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Fern grottoes of the Southern Highlands, New South Wales: important habitat for fern diversity and rare species

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Abstract: The Polypodiopsida (Pteridophyte) flora of the Southern Highlands of New South Wales was investigated and found to be diverse and abundant, reflecting the effects of a relatively high altitude (>400 m) and rainfall (>1000 mm), along with a variable geology. A total of 2,881 records of 91 species was recorded at 138 sites during field surveys and includes 174 records of 26 rare and range-restricted species. The 99 species recorded for the Highlands represents about 52 % of the State's ferns and fern allies.

The results provide an indication of the relative abundance of each species in the Highlands and highlight the conservation importance of some species in a State-wide context. The Southern Highlands is identified as one of the key areas in the State for the conservation of several species of fern that are restricted to moderately high altitude rainforest. The results also point to the need for assessing some species for listing as threatened. The information provided on the Polypodiopsida flora and associated important habitats will assist in land use management decisions.

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Introduction

Grotto 1. A cave or cavern, especially one which is picturesque or an agreeable retreat. 2. An excavation or structure made to imitate a rocky cave, often adorned with shell-work, etc. Oxford English Dictionary.

The fad for ferns in the Victorian era was so intense that a term was coined for it, *pteridomania*. The craze saw the building of artificial fern grottoes on the estates of the English wealthy. In Australia, tourists were enticed to natural fern grottoes, such as those in the Blue Mountains and in the Bundanoon area on the Southern Highlands.

The Minnamurra Falls on the NSW Illawarra coast has been known for its rich fern flora since the collections of Council's ranger, Howard Judd in the 1950-60s. References to ferns on the sandstone plateaus and basalt uplands on and adjacent to the Southern Highlands are included in a few previous studies, including those in the Robertson rainforest (e.g., Kodela 1990; Mills 2020) and, below the plateau, at Macquarie Pass (Fallding and Benson 1985; Mills 2016b) and Minnamurra Rainforest (Mills 2016a). However, no targeted surveys for ferns have been carried out more broadly across the plateau. This study investigated the Polypodiopsida (Pteridophyte) flora of the higher altitudes of the area known particularly in the tourist industry as the Southern Highlands extending from Macquarie Pass National Park and Barren Grounds Nature Reserve in the east to Bundanoon and Penrose in the west (Figure 1). The area covers the south-eastern corner of the Central Tablelands Botanical Subdivision and is within Wingecarribee and Kiama Local Government Areas.

The region encompasses elevated plateaus, generally between 500 and 750 m above sea level, bounded by the coastal and inland clifflines. In addition to the relatively high altitude, the area is characterised by high rainfall, which largely defines the study area, low winter temperatures and significant geodiversity. The Highlands is one of several elevated regions in eastern New South Wales where ferns proliferate. Rainforest, the Highland's primary fern habitat, exhibits floristic characteristics that reflect the altitude, as does the fern flora, which is diverse and unique in the broader region. For convenience, 'fern' includes true ferns and fern allies.

From field surveys at natural sites distributed throughout the region it has become clear that the region is a highly important area for fern conservation in the State, and many of the species are rare locally and more broadly in New South Wales. The aims of this work are to (i) document the fern flora of the Highlands; (ii) identify the botanically significant species; and (iii) highlight the importance of the region for fern conservation in a National and State context.

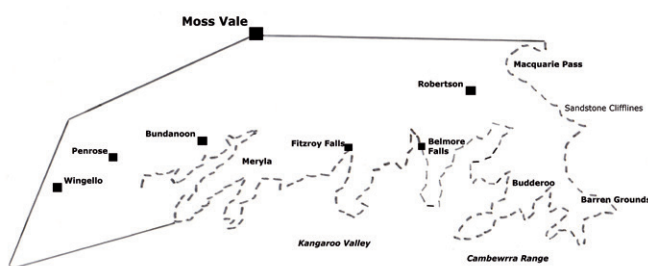


Figure 1. Map of the study area on the Southern Highlands.

Study area

Geology and climate

The base of the Highlands plateau is the Triassic Hawkesbury Sandstone, which is the most southern and highest part of the Nepean Ramp, a structural feature that rises from sea level near Port Hacking to the high country around Robertson. Above the sandstone and covering much of the Highlands, are the Triassic Ashfield Shale, part of the Wianamatta Group of sedimentary rocks, and the overlying Tertiary Robertson Basalt (Robertson 1:50,000 Geological Sheet 9028-IV). High clifflines of Hawkesbury Sandstone are a feature of the eastern and southern edges of the Highlands. Below the sandstone cliffs, various sedimentary rocks of primarily Permian age, ranging from shale to sandstone, and in some places igneous rocks, form the steep slopes below the sandstone cliffs. The Permian Berry Siltstone is extensive in the far south-western corner of the Highlands.

The past climate of the region is characterised by a relatively high rainfall and at times very low temperatures; fog is very common at any time of the year and snow occasionally falls. Rainfall records for the town of Robertson in the east of the Highlands indicate an annual mean rainfall of 1,682 mm (36 years of record), while in the west the figure for Bundanoon (120 years of record) is 1,165.6 mm. To the northwest, away from the escarpments, rainfall is considerably lower; the figure for Moss Vale is an annual mean of 784.5 mm (22 years of record). Mean temperatures at Moss Vale, the only weather station with temperature records, range from 11.9 °C in July to 26.3 °C in January. The mean lowest temperature at Moss Vale is -4.0 °C and recorded for July.

Geography and land tenure

Most of the Highlands is a gently undulating, high altitude plateau, ranging in elevation from around 500 to 700 m. The main drainage systems are the upper Nepean and the Wingecarribee Rivers, which drain inland to the north to northwest. The northern part of the Shoalhaven River catchment covers the southern margins of the plateaus via its tributary the Kangaroo River. Relatively small streams drain the eastern and southern edges of the plateau. These generally flow for short distances before dropping into gorges that incise deep valleys below the plateau, while others fall from sandstone cliffines, producing the many waterfalls that characterise the southern part of the Highlands. A feature of these streams are the small gorges that usually form just above the cliffline; these are often deeply entrenched, very moist and provide a high level of protection from bushfire and solar radiation; these are termed *fern grottoes* here. In some areas, 'upland swamps' occurring on the sandstone landscape yield a year-round flow in these streams, providing near-continual moisture to downstream rainforests. Whilst not part of the Highlands, the adjacent Cambewarra Range, extending along the southern side of Kangaroo Valley west from Barren Grounds, is topped with mesa-like outliers of the Hawkesbury Sandstone and is at a similar altitude to the main plateau to the north; this range is included in this study.

Most of the higher fertility soils derived from basalt and finer-grained sediments are freehold land under rural use and are cleared of native vegetation. In the east and south, the Hawkesbury Sandstone is the surface rock, which largely remains uncleared and is primarily reserved public land. These reserves encompass parts of Macquarie Pass, Budderoo and

Morton National Parks; Barren Grounds Nature Reserve; and Meryla State Forest (mostly gazetted as Meryla Flora Reserve); while Penrose and Wingello State Forests are largely on the underlying Berry Siltstone. The only reserves on the basalt are the tiny Robertson Nature Reserve and a small section of Budderoo National Park. While a few survey sites were available on the basalt soils, most of the survey was restricted to the sandstone landscape and in some cases the immediate slopes below the cliffline.

Methods

This study incorporates many fern surveys undertaken over seven years from 2016–2023. Table 1 shows the various location studies, most are at elevations above 400 m. Most of the surveys were within formally protected conservation areas including national parks and state forests (Mills 2016–2023). Land outside these areas is almost totally cleared and in agricultural use; a few sites were located on private land. While most sites are on the plateaus and often extending just below the cliffline, in a few cases the surveys extended to lower altitudes in the cold upper valleys in Kangaroo Valley. The Minnamurra Falls area was not included as it is at a low altitude.

Overall 138 local sites were explored and surveyed. Local sites, while not defined exactly in terms of aerial extent, were usually within a small rainforest gully and the adjacent slopes and gully edges. Some plateau areas that support forest and swamp vegetation were thus included. The sites were determined prior to survey with topographic maps and aerial photographs to identify the sites that supported rainforest, thus maximising the chances of finding fern species. All fern species encountered were recorded, noting any significant species and their habitat. In part, the surveys aimed to confirm historic records, identify the rare species and potentially generate new records of significant species. A photographic record of all species recorded was maintained. Records in the Australasian Virtual Herbarium were used as a guide to the species that may be present, along with the apparent status of the species in New South Wales and in the Highlands based on the number of herbarium collections. Species names follow the Australian Plant Census maintained by the Australian National Botanic Gardens. A summary of the locations and number of sites in each survey area is shown in Table 1.

Habitat descriptions

The characteristic vegetation of the survey sites is warm-cool temperate rainforest (Mills 1986; Mills & Jakeman 1995; Robertson Environment Protection Society 2021). This rainforest occurs mainly in small gorges cut into the edge of the plateau and on the upper slopes below the high sandstone cliffs, which are included in many sites. The small gorges form the *fern grottoes* where the high diversity of ferns is to be found. The Robertson Basalt once supported a considerable area of warm-cool temperate rainforest, known as the Yarrowa Brush (Mills 1986). Little remains of this rainforest, although a few survey sites were located on basalt.

The dominant rainforest tree is almost invariably *Ceratopetalum apetalum*, often with *Doryphora sassafras*. Other prominent trees are *Cryptocarya glaucescens*, *Eucryphia moorei*, *Polyosma cunninghamii*, *Quintinia sieberi* and *Syzygium smithii*. Additional woody plants include *Coprosma quadrifida*, *Hedycarya angustifolia*, *Melicytus dentatus*, *Olearia argophylla*, *Pittosporum multiflorum* and *Tasmannia insipida*. Vines and creepers are often quite common, including *Aphanopetalum resinosum*, *Celastrus australis*, *Parsonsia brownii* and *Vincetoxicum barbatum*. Common ferns include *Arthropteris tenella*, *Blechnum ambiguum*, *Blechnum watsii*, *Sticherus flabellatus*, *Todea barbara* and several small epiphytes, including *Pyrrhosia rupestris*, *Notogrammitis billardierei* and *Hymenophyllum* species. The tree ferns *Cyathea australis* and *Dicksonia antarctica* are often common.

The surrounding sandstone plateaus primarily support forest, woodland and heathland, with extensive upland swamps in some places, such as on the Budderoo Plateau. Plant diversity is generally high, but fern diversity is relatively low in what can be highly exposed and fire-prone landscapes. Common ferns in that environment include *Lindsaea linearis*, *Sticherus* species, *Gleichenia* species and the fern ally *Selaginella uliginosa*.



Figure 2. A small gorge above the escarpment cliffline on the northern side of Kangaroo Valley, typical of the region's fern grottoes and most of the survey sites.

Results

There were 2,881 observations of 87 species of fern and four fern allies from the 138 sites. An additional six species representing historic collections were not located in the current surveys; these are highlighted in Table 2 and Appendix 1. A further two species not encountered are wetland ferns but known to be present on the Highlands. The species found in the Highlands, including historic collections, represent about 52 % of the State's native fern flora and 77 % of the species found in the southeast of the State (Mills 2023a).

Table 1. The number of fern survey sites in this study for various locations on the Southern Highlands.

Survey area	Reference	No. Sites	Altitude range
Bundanoon area, Morton National Park	Mills (2022a)	15	250 m - 640 m
Barren Grounds Nature Reserve	Mills (2021)	20	360 m - 666 m
Budderoo National Park (plateau)	Mills (2022b)	30	430 m - 650 m
Other	Mills (2023b)	13	450 m - 710 m
Morton National Park, northern escarpment	Mills (2022d)	16	460 m - 640 m
Wingello State Forest	Mills (2023b)	10	500 m - 640 m
Meryla State Forest (incl. Flora Reserve)	Mills (2023c)	21	530 m - 650 m
Budderoo NP (Minnamurra R. catchment)	Mills (2016a)	3	600 m - 650 m
Penrose State Forest	Mills (2023b)	8	610 - 680 m
Macquarie Pass National Park	Mills (2016b)	1	650 m
Robertson Nature Reserve	Mills (2020)	1	760 m
All		138	250 m - 760 m

Two distinct fern floras can be recognised; one group is associated with the sandstone plateaus of the Hawkesbury Sandstone, and a second group on finer-grained soils of the Permian sediments and Robertson Basalt and the highly sheltered fern grottoes mentioned above. Appendix 1 lists all 99 species recorded for the Highlands. The number of sites recorded in Appendix 1 provides an indication of the relative abundance of each species in the region.

Fern species that are rare in southeast New South Wales, as identified by the author, are listed in Table 2, which also shows the total number of herbarium specimens for NSW and for the Highlands; these figures were obtained from the online

Australasian Virtual Herbarium and include all recent and historic records. The final column indicates the number of sites within the Highlands in which each species was recorded in the current study (i.e., 2016-2023).

Rarity is assessed as a species with few herbarium collections, either in the State or on the Southern Highlands, together with the author's extensive field experience on the NSW South Coast. In Table 2, 26 rare species are listed, 26 % of all species recorded for the Southern Highlands, represented by 174 observations across the 138 sites in this study. Almost all of the species listed in Table 2 are restricted to the Southern Highlands within the broader region (Mills 2023a).

Table 2. Conservation status as determined by the author from records of rare fern species on the Southern Highlands. * = Listed under the *Environment Protection & Biodiversity Conservation Act 1999* (Commonwealth). # = Briggs & Leigh (1996).

Species	Local Status	Total No. State	Specimens Local	Observations 2016-2023
<i>Abrodictyum caudatum</i>	rare	88	5 (5.7%)	4
<i>Adiantum diaphanum</i>	rare	64	1 (1.5%)	3
<i>Asplenium flaccidum</i>	uncommon	106	6 (5.6%)	15
<i>Asplenium gracillimum</i>	rare	105	3 (2.8%)	4
<i>Blechnum chambersii</i>	historic only (1957)	4	1 (25%)	-
<i>Blechnum gregsonii</i>	historic only (1960, 1994) #	67	2 (3%)	-
<i>Botrychium australe</i>	rare	97	1 (1%)	1
<i>Deparia petersenii</i> ssp. <i>congrua</i>	uncommon	78	5 (6.4%)	4
<i>Hiya (Hypolepis) distans</i>	rare *	1	1 (100%)	1
<i>Hymenophyllum bivalve</i>	rare	40	14 (35%)	4
<i>Hymenophyllum lyallii</i>	uncommon #	53	19 (36%)	24
<i>Hymenophyllum marginatum</i>	rare	43	16 (37%)	2
<i>Hymenophyllum peltatum</i>	historic only (1984)	1	1 (100%)	-
<i>Hymenophyllum pumilum</i>	historic only (1890, 1964) #	5	2 (40%)	-
<i>Hymenophyllum rarum</i>	uncommon	34	12 (35%)	10
<i>Lastreopsis munita</i>	historic only (1963)	105	1 (1%)	-
<i>Leptopteris fraseri</i>	uncommon	153	17 (11%)	27
<i>Lindsaea trichomanoides</i>	rare #	23	11 (48%)	14
<i>Phlegmariurus varius</i>	rare	68	2 (3%)	11
<i>Polystichum formosum</i>	rare	52	4 (7.7%)	1

Species	Local Status	Total No. State	Specimens Local	Observations 2016-2023
<i>Pteris comans</i>	rare	44	6 (13%)	3
<i>Rumohra adiantiformis</i>	uncommon	74	5 (6.8%)	17
<i>Sticherus urceolatus</i>	uncommon	55	3 (5.5%)	14
<i>Tmesipteris obliqua</i>	rare	66	2 (3%)	1
<i>Tmesipteris ovata</i>	rare	42	5 (12%)	3
<i>Tmesipteris parva</i>	uncommon	46	3 (6.5%)	11



Figure 3. *Lindsaea trichomanoides*; the Southern Highlands is the stronghold of this species in New South Wales.



Figure 4. The Southern Highlands contain 11 species of filmy fern and is a stronghold for several species, including this species *Hymenophyllum rarum*.

Discussion

This study shows that the Southern Highlands is one of the strongholds for upland ferns in NSW, and indeed Australia. The fern flora is characterised by the high number of species present, 52 % of the State's total, and the concentration of

species of State-wide and Regional botanical importance. Of the 99 species recorded for the region, one quarter are identified as being of State or Regional significance, highlighting the significance of the area for fern conservation.

Perhaps the main threat to the fern flora is climate warming, experienced through more frequent and severe drought and associated bushfire; both likely to worsen in future. The generally very wet habitats, the small gorges where the high diversity fern grottoes are to be found, are not immune from these impacts, as the fires that burnt the deep rainforest-filled valleys in the Bundanoon area in early 2020 demonstrated. Prior to survey, 34 sites had been burnt, the impact ranging from complete destruction of the forest canopy to a burnt understorey only. These sites were surveyed a few years post-fire and it was found that the species present appeared to have changed little from the pre-fire situation, even though forest structure was completely altered. Ferns were abundant and the expected species were present; this is put down to the wet years following the fire. The severe flooding that occurred soon after the drought broke, impacted many riparian sites through extreme stream bank erosion and physical destruction by flood debris. Three *La Nina*-driven wet years following the drought helped to restore the fern flora but also triggered landslides and modified stream channels, including in rainforests on and below the escarpments.

Most survey sites are within protected areas under the *National Parks and Wildlife Act 1974* (NSW); the majority of these areas cover sandstone landscapes. Each reserve is covered by a Plan of Management that sets out the appropriate management regime to achieve conservation. An associated map-based Fire Management Strategy covers each reserve but does not identify fire exclusion areas in detail, such as rainforest gullies (e.g., NPWS 2006). It is standard practice to avoid burning rainforest, both during prescribed burns and in fighting wildfires (NPWS staff, pers. comm.).

Identification of the regional, state and national importance of the Southern Highlands for fern species conservation highlights the need for close attention to the management of key habitats within the protected areas and elsewhere. Recognition of this importance assists in developing the finer details of reserve management, such as bushfire management and the provision of visitor facilities and alerts land owners to the importance of land under their control.

A total of 709 plant species is listed as threatened in NSW under the *Biodiversity Conservation Act 2016* but only 15 of these are ferns. Ferns represent 4 % of the native flora of NSW, while the percentage of listed Threatened Species that are ferns is close to 2 %. These figures do not reflect the true situation as most of the ferns occur only in the far eastern part of the state,

where ferns represent a higher proportion of the flora, and the pressure on habitats is greatest. This suggests that ferns are under-represented on the list of the State's threatened plants, most likely due to under-investment in targeted surveys and assessments of their conservation status.

While there are no records of officially listed threatened fern species on the Southern Highlands; there are many very rare ferns that deserve better recognition as species of conservation importance. One species *Hiya distans* (PlantNET) is listed as Endangered on the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. It was recorded for the first time in NSW at Macquarie Pass (described in Mills 2017), but is yet to be listed as Endangered under the NSW *Biodiversity Conservation Act 2016*. Four local ferns were listed by Briggs and Leigh (1996) (Table 2). Two of these, *Blechnum gregsonii* and *Hymenophyllum pumilum*, are known only from the Blue Mountains and Illawarra and are the only Sydney area endemic fern species. As there are only historic records from the Southern Highlands, further targeted searches are needed to evaluate their conservation threat status.

Fern species that are rare in the State and in the region deserve greater consideration in conservation planning, irrespective of listing or not. An assessment of the rainforest flora in the broader region was prepared by Mills (1988), where several ferns of conservation importance are identified; there has been no consideration of fern conservation in the region since that time. The species present and their distributions on the South Coast has been recently published (Mills 2023a).



Figure 5. A fern grotto in a gorge in Penrose State Forest near the western limit of the survey. Such sites are often dominated by *Todea barbara*, as seen here.

Conclusions

The Polypodiopsida (Pteridophyte) flora of the NSW Southern Highlands is diverse and contains a high number of botanically significant species. This study provides information on the fern flora and important fern habitats, including small gorges where the high diversity fern grottoes are to be found. Knowledge of significant fern habitats within protected areas and on private land is the first step in managing them appropriately for conservation. While the flora may seem to be well protected within reserved areas, extreme weather events associated with climate change are likely to increasingly impact fern habitats negatively posing increasing challenges for land management

authorities. Few ferns are currently listed as rare or threatened and there is scope for further investigation of the potential for additional listings under the *Biodiversity Conservation Act 2016* (NSW).

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Appendix 1. List of ferns for the Robertson-Bundanoon Highlands of New South Wales. Total number of sites is 138. The percentage frequency among the sites is the figure in brackets.

Species	No. of sites	Species	No. of sites
<i>Abrodictyum caudatum</i>	4 (3%)	<i>Hymenophyllum lyallii</i>	24 (17%)
<i>Adiantum aethiopicum</i>	39 (28%)	<i>Hymenophyllum marginatum</i>	2 (1.4%)
<i>Adiantum atroviride</i>	1 (0.7%)	<i>Hymenophyllum peltatum</i> (1984)	-
<i>Adiantum diaphanum</i>	3 (2.2%)	<i>Hymenophyllum pumilum</i> (1890,1964)	-
<i>Adiantum formosum</i>	15 (11%)	<i>Hymenophyllum rarum</i>	10 (7%)
<i>Adiantum hispidulum</i>	24 (17%)	<i>Hiya (Hypolepis) distans</i>	1 (0.7%)
<i>Arthropteris beckeri</i>	7 (5%)	<i>Hypolepis glandulifera</i>	61 (44%)
<i>Arthropteris tenella</i>	29 (21%)	<i>Hypolepis muelleri</i>	22 (16%)
<i>Asplenium australasicum</i>	35 (25%)	<i>Hypolepis rugosula</i>	9 (6.5%)
<i>Asplenium flabellifolium</i>	75 (54%)	<i>Lastreopsis acuminata</i>	41 (30%)
<i>Asplenium flaccidum</i>	15 (11%)	<i>Lastreopsis decomposita</i>	18 (13%)
<i>Asplenium gracillimum</i>	4 (3%)	<i>Lastreopsis microsora</i> ssp. <i>microsora</i>	25 (18%)
<i>Asplenium polyodon</i>	4 (3%)	<i>Lastreopsis munita</i> (1963)	-
<i>Azolla pinnata</i>	-	<i>Leptopteris fraseri</i>	27 (20%)
<i>Blechnum ambiguum</i>	74 (54%)	<i>Lindsaea linearis</i>	45 (33%)
<i>Blechnum camfieldii</i>	6 (4%)	<i>Lindsaea microphylla</i>	49 (36%)
<i>Blechnum cartilagineum</i>	94 (68%)	<i>Lindsaea trichomanoides</i>	14 (10%)
<i>Blechnum chambersii</i> (1957)	-	<i>Lycopodiella lateralis</i>	11 (8%)
<i>Blechnum gregsonii</i> (1960,1994)	-	<i>Lycopodium deuterodensum</i>	40 (29%)
<i>Blechnum minus</i>	37 (27%)	<i>Marsilea mutica</i>	-
<i>Blechnum neohollandicum</i>	41 (30%)	<i>Notogrammitis billardierei</i>	66 (48%)
<i>Blechnum nudum</i>	101 (73%)	<i>Pellaea falcata</i>	51 (37%)
<i>Blechnum parrisiae</i>	6 (4%)	<i>Pellaea nana</i>	26 (19%)
<i>Blechnum patersonii</i>	59 (43%)	<i>Phlegmariurus varius</i>	11 (8%)
<i>Blechnum rupestre</i>	14 (10%)	<i>Platynerium bifurcatum</i>	7 (5%)
<i>Blechnum wattsi</i>	80 (58%)	<i>Polyphlebium venosum</i>	13 (9%)
<i>Botrychium australe</i>	1 (0.7%)	<i>Polystichum australiense</i>	18 (13%)
<i>Calochlaena dubia</i>	106 (77%)	<i>Polystichum formosum</i>	1 (0.7%)
<i>Cheilanthes austrotenuifolia</i> (1942)	-	<i>Polystichum proliferum</i>	2 (1.4%)
<i>Cheilanthes distans</i>	2 (1.4%)	<i>Psilotum nudum</i>	1 (0.7%)
<i>Cheilanthes sieberi</i>	12 (9%)	<i>Pteridium esculentum</i>	118 (86%)
<i>Christella dentata</i>	3 (2%)	<i>Pteris comans</i>	3 (3%)
<i>Cyathea australis</i>	117 (85%)	<i>Pteris tremula</i>	30 (22%)
<i>Cyathea cooperi</i>	4 (3%)	<i>Pteris umbrosa</i>	12 (9%)
<i>Cyathea leichhardtiana</i>	20 (14%)	<i>Pteris vittata</i>	2 (1.4%)
<i>Davallia solida</i> var. <i>pyxidata</i>	14 (10%)	<i>Pyrrosia rupestris</i>	77 (56%)
<i>Dendroconche scandens</i>	36 (26%)	<i>Rumohra adiantiformis</i>	17 (12%)
<i>Dennstaedtia davallioides</i>	16 (12%)	<i>Schizaea bifida</i>	2 (1.4%)
<i>Deparia petersenii</i> ssp. <i>congrua</i>	4 (3%)	<i>Schizaea rupestris</i>	36 (26%)
<i>Dicksonia antarctica</i>	74 (54%)	<i>Selaginella uliginosa</i>	36 (26%)
<i>Dictymia brownii</i>	1 (0.7%)	<i>Sticherus flabellatus</i> var. <i>flabellatus</i>	96 (70%)
<i>Diplazium australe</i>	25 (18%)	<i>Sticherus lobatus</i>	66 (48%)
<i>Gleichenia dicarpa</i>	66 (48%)	<i>Sticherus urceolaris</i>	14 (10%)
<i>Gleichenia microphylla</i>	91 (66%)	<i>Tmesipteris obliqua</i>	1 (0.7%)
<i>Gleichenia rupestris</i>	27 (20%)	<i>Tmesipteris ovata</i>	3 (2%)
<i>Histiopteris incisa</i>	59 (43%)	<i>Tmesipteris parva</i>	11 (8%)
<i>Hymenophyllum australe</i>	21 (15%)	<i>Tmesipteris truncata</i>	50 (36%)
<i>Hymenophyllum bivalve</i>	4 (3%)	<i>Todea barbara</i>	112 (81%)
<i>Hymenophyllum cupressiforme</i>	79 (57%)	<i>Zealandia pustulata</i>	40 (29%)
<i>Hymenophyllum flabellatum</i>	11 (8%)		