Date of Publication:
XX November 2015

Cunninghamia

A journal of plant ecology for eastern Australia

The Royal Botanic Garden Sydney

ISSN 0727-9620 (print) • ISSN 2200-405X (Online)

The vegetation and flora of Strzelecki National Park, Flinders Island, Tasmania

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Abstract: A botanical survey of the vegetation of Strzelecki National Park, on south-western Flinders Island, Tasmania (lat. 40° 13' S; long. 148° 06' E) resulted in 313 vascular plant taxa, being recorded. Of these, 16 are introduced. Of the native flora, 9 are currently considered threatened according to the Tasmanian *Threatened Species Protection Act 1995*. Some of these occur on the calcareous rocks and soils on the western coastal fringe of the Park. There is low species diversity in large areas, for reasons that include extensive ground disturbance by pigs, very high fire frequency in some areas and the depauperate nature of island floras. There were also 137 species of liverworts and mosses recorded for the Park.

Most plant habitats on Flinders Island are represented in the Park. The flora retains an interesting rainforest and wet forest element which shares floristic similarities with rainforest gullies in mainland south-eastern Australia, with the Tasmanian north-eastern highlands, and even with western Tasmania. There are also some affinities with the dry Bass Strait and southern Australian floras.

The pattern and composition of the vegetation is strongly shaped by several factors. Extensive fires have been promoted by fuel accumulation and deliberate burning on the Park perimeter. Topography strongly influences the vegetation (Mt Strzelecki is 756 m high) due to the degree of exposure to strong winds and protection from fire. Cloud capping of the mountain increases the potential moisture available. Wind is a large local factor in vegetation structure. Controls on vegetation at any given site are also responsive to aspect, bedrock depth and other factors.

Eleven vegetation mapping communities are defined, the Park being important for the reservation of several of these. The Park is characterised by the presence of rainfall and evapotranspiration extremes and the vegetation varies accordingly, with rainforest patches in fire protected niches of the mountains and dry heathland on the coastal areas. Strong westerly winds combined with the abruptly rugged mountainous topography have caused some violent localised destruction of forest and scrub canopies by wind.

Key words: mountain vegetation, island flora, fire storms, cloud forests, cloud stripping, steep precipitation gradient, Bass Strait, feral pigs, rainforest, heathland, dry sclerophyll forest, bryophytes, Threatened species.

Cunninghamia **(2015) 15: 163–184**
doi:10.7751/cunninghamia.2015.15.009

Introduction

Strzelecki National Park (lat. 40° 13' S; long. 148° 06' E) is on Flinders Island, one of the Furneaux Group of islands off the northeast of Tasmania (Figure 1). The island is 133,300 ha in area of which 7,631 hectares of very rugged, mainly granite terrain on the south west side makes up the National Park. The Park includes Mt Strzelecki, at 756 m the highest peak on the island and was first proclaimed as a Scenic Reserve under the provisions of the *Crown Lands Act 1911* in August 1935 with an area of 8,500 acres. The original boundary was later realigned on the northern side and additional areas were added on the northeast corner, and the western and southern sides of the Park. Significant areas of Crown land on the eastern and northern sides of the Park were added in 2003. The Park abuts private land on all sides except where it extends to the sea. According to archaeological evidence there had been a hiatus in human occupation of Flinders Island of at least 4,000 years (Sim 1991). Studies of vegetation patterns and fire on Flinders Island are thus of particular interest because it is unusual in an Australian context.

As the National Park was first proclaimed for "scenic" purposes, the most important task for many years was the maintenance of the walking track to the top of the mountain. The first naturalist to climb Mt Strzelecki was, by popular account (Mort 2005), Count Paul Edmund de Strzelecki on 15 January 1842. He was on HMS Beagle, under command of Commander Stokes during the hydrographic survey of the Furneaux Islands. Unfortunately there is no written report of his trip because all Strzelecki's manuscripts, diaries and letters were destroyed according to his will (Heney 2014). Stokes named the mountain after his Polish explorer passenger (Mort 2005).

There is an account of an ascent by a party from the Victorian Field Naturalists club in 1893 (Gabriel 1894), but otherwise recorded references to the mountain are rare (Willis 1954), until the creation of the Scenic Reserve and the National Park. Until the early 1970s unpublished Tasmanian Parks and Wildlife Service file notes and documents dealt mostly with boundary, acquisition and property questions. After this date there are memoranda showing an increasing preoccupation with Park management issues such as fire management, feral pigs, track maintenance, access, boundary management, and *Phytophthora* infection. In 1974 the Tasmanian Parks and Wildlife Service began to investigate the feral pig problem, in particular their distribution in the Park and evaluated possible methods of pig control. Published information about feral pigs in the Strzelecki Mountains is confined to a brief mention in Statham and Middleton (1987). Unpublished information is found in Underwood (2000) and Saunders and Yockney (2012). Willis (1954) recorded 120 plant species (including 9 aliens) on Mt Strzelecki. Subsequently, plant species lists made by casual visitors between 1976 and 1983 together indicated less than 130 species for the Park. Munks (1990) gives brief vegetation descriptions for her pygmy possum study sites in Fergussons Gully. The Park was sampled during larger state-wide systematic surveys of heathlands (Kirkpatrick and Harris 1999), coastal vegetation (Kirkpatrick and Harris 1995) and wet forests (Wells 1988). A management plan for Strzelecki National Park was approved in 2000 and guides fire, tourism and feral pig management in the Park (Parks and Wildlife Service 2000).

This study area centred on the tallest and most rugged mountains in Bass Strait with their high biodiversity values is an unusual environment which has not been previously comprehensively surveyed. Additionally, the impact of feral pigs in Tasmania is confined to Flinders Island where a range of natural values is impacted. An understanding of feral pig distribution and impacts to vegetation in the Park is important as this information can be used to inform feral pig control or eradication programs, and for conservation and management planning generally. Similarly, the information about the vegetation of the Park can assist in fire management planning as well as providing a basis for interpretation of the Park for tourism purposes.

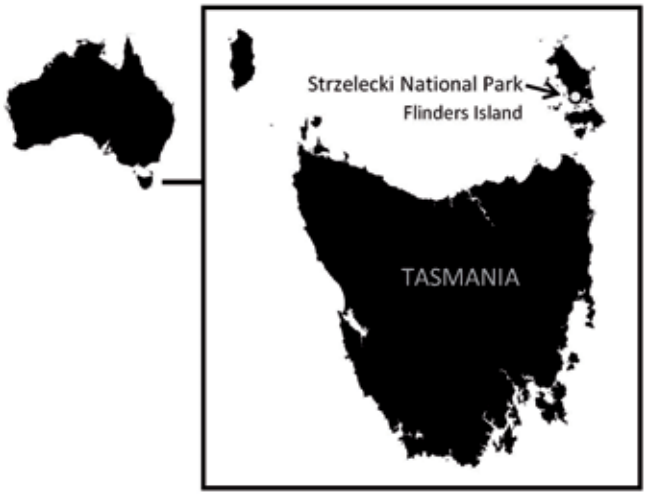

Fig. 1. Locality of the study area in relation to the Australian and Tasmanian mainlands.

Methods

Floristics and vascular vegetation mapping

Vascular plant communities were mapped using a combination of vegetation sampling and aerial photograph interpretation. Mapping began by delimiting vegetation communities on Flinders Island for incorporation into a statewide framework but we considered that a number of communities remained to be satisfactorily resolved in terms of scale and compositional equivalence with statewide mapping units (Harris and Kitchener 2005). We therefore mapped and described communities that were clear to us in the field, subsequently allocating them where possible to nearest equivalent communities in the statewide nomenclature (Table 1). Initially, photo communities were delineated on 1:42,000 black and white aerial photographs and used as a guide to design vegetation sampling.

To pick up the range of vegetation types 179 sample plots each 100 m^2 in area were non-randomly located (GDA94) throughout the Park. Plot locations and photo community

boundaries were transferred to the relevant Tasmania 1:25 000 topographic series maps and checked against field observation, field notes and binocular scanning of areas that were not accessed on foot. Vegetation boundaries were subsequently digitised using ArcGIS software and transferred to the Tasmania 1:25,000 topographic map series layer. Fieldwork for plant community mapping took place over three weeks in September and November 1997 and March 1998. Repeated visits by the authors have occurred since and further notes made.

At each plot location the following information was collected: presence/absence of vascular plant species, vegetation structure and notes on slope, aspect, altitude, fire history (evidence of past fire, age/size class structure, fire scarring on trunks, time since last fire), extent and nature of pig damage, degree of fire protection and exposure to onshore winds.

Climate information was gathered from data collected at Bureau of Meteorology accredited stations at Whitemark and Flinders Island airport. Information was also derived from BIOCLIM modelling (Busby 1991) that develops a predictive surface for temperature, precipitation and radiation variables. It is particularly useful for obtaining an indication of rainfall.

Plant species were identified in the field where possible and when there was uncertainty, pressed dried collections were made for subsequent identification and comparison with specimens in the Tasmanian Herbarium. Representative vouchers for as many species as possible were lodged in the Tasmanian Herbarium. Species nomenclature follows Baker and de Salas (2013) except where otherwise indicated.

Bryophyte species presence was recorded in 22, 400 m^2 plots during spring 2004–2006. Plots were located by random placement using DNR Sample Generator Extension v 2.6 (Minnesota Department of Natural Resources) in ArcView to sample a representative range of vascular vegetation types for the Park. A further 84 plots were sampled outside of the Park and within the Flinders bioregion, for the purpose of analysing the association between vascular plant composition and bryophyte composition. All substrate surfaces were searched including soil, rock, logs and the trunks and branches of vascular plants (to a height of 2 m). For identification purposes, a small collection was made for many taxa and voucher specimens prepared where additional reference material was required. Determinations for most samples were made following microscopic examination. Bryophyte species nomenclature follows the Victorian Biodiversity Atlas (2014).

Non-metric Multidimensional Scaling and Analysis of Similarity (Primer v5.2.0) were used to test for significant differences in bryophyte composition between vascular vegetation types.

Fire ageing

Evidence of fires, such as charred stumps, eucalypts stags and even-aged cohorts of obligate seeders such as *Banksia marginata* can be observed throughout the Park. Evidence of fire frequency can also be assessed from the distribution of vegetation types and associated species composition. Observations were made on the degree of natural fire protection, whether filmy ferns (*Hymenophyllum* species and *Crepidomanes venosum*) were present or not (Brown and Podger 1982), size classes, nodal counts on banksias, presence or absence of eucalypts, fire boundaries, fire scars on trees, presence and vigour of post-fire adventive species, proportions of burned and unburned trunk of *Dicksonia antarctica* and *Xanthorrhoea australis*.

Fire ageing was estimated usually by nodal counts on *Banksia marginata* and recorded as the average of a few counts from several individuals at any one site. This method is recognised as indicative only. In a small number of cases, *Leptospermum* species were sectioned for growth ring counts. Visual estimations of eucalypt age were also done in the field, using as a guide, diameter against ring counts of some eucalypts cut down outside the Park.

Empirical field evidence of fire was cross referenced with Parks and Wildlife Service files, conversations with local residents, Parks and Wildlife Service Rangers, old newspaper reports and Tasmanian State Archives documents. There has been no fire in the core of the Park between 1997 and 2015.

Fig. 2. Strzelecki National Park looking from the south across Armstrong Channel.

Results

Geology

Strzelecki National Park exhibits some of the most rugged granitic topography in Australia (Figure 2). The basement rocks are Devonian granodiorites which are intersected by faults and numerous joint sets (Jennings and Cox 1978). The creeks follow major zones of weakness. Although the lithology is uniform, the structural geology is varied, giving rise to numerous landforms which have a bearing on vegetation history, and fire protection. Landforms characteristic of granite landscapes abound and include: tors, tafoni, sheet structures, gnamma and rillen. The Trousers

Point aeolian calcarenite (Figure 3) is probably of Tertiary age and has weathered to produce highly calcareous soils (typically pH 7.5).

Fig. 3. Trousers Point is bounded variously by sandy, granite and calcarenite coast.

Climate

The nearest climatic record stations are at Whitemark Post Office and Flinders Island Airport, only 8 km and 11 km away respectively, but in a notably different environment to that experienced in the mountains.

Rainfall

Rainfall modelling shows a predicted 1490 mm annual average in the mountains, with reduced evapotranspiration because of the frequent cloud cover and mist, to the coastal area at Trousers Point where the predicted annual average is as low as 468 mm and the limestone bedrock does not retain groundwater.

Winds

The prevailing winds over most of Tasmania are north-west to south-west with greatest strength and persistence in winter. On Flinders Island the greatest wind strength is actually in spring–summer, particularly September to January and is also most persistent from November to April. The annual average monthly maximum wind speed is fairly even throughout the Spring and Summer at 25–30 km/hr and in April–July the wind drops to between 20 and 25 km/hr. Average maxima are fairly similar throughout the year but gusts up to 131 km/hr have been recorded for October (Bureau of Meteorology http://www.bom.gov.au/climate/data/index. Accessed 3 August 2014). Winds have an unbroken fetch from the west.

Above the maximum friction layer at sea level, the Strzelecki massif is buffeted by the higher speed upper layer air stream. As the air rises to blow over the mountain top it is constricted between the summit below and the air layers above and when compressed in this way its speed increases until it passes the summit. As well as horizontal compression, there will be lateral constriction of the air stream as it is funnelled between and around peaks. There are recorded speeds of winds reaching 360 km/hr over mountain tops in the United States (Critchfield 1966). Thus it would be expected that very strong gusts would be more prevalent in the peaks, in addition to turbulence generated by the rugged topography. Once the winds from the south-east to the SW exceeds 35 km/hr at sea level, clouds will form on the Strzelecki Peaks and a cloud cap is present on 30–40% of days of the year (James Luddington pers. comm.).

Temperature

The temperature regime recorded at Flinders Island airport and Whitemark (together with the rainfall pattern) is typical of a Mediterranean climate (Cody 1986), that is, with warm summers 20–25°C monthly means and cool winters (<15°C) in which frosts are rare. The temperatures high in the Strzelecki Mountains will be depressed due both to the adiabatic lapse rate and the cooling westerly winds.

The figures at the lowland coastal station at Flinders Island Airport cannot be expected to reflect the climatic conditions on the Strzelecki Peaks. This applies to such measures as rainfall, temperature, cloud cover, maximum wind gust and mean number of days of strong wind. The Strzelecki Peaks rise to 750 m, a large massif directly in the path of the persistent winds, the rugged topography causing turbulence as the prevailing air stream moves eastward over the peaks, rising rapidly, cooling and causing orographic cloud cover for many days of the year. Clouds also form from warm humid easterly air masses moving from the Tasman Sea and being intercepted by the mountain. Sometimes when this occurs the tongues of mist pour over the summit and stream down the western side of the mountain.

Soils

Soils over most of the study area are acid (typically pH 3.5), skeletal, grey sandy loams or gravelly sands depending on microtopography. Deeper soils occur in the gullies and the few flat areas. The depth of the organic horizon varies, and time since last fire, together with vegetation type determine this. The soils on the limestone on Trousers point are distinctly different being friable, calcareous alkaline sands (typically pH 7.5–8).

Flora and Vegetation

There are 313 vascular plant taxa from 85 genera and 137 taxa of non-vascular plants from 55 genera (20 liverworts genera, 35 moss genera) represented in the Park (see Appendix 1). Sixteen vascular plant taxa are exotics which have penetrated edges from cleared boundaries. These are ubiquitous wind-borne weeds such as *Hypochaeris radicata* which occur on

fire breaks and tracks, and the "human camp followers' such as *Cerastium* species which occur around the heavy use area at the picnic site at Trousers Point. Shoreline weeds include cosmopolitan herbs such as *Plantago coronopus* and *Cakile maritima*, which exhibits a distribution from far eastern Victoria to Flinders Island. Within the core of the Park, weeds are extremely rare. A thistle was observed growing in a valley just south of the head of Big Hollow, perhaps resulting from a chance wind-blown or mammal-borne seed. The native shrub, *Zieria arborescens* is frequent throughout the Park and behaves in a 'weedy' manner because it thrives as a result of ground disturbance by pigs. The introduction of exotic species into such disturbance environments would be unfortunate because they would be encouraged to persist by frequent ground disturbance.

There are 17 vascular taxa that are considered endemic in Tasmania. These are mostly species which are widespread and common on the Tasmanian mainland. There are 9 taxa which are listed on the schedules to the Tasmanian *Threatened species Protection Act 1995*. Of these, at least *Eutaxia microphylla* and *Myoporum parviflorum* are confined in the Park to the coastal limestone or calcarenite on Trousers Point. These species have been discussed by Underwood (1998) and Harris *et al*. (2001). No bryophyte species within the Park has been determined as threatened in a statutory sense, however the moss *Calomnion complanatum* was assessed under IUCN criteria by Scott *et al.* (1997) who considered this species to be endangered within Australia.

Table 1. Mapping units and communities discussed in this paper and their relationship to the Tasmanian statewide TASVEG mapping units (Harris and Kitchener 2005).

Communities discussed in this paper	TASVEG mapping units (Harris & Kitchener (2005)
Coastal Vegetation	Coastal heathland (SHC)
Coastal Vegetation	Heathland on calcarenite (SCH)
Mountain and Peak Complex	Lichen lithosere (ORO)
Melaleuca ericifolia Forest (NME)	*Melaleuca ericifolia* forest (NME)
Eucalyptus viminalis Forest	*Eucalyptus viminalis* Furneaux forest (DVF)
Eucalyptus viminalis Forest	*Eucalyptus viminalis* grassy forest and woodland (DVG)
Eucalyptus nitida Forest	*Eucalyptus nitida* Furneaux forest DNF)
Eucalyptus globulus - *Allocasuarina verticillata*-*Callitris rhomboidea* forest.	*Leptospermum* forest (NLE)
Myrtaceous scrub	Dry scrub (SDU)
Myrtaceous scrub	Heathland on granite (SHG)
Myrtaceous scrub	Regenerating cleared land (FRG)
Allocasuarina verticillata Forest	*Allocasuarina verticillata* forest (NAV)
Spyridium gunnii - *Pomaderris apetala* Cloud Forest	Broad- leaf scrub (SBR)
Zieria arborescens - *Olearia lirata* shrubland.	Broad-leaf scrub (SBR)
Leptospermum lanigerum low forest	*Leptospermum* forest (NLE)
(not described here; very localised)	*Acacia melanoxylon* forest on rises (NAR)

The vegetation can be divided into 11 mapping units which are represented by distinct structural and floristic attributes on the ground (Table 1, Figure 4). Each of these types and their associated communities are described in more detail below. The mapping units follow Harris and Kitchener (2005) but the vegetation communities we describe in the paper do not always have a one to one relationship as we found it convenient to describe what appeared to us to be distinctive facies. Table 1 shows the relationship of the statewide mapping units and the communities we describe here.

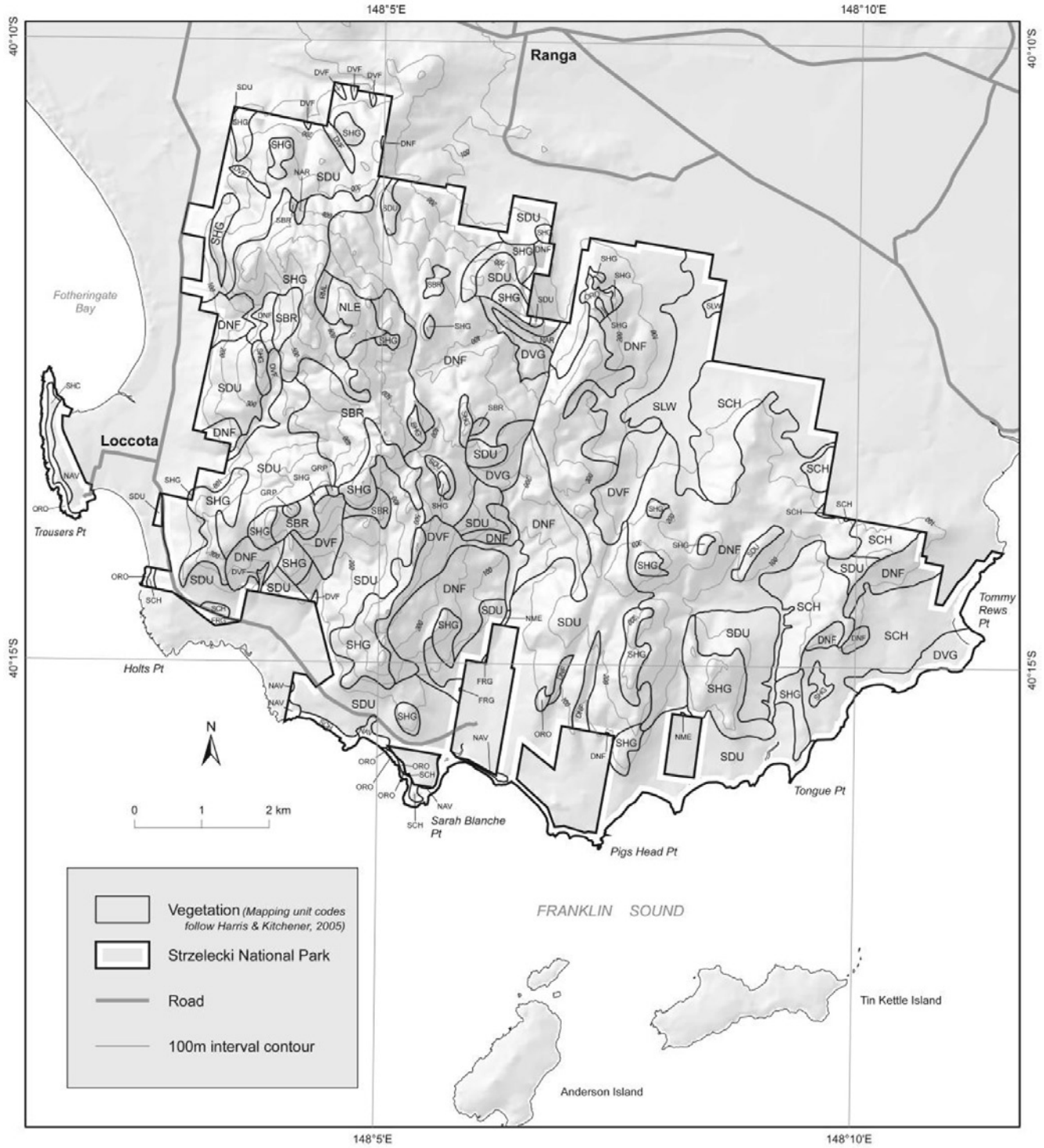

Fig. 4. The vegetation of Strzelecki National Park, Flinders Island. Vegetation types follow Harris and Kitchener (2005).

Coastal Vegetation

The area mapped as coastal vegetation occupies a narrow zone because the hinterland vegetation has fully developed right to the coast. Very high fire frequencies can reduce the stature of vegetation to heath or grassland and allow greater influence by maritime factors such as salt spray further inland. The coastal zone is therefore narrow and divisible into two main types: granite communities and calcarenite communities.

There are many places on the granite where *Allocasuarina verticillata* Forest comes right to the rocky shore and where exposure is not as great, there is no reduction in structure. The usual granite coast zonation on is found here with *Disphyma crassifolium, Apium prostratum* and *Sarcocornia quinqueflora* found in the rocky zone. Windrowed heath is common on the western shore. At Trousers Point wind had gained access through a natural wind funnel. Here there is a marked transverse zonation comprising *Allocasuarina*

flanked by low wind pruned *Kunzea ambigua* shrubs in between these flanks being a corridor of *Austrostipa stipoides*. On a shallow depression at the core of this wind funnel is a low grassy herbfield dominated by *Microlaena stipoides* and comprising mainly *Eryngium vesiculosum*, *Drosera pygmaea*, *Distichlis disticophylla*, *Lobelia anceps, Selliera radicans* and *Oxalis perennans*. *Ficinia nodosa* emerges from this herbfield.

Mountain and Peak Complex.

All of the "bare rock" falls into this complex which comprises four identifiable communities: Lichenfields, *Xerochrysum* Herbfield, *Lepidosperma elatius* Sedgeland and Sparse Mountaintop Heath.

Lichenfields are apparent where bedrock is visible in cliffs, boulder fields, talus slopes, tors and sheet structures. Freshly exposed rock is extremely rare. The dominant lichen species covering these rocks include *Cladia* species (a lichen inventory was beyond the scope of this paper). Few vascular plants are recorded on these areas but in gnamma pits where there may be a small accumulation of gravel there is usually a collection of the following: *Centrolepis strigosa*, *Crassula sieberiana*, *Acianthus* sp., *Drosera auriculata* and *Calandrinia calyptrata*. In rillen, there may be mainly bare water-stained rock with some lichens and bryophytes. While lichens occupy almost 100% of the area of sheet structures, bryophytes are found in depressions and on the perimeters of sheets. The bryophyte patches are often more extensively developed on the upper perimeter of sheets fed by moisture draining through the layers of vegetation above. *Xerochrysum papillosum* is a common understorey component in the mountains but in some rare situations, it dominates small floriferous herbfields, for example one on a shelf with a south-westerly aspect just east of Lovetts Peak. Here, shrubs of *Tasmannia lanceolata* and clumps of *Lepidosperma elatius* up to 1–1.5 m high are scattered through a grassy herbfield with species of *Agrostis, Gnaphalium* s.l.*, Rytidosperma, Viola, Crassula, Tetrarrhena disticophylla* and *Centrolepis strigosa*. This area appears to be highly exposed to wind as well as occurring in the cloud forest zone. It is possible that the site could support an elfin forest and the small *Tasmannia* shrubs may be the pioneers of the community here. The reason for the absence of such a forest may be that the site was burnt in a past fire and succession has been extremely slow because of such a high exposure and the slow growth rates due to low insolation and cooler temperatures.

Lepidosperma elatius or *Gahnia* Sedgeland is a rare community occurring only in a few sites where the areas occupy no more than 0.25 ha (too small to map separately). One notable patch occurs on a saddle west of Mt Belstead and is conspicuous from a light aircraft. In some areas *Gahnia grandis* dominates patches at higher altitudes where fire has made incursions into *Leptospermum* Forest. The *Gahnia* forms such dense swards that other species would be precluded from growing, until the *Gahnia* nears the end of its life span.

Melaleuca ericifolia Forest

Melaleuca ericifolia is a common component of riparian vegetation along the major creeks, forming thickets in basins where there are deeper soils but the best extent of *Melaleuca ericifolia* forest is on the lower reaches of Big River. The forest straddles the boundary with private land and there has obviously been some history of disturbance from stock and feral pigs.

The forest on Big River is more or less even aged (with a 20 cm median diameter at breast height in a sampled *Melaleuca* stand. The co-dominant is *Acacia melanoxylon*. There is a canopy cover of >95% but some open patches occur, perhaps where wind has entered and broken some trees. A sparse shrub layer comprises rare scattered 8 m high *Pomaderris apetala*. There are 3–4 m high patches of *Zieria arborescens* and the ground layer comprises *Hypolepis rugosula, Carex appressa* and juvenile *Melaleuca ericifolia*.

There is a lot of litter but a great deal of bare ground. Pigs have ploughed the deep alluvial soil, pushing litter into heaps and the plants surviving are clearly only those capable of withstanding massive and prolonged ground disturbance. There may have been more species diversity in the understorey in the absence of pigs. *Blechnum nudum* and carpets of bryophytes occur only under the lip of the stream bank inaccessible to pig disturbance. Occasional plants include *Pteris tremula*, *Galium* sp., *Pellaea falcata*, *Cyathea australis, Callitriche* ?*stagnalis* and *Isolepis* sp.

Eucalyptus viminalis Forest

Such forests are not extensive and are best developed on the south-eastern slopes under Mt. Razorback and in some of the larger gullies such as Bob Smiths and Fergussons gullies. *Eucalyptus viminalis* rarely occurs above 450 m asl.

Understorey species associated with *Eucalyptus viminalis* varies according to the site type. In the gullies of Bob Smith and Fergussons, there is a subdominant layer of *Olearia argophylla, Cyathea australis, Elaeocarpus reticulatus* and *Pomaderris apetala*. Sometimes *Eucalyptus viminalis* co-occurs with *Eucalyptus globulus,* e.g. in Costers Gully (where *Callitris rhomboidea* also occurs). It is likely that *Eucalyptus viminalis* together with *Eucalyptus globulus* was a major component of forests on the alkaline soils north of the Park now been cleared for farmland. This is judged from a remnant on private property on the north-western boundary.

In the southeast of the Park there is *Eucalyptus viminalis* grassy forest and woodland (DVG) where frequent low intensity fires have opened up the understorey layer and suppressed any development of a shrub layer.

Eucalyptus nitida Forest

This forest type is extensive and the most widely distributed community in the Park. It is especially abundant on the slopes of the mountain peaks but rare on the coast and on the limestone soils. The vegetation dominated by *Eucalyptus nitida* ranges from 5–6 m scrub, where the eucalypt is

emergent over other co-dominants such as *Leptospermum scoparium, Kunzea ambigua, Acacia verticillata, Pomaderris apetala* and *Allocasuarina monilifera* to older (taller) forest (16–20 m) with a tall shrub layer at 8–9 m often of *Acacia mucronata*. At one site, *Eucalyptus nitida* was emergent at 20 m over an *Acacia melanoxylon-Eucalyptus nitida* sub-canopy at 15 m. In some localities, *Eucalyptus nitida* forms a uniformly 10–12 m tall forest with no co-dominants whereas at other sites it is co-dominant with *Eucalyptus globulus* in forests of 12–20 m tall. *Eucalyptus nitida* co-occurs with *Eucalyptus viminalis* in damp fire-protected sites high in the mountains (e.g. 270 m above sea level). Scrubs as low as 4–5 m were sampled; the tallest forest was 22 m high.

Eucalyptus nitida is most prevalent on the flanks of the mountains and ridges, rarely occurring on the summits or above the boulder fields; in the core of the range there are large eucalypt-free areas. There are clearly even-aged cohorts of eucalypts corresponding to major fires.

The range of floristic variation within the *Eucalyptus nitida* communities is large and reflects various site factors such as drainage, relative protection from feral pigs and aspect (and therefore moisture availability). Apart from the common shrub layer dominants mentioned above, the most common species are the ubiquitous *Zieria arborescens* and *Lepidosperma elatius*. Some moister sites contain filmy ferns on bryophyte-covered boulders and tree ferns. A variety of other ferns may be present including *Polystichum proliferum, Asplenium obtusatum, Ctenopteris heterophylla*, and *Hypolepis rugosula*. Other shrubs commonly include *Banksia marginata, Leptospermum glaucescens*, *Leptospermum scoparium, Hakea teretifolia*, and *Coprosma quadrifida*. Forbs and graminoids include *Ehrharta disticophylla, Hydrocotyle hirta, Xerochrysum papillosum* and *Viola hederacea*. In the well-drained gravelly acid sands near the coast, ground flora diversity is much higher.

Eucalyptus globulus-Allocasuarina verticillata-Callitris rhomboidea Forest

This distinctive community occurs mainly on the western parts of the range at lower altitudes, on the lower to mid slopes. It ranges from scrub of 2.5 m to forests 18 m tall; most of the sampled forests fall within the 8–11 m height range. *Eucalyptus globulus* is often emergent over other species but occasionally is co-dominant with *Eucalyptus nitida, Callitris rhomboidea, Allocasuarina verticillata*, *Eucalyptus viminalis* or *Acacia melanoxylon*. There is often a shrub layer which may be sparse or patchily dense at 2 m or 4–6 m. The shrub layer often includes younger specimens of the dominant trees. Other shrub species which are common include *Leptospermum scoparium*, *Acacia mucronata* and *Kunzea ambigua*. The climbers *Clematis microphylla, Clematis aristata* and *Cassytha melantha* are often present.

The ground layer typically includes *Hydrocotyle hirta, Lepidosperma elatius*, *Poranthera microphylla*, *Dianella revoluta, Pultenaea daphnoides* and *Epacris impressa*. Understorey floristic diversity varies according to variety of microhabitats present. For example, where *Eucalyptus globulus* is emergent over dense scrub, there are few vascular plant species, whereas on a slope where there may be breaks in the canopy together with boulders and rock slabs on the ground there will be more species. The dominants of this community are drought-tolerant and the associated understorey species are likely to exhibit similar characteristics. The community does not occur higher in the cloud zone, nor in deep shaded gullies. It typifies the slopes on the western flanks of the granite mountains where soil may be shallow, indeed often exposing slabs of granite and where they are exposed to the full force of the desiccating westerly winds.

Myrtaceous Scrub.

Myrtaceous scrub is best developed around the perimeter of the Park, especially along Big River Road and near the northern perimeter of the Park. These scrubs are dominated by varying combinations of a few species, mainly *Allocasuarina verticillata, Allocasuarina monilifera, Banksia marginata, Leptospermum scoparium, Acacia verticillata, Leptospermum glaucescens, Monotoca glauca, Kunzea ambigua* and *Eucalyptus nitida*. The vegetation is very dense and is likely to have resulted from fires 28 to 35 years prior to the survey.

Kunzea ambigua was a colonising pioneer on the paddocks at the Big River property that were regenerating to scrub. This area is mapped as Regenerating Cleared Land (FRG).

Low understorey species diversity is evident and some species may only occur in the soil seed bank at a site. This vegetation is highly flammable, in some cases ladder fuels, including *Gahnia grandis* being present. Other common understorey species include *Cassytha melantha, Lepidosperma concavum* and *Lepidosperma elatius*. There is a marked dichotomy in myrtaceous scrubs. Those described above are at lower altitude. Above 700 m in the cloud forest zone there is more protection from high fire frequency; the *Leptospermum* is more gnarled, *Dicksonia antarctica* is sometimes present in the understorey and other species include *Histiopteris incisa, Rumohra adiantiformis, Hymenophyllum rarum, Grammitis* sp.*, Juncus pauciflorus, Huperzia varia,* and *Microsorum pustulatum*. The prevalence of filmy ferns in the understorey of a tea tree scrub seems paradoxical but at higher altitude sites there is both the moisture availability as well as the fire protection to support their persistence.

Allocasuarina verticillata Forest

This vegetation type is not extensive in the Park but reaches its best development on the exposed western shore, on Trousers Point, on the driest aspects on the granite slopes above the western coastal plain, and on some slopes above the Big River homestead.

These forests are mostly dense stands which appear even-aged, generated from particular fire events. In the sampled forests are three clusters of heights (3–5.5 m, 8–11 m and 13–14.5 m) - these heights could represent different age cohorts from different fires. Mostly the stands are dominated

solely by *Allocasuarina verticillata* but occasionally there is *Eucalyptus nitida* or *Eucalyptus globulus*, or *Leptospermum laevigatum*. There is a sparse shrubby understorey at 2–3(–6) m but often the understorey is absent as the canopy closes out. Herbs and shrubs may be rare and scattered. For example at Trousers Point when originally surveyed in 1997 the forest there was then described as having a dense 100% litter layer of needles and branchlets from the sheoak. Rare *Myoporum insulare* about 0.6 m occurs. Other scattered vascular species include *Pimelea serpyllifolia*, *Lysimachia arvensis, Dichondra repens, Clematis microphylla, Trifolium repens, Microlaena stipoides*, *Ajuga australis* and *Rhagodia candolleana*. *Xerochrysum papillosum* has mostly died out. *Beyeria viscosa* is present only in the protection of the cage formed by a fallen branch. Where gaps occur through disturbance such as tree-fall, wind throw or otherwise, the species diversity of these forests becomes apparent. Many of the species clearly require disturbance for regeneration. Following the construction of a road along Trousers Point towards Fotheringate Bay, many species appeared, including: *Apalochlamys spectabilis, Solanum laciniatum, Xerochrysum papillosum, Oxalis perennans, Dichondra repens, Muehlenbeckia australis, Beyeria viscosa, Cirsium vulgare*, *Acaena novae-zelandiae, Pimelea serpyllifolia, Microlaeana stipoides, Trifolium repens, Pelargonium australe*, *Stackhousia monogyna, Gnaphalium* s.l. sp., *Centrolepis* sp., *Crassula sieberiana, Pimelea curviflora* and *Olearia ramulosa*. About 300 m further south a shrubby area in a wind-throw gap contains many of the same species with an extra six species including *Rytidosperma penicillatum* and *Parietaria debilis*, the latter species growing on a granite ledge under litter.

In 2012 violent winds struck the coast in the vicinity and destroyed the canopy of the forest described above, initiating germination of many shrubs in the understorey as well.

Some of the tallest *Allocasuarina verticillata* occurs 2 km to the north and inland of the mouth of the Big River. Although the site is on private land just outside the Park boundary it is described here because it has a wind throw patch about 10 m diameter. Many disturbance species are emerging including *Goodia lotifolia, Hypolepis rugosula* and *Solanum laciniatum*. The diameter at breast height of the largest sheoaks is 48–49 cm at the time of survey.

Spyridium gunnii-Pomaderris apetala Cloud Forest.

This community was sampled at sites between 510 and 680 m around the higher peaks of the Park where there is frequent and often persistent cloud cover resulting from the orographic effect in intercepting the westerly air stream. The community is generally well fire protected because of large boulder fields. In fact the best development of these distinctive forests occurs high around the headwaters of the major creeks in the western part of the Park where mist is first intercepted by being funnelled up the gullies. Huge boulder fields are prevalent in the upper reaches of major creeks like Fotheringate Creek, resulting from topples of weathering remnant granite tor stones. These provide good fire protection (Figure 5). There is evidence that large eucalypts occurred in such sites because on the eastern slope of Lovett Peak above the saddle amidst *Pomaderris apetala* - *Spyridium gunnii* low forest, there was a large (100 cm dbh), charred fallen eucalypt. Similarly on a saddle northwest of Mt Strzelecki (altitude 520 m) amongst a gully boulder field of *Olearia argophylla* - *Pomaderris apetala* low forest with a broken crown, there was a large dead eucalypt downer (fallen limb or tree trunk) which was 110 cm dbh but appeared to be only 6–8 m to the first branch. It is possible these eucalypts may have toppled in from adjacent ridges above their present resting places. *Atherosperma moschatum* also occurs in this community.

The community has a high diversity of species in the understorey, including many ferns and bryophytes. Typical species in the shrub layer include *Olearia phlogopappa, Zieria arborescens*, *Olearia lirata, Tasmannia lanceolata* and *Acacia melanoxylon*. A typical sample plot would contain, as well as the above: *Histiopteris incisa, Xerochrysum papillosum, Microsorum pustulatum, Asplenium appendiculatum, Hypolepis rugosula, Hymenophyllum cupressiforme, Cyathodes juniperina, Polystichum proliferum, Ctenopteris heterophylla*, *Dicksonia antarctica, Coprosma quadrifida, Asplenium flabellifolium* and *Parsonsia brownii.*

Amidst the boulders there is abundant shady protected habitat for ferns, bryophytes and lichens. Many plants grow in skeletal humic soils on tops of large boulders with some trees growing up between boulders.

Fig. 5. Looking over the valley of Fotheringate Creek towards the south-east.

Zieria arborescens-Olearia lirata Shrubland

This is a disturbance disclimax community which is more extensive in some parts of the central and eastern parts of the Park. The shrublands are variously dominated by *Zieria arborescens* which is almost ubiquitous, *Olearia lirata, Pomaderris apetala, Acacia verticillata* and *Olearia argophylla*. *Lepidosperma elatius* is mostly prevalent in the understorey. Canopy cover is usually 85–95%. A typical site occurs at, at 460 m altitude on the upper reaches of Fotheringate Creek where it first swings to the westward. On the slopes above the creek is an extensive field of dense scrub dominated by *Zieria arborescens* and other

species. Emergent over the scrub are some large eucalypt stags presumably burnt by the same fire which instigated the present shrubby regrowth. *Olearia lirata, Olearia argophylla* and *Zieria arborescens* dominate the shrubland and *Lepidosperma* is tall and dense in the understorey. Specimens of *Dicksonia antarctica* survive, especially down toward the creek. Canopy cover is 90% and while species diversity through the patch is low, there is an increase in diversity towards the margins near the creek where relicts of rainforest or mixed forest occur: *Atherosperma moschatum*, *Dicksonia antarctica* and other ferns including filmy ferns.

The facility of *Olearia lirata* and *Zieria arborescens* as colonisers of disturbance sites is illustrated at a site on the slopes above the creek on the upper reaches of Big River at 290 m asl. Here, a landslip zone has been colonised mainly by two species *Olearia lirata* and *Zieria arborescens.* There is a dense mat of grasses and other herbs on the moist ground. The shrubs are now 2–3 m tall while the scrub to the edge of the slip is dominated by *Pomaderris apetala* and is 5–6 m in height. The age of the slip is unknown. *Zieria arborescens* is one of the most abundant shrubs in the reserve and continuous regeneration is evident in many places. The persistence and success of *Zieria* at least, and possibly *Olearia lirata* must be facilitated by feral pig disturbance.

Leptospermum lanigerum Low Forest.

This disturbance community (sampled at five sites between 660 m and 710 m asl) appears to have been long unburnt and comprises a dense forest of umbrageous multi-stem *Leptospermum lanigerum* with a very open understorey characterised by a dense bryophyte and fern carpet. *Monotoca glauca* occasionally occurs as an undershrub and *Dicksonia antarctica* occurs more abundantly along the drainage lines. Bryophyte cover in most parts of the forest is complete and growing from this substrate we observed *Polystichum proliferum*, juvenile *Tasmannia lanceolata*, *Hypolepis rugosula, Histiopteris incisa, Xerochrysum papillosa, Juncus pauciflorus*, juvenile *Coprosma quadrifida, Hydrocotyle* sp., *Uncinia* sp., and juvenile *Cyathodes juniperina*. *Huperzia varia* was occasionally observed growing in the forks of branches on *Leptospermum*. Occasional specimens of *Tasmannia lanceolata* occur in the tree canopy. Some of the above species such as *Histiopteris* and *Xerochrysum* indicate some level of disturbance here but the presence of occasional plants of *Gahnia grandis* which are clearly losing vigour and are approaching death, probably represents the decline of this adventive species from the major fire event that probably triggered germination of the *Leptospermum* forest. In some sites in this forest there are *Epacris paludosa* shrubs with stems 3 m long and basal diameters of 5 cm. At the head of the gully at 660 m amidst 4 m high *Leptospermum lanigerum* there is a solitary contorted multi-stem *Eucalyptus nitida* with dense lichen encrustations on the limbs. Is this analogous to the position of eucalypts in the "dry rainforest" of the pre-Holocene landscape?

Bryophyte association with vegetation mapping units

The eastern Bass Strait climate, with enduring dry windy conditions, ensures that the majority of lower elevation vegetation types are unsuitable for luxuriant bryophyte growth. Only the most desiccation tolerant species are common in coastal dry vegetation and these sites generally include a smaller subset of the Park's bryoflora. Sites that are protected from drying winds yield higher bryophyte richness. Gullies and riparian areas provide conditions more favourable for bryophyte richness compared with surrounding areas (Pharo and Beattie 2001; Dynesius *et al*. 2009), and this is pronounced within the Park. The peak of Mt Strzelecki and high elevation cloud forest provides for high species richness due to lower temperature and higher humidity on average compared with the remainder of the Park (Figure 6).

Within the Flinders bioregion in Tasmania, the contrast in bryophyte composition between cool humid habitats and dry lowland habitats contributes to an overall significant association between bryophyte and vascular plant composition (ANOSIM: Global $R=0.52$, $p<0.001$) (Figure 7). The association, while significant, is only moderate due to a subset of species which occupy similar habitats within a range of dry woodland and scrub communities.

Coastal Vegetation on alkaline sands has a characteristic bryoflora including *Trichostomum eckelianum*, *Tortula antarctica*, *Thuidiopsis furfurosa* and *Rosulabryum billardieri*. The Tasmanian distribution of *Trichostomum eckelianum* appears restricted to the Furneaux Islands (AVH 2014). On bark and logs, the mosses *Racopilum cuspidigerum* var. *convolutaceum* and *Sematophyllum homomallum* are frequently occurring, as is the widespread liverwort *Chiloscyphus semiteres* s.l. In *Allocasuarina verticillata* Forest, bryophytes have very low cover and richness on the ground where the mosses *Gigaspermum repens*, *Trichostomum eckelianum*, *Barbula calycina* and *Tortula antarctica* occur in patches. On acidic, peaty sand the characteristic liverworts *Lethocolea pansa*, *Chaetophyllopsis whiteleggei, Goebelobryum unguiculatum* and occasionally the moss *Campylopus acuminatus* var. *kirkii* occur.

Fig. 6. The understorey of high altitude *Leptospermum lanigerum* forest with a dense bryophyte and fern ground layer.

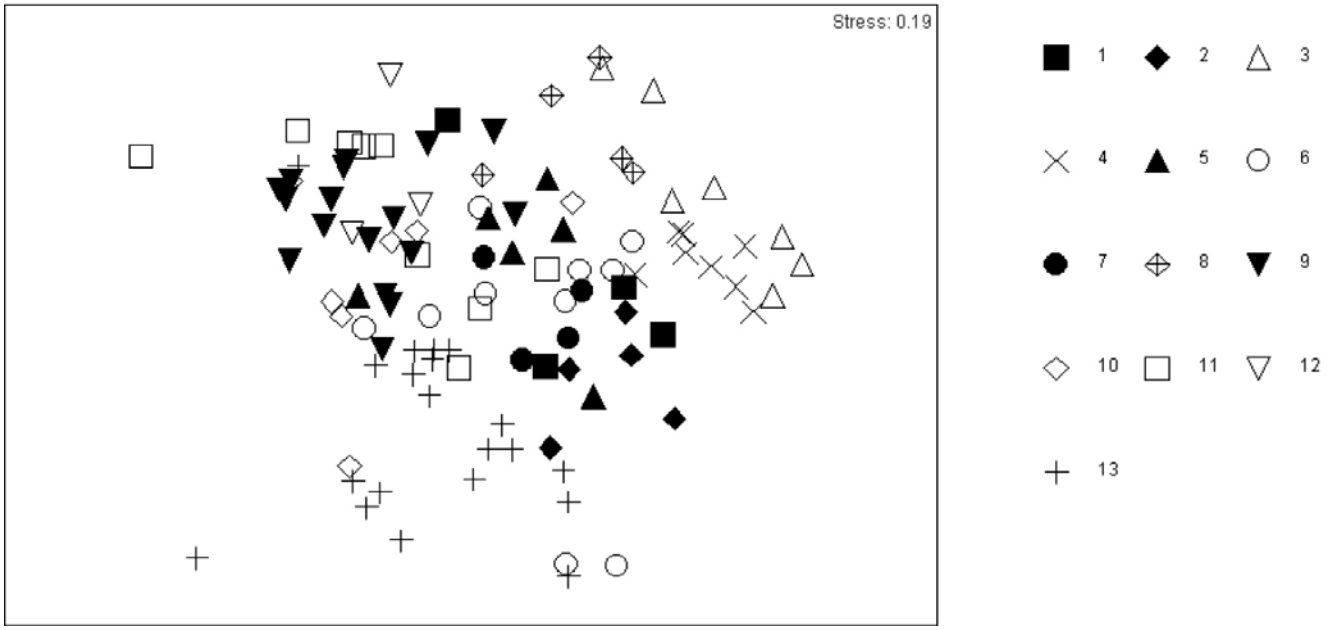

Fig. 7. Site bryophyte compositional similarity in northeast Tasmania, showing factors for vascular vegetation type (n=106): 1. *Eucalyptus amygdalina* coastal forest and woodland (dry), 2. *Melaleuca ericifolia* swamp forest, 3. Broad-leaf scrub / *Nothofagus-Atherosperma* rainforest, 4. *Eucalyptus viminalis* Furneaux forest and woodland (wet) / *Eucalyptus regnans* forest, 5. Dry Scrub, 6. *Eucalyptus nitida* Furneaux forest, 7. *Eucalyptus viminalis-Eucalyptus globulus* coastal forest and woodland, 8. *Eucalyptus amygdalina* coastal forest and woodland (wet), 9. *Leptospermum glaucescens* heathlands and scrubs / Coastal heathland (*Xanthorrhoea* dominant), 10. *Leptospermum glaucescens* heathlands and scrubs / Coastal Heathland (*Banksia* dominant), 11. Wet heathland (graminoid dominant), 12. Wet heathland (shrub dominant), 13. Coastal scrub on alkaline sands / Coastal grass and herbfield.

Away from the coast, the variation of climate and disturbance history at site level in Myrtaceous Scrub provides a range of habitat conditions for bryophytes, although the exposed position of this vegetation makes it incompatible for high bryophyte richness, except at higher elevation. In dry sites, desiccation tolerant species including the moss *Campylopus introflexus* and liverwort *Chiloscyphus semiteres* occur in patches on the ground. Bark of *Allocasuarina littoralis* and other shrub species occasionally have the moss *Sematophyllum homomallum, Rosulabryum billardieri* and liverworts *Frullania probisciphora* and *Frullania monocera*.

Dry scrub, woodland and forest vegetation has more complex topography, vegetation structure and contains a broad ecological subset of the island's bryoflora, partially due to more variation in habitat types at the site scale compared with aforementioned vegetation types. By far, most taxa are found near the ground and elevated substrates have few bryophyte taxa due to exposure. Examples can be seen in *Eucalyptus nitida* Forest where frequently occurring soil bryophytes include *Campylopus introflexus*, *Campylopus australis*, *Rhaphidorrhynchium amoenum*, *Rosulabryum billardieri*, *Hypnum cupressiforme*, *Ptychomnion aciculare*, *Ditrichum difficile* and *Dicranoloma billardieri*. On granite outcrops the mosses *Campylopus bicolor*, *Sclerodontium pallidum*, *Racopilum cuspiderum* var. *convolutaceum* and the liverworts *Acromastigum colensoanum*, *Ballantiopsis diplophylla, Metzgeria furcata* and *Cheilolejeunea mimosa* are relatively frequent. In wetter eucalypt dominated vegetation, bryophyte species occurring on bark include the mosses *Thuidiopsis sparsa*, *Wijkia extenuata*, *Sematophyllum homomallum* and the liverworts *Chiloschyphus semiteres*, *Telaranea tridactylis*, *Chiloscyphus villosus* and *Frullania falciloba*. The moss *Distichophyllum crispulum* is found in wetter examples of *Eucalyptus nitida* Forest and is known in Tasmania only from the Furneaux Islands; it is otherwise distributed along eastern temperate and tropical Australia to northern Queensland (AVH 2014). Within the Park, this species was recorded on soil, rock and *Dicksonia antarctica*. Rock outcrops provide distinctive bryophyte communities which are floristically similar to those described by Ashton and Webb (1977) for the northern extent of the Flinders bioregion on Wilsons Promontory. Bryophyte patches are often more extensively developed on the upper perimeter of granite sheets and in larger cracks where fed by moisture draining through the layers of vegetation above. Those species comprising the highest cover are typically the mosses *Campylopus bicolor, Sclerodontium pallidum, Dicranoloma menziesii* and the liverworts *Jamesoniella colorata* and *Balantiopsis diplophylla*. Rock outcrops in coastal areas have few bryophytes.

In *Melaleuca ericifolia* Forest, the aquatic liverwort *Chiloscyphus planiusculus* occurs submerged on the stream bank and rocks. The small liverworts *Kurzia compacta* and *Zoopsis leitgebiana* are a common component on the stream bank where they form contiguous mats over many square metres. Other species on soil include the mosses *Fissidens tenellus*, *Leucobryum candidum*, *Racopilum cuspidigerum* var. *convolutaceum*, *Rhyncostegium tenuifolium*, *Thuidiopsis sparsa* and *Wijkia extenuata* as well as the liverworts *Heteroscyphus coalitus* and *Chiloscyphus semiteres*. Soil disturbance by pigs provides suitable conditions for the liverwort *Lunularia cruciata*. *Eucalyptus viminalis* Forest

has a more open canopy compared with *Melaleuca ericifolia* Forest and this combined with usually more substrate types contributes to a moderate diversity of bryophyte species. Granite boulders in *Eucalyptus viminalis* Forest include the liverworts *Acromastigum colensoanum*, *Heteroscyphus coalitus*, *Chiloscyphus latifolius*, *Metzgeria furcata*, *Symphyogyna podophylla*, *Balantiopsis diplophylla*, *Kurzia compacta* and the mosses *Hypnodendron vitiense*, *Dicranoloma menziesii*, *Camptochaete arbuscula* and *Rhynostegium tenuifoium*. Treefern trunks in this vegetation type include the epiphytic mosses *Rhizogonium distichum*, *Dicranoloma billardieri*, *Wijkia extenuata* and the liverworts *Chiloscyphus semiteres* and *Zoopsis leitgebiana* amongst others. The moss *Calyptrochaeta brownii* and the liverworts *Chiloscyphus villosus* and *Frullania monocera* are found often on the lower trunk of *Acacia melanoxylon*. *Sphagnum cristatum* occurs on the edge of water pools; this species is generally uncommon in eastern Bass Strait.

Rainforest-like conditions in Bass Strait such as those found in *Spyridium gunnii-Pomaderris apetala* Cloud Forest are very restricted spatially. Some taxa occur as a relic population in this community and, as such, are of biogeographic interest for south eastern Australia. Adjacent to this vegetation type, montane vegetation in the highest elevation zone of Mt Strzelecki represents the most bryophyte rich vegetation on Flinders Island with 55 taxa recorded during the current survey. Regionally important species include the moss *Calomnion complanatum* which occurs on treefern trunks, and a record at the headwater of Fotheringate Creek is an addition to the few documented sites (Meagher 1999) for this species in Tasmania, Victoria and New South Wales. Other bryophyte taxa apparently restricted to higher elevated areas in the Park include the liverworts *Marsupidium setulosum*, *Chandonanthus squarrosus*, *Anastrophyllum schismoides*, *Cuspidatula monodon*, *Jamesoniella colorata* and the moss *Rhacocarpus purpurascens*. In Tasmania, these taxa are otherwise found more commonly in rainforest or at higher elevation on the mainland (AVH 2014).

Fire

The interaction of fire with the Park vegetation has been profound. Different parts of the mountain range have different fire histories. The fire ages for which there is good evidence (including historical records, anecdotal reports and eucalypt ages) are 1948, about 1968, 1978 and 1994. There are charred eucalypt downers and stumps, the diameters of which suggest a fire-free interval until the time of their death of at least 100 years. The rainforest suggests a fire-free interval of several hundred years. Historical evidence indicates bushfires in the 1830s. Robinson in his journal entry for 11 January 1836 (Plomley 1987) remarked that they:

Saw immense smokes these several days past in different parts of the island and a long distance off. These are the smokes of the native fires

Again, on 3 February 1837: *Excessive hot fires these several days past and a great smoke*

In 1913 a party from the Royal Australian Ornithologist's Union (Mellor and White 1913) reported: *A party was formed to visit the lofty Strzelecki Ranges…..Approaching the ranges, which lay about 12 or 14 miles from the main camp, the party met with some fine forest country, thickly timbered with giant blue gums (Eucalyptus globulus). Bush fires had been raging, and many of the splendid trees were dead.*

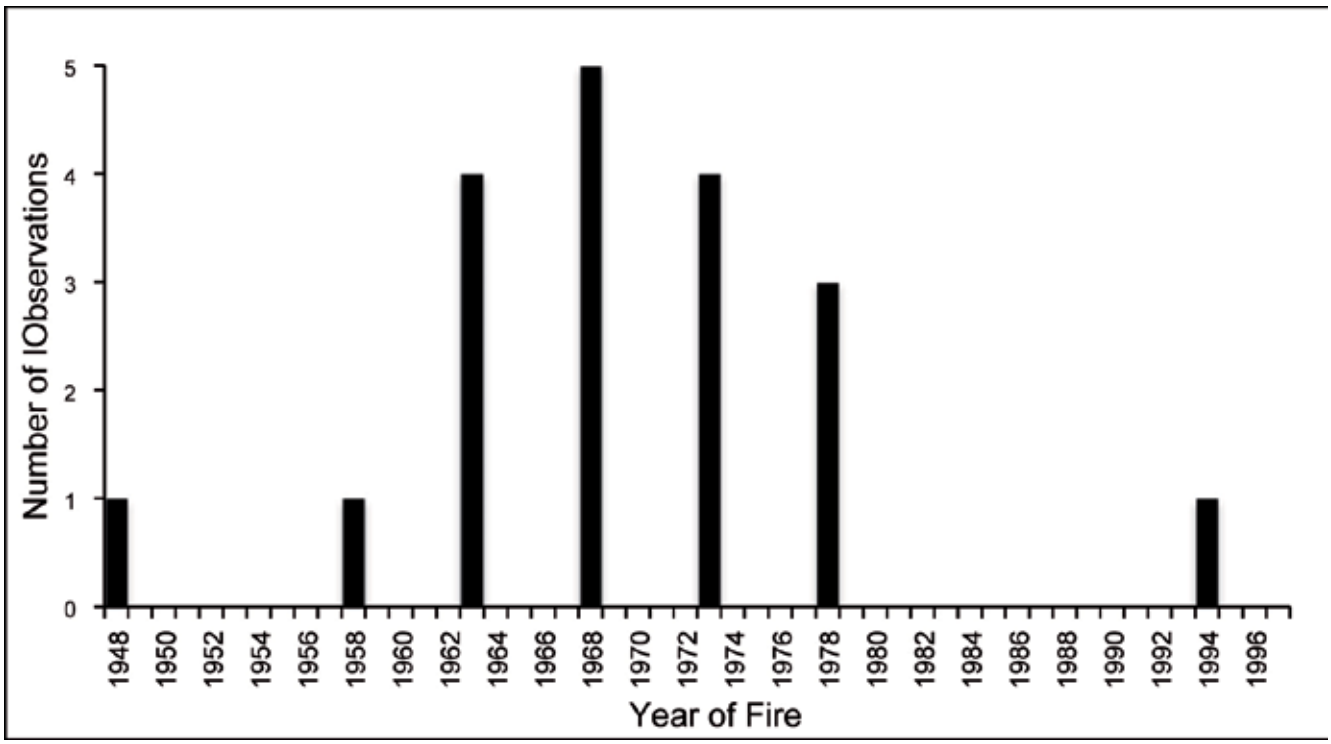

Fig. 8. Years of fire indicated by nodal counts from *Banksia marginata.*

The nodal counts on *Banksia marginata* (Figure 8) indicate germination events (fire) in 1963, 1968 and 1973. At least three *Banksia marginata* sites resulted in average counts indicating an origin for these years. Nodal counts yielding ages outside these years do not necessarily denote a major fire, as there was only 1 site each where trees were counted, and that indicated origins in the years 1948, 1958 and 1994. Spatially, the fire frequency is highest around the lower western slopes of the mountains, above and below the Big River Road where scrub and heath is concentrated. Fire frequency has also been higher on the flatter Crown land areas on the eastern side of the Park. Ignition sources are provided by the road on the western perimeter and farmland to the north and east and the Big River farm. More recent fires mask evidence of earlier ones especially where the vegetation is scrub and heath. In forests, evidence of past fires persists in the form of fire scars on trees or burnt downers and stumps.

The most fire-sensitive vegetation occurs in the headwaters of Fotheringate Creek where *Atherosperma moschatum* dominated rainforest persists because of the fire protection afforded by steep cliffs and boulder fields. This area is the most bryophyte species-rich on Flinders Island. Adjoining the forest is an extensive tract of *Leptospermum lanigerum* forest which has developed free of fire for many years. *Gahnia grandis* is present as a few straggly plants which have lost their vigour. The single age size class in the *Leptospermum lanigerum* suggests an intense fire regenerated this even-aged forest.

The rugged nature of the range provides a great deal of natural fire protection for much of the Park. Patches of tall *Eucalyptus viminalis* forest, rainforest, gallery forests with predominantly relict wet forest and rainforest elements and restricted *Callitris* communities, all benefit from low fire frequency due to position in the landscape. Filmy ferns and some bryophyte taxa are a good indicator of a long fire-free interval (Brown and Podger 1982). Filmy ferns were recorded in a large number of plots throughout the Park except around the perimeter of the mountains where there is less moisture and where fires would have had maximum impact on the ground layer. In much of the mountain range, incursion by fires may still have meant that complete incineration of the ground layer was impossible because of the rugged topography and boulders. Filmy ferns can escape destruction in protected crevices.

Examination of aerial photographs clearly shows the finer textured scrubs, heaths and young regenerating eucalypts as extensive skirting communities around the mountains which contrast with the coarser textured vegetation in the interior of the mountains. Even in the fastness of the mountains, many patches exhibiting different fire ages exist, resulting from spot fires and other disturbances. Escaped burns from around the edge of the mountains have enabled fire incursions with some attendant "spotting" into more remote areas.

The climax vegetation without fire would have been rainforest dominated by *Atherosperma moschatum*, *with Elaeocarpus reticulatus* co-dominant in the deeper valleys. Patches of climax dry rainforest occurred in boulder fields in valleys and some slopes. Large emergent *Eucalyptus globulus, Eucalyptus nitida* and *Eucalyptus viminalis* occurred with *Callitris rhomboidea* and *Allocasuarina verticillata* dominated forests on the more insolated slopes below the cloud forest layer. *Pomaderris apetala* and *Spyridium gunnii* dominated cloud forests on sites where the *Atherosperma moschatum* forest did not occur.

When humans began occupying the Furneaux Islands at the end of the eighteenth century, there had been a hiatus in human occupation of at least 4,000 years (Sim 1991). Although reconstruction of the vegetation is problematic, at the time of European arrival there was probably more extensive old rainforest and *Callitris* dominated forests on the mountains, and old eucalypt mixed forest and wet eucalypt forest. In any case the above-ground biomass would have been large because of the long fire interval. The earliest canopy fires in hot summer north easterly wind conditions would have been huge blazes, firestorms assisted by the winds and turbulence created around the mountains. Much of the Park would have been affected in this early period. Subsequent big fires have also spotted into the Park and because of the topography and wind turbulence that would exist in fire conditions, there would be some sites that have been burnt with great intensity and other sites incompletely burned.

Feral Pig Damage

Feral pigs occur throughout most of the study area and have certainly been present on Flinders Island since the nineteenth century. The Park is one of their main strongholds because there is plenty of cover for them and they are beyond disturbance by hunters. The rainfall is high enough to encourage the more rapid formation of damp humic soil horizon and water is abundant in the mountains.

We observed clear signs of pig rooting and/or pigs in 44 % of plot sites as well as pig disturbance along most of the traverses in between these plots. Pig damage was most obvious in the gullies where the organic soil was deeper, but was by no means confined to such areas. Damage was observed at all altitudes up to 700 m and in a range of vegetation types. Types of damage was noted frequently as: "pig ploughing in deep loamy soil", "lots of litter and ground disturbance from pigs – hoof marks evident", "litter pushed into heaps", "pig ploughing – deep dark humic loams. Sow with five piglets observed", "pig scats nearby", "deep litter except pigs have pushed up litter and mounds of bare soil". Impact on the vegetation is likely to have been profound but there is little chance to compare the present vegetation with what it was like before pigs were introduced, because we believe pigs now occupy all suitable habitat within the mountain range.

Some insight into the possible impacts can be judged from observations nonetheless. The prevalence of *Zieria arborescens*, a disturbance coloniser throughout the Park, even in areas free of fire (the usual initiator of *Zieria* regeneration) is likely due to ground disturbance caused by pigs. The bright green tone visible on aerial photographs across much of the mountain range is *Zieria arborescens* in the understorey. Some species may have been almost

eliminated or at least severely depleted, particularly as pigs are probably exploiting 100% of certain habitats. For example, *Drymophila cyanocarpa* was recorded only once in our survey yet this small ground herb would have been expected in greater abundance. Fungi would be eaten and their fruiting bodies almost never observed in areas corresponding with recent pig disturbance. Similarly orchid tubers would be eaten. *Xerochrysum papillosum* is another disturbance requirer for pulse recruitment and is more abundant in the Park than would otherwise be expected. On the *Melaleuca* flats on the lower reaches of the Big River just outside the National Park boundary, *Blechnum nudum* would be the dominant ground cover except that it has been completely eliminated by the pigs and only a couple of remnant specimens remain where they occur under the lip of a stream bank. *Hypolepis rugosula*, a rhizomatous fern favoured by ground disturbance is abundant at the same site. At similar sites, *Histiopteris incisa*, which is also favoured by disturbance is abundant. Many areas were expected to have a 100% cover of bryophytes and ferns but had much less cover, or none, a condition attributable to the pigs. One site near plot 117, which was in the midst of an area extremely disturbed by pigs, had for some reason been untouched. This patch was bryophyte covered with many individuals of *Hydrocotyle hirta*, *Luzula flaccida*, *Microlaena stipoides*, *Wahlenbergia* sp. and *Zieria* seedlings.

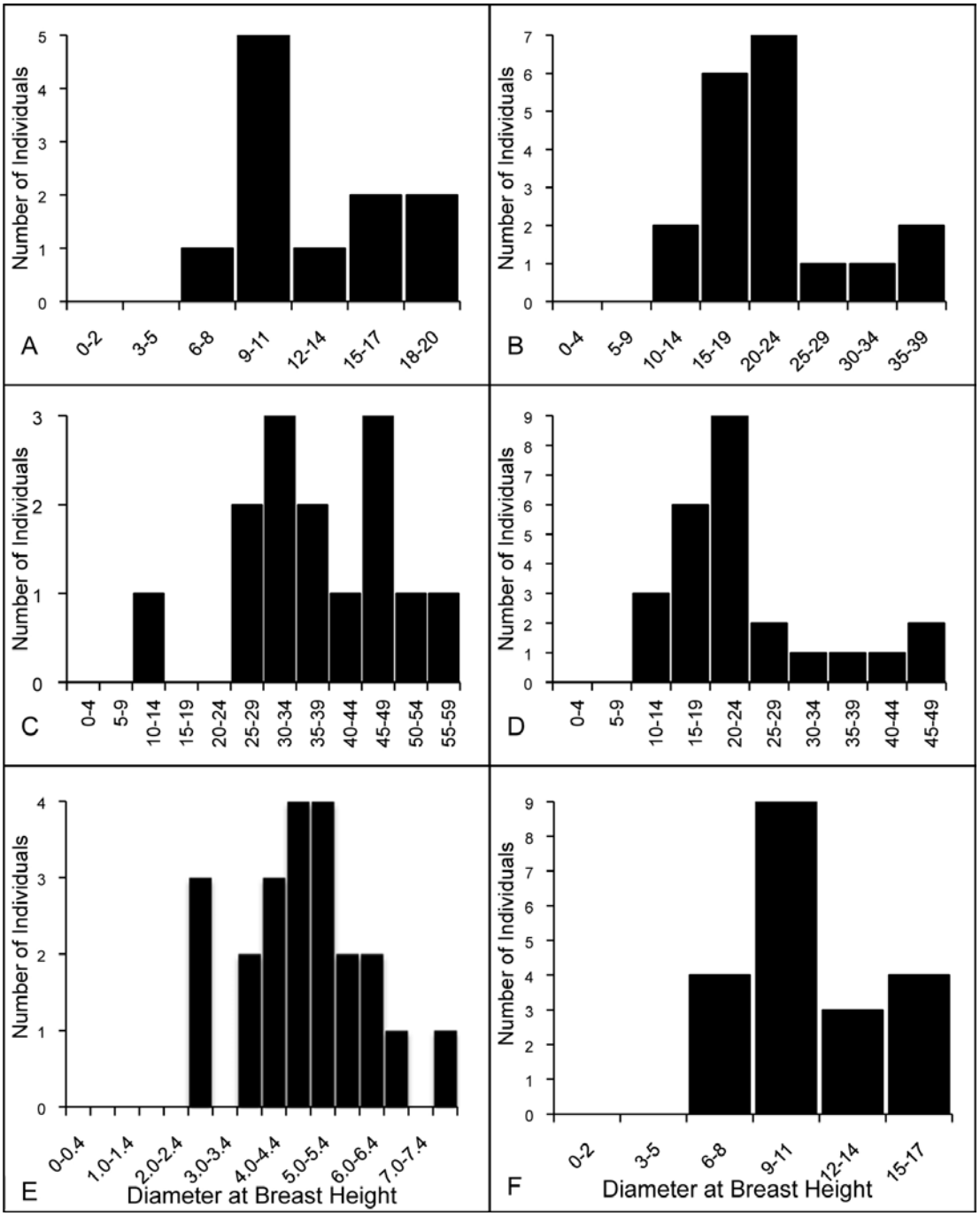

Fig. 9. Diameter at breast height in centimetres of *(A) Elaeocarpus reticulatus, (B) Eucalyptus nitida, (C) Acacia melanoxylon, (D) Melaleuca ericifolia, (E) Zieria arborescens, (F) Leptospermum scoparium*.

No evidence of pigs or pig damage was observed around the southern and eastern lower perimeter slopes of the mountain range, certainly very rarely below the 200 m contour. Soils for the most part here are siliceous shallow mineral soils with barely any organic horizon; this zone corresponds with the shorter fire-interval scrub and woodland vegetation.

The species stem diameter classes shown in figure 9 indicate different age cohorts. The largest stem ranges are 10-60 cm for *Acacia mela*noxylon, 10-50 cm for *Melaleuca ericifolia* and 10-40 for *Eucalyptus nitida*, all relatively long-lived trees. Stems for *Eleocarpus reticulatus* and *Leptospermum scoparium* range from 6-20 cm reflecting the shrubby habit of these species on the perimeter of the Park responding to more recent fires, while *Zieria arborescens* ranges from 2-8 cm, indicating more recent disturbance, either fire or feral pig ground disturbance.

Wind-throw

Wind-throw damage in the Strzelecki Range is sometimes spectacular and evidence for its effects is common. Wind gusts on Flinders have reached 131 km/hr at the coast, and is sufficiently strong to power large wind generators behind Whitemark. As expected, the winds would often be more severe at higher altitudes and given the rugged nature of the Strzelecki Range some considerable turbulence would result. On the coast the effect of onshore wind is demonstrated by the espalier effect on shrubs. In the mountains, the results of strong winds are more likely unpredictable and appear to have catastrophic effects on the vegetation.

In a few sites (for example at plot 49 on the shoulder of the Razorback), it appeared that a strong wind eddy had just blown a hole in the vegetation and lots of limbs and downers lay about on the ground. At the head of a watercourse about 1.5 km due south of the Razorback, *Allocasuarina verticillata* trees up to 15 m high have been blown over and the resulting gap in the forest canopy is up to 250 m across. At 680 m altitude areas of broken canopy occur in the dense closed *Leptospermum lanigerum* low closed forest. We venture the cause of these as being strong wind eddies. Once a gap or hole is created, the way is open for more damage to occur at a later time. For example, just off the main road 2 km north of the Trousers Point turnoff, wind has penetrated a stand of *Eucalyptus globulus-Eucalyptus nitida-Allocasuarina verticillata* and created a blowdown area of about 10 m by 5 m. The roadside edges normally allow some wind protection because of the dense shrubbery but if this is breached then vegetation can be affected. Sites where scrub or forest has developed on skeletal soil on granite slabs or steep sites are particularly vulnerable. Even last century, observations were made about wind throw on a climb up Mt Strzelecki (Gabriel 1894): *At the foot of this peak was a nasty belt of ti-tree, which had been under the influence of fire or something else, and had been blown down with the branches the wrong way.*

Discussion

Strzelecki National Park is a dramatic landscape with the highest mountains in Bass Strait. The altitude contributes to the cloud capping and consequent elevated moisture availability in the mountains. The ruggedness is due to the deeply dissected granite topography and it is likely that the ranges have remained above sea level during glacial and inter-glacial cycles. Together these factors have created niches for vegetation that have been protected from fire for long periods. The consequence is the occurrence of fire sensitive plant communities and plant species that occur nowhere else in Bass Strait and may be sufficiently removed from their nearest congeners to have allowed some evolutionary isolation. Unlike most of Australia there was no Aboriginal presence on the island, therefore no human-initiated fire, for several thousand years but no part of the Park has been completely isolated from fire; there is evidence of lightning strikes being common on the Strzelecki Ranges (as well as the Darling Ranges further north on Flinders Island). Localised fires may start from these; in the Strzelecki Ranges the effect may be highly localised whereas in the drier Darling Ranges lightning initiated fire has been observed to burn large areas of country. Fire frequency would have accelerated with European settlement in eastern Bass Strait in the early nineteenth century; the fires used to clear bush in the early part of the twentieth century burned well up the flanks of the mountains. Spot fires no doubt initiated some of the even-aged eucalypt cohorts in the Park.

Fire is the greatest single consideration in future vegetation management and a fire plan for the National Park and surrounding Crown land should consider fire sensitive vegetation types which will benefit from fire exclusion. Some vascular and non-vascular plant taxa may become extinct on Flinders Island if long-unburnt higher elevation communities are subjected to a different fire regime. The low nutrient granite soils mean a slow return time to pre-fire vegetation condition for burnt rainforest or wet forests.

Currently anticipated changes in regional climate parameters are unlikely to increase the likelihood of adverse conditions for the vegetation, because of the persistence of the fundamental biophysical factors - the constant westerly airstreams and mountain height. Continuation of the high moisture regime in the mountains will continue to aid the persistence of the fire protected communities in the core of the Park.

The presence of highly flammable vegetation around the Park perimeter and occasional high wind speeds and increased air turbulence caused by the steep topography, indicate the likelihood of intense fire storms under certain conditions. Ignition sources may be lightning strikes or more probably from escaped fuel reduction fires along the Park perimeter. Some intense fires have no doubt entered the mountain ranges but the fire frequency around the Park perimeter is clearly much higher.

Fires will originate from outside the Park and burn into it. Management actions should include: encouraging adjoining landholders to cooperate and co-own the prescriptions, having some strategically placed and well maintained fire breaks, closing certain access points in periods of extreme fire danger. Some small patch burning around the perimeters of the Park will be necessary. Fuel reduction burns of the Park on any more than a localised or peripheral scale are not considered necessary or desirable however fire suppression should be considered under some circumstances.

Future Studies

Strzelecki National Park is a unique site for further natural history. We recommend a complete exploration of the lichen flora and its documentation and further sampling of bryophytes within the higher elevations areas is needed to gain a better understanding of the distribution of apparently very rare species to guide management of the Park's biodiversity.

The vegetation communities subject to episodic cloud cover deserve more study, both from a comparative viewpoint with other cloud forests, and in terms of ecophysiological processes within them. Very little literature exists on cloud forests outside of the tropical regions. To assist with future studies, automated climatic station devices capable of recording and transmitting basic climate data need to be placed in the higher part of the mountains.

Feral pigs have had a noticeable impact on the environment in the Park by destroying groundlayer vegetation and stimulating disturbance requirers such as *Zieria arborescens*. We have noted a range of other impacts on flora and there will inevitably be impacts on soil invertebrate fauna. Feral pig eradication may need to be addressed in the context of an eradication plan across the whole of Flinders Island because migration occurs back and forth into the Park from other parts of the island. Notwithstanding this the Park and adjoining bush is bounded by farmland to the north and east, and is a discrete unit within which to control and then eradicate pigs through the use of baited trapping stations and shooting.

Acknowledgements

Chris Arthur, formerly of the Parks and Wildlife Service provided a sketch map of old fire boundaries as well as providing encouragement and showing us the feral pig traps on the fire trail. The authors are pleased to thank Louisa d'Arville and Spencer Chung (both formerly of DPIPWE) who assisted with preparation of the figures. Assistance in the field was provided by Eve Lazarus, Meredith Reardon, Sue Backhouse, Adrian Heard, Andrew Rozefelds, Danielle Wood, Linda Bester and David Cameron. Arduous traverses, often involving overnight bivouacs were cheerfully undertaken at various times by these excellent companions. Candida Barclay (Invasive Species Branch, DPIPWE) discussed the potential use of the feral pig data collected and how it can inform management. Hans Wapstra identified some orchid species.

We are also indebted to Drs Anna and Rob Stewart, Fiona Stewart and Dr David Cheal for their hospitality while some of this work was carried out, Wayne Warren for his local knowledge and to James Luddington for sharing his knowledge of local climatic effects. We thank staff at HO and MEL for information of plant determinations and distributions. Matthew Dell would like to thank Maria Gibson and John Jenkin for supervision.

References

Ashton D.H. & Webb R.N. (1977) The ecology of granite outcrops at Wilson's Promontory, Victoria. *Austral Ecology,* 2: 269–296.

AVH (2014). Australia's Virtual Herbarium, Council of Heads of Australasian Herbaria, http://avh.chah.org.au, accessed 2014.

Baker, M.L. & de Salas, M.F. (2013) *A census of the vascular plants of Tasmania and index to the student's flora of Tasmania and Flora of Tasmania Online*. Tasmanian Herbarium, Tasmanian Museum and Art Gallery, Hobart. 6

Brown, M.J. & Podger, F.D. (1982) Floristics and fire regimes of a vegetated sequence from sedgeland-heath to rainforest at Bathurst Harbour, Tasmania. *Australian Journal of Botany,* 30: 659–676.

Busby, J.R. (1991). BIOCLIM – A Bioclimatic Analysis and Prediction System. In: *Nature Conservation: Cost Effective Biological Survey and Data Analysis*. Eds Margules, C.R. & Austin, M.P. Canberra: CSIRO: 64-68.

Cody, M.L. (1986): Diversity, rarity, and conservation in Mediterranean-climate regions. In: Soule, M.E. (Ed) 1986 *Conservation Biology: The Science of Scarcity and Diversity,* Sinauer, Sunderland, Mass.

Critchfield, H.J. (1966) *General climatology*. 2nd Ed. Prentice-Hall, Englewood Cliffs, NJ.

Department of Environment & Primary Industries (2014) *Victorian Biodiversity Atlas.* State of Victoria, DEPI, Melbourne.

Dynesius, M. Hylander, K. & Nilsson, C. (2009) High resilience of bryophyte assemblages in streamside compared to upland forest. *Ecology*, 90(4): 1042–1054.

Gabriel, J. (1894) Report of Expedition to Furneaux Group. *Victorian Naturalist*, 10(1): 167–184.

Harris, S., Buchanan, A. & Connolly A. (2001) *One hundred islands: The flora of the Outer Furneaux*. Department of Primary Industries, Water and the Environment, Tasmania. Printing Authority of Tasmania, Hobart.

Harris, S. & Kitchener, A. (2005) *From Forest to Fjaeldmark. Descriptions of Tasmania's Vegetation.* Department of Primary Industries, Water and Environment. Printing Authority, Hobart.

Heney, H. (2014) *Strzelecki, Sir Paul Edmund de (1797–1873)*. Australian Dictionary of Biography. National Centre of Biography, Australian National University, http://adb.anu.edu.au/biography/strzelecki_sir_paul_edmund_de_2711/text3809, published in hardcopy 1967, accessed online 3 August 2014.

Jennings, D.J. & Cox, S.F. (1978) *King Island-Flinders Island 1:250 000 geological map sheet compilation.* Geological Survey of Tasmania, Department of Mines.

Kirkpatrick, J.B. & Harris, S. (1999) *The disappearing heath revisited*. Tasmanian Environment Centre, Hobart.

Kirkpatrick, J.B. & Harris, S. (1995) *The conservation of Tasmanian dry coastal vascular plant communities. Wildlife Scientific Report 95/1.* Parks and Wildlife Service, Tasmania.

McCarthy, P.M. (2006) *Checklist of Australian Liverworts and Hornworts.* Australian Biological Resources Study, Canberra. Version 6 April 2006. http://www.anbg.gov.au/abrs/liverwortlist/liverworts_intro.html.

Meagher D (1999) *Calomnion complanatum*: an endangered moss found in Victoria. *Victorian Naturalist*, 116: 68–69.

Mellor, J.W. & White, S.A. (1913) Flinders Island Camp-out Royal Australasian Ornithologists Union. *Emu*, 158–165.

Mort, K. (2005) Mount Strzelecki, p245 in Alexander, A. (ed) *The Companion to Tasmanian History* (Centre for Tasmanian Historical Studies, University of Tasmania: Hobart).

Munks, S.A. (1990) Ecological energetics and reproduction in the common ringtail possum, *Pseudocheirus peregrinus* (Masupiala: Phalangeroidea). PhD Thesis, University of Tasmania.

Parks & Wildlife Service (2000) *Strzelecki National Park Management Plan*. PWS, Department of Primary Industries, Water and Environment. Hobart.

Pharo E.J. & Beattie A.J. (2001) Management forest types as a surrogate for vascular plant, bryophyte and lichen diversity. *Australian Journal of Botany*, 49: 23–30.

Plomley, N.J.B. (1987) *Weep in silence.* Blubber Head Press, Hobart.

Saunders, A. & Yockney, I. (2012) *Managing feral pigs on Flinders Island: past management and future options.* Report for NRM North. Landcare Research, Hamilton, New Zealand.

Scott, G.A.M., Entwisle, T.J., May, T.W. & Stevens, G.W. (1997) *A conservation overview of Australian non-marine lichens, bryophytes, algae and fungi*. Environment Australia.

Sim, R. (1991) *Prehistoric archaeological investigations on King and Flinders Island, Bass Strait, Tasmania.* Unpub. MA thesis, Australian National University, Canberra.

Statham, M. & Middleton, M. (1987) Feral pigs on Flinders Island. *Papers and Proceedings of the Royal Society of Tasmania,* 121: 121–124.

Underwood, S. (1998) Synecology and Conservation of Vegetation on Aeolian Calcarenite, Flinders Island. B.Sc. Hons. Thesis. University of Tasmania.

Underwood, S. (2000) The impact of feral pigs (*Sus scrofa*) on Flinders Island, Tasmania. Report prepared for the Commonwealth Natural Heritage Trust. Department of Primary Industries, Water and Environment.

Wells, P. (1989) *Recommended areas for Protection of Wet Eucalypt Forests. Working Group for Forest Conservation.* PWS & Forestry Commission, Tasmania.

Willis, J.H. (1954) Plants noted on Strzelecki Peaks, Flinders Island, Bass Strait, Tas. Handwritten manuscript, 2 pages. Library, Royal Botanic Gardens, Melbourne.

Manuscript accepted 12 October 2015

APPENDIX 1. List of Non-vascular plants (liverworts and mosses) and Vascular plants (ferns, conifers and flowering plants) in family order, recorded from Strzelecki National Park, Flinders Island, Tasmania.

Vascular flora compiled 2013; bryophytes 2013

r – listed as rare or threatened in Tasmania (Tasmanian *Threatened Species Protection Act 1995*),
e – endemic to Tasmania,
i – taxa introduced to the Park since European settlement.

Liverworts (MARCHANTIOPHYTA)

ACROBOLBACEAE
- *Acrobolbus concinnus*
- *Goebelobryum unguiculatum*
- *Lethocolea pansa*
- *Marsupidium setulosum*
- *Marsupidium surculosum*
- *Tylimanthus diversifolius*
- *Tylimanthus tenellus*

ADELANTHACEAE
- *Adelanthus bisetulus*
- *Calyptrocolea falcata*

ANERUACEAE
- *Riccardia crassa*

BALANTIOPSIDACEAE
- *Balantiopsis diplophylla*
- *Balantiopsis tumida*

CEPHALOZIELLACEAE
- *Cephaloziella exiliflora*
- *Cephaloziella hirta*

GEOCALYCACEAE
- *Chiloscyphus latifolius*
- *Chiloscyphus semiteres*
- *Chiloscyphus villosus*
- *Heteroscyphus biciliatus*
- *Heteroscyphus coalitus*
- *Heteroscyphus fissistipus*
- *Heteroscyphus knightii*
- *Heteroscyphus planiusculus*
- *Heteroscyphus supinus*

HYMENOPHYTACEAE
- *Hymenophyton flabellatum*

JUBULACEAE
- *Frullania clavata*
- *Frullania deplanata*
- *Frullania falciloba*
- *Frullania monocera*
- *Frullania probosciphora*
- *Frullania rostrata*

JUNGERMANNIACEAE
- *Anastrophyllum schismoides*
- *Chandonanthus squarrosus*
- *Cuspidatula monodon*
- *Jamesoniella colorata*

LEJEUNACEAE
Cheilolejeunea mimosa
LEPICOLEACEAE
Lepicolea scolopendra
LEPIDOLAENACEAE
Gackstroemia weindorferi
LEPIDOZIACEAE
Acromastigum colensoanum
Bazzania adnexa
Bazzania monilinervis
Kurzia compacta
Lepidozia glaucophylla
Lepidozia laevifolia var. laevifolia
Lepidozia ulothrix
Telaranea tridactylis
Telaranea centipes
Telaranea herzogii
Zoopsis argentea
Zoopsis leitgebiana
LUNULARIACEAE
Lunularia cruciata
MARCHANTIACEAE
Marchantia berteroana
METZGERIACEAE
Metzgeria furcata
PALLAVICINIACEAE
Symphyogyna podophylla
PLAGIOCHILACEAE
Plagiochila fasciculata
Plagiochila strombifolia
RADULACEAE
Radula buccinifera
Radula compacta
TRICHOCOLEACEAE
Trichocolea mollissima

Mosses (BRYOPHYTA)

ANDREAEACEAE
Andreaea amblyophylla
BARTRAMIACEAE
Breutelia affinis
BRACHYTHECIACEAE
Brachythecium rutabulum
Rhynchostegium tenuifolium
BRYACEAE
Gemmabryum cheelii
Rosulabryum billarderi
Rosulabryum capillare
CALOMNIACEAE
Calomnion complanatum
DICRANACEAE
Dicranoloma billarderi
Dicranoloma menziesii var. *menziesii*
Sclerodontium pallidum subsp. *pallidum*
DITRICHACEAE
Ceratodon purpureus subsp. *convolutus*
Ditrichum difficile
FISSIDENTACEAE
Fissidens curvatus var. *curvatus*
Fissidens sp.
Fissidens tenellus var. *tenellus*
Fissidens taylorii
FUNARIACEAE
Entosthodon subnudus var. *gracilis*
Funaria hygrometrica
GIGASPERMACEAE
Gigaspermum repens
GRIMMIACEAE
Grimmia laevigata
Grimmia pulvinata var. *africana*
Racomitrium crispulum
HEDWIGIACEAE
Hedwigia ciliata
Hedwigidium integrifolium
HOOKERIACEAE
Achrophyllum dentatum
Calyptrochaeta apiculata
Calyptrochaeta brownii
Distichophyllum crispulum
Distichophyllum pulchellum
HYPNACEAE
Hypnum chrysogaster
Hypnum cupressiforme
Hypnum cupressiforme var. *lacunosum*
Hypnum cupressiforme var. *mossmanianum*
HYPNODENDRACEAE
Hypnodendron vitiense subsp. *australe*
HYPOPTERYGIACEAE
Cyathophorum bulbosum
LEMBOPHYLLACEAE
Camptochaete arbuscula var. *arbuscula*
Camptochaete deflexa
Lembophyllum divulsum
Weymouthia mollis
LEPTOSTOMATACEAE
Leptostomum inclinans
LEUCOBRYACEAE
Campylopus australis
Campylopus acuminatus var. *kirkii*
Campylopus bicolor var. *bicolor*
Campylopus introflexus
Campylopus pyriformis
Leucobryum candidum
METEORIACEAE
Papillaria flavolimbata
MITTENIACEAE
Mittenia plumula
ORTHODONTIACEAE
Orthodontium lineare
ORTHOTRICHACEAE
Macrocoma tenuis subsp. *tenuis*
Macromitrium microstomum
Zygodon menziesii var. *menziesii*
Zygodon minutus
PLAGIOTHECIACEAE
Catagonium nitens subsp. *nitens*

POLYTRICHACEAE
Polytrichum juniperinum
POTTIACEAE
Barbula calycina
Calyptopogon mnioides
Tortula antarctica
Trichostomum eckelianum
Triquetrella papillata
Weissia controversa
PTYCHOMNIACEAE
Ptychomnion aciculare
RHACOCARPACEAE
Rhacocarpus purpurascens
RACOPILACEAE
Racopilum cuspidigerum var. *convolutaceum*
RHIZOGONIACEAE
Hymenodon pilifer
Leptotheca gaudichaudii var. *gaudichaudii*
Rhizogonium distichum
Rhizogonium novae-hollandiae
SEMATOPHYLLACEAE
Rhaphidorrhynchium amoenum
Sematophyllum homomallum
Wijkia extenuata
SPHAGNACEAE
Sphagnum cristatum
Sphagnum falcatulum
Sphagnum novozelandicum
SPHLACHNACEAE
Tayloria octoblepharum
TRACHYLOMATACEAE
Trachyloma planifolium
THUIDIACEAE
Thuidiopsis furfurosa
Thuidiopsis sparsa

Ferns (PTERIDOPHYTA)

ADIANTACEAE
Pellaea falcata
ASPLENIACEAE
Asplenium appendiculatum
Asplenium bulbiferum subsp. *gracillimum*
Asplenium flabellifolium
Asplenium obtusatum subsp. *northlandicum*
BLECHNACEAE
Blechnum nudum
Blechnum pennamarina subsp. *alpina*
Blechnum wattsii
CYATHEACEAE
Cyathea australis
DENNSTAEDTIACEAE
Histiopteris incisa
r *Hypolepis muelleri*
Hypolepis rugosula
Pteridium esculentum
DICKSONIACEAE
Dicksonia antarctica
DRYOPTERIDACEAE
Lastreopsis acuminata
Polystichum proliferum
Rumohra adiantiformis
GLEICHENIACEAE
Gleichenia dicarpa
Gleichenia microphylla
Sticherus tener
GRAMMITIDACEAE
Ctenopteris heterophylla
Grammitis billardierei
Grammitis magellanica subsp. *nothofageti*
HYMENOPHYLLACEA
Hymenophyllum australe
Hymenophyllum cupressiforme
Hymenophyllum flabellatum
Hymenophyllum marginatum
Hymenophyllum rarum
Crepidomanes venosum
LINDSAEACEAE
Lindsaea linearis
LYCOPODIACEAE
Huperzia varia
Lycopodium deuterodensum
OSMUNDACEAE
Todea barbara
POLYPODIACEAE
Microsorum pustulatum subsp. *pustulatum*
PSILOTACEAE
Tmesipteris obliqua
r *Tmesipteris parva*
PTERIDACEAE
Pteris tremula
SCHIZAEACEAE
Schizaea bifida
Schizaea fistulosa
SELAGINELLACEAE
Selaginella uliginosa

Conifers (GYMNOSPERMAE)

CUPRESSACEAE
Callitris rhomboidea

Flowering plants – monocots (MONOCOTYLEDONAE)

CENTROLEPIDACEAE
Centrolepis strigosa
CYPERACEAE
Baumea acuta
Carex appressa
Ficinia nodosa
Gahnia grandis
Gymnoschoenus sphaerocephalus
Isolepis aucklandica
Isolepis cernua

Isolepis marginata
Lepidosperma concavum
Lepidosperma elatius
Lepidosperma ensiforme
Lepidosperma filiforme
Lepidosperma gunnii
Lepidosperma longitudinale
Schoenus carsei
Schoenus lepidosperma subsp. *lepidosperma*
Tetraria capillaris
Uncinia tenella

IRIDACEAE
Patersonia fragilis

JUNCACEAE
Juncus pauciflorus
Juncus planifolius
i *Luzula campestris*
Luzula flaccida

LILIACEAE
Dianella brevicaulis
Dianella revoluta
Dianella tasmanica
Drymophila cyanocarpa
Thelionema caespitosum

ORCHIDACEAE
Acianthus caudatus
Acianthus pusillus
Burnettia cuneata
Caladenia carnea
Caladenia dilatata
Caladenia mentiens
Caladenia vulgaris
e *Calochilus herbaceus*
e, r *Corunastylis brachystachya*
Corybas unguiculatus
Diuris orientis
Dockrillia striolata subsp. *striolata*
Gastrodia sesamoides
Prasophyllum brevilabre
Prasophyllum flavum
Prasophyllum sp. aff. *pyriformis*
Pterostylis alata
Pterostylis melagramma
Pterostyls nana
Pterostylis nutans
Ptrostylis parviflora
Pterostylis pedunculata
Pterostylis pedoglossa
Pterostylis tasmanica
Pterostylis tunstallii
Thelymitra flexuosa
Thelymitra holmesii
Thelymitra rubra

POACEAE
Agrostis venusta
Austrostipa stipoides
i *Catapodium* sp.
Deyeuxia monticola
Deyeuxia quadriseta
Distichlis distichophylla
Echinopogon ovatus
Hierochloe redolens
i *Holcus lanatus*
i *Lagurus ovatus*
Microlaena stipoides var. *stipoides*
Poa poiformis var. *poiformis*
Rytidosperma penicillatum
Rytidosperma sp.
Spinifex sericeus
Tetrarrhena distichophylla
Zoysia macrantha subsp. *walshii*

RESTIONACEAE
Baloskion australe
Eurychorda companata
Empodisma minus
Leptocarpus tenax

XANTHORRHOEACEA
Xanthorrhoea australis

XYRIDACEAE
Xyris operculata

Flowering plants – dicots (DICOTYLEDONAE)

AIZOACEAE
Carpobrotus rossii
Disphyma crassifolium subsp. *clavellatum*
Tetragonia implexicoma

APIACEAE
Apium prostratum
Centella cordifolia
Daucus glochidiatus
Eryngium vesiculosum
Hydrocotyle capillaris
Hydrocotyle hirta
Hydrocotyle muscosa
Hydrocotyle sibthorpioides
Trachymene composita var. *composita*
Xanthosia pilosa

APOCYNACEAE
Alyxia buxifolia
Parsonsia brownii

ASTERACEAE
Angianthus preissianus
Apalochlamys spectabilis
i *Carduus tenuiflorus*
Cassinia aculeata
i *Cirsium vulgare*
Cotula sp.
Euchiton japonicus
Gnaphalium indutum
Helichrysum paralium
Helichrysum sp.
i *Hypochaeris radicata*
Lagenophora sp.
i *Leontodon saxatilis*
Leptinella longipes
Leucophyta brownii

Olearia argophylla
Olearia lirata
Olearia phlogopappa subsp. *phlogopappa*
Olearia ramulosa
Olearia stellulata
Ozothamnus argophyllus
Ozothamnus turbinatus
Senecio pinnatifolius
i *Sonchus asper*
i *Sonchus oleraceus*
Xerochrysum bracteatum
Xerochrysum papillosum
BRASSICACEAE
i *Cakile maritima* subsp. *maritima*
CALLITRICHACEAE
i *Callitriche stagnalis*
CAMPANULACEAE
Lobelia anceps
Wahlenbergia gracilenta
Wahlenbergia sp.
CARYOPHYLLACEAE
i *Cerastium glomeratum*
Colobanthus apetalus var. *apetalus*
Sagina sp.
CASUARINACEAE
Allocasuarina littoralis
e *Allocasuarina monilifera*
Allocasuarina verticillata
CHENOPODIACEAE
Atriplex billardierei
Atriplex cinerea
Rhagodia candolleana subsp. *candolleana*
Sarcocornia quinqueflora
Threlkeldia diffusa
CLUSIACEAE
Hypericum sp.
CONVOLVULACEAE
Dichondra repens
CRASSULACEAE
Crassula sieberiana
DILLENIACEAE
Hibbertia hirticalyx
Hibbertia prostrata
DROSERACEAE
Drosera auriculata
Drosera pygmaea
ELAEOCARPACEAE
r *Elaeocarpus reticulatus*
EPACRIDACEAE
Astroloma humifusum
Epacris impressa
Epacris lanuginosa
Epacris paludosa
Leptecophylla juniperina subsp. *juniperina*
Leptecophylla juniperina subsp. *oxycedrus*
Leptecophylla pendulosa
Lissanthe strigosa subsp. *subulata*
Leucopogon ericoides
Leucopogon parviflorus
Monotoca elliptica
Monotoca glauca
Sprengelia incarnata
EUPHORBIACEAE
Amperea xiphoclada var. *xiphoclada*
Beyeria lechenaultii
Beyeria viscosa
Phyllanthus gunnii
Poranthera microphylla
FABACEAE
Aotus ericoides
Daviesia ulicifolia subsp. *rusifolia*
Dillwynnia sericea
r *Eutaxia microphylla*
Goodia lotifolia
Platylobium triangulare
Pultenaea daphnoides
Swainsona lessertiifolia
i *Trifolium repens*
GERANIACEAE
Pelargonium australe
GOODENIACEAE
Goodenia ovata
Selliera radicans
HALORAGACEAE
Gonocarpus sp.
Gonocarpus teucrioides
HYPOPTERYGIACEAE
Cyathophorum bulbosum
LAMIACEAE
Ajuga australis
e *Westringia brevifolia*
LAURACEAE
Cassytha glabella
Cassytha melantha
Cassytha pubescens
LENTIBULARIACEAE
Utricularia tenella
MALVACEAE
Gynatrix pulchella
MIMOSACEAE
Acacia genistifolia
Acacia melanoxylon
e *Acacia mucronata* subsp. *mucronata*
MONIMIACEAE
Atherosperma moschatum subsp. *moschatum*
MYOPORACEAE
Myoporum insulare
r *Myoporum parviflorum*
MYRTACEAE
Calytrix tetragona
Eucalyptus globulus subsp. *globulus*
e *Eucalyptus nitida*
Eucalyptus viminalis subsp. *viminalis*
Kunzea ambigua
e *Leptospermum glaucescens*
e *Leptospermum grandiflorum*
Leptospermum laevigatum
Leptospermum lanigerum

Leptospermum scoparium
Melaleuca ericifolia
Melaleuca gibbosa
Melaleuca pallida
Melaleuca squamea
Melaleuca squarrosa
OLEACEAE
Notelaea ligustrina
OXALIDACEAE
Oxalis perennans
Oxalis rubens
PITTOSPORACEAE
Billardiera mutabilis
Bursaria spinosa
Pittosporum bicolor
PLANTAGINACEAE
e *Plantago bellidioides*
i *Plantago coronopus*
e *Plantago tasmanica*
POLYGALACEAE
Comesperma volubile
POLYGONACEAE
Muehlenbeckia adpressa
PORTULACACEAE
Calandrinia calyptrata
Montia sp.
PRIMULACEAE
i *Lysimachia arvensis*
PROTEACEAE
Banksia marginata
Hakea decurrens subsp. *platytaenia*
e *Hakea epiglottis*
Hakea lissosperma
e *Hakea megadenia*
Hakea teretifolia subsp. *hirsuta*
Isopogon ceratophyllus
e *Lomatia tinctoria*
Persoonia juniperina
RANUNCULACEAE
Clematis aristata
Clematis microphylla
Ranunculus sp.
RHAMNACEAE
Pomaderris apetala subsp. *apetala*
e *Pomaderris elliptica* var. *diemenica*
Pomaderris elliptica var. *elliptica*
r *Pomaderris oraria*
Pomaderris pilifera
e *Spyridium gunnii*
e *Spyridium obovatum* var. *obovatum*
ROSACEAE
Acaena novae-zelandiae
i *Sanguisorba minor*
RUBIACEAE
Asperula conferta
r *Asperula minima*
Asperula oblanceolata
Coprosma hirtella
Coprosma quadrifida
Galium australe
Opercularia varia
RUTACEAE
Boronia anemonifolia subsp. *variabilis*
Correa backhouseana var. *backhouseana*
Correa reflexa
Leionema bilobum
Zieria arborescens subsp. *arborescens*
SANTALACEAE
Exocarpos syrticola
SAPINDACEAE
Dodonaea viscosa subsp. *spatulata*
SCROPHULARIACEAE
Veronica calycina
SOLANACEAE
i *Lycium ferocissimum*
Solanum laciniatum
STACKHOUSIACEAE
Stackhousia monogyna
STERCULIACEAE
Lasiopetalum macrophyllum
STYLIDIACEAE
Stylidium graminifolium
THYMELAEACEAE
Pimelea curviflora
Pimelea drupacea
Pimelea linifolia subsp. *linifolia*
e *Pimelea nivea*
Pimelea serpyllifolia subsp. *serpyllifolia*
URTICACEAE
r *Parietaria debilis*
Urtica incisa
VIOLACEAE
Viola fuscoviolacea
Viola hederacea
WINTERACEAE
Tasmannia lanceolata