

## DISTRIBUTION AND ECOLOGY OF THREE THREATENED TASMANIAN ENDEMIC SPECIES OF *BORONIA*

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### ABSTRACT

A taxonomic review of the *Boronia* genus by Duretto (2003) increased the number of described species in Tasmania from six to fifteen, which included the addition of *Boronia hemichiton* and *B. hippopala* and the reinstatement of *B. gunnii*. These three species are considered a high priority for conservation due to their endemism and apparently restricted distribution and are all listed on the Tasmanian *Threatened Species Protection Act 1995*. Prior to this project, the only formal survey work and conservation assessment for *B. hemichiton*, *B. hippopala* and *B. gunnii* had been undertaken by Schahinger (2004).

In 2005 and 2006 the Forest Practices Authority, with support from Forestry Tasmania, undertook a project to:

- gather information on the size, extent and condition of the known population of these three species;
- conduct extension surveys for each species, and;
- identify sites of significance and develop recommendations for conservation management of the species on State forest.

No new populations of *B. hemichiton*, *B. hippopala* or *B. gunnii* were located during the survey work, which confirmed the distributional gaps previously identified by Schahinger (2004) and supported the threatened conservation status of the three species. Information on population size and extent at significant sites indicated much larger estimated populations than previously reported. However, accurate mapping of area of occupancy was highlighted as a knowledge gap.

For the first time in Tasmania, mature individuals of *B. hemichiton* and

*B. hippopala* were aged using growth ring counts and found to be between 13 and 21 years old. It is likely that this corresponds with a disturbance event, as large numbers of seedlings were recorded growing in recently burnt sites. The results of this project have supported the management recommendations by Schahinger (2004) for protection of significant sites combined with fire management, using a fire interval of 12-20 years.

### INTRODUCTION

The genus *Boronia* is a member of the Rutaceae family and characterised by small to medium aromatic shrubs that generally occupy heath and woodland communities. There are over 100 species of *Boronia* endemic to Australia (Morely & Toelken 2002), with some species listed on the Commonwealth *Environmental Protection Biodiversity Conservation Act 1999* due to small and fragmented populations (Shapcott et al. 2005).

Tasmania currently has 15 described species of *Boronia* (Duretto 2003). This number was increased from six (Curtis &

Morris 1975) after a taxonomic review of the genus by Duretto (2003) and includes nine endemics and three species listed as threatened on the Tasmanian *Threatened Species Protection Act 1995*.

The threatened species are *B. hemichiton* (endangered), *B. hippopala* (vulnerable) and *B. gunnii* (vulnerable), which are also all listed as Vulnerable on the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. *B. hemichiton* (Plates 1 & 9) and *B. hippopala* (Plate 2) were described and *B. gunnii* (Plate 5) was reinstated by Duretto (2003).

These species were often previously identified as *B. pilosa* though they are in fact more closely related to *B. citriodora* (M. Duretto pers. comm.).



**Plate 1.** *Boronia hemichiton*

*B. hemichiton*, *B. hippopala* and *B. gunnii* are found in northeastern and eastern Tasmania in disjunct populations.

*B. hemichiton* is known only from Mount Arthur in the State's northeast. *B. hippopala* and *B. gunnii* are found in the Eastern Tiers in the St Pauls River and Dukes Marshes areas (Schahinger 2004; TSS 2005a; TSS

2005b; TSS 2005c). *B. hemichiton* (Plate 3) and *B. hippopala* (Plate 4) share broadly similar habitat characteristics, occurring in wet heathland or shrubland grading into eucalypt woodland. The associated understorey is dominated by *Leptospermum* species, *Callistemon viridiflorus*, *Melaleuca* species, *Hibbertia* species and *Gahnia grandis* (Schahinger 2004; TSS 2005b; TSS 2005c). *B. gunnii* is a riverine species that occurs in sheltered habitats (Plate 6), such as between boulders, in the flood zone of the St Pauls, South Esk and Apsley river systems (Schahinger 2004; TSS 2005a).



**Plate 2.** *Boronia hippopala*  
insets show flowers and velvety surface of  
branchlets and leaves

A review of the conservation status of these three *Boronia* species was undertaken by Schahinger (2004) with qualifications for listing on the Tasmanian *Threatened Species Protection Act 1995* due to: a small number of disjunct locations and projected decline in extent and quality of habitat (*B. hemichiton* and *B. hippopala*) and; a small number of populations and individuals (*B. gunnii*). At the time of

Schahinger's works, all locations of *B. hemichiton* and *B. hippopala* were known from State forest and two populations of *B. gunnii* were also from State forest (although not exclusively).



**Plate 3.** Woodland habitat of *Boronia hemichiton* near Mount Arthur



**Plate 4.** Wet heathland habitat of *Boronia hippopala* at Flagstaff Marsh

The combination of changes in taxonomy, listing of the three species, locations of the species on State forest and limited survey effort (to date) prompted Forestry Tasmania

to commission a project to conducted a more detailed assessment of the distribution of *B. hemichiton*, *B. hippopala* and *B. gunnii*. This project was undertaken by the Forest Practices Authority in 2005 and 2006 and details of the survey work and results were delivered in an unpublished report to Forestry Tasmania (Chuter 2006). This paper summarises the results of that project and outlines recommendations for conservation of the species' and directions for future study.



**Plate 5.** *Boronia gunnii* growing in crevices of dolerite boulders near Meadstone Falls



**Plate 6.** Flood-prone boulder-strewn river bed habitat of *Boronia gunnii* near Meadstone Falls

## METHODS

### Field methods

Study sites were chosen based on known locations and a report by Schahinger (2004), which identified areas with potential habitat for the three target species. Survey work was undertaken between December 2005 and March 2006, which coincided with the flowering time of the species. The distinctive pink-white four-petalled flowers are an important feature for identification of these three species in areas dominated by thick heath. Known locations were re-visited to assess the extent and condition of the populations and potential habitat sites were targeted for extension survey work. Figures 1 & 2 show the location of all sites surveyed during the project.

At known locations, the target species was relocated using GDA coordinates supplied in Schahinger (2004) and surveys on population size and extent were carried out. At potential habitat sites a widespread search of the area was conducted using maximum person and time allocations.

Where target species were located the population size and extent was assessed by random sampling within a 30 m<sup>2</sup> plot. Within the plot (at random locations), 30 1 x 1 m<sup>2</sup> quadrats were sampled and number of individual plants and life history stage (flowering adult or seedling) was recorded. Number of plots surveyed varied depending on the extent of the area occupied by *Boronia*. A general floristic survey was also undertaken for each 30 m<sup>2</sup> plot.

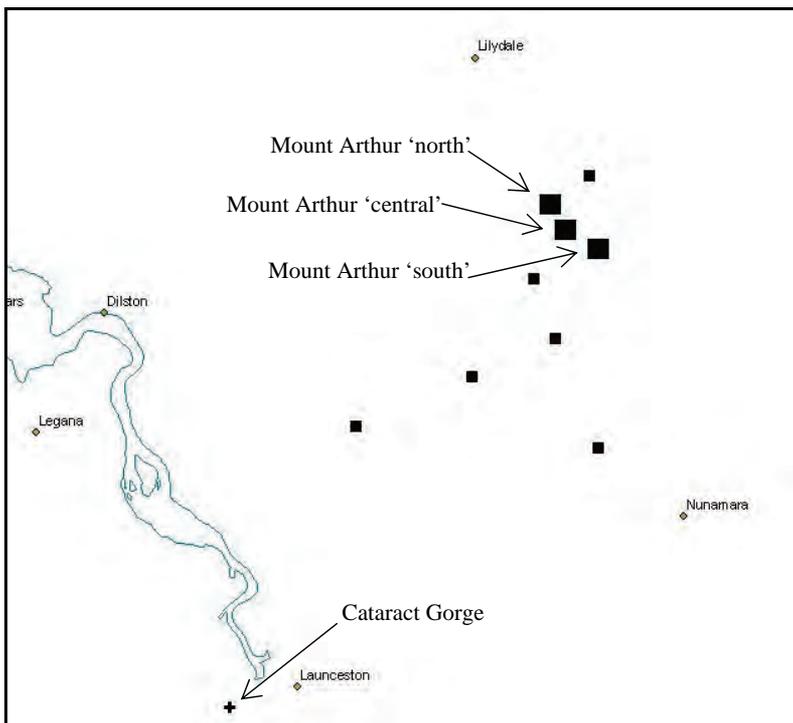
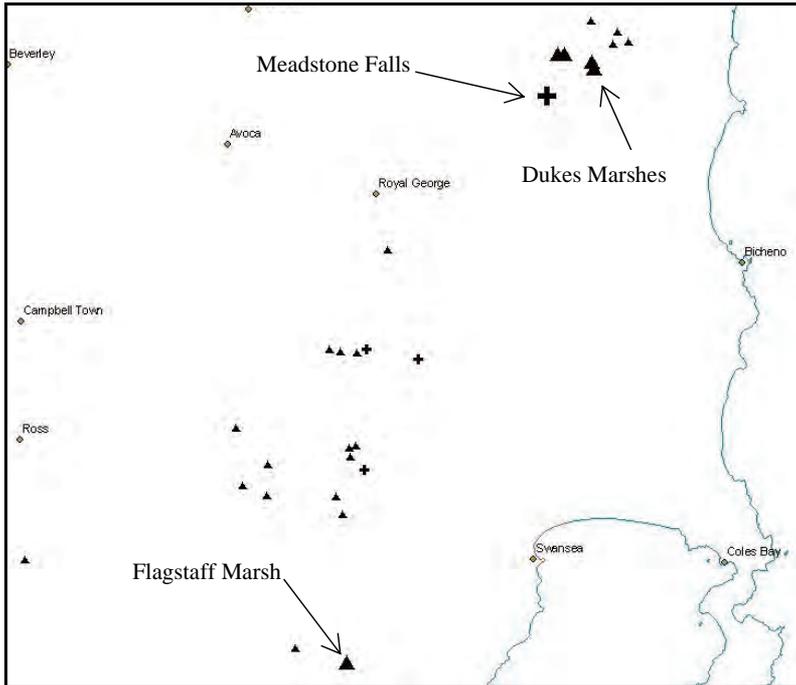


Figure 1. Location of positive (big square) and negative (small square) sites of *Boronia hemichiton*; negative *Boronia gunnii* site (cross) at Cataract Gorge



**Figure 2.** Locations of positive (big triangle) and negative (small triangle) *Boronia hippopala* sites; positive (big cross) and negative (small cross) *Boronia gunnii* sites

### Population age

Two sites were chosen for further field work to age the population of *Boronia*; Mount Arthur (*B. hemichiton*) and Flagstaff Marsh (*B. hippopala*). These sites were considered to be significant based on the large size of the populations, the extent of the potential habitat and the range of life stages (both adult plants and seedlings present). At each site (in addition to the population sampling conducted as outlined in previous section) 10 cm samples of the main stem (at base of stem) of eight mature plants of *B. hippopala* and four mature plants of *B. hemichiton* were collected for growth ring analysis. The stem samples were cut into slices approximately 1 cm in width and sanded to produce a smooth surface for growth ring counts (Plate 7).



**Plate 7.** Cut and polished stem of *Boronia hippopala* from Flagstaff Marsh with visible growth rings (x 3.5) (image: Greg Jordan, University of Tasmania)

**Data analysis**

For sites with positive occurrence of the target *Boronia* species, the results of the floristic survey were analysed for similarity in a Bray-Curtis ordination and a cluster dendrogram using PCORD4. Survey plots were used as the basic level of replication for the floristic association data analysis. Population size at positive sites was estimated from the data collected in the quadrat sampling. The number of plants recorded in the quadrats was extrapolated to represent a 100 m<sup>2</sup> area.

**RESULTS**

**Population abundance, extent and distribution**

A total of 38 sites were surveyed for *B. hemichiton* (9), *B. hippopala* (24) and *B. gunnii* (5). The target species were successfully relocated at 9 sites, all previously identified by Schahinger (2004), but no new populations were discovered. The location of the positive sites is shown graphically in Figures 1 & 2 and exact locations of all sites surveyed using GDA coordinate are given in Appendix 1.

*Boronia hemichiton*

Surveys for *B. hemichiton* were concentrated in the Mount Arthur area in northeastern Tasmania. Three known sites were relocated on Mount Arthur. Other suitable habitat in the area was searched but no new populations were found.

Three distinct locations of *B. hemichiton* are found on Mount Arthur, herein named Mount Arthur ‘south’, ‘north’ and ‘central’ (Figure 1). Estimated population size for the Mount Arthur populations is given in Table 1.

The estimated number of adult plants ranged from 56/100 m<sup>2</sup> at Mount Arthur ‘central’ to 17/100 m<sup>2</sup> at Mount Arthur ‘south’. Mount Arthur ‘south’ has a significantly higher number of seedlings than the other areas, at 320 seedlings per 100 m<sup>2</sup> (Plate 8) compared to 59 seedlings per 100 m<sup>2</sup> at Mount Arthur ‘central’. Mount Arthur ‘south’ was burnt by wildfire in 2003 and *Boronia* seedlings 1-2 years old were observed in high number in the burnt areas and on the road verges. No seedlings were observed at Mount Arthur ‘north’; this site had not been recently burnt.

**Table 1.** Estimated size of populations per 100 m<sup>2</sup> at each positive site sampled

Species	Location	No. of plots / plot numbers	Average pop <sup>n</sup> size (per 100m <sup>2</sup> )
<i>B. hemichiton</i>	Mt Arthur ‘south’	11 (P14 – P24)	320 seedlings; 17 adults
<i>B. hemichiton</i>	Mt Arthur ‘north’	1 (P10)	27 adults
<i>B. hemichiton</i>	Mt Arthur ‘central’	3 (P11 – 13)	59 seedlings; 56 adults
<i>B. hippopala</i>	Dukes Marshes area	4 (P5 – P8)	17 adults
<i>B. hippopala</i>	Flagstaff Marsh	4 (P1 – P4)	17 seedlings; 91 adults
<i>B. gunnii</i>	Meadstone Falls	1 (P9)	23 seedlings; 57 adults



**Plate 8.** Prolific growth of seedlings of *B. hemichiton* was recorded at the burnt marsh on the southern side of Mount Arthur: a large number of seedlings estimated to be one year's growth are shown in the foreground of this photo (image: Justine Shaw, DPIPW)

### *Boronia hippopala*

Known locations of *B. hippopala* were relocated at Flagstaff Marsh, the Dukes Marshes area and the Meadstone Falls area in eastern Tasmania. Extension surveys were conducted throughout the distributional gap in suitable habitat at 19 sites across the Eastern Tiers but no new populations were recorded.

Population abundance surveys were undertaken at Flagstaff and Dukes marshes. The Meadstone Falls area was not assessed for population size as the species was only found scattered along the road edge. An estimated 91 adult plants per 100 m<sup>2</sup> was supported at Flagstaff Marsh at the time of the surveys (see Table 1). This large number of adults was mainly confined to suitable habitat that had not been burnt and did not support seedlings. Some parts of the marsh had been burnt in 2002 and supported the seedling *B. hippopala* population at an estimated 17 seedlings per 100 m<sup>2</sup>.

### *Boronia gunnii*

*Boronia gunnii* was relocated at one site at Meadstone Falls. Four other sites with

potential habitat were surveyed, including a historical record in Cataract Gorge, but no new populations were found. The site at Meadstone Falls was from the riparian area associated with the river and estimated to support 57 adult plants and 23 seedlings per 100 m<sup>2</sup>.

### *Mature plant age*

Stem samples taken from *B. hemichiton* and *B. hippopala* from Mouth Arthur 'south' and Flagstaff March, respectively, were used to age the populations. Samples were taken from mature plant specimens from unburnt areas. The average growth ring count was 20.75 for *B. hemichiton* and 15 for *B. hippopala*.

### *Floristic associations*

The distribution by ordination of plots according to floristic composition is given in Figure 3. Most *B. hemichiton* plots are clustered and distanced from the plots of *B. hippopala* and *B. gunnii*. This indicates that *B. hemichiton* plots are floristically similar in species composition to each other and different to the *B. hippopala* and *B. gunnii* plots. One exception is plot P10, which appears to be floristically different on the ordination.

However, the cluster analysis, which uses the same floristic data, shows that this plot is closely related to the other plots of *B. hemichiton* (Figure 4). The cluster analysis also supports the result that the *B. hemichiton* plots are more closely related floristically to each other than to *B. hippopala* or *B. gunnii* plots.

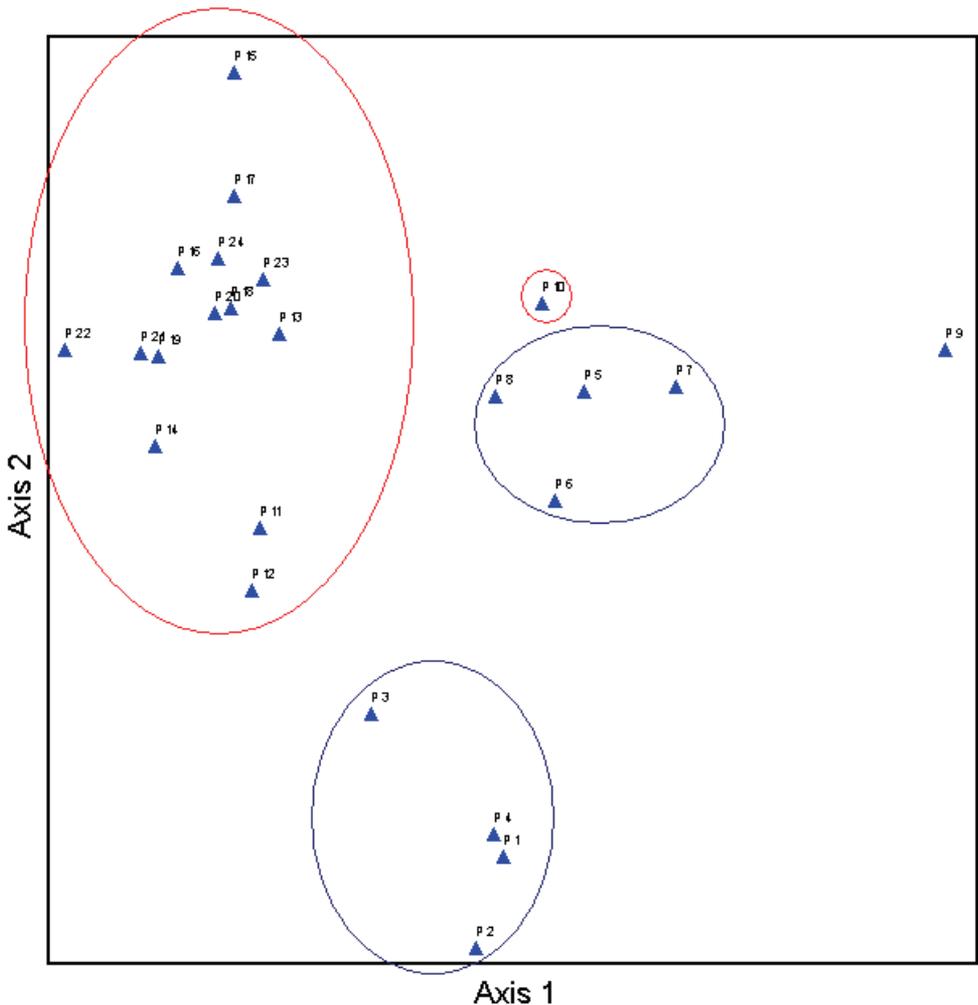
The ordination graph shows two distinct groups of plots of *B. hippopala*: plots 1-4 from Flagstaff Marsh appear to be floristically different to plots 5-8 from Dukes Marshes. Plot P9 is an outlier and is the one *B. gunnii* site. The cluster analysis indicates the *B. gunnii* plot to be closely related to the *B. hippopala* plots from

Dukes Marshes. This is expected as the *B. gunnii* plot is from the Dukes Marshes catchment area.

*Boronia hemichiton*

Floristic composition of all three *B. hemichiton* sites was very similar.

*Eucalyptus delegatensis* and *E. amygdalina* were frequent dominant species with *Callistemon viridiflorus*, *Leptospermum lanigerum*, *Micrantheum hexandrum* and *Gahnia sieberiana* as the more common understorey species (Plate 3).



**Figure 3.** Ordination graph of floristic composition for each plot surveyed with a *Boronia* species present. Plot numbers are marked P1 through to P24 and correspond with the plot numbers given in Table 1. The encircled points on the graph group those plots with the same *Boronia* species present. Red represents *B. hemichiton* and blue represents *B. hippopala* plots. The point not circled represents the *B. gunnii* site.

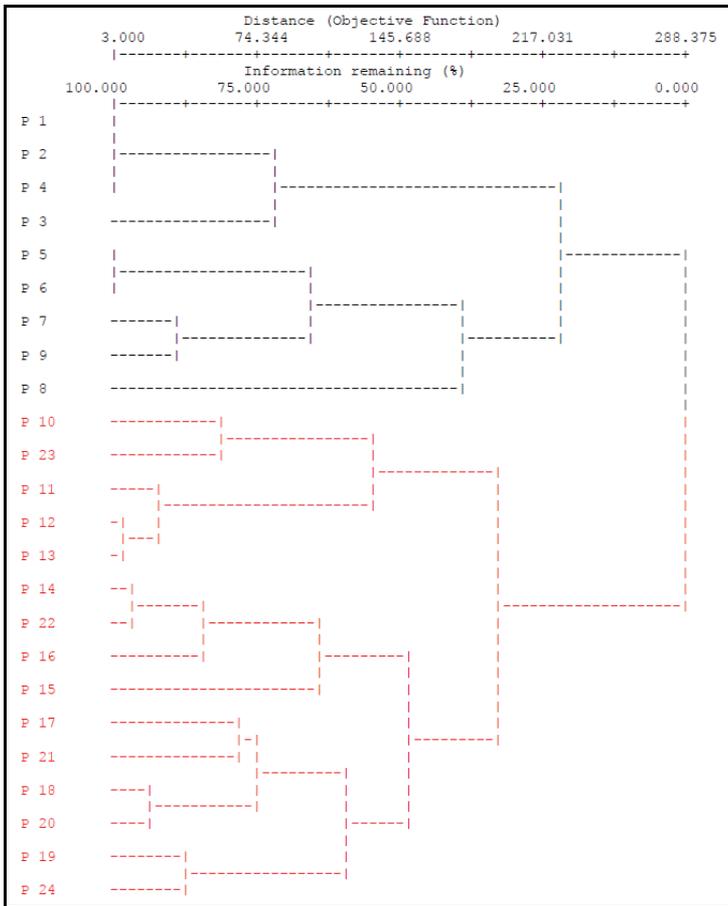
*Boronia hippopala*

At Flagstaff Marsh, *B. hippopala* was found growing in wet scrub dominated by *Eucalyptus rodwayi* (Plate 4). The understorey vegetation comprised *Callistemon viridiflorus*, *Epacris gunnii*, *Melaleuca gibbosa* and *M. squamea*. Populations in the Dukes Marshes area were found in the ecotone between wet scrub and eucalypt woodland as described by Schahinger (2004). The flora associated

with the populations included *Micrantheum hexandrum*, *Leptospermum scoparium*, *Lomatia tinctoria* and *Banksia marginata*.

*Boronia gunnii*

*B. gunnii* was found growing in rock crevices of a river on a dolerite substrate (Plates 5 & 6). The associated vegetation includes *Hakea microcarpa*, *Micrantheum hexandrum*, *Leptospermum lanigerum* and *Lomatia tinctoria*.



**Figure 4.** A dendrogram showing the relationship between plots (plots P11-P24 in red = *B. hemichiton* sites, except plot P10 = *B. gunnii* site; plots P1-10 in black = *B. hippopala* sites; linkage method = Ward's method; distance measure = Euclidean (Pythagorean); percent chaining = 2.67

## DISCUSSION

### *Distribution and population dynamics*

The focus of this project was on surveying potential habitat within distributional gaps to potentially extend the range of the species. Some data on number of plants in a population or at a site was collected; however, the estimates of population size are only indications. In reality, the actual population numbers are likely to be lower than the estimated numbers due to a scattered distribution and varying densities of populations.

*Boronia* species were relocated at known sites on Mount Arthur, at Flagstaff Marsh, Dukes Marshes (and surrounds) and Meadstone Falls. All populations of the target species were in good condition, with two sites, Mount Arthur 'south' and Flagstaff Marsh, supporting a large number of seedlings of *B. hemichiton* and *B. hippopala*, respectively. These sites had been recently burnt, indicating a positive response to disturbance, which supports the findings by Schahinger (2004). Mature plants from the same sites were found to be between 13 and 21 years of age, according to growth ring counts. It was observed in the field that these mature plants were showing signs of being suppressed by the surrounding dense vegetation.

Extrapolation of plot count data indicated large population sizes, ranging from 17 plants per 100 m<sup>2</sup> at Dukes Marshes up to 320 seedlings per 100 m<sup>2</sup> at Mount Arthur 'south'. The estimated population size was larger than that reported by Schahinger (2004). However, this is an upper limit estimate. The area of occupancy for each site is still unknown and the patchy distribution of the plants may result in the actual population numbers being lower than reported here.

The response of these species of *Boronia* to the pathogen *Phytophthora cinnamomi* (PC)

has not been a focus of this project. However, it is worth mentioning as a discussion point. Schahinger (2004) recommended a conservative approach to the management of PC in areas supporting known population of a threatened species of *Boronia*. Lab-based susceptibility trials indicated that in general these species have a high level of resistance to PC, although *B. hemichiton* does show slight susceptibility and both *B. hemichiton* and *B. gunnii* are hosts of the pathogen (Rudman et al. 2008). Field observations during this project did not report any signs of PC in the sampled populations. Although the results of the lab-based testing indicated only a slight susceptibility in *B. hemichiton*, these species can be associated with other PC-susceptible species and vegetation communities and therefore a conservative approach to PC management in known locations is still recommended, following recommendations in Schahinger (2004).

### *Floristic associations*

Impeded drainage associated with wet heathland characterised the floristic similarities between sites supporting populations of *B. hemichiton* and *B. hippopala*. Taller shrubs, such as species of *Leptospermum* and *Melaleuca*, *Callistemon viridiflorus* and *Hakea lissosperma* dominated sites that had not been recently disturbed and contained mostly mature *Boronia* plants. Those sites that had been recently disturbed by fire had a higher occurrence of heath species, graminoids and herbaceous species as well as a high occurrence of *Boronia* seedlings.

Floristic differences between sites supporting populations of *B. hemichiton* and *B. hippopala* sites are mostly confined to the overstorey. *B. hemichiton* sites are typically dominated by *Eucalyptus delegatensis* and *E. amygdalina* with an understorey of dense *Callistemon viridiflorus*, *Leptospermum* species and

*Gahnia* species. *B. hippopala* sites had a similar overstorey dominated by *E. rodwayi*, *E. pauciflora* and *E. viminalis*. *Banksia marginata* commonly occurred with *Boronia hippopala*, as did *Bauera rubioides* and a number of epacrids and herbaceous species. The floristic associations recorded during this project can be used to identify areas of potential habitat for these threatened species. This will be useful for future survey work.

### **Response to disturbance**

Results from this study indicate that *B. hemichiton* and *B. hippopala* respond positively to disturbance from fire, in terms of seedling regeneration. Species of *Boronia* species are known to come back readily after fire from soil-stored seed (M. Duretto, pers. comm.). No mature plants were observed to be re-sprouting after fire, indicating that the plants were killed by the fire. Abundant seedling regeneration after fire was recorded for *B. hemichiton* at Mount Arthur and *B. hippopala* at Flagstaff Marsh (Figure 6). Seedling regeneration was prolific with approximately 320 seedlings per 100 m<sup>2</sup> at Mount Arthur and 17 seedlings per 100 m<sup>2</sup> at Flagstaff Marsh. The number of seedlings is expected to decrease over time (particularly for *B. hemichiton* seedling number at Mount Arthur) as competition with associated vegetation increases. *Boronia* species are poor competitors with tall heath species (M. Duretto pers. comm.).

Other studies have also shown a negative correlation between *Boronia* seedling number and time since disturbance (Shapcott et al. 2005). The growth ring counts indicated that the mature plants were one age cohort, which suggests a single reproductive event, most likely associated with a disturbance. Species of *Boronia* react positively to disturbance from fire and cuttings and quarries (Schahinger 2004).

Schahinger (2004) proposed a fire regime of between 12 and 20 years for populations of *B. hemichiton* and *B. hippopala*. This dependence on disturbance to regenerate may be responsible for the rarity of the species. Schapcott et al. (2005) identified a positive relationship between fire response and rarity in two species of *Boronia* in Queensland. Both species are killed by fire and depend on soil-stored seed for regeneration.

### **CONSERVATION MANAGEMENT**

Conservation of biodiversity in Tasmania is currently achieved through a range of processes, including protection through reservation as well as species-specific management. The recommendations for conservation delivered through this paper are limited to protection of known locations, fire management (*B. hemichiton* and *B. hippopala*) and limiting hydrological disturbance (*B. gunnii*). They closely follow the recommendations delivered by Schahinger (2004).

*B. hemichiton*, *B. hippopala* and *B. gunnii* are currently listed on the Tasmanian *Threatened Species Protection Act 1995* due to small and disjunct populations. The results of this project have shown that the species should retain their threatened status due to the small number of known locations combined with disjunct populations, although the number of individuals may be higher than previously estimated.

Suitable habitat for these species, based on floristic composition and structure at known sites, ranges from open woodlands with a dense shrubby understorey to marshes (*B. hemichiton* and *B. hippopala*) and riparian areas (*B. gunnii*). Known sites have low density of eucalypt cover and may not be of high wood production value, and therefore protection through reservation of key sites is a realistic goal. Some known

sites are already in reserve, such as Flagstaff Marsh, which is part of the Tooms Lake Forest Reserve. However, protection without management for *B. hemichiton* and *B. hippopala* may not be suitable, as results from this and other studies indicate that the species rely on disturbance for regeneration.

Schahinger (2004) recommended fire management for *B. hemichiton* and *B. hippopala*, through implementation of a burn interval of 12-20 years. This burn interval is supported by the results of this project, which recorded large numbers of seedlings areas burnt 3-4 years prior to survey, and aged mature plants between 13 and 21 years. Field observation indicates that the mature plants, from where the stem samples were sourced, were beginning to be suppressed by surrounding vegetation (such as species of *Leptospermum* and *Melaleuca*). Schahinger (2004) recommended strategic burning of three sites: Mount Arthur, Dukes Marshes and Horseshoe Marsh. It is recommended that Flagstaff Marsh be included in this strategic recommendation.

Fire is important in the conservation management of many flora and fauna species in Tasmania, as well as the regeneration of many vegetation communities. A local example of fire being used as a tool for conservation management is the management of the grasslands at Surrey Hills in northwest Tasmania. The 2,000 ha estate of high conservation value grassland is subject to low intensity burns of discrete area units to maintain and enhance the floristic diversity of the grassland and provide habitat for threatened species (e.g. ptunarra brown butterfly) associated with the area (Davey & Duncan 2006). Flagstaff Marsh is also a known location of the ptunarra brown butterfly as well as *B. hippopala*, and tactical burning of this marsh at the recommended burn

interval will mostly likely have conservation benefits for both species.

Implementing habitat protection for *B. gunnii* in wood production areas is relatively simple under current policy and legislation. The species occupies the riparian area around Meadstone Falls, and under the *Forest Practices Code 2000* (FPB 2000) this is a class 1 "stream" and must have a minimum 40 m streamside reserve applied. Schahinger (2004) indicated that *B. gunnii* may be at risk from hydrological disturbance upstream of known locations. The upper reaches of the St Pauls, Dukes and Apsley rivers are on State forest and consideration should be given to downstream populations of *B. gunnii* during forest practices planning.

#### **FUTURE WORK**

Two future research areas have been identified through this project: (1) accurate mapping of area occupied, and (2) reassessment of populations following disturbance by fire.

This project and the work undertaken by Schahinger (2004) attempted to quantify key populations of the three target *Boronia* species. Number of individuals and area of occupancy for Flagstaff Marsh has been based on estimates, extrapolation of small plots and broad-scale vegetation mapping. More population data, including area occupancy polygons and intensive individual plant counts, will provide an accurate picture of the conservation status of the species. In addition to this work, reassessment of the 'significant sites' that were burnt in 2002 (*B. hippopala* at Flagstaff Marsh) and 2003 (*B. hemichiton* at Mount Arthur) will provide additional information on the population dynamics approximately ten years after disturbance. One aspect of interest would be the expected decrease in *Boronia* numbers in

burnt areas where seedling counts were high during 2005-2006. Understanding the role that fire plays in the ecology and distribution of these threatened species is important in the development of conservation management objectives.

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**APPENDIX.** Sites surveyed during this project.

[Sites where the target *Boronia* species were detected have been highlighted in bold.;GPS coordinates are in the GDA94 datum; mapsheets used are from the Tasmap 1:25 000 series]

Target species	Site	Mapsheet	Easting	Northing
<b><i>Boronia hippopala</i></b>	<b>Flagstaff Marsh</b>	<b>Tooms</b>	<b>571 311</b>	<b>5326 119</b>
<i>Boronia hippopala</i>	Alfred Creek	Tooms	566 500	5327 400
<i>Boronia hippopala</i>	Long Marsh	Colonels	541 200	5335 650
<i>Boronia hippopala</i>	Crayfish Swamp	Colonels	570 846	5339 914
<i>Boronia hippopala</i>	Wingys Tier	Leake	570 250	5341 500
<i>Boronia hippopala</i>	Crossins Road	Leake	571 650	5345 250
<i>Boronia hippopala</i>	Shaws Bog	Leake	571 550	5346 000
<i>Boronia hippopala</i>	Big Peppermint Hill	Leake	572 100	5346 200
<i>Boronia hippopala</i>	Old Flagstaff Marsh	Leake	561 550	5342 500
<i>Boronia hippopala</i>	Long Marsh Road	Leake	563 800	5341 600
<i>Boronia hippopala</i>	Wet Gun Swamp	Leake	563 950	5344 450
<i>Boronia hippopala</i>	Ladies Mile Marsh	Leake	560 950	5347 900
<i>Boronia hippopala</i>	Duckhole Flats	Snow	569 700	5355 200
<i>Boronia hippopala</i>	Meetus Falls Forest Reserve	Snow	572 250	5354 900
<i>Boronia hippopala</i>	Ferrars Tier	Snow	570 650	5354 950
<i>Boronia hippopala</i>	White Marsh	Roys	575 100	5364 400
<b><i>Boronia hippopala</i></b>	<b>Dukes Marshes</b>	<b>Fingal</b>	<b>594 456</b>	<b>5381 339</b>
<b><i>Boronia hippopala</i></b>	<b>Horseshoe Marsh</b>	<b>Fingal</b>	<b>591 656</b>	<b>5382 605</b>
<b><i>Boronia hippopala</i></b>	<b>Alberts Marsh</b>	<b>Fingal</b>	<b>590 998</b>	<b>5382 647</b>
<b><i>Boronia hippopala</i></b>	<b>Meadstone Falls Road</b>	<b>Fingal</b>	<b>594 422</b>	<b>5381 293</b>
<i>Boronia hippopala</i>	Black Marsh	Fingal	596 150	5383 500
<i>Boronia hippopala</i>	Timmine Gully	Fingal	597 600	5383 750
<i>Boronia hippopala</i>	Sandy Marsh	Fingal	596 600	5384 650
<i>Boronia hippopala</i>	Fingal Tier	Fingal	594 100	5385 650
<b><i>Boronia hemichiton</i></b>	<b>Mount Arthur 'north'</b>	<b>Patersonia</b>	<b>520 650</b>	<b>5428 300</b>
<b><i>Boronia hemichiton</i></b>	<b>Mount Arthur 'south'</b>	<b>Patersonia</b>	<b>522 250</b>	<b>5425 800</b>
<b><i>Boronia hemichiton</i></b>	<b>Mount Arthur 'central'</b>	<b>Patersonia</b>	<b>521 150</b>	<b>5427 450</b>
<i>Boronia hemichiton</i>	Eaglehawk Road	Patersonia	520 100	5425 850
<i>Boronia hemichiton</i>	Excalibur Road	Patersonia	520 800	5423 850
<i>Boronia hemichiton</i>	Prossers Forest Road	Patersonia	522 250	5420 200
<i>Boronia hemichiton</i>	Blyths Spur	Patersonia	521 950	5429 300
<i>Boronia hemichiton</i>	Boomer Hills	Dilston	514 100	5420 900

<b>Target species</b>	<b>Site</b>	<b>Mapsheet</b>	<b>Easting</b>	<b>Northing</b>
<i>Boronia hemichiton</i>	Butchers Creek	Dilston	518 000	5422 550
<i>Boronia gunnii</i>	Lost Falls	Leake	572 900	5343 950
<i>Boronia gunnii</i>	Meetus Falls Forest Reserve	Snow	573 200	5355 200
<i>Boronia gunnii</i>	Cygnets River	Snow	578 000	5354 300
<b><i>Boronia gunnii</i></b>	<b>Meadstone Falls</b>	<b>Fingal</b>	<b>590 044</b>	<b>5378 683</b>
<i>Boronia gunnii</i>	Cataract Gorge	Launceston	<b>509 850</b>	<b>5411 500</b>



**Plate 9.** *Boronia hemichiton*