



Macquarie Island

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Cover: View from Wireless Hill towards Buckles Bay, Macquarie Island.
Photo: Natalie Tapson

Australian Plants articles

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Editorial

John Aitken

Australia is an island continent, which in turn is surrounded by a myriad of smaller islands. Whilst many of the islands, such as Lord Howe Island, Rottnest Island, Kangaroo Island and the islands of the Whitsunday Passage are well known and visited by many people, the general public knows little about our subantarctic islands, which include Macquarie Island.

Australian Plants is very excited to present this issue, which is devoted to the flora of Macquarie Island. I wish to thank the authors for their wonderful contributions and especially Lorraine Perrins for compiling this issue.

Lorraine has set the scene by providing a snapshot of the subantarctic islands together with an overview of the different ecosystems on Macquarie Island and the plants they contain. Her article on the Subantarctic Plant House at the Royal Tasmanian Botanical Gardens (RTBG), discusses how the Gardens have successfully recreated the climate of Macquarie Island in order to display a selection of flora from the subantarctic region, with emphasis on the plants of Macquarie Island.

Nick Fitzgerald describes the rarest plant on Macquarie Island, the Subantarctic Bedstraw, *Galium antarcticum*.

Orchids on Macquarie Island? Nigel Swarts' article on the tiny, critically endangered helmet-orchid, *Nematoceras dienemum*, proves that orchids grow even under the most inhospitable of conditions.

Jennie Whinam discusses the peatlands and why the distribution of *Sphagnum falciculatum*, the Island's only sphagnum moss, is declining.

Sadly, *Azorella macquariensis*, one of 4 endemic species of plants on the Island, is threatened by dieback. Natalie Tapson describes how the development of a seed orchard at the RTBG can assist in its conservation. Details of how you can financially assist the seed orchard can be found on page 374.

Jenny Scott and Chris Howard discuss the impact that the eradication of rabbits on the flora of Macquarie Island. Jenny's article contains a series of before-and-after photos, which show how the flora has recovered. Chris' comment 'The Island is going off!!' is an apt description of the explosion in plant growth following the eradication.

I am certain that you will enjoy this issue and will gain a valuable insight into the flora of this unique island.



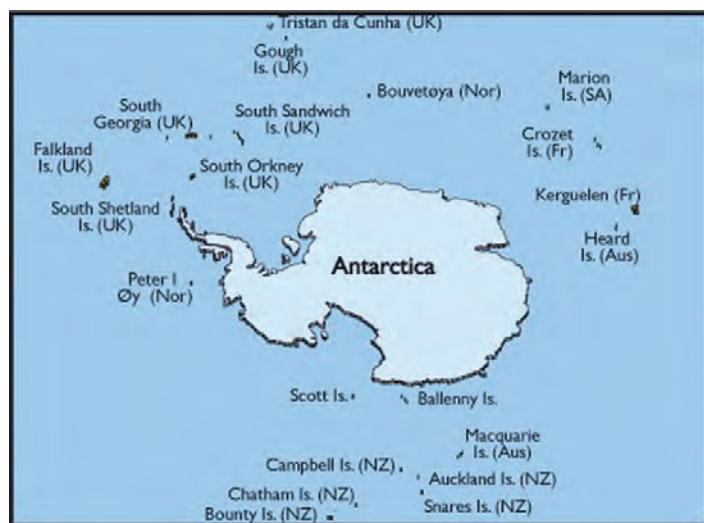
Snapshot of the subantarctic

Lorraine Perrins

Since starting in horticulture in 1985, Lorraine has worked for a number of botanic gardens including the Royal Botanic Gardens Kew in the UK and the Royal Botanic Garden, Sydney. She has worked at the Royal Tasmanian Botanical Gardens since 2005 and is Curator of the Conservation Collections and Subantarctic Flora.

The Subantarctic Region

The subantarctic region consists of 6 remote islands or island groups lying close to the Antarctic Convergence, which is a curve continuously encircling Antarctica where cold, northward-flowing antarctic waters mix with the relatively warmer waters of the subantarctic creating a zone of high biological activity.



Map of Antarctica, the Southern Ocean and Subantarctic Islands
Source: www.btinternet.com/~sa_sa/

All these islands are situated far from any continental land masses and their climates are strongly influenced by the Southern Ocean. This geographical isolation and prevailing climate has created vegetation that supports neither trees nor shrubs and consists primarily of grasses, sedges, cushion plants, bryophytes and lichens.

The six subantarctic islands or island groups are:

- **Macquarie Island** – Lying north of the Antarctic Convergence in the Tasman Sea, Macquarie Island is an Australian Territory managed

by the Tasmanian Government Parks and Wildlife Service. It was inscribed on the World Heritage List in 1997 and has been managed as a nature reserve since 1970.

Macquarie Island is unique in that it is a very rare example of recently uplifted oceanic crust formed around 11 million years ago. It is the only place on earth where rocks from the earth's mantle are being actively exposed above sea level. Unlike other subantarctic islands, there are no active volcanoes or glaciers creating geological deposits on the island making its origin entirely oceanic.

The vascular flora consists of 46 species, 4 of which are endemic: the Macquarie Island Cushion Plant, *Azorella macquariensis*; a salt tolerant grass, *Puccinellia macquariensis*; and two helmet orchids, *Nematoceras dienemum* and *Nematoceras sulcatum*.

- **Heard and Macdonald Island Group** – One of the most isolated places on earth, the Heard and Macdonald Island Group lies in the Indian Ocean, 4,000 km from Australia. As Australian external territories, Heard and McDonald Islands are managed by the Australian Antarctic Division (AAD), and were inscribed on the World Heritage List in 1997.

The Heard and Macdonald Islands contain Australia's only active volcanoes, glaciers and the highest mountain. They are considered one of the few subantarctic islands that are free of human-introduced plants and mammals.

This group has the smallest number of vascular flora species of any subantarctic group, with only 12 species recorded, as well as 42 species of moss and 50 lichen species identified to date. Of the 12 vascular species known from Heard Island, 5 have also been recorded on McDonald Island. None of the vascular species are endemic, although *Pringlea antiscorbutica*, *Colobanthus kerguelensis* and *Poa kerguelensis* occur only on subantarctic islands in the southern Indian Ocean.

- **South Georgia Island** – Lying in the southern Atlantic Ocean South Georgia is a United Kingdom Overseas Territory. Although uninhabited for most of the year, South Georgia has 2 British Antarctic Research Stations as well as a museum and government offices. It is the only subantarctic island in the South Atlantic Ocean and is continental in origin.

Only 25 indigenous vascular plant species have been recorded on the island, and no endemic plants. There are also approximately 25



Pringlea antiscorbutica (Kerguelen cabbage). Photo: Jenny Scott

human-introduced species, which are now considered naturalised on the island.

- **Marion and Prince Edward Islands** – This group of 2 islands lies to the north of the Antarctic Convergence 1,769 km south east of South Africa. The islands are managed as special nature reserves by the South African Government and access to the islands is for scientific study only. Both islands are of volcanic origin. There are 15 indigenous flowering plant species on the islands and 18 introduced species, 12 of which have become naturalised. The fern *Polystichum marionense* is only found on the Prince Edward and Crozet Islands. *Ranunculus moseleyi* is only found on Prince Edward, Crozet and Kerguelen Islands.
- **Iles Kerguelen** – Iles Kerguelen is a French Southern Territory straddling the Antarctic Convergence in the southern Indian Ocean, midway between Africa, Australia and South America. The main island, Grande Terre, is surrounded by another 300 smaller islands and islets, forming an archipelago of 7,215 km². There are 22 recorded vascular species on the archipelago, including the endemic *Lyallia kerguelensis*. The variety of plant life on Kerguelen can be described as limited and consists mainly of the tussock grass *Poa cookii*, the herb *Acaena adscendens* and the famous Kerguelen cabbage *Pringlea antiscorbutica*. *Pringlea* has evolved a method of

cross-pollination which relies on Kerguelen's winds, as there are no flying insects on the island.

- **Iles Crozet** – The Crozet Islands consist of 5 small islands and numerous islets in the southern Indian Ocean. A French Southern Territory, they were declared a national park in 1938 and are used for biological, geological and climatic studies. The Crozets cover 325 km² and are the peaks of an underwater volcanic plateau. There are 17 vascular plant species on the archipelago. The small grass *Poa kerguelensis* is only found on the Crozet Islands and Heard Island and *Ranunculus moseleyi* is only found on Prince Edward, Crozet and Kerguelen Islands.

Climate of the Subantarctic

All of the subantarctic islands experience similar oceanic climates characterised by gale force winds, low variability of temperature, high frequency of low cloud, and a high number of days with precipitation.

Mean monthly maximum temperatures range between 4.8 and 8.6°C and mean monthly minimum temperatures range between -1.5 and -5°C. Snowfall may occur at any time of the year. Considerable variation in the daylight hours between summer and winter is experienced on all subantarctic islands.

The increase in global temperature has been very rapid in the subantarctic (as much as 1°C in the last 50 years) and this trend seems to be continuing. Therefore there is much research underway using the subantarctic islands to predict how ecosystems around the world will respond to higher temperatures.



Changing conditions on the Plateau on Macquarie Island
Photos – Left: T. Rudman, DPIPWE; Right: Natalie Tapson



Brief History

The majority of subantarctic islands were discovered by chance by wild weather blowing merchant sailors off course. The first recorded landing was in 1675 by the British merchant Anthony de la Roche who found shelter in an unnamed bay on South Georgia Island. There is, however, an unconfirmed report that perhaps early Polynesian seafarers may have been the first humans to discover the subantarctic region. Frederick Hasselborough noted on discovering Macquarie Island in 1810 that he saw what appeared to be a wreck of 'ancient design' on the island (Selkirk et al, 1990).

The subantarctic islands all share a history of human exploitation. From the 17th century whalers and sealers regularly utilised these islands as a plentiful source of fur and oil. By 1825, 6 species of fur seal had been hunted to near extinction on most of the subantarctic and antarctic islands. Penguins were also harvested for their oil and at the peak of the industry in 1905, 2,000 penguins at a time could be processed, with each bird producing about half a litre of oil. The operation on Macquarie Island was closed in 1920 by the Tasmanian Government, largely due to a public petition championed by the Australian polar explorer, Sir Douglas Mawson. This is widely considered to have been the world's first wildlife conservation movement.



A Gentoo Penguin sitting amongst *Poa foliosa* grass in front of the historical 'Digesters', which were used for rendering the penguins down into oil. Photo: Natalie Tapson



The Macquarie Island Research Station. Photo: Natalie Tapson

There were no land mammals on any of the subantarctic islands until people intentionally, or unintentionally, introduced rats, mice, rabbits, deer and cats, all of which have had devastating impacts on these fragile ecosystems. The McDonald Islands have only 2 recorded landings by humans and represent, along with Prince Edward Island, the only subantarctic islands with no known alien species.

In the early 20th century meteorological and Antarctic research became the prime focus in the subantarctic region. Macquarie Island hosted the first meteorological station set up by Sir Douglas Mawson in 1911. From the 1940s through to current times research bases have been permanently or occasionally active on all the subantarctic islands by the Australian, British, French and South African governments.

In recent times tourism companies have realised the potential of this region to visitors and now offer wildlife expeditions to numerous subantarctic and Antarctic regions. Their numbers are strictly controlled with an emphasis on minimal disturbance to the natural habitats visited.

Reference

Selkirk, P.M., R.D. Seppelt and Selkirk D.R. *Subantarctic Macquarie Island: environment and biology*. Cambridge University Press, 1990.





Brief introduction to the flora of Macquarie Island

Lorraine Perrins, Curator of the Conservation Collections and Subantarctic Flora,
Royal Tasmanian Botanical Gardens

The vegetation of Macquarie Island is moulded by the harsh climate of the island, which sits at a latitude known as the “Furious Fifties”. Here frequent storms are notorious, resulting in extremely rough and dangerous seas surrounding and strong winds buffeting the island on a regular basis.

Being an oceanic island, 34 km long and 5 km at its widest point, the air temperature varies only marginally between winter, which has an average temperature of 4°C, and summer, averaging 8.4°C. It rains on average 313 days per year, resulting in approximately 954 mm per annum. Macquarie Island is often cloudy, obscuring the plateau in fog. Fogs are observed on average about 65 days each year and are distributed fairly evenly in all months. Visibility in these fogs is often less than 50 metres, especially on the inland plateau. Snow is common between June and October and may even occur in Macquarie Island’s ‘summer’.

There have been 47 vascular plant species recorded for the island, both introduced and native: 24 dicotyledons, 18 monocotyledons and 5 pteridophytes. In addition there are over 90 species of moss. No woody plants are present and most plants rarely grow over 1 m in



Sunset at Brothers Point, *Poa foliosa* tussock grassland with *Stilbocarpa polaris* (Macquarie Island Cabbage). Photo: Nick Fitzgerald



Rock stack, Macquarie Island. Photo: Jenny Scott

height, although the tussock-forming grass *Poa foliosa* has been known to reach a height of 2 m in more sheltered areas.

Endemic flora include the Macquarie Island Cushion Plant, *Azorella macquariensis*; a salt tolerant grass, *Puccinellia macquariensis*; as well as 2 species of helmet orchid, *Nematoceras dienemum* and *Nematoceras sulcatum*.

Macquarie Island has 5 principal vegetation communities: Tall Tussock, Short Grassland, Herbfield, Mire and Feldmark.

The **Tall Tussock** community occurs on the coastal slope areas which blanket Macquarie Island and is dominated by *Poa foliosa*, which provides valuable breeding grounds for the multitude of seabirds that frequent the Island. Another interesting plant that grows in this community is the subantarctic megaherb, *Stilbocarpa polaris*, (Macquarie Island Cabbage), which was utilised by early sealers to prevent scurvy. The coastal zone at the base of the slopes is very interesting, being defined by the storm surges, animal movements and salt sprays.

Rock stacks which occur in this zone can house a complex range of vegetation including *Colobanthus muscoides* and *C. apetalus* which are dense cushion-forming plants that can drape the rocks like an emerald blanket. Another endemic plant, *Puccinellia macquariensis*, is also found in this zone.





Short Grassland communities occur on sheltered upland areas. The dominant species of this zone are *Agrostis magellanica*, *Luzula crinita*, *Uncinia* spp and *Deschampsia chapmanii*.

As well as occurring in the Tall Tussock, *Stilbocarpa polaris* can also be found in the upper **Herbfield** areas, along with another magnificent megaherb, *Pleurophyllum hookeri*. In some areas this species can cover large areas, its spectacular silvery foliage dominating the view.

Other plants which occur in the Herbfield community are the 'Buzzies', *Acaena magellanica* and *A. minor*, which often make their presence



known with their numerous seed heads attaching themselves to expeditioners' ankles!

The **Mire** communities occur in saturated areas where drainage is poor and consist mainly of bryophytes as well as *Ranunculus crassipes*, *Agrostis magellanica*, *Juncus scheuchzerioides* and *Montia fontana* ssp *fontana*. Mire



Above: *Pleurophyllum hookeri* herbfield at Green Gorge. Photo: Nick Fitzgerald

Right: *Stilbocarpa polaris*, (Macquarie Island Cabbage). Photo: Jenny Scott



Pleurophyllum hookeri Photo: Natalie Tapson



Inland mire – the large mire in Red River Valley is dominated by mosses and liverworts and small herbs. Surrounding slopes are vegetated with short grassland. Photo: Jenny Scott





communities include 'featherbed', a deep and spongy peat bog vegetated by grasses and low herbs, with patches of free water.

The **Feldmark** community covers approximately 45% of the island, primarily in the high plateau regions. Consisting of sparse vegetation and bare gravels, this is the most wind swept and hostile environment on Macquarie Island. The dominant species found here are mosses, lichens and the Macquarie Island Cushion Plant, *Azorella macquariensis*.

It is known that Macquarie Island is entirely oceanic in origin, so the question is often raised as to how plants arrived at such a remote location. It is generally accepted that were 3 main ways plants could be dispersed from the southern hemisphere continents to the subantarctic: via water, wind and animals such as birds, seals and humans. For example, bryophytes (mosses and liverworts) and lichens are well adapted for dispersal by wind, producing very fine, dust-like seeds or spores, which can survive extreme conditions.

Birds are a prime dispersal agent and can carry plant material in their guts, beaks or stuck to their feathers. Birds also regurgitate seeds, which can remain viable in their guts for weeks.

Humans have become a significant dispersal mechanism more recently in the subantarctic islands' history. Dr Dana Bergstrom from the Australian Antarctic Division conducted an intensive study in 2009 which found that clothing and equipment carried by expeditioners such as field biologists were a significant source of 'propagules' (seeds, spores and eggs). This work has led to stricter quarantine protocols to prevent alien introductions via humans to both the subantarctic and the Antarctic regions.

Reference

Selkirk, P.M., R.D. Seppelt and Selkirk D.R. *Subantarctic Macquarie Island: environment and biology*. Cambridge University Press, 1990.



Highland feldmark vegetation dominated by the cushion plant, *Azorella macquariensis* and mosses.
Photo: Nick Fitzgerald

Macquarie Island – exciting changes in vegetation and landscapes after eradication of rabbits and rodents

Dr Jenny Scott, Geography and Environmental Studies, School of Land and Food, University of Tasmania. Photos by Jenny Scott, unless indicated otherwise.

Jenny has been studying changes in vegetation and erosion on the island since 1979, the year that myxomatosis was first used to control the rabbit population. Since then, she has regularly followed the ups-and-downs of the rabbit population and the effects of rabbits on the island and its vegetation, especially on the steep tussock-clad coastal slopes. Her most recent field season was in the 2013-14 summer.

Along with most other subantarctic islands, Macquarie Island has had its share of introduced feral mammal pests – cats, rabbits, ship rats and house mice. Over the past couple of decades, all have been eradicated, in several successive campaigns – an extraordinary achievement by the management authority, the Tasmanian Parks and Wildlife Service (TPWS), with logistic support from the Australian Antarctic Division (AAD). Although all these species were interlinked in some way in their effects on each other and on the Macquarie Island ecosystems, rabbits and rodents had the most devastating impacts on the vegetation and the erosion regime, especially rabbits. Rats and mice caused more subtle impacts to vegetation through eating and caching seeds, and have had large impacts on small burrowing birds and invertebrates.

Rabbits were introduced to the island in the 1870s and extensively modified the vegetation over many years, although it was not until the 1970s that a control program was instigated. After years of introducing fleas to the rabbit population to act as a vector, myxomatosis was introduced in 1979 and over the next few decades this led to effective control of the rabbits at low enough numbers to allow partial vegetation recovery. However, in the late 1990s the rabbit population started surging again, a combination of the loss of efficacy of myxomatosis (and cessation of its production on the Australian mainland), eradication of the cats (a major predator) and the extra food now available from recovering vegetation. Possibly the island's changing climate also had an impact. The rapidly increasing rabbit population resulted in severe damage to ecosystems. After a few years of planning and gestation the Macquarie Island Pest Eradication Program (MIPEP), funded half-in-half by the Tasmanian and Commonwealth governments, targeted the rabbits and rodents by aerial baiting in the winters of 2010 and 2011 followed by several years of on-ground 'mop-up' hunting and monitoring.



Now it is 2014 and there does not appear to be a rabbit, rat or mouse on the island. For the last couple of years there have been teams of MIPEP hunters monitoring the island by day and night, some with trained detector dogs. The TPWS website (www.parks.tas.gov.au) has interesting information about the MIPEP program and how it was conducted. There has been no sign of rabbits since the last one was killed in November 2011. In April 2014 the program managers and expert advisers made the momentous decision that the program could be declared a success. What a moment for those like me who love the island and had been watching its rapid deterioration over the past several decades when rabbit numbers exploded.

This past summer, the season of 2013-2014, I spent a 4 month field season on the island. I found it truly extraordinary to travel around the island without seeing any sign of rabbits whatsoever. For many years I had been accustomed to seeing nearly every bare area scruffed about by rabbit diggings, and with rabbit footprints everywhere, and over the past decade or so numerous rabbits were always in sight. Last summer however, I only saw human and dog footprints, and on nearly every bare area – a testament to the dedication and thoroughness of the men, women and dogs of the MIPEP team, who had been combing the whole island for the past 13 months. The MIPEP hunters had all my admiration for their mental and physical stamina – they were out in all weathers traversing extremely challenging terrain, for weeks on end, in the continuing hope of not finding anything!

A series of before-and-after photos of rabbit damage on the island's ecosystems has resulted in much interest over the years, both for interpreting the changes analytically and also to educate and inform the public. One series of these photos are included on page 353 from the many time-series which we now have. The captions tell the story.

Repeat photos, taken at progressive time intervals from the same spot looking in the same direction, are an amazingly simple and effective tool for demonstrating and studying changes over time. Repeat photography is a technique that is often under-rated in this era of focusing on complex and expensive technology in research. There is nothing like it for showing people, including the land users themselves, the effects of progressive changes in vegetation and landscapes over time. The images are something that everyone can instantly understand and relate to. The technique originated with researchers studying the retreat of glaciers in the European Alps, using historic photos as a baseline. If the photos weren't there to prove it, the changes would not be believable.



Steep ungrazed tussock-covered slope at Hurd Point in 1981 with healthy *Poa foliosa* tussock. Small amount of 'natural' landslipping and erosion.



Slope in 2003 when rabbit grazing is just commencing – light to moderate grazing pressure. About 40% of tussock cover has been removed, leaving small understorey herbs and grasses.



Slope in 2006 – severe grazing pressure – almost all tussock removed. Dead tussock stumps and significant erosion. Photo: K. Springer.



Slope in 2009 – one year before rabbit eradication. Continued selective grazing of any tussock regrowth, preventing tussock recovery and continued regrowth of undercover species. Continuing erosion.



Slope in 2012 – two years after grazing ceased on these slopes. Significant regrowth of tussock once selective grazing pressure stopped. Continuing erosion. Photo: P. Black



Slope in 2014 – four years after grazing ceased here. Continuing regrowth of tussock, now covering majority of slope. Continuing gully and landslipping erosion, although vegetation colonisation is starting on some stable bare edges.





The Macquarie Island photos are part of a long-term research program on the island being conducted by myself and my much-valued long-term colleague, Professor Jamie Kirkpatrick, photo-documenting changes in vegetation and landscape over the past 30 or so years with different levels of rabbit grazing damage on the coastal slopes and inland. For the past 10 years we have been helped by the TPWS rangers stationed on the island, who retake a sub-set of our photos each summer if I am not visiting the island that season. TPWS also has an intensive photo-monitoring program covering the whole of the Macquarie Island coast. I try to spend a summer field season on the island every five years to re-take all our various series of photos.

I also re-measure a series of several hundred fixed vegetation plots on the steep coastal slopes, along transects set up in 1980 at the same time as the photo-points. This work involves standing for long periods of time, clad in many warm layers, recording the percentage cover and abundance of all the plants including bryophytes, in each 1 m square plot (quadrat). It is tedious in the extreme and hard on the extremities in the cold winds, but produces great data. We have used this information in a series of scientific publications to show vegetation changes in the steep slope habitat. Other scientists are doing similar work in the mid-altitude short grassland habitats.

Most of the changes can be directly linked to rabbit grazing impacts, with loss of the large palatable plants such as the *Poa* tussock species and *Stilbocarpa polaris* or Macquarie Island cabbage, with replacement by small herbs and grasses in times of heavy grazing, and the reverse when rabbit populations are low. However, in the past few years we have also been able to link some of the changes to probable effects of changing climate – namely the continuing increase of some of the smaller species independent of the grazing regime. Like a time-series of photographs, this is also a ‘slower and subtler than the eye can see or mind can remember’ type of occurrence, but less accessible to a wider audience than the photos. It involves statistical analyses and summarising of detailed numerical data in graphs and tables, in order to be convincing to the scientific community in refereed publications.

The changes in the vegetation were already spectacular in 2013-14, and became noticeable soon after the main baiting program was completed in 2011. My previous visit to the island was in 2009, when damage was still occurring and degradation was widespread. It was heartbreaking to witness, although at that stage we at least knew the eradication program had been funded and baiting would soon be underway to halt the rampage. It was extraordinary the damage that

rabbits caused in those final years. I remember being reduced to tears in 2009 when I first saw the steep slopes of former lush *Stilbocarpa* and *Poa foliosa* tussock at Sandy Bay, which had been transformed into huge bare expanses of eroding peat and rock dotted with burrows and scampering rabbits, just in the previous year. Some of these slopes will take a long time to recover, especially slopes exposed to strong winds which are continuing to erode the bare peat to bedrock (first two photos below). Other more protected slopes have become quickly revegetated with the introduced grass *Poa annua*, which then provides a good base for the natives to re-establish as shown in the photographs below.

During the past decade I worked as a tourist guide for people visiting Macquarie Island by ship and I was asked by an elderly lady with limited walking mobility to show her some of the native plants just at the back of the landing beach at Sandy Bay. To my shame and embarrassment



Sandy Bay slopes in 2009, facing southeast, one year after severe grazing which resulted in removal of the dense *Stilbocarpa* and *Poa foliosa* tussock cover and continuing erosion.



Same slopes in 2014, five years later. Slopes are exposed to winds from the south east and have continued to erode, with more bedrock being exposed, although tussock has recovered in other areas.



Sandy Bay slopes facing northeast, in more sheltered area just north around the corner from previous photo. Photo taken in 2009, just after severe grazing of dense *Stilbocarpa* and tussock leaving bare peat.



Same slopes in 2014 showing invasion by dense swatches of *Poa annua* on lower slopes (light green), with *P. foliosa* tussock starting to grow through.





all I could show her were lush drifts of *Poa annua*, with a few tiny plants of the 2 *Epilobium* species and *Callitriche antarctica* poking up amongst the *P. annua*, and an occasional bedraggled and chewed *Stilbocarpa* plant. *Poa annua*, probably one of the most cosmopolitan flowering plants (and the bane of many gardeners worldwide), has been playing an important role in initially colonising and stabilising a number of the big bare peat slopes devastated by rabbits in the mid to late 2000s. Already *Poa annua* appears to be receding after the rabbit disturbance has ceased and the native species take over again. Time will tell! *Poa annua* is widespread on the island, and has a long-established presence on the coast in seal wallows and around penguin colonies where seasonal disturbance is a constant, as well as on sites disturbed by landslips. It also performs a useful role in helping stabilise the walking tracks created and maintained by humans. However, it cannot compete with the natives if disturbance ceases, and changes can be rapid. A great example of this can be seen in the three photos on page 357 of a fenced TPWS rabbit enclosure at Sandy Bay set up in 2009 on a *Poa annua*-dominated slope.

In the 5 years since my 2009 visit, recovery of the native vegetation has been occurring both on the steep tussock slopes and the short grasslands of the mid-altitude plateau. As well as regrowth of the main large native plant species – the big *Poa* tussock grass species, *Stilbocarpa* and the beautiful silvery mega-herb *Pleurophyllum hookeri*, there have been widespread increases in some of the smaller native grass species such as *Agrostis magellanica* and *Festuca contracta*, and rapid and widespread regrowth of another tussock grass, *Poa cookii*, which was targeted even more strongly by rabbits than *P. foliosa* to the extent that it is appearing now where it was never noticed before. All very gratifying.

Despite the positive vegetation responses, the incidence of landslipping and sheet and gully erosion seems to be still increasing on slopes which were severely impacted by rabbits, which is a concern. We feel that only time will tell as to whether this aspect of landscape change will stabilise, and how. It may have to do with the changing rainfall patterns on the island, with changes in soil moisture due to removal of the tussock and vegetation, and other factors, which one can only speculate about.



TPWS grazing enclosure on lower Sandy Bay slopes in 2009, set up in 2008 in area dominated by *Poa annua* (light green). Slope was previously covered in dense *Stilbocarpa* and *P. foliosa* before severe grazing. One year after protection from grazing, small *Stilbocarpa* and *P. foliosa* plants are already regenerating inside enclosure.



Exclosure in 2011, two years later. Spectacular regrowth of *Stilbocarpa* and *P. foliosa* tussock within enclosure, and the short grass *Agrostis magellanica* (dark green) taking over from lighter green *Poa annua* outside enclosure since recent cessation of grazing disturbance. Photo: K. Springer.



Exclosure in 2014, three years later. Continuing growth of *Stilbocarpa* and tussock within enclosure, and regrowth of tussock outside enclosure, out-competing both *Agrostis* and *Poa annua*.





Subantarctic Bedstraw, *Galium antarcticum*

Article and photos: Nick Fitzgerald

Nick is a postgraduate student at the University of Tasmania, studying the vegetation ecology of Macquarie Island.

The rarest plant on Macquarie Island, Subantarctic Bedstraw or Antarctic Bedstraw (*Galium antarcticum*), is a small creeping herb with tiny delicate pinkish flowers. The species was first recorded in 1983, growing near Skua Lake around halfway along the 34 km long subantarctic island. It was not until 2013, following listing as Critically Endangered on the Commonwealth *Environment Protection and Biodiversity Conservation Act*, and after years of doubt about its persistence on Macquarie Island, that Subantarctic Bedstraw was rediscovered in the same location.



Galium antarcticum growing amongst moss at Skua Lake, Macquarie Island, February 2013. A flower is visible on the right of the plant

The single known population of around 500 plants occurs on a mossy bank in short grassland vegetation. At around 140 metres above sea level on the plateau, which covers most of Macquarie Island, the short grassland habitat in which the species occurs is typical of much of the island. Why it is not more widespread is a mystery. Perhaps it was preferentially grazed by the rabbits, which have had a dramatic impact on the vegetation of Macquarie Island. It may be a recent immigrant

yet to expand its range on the island or a formerly more widespread species nearly grazed to extinction by rabbits.

Macquarie Island is a young and very remote landmass with an unusual cold maritime climate. Consequently its flora is the result of long-distance dispersal and composed largely of subantarctic specialists. *Galium antarcticum* has a wide distribution around the subantarctic, suggestive of dispersal by seabirds. It occurs in Patagonia, South Georgia, the Falklands, Crozet and Kerguelen islands. The species was first described from the Falkland Islands by J.D. Hooker in 1846.

Subantarctic Bedstraw grows to a few centimetres in height and width, with creeping stems and solitary flowers. What appear to be whorls of four fleshy red- or purple-tinged leaves, are actually a pair of leaves and a pair of nearly identical stipules. *Galium* is a large and widespread genus in the Rubiaceae with several native and introduced species in Australia including the familiar garden weed *Galium aparine* (cleavers or sticky weed). Many species have distinctive bristly hairs, whereas *G. antarcticum* is hairless.

The future prospects for *Galium antarcticum* on Macquarie Island are uncertain. It may benefit from the recent eradication of rabbits, expanding its range, or it may struggle to compete with the taller growing grasses and graminoids as the short grassland transitions to a more closed vegetation community.



Galium antarcticum. A partially opened flower is near the middle of the plant (slightly to the top left).





The curious case of the Windswept Helmet-orchid

Nigel Swarts, Royal Tasmanian Botanical Gardens, Queens Domain, Hobart 7000; Tasmanian Institute of Agriculture, University of Tasmania. Email: Nigel.swarts@gmail.com

Nigel is a research scientist holding part-time positions at the University of Tasmania and the Royal Tasmanian Botanical Gardens. At the gardens, Nigel is researching rarity in key Tasmanian threatened orchids and leads a volunteer community group in the ex situ conservation of these species.

For those who love and know terrestrial orchids, recognising that a piece of bush you are walking through is going to contain the orchid you are searching for is almost an intuition. Remnant allocasuarina woodlands of Western Australia's south-west wheat belt, open eucalypt forests of dry southern Victoria, and Queensland rainforests rich with epiphytes are all habitats we commonly associate as orchid habitat. But how about a waterlogged boggy mire, with a soil profile dominated by peat, a vegetation profile containing mostly bryophytes, sedges and cushion plants, a climate characterised by daily averages of 3.5°C, 30 km/h winds, almost constant cloud cover and some sort of precipitation? It's certainly not a habitat in which you would generally consider searching for orchids. Yet, here grows a tiny, inconspicuous, deciduous perennial herb known as the Windswept Helmet-orchid or *Nematoceras dienumum*.



Nematoceras dienumum Photos: Peter Fehre

One of 2 species, both of the same genus, that are endemic to Macquarie Island, the Windswept Helmet-orchid is critically endangered and listed on the federal EPBC list of threatened species.

Sheltering among the mire vegetation in locations less than 30 m above sea level, the orchid forms dense colonies of green leaves via

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The program will explore the genesis of the Bush Capital and its development as a Garden City. We will also investigate current research on native plant systems and habitat recovery. Featured speakers include: David Headon, David Lindenmayer, Ian Fraser, Angus Stewart, Penny Olsen and David Watson. The program will emphasise the work of Study Groups with reports from their leaders.

Program:

Saturday, 14 November: Optional (extra expense) day trip to the Brindabella Range with Ian Fraser

Sunday, 15 November: Free culture bus from AIS to Parliamentary Triangle institutions

Monday, 16 – Friday 20 November: Morning talks and lunch followed by afternoon bus trips to the ANBG, National Arboretum, nature parks and private gardens.

Saturday, 21 November: Optional (extra expense) day trip to the Brindabella Range with Ian Fraser

Field trips:

Pre- conference trip to the coast visiting nature reserves and private gardens.

Post conference trip to the subalpine areas of Namadji National Park

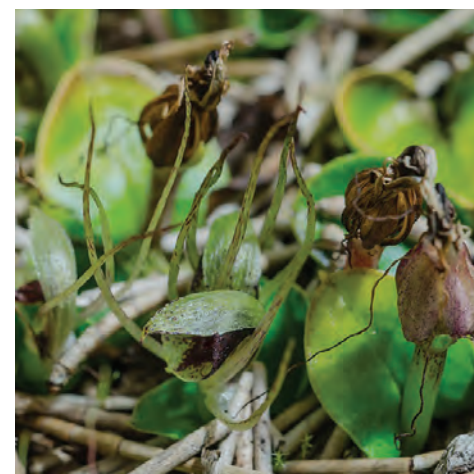
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underground tuberous reproduction, which can be seen from early spring through to mid-autumn. Whilst most of the leaves in the colony remain vegetative, an occasional solitary hooded flower can be found in late November on a tiny stem poking through the leafy mass. Like all species of *Nematoceras*, the flower hood is mostly greenish with red or purple markings. The flower itself contains a relatively large labellum and dorsal sepal with long thin lateral sepals that are held erect, giving the illusion of a spider (Clements *et al.*, 2007). Variations in colour, labellum and leaf-shape help distinguish this species from its Macquarie Island compatriot and other species in the genus.

Almost all species in the *Corybas/Nematoceras* alliance are self-pollinating and the friable pollinia found in the Windswept Helmet orchid suggest that this is most likely the case for this species. However, new evidence is emerging in some species of the alliance that implicates fungus gnats being attracted to flowers and possibly having a role in their pollination. Indeed, an endemic black fungus gnat *Bradysia watsoni* (Sciariidae: Diptera), common on the coastal terraces of Macquarie Island (Greenslade, 1990), has been proposed as a potential pollinator of this orchid species. The mechanism of attraction – be it sexual deceit as found in other Australian terrestrial orchids, food rewarding or food deceit – is still to be confirmed.

Flowers that are pollinated close and the ovary, which is positioned just below the flower, swells to form a fruit-like capsule.

Within 6 weeks, approximately 5,000 dust-like seeds will develop to maturity inside the capsule. As the seeds are maturing, the flowering stem (peduncle) elongates, elevating the drying fruit a further 10 cm



allowing it to poke through the thick low lying vegetation. The dehiscent capsule splits along longitudinal lines, releasing the seed to be dispersed by the 'furious fifties' winds.

What becomes of those 5,000 seeds? Research has demonstrated that even though orchid seed has the capacity to be dispersed a

Developing fruits of *Nematocerus dienemum*
Photo: Peter Fehre





very long distance (up to thousands of kilometres) and indeed some do, most orchid seed falls relatively close to the parent plant. There is an understandable advantage to this in that there are confirmed suitable conditions for germination and growth to occur. Long distance seed dispersal enables the potential colonisation of new locations, however, the conditions must be suitable for this to occur. For the Windswept Helmet-orchid there are few options for colonisation of new locations given the tiny size of Macquarie Island, its proximity to the nearest landmass and the incredible habitat and conditions that the species calls home. In fact, the species is only known from 11 tiny populations in the north of the island, the largest only a few metres square in size.

For seed germination and establishment to occur at a site, orchids require colonisation by a compatible mycorrhizal fungus. The fungus, which is saprophytic, provides all the energy, nutrients and water requirements of the germinating seed, as the seed contains no storage reserves like most other seeds. This association remains with the orchid throughout their life and is generally considered a one way relationship where the orchid is the beneficiary. However, there is now some evidence from other Australian terrestrial orchids that is providing some contradictory evidence to this widely held hypothesis (Sommer *et al.*, 2012).

For the Windswept Helmet-orchid, like all orchids, this means that for it to colonise or survive on the island, its mycorrhizal partner must be present. Little is known about mycorrhizal distribution and the conditions required for their persistence at a site. Even less is known for mycorrhizal fungi occurring in the subantarctic and how these conditions may influence the orchid–mycorrhizal association. Is the orchid limited in its distribution on the island simply because the fungus itself is restricted in its distribution? Or, is the mycorrhizal fungus common on the island and the dispersed seed simply not finding it? Or finally, are the conditions on the island not suitable for the germination process to occur frequently enough to enable further colonisation?

At the Royal Tasmanian Botanical Gardens, we are undertaking research to answer these questions using an *ex-situ* living collection of the Windswept Helmet-orchid. Housed in a shipping container, affectionately known as the Mac House, the plants were collected from Bauer Bay on an Australian Antarctic Division expedition in 2000. Plants are grown with other Macquarie Island species, in a native soil mix under lights with a maximum temperature of 10°C. As the orchid is clonal, they very quickly multiply so we have many plants to work with.

Plants are taken to the laboratory and any potting mix residue rinsed from the stem of the orchid. As with all species in the *Corybas/Nema-*



The Mac House at the Royal Tasmanian Botanical Gardens



Nematocerus dienemum growing in pots in the Mac House



toceras alliance, the mycorrhizal fungi colonises a small section of the underground stem where it subtends the leaf (Ramsay *et al.*, 1986). In the sterile conditions of a laminar flow cabinet, tiny pelotons of fungal hyphae can be teased from the cortical cells of the plant tissue. These pelotons are further rinsed and plated onto nutrient agar media to grow. Once the hyphae have grown sufficiently on this media they can be transferred to liquid media for long-term storage or DNA sequencing or oatmeal agar for *in-vitro* germination experiments.

Seeds collected from Windswept Helmet-orchids growing in the Mac House are distributed over petri dishes containing oatmeal agar inoculated with mycorrhizal fungi isolated from the mature plants. To better understand the conditions required for seed germination on Macquarie Island, we placed germination plates in the dark at 5°C, 10°C or 15°C for 8 weeks. So far no germination has been observed in any of the temperature treatments suggesting that there may be other dormancy factors inhibiting the seed from germinating, or the mycorrhizal fungi we have isolated may not be efficacious in the germination process. Further research is required to unpack the constraints to germination in this species.

To better understand the limitations to the orchid's distribution on the island, further *in-situ* experimentation is required. Sowing seeds in retrievable nylon mesh bags in sites where the orchid has not been found will enable us to determine if the fungus is having a role in restricting the orchid's distribution (Brundrett *et al.*, 2003). Given the nature of fieldwork in such a remote location, this research has yet to be completed and funding is urgently sought to enable this to occur.

Other *in-situ* conservation activities completed on Macquarie Island, such as removing the rabbit population, are having an immediate positive influence on the long-term future of the Windswept Helmet-orchid. Historically, one of the biggest threats to the orchid has been the introduction of rabbits to the island in the 19th century as a food resource for sealers. Rabbits have had a particularly strong impact on the herbaceous plants and vegetation that the Windswept Helmet-orchid is known to grow beneath. The digging action of rabbits degrades habitat structure and damages the peaty soils by making them increasingly unstable (Threatened Species Section, 2011) (TSS). Where vegetation has been removed by rabbits, introduced grasses such as *Poa annua* typically out-compete small herbaceous species including the Windswept Helmet-orchid. The removal of rabbits from the island not only allows the restoration of the existing vegetation structure but also provides potential habitat for future recruitment.

Finally, one of the constraints of small population size, clonal and self-pollinating reproductive strategies is the risk of low genetic diversity and inbreeding. It is expected that levels of genetic diversity may be quite low in the species placing the orchid at significant risk in the event of environmental change (TSS, 2011). Research is urgently required to better understand levels of genetic diversity in the species and how this can be maintained or increased through future supplementary plantings of *ex-situ* propagated plants grown at the RTBG.

With such an unusual list of habitat requirements, this curious species is surely set apart from other terrestrial orchids. This species provides wonderful research opportunities at the most extreme of orchid distribution and provides valuable insight into the mycorrhizal association in this habitat. Unfortunately the species is at considerable risk of extinction and conservation action is urgently required to ensure that this species remains into the distant future.

I wish to acknowledge the Royal Tasmanian Botanic Gardens for the provision of their laboratory for undertaking this research. Many thanks go to Lorraine Perrins and other horticulture staff at the RTBG for the meticulous care of the orchids in the Mac House. Special thanks to Peter Fehre for his provision of the wonderful images of *Nematoceras dienemum*. I highly encourage readers to visit www.flickr.com/photos/fehre/ for more images.

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Patterned mires and Sphagnum moss on Macquarie Island

Jennie Whinam

Jennie is Senior Ecologist for Tasmania's World Heritage Areas in the Biodiversity Conservation Branch of the Tasmanian Department of Primary Industries, Parks, Water & Environment. Jennie has been working on subantarctic islands for over 25 years, with a particular interest in peatlands, biosecurity and impacts of vertebrate pests on the vegetation.

Peatlands, or more accurately raised mires, with peat depths of up to 5.9 metres occur on a terrace of Holocene age at Handspike Point on the north-west coast of Macquarie Island. These water-saturated 'quaking' mires or 'featherbed' occur along a 1 km wide terrace, rising from the shore at slopes of 2° to 4° and covering a total area of 12 ha. The mires are very fragile and difficult to walk on, with wet feet inevitable; they are characterised by low peat ridges, with the conspicuous rosette plant *Pleurophyllum hookeri*, and separated by water troughs, resulting in distinctive surface patterns. The patterning tends to be parallel to the plateau margin.

The Handspike quaking mires exhibit many of the characteristics of patterned peatlands, which are common in the temperate and subpolar regions of the northern hemisphere, but are much less common in the southern hemisphere. These patterned mires are maintained through complex hydrology, which is influenced by the density and organic content of the peat layers, variations in the water table and surface and sub-surface water flow. The patterns were first described by the biologist Harold Hamilton, biologist with Mawson's 1911-1914 Australasian Antarctic Expedition to Macquarie Island, in 1926 and have been described in detail by Rich (1996). Another interesting feature is the numerous staircase ponds which are dammed by the endangered cushion plant *Azorella macquariensis* located on a terrace just below the featherbed. *Sphagnum falcatulum* also occurs on the edges of these pools.

Sphagnum falcatulum is the sole *Sphagnum* species found on Macquarie Island being first recorded by Hamilton in 1912 in the Handspike Point area. It is a semi-aquatic species, bright green in colour, and has been recorded from just above sea level to more than 220 m altitude. On the island *Sphagnum* occurs in poorly drained valley floors, abandoned elephant seal (*Mirounga leonine*) wallows, on the raised beach terraces, and along shallow drainage lines with only slow-moving water-flow. No



'Quaking mire' or 'featherbed' at Handspike Point with *Pleurophyllum hookeri* growing on the ridges and bryophytes dominating the wetter 'troughs'. Photo: Nick Fitzgerald



Sphagnum patches (bright yellow/green) in the Green Gorge basin mire. These patches have expanded and then contracted over the past 25 years. Photo: Jennie Whinam





sporophytes on *Sphagnum* moss have ever been recorded in more than 25 years of observations.

Anecdotal evidence indicated that the distribution of *S. falcatulum* on Macquarie Island had increased noticeably in the decades leading up to 1988, with monitoring sites and photographic records showing a dramatic decline in areal extent and occupancy between 1988 and 1996. Several sites appeared to become drier, with species such as *Luzula crinita*, *Colobanthus muscoides* and *Marchantia bertoana* invading and replacing *Sphagnum* moss. Analysis of meteorological data indicated that desiccation through changes in evapotranspiration may be the cause of decline in *Sphagnum* (see Whinam & Copson, 2006). This accords with work in Tasmania and mainland Australia that has shown that evapotranspiration in the driest month is one of the major factors limiting development of *Sphagnum* peatlands. Some Macquarie sites had significant disturbance from skua bird activity, but skua are also likely to be the major agent of dispersal of vegetative material. Elephant seals destroyed at least two *Sphagnum* moss beds.

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Highland feldmark
vegetation dominated by
the cushion plant *Azorella
macquariensis* and mosses.
Photo: Nick Fitzgerald

Azorella seed orchard on Macquarie Island

Natalie Tapson

Natalie has used her qualifications in horticulture and botany to follow her passion and work with plants. She has worked as a horticultural botanist at the Royal Tasmanian Botanical Gardens since 1997 and spent 7 weeks in late 2013 working on Macquarie Island to collect plants and establish the second stage of the *Azorella macquariensis* seed orchard.

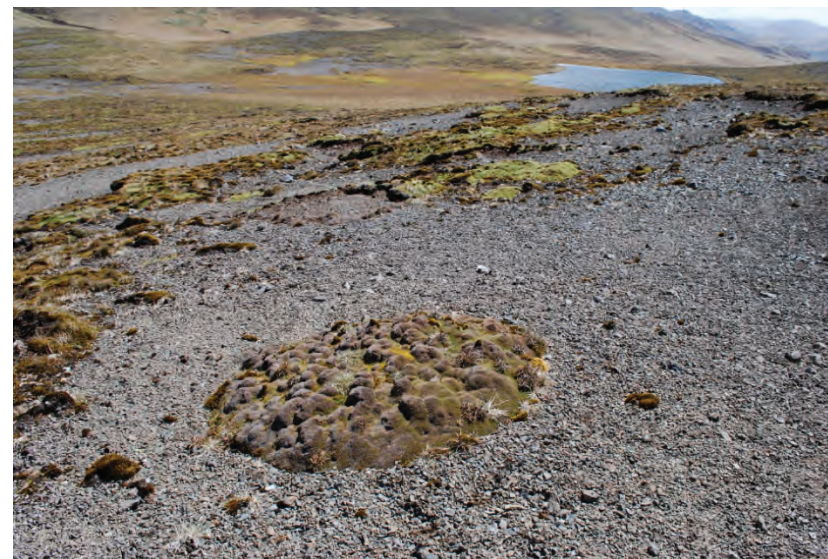


Figure 1: *Azorella* dieback on the plateau

Azorella macquariensis is one of the 4 plants that are endemic to Macquarie Island. It is a cushion plant that mainly occurs on the windswept plateau of the island at altitudes between 200 and 400 m. Feldmark comprises over 45% of Macquarie Island's vegetation and *Azorella* is a keystone species of that community. This member of the family Apiaceae can produce large cushions up to a couple of metres in diameter which are formed by a number of individuals growing together. It goes through a period of winter senescence in which the normally green cushion takes on a bronzed colouration until conditions improve into spring. At the end of 2008, researchers noticed that many plants, particularly on the plateau in the north of the island, had browned off and were dying. This was the first time that what was to be referred to as *Azorella* dieback (Figure 1) was noted. The spread across the island was rapid and the species was listed at the highest level of threat under state and federal legislation in 2009.





Azorella Dieback

The dieback was first recorded in December 2008 and was soon prevalent in the north of the island but has now spread right across the species range from north to south. Conditions on the windswept plateau are extreme and the death of cushions has resulted in large bare patches where the plants are simply blown away as they die. Some affected cushions show signs of what appears to be a classic disease front that moves in a line across the cushions while others tend to die off in patches. Once the cushion's integrity is breached it makes it much easier for wind to blow through the cushion and break it up.

Research into possible causes of the dieback has been ongoing with DNA sequencing technologies used to look for possible pathogens. The fungus *Rosellinia* has been found to be strongly associated with the dieback but as yet it is not known if this is the primary cause or is a secondary pathogen that, rather than causing the dieback, feeds on the affected material. Monitoring the development of the disease across the island continues to be part of a program of research into its impacts on the *Azorella* population.

Research has also been undertaken on the susceptibility of *Azorella* to environmental stress and it has been found that plants have a rudimentary vascular system and are prone to drought stress. It may seem strange to talk about drought stress on a windswept and wet subantarctic island but even though overall precipitation has increased over the last 40 years, the way that rainfalls has changed. Instead of the constant drizzle of the past, there are now more fine days and periods of heavy rain. Climate change is impacting on the amount of water available to the plants during the growing season and resulting in drought stress. It seems likely that the dieback has not resulted from one single thing and that the cause is multi-factorial.

Royal Tasmanian Botanical Gardens Seed Orchard

The Royal Tasmanian Botanical Gardens (RTBG) has worked since 2009 in collaboration with the Tasmanian Government's Biodiversity Conservation Branch (BCB) and Parks and Wildlife Service (TPWS), and the Australian Antarctic Division (AAD) in response to the dieback on the island. Strict hygiene procedures were put in place when the disease was first noticed but despite these the disease quickly spread from the north to the south of the island. There are currently 3 special management areas in the south of the island, in stands of healthy plants, where hygiene protocols are maintained. In 2009 I collected *Azorella* plants and tissue culture material to grow on in Hobart. Unfortunately it

was impossible to mimic the conditions on Macquarie Island under the strict quarantine controls required in cultivation and the tissue culture propagation also failed. It was decided that the best option was to hold an *ex-situ* insurance collection of seed in the RTBG Tasmanian Seed Conservation Centre.

A small amount of seed was collected early on but collecting the seed was problematic given the ferocious weather and the need to be out in the field just as seed was ripe. In 2010 RTBG nursery supervisor, Michelle Lang, established a trial seed orchard on Wireless Hill. Nine plants were collected from the Overland Track that runs from north to south down the island and potted up in an irrigated frame. A photo-monitoring program was established with monthly images taken by the TPWS ranger and this showed that the plants not only survived but grew at a much greater rate than expected. In 2010, once it was established that we could successfully grow plants on the island in an orchard, the RTBG worked towards building the orchard up to a viable size of at least 50 genotypes which would capture the genetic variability within the species.

After some considerable effort, partial funding for the project was received from the Mohamed bin Zayed Species Conservation Fund in 2010 and in 2011 further funding was received from the Foundation for National Parks and Wildlife. These grants, together with support from a public appeal kindly advertised in the *Australian Plants* journal, allowed the project to go ahead and a berth on the island was secured for the end of 2013. Berths were limited because of the need for places for the very important Macquarie Island Pest Eradication Program (MIPEP) to rid the island of rodents and rabbits, so we were originally allocated 5 weeks which became 7 weeks due to delays in shipping. The MIPEP team were integral to the success of the seed orchard project because they collected over half of the 45 new plants for the orchard.

After arriving on Macquarie Island at the end of October 2013 I set up the infrastructure to house a further 45 plants. I collected the first few plants during field training in the north of the island and then made a number of trips out into the field to collect more plants. The original 9 plants had been collected in a line down the island and the aim was to get plants from as many habitats as possible from north to south and east to west across the island. The MIPEP team provided fantastic support as they covered ground monitoring for pests right across the island and were able to collect plants from locations I was unable to get to during the brief period I was on the island. One thing that stands out was the readiness of expeditioners to help out to see my project completed before I left. This included people who gave up their time to

map the location of collected plants (Figures 2a and 2b), cart materials up Wireless Hill, spend time in the field with me collecting plants and others who helped with the maintenance of infrastructure for the seed orchard. It was truly a group effort.

The additional 45 plants were looking relatively healthy, given that they had been recently transplanted, when I completed work on the seed

orchard in December 2013 (Figure 3). Photo monitoring has continued since I left and the plants were last photographed in April 2014 before going into winter senescence. All but a couple were still looking healthy and TPWS ranger in charge, Chris Howard, will continue to monitor the plants when they come out of senescence from September on. Chris has kindly offered to recollect plants from the same area to replace any losses if necessary. In the mean time the Tasmanian Seed Conservation

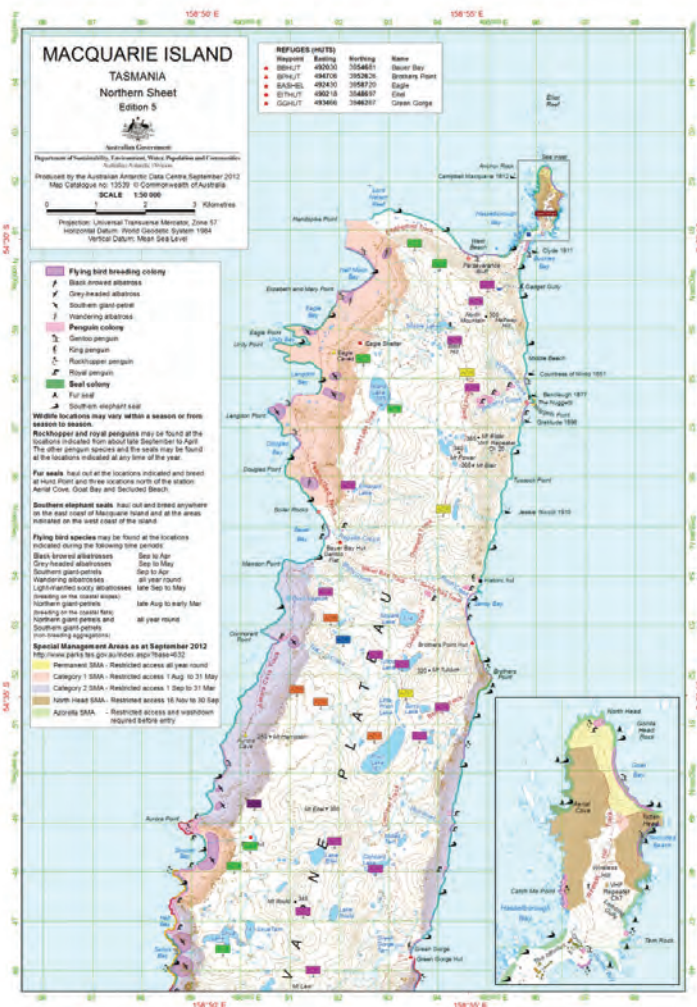


Figure 2a: Location of plants collected for the seed orchard from the north of Macquarie Island. The location of the seed orchard is shown in red at the top of the map.



Figure 2b: Location of plants collected for the seed orchard from the south of Macquarie Island. Yellow denotes plants collected for the trial orchard in 2010 (maps by Chris Howard).



Figure 3: The completed seed orchard of 54 *Azorella macquariensis* plants on Wireless Hill, Macquarie Island.

Centre at the RTBG is undertaking germination trials and as the plants grow, flower and produce seed on Macquarie Island, we will be able to add to our important conservation seed collection at the RTBG.



The ex-situ conservation collection and seed orchard of *Azorella macquariensis* on Macquarie Island will be in place for many years and requires ongoing funding to facilitate maintenance requirements of the orchard, enable future seed harvests and, once the seed harvest has been successfully completed, repatriate all the equipment and materials back to Hobart. With this in mind the RTBG has set up a dedicated *Azorella* Fund to raise the capital required for this purpose.

Tax-deductible donations to support this important work can be sent to Ms Natalie Tapson c/o *Azorella* Fund, Royal Tasmanian Botanical Gardens, Queens Domain, Hobart, 7000, Tasmania, and would be very gratefully received.

If you would like to find out more about this program please contact – Lorraine Perrins, Curator, Subantarctic Island Flora and Conservation Collections email: Lorraine.perrins@trbg.tas.gov.au, or Natalie Tapson, RTBG Horticultural Botanist email: Natalie.tapson@trbg.tas.gov.au

Current vegetation changes on Macquarie Island – a Ranger's perspective

Chris Howard, Tasmanian Parks and Wildlife Service

Chris is currently Ranger in Charge on the island, and has been there now for nearly two years, an extension on the usual 8-12 month stint. His passion for roaming up and down the island and documenting the changes since rabbits and rodents were removed, as well as undertaking all the usual tasks of a ranger in this unique subantarctic nature reserve, remains unabated.

'The island is going off!!' Not perhaps the most quantifiable means by which to describe the observed resurgence in plant growth on the island, but accurate none the less. A very concise description included in one of my monthly reports when referring to the explosion of plant growth associated with the arrival of warm weather during my first spring. I arrived on Macquarie Island in March 2013 for a 12 month posting to this subantarctic wilderness. First impressions of the island were overwhelming; the abundance of wildlife was amazing, the terrain heavily scarred and the vegetation obviously battered. Bare ground still very evident on many ridges and spur lines that had in previous times been covered in thick *Poa* tussock.

Travel around the greater area of Macquarie Island is typically by foot. There is no vehicle access 'down island', other than the occasional boat ride. Rangers going about their tasks can easily travel 70-100 km a week. This style of 'commuting to work' readily promotes opportunities to observe close up some of the landscape changes currently occurring. The tasks associated with on-ground management of this nature reserve are many and varied, but not necessarily unique, when compared perhaps to other conservation reserves, including wildlife monitoring, marine debris removal and track management, tourism during the summer season, and generally keeping an eye out for and reporting on changes in the landscape.

I am one of a recent generation of rangers who will get to see the island without rabbits. Plenty of evidence in the form of old burrows still exists, but with time the burrows will disappear or perhaps be claimed by one of many burrowing seabird species that call the island 'home'. An underlying interest in plants, coupled with an increasing familiarity with native species found on 'Macca', thankfully assisted in detecting 2 new potentially invasive species. A small patch of Common Bentgrass, *Agrostis capillaris*, was detected at Green Gorge, and another small patch of a close relative Creeping Bentgrass, *A. stolonifera*, was detected on a swampy tarn nearby, midway down the island.





Assistance with identification by a colleague helped to confirm the 'new' species as potentially invasive. Prompt action has resulted in the removal of vegetative material from the site; the sites will be monitored into the future for potential re-establishment.

Subsequent surveys radiating from the infestation and across similar sites around the island have yet to identify further outbreaks. The potential impact of grazing of these grasses may have in part been beneficial in that suppression of growth may have prevented the formation of seed heads previously. Specimens at both sites were only observed in a vegetative phase. The source of the incursion is unknown. Both species are known to be widespread across the world, including other subantarctic islands. Seed may have arrived lodged in the feathers of a migratory bird or perhaps by a piece of field equipment carried by an expeditioner travelling to the island. Biosecurity protocols have been progressively tightened over the years and are currently very stringent, however this has not always been so. Ongoing surveys have failed to identify further infestations, suggesting for the moment that the incursion is restricted to these 2 very small sites. Vigilance into the future will be important.

The discovery of expanded populations of the tussock grass *Poa litorosa* has been very exciting. The species has previously been recorded on Macquarie Island, however its distribution was restricted to a small number of discrete locations. Recent surveys on the southern sector of the island have expanded the size of these populations but also resulted in the discovery of two previously unrecorded sites. The recent observations have increased the total area of *P. litorosa* in the south to almost 13 hectares, a considerable increase over previous known areas.

The discovery of the invasive *Agrostis* species and the expanded *P. litorosa* populations has been made all the more easier during the post-eradication era. All 3 species have a growth form that rises above the smaller native grasses and herbs. Initial identification of the grasses came about by their emergence from the short grasslands of otherwise dominant *Agrostis magellanica*. The tussock *Poa* species when grazed heavily is very difficult to identify apart from *Festuca contracta*.

The future for this remarkable subantarctic refuge is very exciting. Already, the *Poa foliosa* and *P. cookii* tussock community is seen to be expanding back up the steep coastal slopes. The lower altitude plateau between the escarpment and the feldmark is starting to support scattered populations of *Stilbocarpa*, and *P. foliosa* tillers are starting



The author with small patch of *Agrostis capillaris* discovered inland of Green Gorge in summer 2013–14, which is the light-green patch rising above surrounding short grassland/herbfield dominated by *Agrostis magellanica*, *Festuca contracta* and *Juncus scheuchzerioides* with scattered *Pleurophyllum hookeri*.



A small patch of *Agrostis stolonifera* discovered at Green Gorge in summer 2013–14, which is the light green grass in the centre. *Stilbocarpa* to the left hand side (leaves approximately 15 cm diameter), *Poa foliosa* tussock along the top of photo (approximately 60 cm high), and *Acaena magellanica* on the lower right hand side. Photos: Jenny Scott.





The author monitoring the spread of medium-sized *Poa litorosa* tussocks in short grassland at the south end of the island.



Regrowth of *Poa litorosa* tussocks, springing up on the plateau in the south of the island, which was previously undetected due to continuous selective grazing pressure. Photos: Chris Howard.

to emerge; propagules previously dispersed on the wind from lower slopes. Dense swathes of the short grassy sedges *Uncinia* spp. and the fine hair-grass *Deschampsia chapmani* are now commonplace. The visual dominance of *Agrostis magellanica* in the short grassland stratum is being fractured by the emergence of taller growing plants of *F. contracta*. Areas of heavier soil disturbance associated with rabbit grazing of the herbfields and short grasslands in valleys on the plateau have been regenerating with thick blankets of *Acaena magellanica* and it is hard to know if this will persist, or be out-competed by other species. Crowns of once ravaged fern *Polystichum vestitum* are also starting to emerge from the protective shroud of the grassland. Lower down on the featherbed, dense swathes of *Stilbocarpa* are being seen to regenerate from previously suppressed crowns or long dormant seed. Dense clumps of *Coprosma perpusilla*, one of the only truly 'woody' species growing on the island, are starting to gently re-emerge from slightly raised mounds on the featherbed. What other changes, and what other species, are waiting to be discovered?



'Yahoo – more grass!' The author discovering yet more *P. litorosa* in unexpected areas. Photo: Chris. Howard





The Subantarctic Plant House - a very cool place

Lorraine Perrins

Tasmania's connection with Antarctica pre-dates historical records. As one of the last land masses to break away from the Gondwanan super continent, Tasmania's geology has strong similarities to the geological formations found in Antarctica. Many fossilised remains of plant species endemic to Tasmania, such as *Lagarostrobos franklinii* (Huon Pine), have been found in Antarctica.

Hobart has acted as host to many explorers engaged in the Age of East Antarctic Exploration. France's Dumont d'Urville, England's James Clark Ross, Norway's Carsten Borchgrevink and Roald Amundsen and Australia's Douglas Mawson all passed through Hobart on their way down to Antarctica. The announcement to the world of Amundsen's success as the first man to reach the geographic South Pole was made from the steps of the Hobart Post Office. Tasmania's own, Louis Bernacchi, was the first Australian to over-winter in Antarctica.

Several key organisations such as the Australian Antarctic Division (AAD), the Office of Antarctic Affairs and the Institute of Antarctic and Southern Ocean Studies have a strong presence in Hobart. In fact every expedition, piece of equipment or load of fresh fruit and vegetables that ends up on an Australian Antarctic research expedition is initiated from the AAD's headquarters just outside Hobart.

In the late 1990s, the Royal Tasmanian Botanical Gardens (RTBG) was offered the opportunity to undertake a field trip to Macquarie Island. Over a period of 2 years, sufficient plant specimens were collected to stock the Subantarctic Plant House, which was constructed with significant financial assistance from the Australian Antarctic Foundation, Hobart City Council and the Friends of the Royal Tasmanian Botanical Gardens. The Subantarctic House opened on 13 October 2000. As the first cold climate house for subantarctic plants in the southern hemisphere, it is essentially a prototype house.

The objective of the Subantarctic Plant House is to display a selection of the flora of the subantarctic region, with the emphasis on the plants of Macquarie Island.

The house was designed to replicate the appearance and environmental conditions of Macquarie Island and also to act as an experimental house for the culture and cultivation of the plants of this region. The curved inner walls are painted with a mural depicting the various

environments of the island, while the landscape has been recreated using plants, mosses and rock collected from Macquarie Island. The cool temperature, cold air being blasted from large fans, and array of sounds recorded on the island complete the effect.

The plantings within the house are segregated into various geographic and ecological zones and these differing environments are reinforced visually by murals. The house exhibits plants from the 5 recognised vegetation zones on Macquarie Island: Tall Tussock/Coastal Slopes, Herbfield, Short Grassland, Feldmark and Mire.

Each of these vegetation zones has its distinct communities, with some overlap.

The house is temperature-controlled to maintain a minimum of 1°C and maximum of 12°C, with a misting system increasing humidity levels to emulate the environmental conditions on the Island. The RTBG currently maintains 20 out of 47 species of the Macquarie Island vascular flora



Interior of the Subantarctic Plant House. Photo: M. Fountain





and 4 of the 11 Heard Island vascular flora species in both public and back of house collections. A number of species are held as seed in the RTBG Seed Bank.

Plants were initially sourced directly under permit from the subantarctic islands, the majority of plants coming from Macquarie Island. These were collected by AAD staff, University of Queensland research staff and students and also, occasionally, by RTBG staff.

Initially plants were all dug up from the island and transported to the RTBG in refrigerated containers, however nowadays seed is the preferred method of receiving species.

Most of the plants in the collection are usually propagated by division. More recently, more emphasis has been placed on growing plants from seed. This has been very successful with most species germinating readily under nursery germination conditions.

A few of the species we have tried to grow in the display house have proved to be rather too successful. A key feature of island floras, particularly those from the subantarctic, is that they have to be very robust and able to travel long distances via a variety of means to colonise new areas. This can make them weedy when they are placed in a new environment not quite as harsh as the one they originally came from. Any species that has been noticed with the potential to spread outside the house and become a problem in Tasmania has been assessed and, either removed from the display, or managed accordingly, for example by the regular removal of seed heads.

Other species have proved difficult for the opposite reason because the conditions we can provide in the house do not quite meet their optimum growth requirements and they slowly lose vigour and die. *Azorella macquariensis* is one such species that we have found very difficult to maintain in cultivation, like its relative *A. selago*. The combinations of differing light levels, lack of shearing winds (which these plants are subjected to on the islands) and complicated drainage requirements can cause the plants to die or become etiolated and lose their natural, compact form.

An important role of the RTBG is to continue to promote the subantarctic region through the medium of the Subantarctic Plant House and associated conservation projects. As part of this work, the RTBG has developed links with an international network of scientists, researchers and subantarctic expeditioners.

The RTBG currently undertakes research to determine the germination requirements of a variety of subantarctic species, primarily from

Macquarie Island and continues to hold stocks of plant material for cultivation for the Subantarctic Plant House and external research programs. The RTBG is an integral part of raising awareness of these unique species and is crucially involved in research and conservation programs. Since 2009 the RTBG has been involved in a project to prevent the extinction of the Macquarie Island Cushion plant, *Azorella macquariensis*, which is also discussed in more detail this issue of *Australian Plants*.

Looking towards the future, the RTBG will continue to investigate the potential for developing a Circumpolar Subantarctic Flora House as part of its overall focus on the southern hemisphere/Gondwanan flora. It is anticipated that this focus will include further collaborative research programs, which will position the RTBG as the world leader in the display, research and cultivation of subantarctic plants.



View Inside the Subantarctic Plant House. Photo: M. Fountain



