

## Black Mountain Symposium 2018 Background Paper No. 6

### Rare plants on Black Mountain Sandstone

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**Abstract.** A provisional list of 317 plant species considered rare or uncommon in the ACT was refined through consideration of about 8,750 location records. The process identified 280 species which are or may be rare in the territory, 34 of which occur on Black Mountain Sandstone geology, mainly on Black Mountain and Aranda Bushland. Twenty (59%) of the rare species are orchids, including seven species for which the Black Mountain Sandstone area appears to be a national stronghold. Black Mountain Sandstone is the only or one of only a few known ACT habitats of a further seven orchids. Non-orchid rare plants present on Black Mountain Sandstone tend to be at or close to a distribution limit there, and rare only in a local context.

#### 1. Introduction

In 2013, the ACT Flora and Fauna Committee endorsed a list of 317 plant species in the ACT that it considered warranted special conservation consideration, because of their suspected rare or uncommon occurrence there. Since then much survey, record checking and use of citizen science has documented the abundance and distribution of these plants in the territory. As a result of this new information, some plants were taken off the list while others were added.

This paper examines those rare species that occur on the sandstone centred on Black Mountain, their abundance on this geology and the importance of the Black Mountain area to their overall conservation. The Black Mountain Sandstone area includes Black Mountain, Aranda Bushland, the Mt Painter triangle paddock, Bruce Ridge and Gossan Hill.

#### 2. Methods

##### 2.1 Collation of ACT rare plant records

Distribution and, where available, abundance records of the 317 potential rare plants, together with records of a few other species poorly recorded in the ACT, were collated and examined. 8,141 location point records of these plants were obtained from the sources shown in Table 1.

**Table 1.** Sources of information and proportion of records

Source	Date accessed	Proportion of all records
Atlas of Living Australia ( <a href="https://www.ala.org.au/">https://www.ala.org.au/</a> ).	19/9/2013	36%
Canberra Nature Map ( <a href="http://canberra.naturemapr.org/">http://canberra.naturemapr.org/</a> ).	1/3/2017	43%
Plot data, internal reports and targeted surveys from 1980 to 2015 held by Conservation Research, Environment Division, ACT Government.	various/2013	21%

The records dated from 1908 to the present, many from the same location. Records generally had a high degree of reliability as they were mainly based on herbarium collections or had their identification confirmed by botanical experts. However, the location precision for some of the records, particularly those predating 1920, could have been out by as much as 10 km.

An additional 608 records were obtained from 2541 vegetation polygons surveyed as part of woodland (ACT Government 2004), grassland (ACT Government 2005) and riparian (Johnston et al. 2009) surveys. A polygon is an area of similar vegetation condition and type and may range from less than one to over several hundred hectares in area. The centre-point of a surveyed polygon was taken to be the location of a rare plant recorded within it.

The abundance categories for Canberra Nature Map records (Table 2) were utilised as well as those polygon and point record data, where abundance data were available, which could include accurate counts or estimates.

**Table 2.** Canberra Nature Map abundance categories

1–3 plants present
4–15 plants present
16–100 plants present
100–1,000 plants present
1,000–10,000 plants present
>10,000 plants present

## 2.2 Criteria for consideration of rare

In revising the 2013 list of special conservation consideration plants, the rationale was to retain or add to the list those species susceptible to local extinction because of their small overall population size and/or restricted distribution within the ACT. The more important the territory is within the overall national distribution of a species, the higher the cut-off criteria for inclusion on the list. The rationale was that local extinction of a species for which the ACT is a stronghold is of greater consequence than local extinction of a species common and widespread elsewhere in Australia and which may just reach its limit of distribution in the territory.

The rules used to revise the rare plant list (Table 3) were arbitrary. There is some regard to IUCN criteria whereby a species with <1000 individuals can be considered as vulnerable to extinction. If there is evidence of significant decline, then a population of <2500 can be considered as endangered (IUCN 2001). However in this study, these global criteria were used in a localised manner. Within Australia, the rare category seems to be used as a loose working list of species that institutions are trying to prevent from truly getting into trouble. This is typified by the Department of Environment and Primary Industry (2014), where a rare species is defined simply as “there are relatively few known populations or the taxon is restricted to a relatively small area.”

**Table 3.** Rules used for revising ACT rare plants list

<b>% that ACT records are of all national records</b>	<b>Inclusion rule for consideration as rare ACT species<sup>a</sup></b>
50–100%	25 or less ACT locations and/or a total ACT population of <5000 plants
10–< 50%	10 or less ACT locations and/or ACT population of <2500 plants
5–< 10%	10 or less ACT locations and/or ACT population of <1000 plants
1–< 5%	5 or less ACT locations and/or ACT population of <1000 plants
0–< 1%	5 or less ACT locations <b>and</b> ACT population of <1000 plants

<sup>a</sup> Only data from 1985 to present were utilised in rule application.

The national record (Table 3) was taken to be the number of records of a species within the Atlas of Living Australia (ALA), despite the following limitations. Because ALA has a ‘user beware’ approach, data are of varying quality and reliability, and records can include cultivated specimens as well as

multiple records of the same collection (which can inflate the number of records). If a new species is split from an existing one, the former records may still remain under the old name so that the species will appear in ALA as rarer than actual records suggest. Finally, the ALA records have not been uniformly or systematically collected from across Australia which can mean that an area of relatively high survey effort (such as the ACT) may appear more significant in a national context than actually is the case.

An ACT location was defined as any record that is separated by 200 m or more from the nearest other record. In applying the Table 3 rules, only records from 1985 or later were considered. This partly addressed the issue of location accuracy, as modern tools enable more reliable means of recording a location. There is also less chance that more recent locations have been destroyed when compared to older recordings. With the 200 m rule, it also means that a plant that grows continuously along the Murrumbidgee (or with recorded breaks <200 m apart) would be regarded as growing in one location, while a plant growing over the same stretch of river but with a fragmented distribution would be regarded as having multiple locations.

Most of the population data came from Canberra Nature Map (CNM), where the number of plants at a sighting is either counted or placed into an abundance category (Table 2). Where population data for a particular species were available for more than 30% of all recorded  $\geq 1985$  locations, a total estimate was made by adding together all actual counts or the mid-point value of category estimates for all sites with data, calculating the average number of plants at these locations and then multiplying this average figure by the total number of post-1984 recorded locations.

### 3. Results

#### 3.1 General findings

Of the 317 species examined 261 met the criteria for being rare, though for 109 of these this may be because of lack of data and survey effort rather than actual rarity. As a result of the review a further 19 species only recently recorded within the ACT were added to the list.

Since 1985, 34 (12%) of the 280 plant taxa that meet the criteria for being rare in the ACT have been recorded on Black Mountain Sandstone (Table 4). Twenty, nearly two-thirds of the rare species, are orchids. The rare plants have an uneven distribution across the Black Mountain Sandstone, probably reflecting past uses and past and current management. Twenty-seven of the species occur within Black Mountain Nature Reserve, and a further four species (*Alisma plantago-aquatica*, *Chiloglottis seminuda*, *Grevillea ramosissima* and *Limosella australis*) are found outside it on Black Mountain. Eighteen rare plant species occur in Aranda Bushland, seven in the Mt Painter Triangle, four in Gossan Hill Nature Reserve and only one on Bruce Ridge.

A further 15 rare species have **not** been observed on Black Mountain Sandstone since 1985. Purdie (2018a) provides an explanation as to why this may be so on Black Mountain for *Blechnum cartilagineum*, *Ozothamnus conditus*, *Stuartina hamata*, *Swainsona monticola* and *Wahlenbergia littoricola*. A 1965 record by Gray of *Craspedia canens* was a mis-identification (of *C. variabilis*), and a 1962 record by McKee of *Pleurosorus subglandulosus* may also be wrongly identified (Purdie 2018b). All *Schoenus latelaminatus* and *Stellaria multiflora* records were from the western or northern bases of Black Mountain from 1961–1971 and may have been cleared as part of roadworks. *Philothea myoporoides*, *Veronica serpyllifolia*, *Epilobium sarmentaceum* and *Pterostylis curta* are records from the grounds of CSIRO or the Australian National Botanic Gardens and are most likely to be planted or adventive plants. A Gauba collection of *Isolepis platycarpa* in 1949 with the location given as Black Mountain hasn't been recorded locally since then.

The origin of three species (*Daviesia acicularis* and *Cyathea australis* (Purdie 2018a) and *Alisma plantago-aquatica*) is uncertain; they may be planted, adventive or naturally occurring. Hoary Sunray (*Leucochrysum albicans* var. *tricolor*) does not meet the rare plant criteria but remains on the ACT rare plant list because it is a nationally endangered species.

On the basis of ALA records, Black Mountain Sandstone appears to be a national stronghold for several species of orchids, while non-orchid species are mainly rare locally (rather than in a national context), typically within the ACT reaching or near a national distribution limit.

### 3.2 Orchids for which Black Mountain Sandstone appears to be an important stronghold

The records suggest that Black Mountain Sandstone is an important stronghold for seven orchid species, each of which is discussed below in the national context, drawing on ALA and CNM (1/12/17) records.

Black Mountain Leopard Orchid (*Diuris nigromontana*). This ACT endemic is largely restricted to Black Mountain Sandstone, including Black Mountain, Gossan Hill, Aranda Bushland, Bruce Ridge and Mount Painter Triangle with an estimated population of around 1,000 plants. The type location is “the Aranda side of Black Mountain” (Jones 2008). There are small outlying populations on Percival Hill, Gungahlin Hill, Mount Wanniasa and the Majura Firing Range. It is widespread on Black Mountain across a range of fire regimes, though there is a statistically weak but significant association with more frequently burnt areas. It also tends to occur on flatter slopes and is uncommon on steeper areas (Seddon in preparation).

Horned Midge Orchid (*Corunastylis cornuta*). The majority of the national records for this species are on Black Mountain and Aranda Bushland. In the ACT it is also known from a few plants in Goorooyarroo Nature Reserve. In NSW it is found between Mt Jerrabomberra and Goulburn extending inland to the Conimbla Ranges near Cowra. Its occurrences are disjunct with mostly small isolated populations. Black Mountain is the type locality (Jones 2008). The estimated ACT population is only a few hundred plants.

Rufous Midge Orchid (*Corunastylis clivicola*)

Nearly half of the national records of this species are from Black Mountain Sandstone. It is a widespread species stretching in an arc from Mt Barker in the Adelaide Hills, through central Victoria through the south-west slopes of NSW up to near Bathurst. It is usually found on slopes and ridges of low hills in dry open forest, amongst leaf litter where there is minimal shrubby understorey and often shallow and stony clay loam (Jones 2007). In the ACT it is known from Black Mountain, Gossan Hill, Aranda Bushland and Gungahlin Hill. There is also quite a large population on Mt Jerrabomberra. It is estimated that up to 250 plants occur on Black Mountain Sandstone.



**Fig. 1.** Rare orchid species for which Black Mountain is a stronghold include: left) Black Mountain Leopard Orchid (*Diuris nigromontana*); centre) Broad-sepaled Leafy Greenhood (*Bunochilus umbrinus*); and right) Late Beard Orchid (*Calochilus therophilus*). Photos: T Wood (left), A Clausen (centre) and R Purdie (right).

**Table 4.** Plants that are rare in the ACT and recorded on Black Mountain Sandstone (BMS) since 1985

Scientific Name	Common Name	% ACT records are of national ALA records	ACT Population Estimate	BMS Population Estimate	No of ACT locations	Presence (+) at BMS locations				
						AB	BM	BR	GH	MPT
<i>Acacia lanigera</i> var. <i>lanigera</i>	Woolly Wattle	10.7	70	60	4	+	+			
<i>Acianthus collinus</i>	Inland Mosquito Orchid	3	200	200	6	+	+			
<i>Alisma plantago-aquatica</i>	Water Plantain	3.9	<500	<10	18		+			
<i>Bunochilus umbrinus</i>	Broad-sepaled Leafy Greenhood	70.9	200	200	11	+	+			
<i>Caladenia atrovessa</i>	Thin-clubbed Mantis Orchid	1.8	300	150	25	+	+		+	+
<i>Caladenia congesta</i>	Pink Caps	3.8	<250	<200	15	+	+			
<i>Caleana minor</i>	Small Duck Orchid	6.7	50	50	9	+	+			
<i>Calochilus montanus</i>	Mountain Beard Orchid	up to 50	100	75	9	+	+			
<i>Calochilus paludosus</i>	Strap Beard Orchid	0.8	50	25	4		+			
<i>Calochilus therophilus</i>	Late Beard Orchid	10–22.7	Insufficient data	30	3		+			
<i>Chiloglottis seminuda</i>	Bare-tip Wasp-Orchid	0.7	25	25	1		+			
<i>Corunastylis clivicola</i>	Rufous Midge Orchid	56.8	250	250	18	+	+		+	
<i>Corunastylis cornuta</i>	Horned Midge Orchid	45.4	100	100	9	+	+			
<i>Cullen tenax</i>	Small Scurf-pea	4.9	100	1	19	+				
<i>Cyathea australis</i>	Rough Tree Fern	2.2	Insufficient data	3	6		+			
<i>Daviesia acicularis</i>	Sand-plain Bitterpea	1	4	4	1		+			
<i>Dianella longifolia</i>	Pale Flax Lily	10.7	750	50	150		+			+

Scientific Name	Common Name	% ACT records are of national ALA records	ACT Population Estimate	BMS Population Estimate	No of ACT locations	Presence (+) at BMS locations				
						AB	BM	BR	GH	MPT
<i>Diplodium truncatum</i>	Little Dumpies	9.5	300	200	11	+	+			+
<i>Diuris nigromontana</i>	Black Mountain Leopard Orchid	100	1000	1000	45	+	+	+	+	+
<i>Eleocharis atricha</i>	Tuber Spikerush	2.4	Insufficient data	4000	7		+			
<i>Grevillea ramosissima</i>	Fan Grevillea	3.9	1750	679	11		+			
<i>Leptorhynchus elongatus</i>	Lanky Buttons	10.2	250	10	13		+			
<i>Leucochrysum albicans</i> var. <i>tricolor</i>	Hoary Sunray	19.9	>100,000	200	>150	+	+		+	
<i>Limosella australis</i>	Austral Mudwort	4.3	Insufficient data	Insufficient data	14		+			
<i>Linguella nana</i>	Dwarf Greenhood	0.8	20	20	1		+			
<i>Lobelia browniana</i>		2.6	100	15	4		+			
<i>Lyperanthus suaveolens</i>	Brown Beaks	2.1	<100	<100	9	+	+			
<i>Orthoceras strictum</i>	Horned Orchid	0.7	30	30	2		+			
<i>Pultenaea laxiflora</i>	Loose-flower Bush-pea	0.7	5	5	1					
<i>Swainsona recta</i>	Small Purple Pea	9.8	1500	5	30	+				
<i>Thelymitra arenaria</i>	Forest Sun Orchid	1.2	Insufficient data	20	5	+	+			+
<i>Thelymitra megalyptra</i>	Swollen Sun Orchid	4.5	<1000	20	10		+			+
<i>Thelymitra nuda</i>	Plain Sun Orchid	0.3	<100	<50	9	+	+			
<i>Thelymitra simulata</i>	Collard Sun Orchid	20	200	100	21	+	+			+
<b>Total number of species</b>						18	31	1	4	7

### Broad-sepaled Leafy Greenhood (*Bunochilus umbrinus*)

Around two-thirds of the national records of this orchid are from Black Mountain Sandstone. It has a fragmented distribution across the ACT and southern NSW occurring from Braidwood to Burrinjuck and then southwards to near Tumut, Woomargama and Carabost. In the ACT it is also known from Rob Roy Nature Reserve and Namadgi National Park. It usually occurs on sheltered slopes, gullies and ridges in open forest with a sparse tussock to dense shrubby understorey (Jones 2006a). On Black Mountain Sandstone the species occurs on Black Mountain and Aranda Bushland and has a preference for long unburnt areas (Seddon in preparation), though this relationship could be influenced by the long unburnt areas typically occurring on the more sheltered east facing side of Black Mountain.

### Mountain Beard Orchid (*Calochilus montanus*)

This orchid has a disjunct distribution between the Moonbi Ranges (near Armidale) and Tumut, growing amongst shrubs and tussocks in open forest and sclerophyll woodland on shallow skeletal soils and well-drained clay loams (Jones 2006b). More than half of the national records are from the Black Mountain Sandstone area, with Black Mountain the type locality (Jones 2006b). However, it is probable that other NSW records are still within the ALA database as *Calochilus campestris*. Mountain Beard Orchid tends to occur in those parts of the Black Mountain Sandstone that have a relatively frequent fire history (Seddon in preparation), on the lower and mid slopes of Aranda Bushland and Black Mountain.

### Late Beard Orchid (*Calochilus therophilus*)

Late Beard Orchid is known from Namadgi National Park and on the lower western slope of Black Mountain. About 30% of the national records are from the ACT, but only tens of plants occur on Black Mountain. It is possible that all ALA records of *Calochilus gracillimus* are this species, in which case 10% of the national ALA records of Late Beard Orchid are from the ACT. It is a widespread species with disjunct occurrences from south-east Queensland to Lorne in Victoria.

### Collared Sun Orchid (*Thelymitra simulata*)

About 20% of the national records of Collared Sun Orchid occur in the ACT and around a third of all ACT records are from Black Mountain or Aranda Bushland. The plant is widespread on Black Mountain but only occurs in low numbers.

## **3.3 Other locally rare orchids**

A north-eastern lower slope on Black Mountain, and one record from Square Rock in Namadgi are the only known local habitats of the Strap Beard Orchid (*Calochilus paludosus*). It is fairly common below 800 m near the coastline from South Queensland, around to South Australia, including the coastline of Tasmania. The nearest other locations are near Wee Jasper and Majors Creek.

The Thin-clubbed Mantis Orchid (*Caladenia atrovvespa*) has a population of around 500 plants across the ACT, of which several hundred may occur on Black Mountain Sandstone. It occurs on the northern and western slopes of Black Mountain, Aranda Bushland, the Mt Painter Triangle and Gossan Hill. Many of the *Caladenia tentaculata* ALA records are this species (Jones 2016), which is widespread in open forest across southern Australia. On Black Mountain Sandstone it is most likely to be found in areas with a frequent fire history (Seddon in preparation).

Steeper slopes on Black Mountain and Aranda Bushland support a disjunct population of about 200 plants of Inland Mosquito Orchid (*Acianthus collinus*). The next nearest recorded location is from Bango Nature Reserve near Yass. On Black Mountain Sandstone it is found on relatively exposed well-drained slopes (Jones et al. 2008).

About 50 plants of the Small Duck Orchid (*Caleana minor*) also occur as a disjunct population on Black Mountain and Aranda Bushland. This usually coastal and coastal hinterland orchid also occurs at Mt Jerrabomberra, with the next nearest record from a nature reserve near Goulburn.

Little Dumpies (*Diplodium truncatum*) is widespread across the northern ACT, but occurs in small patches with an estimated total ACT population of around 300 plants. It is recorded from two locations

within Black Mountain reserve, a site in Aranda Bushland and from the Mt Painter Triangle. A large population of over 1,000 plants is known nearby in Yass<sup>1</sup>.

Nearly all of the ACT population (<100 plants) of Brown Beaks (*Lyperanthus suaveolens*) occurs on Black Mountain or Aranda Bushland where the species is associated with long unburnt areas (Seddon in preparation). Jones et al. (2008) reported that this species “is nearly extinct on Black Mountain as a result of inappropriate burning by the authorities (controlled burns occurring soon after plants have emerged above ground and prior to the formation of replacement tubers)”.

Within the ACT region Horned Orchid (*Orthoceras strictum*) is only known from a flattish area at the base of a north-facing slope on Black Mountain. At most, the population is only a few tens of plants.

The east slope of Black Mountain within the ANBG Bush Precinct is the only known ACT location of the Bare-tip Wasp-Orchid (*Chiloglottis seminuda*), which is mainly found on Sydney sandstone. Black Mountain is also the only known ACT location of Dwarf Greenhood (*Linguella nana*), a widespread species across southern Australia.

Pink Caps (*Caladenia congesta*) is widespread both across the ACT and south-east Australia, but, at least within the ACT region, the scattered populations are small. It is found in the north-eastern section of Black Mountain and in the north-west of Aranda Bushland.

Three additional species of sun orchid occur on Black Mountain Sandstone: Forest Sun Orchid (*Thelymitra arenaria*), Swollen Sun Orchid (*T. megcalyptra*) and Plain Sun Orchid (*T. nuda*). All are rare in the ACT region but more common elsewhere. Forest Sun Orchid occurs in Aranda Bushland, Mt Painter Triangle and Black Mountain. Swollen Sun Orchid occur within the Mt Painter Triangle and Black Mountain, while the Plain Sun Orchid is known from Black Mountain and one site in Aranda Bushland.

### 3.4 Other rare plants

Nikki Taws recently relocated five plants of Loose-flower Pultenaea (*Pultenaea laxiflora*) in a remnant strip of dry forest just south of the junction of Hayden Drive and Belconnen Way. This shrub had been last recorded in the ACT 46 years previously from about the same location. It is reasonably widespread across south-east Australia, but is close to its eastern limit in Canberra.

Woolly Wattle (*Acacia lanigera*) is known from two locations within Aranda Bushland, several sites on Black Mountain (although it has only been recorded there in one location since 1998 (Purdie 2018b)) and one site near the Federal Highway – Majura Parkway intersection. It is common on the Southern Slopes of NSW and in Victoria.

Fan Grevillea (*Grevillea ramosissima* subsp. *ramosissima*) is widely distributed over the NSW tablelands, and nears its southern distribution limit in the ACT where it has a scattered distribution including on the Bullen Range and Mt Ainslie. Two populations occur on Black Mountain on Australian National Botanic Gardens land, one along the eastern boundary fence that extends to adjacent CSIRO land (194 plants) and one in the Bush Precinct (703 plants). This plant is killed by fire, but fire is not necessary to stimulate germination. As plants appear to take at least four years to produce seed, too frequent burning is a likely threat (Purdie 2017).

Seven of the eight known ACT locations of Tuber Spikerush (*Eleocharis atricha*) are from Black Mountain. It is a perennial with small underground tubers and only produces leaves and flowers after prolonged wet conditions in spring/early summer (Purdie 2018b). Austral Mudwort (*Limosella australis*) has only recently been recorded on Black Mountain on CSIRO land. Both are species of damp areas and are widespread across south-eastern Australia, but are not easily recognised or recorded. They are likely more widespread and common in the ACT but have been under-reported.

Pale Flax Lily (*Dianella longifolia*) is essentially a species of the Box Gum woodland community. The Mt Painter Triangle and Black Mountain are the only areas of Black Mountain Sandstone in which it

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<sup>1</sup> <http://canberra.naturemapr.org/Community/Sighting/3375841>

has been recently recorded. A small population of about 10 plants of Lanky Buttons (*Leptorhynchus elongatus*) occurs just south of Belconnen Way at the base of Black Mountain. It was also recorded within two open forest polygons in Aranda Bushland as part of survey work undertaken for the Woodlands Plan (ACT Government 2004), but has not been recorded in either polygon since.

*Lobelia browniana* is recorded from just four scattered locations in the ACT, including Black Mountain. Until recently it was considered a variety of *Lobelia gibbosa* (Walsh et al. 2010), and it is thus likely that some of the 48 records of *L. gibbosa* for the ACT are actually *L. browniana*.



**Fig. 2.** The rare plants left) Fan Grevillea (*Grevillea ramosissima* subsp. *ramosissima*) and right) *Lobelia browniana* occur on the eastern and western slopes of Black Mountain respectively. Photos: M Fagg (left) and R Purdie (right).

One plant of Small Scurf-pea (*Cullen tenax*) was recorded in 2015 within the Aranda snowgum reserve extension. A few plants of Small Purple-pea (*Swainsona recta*) also occur within woodland proposed to be added to Aranda Bushland.

#### 4. Discussion

Table 5 compares Black Mountain Sandstone against other areas in the ACT with a concentration of rare plant species. Black Mountain Sandstone has the third highest number of rare species recorded and the highest density of species (number per 100 ha). Black Mountain Sandstone is the only hot spot where orchids make up more than 50% of the rare species.

In a study of 407 orchid species occurring in south-west Western Australia, Phillips et al. (2011) found the greatest rare orchid species diversity occurred in areas of high overall taxon richness or in naturally fragmented edaphic locations (swamps, salt lake margins and granite outcrops). Black Mountain Sandstone is a very old (430 million years) and regionally rare island of low nutrient sandstone in a landscape dominated by volcanics, tuffs and shales (Finlayson 2008, 2018). It is possible that just as in Western Australia, the fragmented nature of Black Mountain Sandstone has resulted in a high level of orchid rarity because of limited dispersal/colonisation opportunities.

Over 90% of the Black Mountain Sandstone rare species (31 of 34 species) occur on Black Mountain, with much smaller percentages occurring in the other sandstone areas (Table 6). However, Black Mountain is much larger in extent than the others. If species density (number of rare species per 10 hectares) is used as a measure of species richness, Black Mountain has the second lowest value. Bruce Ridge is the only management unit of Black Mountain Sandstone that supports both a low number and a low density of rare plant species.

**Table 5.** The number of rare plants within ACT rare plant hot spot areas

<b>Location</b>	<b>Total area (ha)</b>	<b>Number of rare species</b>	<b>Species per 100 ha</b>
Black Mountain Sandstone	800	34	4.3
Boomberra Rocks – Mt Tenant Area	7000	41	0.6
Brindabella Range (Bulls Head to Mt Murray)	15,500	104	0.7
Lower Molonglo (below Lake Burley Griffin)	750	12	1.6
Mt Ainslie – Mt Majura	1500	20	1.3
Mt Kelly – Mt Scabby – Big Creamy Flats (Namadgi)	2200	29	1.3
Mulligans Flat – Gorooyarroo	1600	11	0.7
Murrumbidgee Corridor (between Jews Corner and Point Hut Crossing)	850	24	2.8
Tidbinbilla and Jedbinbilla Nature Reserve	5500	20	0.4

**Table 6.** Number of rare species per 10 ha of Black Mountain Sandstone management units

<b>Management unit</b>	<b>Total Area (ha)</b>	<b>Number of rare species</b>	<b>Species per 10 ha</b>
Aranda Bushland	103	18	1.7
Black Mountain	500	31	0.6
Bruce Ridge	109	1	0.09
Gossan Hill	46	4	0.8
Mt Painter Triangle	9	7	8

It is not readily apparent why Bruce Ridge should have a lower diversity, but given the similarity of its vegetation and geology to the other areas, the most likely explanation seems to be management history. The reserve is bisected by the Gunghalin Expressway, has a relatively frequent fire history and is subject to a higher level of recreational use (especially mountain bikes) than the other areas.

Together, Black Mountain and Aranda Bushland capture the total diversity of rare plant species and the vast majority of the Black Mountain Sandstone populations of those orchids for which the area appears to be a national stronghold. Their larger size and smaller area to boundary ratio, particularly that of Black Mountain, means that conservation management is likely to be more effective in them.

Given the urban location of Black Mountain Sandstone and its close proximity to the Australian National Botanic Gardens, Australian National University and CSIRO, it is likely that the high percentage of national records found on the sandstone, for some of the orchid species, are as much reflective of survey effort (Purdie 2018c) as of habitat importance. Nevertheless this has yet to be proven and the conservative approach would be to assume a high national importance until demonstrated otherwise.

The citizen science study of fire and orchid distribution on Black Mountain (Seddon in preparation) found that rare orchids as a whole, and orchid diversity in particular, are not associated with fire history, but individual species may be associated with fire frequency. Some species are located in long unburnt areas, some mainly occur in frequently burnt areas, while others appear indifferent to fire frequency or intensity. The data suggest that a priority for fire management should be conservation of the seven species for which Black Mountain Sandstone may be a national stronghold, together with the seven orchid species for which Black Mountain Sandstone contains the majority of the known ACT population (Inland Mosquito Orchid, Small Duck Orchid, Brown Beaks, Horned Orchid, Bare-tip Wasp Orchid, Dwarf Greenhood and Forest Sun Orchid). The citizen science study suggests that Broad-sepaled Leafy

Greenhood and Brown Beaks are likely to decline if their habitat is frequently burnt, while Mountain Beard Orchid and Thin-clubbed Mantis Orchid are likely to decline in habitats in which fire is excluded.

## 5. Conclusion

For its small area, Black Mountain Sandstone supports a relatively high diversity of plants rare in the ACT, and this is largely related to its high orchid diversity. Black Mountain and Aranda Bushland appear to be the national stronghold for some of the orchids, while rare non-orchid species associated with Black Mountain Sandstone are largely taxa at an edge of their distribution range.

## 6. References

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