

## Peak flowering and fruiting patterns in the endangered orchid *Corunastylis* sp. 'Charmhaven' on the Central Coast of New South Wales

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**Abstract:** Population size, and flowering and fruiting developmental stages in the Critically Endangered species *Corunastylis* sp. 'Charmhaven' (Family Orchidaceae, formerly included within genus *Genoplesium*), were investigated in the Warnervale-Charmhaven area over a three year period. Population size in 2012 was 11 plants, in 2013, 14 plants and in 2014 increased to 26 plants, with new plants appearing near the original plants. Proactive management, including mowing and erecting wire protective cages around groups of orchids was partly responsible for this increase in numbers because it prevented browsing by rabbits but only ten plants carried fruits to maturity in the 2014 season to produce seed. Despite an increase in numbers over a couple of years, a population of 26 individuals is very small and warrants maintaining the current conservation listing of Critically Endangered.

The population began to flower between 15<sup>th</sup> and 29<sup>th</sup> February in 2012 and from 3<sup>rd</sup> to 14<sup>th</sup> March in 2013. However in 2014 flowering began on 11<sup>th</sup> February and extended to 19<sup>th</sup> March but it took until 17<sup>th</sup> June to reach the seed dispersal stage. 2014 involved two phases of flowering; whether climatic factors were responsible for this event is not known.

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### Introduction

*Corunastylis* sp. 'Charmhaven' is a terrestrial tuberous herb in the family Orchidaceae with an inflorescence approximately 20 cm long, with up to nine flowers in a well-spaced spike 1.4 cm long. The flowers have green sepals and petals suffused and striped with deep red brown and a burgundy coloured, densely ciliate, obovate labellum with a mucronate tip (P.H. Weston, in NSW Scientific Committee 2012). This contrasts with the acuminate apex of the hairy labellum in the related *Corunastylis fimbriata* which is similar to *Corunastylis* sp. 'Charmhaven' and occurs with it at the Charmhaven site. Many more flowers are usually present on the spike of *Corunastylis fimbriata*. Dorsal sepals of *Corunastylis* sp. 'Charmhaven' are wide, ovate and hooded

with the lateral sepals being narrow, ovate, bent abaxially, erect and ascending.

*Corunastylis* was formerly treated taxonomically as part of *Genoplesium* (the 'pygmy prasophyllums' – see Jones & Clements 1989), but was regarded as a distinct genus by Jones et al. (2002), who resurrected the name *Corunastylis* Fitzg. for it. The most recent taxonomic account of *Corunastylis* is provided by Jones (2006).

*Corunastylis* sp. 'Charmhaven' is confined to the Warnervale-Charmhaven area (latitude -33°14'16", longitude 151°29'28") in the Shire of Wyong on the Central Coast of New South Wales. The species was first found at Charmhaven in 2012 on private property. At Warnervale a few individuals, also on private property, along with a single individual on

government land have been found in subsequent searches. Because of its small population size and very restricted distribution, *Corunastylis* sp. 'Charmhaven' is listed as critically endangered on Part 1 of schedule 1A of the NSW *Threatened Species Conservation Act, 1995*.

Charmhaven supports the largest population of *Corunastylis* sp. 'Charmhaven' and three years of searching and monitoring of the population there have now been completed. The project began in 2012 as an investigation to search and locate plants, followed in 2013 by protection of the species from browsing rabbits and mowing, and in 2014 monitoring of the flowering and fruiting stages and measuring various plant parts. In 2013 all energy was devoted to managing the orchid plants from browsing by rabbits with the construction and placement of wire protection cages. This communication is a summary of those results.

## Methods

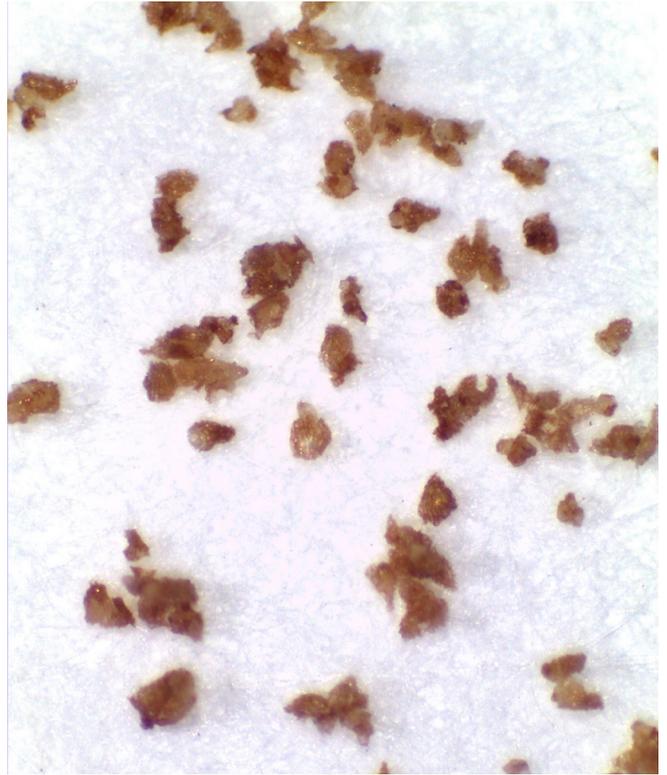
Populations of *Corunastylis* sp. 'Charmhaven' are found associated with Patonga Claystone geology of the Clifton subgroup and the Narrabeen group of rocks which produces saline soils. Vegetation at the Charmhaven site is remnant heathland (See Appendix 3 for a description of the vegetation and the plant species list for the vegetation associated with the orchid at the Charmhaven site). At the Warnervale site (on government land) there is Spotted Gum-Ironbark Forest (*Corymbia maculata* – *Eucalyptus fibrosa*–*Eucalyptus capitellata* – *Eucalyptus globoidea*) with a conspicuous *Melaleuca nodosa* understorey and at Warnervale (on private property) the few individuals are found beneath a group of scattered trees in a paddock.



**Fig. 1a.** In flower showing distinctive rectangular labellum



**Fig. 1b.** Early ovary enlargement stage with flowers waned



**Fig. 1d.** Most of the seed from the 2013 season does not appear to be fully formed. (Australian Botanic Garden photo).



**Fig. 1c.** Late ovary development stage showing brown coloured capsules and withered sepals and petals. The capsule has not yet split to release seed.

Two other *Corunastylis* species also occur at the Charmhaven site. *Corunastylis fimbriata* occurs just upslope of it and flowers at the same time as *Corunastylis* sp. 'Charmhaven'. *Corunastylis insignis*, is also present amongst the *Corunastylis* sp. 'Charmhaven' population but flowers at the beginning of September. *Corunastylis insignis* is listed as endangered on the *TSC Act, 1995*.

The population of *Corunastylis* sp. 'Charmhaven' is on 1.6 hectares of private property at Charmhaven and has been monitored over three years (2012–2014). As a safeguard against damage and vandalism the property has been fenced to deny public access to the orchids. The area in which they grow is also within a Bushfire Asset Protection Zone (APZ) and is subject to maintenance mowing to reduce fuel. Details of the location of the plants are held by the NSW Office of Environment and Heritage (Office of the Premier and Cabinet) as wildlife atlas records.

Monitoring and recording over the three year period (2012–2014) involved regular site visits mainly between seven and ten days apart. The initial 2012 site visits focused on finding individual plants and recording their position using an Ashtech-Trimble Differential Global Positioning System (DGPS) which gave a precision of between 1–2 metres in position, but for orchids in a restricted space that degree of precision is not acceptable. The recording was improved in 2014 when the topographical/cadastral surveyor's plan was upgraded, allowing measurements of individual orchids to be undertaken from the cadastral corner peg along the existing fence line and then normal to the fenceline to

each of the orchid plants found. The information was then transferred to the computerised survey plan, and MGA zone 56 co-ordinates derived for each orchid. This improved the precision to < 0.5m in position and is necessary where development is proposed near small groups of rare plants.

Time spent during the 2012 survey enabled five developmental phases of the growing *Corunastylis* plants to be defined and photographed (Figures 1a, 1d, 1c). In 2014 the surveys recorded the timing of each of the flowering and fruiting phases and included measurements of some morphological characters. The height of the stem (i.e. from the ground to the top of the stem), the rachis (ie from the top of the stem then along its length to the node of the basal flower), leaf length and the length and width of the capsules were measured. Counts of the number of flowers in the inflorescence were also recorded. These additional measurements were taken at the request of Dr Peter Weston of the National Herbarium of New South Wales and some of the details can now be used to refine the measurements in the description of the species that is currently being prepared (Peter Weston in lit.)

## Results

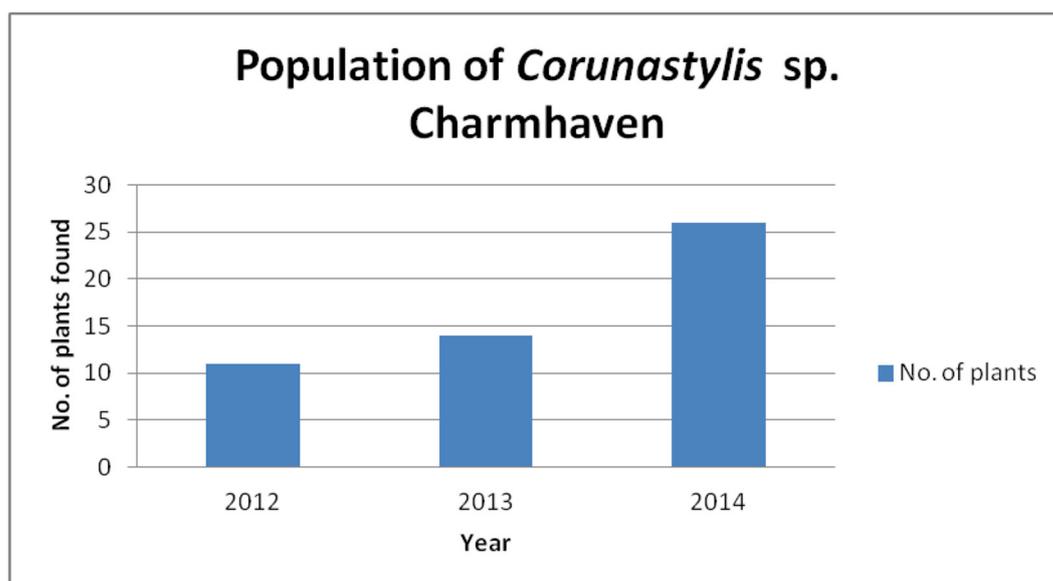
### Population size

In 2012 the population size at Charmhaven was 11 plants (Figure 2), with 14 plants in 2013. In 2014 the population increased to 26 plants, some of which appeared elsewhere near the original plants. Not all plants carried fruits to the capsule dehiscent stage to allow the release of seeds.

### Stages of development

In 2012 five plants of *Corunastylis* sp. 'Charmhaven' were recorded by 15<sup>th</sup> February with flowers reaching anthesis by 29<sup>th</sup> February; this phase was nominated as the flowering stage (Figure 1a). At the end of February eleven plants were present at five locations. Flowers remained open until 12<sup>th</sup> March, then began to wane and the ovaries began to enlarge. All petals and sepals began to wither. Maintenance mowing cut off nine of the plants (the area in which they grow is an asset protection zone) but the two that remained were measured on 23<sup>rd</sup> March 2012. This phase, recognisable by the green colouration of the ovaries, was recorded as the early ovary enlargement stage (Figure 1b). By 6<sup>th</sup> April 2012 only one orchid shoot remained (the other orchids having been browsed by rabbits) and at this stage the ovary colour turned from green to a brown colour and began to split at the apical end; this phase is referred to the late ovary stage (Figure 1c). The last orchid shoot remained until 22<sup>nd</sup> April, but failed to reach the capsule seed dehiscence stage.

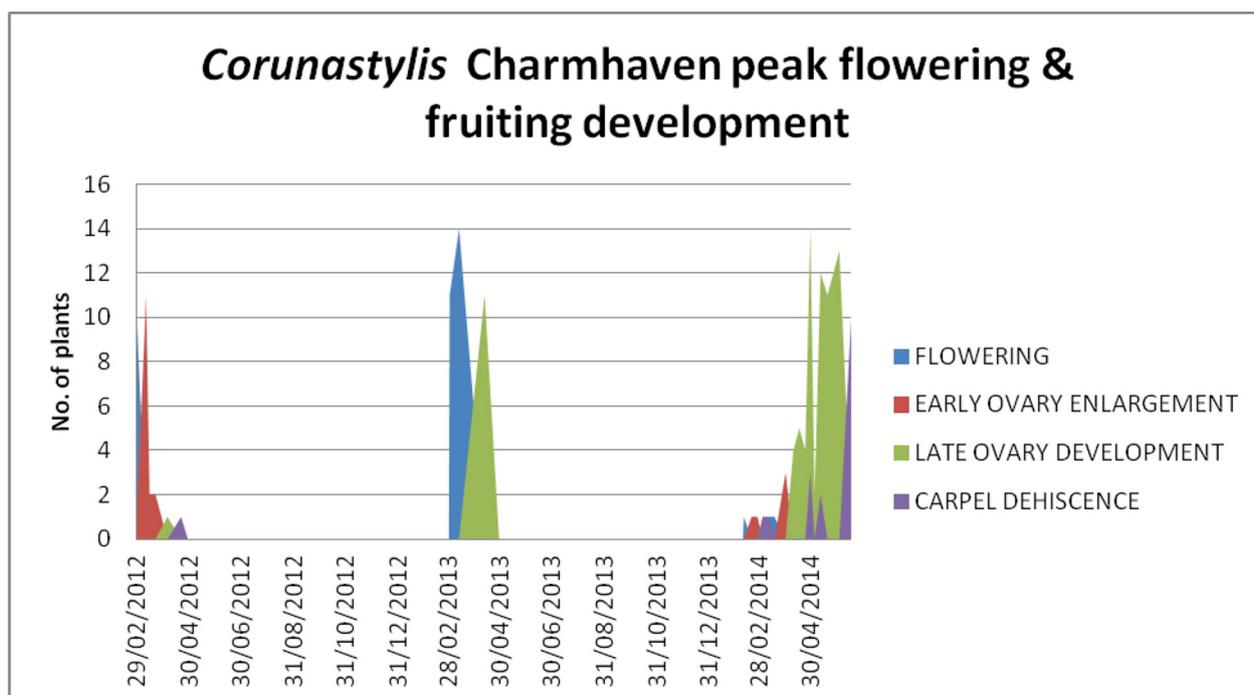
In 2013 the orchids emerged by 13<sup>th</sup> March, approximately 15 days later than emergence in 2012. The number of flowering plants observed had increased from 11 in 2012 to 14 in 2013 though not all plants that flowered in 2012 re-emerged in 2013. Some of the 2013 emerging plants were present in different locations to those found in 2012 indicating some newly recorded plants were present. At this time rabbits were seen browsing on the orchids and wire cages were placed to protect each orchid plant. This procedure took most of the 2013 orchid flowering and fruiting season.



**Fig. 2.** Number of plants recorded in the *Corunastylis* sp. 'Charmhaven' population at the Charmhaven site 2012–2014. Not all plants survive to the capsule dehiscent stage to allow the release of seeds. Despite an increase in numbers in 2014 resulting from protecting plants from rabbits and introducing a specific mowing regime, a population of 26 individuals is very small and warrants the conservation listing of Critically Endangered.

**Table 1: Morphological measurements for *Corunastylis* sp. 'Charmhaven' at Charmhaven in 2014.**

| Parameter            | Stem height(mm) | Leaf length (mm) | Rachis height (mm) | Flowers per inflorescence | Capsule     |            |
|----------------------|-----------------|------------------|--------------------|---------------------------|-------------|------------|
|                      |                 |                  |                    |                           | Length (mm) | Width (mm) |
| Mean± standard error | 189 ±8.9        | 15.5 ±1.3        | 12.5 ±1.1          | 4.1 ±0.2                  | 4           | 2          |
| No. of plants (n)    | 20              | 9                | 16                 | 14                        | 11          | 11         |

**Fig. 3.** Timing of flowering and fruiting development stages for *Corunastylis* sp 'Charmhaven' (2012–2014).

The 2014 survey was the most accurate survey conducted so far, as purposeful weekly visits and measurements were carried out rather than *ad hoc* visits. The orchid emergence in 2014 occurred at two distinct times (Figure 3). The initial emergence, however, only involved one orchid plant, which began to emerge early on 29<sup>th</sup> January 2014 (i.e. earlier than in 2012 or 2013), but did not flower until 11<sup>th</sup> February and by 20<sup>th</sup> February reached the ovary enlargement stage; it remained in that state until 27<sup>th</sup> February. From 5<sup>th</sup> March to 12 May it was in the late ovary enlargement stage and on 20<sup>th</sup> May was in the capsule dehiscence stage.

A second phase of emergence occurred approximately one month later. These plants were noted to be in bud on 12–19<sup>th</sup> March (three plants) with another two plants in flower at the same time. Not all of these plants reached the ovary enlargement stage. Three plants withered and their shoots died on 19<sup>th</sup> March whilst three plants reached the early ovary enlargement stage. Nineteen plants, however, did reach the late ovary enlargement stage by 30<sup>th</sup> April; some of these plants were not found until this stage had been reached because searching for the orchids amongst regenerating and mown heathland is a difficult task as the colour and form of this orchid blends in well with regenerating native vegetation. The late ovary enlargement stage was mostly

from 10<sup>th</sup> April–20<sup>th</sup> May, although some plants terminated this stage before that date (combination of aborting fruits and the plant withering away). Those that reached the capsule dehiscence stage (n=10/26) did so by the 17<sup>th</sup> June when the capsules were just beginning to split (Figure 3). Microscopic examination of the split capsules revealed the presence of seeds (Figure 1d).

Overall, the flowering and fruiting pattern is complicated because of the variation in timing of the stages and because not all of the shoots survive to capsule dehiscence. The data revealed a relatively consistent flowering pattern, which can change in time probably according to climatic conditions. Details are given in Appendices 1 & 2. At the end of the investigation the positions of the orchid plants were marked with a cat's eye reflector 300mm west of each plant, held in place on the ground with a 200mm long bolt.

#### *Morphological measurements*

Leaf measurements of *Corunastylis* sp. 'Charmhaven' were only undertaken in the early growing stages because the leaf withers away early; this is the reason for the low number of measurements (Table 1). Capsule length and width measurements were taken from only eleven plants due to

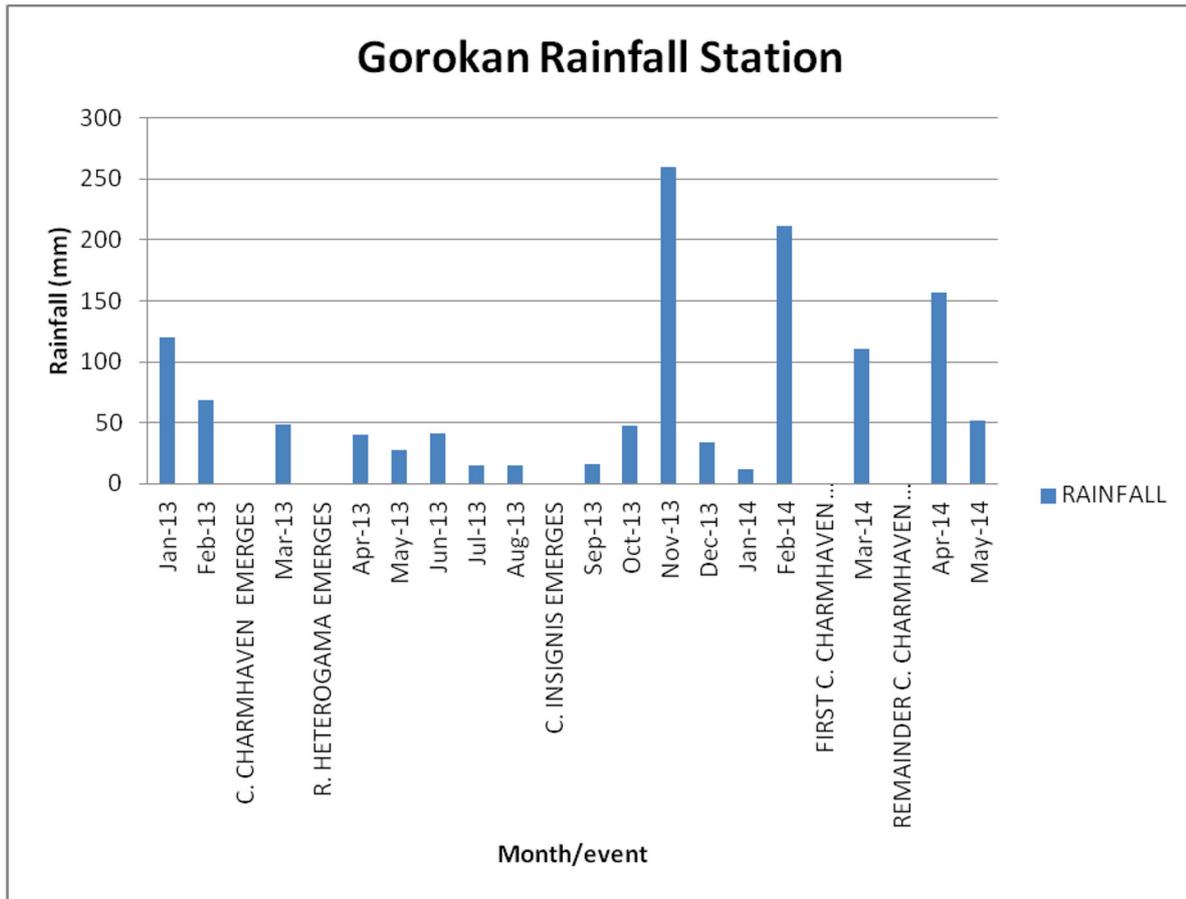


Fig. 4. Monthly rainfall for Gorokan for 2013–2014 showing associated *Corunastylis* sp ‘Charmhaven’ and *Corunastylis insignis* emergence. The co-occurring rare daisy *Rutidosus heterogama* has been included.

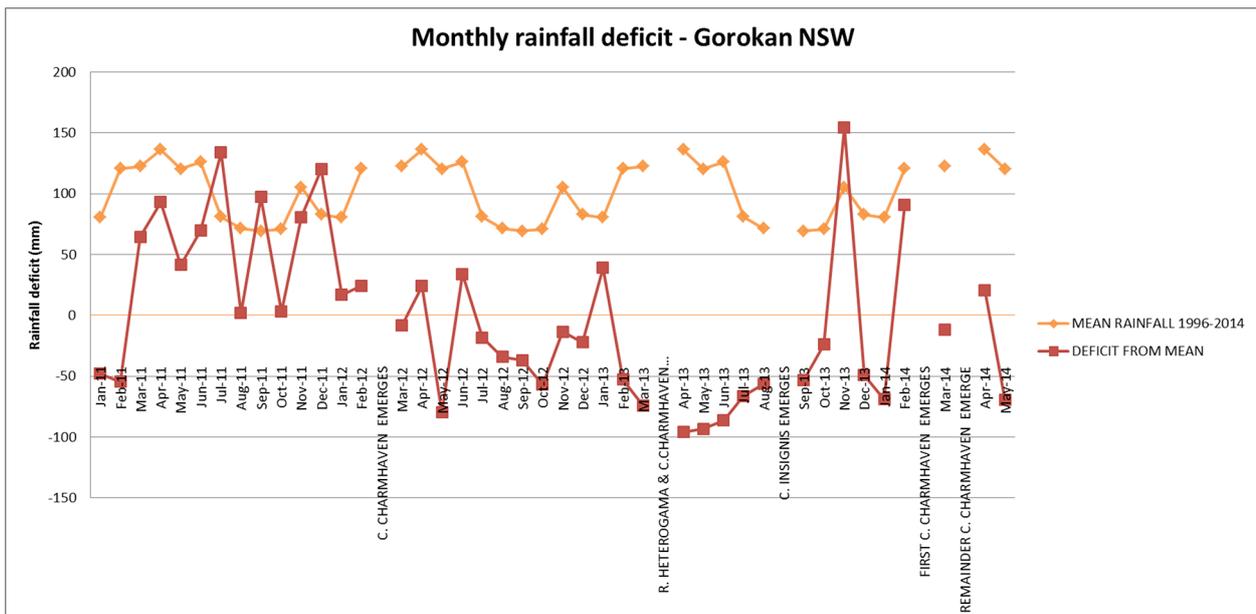


Fig. 5. Graph showing the 2012–2014 emergence of rare plant species *Corunastylis* sp ‘Charmhaven’ and *Corunastylis insignis* and the co-occurring rare daisy *Rutidosus heterogama* in relation to rainfall deficits and peaks from the mean annual rainfall. Source Gorokan rainfall station

the individual plants withering away and losing their fertile parts. Measurements were undertaken with a drawing scale with 1mm intervals; higher quality measurement would be achieved with a micrometer. The mean number of flowers per inflorescence was 4.1 based on a count of 14 plants in 2014, though in 2012, when the orchid was first found, photographs show up to nine flowers can be present in the inflorescence. In comparison in the similar species *Corunastylis fimbriata* there can be up to 30 flowers overall (Jones, 2006).

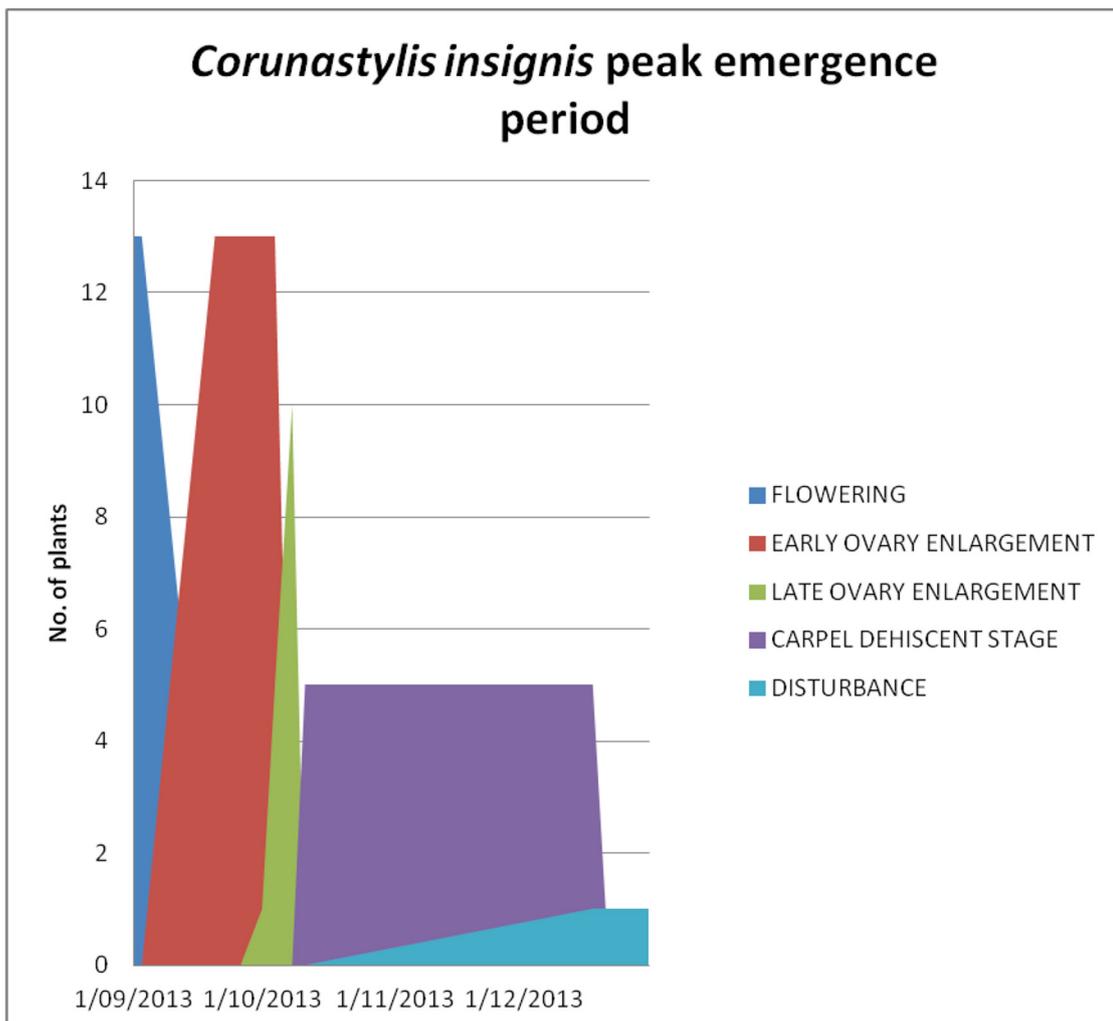
**Discussion**

*Corunastylis* plants are seasonally deciduous perennial herbs with paired tubers, one of which is replaced annually (Jones, 2006). The population size recorded at Charmhaven increased from 11 plants in 2012 to 26 plants, some of which appeared elsewhere near the original plants in 2014. Not all shoots survived to the capsule dehiscent stage to allow the release of seeds. The population may be expanding in the mowed open area and proactive management, by erecting wire protective cages around each orchid or group of orchids

was partly responsible for this increase in numbers because it prevented browsing by rabbits. Alternatively, the number of plants present may be static but the numbers emerging and flowering may have increased between 2012 and 2014. Some of the plants caged in 2013 re-emerged in 2014 but a greater number of emergent new plants were found elsewhere over the site, and may have originated from newly germinating seeds. Despite an increase in numbers over a couple of years, a population of 26 individuals is very small and warrants the conservation listing of Critically Endangered.

Peak flowering of *Corunastylis* sp. 'Charmhaven' for the years 2012 and 2013 began in late February and took about two months to the end of the fruiting stage. However, in 2014 there appeared to be two phases of flowering and fruiting, the first of which was similar to the 2013 and 2014 seasons but the second phase began later, in mid to late March and extended to mid June (when the capsules began to dehisce). Seed-bearing capsules were produced during this second stage.

The cause of this alteration in timing in 2014 is not known with confidence but may be partly related to rainfall. Preliminary



**Fig. 6.** Timing and stages of flowering and fruiting of *Corunastylis insignis* in 2013 (disturbance was caused by trail bikes).

investigation of rainfall does reveal a lengthy deficit (Figures 4, 5) between January and October 2013. A short wet period is evident in February 2014 just prior to flowering but that alone does not explain the two phases of flowering. There is also a deficit in March 2014 (Figure 5) although it is generally known that autumn temperatures were generally higher than normal this year. The local climate station at Norah Head did not record adequate temperature data to investigate this matter further. Nevertheless, it was noted that prior to the second flowering phase the soil became very dry which led to it becoming very hard set, indicating a significant lack of soil moisture.

Another closely related species, *Corunastylis ectopa*, also a seasonal perennial, grows from an underground dormant tuber after summer rains and for the seeds to germinate there must be interaction with a mycorrhizal fungus (Frawley, 2010). It is likely that *Corunastylis* sp. 'Charmhaven' has similar requirements. *Corunostylis insignis*, which also occurs at the Charmhaven site, began flowering in 2013 on the 1<sup>st</sup> September and finished dehiscing seed on the 30<sup>th</sup> December (Figure 6). Flowering and fruiting stages occurred at the end of a very long dry period and summer rains did not appear until these phases had almost passed (Figures 4, 5). Seed set was successful.

Whatever the reason for the second, later flowering stage in *Corunastylis* sp. 'Charmhaven', peak flowering and fruiting extended into winter. The capsule dehiscent stage was sometimes reached, capsules did split and seeds were released, although photographs subsequently taken by The Australian Botanic Garden, Mount Annan indicate that most of the seeds from the 2013 season do not appear to be fully formed (Figure 1d). This may have implications for the long term maintenance of the population.

Rabbit control and mowing are the main management factors for the site. Mowing has been undertaken on a regular basis to protect the premises from fire. Under the original conditions of consent a mowing regime was required to create an Asset Protection Zone (APZ) of ground vegetation 5 cm high. The rare orchids have only appeared in the APZ which supported previously mature heathland, now mown down to

ground level. Since the orchids have been found the mowing regime has been altered and the stem-leaf emergence and orchid flowering periods taken into account so they do not become damaged. By creating extra light conditions APZ management may be related to the observed increase in numbers of emergent rare orchids, though rainfall conditions may also be involved. Despite many botanical searches in the adjoining mature heathland vegetation none of the two rare orchids has been found in that habitat over the survey period.

### Acknowledgements

The Australian Botanic Garden Seed Bank at Mount Annan (Richard Johnson) kindly organised the photographs of the seed of *Corunastylis* sp. 'Charmhaven' and *Corunastylis insignis*, and Greg Bowman, manager of the private property, gave his time to help locate, cage and place permanent markers against the orchids at Charmhaven. An anonymous reviewer also made helpful suggestions and that help is acknowledged also.

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**Appendix 1. Flowering phenology of *Corunastylis* sp. 'Charmhaven' at Charmhaven site 2012–2013**

| DATE        | Days between recording | Cumulative no of days | PHENOLOGY  | REMARKS  |
|-------------|------------------------|-----------------------|--|--|
| 15/02/2012  | 1                      | 1                     | Orchid emerged; Flowers present but not open.                                    | Five plants present 18/02/2012. Photographed.  |
| 29/02/2012  | 14                     | 14                    | Flowers fully open.  | 11 plants present at five locations 06/03/2012. Photographed.  |
| 12/03/2012  | 12                     | 26                    | Flowers waning.  | Ovary beginning to enlarge. All petals/sepals withering.   |
| 16/03/2012  | 4                      | 30                    | Flowers waned. Ovary enlargement evident. Coloration green.                      | 2 plants left due to mowing for the APZ. Photographed.   |
| 23/03/2012  | 7                      | 37                    |  | Stems 15.6–21.9cm high x 0.75mm; ovary range 3–4mm long x 2–2.4mm wide; bract 21mm x 1mm. Maximum flowers number 7 |
| 06/04/2012  | 14                     | 51                    | Enlarged ovary changes to brown coloration and beginning to split at apical end. | One orchid left. Photographed. The other orchids eaten by rabbits.   |
| 22/04/2012  | 16                     | 67                    | Capsule dehiscence and seed production/ejection not observed.                    | Last orchid mown.  |
| <b>2013</b> |                        |                       |  |  |
| 03/03/2013  | 1                      | 1                     | Orchids noted to have emerged with 11 new plants from 2012                       |  |
| 14/03/2013  | 11                     | 11                    | 14 plants in total counted.  | Rabbits browsing.  |
| 13/04/2013  | 30                     | 41                    | Orchids still emerged as cages re-pegged.  | This was to prevent rabbit browsing.   |
| <b>2014</b> |                        |                       |  |  |
| 29/01/2014  | 1                      | 1                     | One orchid emerges. Status in bud.   | By this time a number of cages damaged but five retrieved.   |
| 05/02/2014  | 7                      | 7                     | Orchid still in bud  |  |
| 11/02/2014  | 6                      | 13                    | Orchid now in flower   |  |
| 20/02/2014  | 9                      | 21                    | Orchid now at ovary enlargement stage  |  |

**Appendix 2. Flowering phenology of *Corunastylis* 'Charmhaven' 2014**

| Plant No. | No. of Flowers (capsules)     | Height of plant (mm) | Length of leaf (mm) | Rhachis length (mm) | In bud                | In flower                              | Early ovary enlargement                   | Late ovary enlargement                  | Capsule dehiscence   |
|-----------|-------------------------------|----------------------|---------------------|---------------------|-----------------------|--|---|---|--|
| 4         |                               |                      |                     |                     | 12 <sup>th</sup> Mar  |  | Gone 19 <sup>th</sup> Mar;                | –                                       |  |
| 3         |                               | 112                  |                     |                     | 12 <sup>th</sup> Mar  |  | Bud withering 19 <sup>th</sup> Mar;       | –                                       |  |
| 2         | 6                             | 165                  | 12                  |                     |                       | 12 <sup>th</sup> –19 <sup>th</sup> Mar | gone 1 <sup>st</sup> Apr;                 |   |  |
| 1         | 1 <sup>st</sup> June 4 x 2mm  | 247                  |                     |                     |                       |  |   | Gone presumed died 1 <sup>st</sup> Apr; | 17 <sup>th</sup> June;   |
|           |                               |                      |                     |                     |                       |  |   | 10 <sup>th</sup> Apr;                   |  |
|           |                               |                      |                     |                     |                       |  |   | 17 <sup>th</sup> Apr;                   |  |
|           |                               |                      |                     |                     |                       |  |   | 24 <sup>th</sup> Apr;                   |  |
|           |                               |                      |                     |                     |                       |  |   | 30 <sup>th</sup> Apr;                   |  |
|           |                               |                      |                     |                     |                       |  |   | 12 <sup>th</sup> May;                   |  |
|           |                               |                      |                     |                     |                       |  |   | 20 <sup>th</sup> May;                   |  |
|           |                               |                      |                     |                     |                       |  |   | 3 <sup>rd</sup> June ;                  |  |
| 6a        | 4                             | 130                  |                     |                     | 29 <sup>th</sup> Jan  |  | 20 <sup>th</sup> Feb–27 <sup>th</sup> Feb | 5 <sup>th</sup> Mar;                    | 20 <sup>th</sup> May; 17 <sup>th</sup> June;   |
|           | 1 <sup>st</sup> June 4 x 2mm; |                      |                     |                     | –11 <sup>th</sup> Feb |  |   | 10 <sup>th</sup> Apr;                   |  |
|           |                               |                      |                     |                     |                       |  |   | 17 <sup>th</sup> Apr;                   |  |
|           |                               |                      |                     |                     |                       |  |   | 24 <sup>th</sup> Apr;                   |  |
|           |                               |                      |                     |                     |                       |  |   | 30 <sup>th</sup> Apr;                   |  |
|           |                               |                      |                     |                     |                       |  |   | 12 <sup>th</sup> May;                   |  |
|           |                               |                      |                     |                     |                       |  |   | 3 <sup>rd</sup> June;                   |  |
| 6b        |                               |                      |                     |                     |                       | 12 <sup>th</sup> Mar                   | Withered & dying 19 <sup>th</sup> Mar;    |   | 1x capsule   |
|           |                               |                      |                     |                     |                       |  | Dormant 24 <sup>th</sup> Apr;             |   | 5 <sup>th</sup> March; 3 x capsules 12 <sup>th</sup> Mar; gone 20 <sup>th</sup> May; dead 17 <sup>th</sup> June; |

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|-------|---|---|---|--------------------------|----------------------|---------------------------|---|---|
| 6c    | 3 (4)<br>1 <sup>st</sup> June 4 x<br>2mm; | 92, 19 <sup>th</sup> Mar;<br>142, 1 <sup>st</sup> Apr;  | 15, 19 <sup>th</sup> Mar;<br>10, 1 <sup>st</sup> Apr; | 12, 1 <sup>st</sup> Apr; | 19 <sup>th</sup> Mar | 4x2, 1 <sup>st</sup> Apr; | 10 <sup>th</sup> Apr; 17 <sup>th</sup> Apr;<br>24 <sup>th</sup> Apr; 30 <sup>th</sup> Apr;<br>3 <sup>rd</sup> June; dead 17 <sup>th</sup><br>June;      |   |
| 6d    |   | 176   | 16, 1 <sup>st</sup> Apr;                              | 20, 1 <sup>st</sup> Apr; | –                    | –                         | 4x2, 1 <sup>st</sup> Apr; 10 <sup>th</sup> Apr; 17 <sup>th</sup> Apr;<br>30 <sup>th</sup> Apr; gone 3 <sup>rd</sup><br>June                             |   |
| 6e    | 6   | 340   | 17 3 <sup>rd</sup> June                               | 15, 3 <sup>rd</sup> June |                      |                           | 3 <sup>rd</sup> June;<br>gone 17 <sup>th</sup> June   |   |
| 6f    | 6   | 218 3 <sup>rd</sup> June  | Withered<br>away 3 <sup>rd</sup> June                 | 15, 3 <sup>rd</sup> June |                      |                           | 3 <sup>rd</sup> June;<br>gone 17 <sup>th</sup> June   |   |
| 5(a)  | –   | 199   | 18, 1 <sup>st</sup> Apr;                              | 20, 1 <sup>st</sup> Apr; | –                    | –                         | 4x2, 1 <sup>st</sup> Apr; 10 <sup>th</sup> Apr;<br>17 <sup>th</sup> Apr;<br>Gone 24 <sup>th</sup> Apr;<br>30 <sup>th</sup> Apr;<br>12 <sup>th</sup> May |   |
| 5(b)  |   |   |   |                          |                      |                           | 20 <sup>th</sup> May,<br>3 <sup>rd</sup> June   |   |
| 5©    |   |   |   |                          |                      |                           | Gone 20 <sup>th</sup> May   |   |
| 5(d)  |   |   |   |                          |                      |                           | 30 <sup>th</sup> Apr;<br>30 <sup>th</sup> Apr;  |   |
| 7     | 4;<br>4x2mm 3 <sup>rd</sup><br>June;      | 207, 17 <sup>th</sup> Apr;  |   | 6, 17 <sup>th</sup> Apr; | –                    | –                         | –   | 17 <sup>th</sup> Apr; 24 <sup>th</sup> Apr;<br>30 <sup>th</sup> Apr; 12 <sup>th</sup> May;<br>20 <sup>th</sup> May; 3 <sup>rd</sup> June; |
| 8(a)  | 3;<br>4x2mm 3 <sup>rd</sup><br>June;      | 142 12 <sup>th</sup> May  |   | 12, 12 <sup>th</sup> May |                      |                           |   | 30 <sup>th</sup> Apr;<br>12 <sup>th</sup> May;<br>20 <sup>th</sup> May,<br>3 <sup>rd</sup> June;<br>17 <sup>th</sup> June                 |
| 8(b)  | 4   | 205 12 <sup>th</sup> May  |   | 14 12 <sup>th</sup> May  |                      |                           |   | 30 <sup>th</sup> Apr;<br>12 <sup>th</sup> May<br>20 <sup>th</sup> May; 3 <sup>rd</sup><br>June dormant                                    |
| 9(a)  | 3; 4x2mm<br>3 <sup>rd</sup> June;         | 170 12 <sup>th</sup> May  |   | 10 12 <sup>th</sup> May  |                      |                           |   | 30 <sup>th</sup> Apr;<br>12 <sup>th</sup> May<br>20 <sup>th</sup> May<br>3 <sup>rd</sup> June;<br>17 <sup>th</sup> June                   |
| 9(b)  | 5;<br>4x2mm 3 <sup>rd</sup><br>June;      | 204 12 <sup>th</sup> May  |   | 18 12 <sup>th</sup> May  |                      |                           |   | 30 <sup>th</sup> Apr;<br>12 <sup>th</sup> May;<br>20 <sup>th</sup> May;<br>3 <sup>rd</sup> June;<br>17 <sup>th</sup> June                 |
| 9(c)  | 4; 4x2mm<br>3 <sup>rd</sup> June          | 196 12 <sup>th</sup> May  |   | 12 12 <sup>th</sup> May  |                      |                           |   | 30 <sup>th</sup> Apr;<br>12 <sup>th</sup> May;<br>20 <sup>th</sup> May;<br>3 <sup>rd</sup> June;<br>17 <sup>th</sup> June                 |
| 9(d)  | 5;<br>4x2mm 3 <sup>rd</sup><br>June;      | 214 12 <sup>th</sup> May  |   | 11 12 <sup>th</sup> May  |                      |                           |   | 30 <sup>th</sup> Apr;<br>12 <sup>th</sup> May;<br>20 <sup>th</sup> May;<br>3 <sup>rd</sup> June;<br>17 <sup>th</sup> June                 |
| 10(a) | 3;<br>4x2mm 3 <sup>rd</sup><br>June;      | 192 12 <sup>th</sup> May  | 13 12 <sup>th</sup> May                               | 9 12 <sup>th</sup> May   |                      |                           |   | 30 <sup>th</sup> Apr;<br>12 <sup>th</sup> May;<br>20 <sup>th</sup> May;<br>3 <sup>rd</sup> June;<br>17 <sup>th</sup> June                 |
| 10(b) | 4;<br>4x2mm 3 <sup>rd</sup><br>June;      | 202 12 <sup>th</sup> May  | 18 12 <sup>th</sup> May                               | 11 12 <sup>th</sup> May  |                      |                           |   | 12 <sup>th</sup> May; 20 <sup>th</sup><br>May; 3 <sup>rd</sup> June<br>17 <sup>th</sup> June  |
| 11(a) | 3   | 188 12 <sup>th</sup> May  | 14 12 <sup>th</sup> May                               | 5 12 <sup>th</sup> May   |                      |                           |   | 30 <sup>th</sup> Apr<br>12 <sup>th</sup> May; gone<br>20 <sup>th</sup> May  |
| 11(b) |   |   |   |                          |                      |                           |   | 30 <sup>th</sup> Apr;<br>Missing 12 <sup>th</sup><br>May; cage<br>disturbed+rabbit<br>droppings   |
| 12    | 5   | 247 12 <sup>th</sup> May  | 17 12 <sup>th</sup> May                               | 11 12 <sup>th</sup> May  |                      |                           |   | 12 <sup>th</sup> May<br>20 <sup>th</sup> May<br>17 <sup>th</sup> June   |

### Appendix 3. Description of the vegetation and plant species list associated with the *Corunastylis* sp. 'Charmhaven' site at Charmhaven

LOW WOODLAND *Allocasuarina littoralis*, *Kunzea ambigua* and *Melaleuca nodosa* WITH OPEN TO MOIST CLOSED HEATHLAND *Kunzea ambigua*, *Melaleuca nodosa*, *Callistemon linearis* and *Schoenus brevifolius*

**Structure:** Low woodland with a shrubby, undershrub, herb and grass understorey. In places moist conditions apply.

**Habitat:** Elevated sites confined to drier soils of the Narrabeen undifferentiated geological formation (Patonga Claystones). Gorokan soil landscape unit.

**Distribution:** Heath was well distributed in the Gorokan area but now is mostly cleared or very disturbed.

**Floristic composition:** *Allocasuarina littoralis* (Black She-oak) and *Kunzea ambigua* make up the main canopy layer. Lower shrubs include *Kunzea ambigua* (Tick Bush), *Melaleuca nodosa*, *Lambertia formosa* (Mountain Devil), *Hakea dactyloides*, *Isopogon anemonifolius* and *Callistemon linearis*. Low understorey species include *Lepyrodia scariosa*, *Entolasia stricta* (Wiry Panic), *Themeda australis* (Kangaroo Grass), *Epacris microphylla*, *Schoenus brevifolius* and *Ptilothrix duستا*.

**Comments:** The woodland/heath supports three threatened species; *Rutidosus heterogama*, *Corunastylis* sp. 'Charmhaven' and *Corunastylis insignis* (within the associated mown asset protection zone). The subject land supports mature heath in good condition and a patch that is mowed to maintain a firebreak called an asset protection zone (APZ). It is within the APZ that is constantly mowed that all three species occur. These three species could not be found in the mature heath.

**Related Mapping units:** MU31 Narrabeen Doyalson Coastal Woodland in latest Wyong LGA mapping.

| Family                 | Species                            |
|------------------------|------------------------------------|
| Fabaceae (Mimosoideae) | <i>Acacia longifolia</i>           |
| Apiaceae               | <i>Actinotus minor</i>             |
| Casuarinaceae          | <i>Allocasuarina littoralis</i>    |
| Loranthaceae           | <i>Amyema congener</i>             |
| Poaceae                | <i>Anisopogon avenaceus</i>        |
| Poaceae                | <i>Austrodanthonia tenuior</i>     |
| * Poaceae              | <i>Axonopus fissifolius</i>        |
| Proteaceae             | <i>Banksia oblongifolia</i>        |
| Fabaceae (Faboideae)   | <i>Bossiaea obcordata</i>          |
| Acanthaceae            | <i>Brunoniella pumilio</i>         |
| Colchicaceae           | <i>Burchardia umbellata</i>        |
| Orchidaceae            | <i>Caladenia catenata</i>          |
| Myrtaceae              | <i>Callistemon linearis</i>        |
| Lauraceae              | <i>Cassytha glabella</i>           |
| Lauraceae              | <i>Cassytha pubescens</i>          |
| Cyperaceae             | <i>Chorizandra cymbaria</i>        |
| Polygalaceae           | <i>Comesperma defoliatum</i>       |
| Polygalaceae           | <i>Comesperma ericinum</i>         |
| Orchidaceae            | <i>Corunastylis fimbriata</i>      |
| Orchidaceae            | <i>Corunastylis insignis</i>       |
| Orchidaceae            | <i>Corunastylis</i> sp. Charmhaven |
| Cyperaceae             | <i>Cyperus eragrostis</i>          |

| Family               | Species  |
|----------------------|--|
| Orchidaceae          | <i>Diuris alba</i>                                 |
| Orchidaceae          | <i>Diuris aurea</i>                                |
| Sapindaceae          | <i>Dodonaea triquetra</i>                          |
| Droseraceae          | <i>Drosera lunata</i>                              |
| Droseraceae          | <i>Drosera pygmaea</i>                             |
| Poaceae              | <i>Entolasia stricta</i>                           |
| Epacridaceae         | <i>Epacris microphylla</i>                         |
| Epacridaceae         | <i>Epacris pulchella</i>                           |
| Cyperaceae           | <i>Gahnia radula</i>                               |
| Cyperaceae           | <i>Gahnia</i> spp.                                 |
| Orchidaceae          | <i>Glossodia minor</i>                             |
| Fabaceae (Faboideae) | <i>Gompholobium minus</i>                          |
| Haloragaceae         | <i>Gonocarpus tetragynus</i>                       |
| Goodeniaceae         | <i>Goodenia paniculata</i>                         |
| Proteaceae           | <i>Grevillea humilis</i> subsp. <i>humilis</i>     |
| Proteaceae           | <i>Grevillea sericea</i>                           |
| Proteaceae           | <i>Hakea dactyloides</i>                           |
| Dilleniaceae         | <i>Hibbertia vestita</i>                           |
| *Clusiaceae          | <i>Hypericum gramineum</i>                         |
| *Asteraceae          | <i>Hypochoeris radicata</i>                        |
| Proteaceae           | <i>Isopogon anemonifolius</i>                      |
| Myrtaceae            | <i>Kunzea ambigua</i>                              |
| Proteaceae           | <i>Lambertia formosa</i>                           |
| Cyperaceae           | <i>Lepidosperma laterale</i>                       |
| Myrtaceae            | <i>Leptospermum polygalifolium</i>                 |
| Myrtaceae            | <i>Leptospermum trinervium</i>                     |
| Restionaceae         | <i>Lepyrodia scariosa</i>                          |
| Lindsaeaceae         | <i>Lindsaea linearis</i>                           |
| Lomandraceae         | <i>Lomandra glauca</i>                             |
| Myrtaceae            | <i>Melaleuca nodosa</i>                            |
| Myrtaceae            | <i>Melaleuca quinquenervia</i>                     |
| Myrtaceae            | <i>Melaleuca thymifolia</i>                        |
| Epacridaceae         | <i>Melichrus procumbens</i>                        |
| Orchidaceae          | <i>Microtis parviflora</i>                         |
| Fabaceae (Faboideae) | <i>Mirbelia rubiifolia</i>                         |
| *Asteraceae          | <i>Onopodium acanthium</i> subsp. <i>acanthium</i> |
| Orchidaceae          | <i>Orthoceras strictum</i>                         |
| Apocynaceae          | <i>Parsonia straminea</i>                          |
| Iridaceae            | <i>Patersonia sericea</i>                          |
| Proteaceae           | <i>Persoonia lanceolata</i>                        |
| Proteaceae           | <i>Persoonia levis</i>                             |
| Proteaceae           | <i>Petrophile pulchella</i>                        |
| *Phytolaccaceae      | <i>Phytolacca octandra</i>                         |
| Orchidaceae          | <i>Prasophyllum elatum</i>                         |
| Cyperaceae           | <i>Ptilothrix duستا</i>                            |
| Fabaceae (Faboideae) | <i>Pultenaea paleacea</i>                          |
| Fabaceae (Faboideae) | <i>Pultenaea rosmarinifolia</i>                    |
| Fabaceae (Faboideae) | <i>Pultenaea tuberculata</i>                       |
| Asteraceae           | <i>Rutidosus heterogama</i>                        |
| Goodeniaceae         | <i>Scaevola ramosissima</i>                        |
| Cyperaceae           | <i>Schoenus brevifolius</i>                        |
| Lamiaceae            | <i>Scutellaria</i> spp.                            |
| Goodeniaceae         | <i>Selliera radicans</i>                           |
| *Poaceae             | <i>Setaria italica</i>                             |
| *Solanaceae          | <i>Solanum nigrum</i>                              |
| Orchidaceae          | <i>Spiranthes australis</i>                        |
| Stackhousiaceae      | <i>Stackhousia nuda</i>                            |
| Stylidiaceae         | <i>Stylidium graminifolium</i>                     |
| Orchidaceae          | <i>Thelymitra carnea</i>                           |
| Poaceae              | <i>Themeda australis</i>                           |
| Anthericaceae        | <i>Thysanotus juncifolius</i>                      |
| Anthericaceae        | <i>Thysanotus tuberosus</i>                        |
| Apiaceae             | <i>Trachymene incisa</i>                           |
| Anthericaceae        | <i>Tricoryne simplex</i>                           |
| Goodeniaceae         | <i>Velleia spathulata</i>                          |
| Xanthorrhoeaceae     | <i>Xanthorrhoea resinifera</i>                     |
| Xyridaceae           | <i>Xyris operculata</i>                            |

Species highlighted \* are exotic.

