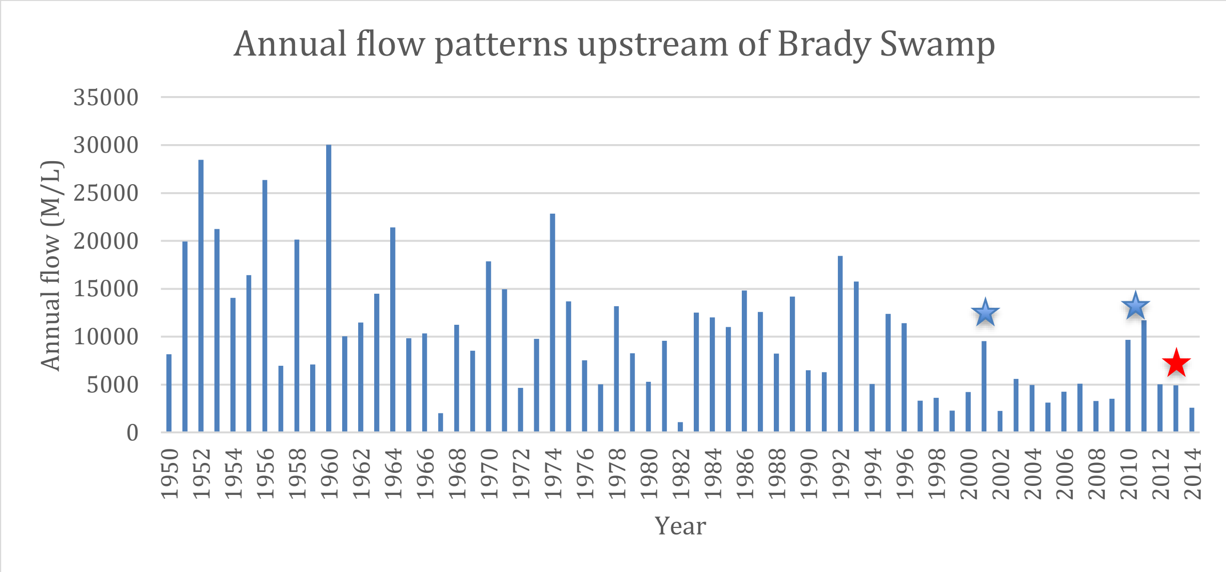

Figure 4.5 Annual flow for the Wannon River at Jimmy's Creek campsite highlighting recent major flows (blue star) and the year of wetland restoration at Gooseneck Swamp (red star).

5 Summary

Remote and field based surveys of the Wannon River floodplain, immediately upstream of Brady and Gooseneck swamps, identified a number of previously unrecorded Callistemon wimmerensis stands. Previous documentation of the species at this site recognised it as probably the most important site across the species range, purely by weight of numbers of plants occurring. This current study has further increased this observation by recording an even greater number of plants. Observations derived during this study suggest that there could be up to 100,000 mature plants. Furthermore, the plants look to be healthy, in terms of canopy, and also show a range of size classes, suggesting regular recruitment events. Age classes have been associated with potential timing of recruitment and appear to correlate with both fire events and episodes of high riverine flow. The most recent evidence of recruitment (<1m juvenile plants) is likely to exhibit a response to wetland restoration trials undertaken in 2013 and 2014, providing support for the role of hydrological wetland restoration in mitigating against the effects of climate change and reduced rainfall, runoff and flow events.

6 References

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