FLINDERS ISLAND

Natural Values Survey • 2012

A partnership program between the Hamish Saunders Memorial Trust, New Zealand and the Natural and Cultural Heritage Division, DPIPWE, Tasmania
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Tasmania’s 334 islands are recognised as unique havens for our wildlife and native flora. They are home to many seabirds, mammals, reptiles and native vegetation, and each has its own characteristics and significant historical and natural features.

Each island around our coast has its own unique history, signs of which can be seen today. In pre-European times, our islands were often used extensively by the Tasmanian Aboriginal people, and after European settlement, some became whaling and sealing centres and were used for early farming ventures.

Some are relatively undisturbed by humans; others reflect the use of the land and waters over generations.

The growth in our knowledge and appreciation of the natural values of our islands has been given a significant boost in recent years through our partnership with the Hamish Saunders Memorial Trust.

The Trust, established in memory of Hamish Saunders who tragically died in April 2003 whilst undertaking an island survey with our staff, has provided both specialist staff from this Department and emerging New Zealand natural scientists with a unique opportunity to visit and study our islands. The expedition to Flinders Island from 3rd to 10th December 2012 has contributed greatly to our understanding of the natural values on the island.

This report, another in the series of reports recording the results of visits to Tasmanian islands by this Department in partnership with the Trust, is a comprehensive and illuminating record of detailed scientific survey work undertaken by the expedition team.

It confirms that while Flinders Island hosts many threatened species, it also has a range of significant threats to its biodiversity.

Our partnership with the Hamish Saunders Memorial Trust aims to foster the growth of personal and professional links between scientists in Tasmania and New Zealand, and the visit to Flinders Island provided another great opportunity for two emerging New Zealand scientists to work in the field with experienced Tasmanian scientists. I understand Ali Caddy and Laura Hines gained a great deal from their experience on the island, and I thank them and their Tasmanian counterparts for their contributions to this report.

Alistair Scott
General Manager,
Natural and Cultural Heritage Division
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 nature conservation. The Tasmanian Government’s commitment and long-term support for the program is reaffirmed in the publication of each of the expedition reports.

For more about Hamish and the Trust, visit http://www.hamishsaunders.com/

ACKNOWLEDGEMENTS

Many thanks to the Hamish Saunders Memorial Trust for partnering the project, particularly to Alan and David Saunders.

All of the team wish to thank each other for one another’s assistance in their respective projects, but most particularly to Andrew Saunders and the Trust’s travel award recipients Ali Caddy and Laura Hines for their direct participation as volunteers in the work in terms of practical effort, stimulating input and great company.

Many thanks too to Wayne Warren, an ex-Parks and Wildlife employee and Flinders native, who has worked professionally controlling weeds on the island for many years, for devoting hours of paid and unpaid time to weed-hunt on the island, and to Mark Alexander, for his weed-spotting and plant identification contributions.

We also thank a number of other Flinders Islanders for their kindness, generosity and tolerance of twelve biologists keen to fit in as much survey work as possible in a single week. We continually remarked on this feature of Flinders Islanders and appreciated it very much. Our warm thanks to Wayne Dick, Ranger in Charge of the Furneaux Islands Parks and Wildlife Service for the multitude of ways in which he supported the team and their work, most practically in terms of his loan of vehicles, but also for his advice and good company. Doug and Libby Barrett supplied the perfect accommodation for our large team, providing wonderful hospitality and invaluable information. We also thank the NRM team Jo Clarke and Vic Epstein for their assistance in survey organisation, including community communications, as well of course as the co-author of one of our chapters Katriona Hopkins. David and Penny Conn generously boated the weed mapping team to the boxthorn infestations on the offshore islands. Alan Reid very kindly shared information and advice on trapping.

Left: Hamish Saunders
Right: Wayne Dick and Matt Webb
(photo: Sally Bryant)
Far right: Doug and Libby Barrett
(photo: Laura Hines)
small mammals, specifically the New Holland mouse, and we also thank the other Flinders Islanders who reported wildlife sightings to us.

Back on the mainland, many thanks to Niall Doran and Alastair Richardson for their invaluable advice on crayfish ecology, and the practicalities of trapping and identification. Peter McQuillan assisted with identification of butterfly larvae and other insects and provided butterfly photos for this report.

Within DPIPWE, we thank Mick Ilowski for his invaluable and varied assistance, including the fetching and carrying of both equipment and the team across Tasmania and entry of all our data onto the Natural Values Atlas. Stephen Harris encouraged Nicole to embark on this expedition, and helped greatly with both the background research for her project and the final report. Bronwyn Tilyard prepared maps for the team’s work, and was tireless in her attempts to make sense of Nicole’s data. Lindsay Mitchell prepared all the maps in this report, and Brett Littletone designed and prepared the layout of the report. Anthony Reid and Sam Thalmann provided valuable advice and editing assistance for the report, and Janet Tieman read the proofs. A number of people contributed substantially in planning and setting up the trip, including Phil Bell and Rosemary Gales. Phil Bell also provided specific guidance on the butterfly project.

Margaret Horton deserves a special thank you for her huge contribution towards all the hardest parts of the project: planning the logistics, safety protocols and the budget, being the key contact throughout - including, most memorably, while we were on the island - and supporting the preparation of the report. She only missed out on the central part, of being on Flinders Island. We all very much appreciated her support.

### SUMMARY

Flinders Island hosts many threatened species and also a range of significant threats to its biodiversity. The Hamish Saunders Memorial Trust 2012 Survey represented a valuable opportunity to review the status of both, to guide and update management and species recovery priorities.

Local threatened species of particular concern include the New Holland mouse *Pseudomys novaehollandiae*, last recorded in-hand in Tasmania in 2004, and not recorded on Flinders Island since 2001. In 2010, the forty-spotted pardalote *Pardalotus quadragintus* was estimated to have declined significantly on the Tasmanian mainland, with the population on Flinders Island, down to only a single colony of less than 20 birds, being perilously close to local extinction.

The island faces a number of biosecurity threats: a number of weeds, pests and pathogens are currently spreading across it, and there is the potential for additional invasive species and pathogens to arrive. The root rot fungus *Phytophthora cinnamomi* threatens a range of ecosystems and species on Flinders Island, and a number of Phytophthora Management Areas are in place to protect conservation values not yet affected by it. Chytrid fungus is a well-known disease threat to many frog species across the world and is known to be present on the island, although its impact on local frogs remains unclear.

Information on Flinders Island’s weeds is relatively scant, but two ‘priority weeds’ include pampas grass *Cortaderia selloana*, tagged as potentially possible to eliminate, and boxthorn *Lycium ferocissimum*, considered to require long term management. Feral pigs *Sus scrofa* are also thought to threaten at least 30 native plant and animal species on Flinders Island.
Key aims of the survey, which took place on 3rd-10th December 2012, included:

- Map threats: extent of boxthorn, pampas grass and *P. cinnamomi*, and areas considered susceptible to *P. cinnamomi* on the basis of latest information, field observations and pathogen isolations (i.e. *P. cinnamomi* extracted from samples in the laboratory).
- Reassess two Phytophthora Management Areas for disease status.
- Isolate the Flinders Island strain of chytrid fungus and assess virulence, then compare it to mainland Tasmania and mainland Australian strains.
- Survey for presence of weeds and native butterflies as yet unrecorded on the island, including the threatened chaostola skipper *Antipodia chaostola*.
- Improve levels of information on species’ distribution and abundance across Flinders Island, targeting threatened species including the forty-spotted pardalote, New Holland mouse, green and gold frog *Litoria raniformis* and Furneaux burrowing crayfish *Engaeus martigener*, and develop management recommendations for these species’ recovery.

Members of the survey team also provided information on shorebird breeding habitat, and impacts to biodiversity both of vehicle use on beaches and of feral pigs *Sus scrofa*, as specifically requested by the Parks and Wildlife Service. Additionally, they assisted with DPIPWE’s surveys of annual short-tailed shearwater (or muttonbird, *Puffinus tenuirostris*) and mammals, which were occurring simultaneously in the area.

**Findings**

- *P. cinnamomi* was confirmed as widespread across Flinders Island, with 48 plant species and 15 vegetation communities likely to be impacted by the disease to some degree (including eight threatened species and four threatened vegetation communities). Structural and floristic differences, typical of medium term changes recorded elsewhere in association with *P. cinnamomi*, were readily observable over considerable areas in the Darling Range and Wingaroo area.
- The Wingaroo and North Patriarch Phytophthora Management Areas retained lower risk locations for susceptible species and communities, but remain dependent on management of access, and control of fire and feral pigs, to minimise the risk of spread of *P. cinnamomi* into core areas.
- Fifty-nine new pampas grass records (building on a single previous record on Flinders), together with 163 new boxthorn records, were entered into the Natural Values Atlas.
- Most notable among other weeds observed during the survey was a large population of Chilean needle grass (*Nassella neesiana*), a species not previously recorded on Flinders Island. This highly invasive grass species, recorded in a large population near Emita, is considered one of the greatest threats to Australia’s native grasslands and also devastating to agricultural enterprises.
- Signs of feral pigs were widely recorded, including extensive vegetation damage, particularly in the south and east of the island. This included impacts on habitat for forty-spotted pardalotes and Furneaux burrowing crayfish. It is also likely that pigs crush and eat the latter species, and spread weeds picked up...
in mud across extensive distances. Additionally, European wasps (Vespula germanica or V. vulgaris) were noted at low abundance: these have a large impact on native invertebrate populations, including butterflies, wherever they have been introduced worldwide.

- The fringed heath-blue butterfly (Neolucia agricola insulana) was recorded on Flinders Island for the first time, together with some evidence for a second new species record, the Master’s skipper (Hesperilla mastersi).

- Observations of the Furneaux burrowing crayfish slightly extended its known distribution, and also, at 115 m above sea level, included the lowest altitude record yet made for this species.

- Findings supported earlier conclusions of a critically low level of the Flinders Island forty-spotted pardalote population, and of the high likelihood of local extinction of the Darling Range and Broughams Sugarloaf colonies.

- Breeding swift parrots Lathamus discolor were observed in the Mt. Strzelecki area - the first formal breeding record on Flinders Island.

- High concentrations of breeding shorebirds were recorded on Planter Beach. Evidence was found for a possible population decline in the red-capped plover Charadrius ruficapillus.

- Extensive tracts of habitat suitable for the New Holland mouse were recorded on the island. However, in the Darling Range, large areas exhibited symptoms of P. cinnamomi, which appeared likely to render the habitat irreversibly unsuitable for the species.

The expedition party

Back row left to right: Ms Nicole Gill (DPIPWE), Ms Ali Caddy (Hamish Saunders Memorial Trust Travel Award Recipient 2012), Mr Tim Rudman (DPIPWE), Mr Gary Davies (DPIPWE), Dr Clare Hawkins (DPIPWE), Ms Laura Hines (Hamish Saunders Memorial Trust Travel Award Recipient 2012).

Front row left to right: Ms Jo Potter (University of Tasmania), Mr Matt Webb (DPIPWE), Dr Annie Philips (DPIPWE), Dr Billie Lazenby (DPIPWE).

Team members not present: Mr Andrew Saunders (Springtide Creations), Dr Sally Bryant (Tasmanian Land Conservancy)

(photo: Laura Hines)
Flinders Island at 1,341 square kilometres and the largest of the Furneaux Islands (and Tasmania’s largest offshore island) is bisected by the 40th parallel. It sits directly in the path of the Roaring Forties, winds with a long fetch from the west across Bass Strait. The island is approximately 70 km north to south and about 25 km east to west. It is roughly three times as large as the next largest island in the Group – Cape Barren Island. The Furneaux Group comprises just over 100 islands ranging in size down to tiny areas of less than a few hundred square metres.

In addition to being the largest island in the group, Flinders is also the most topographically varied. The rugged Strzelecki Peaks in the southwest of the island rise to 756 m above sea level. The Darling Range in the southern central part of the island and the mountains in the north, such as Mt. Killiecrankie and Mt. Tanner, contrast with the large areas of subdued topography in the east – much of the eastern portion of Wingaroo Nature Reserve, the lagoon country on the east coast and the farming areas of Memana and Lackrana.

Flinders Island was the preserve of wooding and hunting parties throughout the nineteenth century, small farms only beginning to be established around the beginning of the twentieth century. The western lowland plains were cleared and developed for farming because of the more fertile soil than the acid granite-derived soils over much of the eastern part of the island. A big surge in land clearing on these soils came following the Second World War with the discovery of the critical trace elements that were required to make them fertile, for the Soldier Settler Farms. The island economy is still strongly based on beef, lamb, and wool production as well as fishing and tourism.

There is a good system of reserves for conservation on Flinders Island, capturing the range of vegetation and habitat types. Internationally significant wetlands occur in the south east corner of the island at Logan Lagoon. The area for which the Parks and Wildlife Service has management responsibility is thus very extensive.

Islands have always interested biologists because of what can be learned about biogeography, evolution and speciation. For conservation biologists in particular, islands represent areas that can be more easily studied or observed and can be subject to different management techniques - such as preservation of refugia or isolated populations free from the depreations and damage of invasive species found usually to be more widespread elsewhere. Where invasive species are present, there is more chance of their eradication on islands, therefore securing such areas for conservation in the long term.

While Flinders is certainly of great interest in terms of its biota, it has not escaped the damage from feral pigs and weeds. Although information about the natural values of Flinders and its satellite islands has been accumulating over the years, there remained tremendous scope for reassessment of some of these values, particularly threatened species in the light of disease and invasive species threats on the island. Extending our knowledge about the biota of the island, especially of particular groups such as threatened species, will increase our ability to manage them into the future.

This then was the motivation for selecting Flinders Island as the target of the 2012 Hamish Saunders Memorial Trust Natural Values Survey.

The expedition party spent from 3rd to 10th December 2012 on the island. It was led by Dr Clare Hawkins (threatened species zoologist). She was joined by Mr Gary Davies (Manager,
Gary Davies with short-tailed shearwater (photo: Laura Hines)
Biodiversity Conservation Branch), Mr Tim Rudman (Phytophthora and flora specialist), Dr Annie Phillips (wildlife veterinary specialist), Dr Billie Lazenby (research advisor and mammal biologist), Mr Matt Webb (threatened species zoologist), Ms Nicole Gill (weeds specialist), Ms Jo Potter (threatened species biologist, University of Tasmania), Mr Alan Saunders (New Zealand) and Dr Sally Bryant (zoologist, Tasmanian Land Conservancy). Ms Ali Caddy and Ms Laura Hines were the two 2012 Hamish Saunders Memorial Trust Award Recipients on the expedition.

Planning the day’s fieldwork. From left: Tim Rudman, Jo Potter, Billie Lazenby (photo: Laura Hines).
Flinders Island Vegetation Types

Major Vegetation Communities
- Agricultural, urban and exesic vegetation
- Dry eucalypt forest and woodland
- Highland and treeless vegetation
- Moorland, sedgeland, rushland and peatland
- Native grassland
- Non-eucalypt forest and woodland
- Rainforest and related scrub
- Saltmarsh and wetland
- Scrub, heathland and coastal complexes
- Wet eucalypt forest and woodland
- Water, sea
- Lichen, lichensphere
- Sand, mud

Kilometres

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Flinders Island has extensive infestations of the exotic soil-borne plant pathogen *Phytophthora cinnamomi*, a pathogen that severely degrades native vegetation. A number of management areas are in place on the island to protect conservation values not yet affected by this pathogen. The present study aimed to: reassess the *Phytophthora* Management Areas for disease 10 years after they were established; describe the status of *P. cinnamomi* on the island through identification of the key plant species at risk from *P. cinnamomi*; prepare maps of *P. cinnamomi* distribution and disease susceptibility on the island.

The capacity to manage *P. cinnamomi* on Flinders Island is limited and its destructive force will trigger long term ecosystem change and rebalance between the pathogen and its host species. There are substantial risks for the conservation of some flora species on Flinders Island which may be eliminated from diseased areas. The continued effectiveness of the *Phytophthora* Management Areas will depend on compliance with hygiene and other management prescriptions. Wild pigs are a major threat for disease spread and as a priority need to be controlled in the north of the island around the *Phytophthora* Management Areas. The focus on threatened flora species at risk from *P. cinnamomi* needs to be broadened to include the dwarf wedgepea (*Gompholobium ecostatum*) and spreading heath (*Brachyloma depressum*) as a priority, and to include the unlisted *Tetratheca* sp. Flinders Is., a species endemic to Flinders Island.

**INTRODUCTION**

*Phytophthora cinnamomi* is an introduced plant pathogen capable of killing a wide range of plant species that occur in Australian bushland, horticulture (e.g. rhododendrons) and agriculture (e.g. avocados). Exactly what this filamentous microscopic pathogen is has been the subject of scientific debate over many years. Originally considered to be a fungus, it is now understood to be quite unlike fungi as it has cellulose cell walls like plants, energy storage systems like algae, and produces zoospores with two types of flagella allowing movement. It is attributed by some to a new informal kingdom of biota called Chromalveolata and is considered to be distantly related to plants. Irrespective of where *P. cinnamomi* fits in the higher taxonomic level, it is a member of the phylum Oomycota (*Cooke et al. 2000*) which are commonly called watermoulds. In Australia, *P. cinnamomi* also goes by the common names *Phytophthora* root rot, wildflower dieback, jarrah dieback or cinnamon fungus.

*Phytophthora cinnamomi* is not observable with the naked eye; it resides within the roots of infected plants or as microscopic spores hidden within the soil. Only the effects of its presence can be observed, by the selective dieback and death in susceptible plant species. It kills by invading the roots of susceptible plants and growing through the root system towards the base of the stem where it may girdle the plant. In so doing it releases enzymes to digest the plant’s root tissues, causing starvation of the foliage of nutrients and water. Death comes much as if the plant has been affected by drought, with a display of yellow, orange, brown or black leaves, depending on the species of plant (Figure 1). The roots may also display brown or stained tissues, sometimes soft, compared to the healthy pale-coloured tissue in healthy plant roots. However, only a laboratory sample or isolation of *P. cinnamomi* can categorically confirm its presence at a site.
It was not until the late 1960s that the cryptic role that *P. cinnamomi* played in destroying Australian native plant species and communities was recognised. Survey work by the then Forestry Commission identified that it was widely distributed in Tasmania, including detecting it on Flinders Island in 1974.

The devastating effect *P. cinnamomi* has on heathlands, moorlands and dry forests in South-western Western Australia, South Australia, Victoria and New South Wales has led to its declaration as a threatening process under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999, and the preparation of a draft national threat abatement plan (Anon 2013), that primarily targets the protection of matters of national environmental significance and the prevention of *P. cinnamomi* causing additional communities or species becoming threatened.

Within Tasmania, the document *Conservation of plants and communities at risk from Phytophthora cinnamomi: Strategic Regional Plan for Tasmania* (Schahinger et al. 2003) identifies a suite of high priority management areas for protection of threatened species and plant communities at risk from disease. This includes two management areas on Flinders Island: Wingaroo and North Patriarch.

**METHODS**

The map of areas susceptible to *P. cinnamomi* on Flinders Island was generated by classifying TASVEG communities for susceptibility based on assessments of their component species’ susceptibility to disease (Harris & Kitchener 2005).

The impact of *P. cinnamomi* on a species can be highly variable. A wide range of plant species are totally resistant to colonization by *P. cinnamomi*. Those species that may host *P. cinnamomi* can vary in response from never developing disease symptoms to experiencing very high mortality in infested populations. Resistant plants may achieve this through defence mechanisms preventing the spread of *P. cinnamomi* through the root system, or a functional capacity for root growth at a rate that disease symptoms do not develop in the above-ground plant as in the case of some monocotyledons (Philips & Weste 1984).

*Figure 1. Mass collapse in southern grasstree, (Xanthorrhoea australis) on infection by Phytophthora cinnamomi alongside a newly constructed fire control line. (photo: Tim Rudman).*
Those species where population decreases are observed in infested areas are termed ‘susceptible’ where a greater or lesser proportion of the population may succumb to disease and die. The response of susceptible plant species to \textit{P. cinnamomi} attack may be variable in time and space. This arises due to the complex interactions between the environment (e.g. soil type, soil moisture, associated plant species, soil microorganisms) and the attacked plant (e.g. genetics) and the pathogen (e.g. genetics, population level). Though highly susceptible species experience high levels of mortality the longer term prognosis for survival is affected by the presence or absence of seedbanks, dispersal capability and refuge habitats.

Existing records for flora species present on Flinders Island were assessed against Departmental (DPIPWE) records and published sources of data on \textit{P. cinnamomi} susceptibility and classified for their susceptibility to disease. Species were classified in accordance with Table 1.

Mapped TASVEG vegetation types present on Flinders Island were assessed for species composition based on data from DPIPWE’s Natural Values Atlas (NVA) (2012), type descriptions, soil type and field observations in the Wingaroo, Darling Range and Mt. Strzelecki areas. Each TASVEG type was then broadly classified based on the likely potential for \textit{P. cinnamomi} to cause floristic change (i.e. proportion of species in the vegetation community that may be reduced in frequency and cover) using the scale described in Table 2.

Site visits were made to reassess the disease status of the Wingaroo and North Patriarch Phytophthora Management Areas (Schahinger et al. 2003) by vehicle and on foot. As the field survey was constrained it targeted high risk areas for \textit{P. cinnamomi} incursion along tracks and protectable areas high in the landscape. Symptom mapping was conducted where disease was well expressed. Isolations - soil samples returned to the laboratory for extraction of \textit{P. cinnamomi} - were obtained where disease was more cryptic or where no isolations had been obtained in the general area to confirm the symptom mapping. New isolation records from the present study were loaded into the Natural Values Atlas and disease symptom observations added to the DPIPWE GIS layers for \textit{P. cinnamomi} symptoms.

Hygiene protocols were applied to vehicles, footwear and equipment prior to entering and on moving in or out of \textit{P. cinnamomi} sites or susceptible threatened species sites.

<table>
<thead>
<tr>
<th>Table 1. The classification system used to assess species’ susceptibility to \textit{P. cinnamomi}</th>
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<tbody>
<tr>
<td><strong>Scale</strong></td>
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<tr>
<td>Highly susceptible (HS)</td>
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<tr>
<td>Moderately susceptible (MS)</td>
</tr>
<tr>
<td>Variable susceptibility (VS)</td>
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<tr>
<td>Low susceptibility (LS)</td>
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<td>Susceptible (S)</td>
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<th>Table 2. The classification system used to assess susceptibility of vegetation communities to \textit{P. cinnamomi}</th>
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<tr>
<td>Variable or Moderately susceptible (VMS)</td>
</tr>
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</table>
Table 3. Indicative responses for plant species expected to be susceptible to disease caused by Phytophthora cinnamomi on Flinders Island. HS – high mortality in a population; MS – moderate mortality in a population; VS – variable mortality between sites or populations; LS – low mortality in a population; R - resistant; S – susceptible uncertain response.

<table>
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<tr>
<th>Rating</th>
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<th>Family</th>
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<td>EPACRIDACEAE</td>
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<tr>
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<tr>
<td>HS</td>
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<td>common fringemyrte</td>
<td>MYRTACEAE</td>
</tr>
<tr>
<td>LS</td>
<td>Melaleuca squamea</td>
<td>swamp honeymyrte</td>
<td>MYRTACEAE</td>
</tr>
<tr>
<td>LS/R?</td>
<td>Persoonia juniperina</td>
<td>prickly geebung</td>
<td>PROTEACEAE</td>
</tr>
<tr>
<td>LS/R?</td>
<td>Boronia parviflora</td>
<td>swamp boronia</td>
<td>RUTACEAE</td>
</tr>
<tr>
<td>S</td>
<td>Allocasuarina paludosa</td>
<td>scrub sheoak</td>
<td>CASUARIACEAE</td>
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<tr>
<td>S</td>
<td>Hibbertia procumbens</td>
<td>spreading guineaflower</td>
<td>DILLENIACEAE</td>
</tr>
<tr>
<td>S</td>
<td>Hibbertia prostrata</td>
<td>prostrate guineaflower</td>
<td>DILLENIACEAE</td>
</tr>
<tr>
<td>S</td>
<td>Hibbertia riparia</td>
<td>erect guineaflower</td>
<td>DILLENIACEAE</td>
</tr>
<tr>
<td>S</td>
<td>Acrotriche serratula</td>
<td>ants delight</td>
<td>EPACRIDACEAE</td>
</tr>
<tr>
<td>S</td>
<td>Brachyloma ciliatum</td>
<td>fringed heath</td>
<td>EPACRIDACEAE</td>
</tr>
<tr>
<td>S</td>
<td>Leptecophylla juniperina</td>
<td>pinkberry</td>
<td>EPACRIDACEAE</td>
</tr>
<tr>
<td>S</td>
<td>Monotoca elliptica</td>
<td>tree broomheath</td>
<td>EPACRIDACEAE</td>
</tr>
<tr>
<td>S</td>
<td>Styphelia adscendens</td>
<td>golden heath</td>
<td>EPACRIDACEAE</td>
</tr>
<tr>
<td>S</td>
<td>Daviesia ulicifolia</td>
<td>spiky bitterpea</td>
<td>FABACEAE</td>
</tr>
<tr>
<td>S</td>
<td>Dillwynia sericea</td>
<td>showy parrotpea</td>
<td>FABACEAE</td>
</tr>
<tr>
<td>S</td>
<td>Goodenia humilis</td>
<td>swamp native-prinrose</td>
<td>GOODENIACEAE</td>
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<tr>
<td>S</td>
<td>Acacia myrtifolia</td>
<td>redstem wattle</td>
<td>MIMOSACEAE</td>
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<td>S</td>
<td>Hakea nodosa</td>
<td>yellow needlebush</td>
<td>PROTEACEAE</td>
</tr>
<tr>
<td>S/R?</td>
<td>Hakea ulicina</td>
<td>furze needlebush</td>
<td>PROTEACEAE</td>
</tr>
<tr>
<td>S</td>
<td>Correa reflexa</td>
<td>common correa</td>
<td>RUTACEAE</td>
</tr>
<tr>
<td>S</td>
<td>Tetrapheca pilosa</td>
<td>hairy pinkbells</td>
<td>TREMANDRACEAE</td>
</tr>
<tr>
<td>S</td>
<td>Monotoca glauca</td>
<td>goldey wood</td>
<td>EPACRIDACEAE</td>
</tr>
</tbody>
</table>

References: Podger et al. 1990, Dawson et al. 1985, Weste & Kennedy 1997; Stephano 2001; T Rudman (pers. obs.)
RESULTS

Flinders Island Species Susceptibility

Forty-eight plant species were identified as likely to be impacted to some degree by *P. cinnamomi* (Table 3).

Flinders Island Vegetation Community Susceptibility

Fifteen vegetation communities are likely to be impacted by *P. cinnamomi* on Flinders Island. Four of the communities are listed as threatened under the *Nature Conservation Act 2002* (NCA) (Table 4). Those plant communities that include an appreciable component of susceptible species and are generally within susceptible environments to disease are also listed in Table 4. Each community has been placed into broad categories of potential impact.

**Distribution**

*Phytophthora cinnamomi* is widespread on Flinders Island where it has been recorded in native vegetation along many roads and tracks in all quarters of the island (Figure 2). Infestations are extensive in the northern heaths of Wingaroo Nature Reserve and in the Darling Range. This survey identified *P. cinnamomi* within 50 metres of the *Gompholobium ecostatum* population on Memana Road, and also along drainage lines and in the heathland scrub complex at Wingaroo to the west of Five Mile Road. The mapping has largely been limited to easily accessible public land and may therefore under-represent the actual distribution of disease.

The core upland part of the Wingaroo Phytophthora Management Area remains free of *P. cinnamomi* symptoms, including the *Banksia serrata* stand and the ridgetop heathlands. A large mosaic of infestation is present on the lower eastern slopes within the management area. Recent infestations were observed associated with bulldozer tracks put in during the last fire near the southern boundary of the management area.

<table>
<thead>
<tr>
<th><em>P. cinnamomi</em> Impact</th>
<th>NCA 2002 Status</th>
<th>TASVEG mapping unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td></td>
<td>heathland on granite (SHG)</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td>coastal heathland (SCH)</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td>inland heathland undifferentiated (SHU)</td>
</tr>
<tr>
<td>High</td>
<td>rare &amp; endangered</td>
<td>heathland scrub complex at Wingaroo (SCW)</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td>heathland scrub mosaic on Flinders Island (SHF)</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td>eastern buttongrass moorland (MBE)</td>
</tr>
<tr>
<td>High</td>
<td>rare &amp; endangered</td>
<td><em>Banksia serrata</em> woodland (NBS)</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td><em>Eucalyptus nitidula</em> Furneaux forest (DNF)</td>
</tr>
<tr>
<td>High</td>
<td>endangered</td>
<td><em>Eucalyptus ovata</em> heathy woodland (DOW)</td>
</tr>
<tr>
<td>Variable or Moderate</td>
<td></td>
<td>coastal scrub (SSC)</td>
</tr>
<tr>
<td>Variable or Moderate</td>
<td></td>
<td>wet heathland (SHW)</td>
</tr>
<tr>
<td>Variable or Moderate</td>
<td></td>
<td>lowland sedgy heathland (SHL)</td>
</tr>
<tr>
<td>Variable or Moderate</td>
<td>rare &amp; vulnerable</td>
<td><em>Eucalyptus viminalis</em> – <em>Eucalyptus globulus</em> coastal forest and woodland (DVC)</td>
</tr>
<tr>
<td>Variable or Moderate</td>
<td></td>
<td>Dry scrub (SDU)</td>
</tr>
<tr>
<td>Variable or Moderate</td>
<td></td>
<td><em>Callitris rhomboidea</em> forest (NCR)</td>
</tr>
</tbody>
</table>
Figure 2. Vegetation susceptible to Phytophthora cinnamomi and disease distribution records, isolations and symptoms on Flinders Island.
Further new localised disease symptoms were recorded along the southern boundary fire break in the SE corner of the management area.

Northern Patriarch’s Phytophthora Management Area has continuous \textit{P. cinnamomi} infestation from the North Patriarch hut to the ridgetop behind. However no \textit{P. cinnamomi} symptoms were observed along the central section of the Northern Patriarch ridgeline. Disease symptoms which were observed along the Gilpins Lagoon track were limited to the lower slopes near the track (Figure 3).

**DISCUSSION**

**Species at risk**

The review of species’ susceptibility to \textit{P. cinnamomi} identified a number of threatened flora species on Flinders Island that are at risk of population decline due to the spread of \textit{P. cinnamomi}. This included a number of species not previously identified as potentially at risk, including \textit{Gompholobium ecostatum}, spreading heath \textit{Brachyloma depressum} and the unlisted \textit{Tetratheca} sp. Flinders Is. (Gray 2011, Baker & de Salas 2013). Threatened species potentially at risk are listed below.

![Figure 3. Known distribution of Phytophthora cinnamomi in the Flinders Island Phytophthora Management Areas.](image-url)
*Isopogon ceratophyllus* (horny conebush, vulnerable Threatened Species Protection Act 1995 (TSPA)) (Figure 4) is at significant risk of loss from areas infested with *P. cinnamomi*. Mortality in this species is commonly observed in Wingaroo Nature Reserve in association with deaths of other *P. cinnamomi* susceptible species. This response is reported on the mainland where *I. ceratophyllus* is widely reported as highly susceptible and locally eliminated by *P. cinnamomi* (Laidlaw & Wilson 2003). *Isopogon ceratophyllus* failed to regenerate in the year following burning of *P. cinnamomi* infested area in Victoria demonstrating the vulnerability of this species to local elimination in infested sites. It is likely that all of the Tasmanian distribution is at risk from infestation by *P. cinnamomi*.

*Banksia serrata* (saw banksia, rare TSPA) is common on the Australian mainland, but its distribution in Tasmania is restricted to just two disjunct populations, one in the northwest and one at Wingaroo on Flinders Island. The Flinders Island stand is vulnerable to loss due to the small size and past mortality due to drought stress (Schahinger 2009).

*Banksia serrata* has a variable response to *P. cinnamomi*, with plants occurring on sandy as opposed to peatier soils showing reasonable resistance to disease in the Rocky Cape area (Schahinger et al. 2003). Susceptibility testing of a mainland *B. serrata* provenance by McCredie (1985) showed resistance over a one year period of pathogen exposure, while high levels of mortality were observed at Wilsons Promontory (Weste 1998), a similar bioregional setting to Flinders Island. There is currently no *P. cinnamomi* within the stand of *Banksia serrata* on Flinders Island. The relatively slow time to maturity and absence of a soil stored seed bank increases the risk of local extinction should *P. cinnamomi* impact on the population. Some uncertainty does remain over the susceptibility of this stand to disease, though as in all such cases a precautionary approach is required.

*Gompholobium ecostatum* (dwarf wedgepea, endangered TSPA). Within Tasmania this species is restricted to Flinders Island. It has been recorded as being susceptible to *P. cinnamomi* in the Grampian Ranges, Victoria where it was able to persist at a reduced cover (<1%) in some plots over 20 years of monitoring (Weste et al. 2002). Whether there is *P. cinnamomi* within the populations of *G. ecostatum* on Flinders Island is not known, however a population of *G. ecostatum* on Centre Hill, where *P. cinnamomi* symptoms were recorded on the north side, may provide evidence of the potential impact if surveyed. This species should be considered to be at increased risk of population decline due to *P. cinnamomi* until proven otherwise. It is likely that all of the Tasmanian distribution is at risk from infestation by *P. cinnamomi*.

*Leucopogon esquamatus* (swamp beardheath, rare TSPA). Within Tasmania this species is restricted to Cape Barren Island and Flinders Island. Glasshouse experiments indicated that the species has a moderate level of susceptibility to *P. cinnamomi* (Barker & Wardlaw 1995), though it is frequently found in infested areas indicating reasonable resistance in the population or field resistance. Sampling of chloritic plants on the northern boundary of Flinders Island...
fire trail of the Wingaroo Phytophthora Management Area failed to recover *P. cinnamomi* from root or soil isolations in early 2012. It is considered at low risk from *P. cinnamomi*.

*Leucopogon lanceolatus* var. *lanceolatus* (lance beardheath, rare TSPA) has a disjunct distribution in Tasmania, occurring in the south east and on King and Flinders Islands where it occurs in riparian vegetation, forest and dune vegetation (DPIPWE 2005b). It also occurs on the Australian mainland. *Leucopogon lanceolatus* was rated as highly susceptible in glasshouse tests (Barker & Wardlaw 1995), though its habitat may provide some protection from disease.

*Hakea ulicina* (furze needlebush, vulnerable TSPA) was determined to be slightly susceptible by glasshouse experimentation (Barker & Wardlaw 1995), though it has been observed to increase in cover in diseased heathland in Victoria’s Otway Ranges (Laidlaw & Wilson 2003). This could conceivably occur due to the species being resistant in the natural environment, genetic variation in resistance or the resistant proportion of the population expanding as competition is released in diseased areas. This species is considered to be at low risk from *P. cinnamomi*, however monitoring will be important should *P. cinnamomi* be found in close association with the species.

*Brachyloma depressum* (spreading heath, rare TSPA) is a spindly shrub commonly found among granite boulders in shrubby vegetation. It is present on mainland Tasmania and Flinders Island, where it has been found on the Dutchman, where *P. cinnamomi* symptoms have been recorded, and in the Killiecrankie area. There are only three records for this species on Flinders Island (Natural Values Atlas 2012), the last being more than 20 years ago. *B. depressum* was rated as highly susceptible in a study of *P. cinnamomi* impact on vegetation in Victoria’s Grampian Ranges (Weste et al. 2002).

*Figure 5. Tetratheca sp. Flinders Is. (photo: Tim Rudman)*
Species at risk of catastrophic population decline include those that are both highly susceptible and restricted to susceptible environments and where they may be dependent largely on vegetative regeneration or aerial stored seed banks. The species on Flinders Island most at risk of local extinction due to *P. cinnamomi* is *Banksia serrata*.

**Communities at risk**

The potential for *P. cinnamomi* to impact on vegetation communities varies with the environment and host species present. Low nutrient and acidic granitic and sandy soils are favourable to disease development, whereas alkaline or nutrient rich soils such as calcarene and basalt soil are inhibitory. Vegetation communities that have an understorey dominated by the susceptible heath species in the Fabaceae, Epacridaceae, Proteaceae and Xanthorrhoeaceae families differentiate floristically most strongly between healthy and diseased states. These include coastal heathland vegetation and wet heaths that typically have an abundance of highly susceptible species such as *Xanthorrhoea australis*, *Leucopogon spp.*, *Aotus ericoides* and *Epacris spp.* Other vegetation communities such as dry scrub include facies that are richer or poorer in susceptible species, sometimes due to fire succession, complicating classification of the level of potential disease impact. These are termed variable impact communities that require field inspection to assess the proportion of susceptible plants present at a site.

Long term quantitative data on the impact of *P. cinnamomi* on Flinders Island is lacking. However, the readily observable structural and floristic differences over considerable areas in the Darling Range and Wingaroo area indicate that medium-term changes similar to those recorded elsewhere (Cahill 2008) are occurring on Flinders Island. To define the longer-term impacts to communities is a more complex task, as the true impacts of *P. cinnamomi* will take many plant generations to be realised.

**Heathland scrub complex at Wingaroo (SCW) (rare and endangered)** This vegetation community is the most at risk from *P. cinnamomi* on Flinders Island. It is wholly restricted to the island’s north, and comprises a mosaic of wetland, wet heath and coastal heath vegetation types. *P. cinnamomi* was observed in this community to be extensive along a drainage line 1 km northwest of 5 Mile Road. It is also likely to be present further north, given that infestations occur uphill of the flats and vehicle tracks enter from known infested areas. As the area is uniformly low lying and wet, *P. cinnamomi* will spread readily over time. This community is highly susceptible to structural and floristic change in both the wet heathland and coastal heathland components of the mosaic. The diseased state of the community may be considered an extreme disturbance-related facies or potentially a novel new community. However the individual vegetation types that comprise this threatened vegetation complex are also present, as elsewhere on Flinders Island or mainland Tasmania where they are mapped in their own right.

**Banksia serrata woodland (NBS) (rare and endangered)** The risk to this community from *P. cinnamomi* on Flinders Island is reflected in the previous discussion of the threat to *Banksia serrata*. This community includes a number of susceptible species and if the defining *Banksia serrata* is affected similar to that observed at Wilsons Promontory in Victoria it could be eliminated from Flinders Island. However this community is unlikely to be eliminated from Tasmania as its occurrences in the State’s northwest are more extensive and are mostly on substrates less susceptible to disease expression.

**Eucalyptus ovata heathy woodland (DOW)** is listed as endangered and has a limited distribution primarily in the northeast of the Island. The *P. cinnamomi* status
of this community on Flinders Island is unknown, however it is also widely distributed on the Tasmanian mainland. Risks to this community are confined to the understorey where degradation of condition rather than community type change may occur with infestation by *P. cinnamomi*.

**Eucalyptus viminalis – E. globulus coastal forest and woodland (DVC) (rare and vulnerable)** There is a small extent of this community on Flinders Island. Where facies of this community include a heathy understorey disease can occur. Disease degrades the condition of the community but does not convert the community type.

**Phytophthora cinnamomi** distribution

Two types of records contribute to the knowledge of the distribution of *P. cinnamomi*. Isolation records provide confirmation of the presence of *P. cinnamomi* from samples analysed in the laboratory and symptom records provide probable presence information based on observations of disease symptoms known to be associated with *P. cinnamomi* infestations. Where symptoms are well expressed they may be reasonably reliable. However, symptom mapping may not always identify infested sites correctly depending on the degree of disease expression, the experience of the observer or other masking disease events (e.g. drought). Asymptomatic presence of *P. cinnamomi* is also possible.

Distribution maps for *P. cinnamomi* on Flinders Island present an imperfect knowledge of its true distribution. Current mapping underestimates the extent of infestation as mapping has been primarily along vehicle tracks, and disease frequently occurs as a mosaic at different scales in the landscape for which determining boundaries is difficult. While existing distribution records maintain currency over time, spread of infestations over time increases uncertainty of disease status in the absence of further survey.

Areas immediately downslope of existing infestations and subject to earth moving machinery, vehicle use and high levels of soil disturbance (e.g. pig infestation) are at greater risk of disease spread.

Disease distribution knowledge is lacking in many areas such as Mt. Tanner, Mt. Killiecrankie and the northeastern Wingaroo heaths.

**Phytophthora Management Areas**

Two representative Phytophthora Management Areas (Schahinger *et al.* 2003) at Wingaroo and North Patriarch are managed for high level protection of susceptible vegetation communities and threatened species at risk from *P. cinnamomi*. Both management areas were recorded as containing some *P. cinnamomi* infestations on their establishment in 2003. The effectiveness of the management areas in protecting the core areas from *P. cinnamomi* incursion required reassessment. Although core areas and tracks were visited, more complete surveys of the Wingaroo (south) and North Patriarch Phytophthora Management Area surveys were hampered by mature vegetation reducing visibility and progress. Future surveys would be most effective in detecting disease in a range of 4-10 years post fire in these locations.

The Wingaroo (south) Phytophthora Management Area contains possibly the largest disease free extent of *Xanthorrhoea australis* (grasstrees) in a Phytophthora Management Area. It also contains populations of two species listed as threatened under the TSPA that are at risk from *P. cinnamomi*: *Banksia serrata* and *Isopogon ceratophyllus*. The management area comprises primarily of *Eucalyptus nitida* Furneaux forest (DNF) and heathland scrub mosaic on Flinders Island (SHF). Wet heathland (SHW) vegetation occurs locally in creeklines and on the flats on the eastern boundary. A small stand of *Banksia serrata* woodland (NBS), listed as threatened under the Tasmanian *Nature Conservation Act 2002* (NCA) occurs in the...
central south. There is reasonable confidence in the absence of *P. cinnamomi* from the high elevation central area. Disease was identified higher on the slopes than previously known in the east where a fire control line intersected an existing infestation. This is not an immediate threat to the core of the management area, though the buffer is reduced. Disease symptoms were found in *Sprengelia incamata* and *Leucopogon esquamatus* on the northern boundary track, but failed to return *P. cinnamomi* isolations. Hygiene considerations continue to be important for activities on the northern and southern boundaries of the management area.

The North Patriarch Management Area (Figure 6) targets populations of *Isopogon ceratophyllus* and *Xanthorrhoea australis*. Though the population density of these species are not as high in this management area as in the heathlands of Wingaroo, it affords relatively lower risk of disease spread due to steep slopes and a belt of dense *Leptospermum* scrub on the mid slopes inhibiting pathogen movement from adjacent infested areas. The main ridgeline has dispersed low density population of *Isopogon ceratophyllus* and *Xanthorrhoea australis* primarily under *Eucalyptus nitida* forest. Small pockets of *Callitris rhomboidea* forest with *Xanthorrhoea australis* in the understorey are also present. The western flanks of the range have a larger area of habitat for the target species. Only moderate — low reliability is ascribed to the disease free status of the southern ridgeline and western slopes due to the limited area surveyed in the dense scrub and lack of visibility. No disease symptoms were observed in a traverse along a section of the ridgeline between the two peaks. Disease symptoms were recorded previously above the hut on the northern most peak. This infestation follows a walking route from the hut to the peak above and appears to have spread minimally in the last ten years. A number of diseased sites were observed immediately adjacent to the Gilpins Lagoon vehicle track on the north eastern boundary. These infestations were limited to within tens of metres of the track.

Both the Phytophthora Management Areas on Flinders Island continue to provide lower risk locations for the management of susceptible species and communities. However, they are at risk from the spread of *P. cinnamomi* infestations into core areas. Ongoing management of access, and the control of fire and feral pigs, will be important to limit the extent of infestation and risk to target species.
A number of additional risks to threatened species not captured within these Phytophthora Management Areas identified previously need assessment on the Island for consideration if management agreements or management areas need to be established to ensure their protection.

REFERENCES


DPIPWE (2005a) Tetratheca ciliata. Threatened Species Notesheet, Department of Primary Industries, Water and Environment, Hobart.

DPIPWE (2005b) Leucopogon lanceolatus var. lanceolatus. Threatened Species Notesheet, Department of Primary Industries, Water and Environment, Hobart.


Nicole Gill and Katriona Hopkins

A survey was undertaken to determine the extent of boxthorn (*Lycium ferocissimum*) and pampas grass (*Cortaderia selloana*) on Flinders Island. These weed species were selected as mapping targets as knowledge of their distribution was needed to support any future control works. Both boxthorn and pampas were introduced deliberately to the island for primarily agricultural purposes.

Boxthorn control work has been undertaken both on the nearby offshore islands, and at strategic sites on the main island, mainly on coastal reserves, conservation areas and significant historical sites. Control on farmland, and on private land generally has not yet been undertaken by many landholders. Encouragingly, at least three local rural landholders have recently initiated significant control work.

Some control of pampas wildlings has been undertaken on public land, by the Parks and Wildlife Service and Flinders Island Council, as well as on private land, by concerned landholders. This has led to a reduction in the number of pampas windbreaks on the island, although pampas wildlings seem to be on the increase.

Several other notable weed species were observed during the survey, most surprisingly perhaps was Chilean needle grass (*Nassella neesiana*). Subsequent surveys have since found the species to be spread across approximately 500 hectares, with a core infestation of approximately 100 hectares.

INTRODUCTION

Publicly available information regarding weeds in general on Flinders Island is quite scant – much of what is known of the island’s weeds is held in the heads of a few people who work with them directly. Prior to this expedition, the online Natural Values Atlas (2012) held relatively few records detailing local weed infestations. There were only 174 records of weeds listed under the Tasmanian Weed Management Act 1999 recorded for the entire island (Natural Values Atlas 2012), which is a disproportionately low number for an area of this size. Of these records, only ten were for boxthorn, and just one was for pampas.

The scarcity of accessible, comprehensive mapping data poses a real problem for land managers, as this lack of information regarding the density and distribution of weed infestations on the island makes strategic planning and the accurate costing of control works difficult. This is not to say that the island’s weed problems are entirely unknown, or that there is a lack of interest in them at a community level – only that this information continues to be mostly and most reliably held in the heads of people who work or live on the island. Many efforts have been made at a local level to digitise some of this information, however a lack of clearly defined, easily accessible means of collating this information in a digital format, and the associated frustrations with often unreliable data interfaces has meant that much of this information has never made it beyond the maps and handheld devices of people working on the island.

The weeds specifically targeted by this survey trip, namely African boxthorn (*Lycium ferocissimum*) and pampas grass (*Cortaderia selloana*), were chosen for survey after consultation with land managers on the island, as well as experts off-island. The Furneaux Region Weed Strategy (Duncan 2002) identified both boxthorn and pampas as “priority weeds”. Pampas was tagged as being possible to eliminate from the...
island; boxthorn was identified as a weed requiring ‘long term management’ (Duncan 2002).

Target weeds – African boxthorn

African boxthorn (Lycium ferocissimum) is a large, woody, very spiky shrub, which was introduced to Australia in the 1800s for use in hedges and boundary fencing. Its hardiness, profligate seed production, swift growth rate and formidable spines have contributed to its invasive success and subsequent recent listing as a Weed of National Significance (WoNS). Boxthorn seeds (Figure 1) are very attractive to a number of animals, notably birds, which are capable of spreading them far from the parent plant. In the Furneaux islands, birds are the primary vector for boxthorn spread (Harris et al. 2001), and on Flinders Island itself currawongs appear to be the main species implicated in spreading this weed (Katriona Hopkins, pers. obs.).

Boxthorn was selected for survey because considerable, successful control work has been undertaken to control this weed on offshore islands. Also, as a prerequisite to develop a complementary control program on Flinders Island itself, a delimitation survey would be required.

The exact date of boxthorn’s introduction to Flinders Island is unknown. Boxthorn was introduced to nearby Goose Island at some stage during the construction of the island’s lighthouse, which began in the 1840s. Goose Island is thought to have been without trees, the boxthorn being planted to create windbreaks for the settlers, their livestock and gardens (Stanley 1991). On this island at least, boxthorn populations expanded sufficiently rapidly to provide fuel for fires to signal on-island emergencies to the main island, and it would not have taken long for birds to spread boxthorn seeds further afield.

It is uncertain when boxthorn was first intentionally introduced to Flinders Island itself, but there are some old, long-established shelterbelts to be seen about the island, most notably on farmland in the vicinity of Reids Peak – Barclay Hill, south of the Lady Barron Main Road, between Whitemark and Lady Barron.

Target weeds – Pampas grass

Pampas grass (Cortaderia selloana) is a tall, bushy grass, which can grow to three metres tall – six metres if the flower spikes are considered (Figure 2). This South American native came to Australia in the 1800s, and is thought to have been introduced primarily for agricultural purposes, for use as stock fodder and in windbreaks. The plants’ flamboyant plumes of feathery flowers also attracted the attentions of

Figure 1. Boxthorn fruit (photo: DPIPWE)
gardeners, with pampas being employed extensively in decorative plantings. It is these plumes of seeds which can make it such an aggressive invader (Parsons and Cuthbertson 2001).

Pampas grass is gynodioecious – that is, there are separate female and hermaphroditic or bisexual plants. For some time it was believed that pampas was prevented from naturalising in many areas due to most plants being female clones; the lack of hermaphroditic plants to pollinate them meant that they could only produce vegetatively from rhizomes (NSW DPI 2013). This appeared to be the case on Flinders Island for some time, but the presence of wildlings observed far from established plants indicates that has not been the case for some time.

Pampas was initially identified as a secondary mapping target, as it was uncertain whether access to the eastern, boggier sections of the island would allow us to map the wild populations there. It was identified as a potential mapping target as individual plants had been observed going wild outside the traditional boundaries of farm shelterbelts.

There is much conjecture regarding the introduction of pampas to Flinders Island. Many local landholders mention it being promoted by “the government” relatively recently, but no evidence of a specific government directive to plant this grass has been discovered in dedicated searches (Stephen Welsh pers.comm.).

There is anecdotal evidence from a number of sources that the then Forestry Department in the early 1980s propagated and sold the plants out of their Perth nursery, which were sold to landholders as effective windbreaks (Tim Duckett and Wayne Warren pers.comm.). The Furneaux Natural Management Strategy (Bayley 1999) mentions that it was recommended as a shelter plant by government agencies in the early 1990s. However, it is thought that pampas may have been present on the island as early as the 1960s, and suggested that the first plantings were likely those on and near Summer Camp Road, in the centre of the island, near Memana (Wayne Warren pers. comm.). Large areas of land were cleared on the island as part of the Soldier Settlement Scheme, and the subsequently harsh pastoral conditions (strong, salty winds, low rainfall, insect attack) made the hardy pampas grass a popular choice amongst farmers for shelterbelt plantings (Bayley 1999). Its swift growth, dense habit, potential

Figure 2. Pampas grass (photo: Amanda Smith)
for use as emergency fodder, and the fact that it was thought unable to reproduce by seed made it a very useful addition to the agricultural landscape, and it is still highly valued by many landholders on the island today.

There is no solid information on when the plants started to appear as wildlings outside the shelterbelt boundaries – the consensus seems to be that wildlings first appeared in significant numbers in the mid 1990s to early 2000s (Tim Duckett, Wayne Warren and Jamie Cooper pers. comm.). The first concrete evidence of a pampas wildling was submitted to the Tasmanian Herbarium by Tim Duckett in 1990. The specimen was taken from the eastern side of the island between Wingaroo Road and Foo Chow Inlet, and until this latest survey, was the only record on the Natural Values Atlas (2012) of pampas grass on the island.

By 1999, pampas was formally mentioned as a serious potential threat to the Flinders Bioregion. The Vegetation Management Strategy for Tasmania: Flinders Bioregion (DPIWE 1998, quoted in Bayley 1999) pointed out “a huge potential for pampas to spread into the large tracts of diverse native vegetation and habitat in the Darling Range and east coast heaths, forests, woodlands and wetlands. Isolated outbreaks have already occurred in these areas.”
METHODS

Prior to leaving for Flinders Island, a desktop assessment of known populations of the target weeds was conducted using the Natural Values Atlas (2012). A number of experts with experience on Flinders Island were also consulted.

Background information on the target weeds was collected from various published and unpublished sources. From these data sources, key areas of survey interest were identified, which essentially extended across most farmed areas of the island, and also included the lagoons and wetland areas of the eastern coast.

Due to time constraints, target areas were surveyed by vehicle, and in some cases, more thoroughly on foot. Waypoints of individual plants and easily accessible populations were captured on a handheld GPS. Where infestations covered larger areas and individual complexes were clearly visible on aerial photos, an approximate waypoint with a description of the population was taken for computer-based mapping later.

Data was compiled and mapped using Google Earth. In addition to the onground mapping, extra weed points and polygons from personal knowledge of the landscape were included in the maps.

RESULTS

Target weeds – African Boxthorn

Boxthorn infestations are generally centred on Flinders Island’s western farming areas (Figure 3). This survey resulted in an additional 163 records to the Natural Values Atlas.

Most of the mapped boxthorn was along the roads that stretch from Lady Barron in the south, north through Whitemark and Emita, to Palana on the island’s northern tip. This could bias the mapping, but also reflects the configuration of roads and farmland on the island, to which the boxthorn was initially introduced. Boxthorn infestations occur around the coastal strip as far north as Stanley Point, with significant infestations observed in the north at Killiecrankie and Leeka, and in the west and south at Wyabalonga, Trousers Point, and Cronleys Creek. It is likely that significant patches of boxthorn in the coastal strip went undetected by this survey, due to the inaccessibility of these areas within the time available.

Notable outliers of boxthorn included those mapped at the southern end of the island between Badger Corner and Lady Barron, which occur on farmland along the Coast Road. Also, those few plants observed within the Patriarchs Conservation Area near the hut, and at nearby Stony Lagoon, near South Patriarch. There was also a sizeable infestation in a paddock at nearby Memana, found east of Lackrana Road and adjacent to Leventhorpe Creek.

Target weeds – Pampas Grass

Most of the pampas populations recorded occurred south of Melrose Road, which runs east from near Emita to the farmlands of Memana. Fifty nine new pampas records were added to the Natural Values Atlas, where previously, there was only one record (Figure 4).
Figure 3. Boxthorn infestations recorded during the survey on Flinders Island (see the Natural Values Atlas for previous and newly added observations).
Figure 4. Pampas grass infestations recorded during the survey on Flinders Island (see the Natural Values Atlas for previous and newly added observations).
About two thirds of the pampas grass populations recorded were in farmland, and were present as deliberately planted shelterbelts (Figure 5).

The remainder were wildling records, self-seeded in areas outside grazing areas. Perhaps most concerning were those occurring in the often difficult to access areas of the eastern lagoons – near the Patriarchs at Stony Lagoon, and also south of these records near E-Shaped, Whitewash, and Sellars Lagoons.

**Opportunistic sampling – other weed species**

During the survey, many different weeds of environmental and agricultural significance were observed, and subsequently mapped. I mention only a handful of the most serious, or unusual, in this report.

Some of the notable species observed during this survey included Chilean needle grass (*Nassella neesiana*), narrow leaf cotton bush (*Gomphocarpus fruticosus*), tall wheat grass (*Thinopyrum elongatum*), sea wheat grass (*Thinopyrum junciforme*), African love grass (*Eragrostis curvula*), Japanese barberry (*Berberis thunbergia*), and karo (*Pittosporum crassifolium*).

**Chilean needle grass (*Nassella neesiana*)**

Chilean needle grass was discovered on the island, while visiting a known infestation of another weedy South American grass, espartillo (*Amelichloa cordata*). The Chilean needle grass was first noted co-existing...
with the espartillo on a roadside and adjacent paddock near Emita. On further inspection, it became apparent that there was a quite large population of this weed on site, with several hectares of infestation being visible from this vantage point alone.

**Narrow leaf cotton bush (Gomphocarpus fruticosus)**

Observations of this species were made on West End Road, and also at Palana in the north, and on the western coast at Whitemark and Trousers Point. None of the populations seen on Flinders Island were extensive.

**Tall wheat grass (Thinopyrum elongatum)**

Tall wheat grass was observed at just south of Blue Rocks on Palana Road, growing in a roadside ditch.

**Sea wheat grass (Thinopyrum junceiforme)**

Sea wheat grass was sighted on the beach, south of Whitemark.

**African love grass (Eragrostis curvula)**

A small, new infestation of African love grass was found on a laneway off Memana Road, near the Flinders Island Airport, not far from the previously known infestation.

**Japanese barberry (Berberis thunbergia)**

Japanese barberry was observed on the Samphire River, near Wallanippi Road, to the east of Strzelecki National Park.

**Karo (Pittosporum crassifolium)**

A single specimen of karo was observed on the beach near the jetty at Whitemark.

**DISCUSSION**

**Target weeds – African boxthorn**

Boxthorn is a common weed of agricultural situations on Flinders Island, where it may be seen invading paddocks, shelterbelts, and popping up along power-line easements. It is also a weed of more natural ecosystems, where it forms dense stands that exclude native flora and fauna, and is of particular concern where it infests breeding colonies of local seabirds, especially on the outer islands. As boxthorn forms dense stands, it invades native tussock grasslands, denying rookery habitat to species such as the short-tailed shearwater (also known as muttonbirds or moonbirds - *Puffinus tenuirostris*) and the Australasian gannet (*Morus serrator*). Boxthorn, like many shrubs, also impinges on suitable feeding and breeding habitat for the Cape Barren geese (*Cereopsis novaehollandiae*) and Pacific Gulls (*Larus pacificus*). Boxthorn spines have also been known to fatally impale adult and juvenile birds (Ziegler and Hopkins 2011).

Recent boxthorn control works on surrounding islands in the Furneaux group date back to 1989, when two full-time Aboriginal weed officers were employed for six months to remove boxthorn from Babel, Cat and Storehouse Islands (Connolly 2002). Works on various outer islands have been conducted sporadically ever since.

Most boxthorn control works have focussed on the outer islands, where this weed poses a serious threat to the viability of breeding shorebird colonies. On outer islands managed for conservation, these works have primarily been undertaken by the Friends of the Bass Strait Islands (FOBSI) Wildcare group. The Aboriginal community continues to undertake boxthorn control on some of their islands, most notably on Babel and Big Dog, and to some extent on Chappell. Members of Flinders Island Landcare initiated the boxthorn control on Roydon Island in 2006, which FOBSI has carried on since 2009.
The first concerted efforts to control boxthorn on Flinders Island itself began in 2002, when a Green Corps team was employed to conduct control works at Emita Beach, Lillies Bay and Fotheringate Bay, complementing volunteer works conducted around the same time on Cat and Chalky Islands. Since this time, the initial works have been followed up by FOBSI volunteers, and have been extended to treat plants at Settlement Point. Since 2002, these primary control works have been completed and followed up by FOBSI volunteers, and have also been extended to treat plants invading Flinders Island’s only ‘mainland’ muttonbird rookery at Settlement Point.

There are problems in removing boxthorn. On this windy island, many landholders value these plants as windbreaks on their properties. There are also often considerable physical difficulties in getting close to the stems of the plant to cut them back, and once this is achieved, the scattering of their thorns on the ground can cause punctures to vehicle tyres. Boxthorn seedlings pose a similar risk and as such, seedling regrowth is best removed rather than sprayed.
Target weeds – Pampas grass

Pampas grass is commonly observed within the shelterbelts of farming properties across the island, and is increasingly evident growing as wildlings in roadside reserves and areas of native vegetation on the island’s east coast. The lack of previous records on the Natural Values Atlas is unsurprising – pampas has largely been considered as a useful agricultural species until quite recently, and the sole previous record represented an isolated wildling sighted in 1990 between Wingaroo Road and Foo Chow Inlet.

Pampas wildlings have been controlled where observed on public land by Wayne Warren in his roles as Parks Assistant Ranger, and more recently as Flinders Island Council contract weed killer. Some private landholders have also begun removing their pampas shelterbelts, either doing the work themselves or employing a contractor to remove the plants. Although there are still a great many pampas windbreaks on the island, there were many more prior to farmers being alerted to the plant’s weediness in the 1990s (Wayne Warren pers. comm.).

Wildlings also occur in roadside reserves adjacent to shelterbelt plantings, but because Wayne Warren has sprayed these periodically in his role as contract weed controller, none were large enough to be noted during the Hamish Saunders Memorial Trust survey. Their presence has since been verified during ongoing roadside weed surveying, to be incorporated into ongoing weed mapping by Flinders Island Council.

The problems associated with the removal of pampas on farms are similar to those of boxthorn. Many landholders regard pampas windbreaks as assets on their properties – they can provide good shelter, and can be opened up to stock to provide emergency feed. It is understandable that graziers do not see pampas as a problem, at least on their own properties – any wildlings which may sprout there are usually swiftly eaten by grazing stock. There is also some resentment that a plant that they were encouraged to plant by government bodies is now a plant that they may be legally obliged to control.

Opportunistic sampling – other weed species

With the possible exception of Chilean needle grass, all of the species mentioned could be considered viable targets for eradication programs. It should be noted that none of these species were actively sought out – as such, the records collected should be considered indicative, rather than definitive, of their actual distribution.

Chilean needle grass (Nassella neesiana)

Chilean needle grass (Nassella neesiana) is a highly invasive grass, considered to be one of the greatest threats to Australia’s native grasslands. It can also be devastating to agricultural enterprises – its very sharp seeds can work their way into the wool and flesh of stock, injuring the animals, and significantly impacting on their market value (Victorian DPI 2007). Chilean needle grass tussocks grow to about 1 m in height, up to 1.5 m when flowering. This grass produces three types of seeds – as well as the regular panicle seeds, it also produces cleistogenes; hidden seeds, which are secreted within its stems, as well as at the base of the Chilean needle grass tillers near the roots. Superficially resembling many native Austrostipa grasses, it is distinguished from these by a distinctive corona of purplish brown hairs on the panicle seeds, which can be observed where the awn meets the seed (Figures 6 and 7).

Subsequent surveys by Kat Hopkins and Invasive Species Branch employees have mapped an island-wide coverage of approximately 500 hectares, restricted to the Emita area, and almost wholly within the boundaries of what was, until relatively recently, a single grazing property.
Narrow leaf cotton bush (*Gomphocarpus fruticosus*)

Narrow leaf cotton bush (*Gomphocarpus fruticosus*), is a perennial shrub, usually between half a metre and two metres tall. It bears distinctive balloon-shaped fruits with soft spines, and exudes a milky white sap when damaged. It is poisonous to both humans and livestock, can invade pasture, grasslands, open woodlands and riparian areas, and is capable of forming dense thickets, outcompeting surrounding plants. Narrow leaf cotton bush reproduces vegetatively by suckers, and also by seed. The fluffy white seeds are easily spread by wind or water, or travel as a contaminant in mud or agricultural produce (Parsons and Cuthbertson 2001).

On Flinders Island, narrow leaf cotton bush is locally known as swan plant or the ‘butterfly bush’. Previous herbarium records have been collected since 1993 in the vicinity of Memana, and on West End Road near Leeka.

This weed has previously been noted to be a weed of concern on Prime Seal Island (Harris et al. 2009). On Flinders Island, it is the host species of the exotic wanderer or monarch butterfly (*Danaus plexippus*), which suggests that the two species may have been introduced together. It is unknown how this plant came to the island, but it is most probable that it is a garden escapee – some older gardens on mainland Tasmania also feature this plant. Since this survey, a much larger infestation has since been located on Cape Barren Island.

Tall wheat grass (*Thinopyrum elongatum*)

Tall wheat grass (*Thinopyrum elongatum*) was introduced to Australia as a fodder crop and reclamation grass for areas affected by salinity, and is still employed for these purposes in some areas. It is a tall, stout, clumping perennial grass, usually growing to around a metre with clumps around 20 cm across, which prefers to grow in wet, saline, clay loams or clays which dry out in summer. Despite its uses in salt-affected areas, it is considered to be a serious weed of native wetland environments, which it can quickly come to dominate. When left unmanaged in pasture, its rapid growth and associated bulk can lead to it becoming a serious fire risk (Victorian DPI 2013).

It is likely that this plant is already widespread on the island as a pasture species – during this survey, its occurrence was noted only in passing. Due to its roadside placement, it is likely that it has been spread far and wide by slashing equipment, and may already pose a threat to the island’s wetland areas.
Sea wheat grass (Thinopyrum junceiforme)

Sea wheat grass (Thinopyrum junceiforme) is an invasive perennial grass from northern coastal Europe, which has become established along parts of the south-east Australian coastline. It grows to about 40 cm tall, has bluish-green leaves, and produces flowers that grow in a brittle spike, which readily breaks into segments upon maturity. Sea wheat grass also produces vigorous creeping underground stems, known as rhizomes, a growth habit that made it an ideal candidate for introduction as a sand-binder (Richardson et al. 2011). These same characteristics also make it an effective invasive pest plant.

Sea wheat grass has previously been reported on the island once before, at nearby Pats River, Whitemark Airport (Natural Values Atlas 2012), and is likely to be relatively widespread along the island’s coastline.

African love grass (Eragrostis curvula)

African love grass (Eragrostis curvula) is a long-lived, tussock forming grass, which can grow up to 1.2 m tall, and can aggressively invade both pasture and native vegetation. Often a weed of roadsides and other degraded areas, it is capable of quickly spreading into adjacent grassy vegetation types, especially those on sandy or rocky soils. While some variants of this plant have been cultivated as fodder for semi-arid areas, or as soil stabilisers, most of the invasive forms show low levels of stock palatability, and producing higher fuel loads than associated native vegetation, can pose a serious fire risk. It spreads by seeds, which are easily dispersed in soil or as a contaminant of agricultural produce. It is often spread by roadside slashing on contaminated machinery. African love grass seeds can also be spread by stock – cattle can excrete viable seed up to 10 days after consuming it (Land Protection 2006).

On Flinders Island, African love grass was previously recorded from a domestic yard south of the Roberts stockyards.

Japanese barberry (Berberis thunbergia)

Japanese barberry (Berberis thunbergia) is a spiny deciduous shrub that can grow to 2.5 m. It has pale yellow flowers and glossy, orange to red egg-shaped berries. These berries are edible, and favoured by birds and small mammals. Japanese barberry is often grown as an ornamental garden plant. It has recently been recognised as a problem invasive plant in the United States, where it is avoided by native grazers, allowing it to form dense thickets in native forests (University of Georgia 2013).

It is likely there is more of this weed growing elsewhere on the island, possibly within the confines of a local garden.

Karo (Pittosporum crassifolium)

Karo (Pittosporum crassifolium), a native of New Zealand, is a hardy small tree or large shrub, which may grow up to five metres tall. Karo is an early
colonizer, which is well adapted to high winds and salt spray. It bears leathery grey green leaves which are furry on their undersides, and its small red-purple flowers produce seed pods which split to reveal the sticky seeds characteristic of this genus. These seeds are easily spread by birds that are implicated in its spread outside its natural range in New Zealand, where it is considered a pest plant (New Zealand Government 2013).

It is possible that karo may have been planted on the beach at Whitemark by someone as part of a personal shoreline beautification project, though it is also conceivable that seed or plant material was washed up with storm-thrown flotsam. The potential ecological effects of the plant in Tasmania are unknown. However, karo is a noted weed on King Island, and is one of the featured weeds in their 2013 Weed Calendar.

This survey allowed for the collection of significant new information regarding the distribution of known weeds, as well as information about weeds previously unknown from the island, most notably the large population of Chilean needle grass.

The maps developed for boxthorn and pampas grass are indicative rather than comprehensive, and could form the basis for further searching and mapping. It is difficult to accurately gauge changes in distribution for boxthorn and pampas – anecdotal evidence suggests that pampas especially is spreading a lot quicker than previously anticipated.

The discovery of the Chilean needle grass in particular points towards a need for more regular surveys in flowering seasons – it is unlikely we would have found this weed were it not flowering. Its discovery also suggests that more weed education, especially as this relates to hygiene practices, could be very useful for council staff, Parks employees and landholders on the island. It is also important to note that at least one of the affected landholders had noticed this plant, realised that it was a problem, but not reported it, prior to our discovery of it on the island.
REFERENCES


Flinders Island Natural Values Survey 2012
Josephine Potter

During the Hamish Saunders Memorial Trust Survey on Flinders Island in December 2012, ten species of butterfly were recorded from various locations and habitats across the island, including one migratory species and one introduced species. One new species was recorded that had not been previously observed on Flinders Island, namely the fringed heath-blue butterfly (*Neolucia agricola insulana*). Additionally, indirect evidence was obtained for the occurrence of the Master’s skipper butterfly (*Hesperilla mastersi*), although further surveys are required to confirm the presence of this species. Regrettably, the threatened chaostola skipper butterfly (*Antipodia chaostola leucophaea*) was not recorded but it remains possible that it occurs on the island due to the presence of suitable habitat and further surveying is recommended.

**INTRODUCTION**

Limited data is available on the species of butterfly present on Flinders Island and their distribution across the island. The Butterflies of Australia reference books (Braby 2000a, b) make note of 12 species that have previously been recorded from the island by various researchers and only one species is currently recorded on the Tasmanian Natural Values Atlas (2012). However, 40 butterfly species are currently known from mainland Tasmania, of which six occasionally migrate from the Australian mainland, two of which are presumed extinct and one is an introduced species. So it is likely that more species are present on Flinders Island than have been tallied thus far. Additionally, due to the proximity of Flinders Island to mainland Australia, it is likely that some mainland butterfly species may be present on Flinders Island that are not found on Tasmania. An island-wide survey was undertaken in December 2012 across various habitats searching for a broad range of species.
particular interest was the chaostola skipper butterfly (*Antipodia chaostola leucophaea*) which is a threatened species on mainland Tasmania that has not previously been recorded from Flinders Island but which may occur there as suitable habitat is present.

**Species Descriptions**

**Monarch / Wanderer butterfly *Danaus plexippus***

Monarch butterflies are originally from America and are renowned for their vast migrations from North America down to South America and back again, often aggregating in huge groups in California and Mexico during winter (Braby 2000b). As the adult butterflies only live for a few months, the return trip generally takes several generations to complete. Monarchs are strong fliers and are believed to have naturally arrived in Australia in 1871 via Hawaii and New Zealand (Braby 2000b). The food plants for the larvae (swan plant, or narrow leaf cotton bush - see Gill & Hopkins, this report) had already been introduced to Australia by European settlers, which enabled the butterflies to colonise the country. They swiftly spread throughout Australia and were first recorded in Tasmania in 1878 where they have been uncommon migrants ever since, rarely breeding in the state (Couchman and Couchman 1977).

Monarch butterflies are large and strikingly patterned in orange with distinct black lines along the veins and around the edges of the wings (Figure 1). There are small white spots within the black wing margins and at the tips of the forewings. The underside is similar to the upperside but paler (Braby 2000b). The large larvae are distinctly striped in narrow bands of yellow, white and black. They have a pair of black antennae-like filaments at both ends of the body (Figure 2).
**Donnysa skipper butterfly** *Hesperilla donnysa aurantia*

Skippers are medium-size butterflies with stout bodies that fly quickly in a jerky manner making them appear to ‘skip’ over the vegetation. The males are territorial and often found on hilltops near the larval food plants waiting for females to fly past, while females generally stay low around the food plants. Skipper larvae build shelters in their grass/sedge food plant by joining several blades together with silk to form a tunnel to hide within. The larvae generally come out at night to feed (Braby 2000a).

Donnysa skipper is a common species in Tasmania and has previously been recorded on Flinders Island. It is geographically variable and has several subspecies, with *Hesperilla donnysa* subspecies *aurantia* exclusive to the Tasmanian region. The larvae are often found resting with their head facing upward in their shelter within the sedges *Gahnia radula*, *G. trifida* or *G. grandis* in a wide variety of habitats in Tasmania. The larvae are large, pale green with a dark green mid-dorsal line and an anal plate with small black or brown spots and white hairs (Figure 3). The head is light brown with a broad dark brown line along the top of the head tapering to a point, and narrow dark brown lines along the side of the head (Braby 2000a).

The adults are less commonly observed and have brown upper wings with large yellow patches, and beige on the underside with a series of small dots in a straight line on the hindwing (Braby 2000a).

**Chaostola skipper butterfly** *Antipodia chaostola leucophaea*

The chaostola skipper is an uncommon species that is endemic to Australia and has a disjunct and localised distribution in Victoria, Tasmania and NSW (Braby 2000a). A different subspecies is recognised from each State, and *Antipodia chaostola leucophaea* is exclusive to Tasmania where it is listed as an endangered species under the *Threatened Species Protection Act*.

*Figure 4. Chaostola skipper butterfly Antipodia chaostola leucophaea at Kingston, Tasmania (photo: Jo Potter)*

*Figure 5. Chaostola skipper butterfly Antipodia chaostola leucophaea underside at Kingston, Tasmania (photo: Jo Potter)*
The species has not been previously recorded from Flinders Island but appropriate habitat is present on the island.

The adults are medium-size skippers with brown wings containing cream patches (Figure 4). The adults can be identified by the underside of the hindwings which is purplish grey with large purple brown spots that appear smudged (Figure 5). The larvae live in Gahnia radula and are distinctive in that they are generally the only species that reside in their shelters with their heads facing downwards. The larvae are small and yellow-green and have a characteristic red prothorax directly behind the head (Braby 2000a).

**Master’s skipper Hesperilla mastersi**

The Master’s skipper is an uncommon species in Australia, and is believed to be extinct in Tasmania due to loss of habitat. This species has not previously been recorded from Flinders Island. Adults are stout-bodied, medium-size butterflies that are rarely seen. They have dark brown wings with orange and cream patches on the upperside, while the underside is chequered with light brown and cream markings. The larvae have previously been recorded living in swampy heathland in Tasmania on Gahnia radula in top opening shelters (Braby 2000a).

The larvae are greenish yellow with a dark line along the centre of the back edged by a white line on either side and a white line along the side of the body (Figure 6). The head is pale brown with a dark brown band along the top of the head and dark brown bands on either side of the head (Braby 2000a).

**Common brown butterfly Heteronympha merope salazar**

The common brown butterfly is distributed across south-eastern Australia and southern Western Australia. It is a common species in Tasmania, including King and Flinders Islands, and is often found in high numbers in grassy woodlands where it lays its eggs.
on native grasses, including *Poa* and *Themeda* (Braby 2000b). Three subspecies have been recognised for this species with *Heteronympha merope* subspecies *salazar* occurring in the Tasmanian region.

The adults are orange with dark brown markings and small eyespots on the corner of each wing (Figure 7). Colouration on the underside is more cryptic and butterflies at rest easily blend in with dead leaves in the litter (Figure 8). This species can be identified by the three small spots on the underside of the hind wing.

**Fringed heath-blue butterfly** *Neolucia agricola insulana*

The fringed heath-blue butterfly occurs across south-east Australia and Tasmania in heathlands where it lays its eggs on native pea plants belonging to the Fabaceae (Braby 2004). Three subspecies have been recognised for this species across its range, with *Neolucia agricola* subspecies *insulana* occurring in Tasmania. The fringed heath-blue has not been recorded from Flinders Island before.

The fringed heath-blue is a small, bronze brown butterfly with a brown and white chequered fringe around the edges of its wings. On the underside it has a pale grey and light brown pattern, with two dark brown V-shapes on the bottom of the hind wings and the chequered fringe around the outside of the wings (Braby 2000b) (Figure 9).

**Cabbage white butterfly** *Pieris rapae*

The cabbage white butterfly is originally from the Palaearctic Region of Europe, northern Africa and northern Asia and was introduced to Australia in the mid twentieth century after which it rapidly spread across the country and was first recorded in Tasmania in 1940 (Braby 2000a). This species has previously been recorded from Flinders Island. The cabbage white butterfly lays its eggs on plant species within the Brassicaceae which includes common garden
vegetables such as cabbages, broccoli and cauliflower, as well as a number of weeds and also some native species. This butterfly and its larvae are common in suburban gardens and farmland.

The cabbage white is a medium-size, white butterfly with black tips on the forewing and one or two central black spots on each wing. The underside forewings are white with pale yellow tips and two black central spots, while the hindwings are pale yellow (Braby 2000a) (Figure 10).

**Chequered blue butterfly** *Theclinesthes serpentata serpentata*

The chequered blue butterfly is found in wetlands and coastal dunes across south-eastern Australia and some pockets within Western Australia and central Australia. Food plants for the larvae include salt tolerant plants such as *Atriplex* spp. (saltbush), *Rhagodia* spp. (coastal saltbush), *Chenopodium* spp. (fat hen), and *Sarcocornia quinqueflora* (glasswort) amongst others. In Tasmania it only occurs in south-eastern saltmarshes, in the north-east and on Flinders Island (Braby 2000b).

The south-eastern population is recognised as the subspecies *Theclinesthes serpentata lavara* and is listed under the *Threatened Species Protection Act 1995* as a rare species, while the north-east and Flinders Island subspecies *Theclinesthes serpentata* subspecies *serpentata* is not listed as threatened.

Chequered blue butterflies are small and have brown wings that change to a purple-blue colour towards the body (Figure 11). The wings are fringed with a brown and white chequered pattern and have a short tail near the tip of each hindwing. The underside of the wings have a brown and white pattern, with a small dark brown spot near the tip of the hindwing and a chequered fringe around the outside of the wings (Braby 2000b) (Figure 12).

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**Figure 10. Cabbage white butterfly Pieris rapae underside** (photo: Jo Potter)

**Figure 11. Chequered blue butterfly Theclinesthes serpentata serpentata** (photo: Jo Potter)
Australian admiral butterfly *Vanessa itea*

The Australian admiral butterfly is found in a variety of habitats, preferring damp areas across south-eastern Australia and some pockets within Western Australia, Queensland and central Australia (Braby 2000b). The larvae feed mainly on nettles such as the native *Urtica incisa*, as well as introduced species such as *Parietaria deblis*. This butterfly is known from the Tasmanian mainland, as well as both King and Flinders Islands.

The Australian admiral is a medium-size butterfly with black forewings containing a distinctive large yellow band (Figure 13). The underside is a cryptic mottled brownish black with grey that assists the butterfly to avoid predators by camouflaging it to resemble a dead leaf.

Australian painted lady butterfly *Vanessa kershawi*

The Australian painted lady butterfly is known from a wide variety of habitats across most of south-western and eastern Australia including Tasmania, Flinders Island and King Island (Braby 2000b). It is a migratory species and large numbers of butterflies have been seen moving south from New South Wales along a front hundreds of kilometres wide. They have also been noted to migrate within Tasmania (Braby 2000b). The larvae mainly feed on native everlasting daisies such as *Xerochrysum bracteatum* (golden everlasting), *Ammobium alatum* (winged everlasting) and *Chrysocephalum* spp. as well as introduced species such as capeweed (*Arctotheca calendula*) and Scotch thistles (*Onopordum acanthium*) (Braby 2000b).

Australian painted ladies are a medium-size butterfly with blackish brown and light orange markings on the wings and four distinctive white dots at the tip of the forewing (Figure 14). They also have four black dots of which three have blue centres on the hindwing. The undersides of the wings are a lighter pattern of cream, yellow and brown (Figure 15).
The common blue butterfly is found in grassy areas throughout Australia including the midlands of Tasmania and Flinders Island. There are two subspecies, of which *Zizina labradus labradus* is the subspecies that occurs on Flinders Island and most of Australia. The larvae feed on a variety of native and introduced pea plants within the Fabaceae including *Lotus australis* (Australian trefoil), *Desmodium* spp. (tick trefoil), *Hardenbergia violacea* (purple coral pea), *Indigofera australis* (native indigo), *Cullen microcephalum* (dusky scurf pea) and *Pultenaea tenuifolia* (slender bushpea) among others. The larvae can also feed on introduced garden peas and beans (Braby 2000b).

Common blue butterflies are small and bluish-lilac in colour, with brown margins around the edges of the wings (Figure 16). The underside is pale grey with faint dark grey markings (Figure 17). These butterflies were recorded in large numbers on *Swainsona lessertifolia* (coast poison pea) at the edge of a grassy paddock on Agricultural land (TasVeg acronym FAG) where peas were present at Settlement Point. A single individual was also recorded in grass on a roadside clearing next to some Riparian scrub (SRI) on Darts Rd. It is likely that this species will occur in other places on the island where grass and pea plants coincide.

Other butterfly species

Other species of butterfly that have previously been recorded on Flinders Island are Klug’s xenica (*Geitoneura klugii*), chrysothrica skipper (*Hesperilla chrysothrica*), shouldered brown (*Heteronympha penelope*), meadow argus (*Junonia villida*) and Mathew’s blue (*Neolucia mathewi*) (Braby 2000b).
METHODS

The chaostola skipper butterfly was the main focus for the butterfly survey and is known to live in open eucalypt woodlands containing *Gahnia radula* (thatch saw-sedge) which is the foodplant and shelter for the larvae. A search of the Natural Values Atlas (2012) database was made prior to departure, to determine locations of *Gahnia radula* and open eucalypt forests around the island, and these areas were targeted and searched for chaostola skipper butterflies and larvae during the expedition.

A search was also undertaken for other butterfly species present on the island. A list of all butterfly species present in Tasmania was produced showing flight periods, food plants and vegetation types utilised for each species, whether the species had been recorded on Flinders Island before, and whether it was likely to be detectable on Flinders Island during the expedition due to the time of year (early December) and due to the habitat types present on the island. An attempt was made to search all habitat types required by the various species throughout the duration of the expedition in order to find the greatest number and variety of species present on the island. These searches were generally made on the way to or from chaostola skipper habitat sites. Table 1 lists the butterfly species previously recorded on Flinders Island.

Figure 16. Common blue butterfly *Zizina labradus* labradus (photo: Jo Potter)

Figure 17. Common blue butterfly *Zizina labradus* labradus underside (photo: Jo Potter)
Additionally, The Complete Field Guide to Butterflies of Australia reference book (Braby 2004) was used during the expedition to assist in identifying any unusual or morphologically similar species, as well as any not observed before, that may be Australian mainland species. Any species not able to be recognised in the field were collected and taken back to Hobart for further identification.

The locations of observed butterflies were recorded using a handheld GPS, the vegetation type was identified, as were any food plants that butterflies or larvae were feeding upon.

### RESULTS

Ten species of butterfly were recorded during the expedition, as shown in Table 2. Noteworthy was the discovery of a population of the fringed heath-blue butterfly (Neolucia agricola) which had not previously been recorded from Flinders Island. The type of habitat that each species was detected in was recorded (Table 2) and the distribution of the butterflies is shown on the map of Flinders Island (Figure 18).

Extensive searches for chaostola skipper larval shelters were undertaken in areas of previously recorded and observed *Gahnia radula* across Flinders Island and the presence or absence of skipper shelters was noted (Figure 19). Two types of hesperiid larvae were found on *Gahnia radula* plants within shelters constructed of sedge leaves, one type with its head facing upwards in its shelter, which is behaviour typical of the more common skipper species such as donnysa skipper (*Hesperilla donnysa*) and chrysotricha skipper (*Hesperilla chrysotricha*), and the other with its head facing down, which is characteristic of the endangered chaostola skipper. A larva of each type was collected for further identification in Hobart where it was confirmed that one larva had the characteristics of donnysa skipper; however, the other was unfortunately not chaostola skipper. The markings on the body of the second larva were more consistent with those of the Master’s skipper (*Hesperilla mastersi*), a species found on the Australian mainland, but which is now believed to be extinct on the Tasmanian mainland.

![Table 1. Butterfly species previously recorded on Flinders Island](image-url)

<table>
<thead>
<tr>
<th>Species name</th>
<th>Common name</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Danaus plexippus</em></td>
<td>Monarch or wanderer butterfly</td>
<td>(Natural Values Atlas 2011)</td>
</tr>
<tr>
<td><em>Geitoneura klugii</em></td>
<td>Klug’s xenica</td>
<td>(Braby 2000b)</td>
</tr>
<tr>
<td><em>Hesperilla chrysotricha</em></td>
<td>Chrysotricha skipper</td>
<td>(Braby 2000a)</td>
</tr>
<tr>
<td><em>Hesperilla donnysa aurantia</em></td>
<td>Donnysa skipper</td>
<td>(Braby 2000a)</td>
</tr>
<tr>
<td><em>Heteronympha merope</em></td>
<td>Common brown</td>
<td>(Braby 2000b)</td>
</tr>
<tr>
<td><em>Heteronympha penelope</em></td>
<td>Shouldered brown</td>
<td>(Braby 2000b)</td>
</tr>
<tr>
<td><em>Junonia villida</em></td>
<td>Meadow argus</td>
<td>(Braby 2000b)</td>
</tr>
<tr>
<td><em>Neolucia mathewi</em></td>
<td>Mathew’s blue</td>
<td>(Braby 2000b)</td>
</tr>
<tr>
<td><em>Pieris rapae</em></td>
<td>Cabbage white</td>
<td>(Braby 2000a)</td>
</tr>
<tr>
<td><em>Theclinesthes serpentata</em></td>
<td>Chequered blue</td>
<td>(Braby 2000b)</td>
</tr>
<tr>
<td><em>Vanessa itea</em></td>
<td>Australian admiral</td>
<td>(Braby 2000b)</td>
</tr>
<tr>
<td><em>Vanessa kershawi</em></td>
<td>Australian painted lady</td>
<td>(Braby 2000b)</td>
</tr>
<tr>
<td><em>Zizina labradus</em></td>
<td>Common blue</td>
<td>(Braby 2000b)</td>
</tr>
</tbody>
</table>
Table 2. Butterfly species recorded during the Hamish Saunders Memorial Trust Survey on Flinders Island, December 2012. Under the ‘Habitat’ column, acronyms refer to TasVeg categories. Note that the identification of the Master’s skipper has not been confirmed.

<table>
<thead>
<tr>
<th>Species name</th>
<th>Common name</th>
<th>Location</th>
<th>Coordinates</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Danaus plexippus</td>
<td>Monarch or wanderer</td>
<td>Butterfly Cove</td>
<td>570188E, 5582529N</td>
<td>Roadside weeds containing <em>Gomphocarpus fruticosus</em> (Swan plant)</td>
</tr>
<tr>
<td>Hesperilla donnysa aurantia</td>
<td>Donnysa skipper</td>
<td>Thule Rd, Melrose Rd</td>
<td>594130E, 5556118N, 584661E, 5572129N</td>
<td>Regenerating scrub on the side of the road next to eucalypt forest and agricultural land</td>
</tr>
<tr>
<td>Hesperilla mastersi?</td>
<td>Master’s skipper?</td>
<td>Thule Rd, Melrose Rd</td>
<td>595212E, 5556182N, 584581E, 5572144N</td>
<td>Regenerating scrub on the side of the road next to eucalypt forest and agricultural land</td>
</tr>
<tr>
<td>Heteronympha merope salazar</td>
<td>Common brown</td>
<td>Trousers Point, Fotheringate Beach, Strzelecki Track, Thule Rd, Manns Rd, Thule Rd, Thule Rd, Marshall Bay, Bob Smiths Gully, Walkers Lookout, Bluff Rd, Wireless Station Rd</td>
<td>587859E, 5546429N, 587464E, 5547595N, 589597E, 5548997N, 591020E, 5557701N, 595261E, 5557120N, 595212E, 5556182N, 595367E, 5558354N, 578889E, 5574779N, 595855E, 5550000N, 592697E, 5565318N, 585701E, 5560803N, 576288E, 5570647N</td>
<td>Variety of habitats including: Allocasuarina verticillata forest (NAV), <em>Melaleuca ericifolia</em> swamp forest (NME), Dry scrub (SDU), Subalpine <em>Diplarrena latifolia</em> rushland (MDS), <em>Eucalyptus viminalis</em>–<em>Eucalyptus globulus</em> coastal forest and woodland (DVC), <em>Eucalyptus viminalis</em> Furneaux forest and woodland (DVF), <em>Eucalyptus nitida</em> Furneaux forest (DNF), Agricultural land (FAG) and Regenerating cleared land (FRG)</td>
</tr>
<tr>
<td>Neolucia agricola insulana</td>
<td>Fringed heath-blue</td>
<td>Wingaroo</td>
<td>576239E, 5583343N</td>
<td>Coastal heathland (SCH)</td>
</tr>
<tr>
<td>Pieris rapae</td>
<td>Cabbage white</td>
<td>Marshall Bay</td>
<td>578889E, 5574779N</td>
<td>Roadside weeds on Regenerating cleared land (FRG)</td>
</tr>
<tr>
<td>Theclinesthes serpentata serpentata</td>
<td>Chequered blue</td>
<td>Fotheringate Beach, Killiecrankie Bay</td>
<td>587574E, 5547605N, 571284E, 5590266N</td>
<td>Coastal heathland (SCH)</td>
</tr>
<tr>
<td>Vanessa itea</td>
<td>Australian admiral</td>
<td>Manns Rd, Smiths Rd, Coast Rd</td>
<td>595367E, 5558354N, 595855E, 5550000N, 597581E, 5551222N</td>
<td>Melaleuca ericifolia swamp forest (NME), <em>Eucalyptus nitida</em> Furneaux forest (DNF), Agricultural land (FAG)</td>
</tr>
<tr>
<td>Vanessa kershawi</td>
<td>Australian painted lady</td>
<td>Wingaroo, North Patriarchs</td>
<td>576239E, 5583343N, 603747E, 5575256N</td>
<td>Coastal heathland (SCH) &amp; Freshwater aquatic herbland (AHF)</td>
</tr>
<tr>
<td>Zizina labradus labradus</td>
<td>Common blue</td>
<td>Settlement Point, Darts Rd</td>
<td>575212E, 5569164N, 600529E, 5547809N</td>
<td>Agricultural land (FAG), Riparian scrub (SRI)</td>
</tr>
</tbody>
</table>
Figure 18. Distribution of observed butterflies on Flinders Island during the expedition. See Table 2 for additional details.
Figure 19. The distribution of skipper shelters discovered on Flinders Island. Note sites that were searched but no identified shelters found are also depicted.
A male monarch butterfly was recorded at Butterfly Cove in roadside weeds in Regenerating cleared land (FRG) on West End Road. It was defending a patch of the weed Gomphocarpus fruticosus (swan plant), presumably waiting for a female monarch to arrive. A number of larvae were also observed at this site living and feeding on the swan plant.

Monarch butterflies are regarded as a rare migrant species to Tasmania and its islands as the food plants for its larvae are not naturally present. The species appears to be breeding at this site on Flinders Island due to the presence of the swan plant weeds.

A number of skipper shelters with the opening to the top were found in Gahnia radula and G. sieberana at several locations on Flinders Island. On Thule Road shelters were observed on foodplants in regenerating scrub cleared at the side of the road next to Eucalyptus nitida Furneaux forest (DNF) and Eucalyptus viminalis–Eucalyptus globulus coastal forest and woodland (DVC). On Melrose Road shelters were observed in remnant native vegetation growing along the roadside, surrounded on both sides by Agricultural land (FAG). A larva collected from Thule Road and later identified in the laboratory had the characteristics of a donnysa skipper larva.

Extensive searches for shelters were undertaken in areas of previously recorded and observed Gahnia radula across Flinders Island (Figure 3). Skipper shelters were more commonly observed at wetter sites where nearby plants were flowering, which would provide nectar to the emergent adults. A larva collected on Gahnia radula on Thule Road that was initially believed to be chaostola skipper, as the larva was facing head down in a bottom opening shelter, was later identified in the laboratory as having the characteristics of a Master’s skipper larva instead. Bottom opening shelters were also observed on Melrose Road (584581E, 5572144N) on Gahnia radula amongst native vegetation growing along the roadside, surrounded on both sides by Agricultural land (FAG). No larvae were collected from Melrose Road, so it is possible that chaostola skipper is present at this site and further investigation is warranted.

A larva collected on Gahnia radula on Thule Road and later examined in the laboratory had some of the characteristics of Master’s skipper. The shelters on Thule Road were observed in regenerating scrub cleared at the side of the road next to Eucalyptus viminalis–Eucalyptus globulus coastal forest and woodland (DVC) and the shelters on Melrose Road were observed in native vegetation growing along the roadside, surrounded on both sides by Agricultural land (FAG). This larva was initially believed to be chaostola skipper, as the larva was facing head down in a bottom opening shelter.

Numerous records were made of the common brown butterfly on Flinders Island where it is widespread and locally prolific. Vegetation types that the butterflies were observed in include Allocasuarina verticillata forest (NAV), Melaleuca ericifolia swamp forest (NME), Dry scrub (SDU), Subalpine Diplarrena latifolia rushland (MDS), Eucalyptus viminalis–Eucalyptus globulus coastal forest and woodland (DVC), Eucalyptus viminalis Furneaux forest and woodland (DVF), Eucalyptus nitida Furneaux forest (DNF), Agricultural land (FAG) and Regenerating cleared land (FRG).
**Fringed heath-blue butterfly Neolucia agricola insulana**

One fringed heath-blue butterfly was recorded on Flinders Island on flowers of Leptospermum scoparium (common teatree) in Coastal heathland (SCH) within the Wingaroo Nature Reserve at the northern end of the island. It is probably more widespread but sporadic across the heathlands of the island.

**Cabbage white butterfly Pieris rapae**

Two cabbage white butterflies were observed flying around roadside brassica weeds within Regenerating cleared land (FRG) on Palana Road alongside Marshall Bay on Flinders Island. This species is undoubtedly more widespread across the island in vegetable gardens and brassica crops.

**Chequered blue butterfly Theclinesthes serpentata serpentata**

Chequered blue butterflies were recorded within Coastal heathland (SCH) at two locations on Flinders Island. One individual was recorded at rest on a coastal currant bush (Leucopogon parviflorus) at Fotheringate Beach and four individuals were recorded on grey saltbush (Atriplex cinerea) at Killiecrankie Beach. It is likely that more populations occur in coastal heathlands across the island.

**Australian admiral butterfly Vanessa itea**

Australian admiral butterflies were recorded on the wing at several locations including within Melaleuca ericifolia swamp forest (NME) on Manns Road, within Eucalyptus nitida Furneaux forest (DNF) on Smiths Road and as roadkill on Coast Road surrounded by Agricultural land (FAG). It was also noted by other scientists across the island and is probably widespread in damp areas where the larval food plants occur.

**Australian painted lady butterfly Vanessa kershawii**

These butterflies were recorded flying in Coastal heathland (SCH) at Wingaroo and settled on Goodenia sp. (native primrose) in a Freshwater aquatic herbland (AHF) below the North Patriarchs. As they are a far-flying species known from a variety of habitats, it is likely that they occur in other parts of the island where daisies are present.

**Common blue butterfly Zizina labradus labradus**

These butterflies were recorded in large numbers on Swainsona lessertifolia (coast poison pea) at the edge of a grassy paddock on Agricultural land (FAG) where peas were present at Settlement Point. A single individual was also recorded in grass on a roadside clearing next to some Riparian scrub (SRI) on Darts Rd. It is likely that this species will occur in other places on the island where grass and pea plants coincide.

### DISCUSSION

Ten butterfly species in total were recorded during this expedition. Of the thirteen butterfly species that have previously been observed on Flinders Island, eight were recorded during this expedition and two additional species were identified that have not been recorded from Flinders Island before. The fringed heath-blue butterfly (Neolucia agricola insulana) is definitely present on the island - in Coastal heathland (SCH) at Wingaroo - and there is indirect evidence for the Master’s skipper (Hesperilla mastersi). Of the ten butterfly species observed during the expedition, one was an introduced species (cabbage white butterfly - Pieris rapae) and one is considered to be a rare migrant (monarch butterfly – Danaus plexippus).

While eight of these species had been observed on the island previously, all but one had not previously been recorded on the Natural Values Atlas (2012),
Tasmania’s online database for flora and fauna records. The majority of the previous records were accessible only in reference books.

As the expedition took place over a week in early December it is highly likely that other species of butterfly that fly at different times of the year were not detected during this survey. This includes species such as Klug’s xenica (Geitoneura klugi), which flies from December to April but was not yet present during the survey, and the shouldered brown butterfly (Heteronympha agricola), which flies from January to April. Other species such as the chrysothrica skipper (Hesperilla chrysothrica) are difficult to detect in their adult form as they fly rapidly close to the ground. It is easier to find larvae of this species in their shelters, generally on Gahnia filum near the coast or in saline areas; however, none were detected during this survey. Additionally, species such as Mathew’s blue butterfly (Neolucia mathewi) are very localised in their distribution and so may have been overlooked during this broadscale survey, as it was not possible to check every patch of habitat.

One migratory butterfly species which occurs on mainland Australia was identified; namely, the monarch butterfly (Danaus plexippus). Larvae of this species were also detected on the island, confirming that this species is breeding on the island and therefore not continually dependent on migration from mainland Australia. It is likely that other butterfly species would sporadically blow down to Flinders Island on strong northerly winds. Butterfly species that might be expected to be rare migrants to Flinders Island include the long-tailed blue (Lampides boeticus), the lesser wanderer (Danaus chrysippus), the varied eggfly (Hypolimnas bolina), the caper white (Belenois java) and the yellow albatross (Appias paulina).

The occurrence of the endangered chaostola skipper butterfly (Antipodia chaostola leucophaea) was suggested on Flinders Island by the discovery of downward opening larval shelters on Gahnia. However, the larva that was collected and later examined had the characteristics of a Master’s skipper butterfly (Hesperilla mastersi) rather than a chaostola skipper. It is unusual for other skipper species to rest with their heads facing downwards in their shelters, but it is known to occasionally occur (Phil Bell pers. comm.). There were several locations where downward facing shelters were recorded on the island and a larva was only collected from one location. So, it is possible that chaostola skipper exists in one of the other locations and further investigation is warranted.

Although the larvae collected and examined in the laboratory were deemed to have the characteristics of donnysa skipper and Master’s skipper larvae, this identification is not conclusive, as the descriptions of larvae in the available butterfly literature are not detailed or systematic. Thus, although it is likely that these larvae represent these species, further investigation on Flinders Island is required, including targeted searches for the adults during their flight season. The presence of Master’s skipper on Flinders Island would be an exciting discovery, as this species is believed to be extinct on the Tasmanian mainland.

Whilst surveying Flinders Island a European wasp (Vespula germanica or V. vulgaris) nest was noted at Lillies Beach (573251E, 5569494N). This is of concern because introduced wasps have been having a large impact on native invertebrate populations, including butterflies, wherever they have been introduced worldwide (Beggs et al. 2011). Not many European wasps were seen on the island and it is recommended that wasp numbers be kept at a minimum in order to protect the diverse invertebrate fauna on Flinders Island. An effective control method is the eradication of nests by qualified persons using appropriate safety procedures.

Phytophthora cinnamomi (root rot) is present in the native vegetation on Flinders Island and appears to becoming more widespread, which may have a
secondary impact on the butterflies of the island. Some species of plants, including those in the Fabaceae (pea) and Epacridaceae (heath) families are particularly susceptible to root rot and the larvae of some species of butterfly feed solely on plant species from these families. If these plants become less abundant, then it is likely that butterfly numbers will consequently also drop. If there is a widespread loss of the larval food plant, or a change in habitat due to root rot, it is likely that localised extinctions of butterfly populations may also occur. Susceptible butterfly species include the fringed heath-blue butterfly (Neolucia agricola insulana) and the common blue butterfly (Zizina labradus labradus) whose larvae feed on species of native pea, and Mathew’s blue butterfly (Neolucia mathewi) whose larvae feed on species of native heaths such as Monotoca elliptica (tree broomheath). It is recommended that the spread of root rot be reduced where possible to lessen the impact on susceptible vegetation types and subsequently on the butterfly species that require these plants in order to complete their life cycle.

Clearing of native vegetation for agriculture, housing or other developments can also have an impact on butterfly species by removing or severely reducing their habitat. If habitat is reduced then butterfly numbers will also be reduced and localised extinctions may occur in some locations. It is recommended that any vegetation clearing be undertaken in a sustainable manner and that enough native habitat be retained for butterflies to persist, as well as other native fauna species.

This survey has added to the knowledge of species of butterfly present, their habitat and their distribution across Flinders Island. It is hoped that this information will assist in planning and carrying out sustainable development on the island.

REFERENCES


Clare E. Hawkins

Two species of burrowing crayfish are known on Flinders Island. One of these, the Furneaux burrowing crayfish, is found only on small, higher altitude areas on Flinders and Cape Barren Islands, and is listed as a threatened species due to its tiny geographic range. This species would benefit greatly from further survey effort. A small contribution towards this was made during the present study, which identified the Furneaux burrowing crayfish in an additional area - Costers Gully in the Strzelecki National Park. This work found the species at the lowest altitude yet recorded, at 115 m above sea level. A trap was trialled and not found to be effective, although further trials of slightly different designs may yet prove successful. Management recommendations for this species are to continue with the survey work and to control this species’ key threats – most importantly, high intensity or overfrequent fire in its habitat, much of which is likely to constitute long term refugia worth protecting for a range of species and vegetation types. The species depends on the maintenance of damp soil. The action of pigs in the area may both dry out soil and kill crayfish, and so pig eradication is also likely to benefit this species. Contrary to earlier expectations, the current climate change predictions in the area do not necessarily indicate a negative impact on the species. A long term monitoring programme is recommended to ensure that conservation efforts are worthwhile and effective.

INTRODUCTION

Tasmania’s burrowing crayfish

Tasmania is home to a rich and diverse group of freshwater crayfish, comprising more than 30 species in 5 genera. These range from the world’s largest - the giant freshwater crayfish (Astacopsis gouldi), weighing up to 6 kg - to a genus of burrowing crayfish, Engaeus, which typically reach a maximum length of 10 cm. Three genera - Astacopsis, Ombrastacoides and Spinastacoides, comprising 18 species - are found only in Tasmania. The other two - Engaeus and Geocharax - are also found on the mainland but nowhere outside Australia.

The Engaeus genus displays remarkable diversity across the relatively small geographic area over which it occurs. As the world’s most terrestrial crayfish group, some species can live independently from running water, relying solely on run-off. Fifteen species have been identified in Tasmania, mostly in the north and west of the state. Thirteen occur only in Tasmania, while two also exist in Victoria. Each species has slightly different habitat requirements so that although a couple of different species may be found on the one property, they will inhabit specific areas depending on water flow, soil type, vegetation and degree of habitat disturbance. Tasmania is thus characterised by a jigsaw pattern of distinct and interlocking ranges for individual species of burrowing crayfish. Overlap between species does occasionally occur, but is not common. Whilst some species appear to be very robust and found over wide areas, others have very limited distributions.

As a consequence of their restricted distributions, combined with other factors such as loss of habitat and environmental degradation of water catchments, five Engaeus species are listed as threatened - at State, Commonwealth and international levels - and are the focus of a recovery plan (Doran 2000).
All Engaeus crayfish are highly specialised, living in burrow systems in muddy banks, seepages and peaty areas. They construct characteristic ‘chimneys’ made from balls of mud placed at the entrance of their burrow (Figure 1). These may range from just a few mud pellets or a structure to 40 cm in height. While most freshwater crayfish live in flowing water, burrowing crayfish live their entire life within their burrow systems, only venturing out occasionally at night and in damp, overcast conditions. Like all crayfish, these species are dependent on water to breathe. Typically their burrows reach down to the water table; over the summer period when the water table drops, they will follow it down through well established tunnels, sometimes to depths of 2-3 metres.

Burrows can be simple and shallow or complex, deep and extensive, and can often be the product of several generations of crayfish families’ digging activity. They may be directly connected to streams or lakes, may connect to the water table, or may simply rely on run-off to stay wet. Reliance on water availability varies with species, and the burrow type reflects this. Species which are less dependent on flowing water - and which therefore can only disperse at times when water is flowing - tend to have more restricted ranges.

Tasmania’s freshwater crayfish can be distinguished by the orientation and shape of their claw, the size of the grooves along their body and the location and number of spines on their body. As they are typically...

Figure 1. Crayfish ‘chimneys’ at burrow entrance (photo: Jo Potter)
Engaeus species have much reduced tails. Unlike the other Tasmanian crayfish, they open their claws vertically rather than horizontally to the body, allowing for larger claws in the confined space of narrow tunnels. They vary in colour from orange to reddish brown, grey-blue and purple.

During the breeding season (late spring to summer) females carry large orange eggs and recently hatched young under their tail. They generally eat decaying organic matter in the soil, such as rotting leaves and twigs but will supplement their diet with occasional small worms or grubs.

Burrowing crayfish make an important ecological contribution. In the various habitats they occupy, they play a major role in soil turnover, nutrient recycling, drainage and aeration, and provide access to the soil for other soil-dwelling species.

An introduced species of yabby, Cherax destructor, has been recorded on mainland Tasmania, but not on Flinders Island. It is important for a number of reasons to avoid bringing this species to the island. Cherax destructor has the potential to outcompete native crayfish, and to carry disease and parasites harmful to them. It can degrade the natural habitats of native species by destroying aquatic vegetation and by increasing water turbidity. Its burrowing activity can also damage farm dam walls and irrigation channels. The introduced yabby has been listed as a ‘controlled fish’ on the Inland Fisheries Act (1995).

The underground lifestyle of burrowing crayfish means that they are extremely difficult to study without disturbing them. As a result there is still much to learn on the life history and requirements of the different species.

**Burrowing crayfish on Flinders Island**

Two species of burrowing crayfish have been recorded on Flinders Island.

*Engaeus cunicularius* The commoner species is *Engaeus cunicularius* (it does not have a common name). A dull brown, relatively large crayfish, males can grow up to 33 mm in carapace length, and females up to 30 mm carapace length (Horwitz 1990). (The carapace is the part of the crayfish’s shell that covers the head and central section of the crayfish, above the tail. It typically takes up approximately half of this species’ body length). This species has one of the largest recorded geographic ranges of the Tasmanian *Engaeus* crayfish (Richardson et al. 2006): at 6 525 km² across the Bass Strait Islands and northern Tasmania, or more than 291 000 km² if its range in Victoria is also included (Doran & Horwitz 2010). Most commonly found in the flat lowland areas of the Bass Strait islands of Flinders, Cape Barren and King Island, appearing to be less abundant in northern Tasmania (Doran & Horwitz 2010a). It typically lives in creeks 1.5-2 m wide and up to 0.5 m deep, with vertical banks at least 0.5 m high. Its burrows are found close to the junction of the banks and the creek (Suter 1977).

The species has been listed under the International Union for the Conservation of Nature’s Red List as Least Concern, on the basis of its large geographical range, local abundance and lack of major threats or significant declines. However, a need for monitoring of this species has been identified because it could come under threat from climate change in future (Doran & Horwitz 2010a).

*Engaeus martigener* Furneaux Burrowing Crayfish

The only other burrowing crayfish known on Flinders Island is the Furneaux Burrowing Crayfish (*E. martigener*). Slightly smaller than *E. cunicularius*, *E. martigener* males reach up to 25.1 mm in carapace length, females up to 25.3 carapace length (Horwitz...
The colour of this species varies, but a distinctive purple hue frequently predominates.

It is most commonly found in boggy habitats, along seepage lines and beside small clear water creeks in higher altitude temperate wet fern gullies (Horwitz 1990, Doran & Richards 1996), as well as in poorly drained mossy tea-tree bogs and small grassy spring/soaks in open dry eucalyptus forests at lower altitudes (Doran 2000). The burrows may have more than one opening. The species appears to breed in November and December (Horwitz 1990, Doran 2000).

**Features distinguishing the two species and their ranges**

The two crayfish can be distinguished by the presence of a patch of setae (looking like a patch of moleskin, or just mud) at the base of the fingers of the claw in *E. cunicularius*, and by the presence of pores on the lateral processes of the sternal keel at the third pereiopods in *E. cunicularius*. By contrast *E. martigener*, in addition to its colour, can be recognised from the characteristic little ‘paintbrushes’ of bristles all over its main front claws (see Figures 4, 5 and 6 in the Results).

Survey work indicates that *E. martigener* has the smallest recorded geographic range of the Tasmanian *Engaeus* crayfish species (Richardson et al. 2006), at 15.1 km² (area of occurrence) or 0.18 km² (area of occupancy), though this work has not been comprehensive. It has been found only on two Furneaux group islands: in the region of Mt. Strzelecki and the Darling Ranges on Flinders Island, and in the higher, fern-rich gullies of Mt. Munro on Cape Barren Island.

There is a transition from *E. martigener* to *E. cunicularius* at lower altitudes, although the altitude at which this transition occurs varies with region. Although not yet identified, points may exist where the lowland species (*E. cunicularius*) and the highland species (*E. martigener*) overlap. Inferring altitudes by applying the coordinates of Natural Values Atlas (2012) records (primarily provided by Niall Doran) to 1:25 000 digitised maps, it appears that *E. cunicularius* has been found at 115 m above sea level (asl) at Butcher’s Peak (east of Mt. Strzelecki) and at 65-280 m asl around the Darling Ranges. On the mainland, around Korumburra, *E. cunicularius* has been found at altitudes of up to 350 m asl (Doran & Horwitz 2010a). The Natural Values Atlas (2012) records indicate that *E. martigener* has been found as low as 135 m asl at Butcher’s Peak, at 500-730 m asl on Mt. Strzelecki and at 210-360 m asl around the Darling Ranges. There thus appears to be the potential for overlap at least in the 200-300 m asl range around the Darling Ranges.

**Conservation status and recommendations for the Furneaux burrowing crayfish**

The Furneaux burrowing crayfish is listed as Vulnerable under Tasmania’s Threatened Species Protection Act 1995, as Endangered under the Commonwealth’s Environment Protection and Biodiversity Conservation Act 1999, and as Endangered on the International Union for the Conservation of Nature’s Red List (IUCN 2012). These threatened listings are on the basis of its extremely small extent of occurrence and area of occupancy, the small number of its populations, and its potential for decline due to the presence of threats in its range.

Densities are considered to be quite high where habitat is high quality, so - depending on the extent of this habitat - the overall population has been estimated at between 22 000 and 142 000 adults (Doran 2000).

However, the extremely restricted range of the species leaves it vulnerable to a range of potential risks.

The principal threat to the Furneaux Burrowing Crayfish is wildfire, which has the potential to wipe out large tracts of the species’ fire-sensitive habitat.
After a fire - and especially after intense or repeated fires - the resulting loss of shade and moisture means that the soil will dry out, which the species cannot survive. The soil itself may also be at risk if the retaining vegetation is burnt, given the erosion-prone nature of the ferny, wet gullies that this crayfish occupies. Loss of similar habitat to fire and drought has been observed on Deal Island (Doran 2000). High levels of fuel exist throughout the Strzelecki National Park, and the lack of access for fire control means that high intensity burns are a real possibility.

Conversely, inappropriate fire regimes also have the potential to pose a threat. While the species appears to survive one-off, low-intensity fires associated with hazard reduction or regeneration fires, the species is very susceptible to high-intensity or frequent fires. For example, frequent burning of gullies on Cape Barren Island could significantly reduce habitat quality by drying it out.

For this reason, prescriptions generated by Threatened Species Section (2010) to secure this species identified the need for a fire management education campaign for Cape Barren Island, and to ensure that the Flinders Island fire management plan avoided burns at sensitive times or too frequently.

The species is also vulnerable to extended periods of drought - in the past these have caused much of its habitat to dry up, reducing habitat quality while increasing the risk of severe bush fires. Some level of fern die-off has been observed under previous drought conditions on Flinders Island (Doran 2000).

Other factors identified as known or potential threats include predation by feral pigs or foxes. With the Natural Values Atlas (2012) holding only a single record of a fox sighting on Flinders Island, there is no indication that foxes are a current threat. Pigs, however, are well established, and considered to be a potential threat, especially in areas with shallow soils where the crayfish can be readily caught. Pigs may impact the species by their substantial turning over of soil, uprooting the moss beds, root mats and other vegetation around burrows, thereby drying out burrows. Crayfish may also be crushed or eaten during these activities.

A recommended action by Threatened Species Section (2010) was to adhere to the feral pig management plan, and include these areas where crayfish are vulnerable.

**Climate change**

All burrowing crayfish have been identified as potentially at risk from climate change if it results in reduced rainfall and less water in their environment. The additional aspect of increased temperature might also appear a special threat to *E. martigener*, since it is only found on the upper slopes of mountains.

Primarily for this reason, *E. martigener* was identified as one of the few species considered not possible to reliably secure from extinction in the wild, in an exercise to identify threatened species recovery action priorities in Tasmania (Threatened Species Section 2010). Recommendations in the face of the threat of climate change included the drastic action of translocation to the Tasmanian mainland (i.e. under specified triggers for this action), although it was considered that this might not be successful.

Other work by the Climate Futures for Tasmania project, however, indicates that prospects are not so definitely poor for this species.

If damp soil is the critical requirement for persistence of *E. martigener*, then the long term survival of this species may not be compromised by climate change. Rainfall intensity and associated flooding is projected to increase across Tasmania, albeit with longer dry periods in between heavy downpours. For Flinders Island, the expected increase in rainfall in combination with a small increase in evapotranspiration is...
predicted to result in an increase all year round for run-off (ACE CRC 2010a).

While temperatures are expected to rise, it is not clear that this change alone will affect the species. On Flinders Island, temperatures are predicted to rise by up to 3˚C over the next 100 years (ACE CRC 2010b). Given that *E. martigener* is consistently found at higher altitudes than *E. cunicularius*, it is possible that it might be sensitive to a temperature increase. However, an analysis of Tasmanian burrowing crayfish ranges found no association with current climate measures (Richardson et al. 2006). Many species’ ranges may have been affected long ago by factors such as glaciation, and, for those species which disperse less easily, may have remained relatively unchanged.

Equivalent information on changes in fire risk is not currently available, and this may be the critical issue for the species, since wildfire is already considered its principal threat. The increase in run-off might reduce fire-risk, but alternatively the combination of increased rainfall and more extreme weather days (ACE CRC 2010c) might result in a higher fuel load and greater risk.

The changes could also cause problems to the species in less direct ways, such as through overall surrounding vegetation changes, or as a result of deeper creeks within the habitat. The increase in run-off could perhaps result in damaging soil erosion in the gullies that *E. martigener* occupies, leaving insufficient burrowing habitat.

As a general conclusion, our current information does not yet indicate that climate change is a certain death knell for *E. martigener*. However - as for all species - plenty of uncertainties still remain. The increase in run-off could conceivably result in problematic soil erosion over the long term. Evapotranspiration data are currently quite limited, and it is difficult to estimate accurately the impacts of extreme weather days. Both droughts and floods could impact on the species if prolonged. Perhaps most significantly, too little is known about fire risks, and about such species’ responses to such a substantial temperature increase, for a confident conclusion at this stage.

**The need for additional survey work**

*E. martigener* has only been surveyed at quite a coarse scale (Doran 2000). The range boundaries for the species are not exactly known, and the quality and quantity of habitat within its range is also poorly understood. There have been repeated calls for additional survey effort on Flinders Island and Cape Barren Island (e.g. Doran 2000; Doran & Horwitz 2010b).

There are several reasons to survey the species more intensively, in terms of improving the effectiveness of any management actions.

Most significantly, it is important to understand where this species lives, so that management actions can be targeted appropriately. Otherwise there is a risk that habitat hosting high densities of crayfish could be lost. In particular, if the key areas of high quality habitat were mapped, these could be identified as a priority for fire management, for example through the Parks and Wildlife Service’s Bushfire Risk Assessment Model (BRAM) (Parks & Wildlife Service 2011; Taylor & Wallace 2011).

The known areas of high quality habitat for *E. martigener* have several characteristics of refugia (Brown 2010). Areas such as montane gullies are likely to provide their resident flora and fauna with run-off water and nutrients, and to protect them from all but the most intense fires. The location of such areas of Tasmania has been identified as a priority (Heller & Zavaleta 2009; Brown 2010), in that they may be important for maintaining resilience, flexibility and adaptability for native vegetation and flora in the face...
of climate change and related stresses.

Further, a number of factors are perceived to threaten the species, but their potential impact is not well understood. If baseline data on distribution and relative densities is available, then areas subsequently affected by one of the perceived threats can be revisited to assess the impact. This information would guide decisions on the level of effort appropriate to devote to managing each threat in terms of its significance to conserving the species overall.

In particular, it is important to understand whether or not on-ground efforts to conserve this species have the potential to counter the effects of climate change. Improved baseline data on the species’ distribution and densities would provide the opportunity for subsequent monitoring to measure the extent of these effects on the species.

Survey work is also required to better assess population size and thereby conservation status. It remains possible that more detailed information on the species’ range would indicate that the species would be more suitably listed as Vulnerable rather than Endangered, again assisting decision-makers with regard to the level of effort required to conserve it effectively. As stated above, depending on the extent of high quality habitat, the species could number anywhere between 22,000 and 142,000 adults (Doran 2000).

More generally, in order to monitor for any change in the status of *E. martigener*, its range and the types of potential sites available for long term monitoring need to be better understood (Doran 2000). It has also been suggested that such work would contribute more generally in monitoring habitat and climate changes, in that burrowing crayfish are likely to be very sensitive indicators of these (Doran & Horwitz 2010a).

### Aim of the present study

Only a brief survey period was available for the present study, so the aim was simply to survey a patch of potential habitat outside the known geographical range, with a view to improving range boundary information.

An additional aim was to trial a crayfish trap, found to be effective for Scottsdale burrowing crayfish (*E. spinicaudatus*) (Niall Doran pers. comm.), with the potential to facilitate future survey effort.

### METHODS

An area of Strzelecki not previously surveyed was selected: Costers Gully, approximately 5 km southeast of the peak of Strzelecki.

The presence of crayfish burrow entrances, often with their raised ‘chimney’ of surrounding mud, indicate that the species may be present at a site. However, definitive identification is only possible through examination of the animal itself.

The conventional method to identify burrow occupants is through excavation of the burrow. Chimneys were dug out in the hope of capturing the crayfish for identification purposes. In all cases, care was taken to restore the earth back into the form of a burrow after the disturbance. There are some drawbacks to this method, however: it can be very time-consuming in the case of deep burrows; it is very difficult and destructive in the case of burrows among tree roots; it can also put the animal at some risk, especially where those with less experience are carrying out the digging. For these reasons, other methods were also used.

A trap found to be successful for the Scottsdale burrowing crayfish, *E. spinicaudatus* (Niall Doran pers. comm.) was trialled for this species (Figure 2). This
comprised a plastic food storage pot (9 cm deep by 11 cm diameter at the top) containing a little water, placed in the ground beside a burrow entrance, so that its opening was level with the ground surface, with a 1 cm cube of salami suspended by wire across the top. Fifteen traps were set for a single night by burrows at various altitudes in the area, five traps being set on 5th December 2012 and the rest on 8th December 2012.

The area was also generally searched for signs of crayfish, on the substrate and under logs and rocks.

RESULTS

Chimneys were found in all the areas where the traps are indicated in Figure 3. Within most of these areas, there was a high proportion of thickly rooted soil which made it difficult to excavate a chimney. It was generally possible to find a chimney to excavate within a few tens of metres, but approximately 60% of these excavations were unsuccessful in locating a crayfish.

Five specimens were identified by creeks along Costers Gully, within 600 m of one another, as detailed in Table 1 and Figure 3. Both a live specimen and a single claw were found in one location, at Flinders Island.
Table 1. Details of five crayfish specimens identified in December 2012 at Costers Gully, Flinders Island. Altitudes are inferred from identifying the nearest contour line to the observations’ coordinates (recorded by GPS), read from a digitised map.

<table>
<thead>
<tr>
<th>Species Name</th>
<th>Altitude (m)</th>
<th>Identification method</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Engaeus cunicularius</em></td>
<td>112</td>
<td>Claw</td>
</tr>
<tr>
<td><em>Engaeus cunicularius</em></td>
<td>112</td>
<td>Live specimen found beside trap</td>
</tr>
<tr>
<td><em>Engaeus martigener</em></td>
<td>115</td>
<td>Claw</td>
</tr>
<tr>
<td><em>Engaeus martigener</em></td>
<td>145</td>
<td>Claw</td>
</tr>
<tr>
<td><em>Engaeus martigener</em></td>
<td>145</td>
<td>Live specimen dug from burrow</td>
</tr>
</tbody>
</table>

Figure 3. Locations of traps and burrowing crayfish identified during the present study.
145 m asl (the most westerly location). Specimens are shown in Figures 4, 5 and 6.

Both new and earlier records are shown in Figure 7. The new records of *E. martigener* are 1780 m from the nearest previous record.

Extensive pig damage was noted in the general area.

**DISCUSSION**

**Range and altitudinal boundary**

The present study has slightly extended the known range of *Engaeus martigener*, both geographically (by 1.8 km from previous records), and also altitudinally.

In Costers Gully area, the altitudinal boundary between the two crayfish species was lower than recorded elsewhere, with *E. martigener* located as low as 115 m asl and *E. cunicularius* not found above 112 m asl. *E. martigener* has not been identified below 135 m asl previously.

While these range extensions are small, it is notable that they were identified through only a small amount of survey effort - further highlighting the value of continuing additional survey work.

**Trap trial**

The 15 trap nights failed to capture any crayfish, but this was a fairly small-scale trial. There may still be some value in trialling slightly different designs and baits, to facilitate the identification of crayfish in areas which are difficult to dig and to reduce risk of injury to crayfish where surveyors are not highly experienced in burrow excavation.

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*Figure 4. Furneaux burrowing crayfish Engaeus martigener. Visible on its body are temnocephalan flatworms and eggs. These have a commensal (i.e. benign, non-parasitic) relationship with burrowing crayfish (photo: Clare Hawkins)*
Figure 5. Engaeus cunicularius (a) entire individual (b) close-up of diagnostic claw features (further information on this within the text, under ‘Features distinguishing the two species and their ranges’ in the Introduction) (photo: Clare Hawkins)
Figure 6: Claws collected during the present study: (a) claws of Engaeus martigener (b) claws of E. cunicularius (photos: Clare Hawkins)
Figure 7. Records of burrowing crayfish on Flinders Island. Note that other records of Engaeus martigener exist on Cape Barren Island, while E. cunicularius is also found on mainland Tasmania and mainland Australia. ‘New’ observations originate from the present study, while the rest are taken from the Natural Values Atlas (2012).
REFERENCES

ACE CRC (2010a) Climate Futures for Tasmania water and catchments: the summary. Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania.

ACE CRC (2010b) Climate Futures for Tasmania general climate impacts: the summary. Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania.

ACE CRC (2010c) Climate Futures for Tasmania extreme events: the summary. Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania.


Amphibian surveys on Flinders Island were conducted over a five-night/six-day period. Amphibians were recorded at 13 sites distributed in varied habitats throughout Flinders Island. All species found by call and/or visual surveys have previously been recorded on the island. Surveys were designed to target the threatened green and gold frog (*Litoria raniformis*), in keeping with the threatened species trip focus. No *L. raniformis* were found during the survey period despite multiple night surveys. Chytrid fungus (*Batrachochytrium dendrobatidis*) is present on Flinders Island and has potential to impact susceptible amphibians. Whilst no further chytrid distribution surveys were undertaken, samples were taken to isolate the Flinders Island strain of chytrid fungus and compare it to mainland Tasmania and mainland Australian strains.

Recommended actions, to reduce the risk of spread of pathogens such as chytrid to new areas within Flinders Island, and the risk of introduction of new pests, weeds and pathogens onto the island, are based on biosecurity measures. Intra-island biosecurity recommendations include control or eradication of pigs and cleaning of personal gear and vehicles when travelling to remote or reserved areas. Inter-island biosecurity recommendations include ensuring livestock, vehicles, freight and personal gear are as clean as possible before travel to the island. To conserve *L. raniformis* on Flinders Island, it is also critical to protect and maintain appropriate pond and wetland habitat into the future.
disease caused by chytrid fungus (*Batrachochytrium dendrobatidis*). *L. raniformis* is known to be moderately susceptible to infection by this fungus (Voyles et al. 2010).

Chytridiomycosis has been implicated in amphibian declines and extinctions globally on all continents where amphibians occur (Berger et al. 1998; Lips et al. 2006; Skerratt et al. 2007), and is thought to be the most significant disease affecting the biodiversity of vertebrates in human history (Skerratt et al. 2007). In mainland Australia, chytridiomycosis has been implicated in the extinction or disappearance of seven amphibian species to date and the decline of many more (Murray et al. 2011b; Schloegel et al. 2006; Skerratt et al. 2007, Berger et al. 1998).

The Australian Chytridiomycosis Threat Abatement Plan aims to restrict the spread and impact of the pathogen (DEH 2006). The Tasmanian Chytrid Management Plan (Philips et al. 2010) similarly aims to restrict the spread and impact of chytrid fungus in Tasmania. It assesses the risk that chytridiomycosis poses to Tasmania’s amphibian species and recommends various management actions, which are currently being developed, guided by monitoring of at-risk species (Philips et al. 2010).

The aim of the present survey was to determine the presence/absence of *L. raniformis* on Flinders Island during a one week period in December 2012. A second aim was to isolate a Flinders Island strain of chytrid fungus, to compare with Tasmanian and Australian mainland strains.

**METHODS**

Flinders Island supports a range of vegetation communities and associated ponds, dams and wetlands suitable for the pond-breeding target species, *L. raniformis*. An initial scoping period identified a combination of historic sites (Natural Values Atlas 2012), possible sites based on local reports, and likely habitat including wetlands with emergent vegetation. Sites selected for repeat surveys included the only historic site that still exists as a waterbody (Patriarchs Lagoon), farm dams, ponds and troughs based on local observations, and sites within the more remote wetlands of Wingaroo Nature Reserve.

Amphibian call surveys were conducted for at least 5 minutes at night over the five night survey period. Opportunistic day time call observations were also recorded. Day and night visual observations of frogs or tadpoles were recorded. Nocturnal call surveys were conducted at selected sites repeatedly over three nights to be 95% confident of *L. raniformis* absence during the late spring-summer period of maximum detectability (Scott Cashins pers. comm.).

Chytrid fungus samples were collected from tadpole mouthparts at known chytrid positive sites from previous surveys (Figure 1). Samples were stored refrigerated or on ice and sent to laboratories at James Cook University for chytrid strain isolation and virulence studies.

Strict field hygiene practices (Phillott et al. 2010) were followed; after visiting sites all gear and equipment was thoroughly cleaned and soaked for three minutes in 4 ml per litre (1:250) F10 Super Concentrate Disinfectant, which is known to kill chytrid fungus (Webb et al. 2007).
Figure 1. Flinders Island amphibian survey locations, December 2012. Chytrid records based on 2009 survey (Natural Values Atlas 2012) and Litoria raniformis historic records (Natural Values Atlas 2012).
RESULTS

Three amphibian species were recorded in various combinations at 12 sites, distributed in varied habitats throughout Flinders Island; L. ewingi, L. dumerili, and C. signifera (Figure 1, Table 1). No L. raniformis were recorded during the survey period despite multiple night surveys.

A Flinders Island chytrid fungus strain has been isolated, though details are not yet available as laboratory studies comparing mainland Australian and Tasmanian chytrid strains and virulence were still in progress at the time of writing.

DISCUSSION

Amphibian surveys

The three species recorded over the surveys period; L. ewingi, L. dumerili, and C. signifera are all commonly found on mainland Tasmania and mainland Australia. L. ewingi and C. signifera appear to be resistant to chytrid fungus and are reservoir species able to transmit infection to susceptible species (Philips et al. 2010). The absence of the three other species previously recorded on Flinders Island, L. tasmaniensis, P. semimarmorata, and L. raniformis (Natural Values Atlas 2012) during the survey period, does not indicate with any degree of confidence that these species are truly absent. A more likely explanation is that environmental conditions during the one-week survey period, and overlap of the survey period with breeding season timing were not ideal to facilitate calling in these species.

Table 1. Amphibian and chytrid results and survey methods. Chytrid records based on 2009 survey (Natural Values Atlas 2012).

<table>
<thead>
<tr>
<th>Date</th>
<th>Site Easting</th>
<th>Site Northing</th>
<th>Species</th>
<th>Chytrid status</th>
<th>Survey method</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/12/2012</td>
<td>590771</td>
<td>5543427</td>
<td>Litoria ewingi (tadpole), Limnodynastes dumerili (tadpole), C. signifera (tadpole &amp; calling)</td>
<td>Positive</td>
<td>Visual survey, call survey</td>
</tr>
<tr>
<td>4/12/2012</td>
<td>589458</td>
<td>5586802</td>
<td><em>Crinia signifera</em> (metamorphs)</td>
<td>Unknown</td>
<td>Visual survey</td>
</tr>
<tr>
<td>5/12/2012- 9/12/2012</td>
<td>585622</td>
<td>5585558</td>
<td>L. ewingi (calling), L. dumerili (tadpole &amp; calling), C. signifera (calling)</td>
<td>Unknown</td>
<td>Visual survey, call survey</td>
</tr>
<tr>
<td>5/12/2012- 9/12/2012</td>
<td>585217</td>
<td>5585302</td>
<td>L. ewingi (calling), L. dumerili (tadpole &amp; calling), C. signifera (calling)</td>
<td>Unknown</td>
<td>Visual survey, call survey</td>
</tr>
<tr>
<td>5/12/2012- 9/12/2012</td>
<td>586808</td>
<td>5558582</td>
<td>L. ewingi (calling), C. signifera (calling)</td>
<td>Unknown</td>
<td>Call survey</td>
</tr>
<tr>
<td>5/12/2012</td>
<td>577818</td>
<td>5572330</td>
<td>C. signifera (calling)</td>
<td>Unknown</td>
<td>Call survey</td>
</tr>
<tr>
<td>5/12/2012- 9/12/2012</td>
<td>603195</td>
<td>5571922</td>
<td>L. ewingi (calling), L. dumerili (calling)</td>
<td>Unknown</td>
<td>Call survey</td>
</tr>
<tr>
<td>9/12/2012</td>
<td>590793</td>
<td>5554967</td>
<td>L. ewingi (tadpole and frogs)</td>
<td>Unknown</td>
<td>Visual survey, call survey</td>
</tr>
<tr>
<td>9/12/2012</td>
<td>589329</td>
<td>5547121</td>
<td>L. ewingi (calling), C. signifera (calling)</td>
<td>Unknown</td>
<td>Call survey</td>
</tr>
<tr>
<td>9/12/2012</td>
<td>589090</td>
<td>5547982</td>
<td>C. signifera (calling)</td>
<td>Unknown</td>
<td>Call survey</td>
</tr>
<tr>
<td>9/12/2012</td>
<td>595239</td>
<td>5553273</td>
<td>L. ewingi (calling), C. signifera (calling)</td>
<td>Unknown</td>
<td>Call survey</td>
</tr>
<tr>
<td>9/12/2012</td>
<td>600444</td>
<td>5552924</td>
<td>L. ewingi (calling), L. dumerili (calling)</td>
<td>Unknown</td>
<td>Call survey</td>
</tr>
</tbody>
</table>
On mainland Tasmania, *L. raniformis* is more likely to call over the period November to February (Wilson *et al.* 2010a). In Victoria, *L. raniformis* calls regularly from January to March (Heard *et al.* 2006). On Flinders Island, *L. raniformis* may be most similar to the Victorian model, more likely to call from late summer to early autumn. The relatively dry conditions that prevailed during the survey period in combination with the early summer timing probably explains the absence of *L. raniformis* call records over the survey period. *L. raniformis* appears to be still present on Flinders Island; a resident recorded calls on the south coast of the island later in December after rain (new Natural Values Atlas record).

The relatively low number of observations and records of *L. raniformis* on Flinders Island, however, suggest that this species occurs at few sites within a relatively small area on the south of the island. The reason for their decline here, as elsewhere in Tasmania and Australia, is probably a combination of drought combined with habitat destruction and modification, and chytridiomycosis (Heard *et al.* 2011). Management strategies to mitigate the decline of *L. raniformis* are discussed below.

Transmission of chytrid fungus and other pathogens and weeds

Whilst a Flinders Island chytrid strain has been isolated, pathologists are yet to determine the degree of similarity to mainland Australia and mainland Tasmanian strains. Once determined, this will indicate whether chytrid fungus was brought to Flinders Island from mainland Tasmania or mainland Australia. In either scenario, chytrid fungus probably came to Flinders Island either with a stowaway frog, or in mud or water brought to the Island on vehicles, livestock or personal gear. This highlights the importance of effective biosecurity to reduce the likelihood of transmitting other strains of chytrid, and other pathogens and weeds onto and within Flinders Island to protect valuable species such as *L. raniformis*.

Pigs appear to travel quite extensively on Flinders Island, with many pig tracks noted particularly in the south and east of the island (pers. obs.). Whilst native animals and livestock can transmit pathogens and weeds with mud, introduced animals, such as pigs, can travel extensive distances and are therefore easily able to transmit pathogens and weeds over long distances on the island. Control or eradication of pigs on Flinders Island would not only mitigate direct damage they cause to vegetation and waterbodies, it would greatly reduce pathogen and weed transmission opportunities.
REFERENCES


Sally Bryant and Matthew Webb

A survey of Planter Beach from Cameron Inlet to Sellars Point in December 2012 identified 91 individual shorebirds including five species and 12 breeding territories. Hooded plover (*Thinornis rubricollis*), red-capped plover (*Charadrius ruficapillus*) and pied oystercatcher (*Haematopus astralegus*) were confirmed breeding and two hooded plover nests were found. These results confirm the findings of previous surveys of this area and support the conclusion that Planter Beach is one of the most significant beaches on Flinders Island for conserving resident shorebird species.

INTRODUCTION (EXTRACT FROM BRYANT 2002)

Shorebird Breeding Habitat Requirements

Every species of shorebird that breeds in Tasmania requires specific conditions which may vary between species and between sites. Shorebird nests are a simple shallow scrape or depression in the sand or on the ground, usually with little or no nesting material. Nests are situated just above the high tide mark or on raised banks or dunes. Eggs are exposed in the nest but are well camouflaged by colour and pattern. Nests invariably are in the open affording the adult bird full view of the surroundings and any approaching threats. Shorebirds are usually long-lived species and pairs are monogamous with high site fidelity.

The red-capped plover (*Charadrius ruficapillus*) has the most flexible breeding requirements in Tasmania, from the margins of salt and freshwater lagoons and from sea level to the high altitude lakes of the Central Highlands. The hooded plover (*Thinornis rubricollis*) breeds on oceanic sandy beaches and spits, above the high tide mark and often on the widest expanse of sand. This species maintains a territory (an exclusive zone) which can be up to several hundred metres in length. Pied oystercatchers (*Haematopus astralegus*) breed on ocean beaches or very occasionally around the shores of larger river estuaries. This species breeds at four years of age and pairs defend their territories for much of the year; and are faithful to the same sites year after year. The nest site is frequently within a few metres of the high tide mark on a raised area of sand, saltmarsh or shell. Sooty oystercatchers (*Haematopus fuliginosus*) breed mainly on rocky coasts around offshore islands above the high tide mark and mostly on shingle or gravels.
Feeding and Roosting Habitat

At regular periods throughout the day and night, shorebirds (particularly migratory species) feed on intertidal mudflats and beaches which are exposed at low tide and then roost (rest) at high tide just above the water level. These habitats are rich in invertebrates and shorebirds have developed a variety of techniques (and beak shapes) enabling their extraction, e.g. probing deep into the substrate, hunting under or in-between beach strewn debris or gathered from the surface.

Diet comprises limpets, snails, bivalves, crustaceans, sandhoppers and other amphipods, worms and sea squirts. The feeding habitat for many migratory species is typified by an elevation above mean low water of no more than 10% of area ‘high and dry’, at least 50% of area ‘wet’, no more than 50% of area ‘shallow’ (to 50 mm deep) and no restriction on tidal flow. Landform and vegetation surrounding feeding sites also influence the location and use of high tide roost sites.

Human Associated Impacts

Human associated activities which threaten shorebirds include the increasing demand on coastal areas for recreation and exploitation especially during summer (i.e. the breeding season). These activities include for example, beach walking and recreation, exercising dogs (on and off lead), driving vehicles (4WDs, quad bikes and other off-road vehicles) on beaches, feral and domestic animal disturbance and predation (e.g. stock grazing on coasts, dogs on beaches, feral cats, etc.).

Other human associated impacts include depleted food supplies through fishing, harvesting of seaweed and shore bivalves, sand mining, urban encroachment and coastal subdivision, changes in habitat particularly dune formation due to weeds like marram grass (Ammophila arenaria), rice grass (Spartina anglica) and sea spurge (Euphorbia paralias), pollution from sewage effluent, industrial and agricultural runoff, oil spills and heavy metal accumulation. Interfering with the natural flow of rivers also threatens the existence and natural integrity of sandbars and spits used for breeding. The impact of these activities on shorebirds are widely known and occur not just in Tasmania but nationally and internationally (Higgins et al. 1996; Bryant 2002, Spruzen et al. 2006, Kirkwood & O’Connor 2010, Woehler & Ruppolo 2010).

Aim of Survey

This survey was undertaken during the period of the Hamish Saunders Memorial Trust Survey, to assist the Tasmanian Parks and Wildlife Service in their assessment of an application seeking to use quad bikes along Planter Beach from Cameron Inlet towards Sellars Point. The survey aimed to:

1. determine whether Planter Beach contains breeding habitat for shorebird species;
2. identify the shorebird species using this stretch of beach; and
3. review the potential impact of vehicle use on shorebirds.
Figure 1. Location of shorebird breeding territories along a section of Planter Beach (from Cameron Inlet to Sellars Point) (1:25000 TASMAP series).
METHODS

Planter Beach was surveyed from Cameron Inlet to Sellars Point on 4 December 2012. The authors walked along the waterline or below the strandline to identify shorebirds in wet and dry sandy habitat up to the edge of the foredune. All birds were counted and their territory boundaries mapped using GPS. Territories were defined as the point where the birds stopped moving in front of the observer and returned to their territory by either doubling back along the foredune or by flying back over water. Breeding habitat was defined as being at least 4 m of sandy beach available between the foredune and the high tide mark (strandline). Limited nest searching was undertaken due to the disturbance to potentially nesting birds.

RESULTS

A total of 91 individual shorebirds were counted along 11.8 km of beach walked. Total counts were a minimum, because during the breeding season one bird will often remain low on the nest or crouching behind debris while its pair acts as a decoy. Five shorebird species were identified, of which three species were confirmed or suspected as breeding. No small terns or migratory shorebird species were seen. No banded or flagged birds were seen.

Table 1. Shorebird species and breeding territories on northern Planter Beach, 4 Dec 2012.

<table>
<thead>
<tr>
<th>Breeding territory</th>
<th>Easting</th>
<th>Northing</th>
<th>Hooded Plover</th>
<th>Red C Plover</th>
<th>Pied O’C</th>
<th>Other Species</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>Start</td>
<td>0609702</td>
<td>5563756</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Cameron Inlet, vehicle tracks at entry point</td>
</tr>
<tr>
<td>1</td>
<td>0609672</td>
<td>5564502</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1 Caspian flying</td>
<td>Vehicle tracks on high dune, limited breeding habitat</td>
</tr>
<tr>
<td>2</td>
<td>0609691</td>
<td>5564629</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Red-caps agitated. Limited breeding habitat</td>
</tr>
<tr>
<td>3</td>
<td>0609499</td>
<td>5567227</td>
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<td>-</td>
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<td>-</td>
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</tr>
<tr>
<td>5</td>
<td>0609202</td>
<td>5569350</td>
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<td>2</td>
<td>1</td>
<td>-</td>
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<tr>
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<td>0609203</td>
<td>5570635</td>
<td>5</td>
<td>14</td>
<td>3</td>
<td>-</td>
<td>Extensive breeding habitat, 2 HP nests found</td>
</tr>
<tr>
<td>7</td>
<td>0609222</td>
<td>5570898</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
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<td>-</td>
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<td>-</td>
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</tr>
<tr>
<td>10</td>
<td>0609780</td>
<td>5573894</td>
<td>4</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>Good breeding habitat</td>
</tr>
<tr>
<td>11</td>
<td>0610010</td>
<td>5574544</td>
<td>11</td>
<td>-</td>
<td>5</td>
<td>1 Sooty O’C on water line</td>
<td>Good breeding habitat. Pair of Pied O’C defending nest site</td>
</tr>
<tr>
<td>Sellars Point</td>
<td>06100</td>
<td>5575200</td>
<td>7</td>
<td>2</td>
<td>6</td>
<td>-</td>
<td>Extensive breeding habitat</td>
</tr>
<tr>
<td>Total</td>
<td>11.8 km</td>
<td>47</td>
<td>20</td>
<td>22</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Species Identified

- Hooded plover *Thinornis rubricollis*
- Red-capped plover *Charadrius ruficapillus*
- Pied oystercatcher *Haematopus australis*
- Sooty oystercatcher *Haematopus fuliginosus*
- Caspian tern *Sternula caspia*

Breeding Status and Territories

All shorebirds were either in pairs or in small groups of between two to five birds, which is indicative of breeding behaviour (i.e. pair of adults with fledglings from the previous season) and not post-breeding flocking or non-breeding congregations.

A total of 12 breeding territories were mapped along the length of the beach up until Sellars Point (Figure 1). Sellars Point is a large expansive area of suitable breeding habitat which was surveyed by walking three transects bisecting a central point to the coast.

Table 1 shows the species’ abundance in each breeding territory, and their breeding status, with brief notes on the suitability of the stretch of beach for breeding. The availability of breeding habitat changed continuously along the coast due to numerous indentations and blowouts. Several blowouts were checked for birds but none were found.

Two hooded plover nests were found, both nests were initially identified with attendant adults (Figure 2). Neither nest contained eggs. One pair of red-capped plovers were deemed breeding due to their agitated behaviour (head bobbing, drooped wing display) and one pair of pied oystercatchers by their alarm calls, repeated swooping and immediate return to their flushed location. No other nests, eggs, chicks or sub-adult birds of any species were seen.

Numerous vehicle tracks were observed at the entry point at Cameron Inlet and these extended along

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Figure 2. (a) Hooded plover nest and (b) vehicle tracks above high tide mark on Planter Beach (photos: Sally Bryant)
Planter Beach, including above the high tide mark, for several kilometres (Figure 2).

In 2008, Woehler (2008) completed a shorebird survey of the coast of Flinders Island including the same stretch of Planter Beach. Table 2 compares the results from each survey.

**DISCUSSION**

The east coast of Flinders Island is an interconnection of freshwater and saline wetlands, lagoons, vast tidal mudflats and sandy beaches, all of which provide a rich network of breeding, roosting and foraging sites for shorebird species (Bamford et al. 2008, Woehler 2008, Kirkwood & O’Connor 2010, Woehler & Ruppolo 2010). Within this vast complex are key sites such as Logan Lagoon Conservation Area (Ramsar site), Cameron Inlet, Patriarch Inlet and the many coastal beaches and inlets connecting them. The findings of this survey further support Flinders Island being a very significant site for shorebird conservation in Tasmania.

The identification of 91 individual shorebirds including five resident species and 12 breeding territories along 11.8 km of Planter Beach from Cameron Inlet to Sellars Point is significant for shorebird conservation. The shorebird species identified and their relative densities are consistent with the findings of Woehler (2008) and further support that Planter Beach is one of the most significant stretches of coastline for breeding shorebird species on Flinders Island and in Tasmania. A comparison of total numbers of hooded plovers and pied oystercatchers between 2008 and 2012 suggest that the population of these two species on Planter Beach has remained relatively stable (Woehler 2008, Table 7). In contrast, the smaller number of red-capped plovers found in this study compared to Woehler may be due to either more birds sitting tight on nests during the survey and therefore not seen, or, a real decline in numbers. This discrepancy requires further investigation as it may represent a decrease in red-capped plover population size due to human induced disturbance.

The use of vehicles on beaches is known to impact on breeding shorebirds through destruction of nests, loss of eggs and chicks. After hatching, chicks and pre-fledged young feed on the waterline and are prone to disturbance or death from vehicles driving above high tide or on the waterline. Shorebirds are long-lived species with high site-fidelity; hence, they persist in an area for long periods even when their breeding productivity is being seriously impaired. If threats continue unabated then the species will decline and local extinction can occur. The observation of vehicle tracks along Planter Beach is consistent with the findings of Woehler (2008) and confirms the ongoing potential for vehicles to cause serious risk to shorebird productivity. Any increase in vehicle use would exacerbate this impact and threaten the conservation status of these species. The only period when vehicle impact has reduced impact is during the winter period (from April to August) by driving

<table>
<thead>
<tr>
<th>Shorebird Species</th>
<th>This survey (2012, 11.8 km)</th>
<th>Woehler (2008, 12.4 km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hooded plover</td>
<td>47 (3.98 birds / km)</td>
<td>52 (4.19 birds / km)</td>
</tr>
<tr>
<td>Red-capped plover</td>
<td>20 (1.69 birds / km)</td>
<td>68 (5.48 birds / km)</td>
</tr>
<tr>
<td>Pied oystercatcher</td>
<td>22 (1.86 birds / km)</td>
<td>23 (1.85 birds / km)</td>
</tr>
<tr>
<td>Sooty oystercatcher</td>
<td>1 (0.08 birds / km)</td>
<td>0 (0.00 birds / km)</td>
</tr>
<tr>
<td>Caspian tern</td>
<td>1 (0.08 birds / km)</td>
<td>0 (0.00 birds / km)</td>
</tr>
</tbody>
</table>
on the waterline. The national trend is to legislatively prohibit any vehicle use on beaches and support this restriction with community awareness and education about shorebird conservation.

REFERENCES


The endangered forty-spotted pardalote is found only in Tasmania. Its status on Flinders Island was poorly known, but increasing evidence has emerged of its severe decline there. In 2010 and 2011, only one colony could be found, containing less than 20 birds. The key aims of the present study were to re-confirm the status of this colony, re-survey other areas and develop recommendations for the species’ recovery. Surveys were carried out across seven days in December 2012, in the Darling Range, Broughams Sugarloaf and Strzelecki range areas. The findings confirmed that the Flinders Island population of the forty-spotted pardalote is at a critically low level, with high probability of local extinction of the Darling Range and Broughams Sugarloaf colonies. A small number of individuals (including a single breeding record) were observed around the Costers Gully and Big River Valley areas of the Strzelecki range.

Swift parrots were also observed breeding in Costers Gully – significantly these are the first formal breeding records for this species on Flinders Island.

Pig damage was widespread in the Strzelecki Range area, resulting in significant soil disturbance, loss of understorey species and a lack of regeneration of forty-spotted pardalote habitat trees.

Recommendations to address these issues include the urgent progression of a management plan, including a translocation protocol. Other recommendations include work to improve our understanding of the factors limiting the current population, as well as protection of habitat from the obvious threats of fire and feral pigs.

INTRODUCTION

The forty-spotted pardalote (Pardalotus quadragintus) is a small passerine (perching bird) and one of four pardalote species in the family Pardalotidae. All pardalotes are similar in appearance and have rounded wings, short tails, and plumage characterised by spots or streaks and bright red or yellow markings. Typically insectivorous birds, pardalotes occur in dry sclerophyll forests and woodlands across Australia, but the forty-spotted pardalote is only known from Tasmania.

This species now occurs in only a few small areas of dry forest that contains white gum (Eucalyptus viminalis) trees, on which it depends. The most recent overall population estimate is of around 1500 individuals (Bryant 2010), and the forty-spotted pardalote is listed as Endangered under both State and Commonwealth legislation.

The distribution and status of the forty-spotted pardalote on Flinders Island has been poorly known since the species was first identified there in 1901 (LeSouf 1902; Green 1969, 1971). The species was probably reasonably widespread based on the historical distribution of white gum (Eucalyptus viminalis) habitat across the island. By the 1970s, the species had obviously declined and could only be found in a small localised patch of white gum forest at Bob Smiths Gully in the Mileara Valley (Milledge 1980). In 1985, after extensive surveys across the island, a colony containing 10 to 15 pairs of birds was found between Walkers Lookout and Lucks Hill, in the Darling Range (Brown 1986). In 1994 another site containing two more colonies was found, 7 km to the east of Walkers Lookout in the Broughams Sugarloaf area (Bryant 1997). By this time the Bob Smiths Gully colony could no longer be detected and in 1997 the status of the species on Flinders Island was estimated at 70 birds in three colonies occupying 300 ha (Bryant 1997).
Severe wildfires swept across central Flinders Island in 2002-2003, and post fire surveys failed to detect the forty-spotted pardalote in either the Darling Range or Broughams Sugarloaf area (Bryant 2005). It was noted at the time that small patches of white gum habitat remained intact and that these could have provided some refuge. Due to growing concern about the species precarious status, surveys were undertaken in 2010 and 2011 to once again systematically survey all areas containing white gum habitat and revisit the colony sites. Despite best efforts no birds were identified in the Darling Range, Broughams Sugarloaf, Bob Smiths Gully or areas searched previously by Brown in 1985. Fortunately, in 2010 one small colony was found on a sweeping bend intersecting Costers Gully and Fannings Creek, in the Strzelecki National Park (Bryant et al. 2012). The colony was estimated to contain less than 20 birds and was confirmed again in 2011. This site is approximately 3 km to the south of Bob Smiths Gully and is part of a larger area of contiguous habitat extending south into the Big River area. The finding confirmed that while the species still survives on Flinders Island it was perilously close to extinction and active intervention is urgently needed.

The aim of the present study was to:

1. Reconfirm the status of the Costers Gully colony
2. Resurvey the Darling Range and Broughams Sugarloaf areas
3. Resurvey the Bob Smiths Gully monitoring sites established in 2010
4. Survey other potential habitat surrounding Costers Gully
5. Record sites with evidence of pig damage
6. Make recommendations for the species’ urgent recovery.

METHODS

A combination of survey techniques was used to improve species detectability. Active searching involved listening for calls while walking transects through areas of suitable white gum habitat and scanning the canopy for sign of forty-spotted pardalote movement (Bryant 2010).

Stationary call detection was also used (under permit) within a 10 minute period for repeat site visits. This follows the methodology developed by Webb (2008) for the swift parrot which shows that repeat visits over an extended period can improve detectability and the confidence of population estimates. Call playback was used for five minutes during this stationary period to further improve the possibility of detection (Magrath et al. 2008).

RESULTS

The surveys were undertaken from 3 to 9 December 2012. The areas listed below were surveyed and their locations are shown in Figures 1 and 2.

- Darling Range – Walkers Gully, Officers Creek and surrounds
- Broughams Sugarloaf area
- Bob Smiths Gully
- Costers Gully colony
- Ridge lines and gullies around Costers Gully
- Costers Gully to Smiths Road via the fire trail
- Gully above Big River Road

The GPS locations and survey findings are provided in Appendix A. This information has been lodged on the DPIPWE Natural Values Atlas database.
Darling Range and Broughams Sugarloaf

Surveys undertaken above, in and below the Walkers Gully colony did not find birds (Figure 1). The habitat along Officers Creek surveyed in 2010 and 2011 was rechecked, but no birds were found. A small patch of white gum in a gully off Memana Road was surveyed but did not contain birds. Significant stands of white gum occur in this area and the habitat appeared in good condition with many mature trees supporting large spreading canopies. No pig damage was observed. Forty-spotted pardalote have not been recorded in this region since 1997 and it is likely this colony is now locally extinct.

The two Broughams Sugarloaf colonies that were identified in 1994 were resurveyed, but no birds were found (Figure 1). The white gum habitat throughout this area was thinly scattered and trees were generally in poor condition. Large mature or senescing white gums were scarce, and the area still appears degraded after the 2002 wildfire. No pig damage was seen. Forty-spotted pardalotes have not been seen in the Broughams Sugarloaf area since the late 1990s and it is likely that these colonies are now locally extinct.

Bob Smiths Gully

In 2010 two monitoring sites were established at the head of Bob Smiths Gully, one on the edge of a large patch of white gum forest and the second along the creek line to the west (Figure 2). These areas were rechecked and searching extended up into the gully. No birds were detected. The habitat was extensive
and appeared in excellent condition. White gum comprising up to 100% of forest composition in many areas and a significant number of mature and mixed age stands were present. Recent signs of pig damage were numerous throughout the area (diggings and droppings) and a small herd was seen at the site. Forty-spotted pardalote have not been detected in this region since the 1970s.

Costers Gully area

The Costers Gully colony which was identified in 2010, and confirmed to be active in 2011, remained active during this survey period. One nest was found with two parent birds in attendance feeding chicks (Figure 3a). The nest was approximately 15 m high in a small hollow in a branch elbow of a white gum (Figure 3b). The nest was visited during consecutive days of the survey period and the birds remained in attendance and undisturbed.

One short contact call of a third individual forty-spotted pardalote was heard in the Costers Gully area, making a total of three birds detected. Recent signs of pig damage were extensive throughout the gully and in many areas the soil had been completely dug over on the forest floor.

Several ridge lines and gullies around Costers Gully were surveyed as well as the monitoring sites established along the fire trail back to Smiths Road. After three days of intensive searching, a total of four individual birds were identified in the gullies 1-2 km from the nest site. These birds were detected by sight.
and call, although calling was in short bursts and of short duration. No birds were identified at any of the monitoring sites along the fire trail despite repeated survey each day during entry and exit from the site.

Evidence of swift parrots (*Lathamus discolor*) breeding was also recorded, with breeding behaviour specifically observed in two pairs in the area.

Extensive white gum habitat occurs throughout this area with most stands being even aged with only a small scattering of over-mature and senescing trees. This may be due to an historic fire event that destroyed much of the habitat 60+ years ago. The habitat appears in excellent condition with abundant foliage and contains a diverse forest bird fauna. Recent signs of pig damage were numerous throughout the entire area. Watering points including small water holes and creek lines showed an abundance of foot prints, tree rubs, browsing damage, droppings and extensive diggings. In many areas the soil substrate had been completely dug over.

**Big River Gully**

A gully extending above the last homestead on Big River Road was searched and a small localised patch of white gum habitat was identified about 2 km above the homestead (Figure 2). Two individual birds were located in this area and they were both identified by calling. The habitat is thinly scattered along the creek line and forms a natural corridor linking to Costers Gully. It is likely that birds use this area permanently and seasonally as a dispersal site. No evidence of pig damage was noted.

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*Figure 3. (a) Adult forty-spotted pardalote at the nest (photo: Laura Hines); and (b) location of the nest in the white gum shown by arrow.*
DISCUSSION

The findings of this survey are significant. They confirm the critically low population level of forty-spotted pardalotes on Flinders Island, the high likelihood of local extinction of Darling Range and Broughams Sugarloaf colonies and the need to undertake recovery actions immediately if the species is to survive on the island into the long term. A total of 9 individual forty-spotted pardalotes including one active nest were detected after 6 days of targeted survey. This total included 7 birds in the general Costers Gully area, two of which were attending a nest, and two individual birds in the Big River Valley. It is likely that the species is moving through the corridors of habitat stretching from Bob Smiths Gully through the Strzelecki area to Big River and that these birds are few in number and widely dispersed. It may be that this area has contained birds for decades but due to its remoteness and the small population present, the species has been difficult to detect. The white gum habitat throughout this region is largely even aged stands, but visually appears in excellent condition, so the reason for the species decline is problematic and may involve a variety of factors. These include historical loss of habitat leading to a fragmented landscape, a naturally isolated and restricted population which has become genetically limited, and increasing competition from other bird species for limited resources such as breeding hollows.

The survey also made the first formal records of swift parrots breeding on Flinders Island. The swift parrot is another threatened bird species which is listed as Endangered at both the State and Commonwealth level. During breeding, it is dependent on flowering blue gum or black gum (for food) including or near mature trees (for nest hollows in which to raise chicks).

Pig damage was widespread throughout the Strzelecki Range area in the form of significant soil disturbance, loss of understorey species and a lack of regeneration of white gum and other tree species. The forty-spotted pardalote is totally reliant on white gum, especially mixed age stands, for colony formation; hence this is critical for the species’ long-term survival. In addition, any loss of understorey plant species reduces the diversity and density of invertebrates which form a major component of the diet of this bird species.
REFERENCES


Appendix A - GPS locations and survey findings

* Orange shading and asterisk indicates forty-spotted pardalote record.

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>East GDA</th>
<th>North GDA</th>
<th>Survey Mins</th>
<th>Birds heard</th>
<th>Birds seen</th>
<th>Notes</th>
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<td>587278</td>
<td>556872</td>
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<td>Junction of track, 5 min playback</td>
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<td>5568774</td>
<td>40</td>
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<td>0</td>
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<td>10</td>
<td>0</td>
<td>0</td>
<td>Just above sentinel white gums</td>
</tr>
<tr>
<td>4/12/2012</td>
<td>Bob Smiths Gully Site 138</td>
<td>594915</td>
<td>5549660</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>End of paddock near pig lure site, 5 min playback site 138</td>
</tr>
<tr>
<td>4/12/2012</td>
<td>Bob Smiths Gully Site 141</td>
<td>594628</td>
<td>5549531</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>Fenceline above creek, 5 min playback site 141</td>
</tr>
<tr>
<td>5/12/2012</td>
<td>Fire Trail Site 5</td>
<td>595883</td>
<td>5548901</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>Fire Trail to Costers, first white gum stand at track bend, 5 min playback</td>
</tr>
<tr>
<td>5/12/2012</td>
<td>Costers Gully 40-spot Nest</td>
<td>596799</td>
<td>5545672</td>
<td>20</td>
<td>2</td>
<td>2</td>
<td>* 2 adults feeding chicks in nest in white gum hollow on elbow 15 m above ground. Two short contact calls.</td>
</tr>
<tr>
<td>5/12/2012</td>
<td>Costers Gully 40-spot Nest</td>
<td>596799</td>
<td>5545672</td>
<td>10</td>
<td>0</td>
<td>2</td>
<td>* 2 adults feeding chicks in nest in white gum hollow on elbow 15 m above ground. Two short contact calls.</td>
</tr>
<tr>
<td>6/12/2012</td>
<td>Fire Trail Site 5</td>
<td>595866</td>
<td>5548689</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>Flame robin, black-headed honeyeater; striated pardalote all nesting at this site, 3 photos taken</td>
</tr>
<tr>
<td>6/12/2012</td>
<td>Fire Trail to Costers</td>
<td>595861</td>
<td>5547218</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>Pig enclosure fence, burrowing crayfish on creekline, green rosellas nesting, 3 photos taken</td>
</tr>
<tr>
<td>6/12/2012</td>
<td>Fire Trail to Costers</td>
<td>595925</td>
<td>5546787</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>5 min playback. Photos of pig damage</td>
</tr>
<tr>
<td>6/12/2012</td>
<td>Fire Trail Site 4</td>
<td>596103</td>
<td>5546760</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>3 photos, 5 mins playback, old lunch spot site</td>
</tr>
<tr>
<td>6/12/2012</td>
<td>Fire Trail to Costers</td>
<td>596733</td>
<td>5546102</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>3 photos taken, 5 min playback</td>
</tr>
<tr>
<td>6/12/2012</td>
<td>Costers Gully Site 3</td>
<td>596677</td>
<td>5545902</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>3 photos taken, 5 min playback</td>
</tr>
<tr>
<td>6/12/2012</td>
<td>Costers Gully 40-spot Nest</td>
<td>596799</td>
<td>5545672</td>
<td>10</td>
<td>0</td>
<td>2</td>
<td>* 2 adults still attending nest. Foraging close by, no calling.</td>
</tr>
<tr>
<td>6/12/2012</td>
<td>Costers Gully Mapped Site A</td>
<td>596669</td>
<td>5545558</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>Extensive pig damage entire gully floor</td>
</tr>
<tr>
<td>6/12/2012</td>
<td>Costers Gully Mapped Site B</td>
<td>596606</td>
<td>5545614</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>100% white gum beautiful condition, 5 min playback</td>
</tr>
<tr>
<td>6/12/2012</td>
<td>Costers Gully Mapped Site C</td>
<td>596596</td>
<td>5545733</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>* 1 bird made 2 contact calls, no response to playback</td>
</tr>
<tr>
<td>6/12/2012</td>
<td>Costers Gully Mapped Site D</td>
<td>596562</td>
<td>5545808</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>5 min playback. Swift parrots begging calls and flying through canopy</td>
</tr>
<tr>
<td>7/12/2012</td>
<td>Costers Gully 40-spot Nest</td>
<td>596799</td>
<td>5545672</td>
<td>10</td>
<td>0</td>
<td>2</td>
<td>* 2 adults still feeding chicks 1 min intervals, no calls. Tim Rudman Photos</td>
</tr>
<tr>
<td>Date</td>
<td>Location</td>
<td>GPS Coordinates</td>
<td>Duration</td>
<td>Notes</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>------------</td>
<td>---------------------------------</td>
<td>-----------------</td>
<td>----------</td>
<td>------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/12/2012</td>
<td>Matt's GPS Site 15</td>
<td>596502 5544963</td>
<td>10 mins</td>
<td>5 mins playback</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/12/2012</td>
<td>Matt's GPS Site 28</td>
<td>595956 5545979</td>
<td>10 mins</td>
<td>5 mins playback</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/12/2012</td>
<td>Matt's GPS Site 31</td>
<td>595956 5545806</td>
<td>10 mins</td>
<td>Photos of Slender Tree Fern.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/12/2012</td>
<td>Matt's GPS Site 33</td>
<td>596715 5545364</td>
<td>10 mins</td>
<td>5 min playback, no birds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/12/2012</td>
<td>Matt's GPS Site 34</td>
<td>596633 5544983</td>
<td>10 mins</td>
<td>* 2 birds in total. Both responded to playback. 1 bird no call, 2nd bird high pitch contact call twice, had manna in beak.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/12/2012</td>
<td></td>
<td>595916 5546143</td>
<td>10 mins</td>
<td>* 1 bird breeding call, no response to playback</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/12/2012</td>
<td></td>
<td>595924 5546356</td>
<td>10 mins</td>
<td>* 1 breeding call once, no response to playback</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/12/2012</td>
<td>Towards Costers</td>
<td>596027 5546534</td>
<td>10 mins</td>
<td>5 min playback. Near main track intersection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/12/2012</td>
<td>Fire Trail 2</td>
<td>596115 5546765</td>
<td>10 mins</td>
<td>5 min playback, no birds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/12/2012</td>
<td>Fire Trail 3</td>
<td>595928 5546768</td>
<td>10 mins</td>
<td>5 min playback, no birds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/12/2012</td>
<td>Fire Trail 4</td>
<td>595928 5547154</td>
<td>10 mins</td>
<td>5 min playback, no birds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/12/2012</td>
<td>Fire Trail 5</td>
<td>595866 5548683</td>
<td>10 mins</td>
<td>5 min playback, no birds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/12/2012</td>
<td>Costers Gully</td>
<td>596026 5546531</td>
<td>10 mins</td>
<td>5 min playback, no birds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/12/2012</td>
<td>Costers Gully</td>
<td>597533 5545824</td>
<td>10 mins</td>
<td>5 min playback, no birds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/12/2012</td>
<td>Costers Gully</td>
<td>595636 5547208</td>
<td>10 mins</td>
<td>5 min playback, no birds. Crayfish Creek 200 m up from track, Striated pardalote family group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/12/2012</td>
<td>Costers Gully</td>
<td>595458 5547109</td>
<td>10 mins</td>
<td>5 min playback, no birds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/12/2012</td>
<td>Costers Gully</td>
<td>595542 5547160</td>
<td>10 mins</td>
<td>5 min playback, no birds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/12/2012</td>
<td>Big River Valley</td>
<td>594112 5545348</td>
<td>10 mins</td>
<td>Top of gully, white gums emergent in creekline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/12/2012</td>
<td>Big River Valley</td>
<td>594213 5545603</td>
<td>10 mins</td>
<td>* 1 bird breeding call made twice, photos of slender tree fern</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/12/2012</td>
<td>Big River Valley</td>
<td>594161 5545726</td>
<td>10 mins</td>
<td>* 1 bird breeding call, 5 mins playback</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/12/2012</td>
<td>Walkers Hill – roadside entry Gaffneys tip</td>
<td>590709 5566802</td>
<td>10 mins</td>
<td>5 mins playback, nice white gums</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/12/2012</td>
<td>Darling Range Officers Creek</td>
<td>590837 5564740</td>
<td>10 mins</td>
<td>5 mins playback, no birds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/12/2012</td>
<td>Darling Range colony</td>
<td>592409 5566525</td>
<td>10 mins</td>
<td>5 mins playback, no birds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/12/2012</td>
<td>Darling Range colony</td>
<td>592409 5566525</td>
<td>10 mins</td>
<td>5 mins playback, no birds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/12/2012</td>
<td>Darling Range low site</td>
<td>592262 5566810</td>
<td>10 mins</td>
<td>5 mins playback, no birds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/12/2012</td>
<td>Darling Range low site</td>
<td>592361 5567003</td>
<td>10 mins</td>
<td>5 mins playback, no birds</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Billie T. Lazenby

Small mammals are an important component of many of our ecosystems that are rarely seen without concerted and targeted survey effort. Six native and three introduced small mammals have been recorded on Flinders Island, one of which is the native New Holland mouse (Pseudomys novaehollandiae). This species is recognised by State and Federal legislation as threatened. Up-to-date knowledge of the distribution of species is an important tool for their management, and this is especially true for threatened species. Small mammal surveys were conducted on Flinders Island at six sites in December 2012 in areas consistent with New Holland mouse habitat. Surveys were conducted using Elliott small mammal traps in a survey effort totalling 460 trap nights (i.e. number of traps x number of nights). The native swamp rat (Rattus lutreolus velutinus), swamp antechinus (Antechinus minimus minimus), and eastern pygmy possum (Cercartetus nanus), and the introduced black rat (Rattus rattus) and house mouse (Mus musculus), were recorded. The New Holland mouse was not recorded despite extensive tracts of habitat consistent with past descriptions. Further surveys, and appropriate habitat management including fire and Phytophthora cinnamomi management, are recommended for this threatened species.

INTRODUCTION

Small mammals are a very important but rarely seen component of our ecosystems. Through food web relationships alone, they may directly influence the population levels of the predators that eat them, and the prey (including plant material) that they consume. In addition, some species of small mammal have specific habitat requirements that overlap with a range of other threatened plants and animals. In this regard their presence within an area can signify a healthy landscape.

For the purposes of this report, the term ‘small mammal’ will apply to mammals weighing less than 500 g. There are 12 species of small mammal in Tasmania (nine native and three introduced); of which six native and three introduced have been recorded on Flinders Island. Despite the separation of Flinders Island from Tasmania for several thousand years, all species found on the island are currently considered to be of the same taxonomic status as those found on the mainland of Tasmania.

New Holland mouse, Pseudomys novaehollandiae

There is one species of small mammal that is considered to be under threat of extinction in Tasmania – the New Holland mouse, Pseudomys novaehollandiae. It is listed as Endangered under the Threatened Species Protection Act 1995 and Vulnerable under the Environmental Protection Biodiversity Conservation Act 1999. The species weighs an average of 22 g in Tasmania (Hocking 1980) and can be distinguished from the superficially similar house mouse by a more fluffy appearance, lack of a mousey odour, a bi-coloured tail which is grey on the upper side and white or pink underneath (as opposed to the house mouse which tends to have a tail which is brown or grey on both sides). The New Holland mouse also has a more rounded head profile.
The New Holland mouse is found in Queensland, New South Wales, Victoria and Tasmania, and is often described as a habitat specialist. It has been recorded in coastal heathlands, woodlands with a heathland understorey, and vegetated sand dunes, and is often associated with these vegetation types in the early to mid stages of regeneration following fire (Hocking 1980; Lazenby et al. 2007; Norton 1987; Pye 1991; Seebeck et al. 1996). The New Holland mouse has been recorded to peak in abundance three to five years following fire although this can vary with factors such as soil fertility and fire intensity (Seebeck et al. 1996). Interestingly a number of co-occurring small mammals are also affected by fire but in different ways: the swamp rat tends to peak in abundance in the latter stages of vegetation succession when the vegetation is more dense and overgrown, the swamp antechinus tends to be found in the dense vegetation associated with poorly drained areas which are intermingled throughout New Holland mouse habitat, and the house mouse can be found at any stage of vegetation succession but is believed to be outcompeted by native small mammals when these species are abundant (Fox 1982), which is often the mid to later stages of vegetation succession.

Actions and processes which have led to the New Holland mouse’s threatened status include loss of habitat, modification of habitat from either infection with root rot fungus, Phytophthora cinnamomi, or altered fire regimes, predation by introduced carnivores, and competition with introduced small mammals (Seebeck et al. 1996; Threatened Species Section 2008).

The New Holland mouse has not been recorded in-hand in Tasmania since 2004, however hairs consistent with the species have been found in hair tubes: in 2009 at St Helens and 2010 at Waterhouse Conservation Area (Natural Values Atlas 2013). The species was last recorded on Flinders Island in 2001 (in hair tubes). Relatively extensive efforts to survey the species using Elliott live capture and release traps in historic areas on mainland Tasmania in the last four years have failed to detect it. The New Holland mouse is not known to be a hard species to detect – when the species is entering traps, success rates of up to 10% have been recorded in Tasmania (Hocking 1980). However, as with most species, the factors which affect the chance of a New Holland mouse entering a trap are unknown. These might be particularly relevant when they are in low numbers and include food availability (hence altered incentive to enter traps), season, and fear of predation.

Other small mammals

**Swamp rat Rattus lutreolus velutinus**

This sub-species of swamp rat is a common small mammal endemic to Tasmania. It weighs an average of 122 g and is characterised by dark brown feet, short rounded ears, and a tail which is shorter compared to combined head-body length (Menkhorst & Knight 2001). Their diet consists largely of vegetation however insects and larvae have also been recorded (Driessen 1987). It occurs in a range of habitats from coastal heathland and sedgeland to wet and dry sclerophyll forest, and rainforest (Monamy 1995).

**Swamp antechinus Antechinus minimus minimus**

The swamp antechinus is also another subspecies restricted to and considered locally common in Tasmania. However the related A. m. maritimus which occurs in Victoria is considered near threatened. The swamp antechinus weighs between 28 and 100 g and has pale yellow ginger fur with a distinctive yellowish or rufous wash. The underparts are paler. It generally occupies dense wet heath, woodland, and sedgeland habitats (Menkhorst & Knight 2001). As with other antechinus species, the head is characterised by a long pointed snout with rows of sharp incisors. The species
eats a range of insects and other invertebrates (Sale et al. 2006) but will also occasionally take small vertebrates such as lizards.

**Eastern pygmy possum Cercartetus nanus**

The eastern pygmy possum is considered to range in abundance from sparse to locally common in Tasmania and south-eastern Australia (Menkhorst & Knight 2001) although it has been suggested that this species may be in lower population numbers in Tasmania compared to mainland sites (Harris et al. 2008). The tail is prehensile, very sparsely furred and can be swollen at the base. The eastern pygmy possum can be distinguished from the superficially similar little pygmy possum *C. lepidus* because it is more than twice the weight of the latter species and the fourth molar has one point as opposed to two. The eastern pygmy possum eats nectar, pollen, arthropods and fruit, and can be found in a range of habitats including wet and dry eucalypt forest, subalpine woodland, coastal banksia woodland, and heathlands.

**Black rat Rattus rattus**

The black rat is introduced to Australia and many of the continent’s off-shore islands. The species has a slender body with sleek fur that can range from light grey to black in colour, and the tail is clearly longer than the combined head body length (Menkhorst & Knight 2001). It weighs between 95 and 300 g. It has been suggested that it is a serious predator and competitor of native wildlife (Banks and Hughes 2012). The species has a very broad diet including seeds, fruit, insects, green plant matter, carrion and human food scraps (Menkhorst & Knight 2001). It can be found in a broad range of habitats and is scattered and locally common in most regions of Australia.

**House mouse Mus musculus**

The house mouse is also introduced to Australia and many of the continent’s off-shore islands. There is considerable colour variation in the species which includes grey, brown and yellow. The tail is slightly longer than combined head body length, and has very few hairs with clear rings of scales that are pinkish-brown (Menkhorst & Knight 2001). The species can be found in a range of habitats, and population numbers are believed to fluctuate markedly according to climate and food availability. The species has a broad diet including seeds, green shoots, fungi, insects and almost all human food. Some native species are believed to outcompete the house mouse when the native species are at relatively high densities (Fox & Pople 1984), however the point at which the house mouse can outcompete native small mammals is unknown but is likely to occur during the irruptions that are common in this introduced rodent.

The present study aimed to survey for the New Holland mouse and other co-occurring small mammals in areas consistent with good quality New Holland mouse habitat. The results have implications for the management of coastal heathlands on Flinders Island and our understanding of the New Holland mouse within Tasmania more generally.

**METHODS**

**Survey**

Trapping surveys were targeted towards detecting the New Holland mouse. In order to do this, potentially suitable habitat was identified in the two days prior to setting traps by re-visiting historic sites, and inspecting areas that had been identified as potential habitat via desktop assessments of vegetation type and fire history.

Twenty Elliott standard small mammal traps (Elliott Scientific Company, Victoria) were set at each of six survey sites for four nights (with the exception of one site which was surveyed for three nights) (Figure 1). Individual trap locations were marked with a GPS and...
labelled with a section of numbered flagging tape tied to a branch above. Traps were set either in grids in a 5x4 pattern, or 2x10 transects. Traps were spaced 20 – 30 m apart. Each survey was conducted beside a vehicular access track. Most sites were separated by at least 1 km excluding the Carnacs Flat sites which were adjacent. Traps were checked twice daily: first thing in the morning and a second time in late-afternoon.

Traps were baited with a peanut butter, rolled oats and honey mixture. A handful of commercial rabbit bedding (clean woodchip shavings with the dust extracted) was placed at the back of each trap for insulation. They were set under dry logs, bushes, and in other areas sheltered from sunlight and rain. For each captured animal:

- weight was recorded
- head length measured (from tip of nose to back of cranium)
- the ear was marked with an individual-specific ear clip (a half circle on the clock positions around the ear) for example R12 or L9. The tissue removed for the ear clip was stored in 70% ethanol
- gender was determined
- scrotal testes or pigmentation was recorded (males), and lactation status (females)
- release was at the site of capture

Traps that had captured animals were replaced with clean traps, bait and bedding and dirty traps were scrubbed with water and air dried in sunlight off-site.

A selection of ear clips was sent to a researcher at the Queensland University of Technology who is investigating genetic diversity and species classification in swamp antechinus, dusky antechinus and swamp rat. This research, and provision of samples from Flinders Island, will help to elucidate whether there is a genetic distinction between these species in Tasmania, Tasmania’s offshore islands, and mainland Australia.

Biosecurity

Root rot fungus, *P. cinnamomi*, is a significant and irreversible threat to the dry heathlands that were sampled. In order to avoid spread of this and other potential pathogens or weeds, the following measures were taken:

- Elliott traps and associated carry cases were scrubbed clean with water and air dried in sunlight before importing them to the island.
- Elliott traps were not moved between survey sites unless they had been cleaned thoroughly and air dried.
- Boots were either scrubbed with F10 or sprayed with methylated spirits before entering survey sites.
- Areas supporting patches of vegetation with symptoms consistent with *P. cinnamomi* infection were either avoided or boots were sprayed with methylated spirits immediately after walking clear of the suspected infection.

RESULTS

Habitat searches

Searches for suitable New Holland mouse habitat were broadly concentrated on the Darling Range in the south, and the Wingaroo and Foochow Nature Reserves in the north of the island. Large tracts of heathland habitat in the Darling Range, especially in areas radiating out from vehicular access trails, had symptoms consistent with *P. cinnamomi* infection.
Figure 1. Map of Flinders Island and associated islands showing the locations where Elliott traps were set during a small mammal survey in December 2012.
(Figure 2) making them potentially irreversibly unsuitable for New Holland mouse habitat. On the contrary there were extensive tracts of heathland consistent with past descriptions of New Holland mouse habitat in the Wingaroo and Foochow Nature Reserves.

A plant list was compiled by Tim Rudman during this Hamish Saunders Memorial Trust survey in the vicinity of an historic New Holland mouse record at Carnacs Flat (see Rudman, this report). The area consisted of three year old coastal heathland with occasional small patches grading into wet heath on the poorly

Figure 2. Photograph taken from the main fire access trail that traverses the Darling Range. Note the dead yacca (or grass tree, Xanthorrhoea sp.) and the predominance of sedge species in the foreground which are both indicators of P. cinnamomii infection.
drained depressions and lower flats. This area was also
surveyed with Elliott traps (and the study sites are
referred to henceforth as Carnacs 1 and Carnacs 2).
Plant species identified and principally described from
Carnacs 1 with some additional species described
from Carnacs 2 are included in Appendix A.

Trap effort consisted of a total of 460 trap nights
(the number of traps set multiplied by the number
of nights), and five species of small mammal were
recorded: three native and two introduced (Table 1).
Small mammal capture records were added to the
Natural Values Atlas (NVA). The last formal record

<table>
<thead>
<tr>
<th>Survey Site</th>
<th>Easting</th>
<th>Northing</th>
<th>Pred. fire age (years)</th>
<th>No. traps set</th>
<th>Start date</th>
<th>End date</th>
<th>No. nights</th>
<th>No. trap nights</th>
<th>Species recorded (no. individuals)</th>
</tr>
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<tbody>
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<td>PCM1</td>
<td>577700</td>
<td>5583500</td>
<td>3-5</td>
<td>20</td>
<td>6/12/12</td>
<td>10/12/12</td>
<td>4</td>
<td>80</td>
<td>swamp antechinus (2) swamp rat (3)</td>
</tr>
<tr>
<td>PCM2</td>
<td>578300</td>
<td>5583700</td>
<td>3</td>
<td>20</td>
<td>6/12/12</td>
<td>10/12/12</td>
<td>4</td>
<td>80</td>
<td>eastern pygmy possum (1) house mouse (1)</td>
</tr>
<tr>
<td>PCM3</td>
<td>580200</td>
<td>5583700</td>
<td>3-5</td>
<td>20</td>
<td>7/12/12</td>
<td>10/12/12</td>
<td>3</td>
<td>60</td>
<td>swamp antechinus (2) swamp rat (2)</td>
</tr>
<tr>
<td>Carnacs1</td>
<td>583600</td>
<td>5583900</td>
<td>3</td>
<td>20</td>
<td>5/12/12</td>
<td>9/12/12</td>
<td>4</td>
<td>80</td>
<td>black rat (1) swamp rat (1)</td>
</tr>
<tr>
<td>Carnacs2</td>
<td>583900</td>
<td>5584200</td>
<td>3</td>
<td>20</td>
<td>5/12/12</td>
<td>9/12/12</td>
<td>4</td>
<td>80</td>
<td>swamp rat (3)</td>
</tr>
<tr>
<td>Foochow</td>
<td>585800</td>
<td>5585200</td>
<td>3</td>
<td>20</td>
<td>5/12/12</td>
<td>9/12/12</td>
<td>4</td>
<td>80</td>
<td>eastern pygmy possum (1) swamp rat (1)</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>120</td>
<td>23</td>
<td>460</td>
</tr>
</tbody>
</table>

Table 1. Trap effort and species recorded, including the number of individuals in brackets, during Elliott trap live-capture and release surveys in December 2012 on Flinders Island. Grid references are given in GDA 94.

<table>
<thead>
<tr>
<th>Species</th>
<th>State-wide records in NVA</th>
<th>Records specific to Flinders Island in NVA (numbers in brackets represent the records arising from the present survey)</th>
<th>Other published sources of records not in NVA</th>
<th>Last formally recorded on the island (prior to present survey)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern pygmy possum</td>
<td>42</td>
<td>2 (2)</td>
<td>15 records from 6 locations (Harris et al. 2008)</td>
<td>&gt;1964 and &lt;1990</td>
</tr>
<tr>
<td>Little pygmy possum</td>
<td>64</td>
<td>1 (0)</td>
<td></td>
<td>1980</td>
</tr>
<tr>
<td>New Holland mouse</td>
<td>57</td>
<td>9 (0)</td>
<td></td>
<td>2001</td>
</tr>
<tr>
<td>Swamp antechinus</td>
<td>141</td>
<td>10 (4)</td>
<td></td>
<td>2001</td>
</tr>
<tr>
<td>Swamp rat</td>
<td>243</td>
<td>21 (12)</td>
<td></td>
<td>2001</td>
</tr>
<tr>
<td>White-footed dunnart</td>
<td>38</td>
<td>1 (0)</td>
<td></td>
<td>1999</td>
</tr>
</tbody>
</table>
for the eastern pygmy possum on Flinders Island was over 20 years ago; however, it is very important to note that this species in particular is sometimes observed by residents on the island but these records are not formalised within the NVA (Table 2).

Analyses of genetic samples sent to the Queensland University of Technology were ongoing as at December 2013.

DISCUSSION

Elliott trapping confirmed the presence of three native small mammals on Flinders Island in December 2012, however the Endangered and previously recorded New Holland mouse was not detected. This was despite large tracts of habitat consistent with past descriptions of suitable habitat for the species (Hocking 1980; Lazenby et al. 2007; Norton 1987; Pye 1991; Seebeck et al. 1996). The reason/s for the lack of capture of the New Holland mouse are difficult to ascertain because the species may have been present but simply not trapped. Factors which can influence the trappability (otherwise known as the detectability) of a species include:

- Density (the more individuals generally the greater chance of trapping one)
- Season (mating and climate can affect animal behaviour and therefore the chance of an animal entering a trap)
- Food availability (which can be related to season – generally the more food that is available the less likely an animal is to enter a trap)
- Fear of predation (the threat of getting eaten can alter animal behaviour such that they are less likely to enter a trap)

The density or abundance of the New Holland mouse is likely to be highest during late summer/autumn which coincides with the end of the breeding season for the species, therefore surveys conducted at this time of year can maximise the chances of trapping the New Holland mouse. Increases in survey effort (e.g. the number of traps deployed and/or the number of nights they are set) can also increase chances of trapping the species. It is important to confirm the New Holland mouse’s current presence on the island in order to inform management and also to help understand the recent lack of detection for the species in recent years across broader Tasmania.

Regardless of whether the New Holland mouse is detected in the near future on Flinders Island, the species’ habitat should be managed for its presence (Threatened Species Section 2008). This includes applying appropriate ecological fire regimes, and minimising and preferably halting the spread of *P. cinnamomi*. The large tracts of heathland infected by *P. cinnamomi* observed in the Darling Range are testament to the damage that this pathogen can do to New Holland mouse habitat. For more details about *P. cinnamomi* management please refer to Rudman (this report).

MANAGEMENT RECOMMENDATIONS

- A comprehensive re-survey for the New Holland mouse be conducted at an appropriate time of year and with sufficient survey effort to maximise the chance of detecting the species.
- Heathland habitat be managed with appropriate ecological fire regimes.
- *P. cinnamomi* spread be minimised or halted.
REFERENCES


Appendix A - Plant species identified and principally described from Carnacs 1 with some additional species described from Carnacs 2.

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>common name</th>
<th>Threatened status (Threatened Species Protection Act 1995)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acacia genistifolia</td>
<td>spreading wattle</td>
<td></td>
</tr>
<tr>
<td>Acacia myrtifolia</td>
<td>redstem wattle</td>
<td></td>
</tr>
<tr>
<td>Acacia suaveolens</td>
<td>sweet wattle</td>
<td></td>
</tr>
<tr>
<td>Allocasuarina monilifera</td>
<td>necklace sheoak</td>
<td></td>
</tr>
<tr>
<td>Amperea xiphoclada</td>
<td>broom spurge</td>
<td></td>
</tr>
<tr>
<td>Aotus ericoides</td>
<td>golden pea</td>
<td></td>
</tr>
<tr>
<td>Banksia marginata</td>
<td>silver banksia</td>
<td></td>
</tr>
<tr>
<td>Brachyloma ciliatum</td>
<td>fringed heath</td>
<td></td>
</tr>
<tr>
<td>Cassytha globella</td>
<td>slender dodderlaurel</td>
<td></td>
</tr>
<tr>
<td>Comesperma calymega</td>
<td>bluespike milkwort</td>
<td></td>
</tr>
<tr>
<td>Dampiera stricta</td>
<td>blue dampiera</td>
<td></td>
</tr>
<tr>
<td>Daviesia ulicifolia</td>
<td>spiky bitterpea</td>
<td></td>
</tr>
<tr>
<td>Dillwynia glaberrima</td>
<td>smooth parrotpea</td>
<td></td>
</tr>
<tr>
<td>Dillwynia sericea</td>
<td>showy parrotpea</td>
<td></td>
</tr>
<tr>
<td>Empodisma minus</td>
<td>spreading roperush</td>
<td></td>
</tr>
<tr>
<td>Eucalyptus nitida</td>
<td>western peppermint</td>
<td></td>
</tr>
<tr>
<td>Gompholobium huegeli</td>
<td>common wedgepea</td>
<td></td>
</tr>
<tr>
<td>Gonocarpus tetrovynus</td>
<td>common raspwort</td>
<td></td>
</tr>
<tr>
<td>Hibbertia sericea</td>
<td>silky guineaflower</td>
<td></td>
</tr>
<tr>
<td>Hypolea fastigiata</td>
<td>tassel roperush</td>
<td></td>
</tr>
<tr>
<td>Isopogon ceratophyllus</td>
<td>horny conebush</td>
<td>vulnerable</td>
</tr>
<tr>
<td>Lepidosperma concavum</td>
<td>sand swordsedge</td>
<td></td>
</tr>
<tr>
<td>Lepidosperma filiforme</td>
<td>common rapiersedge</td>
<td></td>
</tr>
<tr>
<td>Leptocarpus tenax</td>
<td>slender twinerush</td>
<td></td>
</tr>
<tr>
<td>Leptospermum scoparium</td>
<td>common teatree</td>
<td></td>
</tr>
<tr>
<td>Leucopogon virgatus</td>
<td>common beard-heath</td>
<td></td>
</tr>
<tr>
<td>Lindoaea linearis</td>
<td>screw fern</td>
<td></td>
</tr>
<tr>
<td>Lomatia tinctoria</td>
<td>guitarplant</td>
<td></td>
</tr>
<tr>
<td>Melaleuca gibbos</td>
<td>slender honeymyrtle</td>
<td></td>
</tr>
<tr>
<td>Patersonia fragilis</td>
<td>short purpleflag</td>
<td></td>
</tr>
<tr>
<td>Platylabium triangulare</td>
<td>arrow flatpea</td>
<td></td>
</tr>
<tr>
<td>Schoenus lepidosperrma</td>
<td>slender bogedge</td>
<td></td>
</tr>
<tr>
<td>Sprengelia incarnata</td>
<td>pink swampheath</td>
<td></td>
</tr>
<tr>
<td>Xanthorrhoea australis</td>
<td>southern grasstree</td>
<td></td>
</tr>
<tr>
<td>Xanthosia pilosa</td>
<td>woolly crossherb</td>
<td></td>
</tr>
</tbody>
</table>
It was the middle of my final exams of my bachelor’s degree when I received an email from a lecturer about the Hamish Saunders Memorial Trust Flinders Island trip. After reading the application I was immediately interested, it didn’t take long before I found myself writing an application letter, getting my C.V. together and arranging referees. To my astonishment a few days later I received the email from David Saunders reading I was one of the successful applicants. Time seemed to fly by, it wasn’t long before I was packing my bags and heading for the airport. After a stopover in Melbourne I had landed in Hobart, Clare one of the team leaders picked me up where I was whisked away to complete the risk assessment paperwork with Gary our supervisor which was extremely thorough. We then met with Ali, the other successful New Zealand volunteer of the Hamish Saunders Memorial Trust and Sally, a bird expert.

The following day the greater adventure began, destination: Launceston where we would pick up Andrew, Hamish’s brother and camera man and board a small plane, our transport to Flinders Island. Flinders is beautiful, I hadn’t had the opportunity to travel much before so I found this trip even more special as there were so many things that were new to me. After unpacking our gear we headed up to Walkers Lookout to search for butterflies with Jo, the butterfly expert, in particular the chaostola skipper. Andrew filmed us throughout the hike, gaining footage for the Trust website. On night fall the search for frogs with Annie began, we left armed with torches in the hope of hearing and seeing a green and gold frog. We searched a few ponds but only found tadpoles.

Every morning while on Flinders Island I bounced out of bed ready for the next adventure, no matter how late at night or how early the alarm clocks sounded. There were many highlights of this trip, many included seeing animals I hadn’t seen before including blue tongue lizards, tiger and copper head snakes, mountain dragon lizards, much of the bird life and wombats and wallabies which were present in great abundances.

Climbing Mt. Strzelecki in search of the Furneaux burrowing crayfish saw many laughs with the challenge of finding such a crayfish. This is harder than it would seem and required much digging and sifting through mud when a chimney was spotted near a stream. With burrows being up to 1.5-2 m in depth it wasn’t long before we found ourselves covered in sparkly mud as it was filled with weathered minerals from the granites forming the mountain range.

A day with Sally and Matt, both bird experts of the trip saw us tramp through Strzelecki National Park in search of the forty-spotted pardalotes within the canopy of the surrounding forest. It was here I had my first encounter with a wild snake, a tiger snake was basking in the sun very near to the track and blended in well with the surrounding forest floor. Seeing how well they blend in with the surroundings made me wary where I put my feet for the rest of the day, even so Andrew still had to warn me of a copper head snake not too far in front of me a few moments later. We also had the opportunity to see and film two mountain dragon lizards which were very accepting to our cameras. Around midday Sally spied a forty-spotted pardalote, not one but two a pair flying to and from the nest feeding their young. The cameras were whipped out and the filming and screeds of photographs began.

Ali and I were fortunate enough to survey shearwaters on Fisher Island with the Wildlife Management Branch team. Upon reaching the island we were shown around an old hut and told the
history of it and about its significance to the many years of involvement with surveying shearwaters. While Andrew filmed Ali and I got to search for shearwaters, this involved putting an arm down a hole to find out if it contains a bird or an egg, or a penguin in a few cases. Birds were captured, weighed, tagged and released back into their burrows. To be involved with tagging was a great experience. A visit to Trousers Point on the way home was a great break. Andrew seized this opportunity to film Ali and me individually for the Hamish Saunders Memorial Trust website before heading back to camp to join Billie, another wildlife officer specialising in small mammals. We set traps and checked others at the Wingaroo Reserve in the hope of finding a New Holland mouse. There was always great excitement to see a trap had been set off, no mice were found however blue tongue lizards, swamp rats and white skinks were among those which have a taste for peanut butter, honey and oat bait we had used in our traps.

Sue and Nancy from the Wildlife Management Branch team kindly invited Ali and me to join them spotlighting one night. This simply records which animals are present along certain roads while travelling at a slow speed. I was amazed with the amount of wildlife that congregate on the side of the road at night. We even spotted a couple of boobooks, a small owl similar to our morepork.

I also seized the opportunity to travel to Big Green and East Kangaroo Islands with the Wildlife Management Branch team for shearwatering. This
involved measuring 10 transects per island (basically a string line). These were 200 m in length where every burrow within a meter each side of the transect was checked for a bird. Some proved to be empty and others would be too long for us to reach the end. This was hot work, while the constant threat of snakes potentially being present down some of these burrows made for an exciting day.

During my time on Flinders Island, I learnt a lot from Tim about Phytophthora cinnamomi, a soil-borne watermould resulting in root rot. This is an incredibly invasive plant pathogen and was especially important to be aware of as some areas of the island displayed a great presence of this compared to others. This meant cleaning boots, gear and vehicles to help prevent the spread of this pathogen to other areas.

I also had the opportunity to join Nicole and a team of weed experts on a weed hunt around the eastern side of the island, this included GPS plotting of weed species. Boxthorn and pampas grass were noted frequently. During our drive across a lagoon area we also spotted an echidna, another great photo opportunity.

Although we managed to fit a lot into each day it wasn’t long before the final day on the island arrived. Jo, Nicole and I managed to juggle our time to be able to fit some diamond hunting in at Killiecrankie. Doug and Libby, the owners of the B&B where we were staying, were extremely kind and lent us some of their sieves. We were unsuccessful but we had a blast giving it a go. Upon leaving for the airport that afternoon Doug treated us all to a handful of Killiecrankie diamonds, a sweet and generous gesture. In the future I plan to make them into an item of jewellery in remembrance of the amazing time I had on Flinders Island and of all the incredible people I met along the way.

I would encourage others to apply for future surveys, this is a great opportunity to meet like-minded experienced people, work in another country and see the beauty it has to offer. This has given me a greater understanding of research, threatened species studies and protection measures within the field.

I would like to personally thank every member of the team for sharing such a wealth of knowledge, I learnt a lot in my time where we enjoyed many laughs and many great moments. I got to meet many amazing people and I wish you all well with future endeavours. This experience was certainly a once in a lifetime opportunity and I would like to thank the Hamish Saunders Memorial Trust for selecting me as an applicant and allowing me to participate in such a great opportunity. This is an experience I will always remember and one I treasure deeply forever.
Having my application for the Flinders Island survey accepted was really exciting as I wasn’t at all confident when I sent it off. My expectation was that the Trust would choose people in the more specialised fields, like botany or zoology, while I’m something of a generalist and beginning a career focussed on environmental policy.

Taking part in this survey has given me a real-world experience and contributed to a broader ecological understanding that I feel is important for under-pinning work in the public sector.

As a curious person who likes to ask lots of questions, going to such a different environment with a team of approachable and knowledgeable scientists was fantastic. It was very interesting for me to think about the conservation management theories I’ve studied through the lens of a different ecological landscape. Looking at things from this different perspective was very worthwhile, and I was pleased to find that a lot of my experience and learning from New Zealand was directly transferable.

Eight days on Flinders Island seemed a lovely long time when we first touched down, but it quickly became evident just how much there was to do. As we settled ourselves into our comfortable accommodation, and began to explode the contents of boxes and bags across the lawn, the enthusiasm of the team became apparent and I knew they were determined to make the most of the trip. Several projects had been chosen from a pool of ideas put forward in the previous weeks and everyone was obviously excited to be part of the expedition and get cracking as soon as possible. Laura, Andrew and I set off on our first mission, to look for butterflies with Jo Potter, within a couple of hours of arrival.

Andrew had set himself the task of filming our adventures over the first few days of the survey, and my initial challenge was getting used to it! Although Andrew was completely non-threatening and supportive, the first couple of days being filmed were difficult for me—I didn’t feel at all confident or photogenic. Despite this, I quickly became accustomed to “being watched” and was able to handle the interviews without being disabled by nervousness. In retrospect, this part of the experience was really valuable for me and I’m looking forward to seeing what Andrew has put together.

The size of the island meant the logistics of getting around, sharing vehicles and organising rendezvous had to be carefully planned for each day. Clare Hawkins and Gary Davies worked especially hard to ensure everything ran as efficiently as possible. Laura and I were spoilt for choice when it came to deciding what to do each day. I wanted to do a bit of everything and make sure I spent time with each member of the team. This meant early mornings and late nights, but there was no way I was going to waste my time on this trip—who wants to sleep when you could be trapping small mammals, digging for crayfish, bush bashing to look for rare birds, spotlight surveying for nocturnal wildlife, tramping through wetlands or listening for frogs! Any time we weren’t out in the field was spent sharing what had been found each day, discussing the similarities and differences between New Zealand and Tasmanian conservation challenges, and scribbling in my journal to make sure I wouldn’t forget anything in the whirlwind of activities and insights.

A major highlight of the trip for me was bird watching with Sally Bryant and Matt Webb. It was wonderful to be in such different bush than at home, and to be participating in such an important mission—to find the threatened forty-spotted pardalote. We were all really excited when Sally found a nest and we spent a good while watching the hard-working pair flying in and out to gather food for their young. I really enjoyed all the incidental birding along the way.
too, learning the local birds’ calls and distinguishing their features and habits. Sally, in particular, is so knowledgeable and generous, I found her passion for birds totally infectious.

It was fascinating for me to learn about the role of fire in Australia’s ecology. While trapping for small mammals with Billie Lazenby, this became really apparent to me. The heathland we were surveying for New Holland mice was about three years post-burn, but was almost free of weeds. This struck me as really astounding; a fire in New Zealand would almost guarantee a weedy free-for-all. When doing a floral survey with Tim Rudman in this area we found around 30 native species in a short space of time, so it’s clear that many plants are fully adapted to this type of disturbance. This is also true of small mammals, with many experiencing population growth at certain stages in the fire cycle. Although it was disappointing not to establish the presence of the New Holland mouse, I really enjoyed being in the heathland. The most exciting trap-inhabitant was a pygmy possum. It was about the length of the palm of my hand, with round ears, big eyes and a perfect little spiral of a tail.

After the survey, I was lucky enough to spend a few days in Hobart, graciously hosted by members of the Flinders team. Going to Mt. Field National Park, walking up Mt. Wellington and visiting the fabulous MONA gallery were real highlights that I recommend to others. I’m determined to visit Tasmania again; pictures of the interior of the island are especially enticing and I hear there are some great tramping tracks. All too soon it was time to start the trip home.
I’ve been asked to make recommendations for future surveys:

Firstly, I would urge all involved to keep up the good work! This programme really is an amazing opportunity for volunteers, and the standard of the survey work produced is very high. The sense of adventure and enthusiasm for new scientific knowledge that the HSMT-DPIPWE partnership promotes should continue to be highly valued, and I would not like to see a reduction in the scale of the programme.

Secondly, the idea to expand the programme to Tasmanian volunteers and New Zealand islands should be seriously considered. I understand that this would require buy-in from the Department of Conservation and that there would be a whole new set of logistics involved, but I believe the benefits of strengthening the trans-Tasman relationship would justify the effort. There is also huge potential for gathering valuable data in some remote and wonderful places off the New Zealand mainland.

Third, and lastly, I think it’s important to try to keep alive the links made between the Trust, volunteers and the team in Tasmania. To an extent this is up to the volunteers themselves, but I think there’s a lot to be said for keeping the lines of communication open. Personally, I’d really like to meet past volunteers and see how their careers have developed. I am happy to be contacted by future volunteers too, and I see value in maintaining the network that has been created around the programme.

Potential volunteers for future surveys

Go ahead and apply! You never know, it could be you.

The Tassie team, Flinders Island community, Andrew and Laura

Thank you for sharing this amazing experience with me, for being so enthusiastic, inspiring and hospitable. You’re a fantastic bunch and I hope to see you all again.

David and Carmo, Judy and John, and HSMT trustees

Thank you for your commitment to this programme, for all your hard work making it happen each year, and for your open-hearted support and encouragement. Thank you also to Judith, who I know was a driving force behind the establishment of the Trust.

Hamish

Thank you for so inspiring your family and the people who met you.
In December 2012, I had the privilege of travelling with the Hamish Saunders Memorial Trust survey party to the selected survey location, Flinders Island. Accompanying the volunteers and team scientists on various excursions around this rugged and beautiful island was a new experience for me. I work in the media industry, and felt I was able to observe the trip from two equally rewarding perspectives; firstly from a non-scientific, public viewpoint, and secondly as Hamish’s brother and a representative of the Saunders family.

Speaking with team members, hearing about and then seeing the impacts of invasive species and habitat destruction on Tasmanian island environments was quite confronting, and indeed a reality check. The urgency and scale of the challenges facing island communities was very apparent in natural areas such as national parks, as well as farmland, both at risk due to the spread of exotic species. However, meeting local members of the community who are actively working to conserve and restore habitats, as well as eradicate invasives, was a positive and reassuring hope for the future.

The few days I spent on Flinders, for me, demonstrated the importance of the annual surveys. The data gathered by the highly experienced and specialised teams of scientists enables conservation strategies to be outlined and implemented in island environments.

Spending time with the volunteers also confirmed for me the value of the survey programme. There is no doubt in my mind that both Laura and Ali will continue to contribute greatly to science and conservation as they progress with their respective careers. Both possess an obvious passion for the natural world and are excellent ambassadors for the volunteer programme.

Upon reflection of the trip, I am confident that Hamish’s values and legacy are being well represented by the professional, dedicated and enthusiastic people involved in the annual island surveys and on behalf of the Saunders family, I wish to thank all involved for their support and contributions.