PRIME SEAL ISLAND

Scientific Expedition

2008

The Hamish Saunders Memorial

Island Survey Program

HAMISH SAUNDERS MEMORIAL TRUST, NEW ZEALAND

Biodiversity Conservation Branch
Department of Primary Industries, Parks, Water and Environment

Tasmania
Explore the possibilities

Prime Seal Island Scientific Expedition 2008

A partnership program between the Hamish Saunders Memorial Trust, New Zealand and Biodiversity Conservation Branch, DPIPWE, Tasmania.

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Hamish Saunders Memorial Trust, New Zealand *and*

Biodiversity Conservation Branch, DPIPWE, Tasmania.

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Photo by Rolan Eberhard.

Foreword

Photo by Rolan Eberhard.

The Hamish Saunders Memorial Island Survey Program was established in 2005 as the result of a partnership agreement between the Tasmanian Government and the Hamish Saunders Memorial Trust. The program arose from the tragic loss of this young New Zealand scientist while he was assisting in Tasmanian Government research on remote Pedra Branca Rock in south western Tasmania.

The program aims to collect scientific information on Tasmanian and New Zealand islands as a contribution to the long term management and conservation of their natural values. Islands not only hold a special romantic and scenic attraction but are also regarded as scientifically important repositories of biodiversity including biogeographically significant species. Islands are also valuable areas that can be used as benchmarks against which wider threats and changes can be measured. They can also be considered in some cases as playing a role in quarantining insurance populations of threatened species.

Since the partnership agreement was signed in 2005 each of the expeditions has resulted in a report which the department has published in the Hamish Saunders Memorial Island Survey Program series.

In this volume the results of the third expedition are reported. Prime Seal Island is one of the largest of the Outer Furneaux Islands and the twelve papers in this volume cover diverse aspects of its natural values. This will assist in the long-term management of the island by the government and the lessees who currently occupy much of the island.

The island survey program was recently reviewed and both the Tasmanian Government and the Trust have re-affirmed their commitment to building on the work so far in both Tasmania and New Zealand. Apart from all the practical benefits, the professional and personal interaction that this program generates between scientists on both sides of the Tasman will be one of the legacies of Hamish Saunders.

Kim Evans
Secretary
Department of Primary Industries, Parks, Water and Environment
Tasmania

David Saunders
Hamish Saunders Memorial Trust
New Zealand

Hamish Saunders

Hamish Saunders was a New Zealand volunteer who died tragically in 2003 while conducting survey work on a Tasmanian endangered species program. Hamish graduated from Waikato University with a First Class Honours and Masters degree in marine geology. He later completed a postgraduate GIS course with distinction. He also achieved qualifications as a scuba dive instructor, was a good sportsman and was talented, not solely academically, but as an all round individual.

As an explorer, Hamish achieved in his 26 years much of which most only dream. From Antarctica to the Galapagos, Central America, South America, South-East Asia, Europe and Australia, he combined his passion for the natural world and conservation with that of an interest in local cultures and people. Not only did he travel to these places, but he also took a great interest in the people around him. He touched many lives. Hamish was a remarkable and talented young man. The passion and enthusiasm he engendered in those whom he met and the gentle leadership he embodied is his legacy.

This island survey program is dedicated to the memory of Hamish Saunders and intended as a platform for emerging leaders in marine conservation. The Tasmanian Government's commitment and long-term support for the program was endorsed by the then Minister for Environment and Planning, The Hon. Judy Jackson MHA, on 8 July 2005.

Acknowledgements

We especially thank once again, the Hamish Saunders Memorial Trust for participating in the program, particularly Alan and David Saunders, and the Trust's travel award recipients Bridgette Moffat and Dylan van Winkel. Sincere thanks to George Jennings of Shaw and Sons Pty Ltd. and John Cooper of Flinders Island who were supportive of the study and provided background information as needed. James Luddington provided transport between Flinders Island and Prime Seal Island and we are grateful for his logistical support in this regard. Penny Wells and Mike Pemberton provided Agency support. We also thank Wayne Dick, the Parks and Wildlife Service Ranger on Flinders Island for taking a keen interest in the study and for visiting the party in the field. Wayne Warren of Parks and Wildlife Service, Lois Ireland and Noel Whittaker of Flinders Island were helpful to the party.

We thank the many people who provided their time and expertise, some in a volunteer capacity, across the range of specialties dealt with in this report – they are acknowledged separately in the individual reports herein.

Thanks to Brett Littleton of the ILS Design Unit in the Department of Primary Industries, Parks, Water and Environment for his design and layout of the report.

Summary of Results

1. Prime Seal Island comprises a granite basement overlain by alkaline dunesands which accumulated prior to the Last Glacial Maximum. Some dunes are still mobile.

2. There are a number of significant geomorphic features, especially around the coast. These have been added to the Tasmanian Conservation Database.

3. The vegetation comprises 13 vegetation communities, including 3 listed as threatened: *Eucalyptus ovata* forest and woodland (DOV), Heathland on calcarenite (SHC) and Seabird rookery complex (SRC).

4. The native vegetation cover has expanded over the last few decades.

5. An additional 40 species of plants have been added to those known for the island, taking the total to 193.

6. The island has populations of 10 threatened plant species. Where population estimates were carried out these demonstrated much larger populations than previously thought.

7. Prime Seal Island supports one of the greatest diversities of reptile species of all the Outer Furneaux Islands. The presence of cats and house mice could potentially have an effect on the reptile fauna.

8. The introduced flora was assessed for problem species. Seven of these were mapped and prioritized for action, 5 of which are high priority.

9. The current occupants of the island have undertaken extensive control of boxthorn, with evidence of manual removal across much of the island.

10. The mammal survey revealed five wild mammal species, one of which was the Tasmanian pademelon, common on the island. Evidence of Brushtail Possum was detected but sightings not made. The most common introduced mammals were house mice and feral cats.

11. The first collection of spiders yielded 75 species, including Tasmania's largest wolf spider *Tasmanicosa godeffroyi* with a body length of 26 mm.

12. A species of cave cricket previously known only from Flinders, Babel and Little Dog Island was found in Manalargenna Cave.

13. The survey resulted in the first record of the spur-throated locust from eastern Tasmania and the first record of a raspy cricket from the eastern Bass Strait islands.

14. Several new species of invertebrates were discovered including a new species of centipede, and a possible new species of bristletail. Over 7 000 specimens were collected from the island.

15. The invertebrate fauna of the island is quite diverse and likely to be relatively intact with fewer exotic species than expected.

16. The invertebrate fauna of the island is likely to be best conserved by maintaining the island in its present condition.

17. An undescribed geometrid moth is a new record for Tasmania.

18. Forty-seven bird species were recorded for the island including wedge-tailed eagles. Although no presently used nest of the species was found, a disused nest was observed. Birds would be favoured by eradication of cats, better fencing in some areas, and careful fire management.

19. Fifty-one fish species were recorded inshore on a small portion of the east coast of Prime Seal Island. The species are typical of what could be expected in this locality.

INTRODUCTION

Prime Seal Island.
Basemap: 1:25000 map Wybalenna 5656 (reproduced courtesy of TASMAP, DPIPWE).

Prime Seal Island, at 1221 hectares, is one of the largest of the approximately one hundred outer islands in the Furneaux Group in eastern Bass Strait. The island occurs at 40°03'45" latitude, 147°45'31"longitude about ten kilometres to the west of Flinders Island itself and is about ten times longer than it is wide. The island has a north-south orientation.

Flinders, Cape Barren and Clarke Islands are the three main islands in the Furneaux Group. Together with their outer islands and those of the Kent, Hogan and Curtis Groups further north, they form an archipelago between Wilsons Promontory in Victoria and the Tasmanian mainland. These islands have variously been part of a land bridge at times of lower sea level such as during the Last Ice Age prior to about 8 thousand years ago, or separated as they are now by higher sea level.

The island is varied in topography and looks imposing with its three rounded elevated hummocks visible from a considerable distance. Like most of the islands in the group, it is composed mainly of granite with a mantle of calcarenite, alkaline sandy soils, and acid soils formed directly over the granite exposures. Islands in the Furneaux Group with limey sands were considered fairly fertile compared with the granite islands and their infertile siliceous soils. Consequently the more fertile islands were settled from the early nineteenth century as farming and fishing took on more importance following the demise of the sealing period in about the 1820s.

Much of the island is still operated as a wool growing operation under leasehold by the Crown to Shaw and Sons Pty Ltd. In the 2008 shearing season 43 bales of medium to fine merino wool was taken off the island. The lessees also carry out infrastructure maintenance, weed control, game management and burning. There is a network of vehicle tracks on the island, an airstrip, shearing, machinery and generator sheds, accommodation, water tanks and fencing.

Islands are significant for biological conservation and there have been many practical examples of the role played by islands in being refuges for scientifically important biota, sometimes free from feral or problem animals and as potential sites for translocations or reintroductions of endangered species that might otherwise be under pressure in the rest of their range.

There had been very little focussed scientific exploration on Prime Seal Island. Books on the flora and fauna of the Furneaux Islands by Stephen Harris and Nigel Brothers and colleagues assembled most of the information on which this expedition has been able to build. There were still many gaps in our knowledge of the island. The size, and geographic location of the island, together with government's joint management responsibility (a small part of the island is outside the leasehold) with a private lessee, were amongst the factors that made this island an ideal target of the Hamish Saunders Memorial Island Survey Program.

The expedition party landed on Flinders Island on 13 October 2008 thence to Prime Seal Island the following day. The team departed Prime Seal Island on the 19 October 2008 and then Flinders Island on 20 October. The expedition party leader was Stephen Harris, joined by Michael Driessen (mammals, reptiles), Nick Mooney (wildlife), Clare Hawkins (mammals), Rolan Eberhard (geomorphology), Emma Betts (geomorphology), Abbey Throssel (invertebrates), Kevin Bonham (invertebrates), Sarah Munks (mammals), Dylan van Winkel (Hamish Saunders Memorial Trust Travel Award Recipient 2008, wildlife), Bridgette Moffat (Hamish Saunders Memorial Trust Travel Award Recipient 2008, natural history), Micah Visoiu (vegetation/flora) and Oliver Strutt (weeds).

GEODIVERSITY

Plate 1 Quaternary sands exposed by erosion on the southwest coast.
Photo by Rolan Eberhard.

By Rolan Eberhard

Geologically, Prime Seal Island comprises a granite basement overlain by Quaternary sediments, principally dunesands. Weathering of the granite combined with aeolian and coastal processes have strongly influenced the geomorphology. Thermoluminescence dates for dunesands indicate an extended period of aeolian sedimentation in the period leading up to the Last Glacial Maximum. Sandy alkaline soils and calcrete duricrusts reflect the role of calcareous sand as the dominant soil parent material. Prime Seal Island was episodically connected to, and isolated from, adjacent land masses, due to oscillating sea levels during Quaternary glacial-interglacial cycles. The most recent period of isolation may have commenced around 8 000 years ago. The 2008 Prime Seal Island expedition provided information that will be used to update the Tasmanian Shoreline Geomorphic Types Digital Line Map Version and the Tasmanian Geoconservation Database. It highlighted the importance of avoiding land management practices with potential to exacerbate soil erosion hazards on Prime Seal Island.

INTRODUCTION

The geodiversity (geology, geomorphology and soils) of Prime Seal Island is poorly documented. The scale of available geological mapping is limited to the 1:250 000 Flinders Island sheet (Jennings and Cox 1978). Geomorphological aspects are touched on in reports concerning Mannalargenna Cave, the cultural significance of which was recognised in the late 1980s (Harris 1988; Brown 1991). The island was visited briefly during a reconnaissance inventory of the geoconservation values of Tasmania's islands in the mid 1990s. Some unusual karst features were noted at this time (Dixon 1996) and later listed in the Tasmanian Geoconservation Database as the Prime Seal Island Karst and Concretions site (http://www.dpiw.tas.gov.au/inter.nsf/WebPages/LBUN-6TY32G?open). The soils have been described only insofar as their agricultural capability is considered in unpublished documents relating to the leasehold arrangement for the island. The Hamish Saunders Memorial trip was an opportunity for additional observations on aspects of the geodiversity of Prime Seal Island.

METHODS and RESULTS

This overview of the geodiversity of Prime Seal Island is based on an examination of recent and historical air photos and 3 field days, during which time the main parts of the island, including most of the coast, major sandblows and features of interest reported previously, such as Mannalargenna Cave and karst on the northwest coast, were covered. Sand samples were collected for thermoluminescence (TL) dating by David Price (University of Wollongong). This paper alludes to the dating results, although this work will be described in detail elsewhere.

Geology

Prime Seal Island is essentially a single large outcrop of granitic basement rock, probably granodiorite but referred to here as granite for simplicity. Although locally obscured by Quaternary sediments, the granite crops out extensively on all parts of the island. The rock is most likely a member of the Wybaleena suite of granitoids, which are widespread along the western side of the Furneaux Group (Reid 1987). Granitoids account for approximately 70% of the Palaeozoic basement of the Furneaux Islands (ibid), part of a broader north-south oriented granitoid mass that underlies much of eastern Tasmania. These rocks are Devonian in age and were emplaced as a series of large magmatic intrusions into older sedimentary strata (Mathinna beds) between 395 and 368 million years ago (Seymour and Calver 1995). Uplift and erosion over an extended period of geological time has exposed the granite at the surface.

The Quaternary sediments are dominated by unconsolidated dunesands of variable thickness. These sediments are well exposed in sandblows and erosion gullies on the western side of the island (Plate 1).

Plate 2 Sandrock cropping out on the coast near Target Hilll.
Photo by Rolan Eberhard.

Older lithified sands are associated with aeolianite that crops out on or near the coast at many sites (Plate 2). The aeolianite is thinly bedded with dips of 0-30° and frequent cross bedding. The presence of numerous shell macrofossils in strata at one or two sites on the east coast implies a marine or beach origin for some coquina-like facies, but the grain and bedding characteristics are clearly aeolian in the majority of cases.

Examination of hand specimens under low power optical microscope indicate a high siliceous content for some aeolianite units. A sample from near Mannalargenna Cave was found to consist mainly of subangular to rounded siliceous grains typically about 1 mm in diameter and, to a lesser extent, platey shell fragments of similar size. These materials were cemented by a meagre (<10%) whitish matrix of presumed carbonate. A sample of pinkish sandrock from Peacock Bay comprised well sorted subangular to rounded siliceous grains about 0.25-0.5 mm in diameter. About 30% of the rock was whitish matrix.

A second specimen from the same general locality was a mixture of shell fragments up to 20 mm and poorly sorted subangular to angular siliceous grit ranging in diameter from about 0.25 to 7 mm. In this case the matrix, creamy amorphous material, was estimated to constitute about 50% of the rock.

These observations suggest that some rocks which have been referred to as limestone, such as the strata in which Mannalargenna Cave has formed, may be better described as calcareous sandstones or 'sandrock' [1]. Secondary carbonate deposits on the cliff containing the cave, and within the cave itself, are potentially accounted for by leaching from overlying shell-rich sands (Plate 3). On the other hand, the degree of karstification at certain other locations indicates the presence of limestone *sensu stricto* (ie. >50% calcium carbonate). The parent material implies a form of limestone known as aeolian calcarenite ie. lithified calcareous dunes. Aeolian calcarenite referred to as Palana Limestone (Sutherland and Kershaw 1971) crops out extensively on the eastern parts of Flinders Island. Palana Limestone at Settlement Point, 6 km from Prime Seal Island and the closest point to it on mainland Finders Island, contains a moderate to high calcium carbonate content of 61-95% (Hughes 1957). The formation is evidently somewhat heterogeneous, with some facies

[1] Sandrock is a field term for sandstone that is not firmly cemented (Jackson 1997)

Plate 3 Secondary carbonate coatings on the cliffline containing Mannalargenna Cave.
Photo by Rolan Eberhard.

reported to contain considerable amounts of angular to rounded quartz grit (Sutherland and Kershaw 1971), suggesting possible parallels with sandrock units on Prime Seal Island.

Sutherland and Kershaw (1971) argue that the Palana Limestone developed from late Tertiary to early Pleistocene calcareous dunes, suggesting 'a Lower Pleistocene, pre-Riss/Wurm age for most of it' on the basis that the limestone is cut by what they regard as a Last Interglacial sea level. Kiernan (1992) supports a pre Last Interglacial age for aeolian calcarenite at Fotheringate Bay on Flinders Island, also on the evidence that it too was planed off by Last Interglacial marine erosion. A pre Last Interglacial age is potentially consistent with the degree of lithification of at least some aeolian formations on Prime Seal Island, although evidence of truncation by a Last Interglacial sea level is debateable. However, a thermoluminescence date of 56 ka for cavernous sandrock on the west coast implies a post Last Interglacial age in this case (Eberhard in prep.).

Thermoluminscence dates for unconsolidated dunesands interbedded with slope deposits from a site on the southwest coast of Prime Seal Island suggest that the sediment accumulated between about 38 and 7 ka, with a strong aeolian contribution prior to the Last Glacial Maximum (Eberhard in prep.). A buried soil horizon near Target Hill was dated to 3-4 ka, implying more stable conditions by the mid-late Holocene. These results contrast with dates for dunesands in northwest Tasmania of 24-22 ka (Duller and Augustinas 2006) and 29-14 ka (McIntosh *et al.* 2009). Tasmania-wide data indicates a significant increase in landscape instability from 35 ka onwards, although a number of older dates for aeolian sediments have been reported (McIntosh *et al.* 2005). The Prime Seal Island dates imply that the period of increased aeolian activity recorded after 35 ka elsewhere in Tasmania may have commenced at about the same time or somewhat earlier on the Furneaux Group.

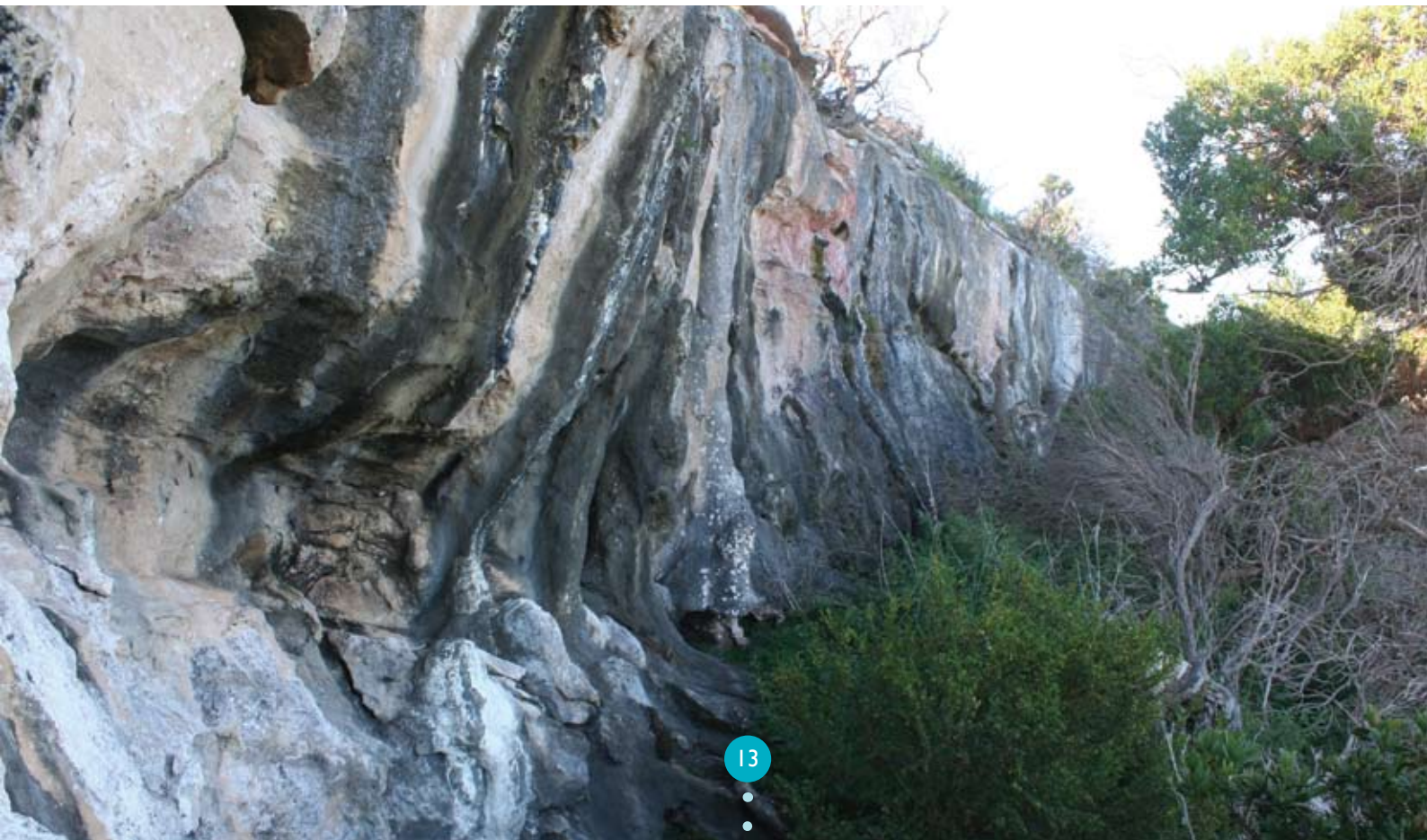


Plate 4 Granite tor near Sealers Cove.
Photo by Rolan Eberhard.

Plate 5 Limestone shore platform, north of Peacock Bay.
Photo by Rolan Eberhard.

Geomorphology

Prime Seal Island is approximately 10 km long on the north-south axis and typically about 1 km wide on the east-west axis. Four principal hills, rising to a maximum elevation of 155 m and separated by more-or-less equally spaced wind gaps, give the island its characteristic humped profile, with some older publications referring to it as Hummock Island. The bold domed form of the hills is typical of granitic terrains with widely spaced joint fractures. Little evidence was seen of solutional features which often develop on granitic rocks, such as runnels and gnammas. However, some small but spectacular isolated tors and bluffs, another landform typical of granitic terrain, are present along the mid and upper slopes on the western side of the island (Plate 4).

Prime Seal Island's coast is approximately 29.2 km long. Although its location within the low-moderate wave energy zone of Davies' (1978) qualitative classification of wave energy for Tasmania suggests a relatively quiet coastal environment, mariners attest to Bass Strait as a stormy seaway not lacking in wave energy. This is due to a combination of frequent strong winds associated with passage of low pressure weather systems across the region and south-westerly swells reaching western Tasmania being refracted eastwards through Bass Strait. Accordingly, the western side of the island is considerably more exposed than the east. This is reflected in the character of coast on the respective sides of the island.

The western coast comprises a virtually continuous rocky shore dominated by broad shore platforms up to 100 m or more in width, with offshore reefs and occasional deeply indented coves and gulches. Strong structural control of the coastline is clearly evident in air photos, which highlight the results of vigorous mechanical erosion along frequent intersecting linear features such as conjugate joint sets. A few short sandy beaches account for less than 4% of the coast on this side of the island. Some of these are developed on the landward side of rocky shore platforms. Minor boulder beaches are present. In contrast, about 20% of the relatively sheltered eastern side is sandy beaches, which tend to be broader than those of the west. Shore platforms are common, but rarely exceed 30 m in width [2].

[2] A number of discrepancies were noted for shoreline geomorphic types attributed to Prime Seal Island on the Tasmanian Shoreline Geomorphic Types Digital Line Map Version 4.0 (Sharples 2006). For example: (1) shorelines mapped as upper intertidal cliffs between Spit Point and Peacock Bay, and at South Bay, are steeply inclined in places but rarely vertical, and better described as rocky (bedrock) shorelines; (2) a shoreline east of Target Hill is mapped as upper intertidal cliffs with no distinctly different lower intertidal shoreline element, whereas the shoreline actually comprises a well-developed lower intertidal shore platform in limestone below a rocky upper intertidal shore; (3) shorelines east of North Hill, and at Wolff Bay, mapped as upper intertidal shell, pebble cobble or boulder beaches or shorelines, are in fact sandy beaches; and (4) a shoreline south of Sealers Cove mapped as upper intertidal cliffs, is actually a shore platform backed by a steep slope formed in Quaternary sands. The Tasmanian shoreline geomorphic types map is based generally on a combination of published and unpublished sources, air photos and field verification in some places. Older unpublished maps based on air photo interpretation by Revel Munro, with no field verification, were the source in the case of Prime Seal Island (C. Sharples, pers. comm.). By convention, the geomorphic types map A number of discrepancies were noted for shoreline geomorphic types attributed to Prime Seal Island on the Tasmanian Shoreline Geomorphic Types Digital Line Map Version 4.0 (Sharples 2006). For example: (1) shorelines mapped as upper intertidal cliffs between Spit Point and Peacock Bay, and at South Bay, are steeply inclined in places but rarely vertical, and better described as rocky (bedrock) shorelines; (2) a shoreline east of Target Hill is mapped as upper intertidal cliffs with no distinctly different lower intertidal shoreline element, whereas the shoreline actually comprises a well-developed lower intertidal shore platform in limestone below a rocky upper intertidal shore; (3) shorelines east of North Hill, and at Wolff Bay, mapped as upper intertidal shell, pebble cobble or boulder beaches or shorelines, are in fact sandy beaches; and (4) a shoreline south of Sealers Cove mapped as upper intertidal cliffs, is actually a shore platform backed by a steep slope formed in Quaternary sands. The Tasmanian shoreline geomorphic types map is based generally on a combination of published and unpublished sources, air photos and field verification in some places. Older unpublished maps based on air photo interpretation by Revel Munro, with no field verification, were the source in the case of Prime Seal Island (C. Sharples, pers. comm.). By convention, the geomorphic types map records all rocky shore platforms as lower intertidal landforms, despite the fact that such features often extend into the upper intertidal zone. This is true of the majority of shore platforms on Prime Seal Island.

Plate 6 Limestone pinnacles on beach, Peacock Bay.
Photo by Rolan Eberhard.

An exception to the generally modest shore platforms of the eastern side of the island is a feature developed in aeolian calcarenite about 1 km south of Mannalargenna Cave. This shore platform is in the order of 50 m wide, strikingly level and covered by a dense mat of the seaweed *Hormosira sp.* (Plate 5). It bears comparison with the extensive limestone shore platforms of the western coast of Flinders Island (Kiernan 1992). A combination of solutional lowering and mechanical abrasion are considered to account for the formation of broad, flat shore platforms that characterise many limestone coasts (Trudgill 1985), implying that these features are partially karstic in origin.

Karst has also developed on thin (ca. 2 m thick) case hardened limestone that crops out at South Bay and intermittently between Sealers Cove and the northern tip of the island. A variety of karren forms are present including pans, pits, rills and runnels. Pointy karst pinnacles (spitzkarren) protrude through sand on the beach north of the camp on Peacock Bay (Plate 6). Small caves, generally shelter-like cavities and arches, extend beneath the case hardened caprock (kankar) at several locations (Plate 7). The presence of an indurated capping layer provides the structural integrity necessary to support the cave roof, a phenomenon that has been noted in other aeolian calcarenite karsts (White 1994). The entrances of larger examples tend to face west into the prevailing weather, suggesting that they may be less a product of solution than physical and/or chemical weathering, under conditions of more or less continuous assault by salt-laden wind and spray. A mantle of loose fine sediment on the cave floors would

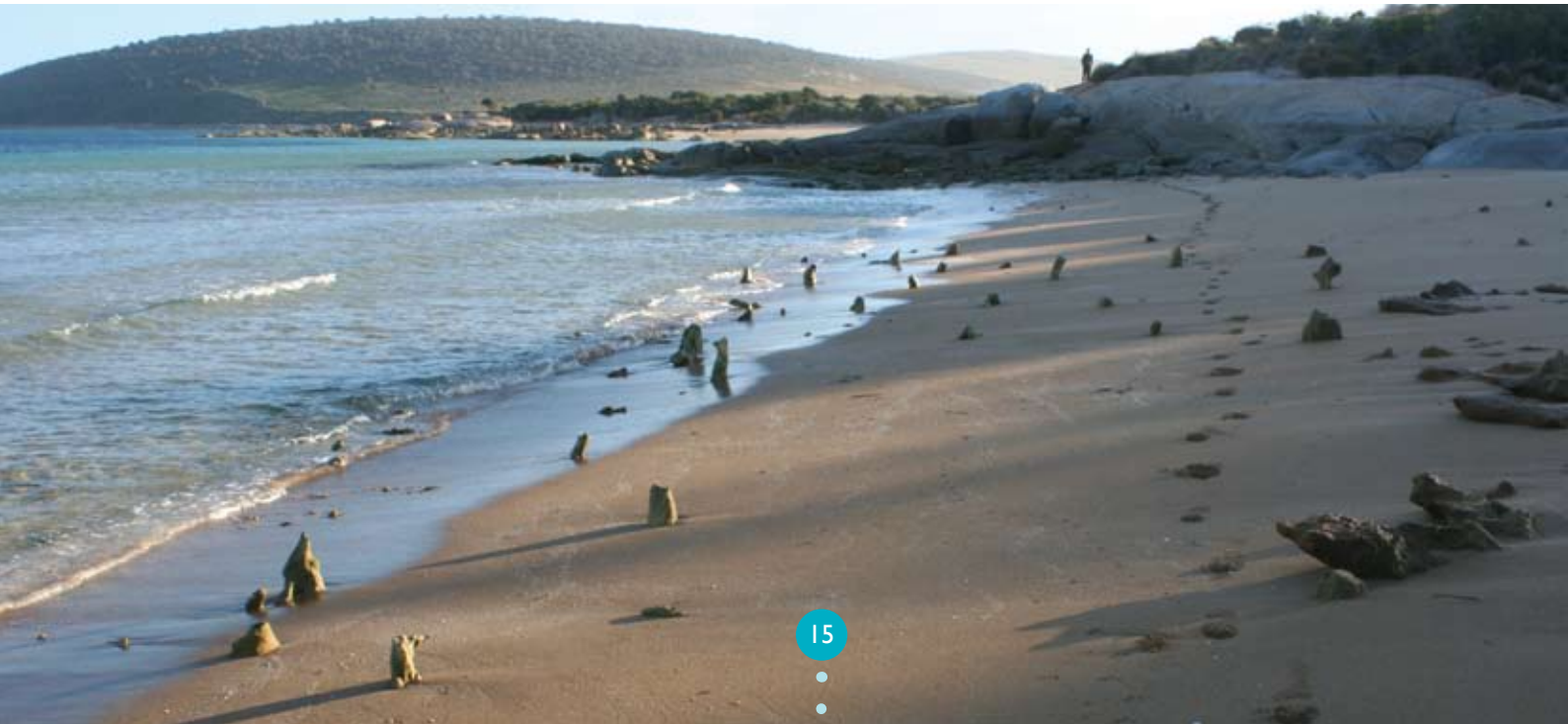


Plate 7 Cave developed in case-hardened aeolian calcarenite.
Photo by Rolan Eberhard.

Plate 8 Tufa terraces on coast near Target Hill.
Photo by Rolan Eberhard.

Plate 9 Relict aeolian sands deposited on the windward (western) side of the island. Note evidence of recent burning.
Photo by Rolan Eberhard.

be consistent with the disintegration of the parent rock through a process such as salt wedging. On the other hand, the deposition of speleothems such as stalactites and columns implies either solutional erosion of the limestone above the caves or leaching of carbonates from overlying shell-rich sands. This does not necessarily contradict a non-karstic mode of cave formation.

The sandrock in which it has developed and domed internal form of Mannalargenna Cave, the only cave of significance on the eastern side of the island, suggests that it too is not primarily a karst feature, despite the presence within it of presumed carbonate speleothems. First reported by Harris (1988), this cave comprises a 6 m wide entrance leading to a small inner chamber (Figure 1). No part of the accessible cave is more than about 6 m from the dripline. The full extent of the original cavity is more spacious than it appears, as archaeologists dug through 4 m of sediment before encountering the sloping bedrock floor of the inner chamber (Sim 1991). Mannalargenna Cave is about 50 m above present sea level and faces southeast. The site was occupied by Pleistocene humans between about 8 and 20 ka (Brown 1991).

The 'knobbly concretions' associated with the karst reported by Dixon (1996) are typically about 30 mm in diameter, near spherical in form with a rough botryoidal texture on the surface. They appear to be restricted to several square metres of limestone pavement a few metres above sea level at one site on the northwest coast. The mode of formation is unclear. Concentrically banded concretions in caves known as cave pearls develop in shallow pools where a mineral coating develops on a nucleus such as a sand grain. The detached spherical form of cave pearls requires cave drips to agitate the particles, preventing them from becoming cemented to other surfaces (Hill and Forti 1997). A similar process can be ruled out for the Prime Seal Island concretions, as the size of the particles precludes agitation by wind or rain and the context is not a pool. An alternative explanation is that the concretions are a calcrete duricrust deposited as a lag following deflation of the carbonate-rich sands in which they formed. This explanation does not account for the consistent size of the concretions or their absence from other sites. Irrespective of their origin, the concretions are an unusual feature of which Prime Seal Island is the only recorded Tasmanian example.

Springs are common where the contact between the granite basement and overlying calcarenite and/or Quaternary sands is exposed along the high water mark. Seventeen springs or

clusters of springs were counted in October 2008. Rapid infiltration of precipitation and the seaward deflection of groundwater along the geological contact account for both the abundance of coastal springs and the paucity of surface runoff and fluvial landforms. There is little evidence of the latter barring some gully erosion on the southern part of the island.

Many of the springs have precipitated carbonate in the form of tufa. A major example occurs at the head of a small bay west of Target Hill. Here, an impressive series of tufa terraces has developed (Plate 8). Water samples obtained from two springs on the southern coast were high in dissolved salts, with sodium and chloride levels that suggest a significant contribution from windblown spray off the sea (Appendix 1). Calcium levels are towards the upper end of the range reported for karst waters in Tasmania (Eberhard and Houshold 2002). Despite the salinity, the quality of water would not necessarily be considered unsuitable for stock to drink.

Aeolian landforms characterise those parts of Prime Seal Island which are mantled by Quaternary sands. These include linear transgressive dunes several hundred metres long and oriented east-west across the wind gaps between Sealers Bay and Peacock Bay and between North Hill and Target Hill. As on Flinders Island (Kershaw and Sutherland 1972), the dunes are relict features, being vegetated and no longer mobile, despite localised sandblows. Aeolian sands interbedded with slope deposits crop out on the western flanks of Prime Seal Island's main southern hill. The sands are incised by a few deep gullies of recent origin and truncated by marine erosion near present sea level (Plate 9). Thermoluminescence

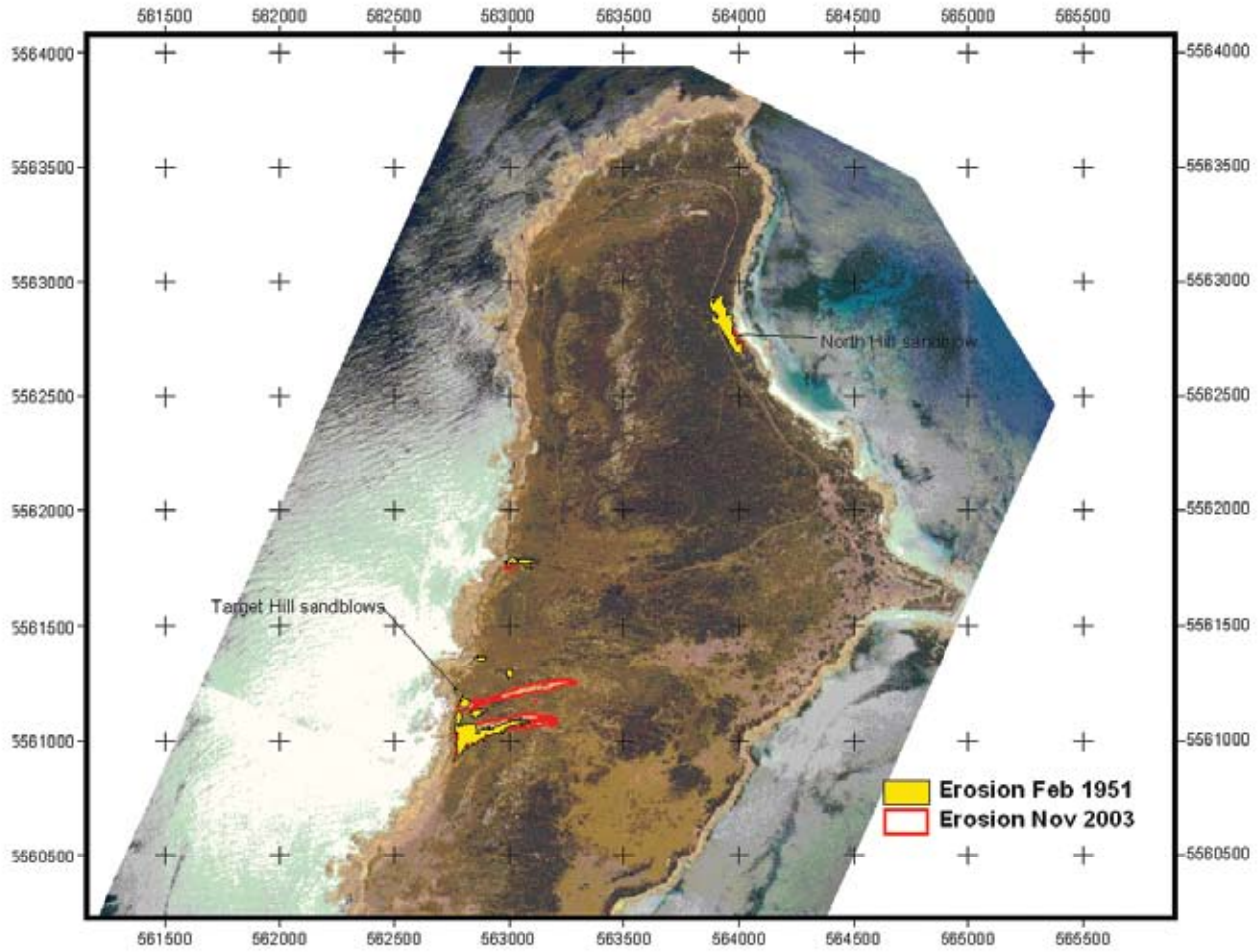


Figure 1. Extent of sand erosion on north Prime Seal Island in 1951 and 2003. Basemap: November 2003 air photo (reproduced courtesy of TASMAP, DPIPWE).

dates indicate that the sediment accumulated between about 38 ka and 7 ka (Eberhard in prep.). The age of the top of the sequence is close in time to the culmination of the Holocene marine transgression at 6 ka. The absence of buried soil horizons within the profile suggests a high level of landscape instability and harsh environmental conditions, particularly prior to the Last Glacial Maximum, when the bulk of the sediment accumulated.

Active sandblows are present several locations on Prime Seal Island, mostly but not exclusively on the more exposed western side (Figure 1). These include a notable pair of parallel sandblows which extend for ca. 0.5 km from near sea level to an elevation of ca. 70 m on Target Hill. To estimate the extent and trajectory over time of actively eroding sand country on Prime Seal Island, areas interpreted as bare or mobile sand (excluding beaches) were digitised from scanned and

Table 1: Approximate extent in hectares of bare or actively eroding sand on Prime Seal Island, as interpreted from air photos between 1951 and 2003. Refer to Figures 1 and 2 for locations. Note that air photo coverage was not available for South Bay or the Lower South-west in 1986.

	1951	1973	1974	1982	1986	1998	2003
North Hill	1.33	2.36	1.78	1.59	1.18	0.03	0.12
Target Hill	2.33	7.44	6.24	6.16	4.44	3.74	3.80
Sealers Cove	5.92	7.37	3.15	1.41	0.28	0.18	0.06
Lower South-west	2.12	0.92	3.39	3.86	-	1.53	5.39
South Bay	0.00	0.26	2.19	0.59	-	0.21	0.37
TOTAL	**11.70**	**18.35**	**14.79**	**13.61**	**(>5.90)**	**5.71**	**9.74**

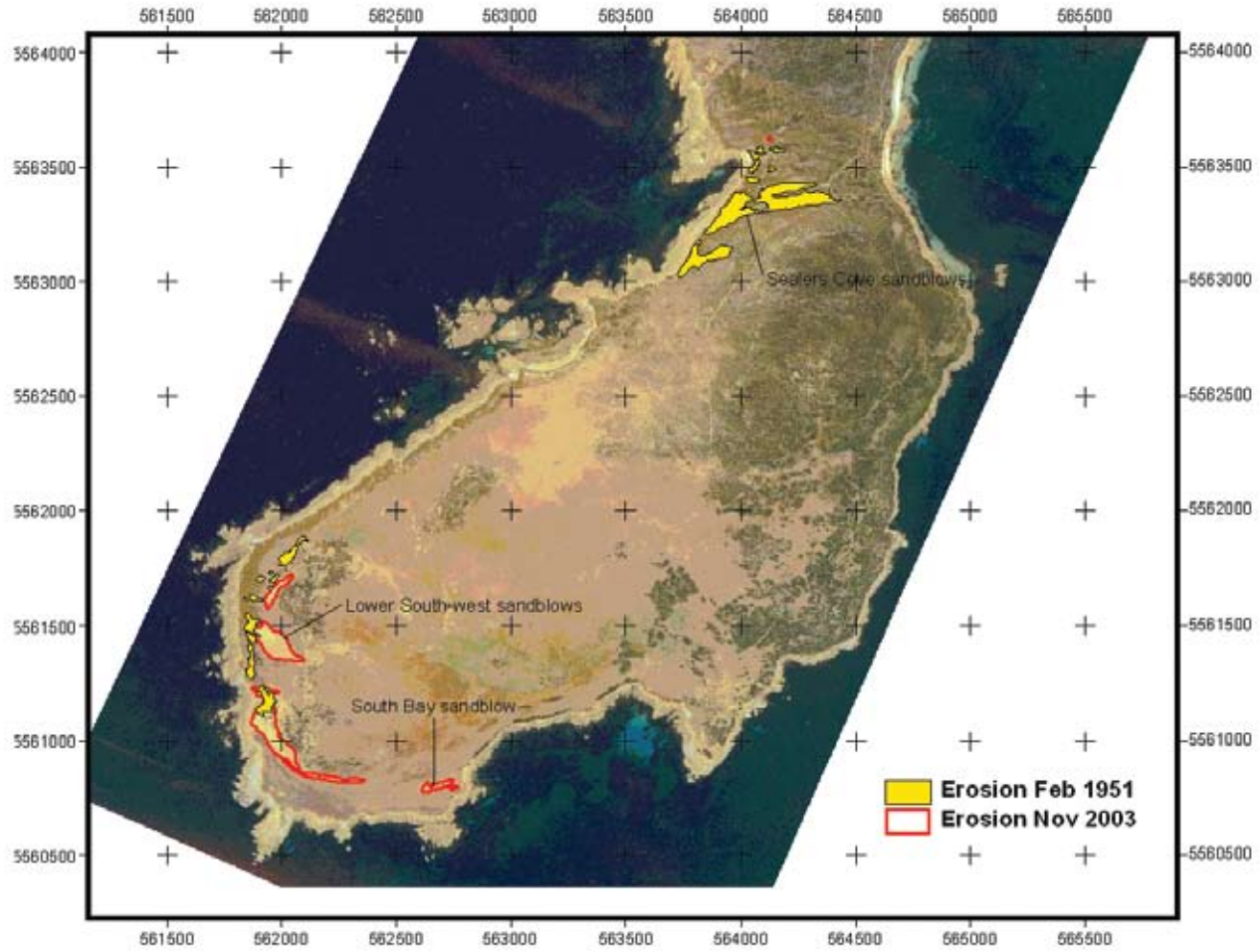


Figure 2. Extent of sand erosion on south Prime Seal Island in 1951 and 2003. Basemap: November 2003 air photo (reproduced courtesy of TASMAP, DPIPWE).

orthorectified air photo mosaics in a GIS (Figures 1 and 2). The methodology is subject to variations in the quality of the images and the light conditions at the time the images were captured, both of which affect the ability to accurately assess erosion status. The area totals should therefore be considered indicative only (Table 1).

About 11.7 ha of the island appear to have been actively eroding at the time of the first air photos in 1951. This increased by 6.7 ha (57%) between 1951 and 1973, but then retreated between 1973 and 1998. By 1998 the total eroded area had contracted by 12.6 ha, reducing it to about half what it had been in 1951. Results in the latter part of this period are skewed in favour of a lower result because air photo coverage for the two more southerly sites was not available for 1986. This trend was reversed between 1998 and 2003 when the total eroded area is seen to expand again, gaining 4.0 ha (71%) but still remaining lower than results for 1982 and earlier runs. The pattern is not consistent across the island as a whole. For example, the eroded area in the lower south-west shrunk by 1.2 ha (57%) between 1951 and 1973 when eroded areas elsewhere on the island were expanding, although it later increased to gain 3.3 ha (154%) by 2003. Only the sandblow at South Bay is not present to some degree over the entire air photo record. This feature developed between 1951 and 1973, expanding rapidly to its maximum extent between 1973 and 1974.

These results should not be interpreted simply as evidence that land management practices over the last 30+ years have reduced the scale of erosion on Prime Seal Island. In fact, the apparent increase in erosion post 1998, especially in the southern parts of the island, and field observations concerning active sandblows and deep gullying on seaward slopes that had recently been burnt, suggest a more complex scenario.

Soils

The soils of Prime Seal Island are dominantly well-drained loamy sands or light sandy loams of weak to moderate structure. Soil pH ranges from 8-9 (Poole *et al.*

Plate 10 Calcrete duricrust.
Photo by Rolan Eberhard.

Plate 11 Calcified tree roots in sandblow at Target Hill.
Photo by Rolan Eberhard.

Plate 12 Residual pedestal formed by loss of soil around knobby clubsedge root ball.
Photo by Rolan Eberhard.

2002), which is consistent with the alkaline soil parent material – calcareous Quaternary sand. A calcrete duricrust is widespread in the form of hardpans and rounded whitish clasts, often exposed by erosion or brought to the surface by anthropogenic disturbance (Plate 10). The calcrete results in stony soils on some parts of the island.

The soils and sand units on which they are formed are highly erodible, as demonstrated by sandblows and erosion gullies described elsewhere in this paper. Some of these sandblows contain lags of calcareous pipes formed around plant roots (Plate 11), reminiscent of King Island's Calcified Forest. Burrowing seabirds are a source of intense local bioturbation of soils on the southwestern coast, exacerbating erosion hazards in areas that have been burnt. Up to 1 m of sediment has been lost from some sites, as indicated by the height of pedestals formed where soil has been retained around knobby clubsedge root balls (Plate 12). Numerous bones from seabird and small mammals litter the surface of some deflated areas.

GENERAL DISCUSSION and CONCLUSION

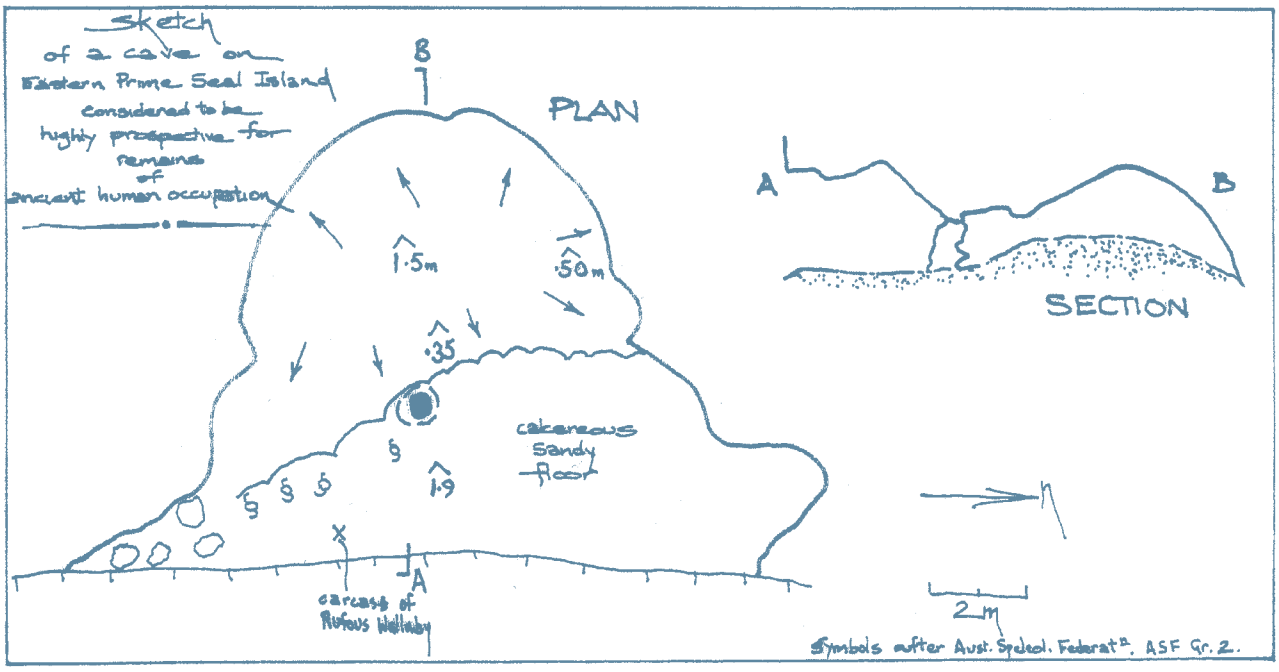
Crustal deformation associated with the separation of Australia and Antarctica produced the Bass Basin, into which the sea began to intrude early in the Tertiary Period. This process culminated in the separation of Tasmania from mainland Australia about 38 million years ago. Since that time, eustatic fluctuations in sea level have periodically exposed the land bridge, notably during Quaternary ice ages, or flooded it (Jennings 1959). Prime Seal Island would have first come into existence as an island in its own right, as opposed to a range of hills on the eastern margin of the Bassian Plain, during one of these sea level highs. Cainozoic marine sediments up to 18 m above present sea level on Flinders Island (Sutherland and Kershaw 1971) imply that, on one or more occasions, the wind gaps between the hills of Prime Seal Island would have been submerged, creating a minor archipelago of three or four smaller islands.

The timing and duration of isolation events (islands) versus connectivity events (land bridges) can be modelled using bathymetry data and Quaternary sea level curves. An important caveat on this is that it cannot necessarily be assumed that submerged Quaternary land surfaces have been preserved following post glacial rises in sea level, due to sediment movement in the marine environment. This is particularly pertinent around Flinders Island, where strong currents have both scoured deep trenches and deposited extensive sandy shoals (Jennings 1959). Nor can it be assumed that the elevation of the land relative to the sea is affected only by fluctuations in sea level, as land can be pushed up or down through tectonic movement or isostatic pressure. However, although there is evidence that many parts of the Tasmanian coast have experienced Quaternary uplift, this does not appear to be the case on Flinders Island in the latter part of the Pleistocene (Murray-Wallace and Goede 1995).

Other factors being equal, the depth of water overlying a former land bridge is a threshold that determines whether a change in sea level has potential to expose the land bridge or drown it. In the case of Prime Seal Island, the channel between it and Flinders Island is shallow, being about 10-15 m deep (Australian Hydrographic Service 2002). This would require only a modest fall in sea level to create a land bridge. Within 1-2 km west of Prime Seal Island, the sea bed drops fairly rapidly to a depth of about 40 m, due to the presence of a linear submarine feature interpreted as a probable fault (Jennings 1959). Further west, the gradient of the sea bed moderates, and the 60 m depth contour – the approximate average depth of the Bassian Rise, the presumed former land bridge between Tasmania and mainland Australia – is some 30 km offshore. Consequently, below the 40 m depth contour, a small change in relative sea level would result in a major shift in the position of the coastline. The 40 m depth contour is also the approximate depth of the presumed former land bridge between Flinders Island and Tasmania, now Banks Strait.

A post-glacial sea level curve based on dated marine sediments from the eastern Australian region (Hopley 1987) suggests that the most recent major sea level transgression, which commenced after 20 ka, would have overtopped the Bassian Rise around 12-13 ka. The same sea level curve suggests that the Flinders-Tasmania land bridge would have disappeared at about 10-11 ka, while Prime Seal Island would have ceased to be joined to Flinders Island at 8-9 ka. This potentially corroborates the age of the youngest dated cultural horizon in Mannalargenna Cave, as it is plausible that humans ceased to make use of the cave when it became isolated by sea. Sea level curves based on more recent reviews of data from eastern Australia suggest that Prime Seal Island became separate from Flinders Island around 8.5-10 ka (Sloss *et al.* 2007). Differences between these and other sea level curves reflect the field data from which they are derived, which in turn are affected by many local factors. Blom (1988) argues that the Bassian Rise was not overtopped until as late as 8 ka, based on a date for

Figure 3. Sketch plan of Mannalargenna Cave (from Harris 1988).



the first appearance of an oceanic facies in a sediment core from Bass Strait. Thus, at present, the timing of the most recent inundation of the presumed former land bridges can only be constrained to within several thousand years.

A sea level curve based on dates from uplifted coral terraces on the Huon Peninsula, Papua New Guinea, is available from 260 ka onwards (Aharon and Chappell 1986). Inferences made on the basis of this curve would suggest that Prime Seal Island was rarely cut off from Flinders Island prior to the most recent marine transgression. It was probably isolated for a period between about 118-135 ka and possibly briefly at around 106, 220 and 240 ka. The same sea level curve suggests that the Bassian Rise was exposed on various occasions: prior to 250 ka, around 190 ka, between about 170-140 ka, possibly briefly at 110 ka, intermittently between 80-30 ka and then again at around 29-12 ka. The Flinders-Tasmania land bridge would have been dry for longer periods and may have escaped inundation for most of the period 10-80+ ka. Although earlier sea level curves are available, these are more speculative still and their applicability to Prime Seal Island, where a mere 10 m rise or fall in sea level is critical, is questionable. However, the general pattern of episodic isolation and connectivity events can be assumed to have applied during earlier Pleistocene glacial-interglacial cycles.

Conclusions

Whereas a 6.4 km wide seaway currently separates Prime Seal Island from Flinders Island, which in turn lies about 50 km off the coast of northeast Tasmania, Prime Seal Island existed for extended periods only as an outlying cluster of hills on the windy Bassian Plain, overshadowed by the higher ranges to the east on present-day Flinders Island. The physiographic context at this time was continental rather than maritime. Consistent with this is the presence on the island of relict sandsheets and longitudinal dunes, a legacy of the once extensive aeolian landscape that extended south to Tasmania across the Bassian Plain.

Despite strong similarities with other parts of the Furneaux Group, the geodiversity of Prime Seal Island includes features which are particularly well developed or otherwise of considerable interest for science and conservation. These include aeolianite karst phenomena, which are common in parts of Bass Strait but poorly represented in Tasmania generally. Additionally, eroded sections through Quaternary sands provide access to sedimentary sequences spanning a period of major environmental change during the late Pleistocene and Holocene. These features warrant consideration for listing [3] in the Tasmanian Geoconservation Database, which currently contains only one reference to PrimeSeal Island, the Prime Seal Island Karst and Concretions site.

While sand erosion has facilitated access to valuable scientific evidence, the same process is depleting the overall scientific resource while creating a potentially serious source of land degradation. Evidence of recent or ongoing sand movement can be observed on many parts of Prime Seal Island today, particularly where the land management practices include grazing and burning on steep and/or exposed slopes. In the interest of avoiding further anthropogenic modification to relict aeolian landforms and compromising important sedimentary records, these practices should be avoided.

ACKNOWLEDGEMENTS

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[3] These have now been listed.

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Appendix 1. Physico-chemical characteristics of two Prime Seal Island springs

	Spring 1	Spring 2
Location		
Easting (GDA)	562760	563630
Northing (GDA)	5560890	5561210
Field measurements		
Temperature (°C)	14.8	13.7
pH	8.70	-
Conductivity (mS/cm)	2.54	-
Analyte		
Bromide (mg/L)	2.9	3.1
Chloride (mg/L)	513	631
Fluoride (mg/L)	1.09	0.98
Sulphate (mg/L)	179	342
Ammonia (mg-N/L)	0.018	0.016
Nitrate (mg-N/L)	10.1	7.82
Nitrite (mg-N/L)	0.029	0.005
Nitrogen (mg-N/L)	11	8.4
Phosphorus (mg-P/L)	0.237	0.362
Silver (µg/L)	<1	<1
Aluminium (µg/L)	2500	1880
Calcium (mg/L)	56.2	98.1
Cadmium (µg/L)	<1	<1
Cobalt (µg/L)	1	<1
Chromium (µg/L)	6	6
Copper (µg/L)	1	3
Iron (µg/L)	2030	2030
Magnesium (mg/L)	37.4	42.4
Manganese (µg/L)	39	49
Sodium (mg/L)	445	611
Nickel (µg/L)	<10	<10
Lead (µg/L)	<7	<7
Zinc (µg/L)	5	6

VEGETATION

Photo by Micah Visoiu

By Micah Visoiu

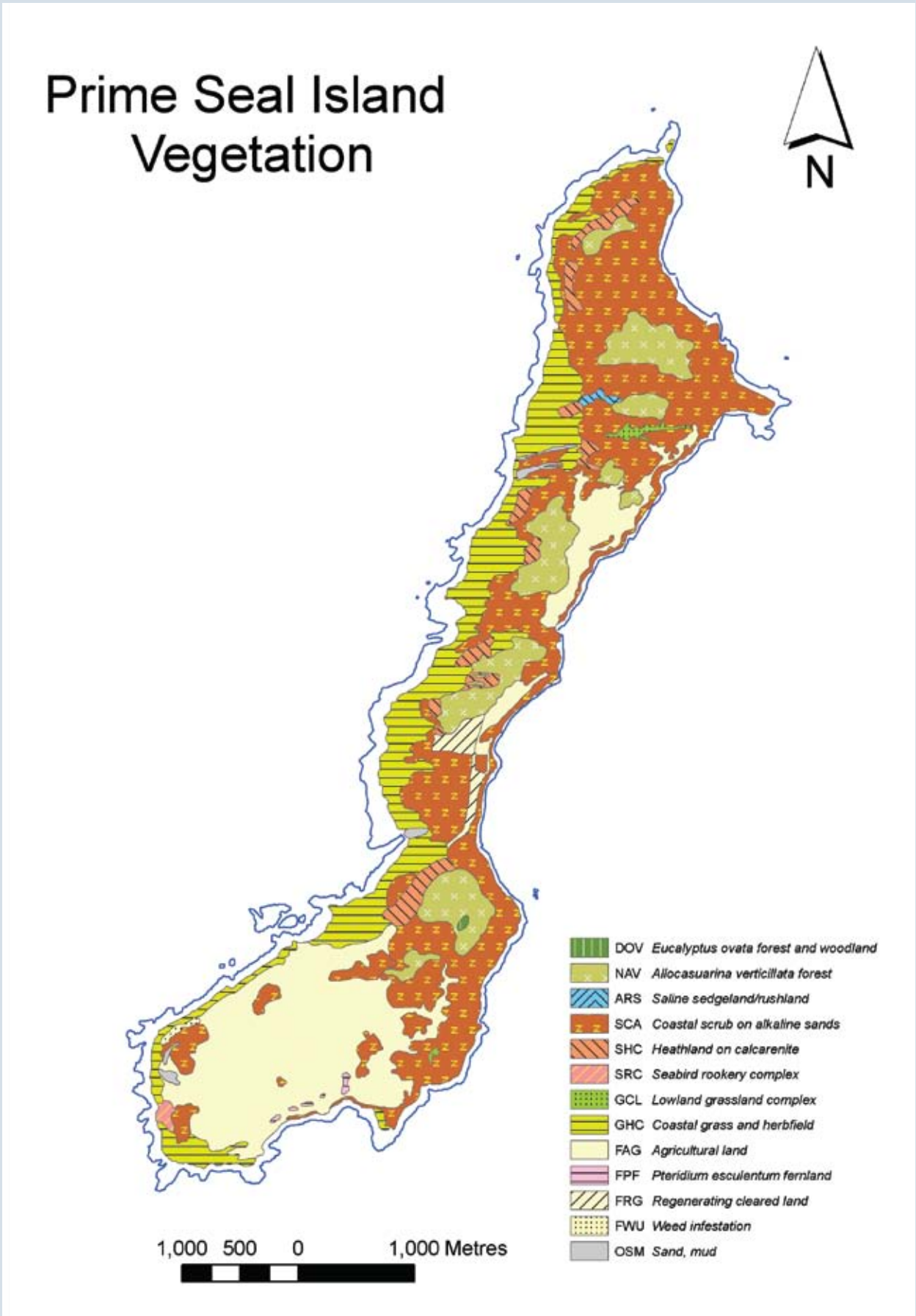
A survey of Prime Seal Island in October 2008 resulted in identification, description and mapping of 13 TASVEG mapping units (Harris & Kitchener 2005). The mapping units identified are '*Allocasuarina verticillata* forest (NAV)', '*Eucalyptus ovata* forest and woodland (DOV)', 'Coastal scrub on alkaline sands (SCA)', 'Heathland on Calcarenite (SHC)', 'Coastal Grass and Herbfield (GHC)', 'Seabird rookery complex (SRC)', 'Saline sedgeland/rushland (ARS)', 'Lowland grassland complex (GLC)', 'Sand Mud (OSM)', '*Pteridium esculentum* fernland (FPF)', 'Agricultural Land (FAG)', 'Weed Infestation (FWU)' and 'Regenerating cleared land (FRG)'. Distinct facies within these communities have been described and related to previous literature descriptions.

INTRODUCTION

The first signs of human occupation of Prime Seal Island has been dated at 18 500 years BP, through archaeological work undertaken at Mannalargenna Cave on the island's north east coast. The use of this site continued until at least 15 000 years BP. However after this date it is thought that rising sea levels reduced and finally eliminated human influence from these islands until the arrival of Europeans in the late 18th and early 19th centuries. From this time onwards the human impacts on the majority of Furneaux Islands including Prime Seal Island was very significant (Harris *et al.* 2001). Since the arrival of sealers on the island in these early years, fire has been a significant shaping influence on the vegetation. Clearing through burning and then the grazing of livestock has been a use of the island for well over a century (Whinray 1971). Aerial photographs taken in the early 1950's show that woody vegetation at that time covered probably less than 20% of the island, this is a significant change to the observations made by Campbell in 1828 who stated the island to be 'lofty and covered in trees' (in Harris *et al.* 2001). More recent Aerial photographs show that the cover of woody vegetation on the island has increased markedly in the last 50 years. It would appear from the available aerial photographs (1951, 1974, 1982, 1998, and 2004) that the vegetation is very dynamic. The development from grassland then heathland, scrub and forest is rapid, whilst fire is an ever present stochastic factor that can halt this succession at any time.

The first vegetation map of Prime Seal Island was published in 2001 (Harris *et al.* 2001) as part of a volume that described and mapped the vegetation of islands within the outer Furneaux Group in Bass Strait. Nineteen mapping communities were identified during several visits to the island in the early late 1980s and early 1990s. The extent of these mapping units on the ground was then mapped using 1998, 1:24 000 aerial photography, along with field notes. This map and associated vegetation descriptions of Harris *et al.* (2001) together with some new aerial photographic interpretation (using 2003 1: 42 000, air photos) were used to classify and map the island's vegetation within the 1:25 000 statewide Tasmanian Vegetation map 'TASVEG 2.0' in 2008 (TVMMP 2009). The process of converting the original units into TASVEG mapping units described in Harris & Kitchener (2005), is not straightforward and may have resulted in some translation errors.

The extensive ground survey work on the island during the 2008 expedition provided an invaluable opportunity to ground truth the current vegetation mosaic, update the mapping and determine the most appropriate TASVEG mapping units in which to place the vegetation communities present. This paper therefore provides an updated vegetation map of Prime Seal Island, along with detailed descriptions of the vegetation communities on the island. Extent and occurrence of threatened species and species of biogeographic significance are dealt with elsewhere in this report, as is the occurrence and extent of exotic species on the island.


Prime Seal Island
Vegetation
N
DOV Eucalyptus ovata forest and woodland
NAV Allocasuarina verticillata forest
ARS Saline sedgeland/rushland
SCA Coastal scrub on alkaline sands
SHC Heathland on calcarenite
SRC Seabird rookery complex
GCL Lowland grassland complex
GHC Coastal grass and herbfield
FAG Agricultural land
FPF Pteridium esculentum fernland
FRG Regenerating cleared land
FWU Weed infestation
OSM Sand, mud
1,000 500 0 1,000 Metres

METHODS

The island was comprehensively traversed on foot. Composition of floristic communities was noted in areas that were determined to be representative of the vegetation on the island. Vegetation extent and community boundaries were subsequently mapped using a variety of remotely sensed imagery. The most recent aerial photography was at 1: 42 000 scale and dated from 2003, the only 1:24 000 coverage was 1998 black and white imagery. Examination of these two photo runs suggested that the vegetation on the island was very dynamic, with changes in vegetation extent in this 5 year period obvious in several areas. Google Earth (www.earth.google.com 2009) was found to use 2009, 2.5 metre resolution SPOT 5 imagery, which indicated further changes in vegetation community extents since 2003. The 2009 SPOT 5 imagery was deemed to be of high enough quality to map the vegetation when used in conjunction with the 1998 and 2003 aerial photography, ground observations and landscape photographs taken during the field trip. Mapping was carried out on transparency overlays over ~1:15 000 sized SPOT 5 printouts from Google Earth. The vegetation mapping units used are from Harris & Kitchener (2005). Some of the floristic communities (facies) within these mapping units were also described.

Species nomenclature follows Buchanan (2005). Structural classification follows the National Vegetation Information System (NVIS) structural formations rule set (Thackway *et al*., in Mackenzie *et al.* 2008).

RESULTS

On-ground observations on Prime Seal Island over the course of the six day field trip provided a good insight into the vegetation associations present. A number of these associations would seem to be unique within Tasmania, primarily due to *Lasiopetalum discolor* which is extensively distributed over the island and is dominant or sub-dominant in several communities. This species, within Tasmania, is confined to this island.

Examination of aerial photographs and satellite imagery, combined with extensive field observations suggest that the vegetation is very dynamic. An apparent reduction in the extent of grazing of the island in recent years along with an associated reduction in burning of some areas has resulted in a significant increase in the cover of scrub communities, whilst some areas of *Allocasuarina verticillata* forest also seem to be expanding. No vegetation was seen on the island that did not show signs of fire in the past.

The floristic communities have been described in *Community descriptions and biogeographic notes*.

Vegetation Map

Community descriptions and biogeographic notes

The vegetation on Prime Seal has been categorised here into 13 TASVEG mapping units (Harris & Kitchener 2005). Within several of these mapping units there is more than one facies. The vegetation mapping units present are listed in Table 1, along with the different floristic/structural associations where present. Floristic communities described elsewhere from statewide surveys which are related to those seen on Prime Seal Island are also indicated. All the defined vegetation associations which were noted on the Island are described below.

Table 1: List of Mapping units and floristic associations observed on Prime Seal Island (2008)

TASVEG mapping Unit Name	Code	Floristic/structural associations distinguished	Similar described floristic Communities
Allocasuarina verticillata forest	NAV	*Allocasuarina verticillata* short open forest	*2. Allocasuarina verticillata* forest (Harris *et al.* 2001) Coastal *Allocasuarina* low forest (Duncan & Brown 1985)
		Allocasuarina verticillata, Myoporum insulare, Bursaria spinosa short closed forest	*2. Allocasuarina verticillata* forest (Harris *et al.* 2001) Island *Allocasuarina* low forest (Duncan & Brown 1985)
Eucalyptus ovata forest and woodland	DOV	*Eucalyptus ovata, Allocasuarina verticillata* short closed forest	
Coastal scrub on alkaline sands	SCA	*Beyeria lechenaultii, Myoporum insulare* closed shrubland	17. *Leptospermum laevigatum* scrub (+/- *Leucopogon parviflorus, Bursaria spinosa, Dodonaea viscosa, Melaleuca ericifolia, (Melaleuca armillaris* –Long Island only), *Correa alba)* (Harris *et al.* 2001)
		Leptospermum laevigatum, Allocasuarina verticillata, Pomaderris paniculosa subsp. *paralias, Dodonaea viscosa, Leucopogon parviflorus, Bursaria spinosa, Olearia ramulosa* closed shrubland	17. *Leptospermum laevigatum* scrub (+/- *Leucopogon parviflorus, Bursaria spinosa, Dodonaea viscosa, Melaleuca ericifolia, (Melaleuca armillaris* –Long Island only), *Correa alba*) (Harris *et al.* 2001) Dominance community 19. *Leptospermum laevigatum* scrub (Kirkpatrick & Harris 1995)
		Myoporum insulare tall closed shrubland	24. *Myoporum insulare* closed Scrub (Harris *et al.* 2001) Dominance community 24. *Myoporum insulare* shrubland (Kirkpatrick & Harris 1995)
Heathland on Calcarenite	SHC	*Beyeria lechenaultii, Pimelea serpyllifolia* heathland	11. Heathland on calcarenite (Harris *et al.* 2001)
		Lasiopetalum discolor heathland	11. Heathland on calcarenite (Harris *et al.* 2001)
		Acrotriche cordata, Lasiopetalum discolor open heathland	11. Heathland on calcarenite (Harris *et al.* 2001) Floristic community 34. *Spyridium vexilliferum-Acrotriche cordata* heath (Kirkpatrick & Harris 1995)

TASVEG mapping Unit Name	Code	Floristic/structural associations distinguished	Similar described floristic Communities
Coastal Grass and Herbfield	GHC	Fire disclimax *Austrostipa stipoides* closed tussock grassland	4. *Austrostipa stipoides* tussock grassland (Harris *et al.* 2001) Dominance community 30. *Austrostipa stipoides* tussock grassland (Kirkpatrick & Harris 1995)
		Austrostipa stipoides, Disphyma crassifolium, Tetragonia implexicoma, T. tetragonoides open tussock grassland	32. Succulent herbfield (*Tetragonia implexicoma / Disphyma crassifolia / Sarcocornia quinqueflora succulent herbfield*) (Harris *et al.* 2001) Floristic community 15. *Austrostipa stipoides-Disphyma crassifolium* tussock grassland (Kirkpatrick & Harris 1995)
Seabird rookery complex	SRC	*Leucophyta brownii, Tetragonia implexicoma* sparse shrubland	18. *Leucophyta brownii* heathland (Harris *et al.* 2001) Dominance community 7. *Leucophyta brownii* shrubland (Kirkpatrick & Harris 1995)
Saline sedgeland/ rushland	ARS	*Juncus kraussii* rushland	14. *Juncus kraussii* rushland (Harris *et al.* 2001) Dominance community 16. *Juncus kraussii* rushland (Kirkpatrick & Harris 1995)
Lowland grassland complex	GCL	*Austrostipa flavescens Austrodanthonia* spp. *Poa labillardierei* closed grassland	
Sand Mud	OSM		
Pteridium esculentum fernland	FPF	*Pteridium esculentum* closed fernland	28. *Pteridium esculentum* fernfield (Harris *et al.* 2001)
Agricultural Land	FAG	Improved pasture	9. Exotic grassland and improved pasture (Harris *et al.* 2001)
Weed Infestation	FWU	*Mesembryanthemum crystallinum* closed forbland	
Regenerating cleared land (FRG)	FRG	Slashed scrub on alkaline sands	10. Exotic grassland and improved pasture dominated by *Ficinia nodosa* (Harris *et al.* 2001)

Allocasuarina verticillata forest (NAV)

The high fire frequency on the island since European discovery has contributed to reduced tree cover. Harris *et al.* (2001) cites an early account by Campbell, who in 1828 described the island as lofty and covered in trees. This general reduction in tree cover is well illustrated by a 1951 aerial photo which clearly shows the *Allocasuarina verticillata* forest extent on the island (presumably *A. verticillata* was the only widespread tree species on the island at this time), to be confined to two small patches and a number of other areas of scattered trees. This forest type has since this time expanded considerably as shown by more recent aerial photos. In several stands large mature and often senescing trees were located at the centre with younger individuals found towards the outside.

A. verticillata forest currently occurs in stands on the more rocky areas on the summits of the hills extending down slope on the northern sides. Patches also persist on well drained sandy rises, presumably in areas that have escaped high intensity burning regimes. These site characteristics are typical for the vegetation mapping units in north eastern Tasmania (Harris & Kitchener 2005). In long undisturbed areas on the island *A. verticillata* forest is characterised by complete dominance by *A. verticillata* underlain by a thick cover of leaf litter on the ground. Individual *Pimelea serpyllifolia* are occasional in the understorey. In gaps caused by the breaking down of "old growth" *A. verticillata; Lasiopetalum discolour* and *Myoporum insulare* occur, as do the short lived shrubs *Apalochlamys spectabilis* and *Zygophyllum billardierei*. These disturbance gaps would appear to be short lived as regeneration of *A. verticillata* was also apparent in many of the canopy gaps in which senescing trees were observed. This facies of the community best matches the structure and habitat of "Coastal *Allocasuarina* low forest" as described by Duncan and Brown (1985); however the associated species are different from the common associates seen on mainland Tasmania. This is due to the flora of Prime Seal Island lacking many of these species, and including many species that do not occur commonly on the Tasmanian mainland.

In some areas, primarily on the large hill to the south of Peacock Bay, a second facies of *A. verticillata* forest has developed that is far more species rich than the typical form elsewhere on the island. Contributory factors to this might include more recent fire disturbance as indicated in this area by the presence of fire scars on several larger trees and a single cohort regeneration of several species including *A. verticillata*, two to three metres in height. The overstorey incorporates *Myoporum insulare,* and occasionally *Bursaria spinosa*. A quite dense shrub layer is developed that includes *Pomaderris paniculosa* subsp. *paralius, Bursaria spinosa, Dodonaea viscosa, Leucopogon parviflora* and *Lasiopetalum discolour*. The ground layer is quite dense with a cover of grasses; predominantly *Poa labillardierei* and *Austrodanthonia* sp., and herbs such as *Wahlenbergia gracilenta, Daucus glochidiatus* and *Ajuga australis*. Several orchid species are also present; most commonly *Caladenia latifolia* and *Microtis uniflora* however *Cyrtostylis robusta* and a large stout fruiting specimen of a *Pterostylis* sp. were also encountered. The facies of *Allocasuarina verticillata* forest fits the floristic community "Island *Allocasuarina* low forest" (Duncan & Brown 1985). In the description of this community it is stated that this type of vegetation was probably extensive on Prime Seal Island (amongst others) prior to European use of the Island.

Eucalyptus ovata forest and woodland (DOV)

There is a small area of *Eucalyptus ovata* forest and woodland (DOW) present on the large hill to the south of Peacock Bay. It occurs on north easterly slope on deep limey sands overlain by a +/- 10 cm thick layer of gray brown sandy loam. This vegetation is floristically very similar to the higher diversity facies of *Allocasuarina verticillata* forest, however a sparse population of *Eucalyptus ovata* is also scattered throughout forming a sub-dominant layer amongst the slightly taller *A. verticillata*. This situation is quite unusual and the resulting floristic community could be interpreted as a facies of *A. verticillata* forest

(NAV), however the significance of the occurrence of *E. ovata* at this site warrants its separate mapping unit (see other paper by Visoiu this volume). The *E. ovata* at this site are low spreading +/- mallee form trees and are 1-2 metres shorter than the surrounding overstorey and often have no shrub layer beneath, with a lush thick herbaceous ground layer. This community is floristically distinct from *E. ovata* described elsewhere in Tasmania (Duncan & Brown 1985). It has similarities with "Island *Allocasuarina* low forest" (Duncan & Brown 1985); however *E. ovata* is not named as an associate in this community elsewhere, although *E. globulus* occurs commonly with it on Flinders Island.

In the early 1950s, the site of the *E. ovata* population was located in a small forested remnant situated in an extensively cleared landscape, as shown in aerial photographs taken early 1951. Since that time much of the surrounding pasture has been invaded by native vegetation with significant areas of *A. verticillata* forest and scrub on alkaline sands now surrounding this original remnant. Despite the significant expansion of this woody vegetation, the *E. ovata* does not appear to have spread from the original wooded patch visible in 1951. Harris *et al.* (2001) suggested the confinement of this species to this site (only one individual was encountered at that time) suggested a paucity of eucalypts on the island prior to European use.

Coastal scrub on alkaline sands (SCA)

This mapping unit incorporates much of the vegetation on Prime Seal Island, however the vegetation it covers is quite heterogeneous. The areas mapped as *Coastal scrub on alkaline sands* (SCA) are a fine scale mosaic of scrub communities delineated mainly by period since last fire. They are however all similar in that they all occur on limey and sometimes cemented sands with characteristic species including *Beyeria lechenaultii, Myoporum insulare* and *Leptospermum laevigatum* present in varying combinations. This scrub complex fits loosely into mapping unit 17 "*Leptospermum laevigatum* scrub (+/- *Leucopogon parviflorus, Bursaria spinosa, Dodonaea viscosa, Melaleuca ericifolia, (Melaleuca armillaris* –Long Island only), *Correa alba*)" described by Harris *et al.* (2001).

In its simplest form the CS community on the island is dominated by *Beyeria lechenaultii* and/or *Myoporum insulare*, the dominance of which is determined by the substrate, with *B. lechenaultii* most prevalent on calcarenite and consolidated sands whilst *M. insulare* dominates on deeper limey sands. *Pimelea serpyllifolia, Lasiopetalum discolor* and *Pomaderris paniculosa* subsp. *paralia* are usually also present as scattered midstorey shrubs. The dense nature of this closed scrub usually prevents the development of a ground layer; instead leaf litter and detritus cover the ground along with areas of exposed sand. In many areas this facies occurs in association with granite outcrops. However, the soil in these areas remains calcareous, often with calcarenite sheets developed on the outcropping granite bedrock where it meets the ground. Occasionally at the centre of these outcrops there are areas where the calcium carbonate has been leached out. In these areas other species associations occur and would be mapped as Dry scrub (SDU) if they were sufficiently extensive to map, but their rarity and small extent precluded them from being distinguished in the mapping. Species that occur in these areas are rare on the island and include *Leptecophylla juniperina* subsp. *oxycedrus, Pultenaea daphnoides* var. *obcordata* and *Kunzea ambigua.*

A second more complex facies of scrub on alkaline sands is found on some areas of deeper sands. At these sites *Allocasuarina verticillata, Leptospermum laevigatum, Pomaderris paniculosa* subsp. *paralia, Dodonaea viscosa, Leucopogon parviflora, Bursaria spinosa* and *Olearia ramulosa* also occur. *Myoporum insulare* is usually present, but *Beyeria lechenaultii* is often absent. There is often no obvious dominant; instead there is a mixture of +/- even height individuals of a selection of the above species or a fine scale mosaic of small patches of those species. The cover of any one of these species rarely exceeds 20%. *Poa labillardierei, Austrostipa flavescens* and *Austrodanthonia* sp. often form

a grassy ground cover. The shrubs *Apalochlamys spectabilis, Zygophyllum billardierei,* and herbs *Parietaria debilis, Dichondra repens, Senecio biserratus* and *Urtica incisa* are all commonly present amongst the grass tussocks or in relatively bare areas. No systematic survey and classification of scrub communities has been undertaken in Tasmania, however areas of this facies may fit into the dominance community "19. *Leptospermum laevigatum* scrub" (Kirkpatrick & Harris 1995).

A third floristic community that has been mapped in the SCA mapping unit occurs in areas that have remained undisturbed for a long time. This facies is predominantly located on easterly facing slopes. In such areas *Myoporum insulare* forms a more or less closed scrub often with occasional *Allocasuarina verticillata.* The vegetation ranges from 3 to 6 metres in height with a +/- open understorey with a well developed ground layer of herbs, grasses and orchids. The best examples of this *M. insulare* closed scrub are present on the eastern slopes of the large hill to the south of Peacock Bay. This vegetation type has been identified by Harris *et al.* (2001) as mapping unit 24 "*Myoporum insulare* closed Scrub" and occurs on a number of the Furneaux Islands. It has however not been floristically described elsewhere.

Heathland on Calcarenite (SHC)

There is a reasonably large extent of heathland on calcarenite on Prime Seal Island. Patches are primarily located on westerly to north-westerly facing slopes and are found on most of the hills along the length of the island. The substrate in all these areas is granite overlain by a cap of calcarenite which is in places exposed as a sheet or as beds of broken and angular rubble, calcareous sands form the subsoil with a thin (5 cm thick) layer of dark brown organically enriched top soil. There are three distinct facies of this heathland on the island which seem to be determined by soil type. All three facies are included in mapping unit 11 "Heath on calcarenite" (Harris *et al.* 2001).

The first facies is characterised by deeper limey sands with little organic matter, there is little or no exposed limestone, however fragments are scattered on the surface. This soil type is generally found on the lower slopes and flats below hills. The dominant species is generally short *Beyeria lechenaultii* var. *latifolia* 0.5-1 metres high with 25-75% cover. *Pimelea serpyllifolia* forms a 25-50% cover with bare ground often prevalent (10-50% cover). Other species that are often present with lower covers are *Pomaderris paniculosa* subsp. *paralia, Zygophyllum billardierei* and stunted *Myoporum insulare*. This floristic community has not been specifically described elsewhere.

The second facies is generally found on the steeper slopes in areas where outcropping rock is limited. The soil is comprised of a higher organic content in the top 5cm, with limey sands, mixed with granite gravels below this; fragments of calcarenite are also common. The overwhelming dominant is *Lasiopetalum discolor* 50-80cm high and with 25-75% cover. *Beyeria lechenaultii* var. *latifolia* and *Pimelea serpyllifolia* are both also prevalent with 10-30% cover each. *Hibbertia sericea* is also present as is *Zygophyllum billardierei*. There are few herbs and ground covers and bare ground is common. This floristic community has not been described specifically elsewhere. The dominance of *L. discolor* would make this community unique to Prime Seal Island.

The third facies is associated with outcropping and broken surface calcarenite rubble with a matrix of calcareous sand and low levels of organic matter. In these areas *Acrotriche cordata* commonly dominates with 10-50% cover. *Lasiopetalum discolor* and *Beyeria lechenaultii* are always present, with *Hibbertia sericea* also usually present. *Spyridium vexilliferum* and or *Eutaxia microphylla* are also occasionally present in these areas. This floristic community has affinities with "Floristic community 34. *Spyridium vexilliferum-Acrotriche cordata* heath" described by Kirkpatrick & Harris (1995), from north eastern Flinders Island. It differs from this community in that *L. discolor* makes

up a substantial proportion of the cover. *A. cordata* and *E. microphylla* have been seen to have similar environmental preferences on Flinders Island, where they occur together in the few sites they are known from (Underwood 1998).

Seabird rookery complex (SRC)

There are small areas of sea bird rookery in the south western corner of the island which are occupied by a relatively small breeding colony of less than 3000 pairs of short tailed shear waters (*Puffinus tenuirostris*) (Brothers *et al.* 2001). These areas differ from the normal sea bird rookery vegetation in the Furneaux islands in that the dominant species is *Leucophyta brownii*, with interspersed *Tetragonia implexicoma*. There are also large scattered individuals of South African boxthorn (*Lycium ferocissimum*). The *L. brownii* individuals are very large, some being up to 1.5 metres in height and 2 metres in canopy width. The colonies are located on flats and steep slopes which are composed of consolidated calcareous sands that are rich in sub-fossil bird and marsupial remains. Bare sand with scattered sub fossil remains comprises 30-60% of the ground cover. This community is described as mapping unit 18 "*Leucophyta brownii* heathland" by Harris *et al.* (2001); however it has not been floristically distinguished beyond this. It would however fit into the dominance community "7. *Leucophyta brownii* shrubland" (Kirkpatrick & Harris 1995).

Saline sedgeland/rushland (ARS)

There are small patches of this vegetation in the saddle to the south of North Hill. At this site wind is funnelled inland bringing salt spray during onshore westerly weather. The facies is very species poor, being dominated by *Juncus kraussii* of around 50% cover, with bare red/orange soil exposed over much of the remaining area, often with a visible salt crust. Occasional herbs are *Gnaphalium indutum, Vellereophyton dealbatum* and *Disphyma crassifolium*. This is similar to areas of saline sedgeland/rushland in other coastal areas of Tasmania (Harris & Kitchener 2005) and the Furneaux Islands (Harris *et al.* 2001).

Lowland grassland complex (GCL)

There are several small patches of native grassland on the island that have developed in areas of previously improved pasture. These are generally openings in regenerating scrub and are dominated by *Austrodanthonia racemosa, Austrostipa flavescens* and *Poa labillardierei*. Annual weed grasses are relatively common in these areas however the native grasses are the dominant. This vegetation mapping unit is rare on the Outer Islands of the Furneaux Group and may only occur on the biggest islands. The site characteristics and floristics are typical of the vegetation types throughout the drier areas of the Tasmanian mainland (Harris & Kitchener 2005). The one slightly unusual aspect of the community on Prime Seal Island is the presence of *Austrostipa flavescens* as one of the

dominants. This species is uncommon away from coastal areas, with other *Austrostipa* species more common in Lowland grassland complex (GCL) within its primary occurrences', which is in the northern and southern midlands.

Coastal Grass and Herbfield (GHC)

Coastal grassland and herbfield is widespread along the western and southern coast of Prime Seal Island where it is primarily located on alkaline sands which are in varying stages of calcarenite formation. There are two main facies represented in this mapping unit, both of which fit into mapping unit 4 "*Austrostipa stipoides* tussock grassland" described by Harris *et al.* (2001) for the Furneaux Islands.

The first and most widespread facies is a fire disclimax community, being characterised by large tussocks of *Austrostipa stipoides* with few other species present. These areas are maintained by patch burning, with fires set as soon as the vegetation will hold a fire which is usually every three to four years (J. Cooper pers comm). This type of grassland is common and extends several hundred metres inland in many areas. In some places there is an obvious succession between this community and the SCA community. Where the fire frequency is lower, *Myoporum insulare* and *Beyeria lechenaultii* begin to overtop the grass tussocks and the conversion to scrub is rapid. Examination of historical aerial photos (1951, 1974, 1982, 1998) indicates the boundaries between these two communities are quite dynamic and are often represented by wide ecotones.

Just to the south east of Sealers Cove on a steep dune face an interesting example of the fire disclimax community occurs with *Pultenaea tenuifolius* and *Eutaxia microphylla* common amongst the *A. stipoides* tussocks in otherwise bare sand.

The second facies of Coastal grass and herbfield (GHC) appears to be the more natural of the two. It is less fire dependent gaining disturbance instead from salt spray and coastal processes. This facies has higher species diversity. Typically there is a 25-50% cover of *A. stipoides,* with inter-tussock spaces covered by mats of *Tetragonia implexicoma* and to a lesser extent *T. tetragonoides, Disphyma crassifolium,* and short spreading *Myoporum insulare. Poa poiformis* is scattered and occasional throughout the grassland and herbfield. The best examples of this herbaceous community are located in the north western eastern tip of the Island, where extensive beds of *Disphyma crassifolium* occur. This vegetation fits floristic community 15 "*Austrostipa stipoides-Disphyma crassifolium* tussock grassland" as described by Kirkpatrick and Harris (1995). Areas of it are mapped as unit 32 "Succulent herbfield (*Tetragonia implexicoma / Disphyma crassifolia / Sarcocornia quinqueflora*

Zygophyllum billardieri in flower on a limestone cliff, western side of Prime Seal Island.
Photo by Micah Visoiu

succulent herbfield)" by Harris *et al.* (2001).

Sand Mud (OSM)

There are a number of areas along the western coast of the island where sand blows have occurred. The cemented and semi-cemented nature of the sands has caused several of these blows to form vertical sides, exposing a multitude of bird and marsupial sub-fossil remains some of which are from species no-longer present on the island. Occasional shrubs of *Leucophyta brownii, Ozothamnus turbinatus* and *Olearia axillaris* are present in stabilising areas.

Pteridium esculentum fernland (FPF)

On the south eastern slopes of the large unnamed hill to the south of Peacock Bay there are several large patches of *Pteridium esculentum.* These have apparently invaded areas previously cleared and converted for agricultural use and are on deep alkaline sands. *Pteridium esculentum* dominates with close to 100% cover; there are occasional pasture species present. This is a typical community of disturbed sandy areas throughout Tasmania (Harris *et al.* 2001, Harris and Kitchener 2005).

Agricultural Land (FAG)

Agricultural land of varying levels of improvement covers much of the Island. The largest patches occur along the east coast and cover the majority of the large unnamed hill to the south of Sealers Cove and Peacock Bay. The majority of the area that has been converted to this land use is underlain by deep alkaline sands with occasional limestone and granite outcrops. The floristic make-up of the pasture varies depending on the level of improvement. Common pasture grasses are *Lolium perenne* and *Bromus diandrus.* A number of *Trifolium* species are also widespread and dominant in places. Annual weed grasses including *Parapholis incurva, Lagurus ovatus* and *Catapodium rigidum* are common and widespread as are herbaceous species *Geranium molle, Cerastium glomeratus* and *Arctotheca calendula.* In many less improved areas native species persist or continue to invade. These include *Apalochlamys spectabilis, Bulbine semibarbata, Lasiopetalum discolor, Ficinia nodosa, Austrostipa stipoides* and *Pimelea serpyllifolia.*

Weed Infestation (FWU)

There are scattered weeds present in various places on Prime Seal Island. The weed issues and mapping of these species are dealt with by Strutt (this volume). The only infestation large enough to be mapped as a distinct patch is located on the south western tip of the island. At this site the succulent halophyte *Mesembryanthemum crystallinum* is dominant over an area of between one and two hectares. The species is annual to biennial and forms a dense mat in the area. *M. crystallinum* accumulates salt. The salt is released once the plant dies, increasing the salinity of the soil (Vivrette & Muller 1977). This makes the habitat unsuitable for all but the most salt tolerant species and allows a new generation of *M. crystallinum* seeds to germinate with little competition (Bohnert & Cushman 2000). *M. crystallinum* is a rare weed in Tasmania (Harris *et al.* 2001, NVA 2009), and is not known to have formed any other infestations of a mappable size anywhere else in the state.

Regenerating cleared land (FRG)

The vegetation on Prime Seal Island shows signs of having undergone significant changes in land use in the past. Aerial photos taken in 1951 show that substantially more of the island was cleared at that point than now. Slashed regrowth scrub in areas that have reverted to native vegetation occur in the southern part of the island. There are several large areas around the shearing shed where this has recently occurred. The resulting vegetation is rapidly re-sprouting and numerous seedlings of native shrubs are quickly growing. These areas have been mapped as regenerating cleared land, although it is unclear whether they will regenerate fully to scrub or be further improved and converted back to improved pasture.

GENERAL DISCUSSION & MANANGEMENT RECOMMENDATIONS

There is incomplete correspondence of the mapping units from Harris *et al.* (2001) with TASVEG mapping units (Harris & Kitchener 2005) resulting in the allocation of the scrub communities on the island to "*Acacia longifolia* coastal scrub (SAC)" and "Heathland scrub mosaic on Flinders Island (SHF)" in TASVEG 2.0. In the vegetation mapping presented in this paper the areas mapped as these two mapping units have been incorporated under "Coastal scrub on alkaline sands (SCA)", which was deemed to be warranted by the floristics and substrate on which they occurred.

The fast rate of vegetation progression on the island has also meant that the TASVEG 2.0 mapping of vegetation extent was already out of date when it was previously mapped due to the lack of contemporary aerial photographs.

Acacia longifolia coastal scrub (SAC) is a distinct vegetation assemblage of *A. longifolia* and *Leucopogon parviflorus*. However, *A. longifolia* was found to be extremely rare on the island, only being seen at one site with less than 5 individuals. Heathland scrub mosaic on Flinders Island (SHF) is a mosaic of scrub and heath that is characterised by a group of species that are not present on Prime Seal Island. These include *Eucalyptus nitida, Xanthorrhoea australis, Banksia marginata, Leptospermum scoparium,* and *Leptospermum glaucescens.* This species list would suggest that the vegetation type is situated on less fertile substrates with a lower pH than those that are typical of Prime Seal Island.

The two other mapping units used in TASVEG 2.0 have been reallocated. Succulent saline herbfield (ASS) on the island has been absorbed into "Coastal grass and herbfield (GHC)". The Coastal heathland (SCH) has been reallocated to Coastal scrub on alkaline sands (SCA).

The rapid development of the vegetation, combined with the removal of African boxthorn (*Lycium ferocissimum*) infestations by the land manager and some small amounts of scrub clearance, have all contributed to changes in vegetation boundaries since the TASVEG 2.0 mapping (based on 1998 1:24 000 aerial photos and 2003 1:42 000 photos). In general the *Lycium ferocissimum* is no longer mappable as weed infestations in the north eastern part of the island, scrub communities have expanded significantly, *Allocasuarina verticillata* forest has expanded noticeably and a small amount of scrub in the centre of the island has been slashed. The extent of Heathland on calcarenite (SHC) is not as extensive as was thought in the south of the island, due probably to over-mapping of it previously rather than clearance. This vegetation type was however found to be under mapped in the central and northern part of the island.

It would be beneficial if fire was excluded from the reserve in the north of the island, and the vegetation in this area was allowed to continue to grow older. Likewise it would be a priority to keep fire out of the scrub and forest communities on the large hill to the south of Peacock Bay. The *Eucalyptus ovata* in this area is of high conservation significance within the outer islands and it would benefit greatly from being left unburnt. The *Allocasuarina verticillata* forest on the hills through the centre of the island should also be left unburnt.

The dynamic nature of the vegetation on Prime Seal Island mean that this description is a snapshot in time. It will continue to change and develop, and burn, and start again.

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Photo by Emma Betts

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A REVISED FLORA

Photo by Micah Visoiu

By Micah Visoiu

A survey of Prime Seal Island in October 2008 resulted in 40 species of vascular plant being added to those previously recorded. These comprise 13 exotic species and 27 species that are native to Tasmania. This takes the known flora of the island to 193 taxa. The island provides habitat for populations of the threatened taxa *Lasiopetalum discolor, Pomaderris paniculosa subsp. paralia, Eutaxia microphylla* var. *microphylla, Spyridium vexilliferum* var. *vexilliferum, Zygophyllum billardierei, Acrotriche cordata, Parietaria debilis, Stellaria multiflora, Cyrtostylis robusta*, and *Leucopogon lanceolatus*. Biogeographically significant taxa encountered were: *Threlkeldia diffusa, Eucalyptus ovata, Convolvulus erubescens* and *Asplenium trichomanes*. An exotic species, *Orobanche minor sensu lato*, is included in this section as its presence on this island intriguing. *Callitris rhomboidea* was previously recorded but was not encountered in this survey. The population size and extent of each threatened or otherwise significant taxa were described on the basis of the 2008 and previous surveys.

INTRODUCTION

Prime Seal Island has been known for some time to have an interesting and in some ways unique flora when compared to the other Furneaux Islands and mainland Tasmanian. In the first half of the 19th century the island was visited by at least two well known Tasmanian naturalists, those being R.C. Gunn and J. Milligan both of whom recorded the presence of *Lasiopetalum discolour*, amongst other things (Tas. Herbarium data, Whinray 1971). The first vascular plant species list for the island was published J. Whinray in 1971 and contained 66 taxa. A second, more comprehensive list was published in 2001 (Harris *et al.*) and contained 143 taxa. Both of these lists were based on the authors' ground surveys; with the exception of one historical record of T*araxacum cygnorum* (J. Milligan 1844) included by Harris *et al.* (2001). Combining the lists provided a total known flora of 155 taxa, including 50 exotic species and two endemics.

Harris *et al.* (2001) produced a vegetation map of the island, descriptions of the vegetation and preliminary estimates of some populations of threatened taxa. At that time eight species listed under the *Tasmanian Threatened Species Protection Act 1995* (TSPA 1995) were known from the Island, (*Acrotriche cordata, Eutaxia microphylla var. microphylla, Lasiopetalum discolor, Leucopogon lanceolatus, Pomaderris paniculosa* subsp. *paralia, Parietaria debilis, Spyridium vexilliferum var. vexilliferum* and *Zygophyllum billardierei)*. *Taraxacum cygnorum* which is listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA 1999) has also been recorded there in the past.

The Hamish Saunders Memorial expedition to Prime Seal Island in October 2008 provided the opportunity to complete a more thorough examination of the island's vegetation and flora, and improve population estimates for threatened or biogeographically interesting plant taxa on the island. It is hoped that the information presented here will be of value for future conservation management planning on this and other Bass Strait Islands, as well as being relevant to future assessment and monitoring for threatened flora inhabiting Prime Seal Island. The information provided here also adds to the understanding of biogeographic relationships in the flora of Bass Strait

METHODS

The island's vegetation was sampled by means of traversing along a number of routes over the six day period. The island was only sampled and this incomplete coverage of the island is a limitation of the survey. Data were recorded during the survey of all plant species and vegetation formations observed. Data on the habitat preferences and distributions of particular target taxa were used to estimate the area

of occupancy for these taxa on the Island. Vegetation maps (Visoiu this volume) also assisted in determining habitat availability. Population counts/densities of target species were estimated by counting or estimating the number of individuals within a small sample area and extrapolating average densities to the total area of occupancy. In some instances belt transects were used to determine population densities. Error ranges were included in assessments; these were subjective and based on the confidence in the population estimate. This was deemed to be a more reliable and accurate representation of the true population given the limitations of the survey than would an arbitrary error percentage.

The species records from the 2008 survey of the island were compared with the two previous published lists for the Island (Whinray 1977, Harris *et al.* 2001) as well as records held by the Tasmanian Herbarium, and data available online on the Natural Values Atlas (NVA July 2009) and Australia's Virtual Herbarium (AVH July 2009). This information was used to create the most comprehensive list so far prepared for Prime Seal Island (Appendix 1).

Taxonomic nomenclature for plant taxa follows Buchanan (2005). The nomenclature adopted here for vegetation communities follows Harris and Kitchener (2005).

RESULTS

An updated species list for Prime Seal Island is located in Appendix one. It contains 193 taxa which include 66 introduced species and 127 native taxa of which two are endemic to Tasmania. Forty species were observed for the first time on Prime Seal Island during the 2008 survey, 27 of these were indigenous Tasmanian taxa, while 13 were exotics that have become naturalised in Tasmania (Buchanan 2005).

Populations of nine threatened species were located during the 2008 survey; two other species have been recorded from the island in the past but were not located during the 2008 survey. Six species of biogeographic interest within the Furneaux Islands were also observed. The species for which population information is described are summarised in Table 1.

Threatened taxa

Acrotriche cordata

Acrotriche cordata is a small heath (up to 50cm tall and 80cm broad) in the family ERICACEAE, and is listed as Vulnerable in Tasmania (TSPA 1995). It has a disjunct distribution, its western most populations occurring around the south west coast of Western Australia where it is considered relatively common. It is also considered common in the south east of South Australia. It occurs sporadically in Victoria near the South Australian border and is listed as Rare under the *Advisory List of Rare or Threatened Plants in Victoria 2005* (ALRTPV 2005). The population in Tasmania is confined to a localized area in the Furneaux Islands approximately 800 km from the South Australian and Victorian populations. Within the islands it is known only with certainty from Flinders and Prime Seal Island (NVA July 2009). There is also one specimen held in the Australian National Herbarium (Canberra) which may have been collected on one of the Sisters Islands which are off the north coast of Flinders Island. The grid accuracy and location notes of this specimen are, however, inconclusive (Unit ID 668889, ANHSIR July 2009). *Acrotriche cordata* is one of a group of taxa, the populations of which in Tasmania are regarded as southern outliers of the Australian mainland core distributions (Underwood 1998).

On Prime Seal Island *Acrotriche cordata* was first collected in the mid 1960's and has been collected several times since however no population data has been provided until now. During the 2008 survey *A. cordata* was determined to be locally common on westerly to north westerly facing slopes in 'Heathland on calcarenite'. The species is known to occur on the same substrate on Flinders Island (Underwood 1998). On Prime Seal Island the species tends to be concentrated in the rockier facies of the heathland where plant cover is lower and sandy

Table 1: Plant taxa for which population distributions and estimates were determined.

Threatened taxa	Common name	Family	Distribution	Status	First Recorded
Acrotriche cordata#	coast groundberry	EPACRIDACEAE	WA, SA, VIC, TAS	Vulnerable	1966
Cyrtostylis robusta	large gnat-orchid	ORCHIDACEAE	WA, SA, VIC, TAS	Rare	2008
Eutaxia microphylla var. microphylla#	spiny bushpea	FABACEAE	WA, SA, VIC, NSW, TAS	Rare	1986
Lasiopetalum discolor#	coast velvetbush	STERCULIACEAE	WA, SA, TAS	Rare	Mid 19th century
*Leucopogon lanceolatus**	lance beardheath	EPACRIDACEAE	SA, VIC, NSW, QLD, TAS	Rare	Early 1990's
Pomaderris paniculosa subsp. *paralia*	shining dogwood	RHAMNACEAE	WA, SA, VIC, TAS	Rare	1966
Parietaria debilis	shade pellitory	URTICACEAE	All states	Rare	1966
Spyridium vexilliferum var. *vexilliferum*	helicopter bush	RHAMNACEAE	SA, VIC, TAS	Rare	Mid 19th century
Stellaria multiflora	rayless starwort	CARYOPHYLACEAE	WA, SA, VIC, NSW, TAS	Rare	2008
Taraxacum cygnorum#*	coast dandelion	ASTERACEAE	WA, VIC, TAS	Vulnerable (EPBCA 1999)	Mid 19th century
Zygophyllum billardierei#	coast twinleaf	ZYGOPHYLACEAE	WA, SA, VIC, TAS	Rare	
Taxa of biogeographic significance					
Asplenium trichomanes	maidenhair spleenwort	ASPLENIACEAE	WA, VIC, NSW, TAS		2008
Callitris rhomboidea	oyster bay pine	CUPRESSACEAE	SA, VIC, NSW, QLD, TAS		1965
Convolvulus angustissimus subsp. *angustissimus*	blushing bindweed	CONVOVULACEAE	WA, SA, VIC, NSW, QLD, TAS		1965
Eucalyptus ovata	black gum	MYRTACEAE	SA, VIC, NSW, TAS		Mid 1980's
Orobanche minor sensu lato	lesser broomrape	OROBANCHACEAE	WA, SA, VIC, NSW, QLD, TAS		Mid 1980's
Threlkeldia diffusa#	coast bonefruit	CHENOPODIACEAE	WA, SA, VIC, TAS		Mid 1980's

* Taxa that were not observed during the survey
# Taxa with highly restricted distributions within Tasmania

coloured broken limestone covers the ground. *A. cordata* dominates these heaths providing 10-50% of the vegetation cover. *Lasiopetalum discolor* and *Beyeria lechenaultii* always co-occur with *A. cordata* in this community.

There are three locations on the island where *Acrotriche cordata* was found to be densely populated. At North Hill there are a number of small patches of *A. cordata* dominated vegetation, which are occupied by 750 mature plants (plus or minus 250). Similarly on the small hill to the south of Target Hill where three distinctive patches were observed to include 750 mature plants (plus or minus 250). The largest population was observed on the unnamed large hill south of Peacock Bay. In this area there are 2300 mature plants (plus or minus 700). Therefore the total estimated population of *A. cordata* on Prime Seal Island is 3800 mature plants (plus or minus 1200).

Cyrtostylis robusta

Cyrtostylis robusta in the family ORCHIDACEAE is a geophytic colony forming terrestrial orchid. It has a single ground hugging reniform leaf and a six to 25cm high scape with up to seven insignificant brownish red flowers (Jones *et al.* 1999). It is regarded as common and widespread in the south west of Western Australia, Likewise on the south east coast of South Australia. It is scattered in Victoria where it is regarded as not threatened. In Tasmania it is distributed around the east and northern coastal areas of Tasmania and it is listed as Rare (TSPA 1995). On the Furneaux islands *C. robusta* is known from Flinders, Babel, Badger and Vansittart islands (Harris *et al.* 2001, NVA July 2009). It has also been collected from Inner Sister Island and the Kent Group of Islands (National Herbarium of Victoria, AVH July 2009).

Cyrtostylis robusta was first recorded on Prime Seal Island during the 2008 survey. It was found in the grassy herbaceous understorey of *Allocasuarina verticillata* and *Myoporum insulare* open forest ('*Allocasuarina verticillata* forest'). It was located in free draining site on a substrate of calcareous sands with a layer of organically enriched top soil. The site had a north easterly aspect and gentle (four degree) slope. The colony occupied an area of one square metre and was composed of about 15 leaves. No plants were in flower at the time however several individuals had maturing fruit present. The habitat and leaf morphology combined with residual floral features present on the maturing fruit were sufficient to identify the taxa. Time constraints prevented further extensions surveys for the species in the immediate vicinity. There were at least several hectares of similar habitat in the local area that may support further colonies.

Eutaxia microphylla var. microphylla

Eutaxia microphylla in Tasmania is a spiney prostrate shrub in the family FABACEAE. It generally grows to 5-10cm high and can get up to one metre in diameter, although some Australian mainland populations grow as small upright shrubs. *Eutaxia microphylla* is widespread and locally common in the southwest of Western Australia, it is also common in southern South Australia, throughout Victoria and in the southern half of New South Wales. It is listed as Rare in Tasmania (TSPA 1995).

Within Tasmania the *Eutaxia microphylla* is usually associated with Tertiary limestone and limey sands in close proximity to the coast. It is known from a number of sites on the west coast of Flinders Island, and on Cape Portland. Two populations are known from the South East, one on the Forestier Peninsula and one near Midway Point (Lynch 1993). When Lynch (1993) surveyed the majority of known populations in the early 1990s, all populations contained less than 100 individuals each with the exception of the Forestier Peninsula population which was estimated at 200 while a loose estimate of 1000 individuals was given for Prime Seal Island (Lynch 1993).

During the recent trip to Prime Seal Island *Eutaxia microphylla* was surveyed more extensively. Akin to the Flinders Island populations, it was found to occur in areas mapped as 'Heathlands on calcarenite', and also in calcareous sand dunes. It was noted as being present just inland of Wolff Bay on the west coast, at this site there were only a handful of plants seen. In dunes just to the

Lasiopetalum discolor in flower.
Photo by Micah Visoiu

southeast of Sealers Cove 300 (plus or minus 100) smallish plants were encountered growing with *Austrostipa stipoides* and *Pultenaea tenuifolia* in an area that appears to have a high fire frequency (in the vicinity of five to ten year fire intervals). Several hundred metres south of this site there is a large patch of 'Heathland on calcarenite' growing on the western slope of a large un-named hill. At this site *Acrotriche cordata, Lasiopetalum discolour* and *Beyeria lechenaultii* co-dominate on broken limestone and shallow soil, 1500 (plus or minus 500) *Eutaxia microphylla* were estimated to be present. At this site plants were large and well established with some reaching a metre in diameter.

The total estimated Prime Seal Island population of *Eutaxia microphylla* is therefore 1800 (plus or minus 600) mature plants more than double the population estimate (500 plants) for the rest of Tasmania (Lynch 1993).

Lasiopetalum discolor

Lasiopetalum discolor is a medium sized multi-stemmed shrub (one metre by one metre) in the family STERCULIACEAE. It is common along the south coast of Western Australia and in coastal areas of South Australia where is extends nearly as a far as the Victorian Border. The only known extant population in Tasmania occurs on Prime Seal Island which is around 800km east and 200km south of the nearest South Australian population.

While there are several historical records from north western Tasmania there is some doubt about the accuracy of the locality descriptions for these collections (see discussion below). *Lasiopetalum discolor* is listed as Rare in Tasmania (TSPA 1995).

On Prime Seal Island this species is the dominant in most areas of 'Heathland on calcarenite' (Harris & Kitchener 2005). In particular those areas on the steeper slopes which have lower amounts of limestone outcropping and incorporate some granite gravels and dark coloured organic matter is more prevalent in the soils. In such areas *Lasiopetalum discolor* reaches up to 75% total cover. It often dominates in the rockier facies of the heathland where plant cover is lower and sandy coloured broken limestone covers the ground. In these areas it grows with *Acrotriche cordata*. At one site on North Hill plants were counted in a transect measuring 135 metre long and ten metres wide through a patch of heathland dominated by *Lasiopetalum discolour*. A total of 674 plants were counted. The heathland extent at this site was 4.5 ha and was likely to contain a population of about 22 500 plants (plus or minus 2 500). The species attained a similar density in the other areas mapped as 'Heathland on calcarenite' and also occurred extensively, although not so densely, in areas of 'Coastal scrub on alkaline sands'. In these two vegetation units this species was found to be very common over much of the Island. Extrapolation from the survey at North Hill suggests that a conservative estimate of 20 hectares

of 'Heathland on calcarenite' on the Island could support approximately 100 000 (plus or minus 10 000) plants. The less dense but far more extensive occurrence outside of this vegetation would at least double if not triple this number, producing a conservative estimate of 200 000 (plus or minus 50 000) individuals on Prime Seal Island.

Leucopogon lanceolatus

Leucopogon lanceolatus is a tall narrow-elliptical shrub to three metres high (Curtis 1963). Its most noticeable feature is the bright red colouration of the young stems and narrow lanceolate leaves. *L. lanceolatus* occurs extensively on the eastern side of the Great Dividing Range from Fraser Island in Queensland, through New South Wales and into eastern Victoria. It is further scattered throughout southern Victoria, occurring in the border area with South Australia with an outlying population further north west on Kangaroo Island. It is listed as Rare in Tasmania (TSPA 1995) due to its limited distribution in Tasmania. In the state it occurs on King Island and the Furneaux Islands.

On the Furneaux Islands *L. lanceolatus* occurs on Flinders, Cape Barren, Long, Inner Sister, Badger and Clarke islands (Harris *et al.* 2001, Tas. Herbarium specimens). It has also been recorded once from Prime Seal Island by Harris *et al.* (2001), although no herbarium specimen was collected. It was not recorded from the island on the present trip; however suitable habitat was noted to be present on the hill to the south of Peacock Bay, in herbaceous '*Allocasuarina verticillata* forest'. This site had similarities to Robin Hill and Steep Hill on Clarke where *L. lanceolatus* occurs commonly (*pers obs*., Harris & Reimer 1994). It is likely that further surveys in this area would re-locate the species. However the fact that the species was not observed during the six day survey of the island in 2008 suggests that the total population for the species is likely to be low.

Pomaderris paniculosa subsp. paralia

Pomaderris paniculosa subsp. *paralia* is a medium sized shrub in the family RHAMNACEAE. It grows up to two metres tall and can form dense thickets. It is often associated with limestone, coastal dune systems and cliff lines (Walsh & Entwistle 1994). This taxon occurs on the south coast of Western Australia and is not considered threatened in that state. It is common in South Australia and Victoria. It is listed as Rare in Tasmania (TSPA 1995), where it occurs predominantly in the Furneaux Islands and north east Tasmania, with one confirmed outlying population on King Island (NVA July 2009).

On Prime Seal Island *Pomaderris paniculosa* subsp. *paralia* is widespread and common in a number of heath, scrub and forest communities throughout the areas of native vegetation on the Island. It occurs in 'Heathlands on calcarenite' and 'Coastal scrub on alkaline sands'. This species is a significant component of these heathlands, especially in areas with higher disturbance regimes. Seedlings and individual bushes were also encountered in areas of cleared land. No calculation of the population on the island was made however it is likely to be in the order of tens of thousands.

Parietaria debilis

Parietaria debilis is a small soft light green annual herb in the URTICACEAE family. It is quite widespread but not common, in all temperate areas of Australia, occurring in all states. It also occurs in New Zealand. It favours well drained and often alkaline soils (Harden 1990). In the Furneaux Islands it occurs in shady sites under scrub and heath in slightly damp areas (Harris *et al.* 2001). *Parietaria debilis* is listed as Rare in Tasmania (TSPA 1995). It occurs sporadically throughout the coastal areas of the State, with the majority of known populations in the Bass Strait islands.

During the 2008 survey of Prime Seal Island *Parietaria debilis* was occasionally encountered around the southern coast of the island. It was usually under *Myoporum insulare* in areas of sandy soil around granite tors and on the landward edge of granite coastline. It was also found growing in dense 'Scrub on alkaline sands' in the flat plain between Sealers Cove and Peacock Bay. No

population counts were made of this species during the 2008 survey but it is likely that the population is in the order of tens of thousands.

Spyridium vexilliferum var. vexilliferum

Spyridium vexilliferum var. *vexilliferum* is usually a small open shrub (30-90 cm tall) in the family RHAMNACEAE. The taxon is fairly common and widespread in South Australia and Victoria. In Tasmania it occurs in sandy heaths and on rocky outcrops in the east, north and west of Tasmania (Curtis & Morris 1975). On the Bass Strait islands it has been recorded and collected several times from Prime Seal Island. There is one mid 19th century specimen collected by J. Milligan attributed to Flinders Island. Although no specimens have subsequently been collected from Flinders Island (Tas. Herbarium records, AVH July 2009, NVA July 2009) it is reported to still occur there in several localities associated with calcarenite (S. Harris *pers com.*). *Spyridium vexilliferum* is listed as rare in Tasmania (TSPA 1995).

This species was first collected from Prime Seal Island in the mid 19th century and has been observed there several times since. Observations during the 2008 survey indicated that this species is quite restricted in its distribution on the island. It was observed most often in areas of thin sandy soil over granite and limestone, within SHC and SCA. The majority of populations of *Spyridium vexilliferum* seen on the island were in areas that had recent or ongoing disturbance, such as slashed areas and vehicle track edges.

Spyridium vexilliferum was observed at three sites in 2008. The largest population was encountered in an area of broken rocky ground in an area of regularly slashed heathland 200 metres to the south east of Wolff Bay. At this site approximately 400 (plus or minus 100) plants were present in an area of about half a hectare. Associated species were *Acrotriche cordata, Beyeria lechenaultii* and *Pimelea serpyllifolia*. A handful of plants were also seen on the eastern face of North Hill in 'Heathland on calcarenite'. A similarly small group of less than ten plants were seen on the western face of the hill to the south of Peacock Bay. All plants seen on the island were characterised by a low dense spreading habit, with most plants being less than 30 cm tall and up to one metre in diameter. This is unusual for the species; but exposure to sea breezes may go some way to explaining this growth form.

Stellaria multiflora

Stellaria multiflora is a tiny annual herb that grows 2-5 cm tall. It has a scattered distribution across the southern half of Australia. It is occasional on the south coast of Western Australia and is listed as rare under the *National Parks and Wildlife Act 1972* (NPWA 1972) in South Australia. It also occurs in Victoria and New South Wales. In Tasmania it is widespread but very occasional from sea level to the Central Plateau. *Stellaria multiflora* is listed as rare in Tasmania (TSPA 1995). On the Bass Strait Islands it is known from Flinders Island, Babel Island, the Kent Group, Curtis Island and Three Hummock Island. The first record of species on Prime Seal island was made during the present survey.

Stellaria multiflora was found growing on a granite rock plate approximately 200 m south west of the shearing shed, and was most prevalent in partial shade around the edges of *Myoporum insulare* shrubs that overhung the rock plates. The vegetation in the surrounding area was 'Regenerating cleared land', with the areas around the rock plates retaining some shrubs and native vegetation. Associated species were *Cotula australe, Gnaphalium indutum* and *Galium murale*. The population was not fully surveyed but would have been in the range of 70 individuals (plus or minus 30). There were numerous other similar rock plates in the surrounding area that may also have harboured populations of this species.

Taraxacum cygnorum

Taraxacum cygnorum is a rosette forming herb in ASTERACEAE. It is very similar in appearance to the introduced dandelion (*Taraxacum officinale*). It was first described from specimens collected in Western Australia; however it is now listed as extinct in that state. It occurs in four small populations in south western Victoria where there is believed to be significantly less than 1000 plants and it is listed as endangered under

the State Act there (Carter 2004). *Taraxacum cygnorum* is also listed nationally as Vulnerable (EPBCA 1999). It is not listed in Tasmania (TSPA 1995).

There are three herbarium specimens of *Taraxacum cygnorum* collected in Tasmania in the mid 19th century (Harris *et al.* 2001). They are from King Island, Flinders Island and Prime Seal Island. The taxon has not been collected in Tasmania since this time, despite some efforts to relocate it. In Victoria *Taraxacum cygnorum* is associated with near coastal grassy woodlands on limestone and limey sands (Carter 2004). A small area of such habitat does still exist on Prime Seal Island which may be worth targeting in future surveys of the island at a different time of year or after a wet spring.

Zygophyllum billardierei

Zygophyllum billardierei is a sprawling succulent perennial herb with bright yellow flowers growing up to 40 cm high and one metre wide. It is in the family ZYGOPHYLLACEAE. It occurs along the southern coast of Australia from Western Australia through South Australia and along the Victorian coast. It is listed as rare in Victoria and not threatened in the other states. In Tasmania *Zygophyllum billardierei* is confined to disturbed area on calcareous sands and limestone's on the islands of eastern Bass Strait (Underwood 1998, Harris *et al.* 2001). *Zygophyllum billardierei* is listed as rare in Tasmania (TSPA 1995). On islands of the Furneaux, Kent and Hogan groups *Zygophyllum billardierei* can be locally very common after disturbance (Harris *et al.* 2001).

On Prime Seal Island *Zygophyllum billardierei* was first recorded in the mid 1960s (Whinray 1971), and has been observed there several times since (NVA, May 2009). At the time of the 2008 survey this species was locally dominant over quite extensive areas, predominantly in disturbed areas such as scrub that had been slashed within the last two years and along slashed fence lines. It also occurred commonly within 'Heathland on calcarenite'. The largest single patch observed was on the north face of the large hill to the south of Peacock Bay. At this site approximately one hectare of regenerating cleared land had been slashed and had been colonised by *Zygophyllum billardierei* where it provided 70-90% of the vegetation cover. Estimating a density of 0.75 plants per square metre, this population contained about 7 500 individual plants (plus or minus 750). A less dense population occurred along several hundred metres of fence line just inland from Wolff Bay. At this site 1000 mature plants (plus or minus 250) were estimated to occur. Other populations of this species were commonly encountered over most of the island. A estimate of the total population of *Zygophyllum billardierei* on the island at the time of the visit would be 30 000 (plus or minus 10 000) mature individuals.

Taxa of biogeographic significance

Asplenium trichomanes

Asplenium trichomanes in the family ASPLENIACEAE, is a small fern with a cosmopolitan distribution in temperate areas of the world; occurring in Australia, New Zealand, Africa, Europe, Asia and North America. Within Australia it is listed as rare in Victoria (ALRTPV 2005) and South Australia (NPWA 1972), it also occurs in New South Wales and Western Australia. Within Tasmania the subspecies *Asplenium trichomanes* subspecies *quadrivalens* has a localised distribution predominantly on Ordovician limestone (Harris *et al.* 2001). It has in the past been identified as significant on the Furneaux Islands where it occurs on Tertiary limestone. There is one record from Flinders Island where the population size is unknown. It has been recorded from a limestone outcrop on Badger Island where less than 20 individuals are estimated to occur (S. Harris *pers com.*). The specimen from Prime Seal Island has not yet been identified to subspecies, however geographically it is likely to be this taxon.

This is the first record of this species from Prime Seal Island. The population is located on a south easterly facing limestone cliff face just north of Mannalargenna Cave. Only a handful of individuals (5-10) were present at this site. Associated

Callitris rhomboidea.

Illustration by Brett Littleton

species were *Galium australe* and *Plantago bellidioides*.

Callitris rhomboidea

Callitris rhomboidea is a medium sized tree up to 10 metres in high with fine dark green foliage (Harris *et al.* 2001). It is in the family CUPRESSACEAE. It occurs down the eastern seaboard of Australia from Queensland through New South Wales and Victoria and into South Australia. In Tasmania *C. rhomboidea* is confined to dry areas on the east and north east coast and it is also widely distributed on the Furneaux islands including a number of the larger outer islands.

Callitris rhomboidea was recorded from Prime Seal Island in 1965 (Whinray 1971). It has not been recorded since despite active searching for this species by S. Harris in the late 1980s and early 1990s and during the 2008 survey, see discussion.

Convolvulus angustissimus subsp. angustissimus

Convolvulus angustissimus is a small twining pink flowered herb in the family CONVOVULACEAE. It is locally common in all states of Australia except Northern Territory. Within Tasmania it is common in native grasslands and grassy woodlands throughout the midlands and along the east coast. There are no records of this taxon from the Furneaux Islands held at the Tasmanian Herbarium, nor are there any records on the Tasmanian Natural Values Atlas (NVA July 2009). However the National Herbarium of Victoria hold three specimens, two from Flinders Island and one from Prime Seal Island (Royal Botanic Gardens Board, Melbourne, MELISR database, 27th March 2009). The Prime Seal Island specimen was collected by J. Whinray sometime in the 1960s, however it is not included in his species list published in 1971 (Whinray 1971).

During the 2008 trip to Prime Seal Island a small population of *Convolvulus angustissimus* subsp. *angustissimus* was located at the northern end of the leasehold, on the flats just to the south of North Hill. At this site vegetation was rough pasture with a mix of native and exotic grass as well as emergent saplings of *Pomaderris paniculosa* subsp. *paralia, Myoporum insulare* and *Ficinia nodosa.* This is currently the only population of this taxon that is known from the outer Furneaux Islands.

Eucalyptus ovata

Eucalyptus ovata is a medium sized tree in the family MYRTACEAE. It occurs throughout south eastern Australia on damp to wet fertile soils. It is locally common in South Australia, Victoria, New South Wales and Tasmania. Very few of the outer islands have any eucalypts, presumably because those that were present at the time of European settlement were eliminated by a high fire frequency (Harris *et al.* 2001). *Eucalyptus ovata* occurs on the larger Islands of Flinders, Cape Barren and Clarke however Prime Seal Island would appear to be the only known site where this species occurs on an outer Island.

Eucalyptus ovata has previously been recorded from the Island; however this record from the mid 1980's was of a single tree stumbled upon whilst forging through dense *Allocasuarina verticillata* forest (S. Harris *pers com.*). The approximate site of this tree on the north face of the large hill

to the south of Peacock Bay was approached from the top of the hill during the 2008 survey. The species was re-located in dense scrubby '*Allocasuarina verticillata* forest'. The dense understorey of *Myoporum insulare, Bursaria spinosa, Pimelea serpyllifolia* and *Leucopogon parviflora* created difficulties in ascertaining the extent and size of the population.

Exploration of the immediate area revealed the population to be made up of three quite distinct size classes. The first of these were large mature trees up to five metres in height with two to three spreading trunks diverging within a metre of the ground with the larger trunks being 20-40 cm in diameter. These trees were large enough to inhibit the growth of other woody plants beneath their canopy and generally were underlain by a herb rich *Poa labillardierei* grass sward. The second size class was characterised by lignotubers 20-40 cm in diameter supporting 3-7 slightly spreading small mallee trunks 3-10 cm in diameter. These mallee trees were usually around four metres in height with dead wood present at their extremities and often with one or two dead trunks, the open areas around these individuals was much smaller than for the larger trees. The third size class was comprised of scattered saplings up to one metre in height. The population size was estimated at 20 large trees (plus or minus 3), 45 mallee trees (plus or minus 5) and 25 saplings (plus or minus 5).

The surrounding vegetation of large *Allocasuarina verticillata* and *Myoporum insulare* were a single cohort that regenerated after a major fire event. The tallest of these trees were seven metres in height, overtopping the *E. ovata* formed the mid-storey in this vegetation. The majority of trees showed significant signs of stress, with almost all trees having numerous dead branches and had generally sparse foliage. Mature fruit were only found on a handful of the larger trees, with flower buds also present on these and several others. Very few old fruit were seen, indicating seed production in this population has been limited by stress over the last few years. A small seed collection was made and has been lodged with both the Tasmanian Seed Conservation Centre and Millennium Seed Bank.

Orobanche minor sensu lato

Orobanche is a genus of holoparasitic herbaceous plants in the family ORABANCHACEAE. Species have no photosynthetic pigments and are only present above ground when they are flowering and fruiting. All records of this genus in Tasmania have been determined as the introduced European species *Orobanche minor.* Despite its introduced status, the occurrence of the species on Prime Seal Island is of biogeographic interest (see discussion).

The site that this taxa was found on Prime Seal Island during the present trip was on an old track on limey sand soils in the northern side of North Hill. Approximately 5 patches of plants were seen, all of which were growing in open

Orobanche in native vegetation.

Photo by Micah Visoiu

sandy areas on the track through native vegetation. The only species growing within one metre of these patches were the annual lily *Bulbine semibarbata* and the native daisy bush *Olearia ramulosa*. It seems likely that the host for the *Orobanche* plants was *O. ramulosa* given that the species has a known preference for ASTERACEAE. ASTERACEAE and FABACEAE are the two most common host families for *Orobanche minor sensu lato* (Rumsey & Jury 1991).

Threlkeldia diffusa

Threlkeldia diffusa is a low growing succulent plant in the CHENOPODIACEAE. It has a mainly coastal distribution from around the 20° line of latitude on the Western Australian coast right around the south west coast, entire coast of South Australia and western coast of Victoria. It reaches its most easterly distribution in Tasmania's Furneaux Islands. It also occurs sporadically and probably ephemerally on Tasmania's north coast. *Threlkeldia diffusa* is not listed as threatened in any of the states in which it occurs. However it has a very restricted distribution in Tasmania.

On Prime Seal Island *Threlkeldia diffusa* was observed occasionally as single plants or small groups of plants in areas that had been exposed to recent disturbance. No population counts were made, however the population on the island would be reasonably small with a high turnover.

GENERAL DISCUSSION

The known flora of Prime Seal Island comprises 193 taxa which include 68 introduced species and 130 native taxa of which 2 are endemic to Tasmania. Thirteen threatened species have been recorded from the island.

The populations of *Acrotriche cordata, Eutaxia microphylla, Lasiopetalum discolor* on Prime Seal Island comprise a very significant proportion of the total estimated populations of these taxa in Tasmania.

There are no size estimates for the Flinders Island populations of *Acrotriche cordata*, however anecdotally it would seem that the population on Prime Seal Island which is 3800 mature plants constitute a large percentage of the total Tasmanian population of this species. Anecdotal evidence suggests this taxon has increased in abundance on Prime Seal Island in the last 30 years. Whinray (1971) noted that only three plants were seen on the northwest side of North Hill in the mid 1960s. The low vegetation that this species occurs in and distinct colour it has amongst other vegetation tend to make it quite noticeable where it grows. On the present survey this same site on the northwest side of North Hill was estimated at about 750 mature plants. Aerial photographs taken in 1974 show the native vegetation extent in this area was substantially less at that time. The expansion of native vegetation may account for the apparent population increase in this species. Harris *et al.* (2001) also gave a considerably lower estimate of the population for this species on the island, suggesting there were only 20 plants in the late 1980s and early 1990s.

The estimated Prime Seal Island population of *Eutaxia microphylla* of about 1800 mature plants comprises two to three times more plants than the total estimated population of this species for the rest of Tasmania (Lynch, 1993). This is an increase on the estimates of 600 and 1000 individuals on the island made in the early 1990s (Harris *et al.* 2001, Lynch 1993). It is unlikely that the increase that was made in the estimated population is a result of population increase; rather it is a factor of increased survey effort. The extensive survey effort on the island during the 2008 trip failed to find new population locations.

Lasiopetalum discolor would appear to be confined to Prime Seal Island within Tasmania, although several herbarium specimens have been regarded as coming from other localities historically. There are two early collections made by J. Milligan held in the Australian National Herbarium in Canberra which have been attributed to Three Hummock Island in western Bass Strait (ANHSIR July 2009). This location seems to have been extrapolated from the tag which denotes the locality as "Hummocky

Island". Prime Seal Island has in the past been known as "Hummock Island' (Whinray 1971, Harris *et al.* 2001), so it would seem more probable that it was this locality that Milligan referred to. Indeed, J. Milligan made a number of collections from "Hummock Island" in the 1840s that are held at the Tasmanian Herbarium which have been determined as coming from Prime Seal Island.

There is one undated herbarium specimen of *L. discolor* collected by Leonard Rodway, who collected in Tasmanian from the 1890s until the 1930s , which has been regarded as coming from Sisters Beach (North West Tasmania). The specimen, which is held at the Tasmanian Herbarium has very little original collection information recorded. Other than the collectors name it says 'the sisters, north _____ coast', the largely illegible word between 'north' and 'coast' has been interpreted as 'west', although this is by no means explicit. The Sisters Beach and Rocky Cape areas have been surveyed extensively since this time and this species has never been relocated, indeed it is uncertain what locality in this area that is known as 'the sisters'. No other collections by Rodway have been located that have this same collection locality, which could give further clues to the original locality. It would be reasonable to conclude therefore, that the origin of this particular *L. discolor* specimen is unknown. This would make the Prime Seal Island population of *Lasiopetalum discolor* the only known extant population in Tasmania. The population on the island is large with an estimated 250 000 mature individuals and would seem to be secure. Examination of historical aerial photographs from the 1960s 70s and 80s show that the extent of native vegetation in those areas now dominated by this species has increased significantly since that time. It is therefore reasonable to assume that the population of *L. discolor* has increased over that period.

There were two threatened species that have been recorded from Prime Seal Island in the past, were not recorded during the 2008 trip. *Taraxacum cygnorum* has not been recorded in Tasmania since the 1840s. Descriptions of the habitat where this species occurs in Victoria (Carter 2004), would suggest that there is still a small amount of suitable habitat for this species present on Prime Seal Island. This area which is located in the area of *Eucalyptus ovata* on the large hill to the south of Peacock Bay should be surveyed more thoroughly for this species at a time when it is likely to be in flower. This area is also likely to be the habitat for *Leucopogon lanceolatus* which was also not recorded on the present trip.

The serotinus conifer, *Callitris rhomboidea,* was recorded form Prime Seal Island in the mid 1960s (Whinray 1971), and has not been relocated since, despite active searching by S. Harris in the late 1980s and early 1990s and also on the 2008 expedition. This species is a component of dry vegetation on a number of the Furneaux Islands; however it is killed outright by fire. Fire also triggers the mass dispersal and germination of seed. Therefore the period between fires needs to be greater than eight years to allow maturation of a new cohort of individuals and production of new seed. Any shorter period between fires and the species is lost from the area (Harris 1989). It is possible that this species survived until the mid 1960s and has since become extinct on the island due to several fires in short succession (fires are regular on the island and the extent of them is not mapped). However it is also possible that intensive surveying of those areas that are visible as forest in aerial photographs in the 1950s and 1970s (vegetation cover has expanded significantly since this time) may enable this species to be relocated.

The presence of *Orobanche minor* on Prime Seal Island is a curiosity. Within its native range it is often referred to as *Orobanche minor sensu lato* and is regarded as presenting significant taxonomic difficulties, with morphologically reduced diagnostic characters combined with unknown host specific effects, and the unrepresentative nature of dried specimens making determining this and a raft of closely related species very difficult (Rumsey & Jury 1991). *Orobanche minor sensu lato* shows unusually low host specificity for the genus *Orobanche*, the majority of species of which

show high host specificity. This has led to the idea that *Orobanche minor sensu lato* is a species aggregate, with morphological characters of lower selective importance than the physiological characteristics that determine host and habitat range (Rumsey & Jury 1991). That is to say that morphologically similar populations that parasitise different species or families in different habitats may in fact be genetically distinct taxa. The fact that species of *Orobanche* are largely inbreeding lends credence to this theory.

Despite the introduced status of *Orobanche* in Tasmania, the taxon has some curious distributions within the state. The majority of records and specimens are from the fertile vegetable growing and dairy farming areas on the central north coast and in the north west. Specimens have also been collected from Christmas and New Year Islands off the north west coast of King Island, and Prime Seal Island on the opposite side of Bass Strait. These island occurrences are interesting as they all occur in +/- native vegetation and in offshore island habitats. Christmas and New Year islands lie within a couple of hundred metres of each other in western Bass Strait. They are both in a largely natural state (Brothers *et al.* 2001). New Year Island is reputed to have been the site of a short lived market garden set up in the early 1860s by two Chinese men from Geelong; to where produce was regularly shipped (Hooper 1973). This is the most likely origin of the other unusual weed on these two islands, *Brassica oleracea*, which is the wild form, from which kale, Chinese broccoli, cauliflower, cabbage, kohlrabi and broccoli have all been bred. It is one possible origin of an introduced *Orobanche* species. However, *Orobanche minor sensu lato* does not seem to have been recorded in Tasmania before the 1960s, or within Australia before the 20th century (AVH July 2009, NVA July 2009). On Prime Seal Island *Orobanche* was seen in an area of native vegetation along a sandy track edge, and apparently parasitising *Olearia ramulosa*. Historical aerial photographs show the locality of the population has regenerated from pasture in the last 25 years.

Harris *et al.* (2001) has invoked the lithological and climatic similarities of islands in eastern Bass Strait and the coasts of South Australia and south west Western Australia as an explanation for the high floristic congruity across these areas. They postulated that the very alkaline substrate in conjunction with a Mediterranean climate, explained the distribution of such species as *Lasiopetalum discolor, Acrotriche cordata* and *Threlkeldia diffusa*. These species have their strongholds on the limestone coasts of South Australia and Western Australia. This habitat in South Australia also supports populations of the Rare (NPWA 1972) native taxa *Orobanche cernua* var. *australiana* (ARBCP July 2009). In this area it is thought to parasitise ASTERACEAE species in coastal dune areas and inland sandy places (ARBCP July 2009, EFSA July 2009). The taxon *Orobanche cernua* var. *australiana* is regarded as native in Australia but is poorly defined with no definitive diagnostic characters yet provided (EFSA July 2009). It is however very similar to *Orobanche minor sensu lato*. The previously described issues with determining *Orobanche* taxa combined with the habitat of this taxon on Prime Seal Island and presumably also Christmas and New Year Islands would suggest a close look at fresh material from these locations is warranted.

Prime Seal Island is a site of very high conservation significance within Tasmania. The expansion of native vegetation in the last 40 years contains important populations of a range of threatened flora species and is the only known site in Tasmania where *Lasiopetalum discolor* is known to occur. It also harbours a number of species that are biogeographically significant in their occurrence on an outer island of the Furneaux Group. It is probable that other plant species both threatened and non-threatened remain to be found on this unique island.

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Appendix one Prime Seal Island vascular plant species list

The '*' in the right hand columns indicate where the records have come from. There are a number of species that were not seen in the current survey. In most cases this is due to the season in which the survey was undertaken. There are also a number of unverified records, which may have been recorded in error, namely *Hibbertia prostrata, Hibbertia riparia* and *Lasiopetalum macrophyllum*. *Pomaderris oraria* has been recorded in the past, however this taxon has not been included on the list as it is most likely that this refers to *Pomaderris paniculosa* subsp. *paralia* which is common on the island.

FAMILY		SPECIES NAME	COMMON NAME	Whinray 1971	Harris *et al* 2001	Other	Current survey
DIOCOTYLEDONS							
AIZOACEAE		*Carpobrotus rossii*	native pigface	*	*		*
AIZOACEAE		*Disphyma crassifolium*	round-leaved pigface	*	*		*
AIZOACEAE	i	*Mesembryanthemum crystallinum*	iceplant		*		*
AIZOACEAE		*Tetragonia implexicoma*	bower spinach	*	*		*
AIZOACEAE		*Tetragonia tetragonoides*	new zealand spinach	*			*
APIACEAE		*Apium insulare*	island sea-celery		*		*
APIACEAE		*Apium prostratum* subsp. *prostratum* var. *filiforme*	slender sea-celery				*
APIACEAE		*Hydrocotyle hirta*	hairy pennywort		*		*
APIACEAE		*Lilaeopsis polyantha*	jointed swampstalks				*
APOCYNACEAE		*Alyxia buxifolia*	seabox	*	*		*
ASTERACEAE		*Actites megalocarpa*	dune thistle		*		*
ASTERACEAE		*Apalochlamys spectabilis*	sticky firebush	*	*		*
ASTERACEAE	i	*Arctotheca calendula*	capeweed		*		*
ASTERACEAE		*Brachyscome diversifolia* var. *maritima*	tall daisy	*			
ASTERACEAE	i	*Carduus tenuiflorus*	winged thistle		*		*
ASTERACEAE		*Cassinia aculeata*	dollybush		*		*
ASTERACEAE	i	*Centaurea melitensis*	malta thistle		*		
ASTERACEAE		*Cotula australis*	southern buttons				*
ASTERACEAE		*Cymbonotus preissianus*	southern bears-ears		*		*
ASTERACEAE		*Euchiton collinus*	cudweed		*		*
ASTERACEAE	i	*Gamochaeta calviceps*	grey cudweed				*
ASTERACEAE	i	*Gamochaeta purpurea*	purple cudweed or spiked cudweed		*		
ASTERACEAE		*Gnaphalium indutum*	tiny cottonleaf	*	*		*
ASTERACEAE		*Helichrysum leucopsideum*	satin everlasting	*	*		*
ASTERACEAE	i	*Hypochoeris glabra*	smooth catsear		*		*
ASTERACEAE	i	*Hypochoeris radicata*	rough catsear		*		*
ASTERACEAE	i	*Leontodon taraxacoides*	hairy hawkbit		*		*
ASTERACEAE		*Leucophyta brownii*	cushionbush		*		*
ASTERACEAE		*Olearia axillaris*	coast daisybush	*	*		*
ASTERACEAE	e	*Olearia phlogopappa* var. *brevipes*	dusty daisybush	*	*		*
ASTERACEAE		*Olearia ramulosa*	twiggy daisybush	*	*		*
ASTERACEAE		*Olearia stellulata*	sawleaf daisybush		*		*
ASTERACEAE		*Olearia viscosa*	viscid daisybush		*		*

ASTERACEAE	*Ozothamnus turbinatus*	coast everlastingbush		*		*
ASTERACEAE	*Pseudognaphalium luteoalbum*	jersey cudweed	*	*		*
ASTERACEAE	*Senecio biserratus*	crosscut fireweed				*
ASTERACEAE	*Senecio glomeratus*	purple fireweed		*		*
ASTERACEAE	*Senecio pinnatifolius* var. *lanceolatus*	groundsel		*		
ASTERACEAE i	*Silybum marianum*	variegated thistle		*		*
ASTERACEAE	*Taraxacum cygnorum* VU	coast dandelion			*	
ASTERACEAE i	*Vellereophyton dealbatum*	white cudweed		*		*
BORAGINACEAE	*Cynoglossum suaveolens*	sweet houndstongue		*		*
BRASSICACEAE i	*Cakile edentula*	searocket				*
BRASSICACEAE i	*Cakile maritima*	american searocket		*		*
BRASSICACEAE i	*Hymenolobus procumbens*	oval purse	*	*		*
CAMPANULACEAE	*Lobelia anceps*	angled lobelia		*		*
CAMPANULACEAE	*Wahlenbergia gracilenta*	annual bluebell				*
CAPRIFOLIACEAE	*Sambucus gaudichaudiana*	white elderberry		*		*
CARYOPHYLLACEAE i	*Cerastium glomeratum*	sticky mouse-ear	*	*		*
CARYOPHYLLACEAE i	*Minuartia mediterranea*	fineleaf sandwort				*
CARYOPHYLLACEAE i	*Petrorhagia nanteuilii*	proliferous pink		*		
CARYOPHYLLACEAE i	*Polycarpon tetraphyllum*	fourleaf allseed	*	*		*
CARYOPHYLLACEAE i	*Sagina apetala*	annual pearlwort				*
CARYOPHYLLACEAE i	*Sagina maritima*	sea pearlwort		*		*
CARYOPHYLLACEAE i	*Stellaria media*	garden chickweed	*	*		*
CARYOPHYLLACEAE	*Stellaria multiflora* r	rayless starwort				*
CASUARINACEAE	*Allocasuarina verticillata*	drooping sheoak	*	*		*
CHENOPODIACEAE	*Atriplex cinerea*	grey saltbush	*	*		*
CHENOPODIACEAE i	*Chenopodium glaucum*	pale goosefoot		*		*
CHENOPODIACEAE i	*Chenopodium murale*	nettleleaf goosefoot		*		*
CHENOPODIACEAE	*Rhagodia candolleana* subsp. *candolleana*	coastal saltbush	*	*		*
CHENOPODIACEAE	*Sarcocornia quinqueflora*	beaded glasswort	*	*		*
CHENOPODIACEAE	*Threlkeldia diffusa*	coast bonefruit	*	*		*
CONVOLVULACEAE	*Convolvulus angustissimus* var. *angustissimus*	blushing bindweed				*
CONVOLVULACEAE	*Dichondra repens*	kidneyweed	*	*		*
CRASSULACEAE	*Crassula decumbens* var. *decumbens*	spreading stonecrop		*		*
CRASSULACEAE	*Crassula sieberiana* subsp. *tetramera*	wiry stonecrop	*	*		*
DILLENIACEAE	*Hibbertia prostrata*	prostrate guineaflower			*	
DILLENIACEAE	*Hibbertia riparia*	erect guineaflower		*		
DILLENIACEAE	*Hibbertia sericea* var. *sericea*	silky guineaflower	*			*
EPACRIDACEAE	*Acrotriche cordata* v	coast groundberry	*	*		*
EPACRIDACEAE	*Leptecophylla juniperina* subsp. *oxycedrus* r	coastal pinkberry				*
EPACRIDACEAE	*Leucopogon lanceolatus* var. *lanceolatus*	lance beardheath		*		
EPACRIDACEAE	*Leucopogon parviflorus*	coast beardheath	*	*		*

EUPHORBIACEAE		*Beyeria lechenaultii* var. *latifolia*	pale turpentine-bush	*	*		*
EUPHORBIACEAE	i	*Euphorbia paralias*	sea spurge				*
EUPHORBIACEAE	i	*Euphorbia peplus*	petty spurge		*		*
EUPHORBIACEAE		*Phyllanthus gunnii*	shrubby spurge	*	*		*
FABACEAE		*Eutaxia microphylla* var. *microphylla*	r	spiny bushpea		*		*
FABACEAE	i	*Melilotus indicus*	sweet melilot		*		*
FABACEAE		*Pultenaea daphnoides* subsp. *obcordata*	heartleaf bushpea				*
FABACEAE		*Pultenaea tenuifolia*	slender bushpea	*	*		*
FABACEAE		*Swainsona lessertiifolia*	coast poisonpea		*		*
FABACEAE	i	*Trifolium campestre*	hop clover				*
FABACEAE	i	*Trifolium glomeratum*	cluster clover		*		*
FABACEAE	i	*Trifolium stellatum*	star clover		*		*
GENTIANACEAE	i	*Centaurium tenuiflorum*	slender centaury		*		*
GENTIANACEAE		*Sebaea ovata*	yellow sebaea				*
GERANIACEAE	i	*Erodium cicutarium*	common heronsbill	*	*		*
GERANIACEAE	i	*Geranium molle*	soft cranesbill		*		*
GERANIACEAE		*Geranium potentilloides*	mountain cranesbill				*
GERANIACEAE		*Pelargonium australe*	southern storksbill		*		*
LAMIACEAE		*Ajuga australis*	australian bugle		*		*
LAMIACEAE	i	*Marrubium vulgare*	white horehound	*	*		*
MALVACEAE		*Lawrencia spicata*	candle saltmallow				*
MALVACEAE	i	*Malva dendromorpha*	tree mallow		*		*
MALVACEAE	i	*Malva parviflora*	smallflower mallow		*		*
MIMOSACEAE		*Acacia longifolia subsp. sophorae*	coast wattle	*			*
MYOPORACEAE		*Myoporum insulare*	common boobialla	*	*		*
MYRTACEAE		*Eucalyptus ovata* var. *ovata*	black gum		*		*
MYRTACEAE		*Kunzea ambigua*	white kunzea	*			*
MYRTACEAE		*Leptospermum laevigatum*	coast teatree	*	*		*
MYRTACEAE		*Melaleuca ericifolia*	coast paperbark		*		*
ONAGRACEAE		*Epilobium billardierianum*	willowherb		*		*
OROBANCHACEAE	i	*Orobanche minor*	lesser broomrape				*
OXALIDACEAE	i	*Oxalis corniculata* subsp. *corniculata*	yellow woodsorrel	*			*
OXALIDACEAE		*Oxalis perennans*	grassland woodsorrel		*		*
PAPAVERACEAE	i	*Glaucium flavum*	yellow poppy				*
PITTOSPERACEAE		*Bursaria spinosa* subsp. *spinosa*	prickly box	*	*		*
PLANTAGINACEAE	e	*Plantago bellidioides*	herbfield plantain		*		*
PLANTAGINACEAE	i	*Plantago coronopus* subsp. *coronopus*	slender buckshorn plantain		*		*
POLYGALACEAE		*Comesperma volubile*	blue lovecreeper	*	*		*
POLYGONACEAE	i	*Accetosella vulgaris*	sheep sorrel	*			*
POLYGONACEAE		*Muehlenbeckia adpressa*	climbing lignum	*	*		*
POLYGONACEAE		*Rumex brownii*	slender dock		*		*
PORTULACACEAE		*Calandrinia calyptrata*	pink purslane	*			*
PRIMULACEAE	i	*Anagallis arvensis* subsp. *arvensis*	scarlet pimpernel		*		*
PRIMULACEAE		*Samolus repens*	creeping brookweed		*		*

RANUNCULACEAE	*Clematis microphylla*	small-leaf clematis	*	*		*
RHAMNACEAE	*Pomaderris apetala*	dogwood	*			
RHAMNACEAE	*Pomaderris elliptica*	yellow dogwood		*		
RHAMNACEAE	*Pomaderris paniculosa* subsp. *paralia* r	shining dogwood	*	*		*
RHAMNACEAE	*Spyridium vexilliferum* var. *vexilliferum* r	helicopter bush		*		*
ROSACEAE	*Acaena novae-zelandiae*	common buzzy	*	*		*
ROSACEAE	*Acaena pallida*	dune buzzy				*
ROSACEAE i	*Aphanes arvensis*	parsley piert				*
RUBIACEAE	*Galium australe*	tangled bedstraw	*			*
RUBIACEAE i	*Galium murale*	small bedstraw				*
RUBIACEAE i	*Sherardia arvensis*	field madder				*
RUTACEAE	*Correa alba* var. *alba*	white correa	*	*		*
RUTACEAE	*Correa backhouseana* var. *backhouseana*	velvet correa		*		*
RUTACEAE	*Correa reflexa*	common correa	*	*		*
SAPINDACEAE	*Dodonaea viscosa* subsp. *spatulata*	broadleaf hopbush	*	*		*
SCROPHULARIACEAE	*Mimulus repens*	creeping monkeyflower				*
SOLANACEAE i	*Lycium ferocissimum*	african boxthorn	*	*		*
SOLANACEAE	*Solanum laciniatum*	kangaroo apple		*		*
SOLANACEAE i	*Solanum nigrum*	blackberry nightshade		*		*
SOLANACEAE	*Solanum vescum*	gunyang				*
STERCULIACEAE	*Lasiopetalum discolor* r	coast velvetbush	*	*		*
STERCULIACEAE	*Lasiopetalum macrophyllum*	shrubby velvetbush		*		
THYMELAEACEAE	*Pimelea serpyllifolia* subsp. *serpyllifolia*	thyme riceflower	*	*		*
URTICACEAE	*Parietaria debilis* r	shade pellitory	*	*		*
URTICACEAE	*Urtica incisa*	scrub nettle	*	*		*
URTICACEAE i	*Urtica urens*	stinging nettle				*
VALERIANACEAE i	*Valerianella eriocarpa*	italian cornsalad		*		*
ZYGOPHYLLACEAE	*Zygophyllum billardierei* r	coast twinleaf	*	*		*
PTERIDOPHYTES						
ADIANTACEAE	*Pellaea falcata*	sickle fern				*
ASPLENIACEAE	*Asplenium flabellifolium*	necklace spleenwort				*
ASPLENIACEAE	*Asplenium trichomanes* subsp. *quadrivalens*	limestone spleenwort				*
DENNSTAEDTIACEAE	*Pteridium esculentum*	bracken	*			*
GYMNOSPERMS						
CUPRESSACEAE	*Callitris rhomboidea*	oyster bay pine	*			
MONOCOTYLEDONS						
ARACEAE i	*Zantedeschia aethiopica*	arum lily		*		*
CENTROLEPIDACEAE	*Centrolepis polygyna*	wiry bristlewort				*
CENTROLEPIDACEAE	*Centrolepis strigosa* subsp. *strigosa*	hairy bristlewort	*			*
CYPERACEAE	*Carex breviculmis*	shortstem sedge		*		
CYPERACEAE	*Ficinia nodosa*	knobby clubsedge	*	*		*

CYPERACEAE	*Isolepis cernua*	nodding clubsedge		*		*
CYPERACEAE	*Isolepis marginata*	little clubsedge		*		
CYPERACEAE	*Isolepis platycarpa*	flatfruit clubsedge		*		*
CYPERACEAE	*Lepidosperma ensiforme*	arching swordsedge				*
CYPERACEAE	*Lepidosperma gladiatum*	coast swordsedge		*		*
JUNCACEAE	*Juncus bufonius*	toad rush		*		*
JUNCACEAE	*Juncus kraussii*	sea rush		*		*
LILIACEAE	*Bulbine semibarbata*	smallflower leeklily		*		*
LILIACEAE	*Dianella brevicaulis*	shortstem flaxlily		*		*
LILIACEAE	*Hypoxis glabella* var. *glabella*	tiny yellowstar				*
ORCHIDACEAE	*Caladenia latifolia*	pink fairies		*		*
ORCHIDACEAE	*Cyrtostylis robusta* r	large gnat orchid				*
ORCHIDACEAE	*Microtis uniflora*	onion orchid				*
ORCHIDACEAE	*Pterostylis* sp.	greenhood				*
POACEAE i	*Aira caryophyllea*	annual hair grass				*
POACEAE i	*Ammophila arenaria*	marram grass				*
POACEAE	*Austrodanthonia racemosa* var. *racemosa*	stiped wallabygrass		*		*
POACEAE	*Austrofestuca littoralis*	coast fescue	*	*		*
POACEAE	*Austrostipa flavescens*	yellow spear-grass		*		*
POACEAE	*Austrostipa stipoides*	coast speargrass	*	*		*
POACEAE i	*Briza minor*	lesser quaking-grass		*		*
POACEAE i	*Bromus diandrus*	great brome		*		*
POACEAE i	*Bromus hordeaceus*	soft brome		*		*
POACEAE i	*Bromus sterilis*	barren brome		*		
POACEAE i	*Catapodium rigidum*	ferngrass	*	*		*
POACEAE	*Distichlis distichophylla*	australian saltgrass		*		*
POACEAE i	*Holcus lanatus*	yorkshire fog	*	*		*
POACEAE i	*Hordeum murinum* subsp. *glaucum*	bluish barleygrass		*		*
POACEAE i	*Lagurus ovatus*	harestail grass	*	*		*
POACEAE i	*Lolium loliaceum*	stiff ryegrass				*
POACEAE i	*Lolium perenne*	perennial ryegrass		*		*
POACEAE i	*Parapholis incurva*	coast barbgrass		*		*
POACEAE	*Poa labillardierei*	tussockgrass				*
POACEAE	*Poa poiformis*	blue tussock grass		*		*
POACEAE i	*Polypogon maritimus*	coast beardgrass			*	
POACEAE i	*Polypogon monspeliensis*	annual beardgrass		*		*
POACEAE i	*Rostraria cristata*	annual catstail		*		*
POACEAE i	*Secale cereale*	rye		*		
POACEAE	*Spinifex sericeus*	spinifex	*	*		*
POACEAE i	*Stenotaphrum secundatum*	buffalo grass		*		*
POACEAE i	*Vulpia myuros*	fescue		*		*