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THE TASMANIAN NATURALIST

EDITOR: MARK WAPSTRA

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Reviews

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EDITORIAL NOTE

Mark Wapstra

Editor, *The Tasmanian Naturalist*

One of the exciting things about editing a journal like *The Tasmanian Naturalist* is anticipating the articles that may get submitted each year, and then seeing those articles go from a draft through the review process and finally appear as you see them in these pages. I no longer seem to need to chase articles, which is hopefully a reflection that while we may not be *Nature*, we are being seen as a suitable forum for publishing by a wide range of people from academic researchers through to amateur naturalists.

In this edition, we move from daisies to the daisy pan moss, from giant snakes to tiny bats, whales to beetles, birds to jumping spiders, eucalypts to weeds, argonauts to nudibranchs: hopefully something for everyone. I think it is easily the most exciting and varied edition I've presided over in my time as Editor.

In the past, the Club has used *The Tasmanian Naturalist* as a forum for special issues. In 1984, there were two issues dedicated to Macquarie Island, followed by one in 1992 dedicated to the management of the Tasmanian World Heritage Area. In my time as Editor, I encouraged a special section in the 2008 edition dedicated, with no surprises to many, to Tasmanian native orchids. This year, following discussions with a number of people, the Club decided to dedicate a section of the present edition to the role of community groups, volunteers and small projects to natural resource management in Tasmania. After sending out an email to friends and colleagues "in the business", and asking them to forward along to others they thought might be interested in penning a piece on this subject, I was pleasantly welcomed by a number of very relevant articles, which appear after the usual set of contributed research articles and naturalist notes.

What is interesting to note is that many of the articles in the main section of this edition also highlight the role of volunteers in natural history research: Lisa Cawthen's work on bats is obviously highly reliant on volunteers willing to spend hours operating with the same activity pattern as the bats they are tracking, the discovery of the new daisypan moss site was by volunteers working on the orange-bellied parrot monitoring project, and many of the other articles are by long-term dedicated natural history observers and "citizen scientists" making observations outside their formal career role.

This year the Club gratefully acknowledges the sponsorship by *La Golondrina Charters* (www.lagolcharters.com.au), the *Queen Victoria Museum & Art Gallery* (www.qvmag.tas.gov.au) and *Redmap* (www.redmap.org.au – see also article on page 158) for contributing to the cost of producing the 2014 volume. We also received a grant from NRM South under their Naturally Inspired Bite-sized Grants program, a fitting sponsor for the themed section. This generous support allows us to keep membership fees low and still produce a quality bound and printed journal. As Editor, I have once again indulged a number of authors with a selection of images to accompany articles, choosing, wherever possible, to "upsize" images, simply because small images just don't do them justice. An image of a fully stretched monster snake can only go across one page, surely, and some of the images of our beautiful beasts almost leap (or fly) off the pages I think. Some of the articles don't *need* images but I think including them, to show the reader what the author saw, adds to the *experience*. Please enjoy.

WHEN GIANTS ROAMED THE LAND: DID RABBIT PLAGUES PRODUCE A SHIFT IN MAXIMAL SIZE OF TIGER SNAKES (*NOTECHIS SCUTATUS*) IN TASMANIA?

Simon Fearn

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INTRODUCTION

The 1803 arrival of Europeans in Tasmania instigated a cascade of ecological consequences for the island State's fauna and flora. Within 40 years of settlement, tribal Aborigines and their profound effect on the environment over millennia were functionally removed from the landscape (Ryan 2012) and the top non-human predator (the thylacine) had begun its steady march towards extinction a little more than half a century later (Paddle 2000). Coupled to these two relatively understood ecological shock waves was a raft of others, equally important but less understood. Land clearing, altered fire regimes, hunting, the introduction of thousands of sheep as well as a wide variety of introduced plants and animals must have had profound ecological consequences. Unfortunately, reliable baseline data on plants and especially animals from those early colonial days are almost entirely lacking, making it extremely difficult for modern Tasmanians to fully understand the recent ecological history of our island and how these events impacted on the fauna. Much of the information from those early years that remains to us today is in the form of anecdotal notes in journals, dairies and early newspapers. Some of this information is intriguing and often raises a variety of interesting questions and scenarios that while now impossible to prove, nonetheless allows some measured, educated speculation about some of the trophic interactions and associated selection pressures that may have occurred between our native and introduced fauna in the recent past.

While conducting historical research on Tasmanian snakes and early European perceptions of and interactions with them, I was amazed at how the fear of these animals bordered on hysterical. Living as we currently do in a post-snake bite antivenom world with first class medical support systems, it is easy to forget that there was a time when a serious bite from a tiger snake was, more likely than not, a death sentence. Tasmania has always been a predominantly rural society and until the end of the Second World War work in fields and the bush was very much more manual than it is today. Snakes were plentiful and unfortunate encounters common. Perhaps reflecting these factors as well as the relative isolation of small rural hamlets within the overarching isolation of an insular society, snakes were regional news and seemingly every specimen seen or killed was dutifully recorded in the press with inspiring banners such as "One less to worry about".

Two things became clear during my research: (1) dead snakes appeared to be reasonably reliably measured by correspondents in newspaper articles to the nearest inch, and (2) there appeared to be a lot more very large tiger snakes recorded than are typically encountered in the wild today. It would be very easy to dismiss this anecdotal information as typical snake story exaggerations if it wasn't for the occasional photograph depicting some truly giant specimens (Plates 1-4).

Of the three species of venomous elapid snakes native to Tasmania (white-lipped snake *Drysdalia coronoides*, copperhead

Austrelaps superbus and tiger snake *Notechis scutatus*) it is only copperheads and tiger snakes that grow large enough to threaten human life.

Plate 1. A 1.8 m black tiger snake from Interlaken in Tasmania's central highlands. The snake is being held by Fred Wade, a snake handler on the Australian show circuit from the 1920s to 50s. Wade's career is discussed by Cann (1986). This magnificent male snake along with 41 other tiger snakes caught by Wade in one day at Interlaken in 1949 would have slowly succumbed to starvation and stress on the Australian show circuit. [photo courtesy of *The Mercury*, 11 Feb. 1949: 23]

Snakes tick all the boxes for perhaps being more responsible for outrageous size claims than any other dangerous animals with the possible exception of sharks. In Tasmania, rounding up to the nearest metre appears to be mandatory and it is amazing how many 2 m plus tiger snakes have been solemnly reported to me over the years. However, after studying Tasmanian snakes for over 30 years, I have found that nothing brings a good snake story back to earth faster than a tape measure. Tasmanian copperheads typically range between 1 and 1.3 m in total length. I have measured a few dozen copperheads from the main island of Tasmania that were close to 1.5 m in length and only one that attained that figure. On King and Flinders islands much larger copperheads can be encountered over 1.7 m in length. The reasons for this are unclear as these island copperheads eat the same prey (predominantly lizards and frogs) as specimens from the Tasmanian mainland (Fearn 1994). The most impressive aspect of the size attained by copperheads is their girth. Well-conditioned specimens 1.4-1.5 m in length typically weigh 1.5-2 kg. A glimpse of a portion of such a creature gliding away through long grass has generated many a giant snake story over the years.

Perhaps because of their relatively belligerent attitude as well as many historical human deaths to their record, tiger snakes are the subject of endless debate about how large they can grow. Tiger snakes between 1.2 and 1.5 m can be encountered almost anywhere in Tasmania but specimens much larger than this are rare. Having captured and measured thousands of tiger snakes throughout Tasmania and the Bass Strait islands, I would suggest that any specimen over 1.7 m is a giant and specimens over 1.8 m extremely rare (see Plate 6).

From the early days of settlement to the mid-1950s, tiger snakes[1] between 1.7 and

[1] For much of Tasmania's history the common name 'tiger snake' was only used for obviously banded specimens. Predominantly black specimens were universally referred to as 'black snakes' and brownish and yellowish specimens with bands or splotch like markings referred to as

2 m in length were reportedly commonly recorded, often with precise sounding measurements and even ecological information such as prey items recorded from snake stomachs (Table 1). If these reports were essentially reliable, occasionally supported with photographs from the 1940s onwards, I began to wonder what could have been responsible. I knew from scientific studies from around the southern Australian coastline (e.g. Schwaner 1985; Schwaner & Sarre 1988; 1990; Shine 1987; Keogh et al. 2005; Aubret & Shine 2007) that isolated island tiger snake populations can morph into giants or dwarfs very rapidly under intense selection pressure based primarily on prey type and size. Was there a major change in potential tiger snake prey in Tasmania some time in the mid 1950s that would account for an overall reduction in average and maximal size? My number one suspect was the rabbit *Oryctolagus cuniculus*.

It is unclear precisely when rabbits were first liberated in Tasmania. A correspondent to *The Mercury* newspaper (Shaw 1951) suggested that a Mr Meredith who settled at "Cambria", Swansea on the east coast in 1821 had captive rabbits in a brick hutch. Rolls (1969) records that George Evans (Surveyor-General of the colony) noted that rabbits were thriving abundantly in the wild by 1822. Fenner & Ratcliffe (1965) record that the first reports of wild rabbits causing concern in Australia came from Tasmania. The *Hobart Colonial Times* of 11 May 1827 reported thousands of common rabbits at large about some of the large estates. By 1869 James Calder (Surveyor-General of Tasmania) wrote to England stating that the English rabbit had multiplied prodigiously (Rolls 1969). So serious had the problem become that the press began referring to the "rabbit plague". *The Mercury* for 6 September 1869 records a Campbell Town meeting of influential land holders to decide on what to do about the "fearful increase of rabbits". While a range of destruction techniques were discussed and a petition prepared to present to Parliament for a Commission of Enquiry, these efforts must have been to little effect as a special report in *The Queenslander* of 21 October 1876 on the rabbit nuisance in Tasmania noted that they were rapidly spreading across the settled districts of the State and that in 1874, 474,468 rabbit skins were exported from Hobart and another 433,404 skins in 1875.

I suspect that most modern day Tasmanians would find it difficult to believe the extent of the rabbit population in Tasmania for 100 years and some of the numbers involved. *The Mercury* (22 Apr. 1903: 4) reported that in 1901, 4,132,596 rabbit skins were exported from Tasmania. Between 1923 and 1931, 68,224,304 skins were recorded in Tasmania (*The Mercury* 18 Aug. 1932: 3). In 1926 alone, 10 million skins were exported from the State (*The Mercury* 31 Aug. 1927: 5). Rabbit meat was also an important export earner for the State. From January to June in 1928, 11,000 carcasses were inspected in Launceston alone (*The Mercury* 18 Jun. 1928: 7). In the whole 1928-29 season, 5.5 million skins and 60,000 carcasses were exported to the United Kingdom. Impressive as these figures are, such harvesting appeared to have no measurable impact on overall numbers and it was reported that there was a huge increase in the population during 1930 (*The Mercury* 17 Feb. 1931: 11). Millions of rabbits were exported from Tasmania to the UK during the war years and demand continued for some time after

'carpet snakes'. Many early correspondents believed these variants represented distinct species and early newspapers are full of debates on how many species of snakes actually occurred in Tasmania.

the cessation of hostilities. In 1949, 1,750,000 frozen rabbits left Tasmania for the UK (*The Mercury* 10 Feb. 1950: 5). Throughout this period farmers were waging a constant chemical war against the rabbit using toxins and techniques that would horrify many environmentally aware modern Tasmanians. Strychnine was the preferred option usually mixed with carrots or grains and placed in long trails or furrows. On the northwest coast in 1919, a 1.5 mile trail yielded 1000 dead rabbits collected the following day (*The Mercury* 4 Apr. 1919: 4). A series of strychnine trials in the Bothwell district in 1923, following several days of free feeding, yielded 5,500 rabbits collected on one day (*The Mercury* 29 Mar. 1923: 6). Several months later, strychnine was once again used at Bothwell to destroy 47,800 rabbits (*The Mercury* 24 May 1923: 6). Decades later Bothwell was still a favoured location for rabbit poisoning trials and an 8 km long furrow poisoned with strychnine in 1952 yielded 4,000 rabbit carcasses (Statham 2005).

It is inconceivable that native and introduced predators would not have taken full advantage of such a bounty. As entirely expected, tiger snakes appear to have been quick to respond, not only to prey on rabbits but also make use of their extensive warrens as shelter and over-wintering sites. This close association led to many human snake bites through people and snakes coming into contact while both engaged in the same pursuit – hunting rabbits (Table 2). It is clear from the number of deaths that rabbiting was a potentially dangerous pastime and if the effects of envenomation didn't claim victims, then the rough first aid of the time also had the potential to cause serious complications. Such was the mortal terror of being bitten by a snake that digits were commonly hacked off with axes and knives or amputated by being placed over the barrel of a shotgun and the weapon discharged (Table 2).

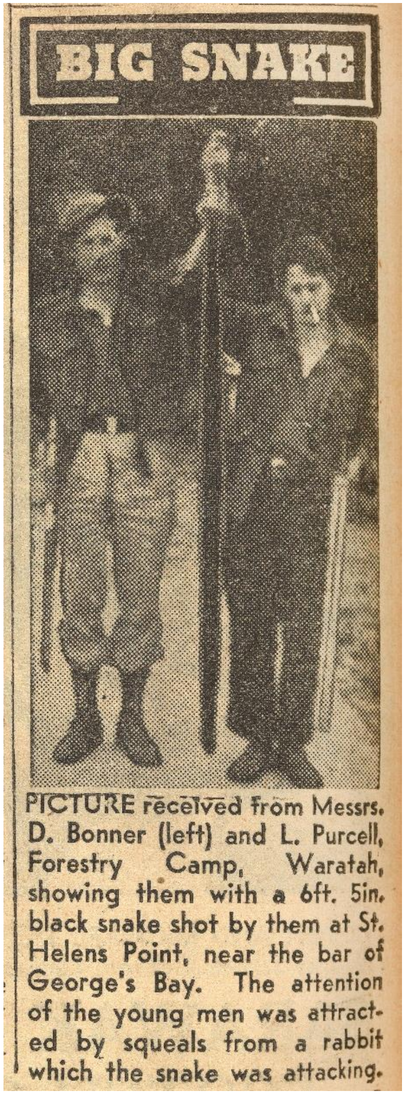

Figure 2. The balanced build and perfect proportions of this giant tiger snake do not indicate stretching or any other tampering with the carcass, nor is there anything in the photograph to refute the stated length. Such a snake would weigh in excess of 3 kg and would be capable of ingesting rabbits greater than half grown in size. [photo courtesy of *The Examiner*, 9 Feb. 1950: 4]

I have not been able to find any references or photographs of outsize copperheads (commonly referred to as 'diamond snakes', 'swamp snakes' or 'brown snakes' in the early years) in Tasmanian newspapers. Nor have I been able to find any fatal human bites associated with rabbit hunting that can definitely be attributed to them. This is perhaps not surprising as copperheads are specialist frog and reptile feeders with relatively small heads and thus a limited gape and therefore incapable of ingesting juvenile rabbits of any size (Fearn et al. 2012).

There are many early newspaper accounts of tiger snakes associated with rabbit warrens, either utilising them as home sites, dug out of them, flushed out of them by ferrets or caught in rabbit traps placed over burrow entrances. Large tiger snakes were also discovered in the act of swallowing rabbits up to half grown in size (*The Examiner* 27 Feb. 1912: 3, 2 Dec. 1938: 3; *The Advocate* 4 Jan. 1923: 4, 26 Nov. 1926: 4, 27 Feb. 1929: 4). In one remarkable instance (*The Examiner* 30 Nov. 1915: 4) a correspondent relates an experience from St. Helens and states "While crossing Mr Steeles run at St Helens, Mr Holloway noticed a half grown rabbit run across the track, topple over and die. This drew his attention to the rabbit and he picked it up, and while so doing another did the same thing. He stepped back into the ferns in the direction from where they came, when the third made its appearance ran a few yards, and also toppled over and died. He then observed a burrow, and while investigating the fourth rabbit put its head out, and was struggling with a tiger snake which was holding on to it. Mr Holloway allowed the snake to come out and then dispatched it. The fourth rabbit died almost immediately". This is known behaviour for tiger snakes in a confined space with multiple prey. In such situations they enter a 'biting frenzy' initiated by any movement in close proximity. Such behaviour has been documented in chicken coups and the drays of ring-tailed possums, *Pseudocheirus peregrinus* (Oliver et al. 2010). Tiger snakes did not always have an easy time capturing young rabbits. Adult female rabbits will aggressively defend the maternal nesting chamber. A female rabbit was observed savagely attacking a 1.5 m tiger snake (*The Advocate* 3 Feb. 1940: 6) and using its teeth and claws while jumping on it. Similar behaviour has been recorded for female black rats defending nests of young (Fearn & Spencer 1995). In another instance an exposed nest of juvenile rabbits was discovered amidst flattened and trampled grass where a fresh dead rabbit and a 1.2 m tiger snake, also dead, were observed (*The Examiner* 18 Jan. 1910: 4). Well known Tasmanian author and naturalist, Michael Sharland, published a popular natural history column in *The Mercury* under the alias "Peregrine". He also recorded that female rabbits will attack snakes approaching the maternal nest and observes that tiger snakes primarily predate on juvenile rabbits once they are weaned and leave the maternal burrow. He also noted that tiger snakes were common in rabbit infested country (*The Mercury* 22 Nov. 1941: 5) and that large numbers of snakes overwintered in warrens in sandy ground on north facing slopes in the Epping Forest district (*Mercury* 11 Jun. 1938: 5).

I have always been extremely sceptical of uncorroborated claims of outsize snakes, and publically so (Fearn 2007). Until I saw the newspaper photographs reproduced in this work, I was extremely doubtful if any tiger snakes from the main island of Tasmania could attain 183 cm (6 feet) in total length. While purely speculative, I suspect that the introduction and rapid spread of fantastic numbers of rabbits throughout the settled parts of the island in the mid-1800s had a large impact on tiger snakes in several ways.

(1) Vast quantities of readily available novel prey would have allowed tiger snakes to grow to their potential maximum size relatively quickly.

(2) Such readily available quality prey may well have allowed female tiger snakes to invest more energy into average and maximal clutch size resulting in an overall increase in tiger snake numbers.

(3) Selection for very large 'super males' may have occurred in some districts. The costs of reproduction to female tiger snakes are relatively severe. Producing large clutches of live neonates can deplete female energy stores (fat) to the point where they need to 'rest' from reproduction for several years in order to build up body condition (Shine 1994; Fearn et al. 2012). Sperm on the other hand is relatively energetically 'cheap' to produce and so adult males can be sexually active every year seeking a fewer number of ovulating females. Competition for access to females leads to male-male combat in tiger snakes. These ritualistic wrestling bouts that are a test of strength and endurance, generally occur when two similarly sized males converge on a single female (Fearn & Staubmann 2001). Combat bouts can last for several hours if the snakes are evenly matched in length and weight with the dominant animal eventually tiring its opponent and forcing its head to the ground. Selection therefore favours larger male size through the winners of combat bouts attaining more matings. Male Tasmanian tiger snakes are larger than females in all parameters studied to date (body size (both length and weight), tail length and head size) (Fearn et al. 2012). Before rabbits arrived in vast numbers, the maximal size that a male tiger snake could attain was probably a trade-off between prey availability (in terms of type, size and abundance) and energy expenditure in seeking and subduing prey as well as covering large distances in search of receptive females and possibly engaging in energy expensive combat bouts with rival males. Maintaining optimal body condition, continuing to grow and storing adequate fat for the long winter torpor are additional burdens limiting the size a snake could attain. All these factors would still have been at play during the rabbit plagues but a relatively large, abundant, easy to catch and nutritious prey species may have allowed some males to attain sizes never before possible. Such males would not only be formidable combat opponents but would also have avoided combat altogether by intimidating most rivals by their size. It would be remarkable if the snake in Plate 2 encountered many other snakes its own size.

So how large did tiger snakes grow? One of the largest specimens reported also includes a photo (Plate 2) so it is possible that some specimens exceeded 2 m in length. Some of the largest snakes recorded in Tasmania and initially identified as tiger snakes later turned out to be pythons that had escaped from travelling menageries associated with the show circuit. One such case was a 9 foot (274 cm) 'tiger snake' killed at Kempton (*The Mercury* 5 Feb. 1915: 4). A 12 foot 6 inch (381 cm) 'tiger snake' was run over at Conara and featured on the front page of *The Examiner* on 26 February 1957. The identification was made by an inexperienced staff member at the Queen Victoria Museum and Art Gallery, which caused the Museum some embarrassment when the snake generated interest from all over Australia and was subsequently identified as a north Queensland scrub python (*Morelia kinghorni*) that had escaped from a travelling reptile collection. I suspect that the 8 foot (243 cm) snake that was residing around the Circular Head Wharf for several years and finally captured after falling into a well in 1875 was also a python that had made its way to Tasmania in freight (*Launceston Examiner* 2 Mar. 1875: 3).

Plate 3. Mr Archer holding the well-conditioned 5' 7.5" (175 cm) male tiger snake he killed in a field at Seabrook, northwest Tasmania in 1953. In thirty years of field work I have not seen a living snake on the main island of Tasmania as long as this. [photo courtesy of *The Advocate*, 2 Feb. 1953: 3]

There are some outsize tiger snake reports that I am unsure what to make of. One of the most outlandish is from 1922 when a disturbance among some pigs at Ridgley revealed a "monster tiger snake" in the act of "swallowing a seven day old sucker". After being dispatched with a fern hook the carcass was displayed at the "Armytage" homestead. On being dissected, the snake was found to contain a full grown rabbit. No length was recorded for the snake (*The Advocate* 15 Mar. 1922: 6). Equally bizarre is an 1843 report of when a cow owned by a Mr O'Connor was observed lying on its side and in distress at St Peters Pass. The person dispatched to investigate discovered a tiger snake nearly 8 feet (243 cm) long with proportionate thickness, lying beside the cow. The snake was "dispatched with difficulty" and was "considered by all who viewed it, the largest snake ever killed in the colony" (*The Courier* 20 Jan. 1843: 2).

Hall (1859) wrote one of the very first scientific and rational accounts of Tasmanian snakes and snake bites during the colonial period and suggests that 4-5 feet (120-153 cm) is the common length for the black snake (= tiger snake) but the largest one he ever saw was "killed with a stock riders whip on the high road, by a gentleman riding with me. It was of the black species, and seven and a-half feet long" (228 cm). While these last two instances are nothing more than uncorroborated stories, I believe there is sufficient evidence to suggest that tiger snakes in excess of 183 cm were once more generally common than they are today. One of the most interesting contemporary discussions of the topic was an article written for *The Mercury* by the Tasmanian Museum Director, Clive Lord, in 1910. In the late 1800s a sceptical gentleman called Morton Allport offered the princely sum of 5 pounds for anyone who could produce a tiger snake more than 6 feet (183 cm) long (*The Mercury* 19 Feb. 1881: 3). Known as the 'Allport Reward', it was soon withdrawn after he quickly received several specimens in excess of that length. Lord went on to state "as far as can be ascertained now, all the big snakes sent in were of the black variety of the ordinary tiger snake (*Notechis scutatus*)". He goes on, "the largest specimen of *Notechis scutatus* in the Museum is 6′ 2.5″ inches in length and was killed at Melton Mowbray. It was presented to the Museum by Mr E. O. Bisdee" (*The Mercury* 16 May 1910: 2). Sadly this specimen is now lost (Andrews 1987) but it was on public display, spirit-preserved in a large jar for many years (*The Mercury* 16 May 1910: 2).

Plate 4. A big male tiger snake 6′ 2″ (189 cm) from Railton, northwest Tasmania in February 1953. It is being held by Mr C. McGinty (right) and Mr L. Maney. The large prey bolus two thirds of the way down the body from the head could well be a rabbit. [photo courtesy of *The Advocate*, 5 Feb. 1953: 1]

The introduction of myxomatosis into Tasmania coupled with a well organised Government destruction program and a series of wet winters in the mid 1950s saw the Tasmanian rabbit population plummet (Meldrum 1959). Rabbits are still present throughout peri-urban and rural Tasmania and tiger snakes still eat them (Fearn 1988) but the almost unbelievable densities before myxomatosis are probably gone forever. The outsize tiger snakes appear to have largely gone with them. Snakes that had attained lengths of 1.7 m and over probably struggled to maintain condition in a landscape suddenly largely emptied of rabbits. There must also have been large numbers of other predators from quolls to masked owls that suddenly faced similar challenges. All of these predators would have had to have switched to alternative prey and thus placing those species under intense predation pressure. The loss of millions of rabbits in such a short time must have sent shock waves through the Tasmanian ecosystem.

There appear to have been only been a couple of photographs of very large wild tiger snakes in Tasmanian newspapers after 1954. A robust 5′6″ (167 cm) specimen was captured at Interlaken in January 1970 (*The Mercury* 16 Jan. 1970: 1) and a 6′1″ (186 cm) specimen was killed at Oatlands in 1973 (*The Mercury* 25 Jan. 1973: 2). The last truly gigantic snake to appear in a Tasmanian newspaper was a 5′8″ (176 cm), 2.2 kg female[2] captured in a newly established pine plantation beside the Wesley Vale pulp mill in 1979 (Plate 5)

[2] This snake was erroneously identified as a male in one of the author’s earlier works (Fearn 1993).

(*The Advocate* 1 Mar. 1979). While this snake may well have consumed the occasional rabbit, I believe it represents a rare example of an outsized freak. This snake would be very large for a male, and as discussed earlier, male Tasmanian tiger snakes typically grow much larger than females (Fearn et al. 2012) so this specimen is a true giant. Based on clutch sizes from specimens a third of this size, this giant female had the potential to produce clutches of more than 100 neonates. Unusually for giant snakes, this specimen eventually made its way to the Queen Victoria Museum and Art Gallery in Launceston where it still resides in the spirit collection (Registration No. QVM: 1985:3:1).

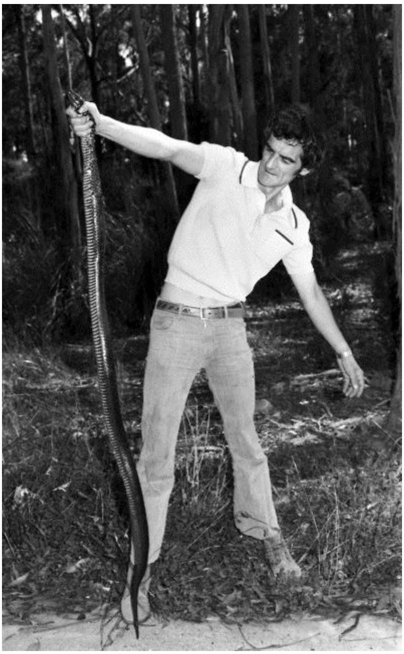

Plate 5. Frank Bingham holding the giant 5’ 8” (176 cm) female tiger he captured on land beside the Wesley Vale pulp mill in March 1979. This is the biggest female tiger snake recorded anywhere in Australia and also the heaviest wild tiger snake ever recorded. [photo courtesy of, 1 Mar. 1979]

There have been some rather clumsy and obvious hoaxes of giant tiger snakes over the years. One such is a claim of a 6′6″ (201 cm) for a specimen killed at Agnews Marsh, Interlaken in 1977 (*The Mercury* 17 Mar. 1977: 11). The accompanying photograph shows the snake’s slayers standing on the head of the skin only and stretching it to arm’s length above their heads. Snake skins typically stretch by 30%, so the living snake was considerably shorter than the claimed length. As recently as 2011 a photograph purporting to show a 9′6″ (292 cm) tiger snake killed at Bagdad went viral in social media and appeared in Tasmanian newspapers (e.g. *The Advocate* 18 Mar. 2011: 7). The photo was nothing more than an optical illusion produced by its slayer holding the approximately 1.5 m long dead snake out in front of himself on a long stick.

Today dozens of people are involved in “nuisance” snake removals all over Tasmania and the majority of the population carries a mobile phone capable of taking high quality pictures. If tiger snakes much over 1.7 m still exist, then they must be extremely rare. As a person with a lifelong fascination with snakes I am a little sad that I missed the ‘golden era’ for tiger snakes in this State. Imagine stumbling onto a 2 m tiger snake with a freshly sloughed skin flattened out to nearly 20 cm in width in the morning sun. It would seem that half a century ago such an event was possible.

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Plate 6. This 1,663 mm male tiger snake from South Nietta is the longest living snake the author has encountered in more than 30 years of field work on the main island of Tasmania: it is snakes like this that may have been able to grow rapidly to a much larger size when hundreds of thousands of rabbits invaded the Tasmanian landscape in the mid 1800s

Table 1. Records of Tasmanian tiger snakes (*Notechis scutatus*) greater than 1.5 m in length from Tasmanian newspapers 1843-1954

[A = *The Advocate*, E = *The Examiner*, LE = *Launceston Examiner*, M = *The Mercury*, CT = *Colonial Times*, TC = *The Courier*; * photo present, ** photo present and reproduced in this work (Plates 1-4)]

No.	**Year**	**Location**	**Stated length** (feet, inches)	**Metric conversion** (cm)	**Reported prey**	**Source, date and page number**
1	1843	St Peters Pass	8	243		TC Jan. 20: 2
2	1844	Georgetown	5.9	180		CT May 28: 3
3	1846	Georgetown	5.9	180		E Nov. 3: 6
4	1848	Pleasant Hills	6	183	baited from hole with dead parakeet tied to string	CT Feb. 4: 3
5	1889	Richmond	5.8	176	3x young rabbits	LE Mar. 15: 3
6	1900	Rokeby	5.6	173		M Mar. 17: 2
7	1900	Campbell Town	5.6	173		E Mar. 17: 7
8	1903	Campbell Town	6.25	189		E Oct. 13: 7
9	1904	Campbell Town	5.8	176		M Aug. 15: 2
10	1909	Springfield	5.10	182		E Feb. 16: 4-5
11	1910	Stanley	5.85	176		E Nov. 19: 5
12	1911	Hobart	7.2	219		E Feb.8: 5
13	1912	Kelso	5.7	174		E Apr. 4: 4
14	1915	Scottsdale	5.4	164	dug from rabbit warren	E Apr. 13: 4
15	1915	Scottsdale	5.3	161	dug from rabbit warren	E Apr. 13: 4
16	1915	Bream Creek	6	183		M Sep. 11: 4
17	1916	Avoca	5.6	173		E Jul. 18: 4
18	1916	Lilydale	6.4	195		E Feb. 9: 4
19	1919	Sheffield	6.15	187		E Mar. 5: 3

No.	**Year**	**Location**	**Stated length** (feet, inches)	**Metric conversion** (cm)	**Reported prey**	**Source, date and page number**
20	1919	Claude Road	7	213		A Mar. 4: 2
21	1920	Crayfish Creek	5.7	174		A Feb. 7: 2
22	1920	Claude Road	5.7	174		A Feb.12: 2
23	1920	Moorleah	5.3	161	ingesting hare	A Mar. 18: 2
24	1922	Ridgley			adult rabbit in gut	A Mar. 15: 6
25	1922	Nietta	5.3	161		A Feb. 23: 5
26	1922	Nietta	5.9	180		A Feb. 23: 5
27	1922	Wilmot	5.6	176		A Jun. 14: 4
28	1922	Central Castra	5.3	161		A Jan. 30: 5
29	1922	Claude Road	6.1	186		A Apr. 8: 4
30	1923	Ashwater	6.1	186		A Feb. 23: 4
31	1923	Tooms Lake	7	213		M June 19: 9
32	1924	Preston	5.9	180		A Mar. 11: 4
33	1924	Launceston	5.10	182		A Jan. 29: 5
34	1924	Zeehan	5.3	161		A Feb. 11: 4
35	1924	Zeehan	5.2	158		A Feb. 4: 4
36	1925	Upper Natone	6.10	210		A Oct. 24: 4
37	1927	Stowport	5.10	182	swallowing rabbit	A Jan. 25: 4
38	1927	Burnie	5.9	180	attacking hatchling chickens	A Oct. 22: 4
39	1928	Black River	6	183		A Feb. 8: 4
40	1928	Mooreville Road	5.7	174		A Feb. 20: 4
41	1928	West Pine	5.4	164		A Nov. 17: 4
42	1930	Lefroy	6.3	192		E Apr. 10: 5
43	1931	Cuprona	5.6	176		A Feb. 10: 4

No.	**Year**	**Location**	**Stated length** (feet, inches)	**Metric conversion** (cm)	**Reported prey**	**Source, date and page number**
44	1931	Bothwell	5.6	176		M Sep. 29: 5
45	1933	Wynyard	5.3	161		A Feb. 16: 6
46	1933	Romaine	5.9	180		A Nov. 17: 6
47	1933	Ouse	5.10	182		M Jan. 24: 5
48	1933	Melton Mowbray	5.7	174		M Jul. 26: 5
49	1933	Broadmarsh	5.45	165	2x half-grown rabbits in gut	M Feb. 4: 9
50	1933	Bothwell	5.9	180		M Oct. 5: 6
51	1934	Turners Marsh	5.3	161		M Jan. 23: 12
52	1934	Launceston	5.6	176		E Sep. 3: 6
53	1935	Adamsfield	5.4	164		M Feb. 25:4
54	1935	Westerway	5.9	180		M Feb. 14: 10
55	1936	York Plains	5.6	176	attacking young chickens	M Feb. 1: 9
56	1936	New Norfolk	5.6	176		M Mar. 19: 3
57	1936	Bishopsbourne	5.4	164		E Feb. 18: 5
58	1937	Wynyard	5.6	176		A Mar. 2: 6
59	1937	Calder	6.3	192		A Sep. 15: 6
60	1938	Bridgewater	5.4	164		M Feb. 7: 4
61	1938	Whitefoord	5.8	176		M Feb. 8: 4
62	1938	Preolenna	5.4	164		A Mar. 3: 6
63	1939	Wynyard	5.7	174		E Feb. 25: 6
64	1939	Sheffield	6.4	195		E Feb. 27: 6
65	1940	Wynyard	5.2	158		A Jan. 18: 6
66	1940	Mole Creek	7	213		A Dec. 17: 4

No.	**Year**	**Location**	**Stated length** (feet, inches)	**Metric conversion** (cm)	**Reported prey**	**Source, date and page number**
67	1941	Black Hills, Derwent Valley	5.6	176		M Jan. 18: 7
68	1942	Ridgley	6.1	186	attacking rabbit	A Dec. 14: 3
69	1942	Preolenna	5.7	174		A Jan. 23: 4
70	1942	Preolenna	5.11	182		A Jan. 23: 4
71	1943	Preolenna	5.2	158		A Nov. 2: 4
72	1944	Gretna	5.6	176		M Feb. 9: 5
73	1945	Tewkesbury	6.3	192		A Jan. 23: 4
74	1946	Oldina	5.3	161		A June 20: 4
75	1949**	Interlaken	6	183		M Feb. 11: 23
76	1949	Burnie	5.10	182	adult black rat in gut	A Jan. 29: 11
77	1950	Swansea	5.3	161		M Jun. 15: 10
78	1950**	St Helens Point	6.5	198	attacking rabbit	E Feb. 9: 4
79	1950	Wynyard	5.2	158		A Apr. 4: 8
80	1951	Oatlands	5.7	174		E Feb. 1: 8
81	1952	Tewkesbury	6.1	186		A Mar. 1: 13
82	1953*	Nabageena	5.6	176		A Mar. 28: 3
83	1953**	Railton	6.2	189		A Feb. 5: 1
84	1953**	Seabrook	5.75	175		A Feb. 2: 3
85	1954	Oatlands	6	183		M Feb. 15: 9

Table 2. Tiger snake (*Notechis scutatus*) bites associated with rabbit hunting from Tasmanian newspapers 1844-1942

[A = *The Advocate*, E = *The Examiner*, LE = *Launceston Examiner*, M = *The Mercury*, CT = *Colonial Times*, TC = *The Courier*, EBT= *Emu Bay Times and North West and West Coast Advocate*]

No.	Year	Location	Name	Age	Activity when bitten	Outcome	Source, date and page number
1	1844	Black Brush	surname Argent	boy	retrieving rabbit from hollow log	died	CT Dec. 10: 3
2	1848	Launceston	not named	not stated	inserting arm into rabbit burrow	not recorded	LE Jan. 29: 6
3	1869	Mole Creek	Richard How	boy	retrieving rabbit from hollow log	died	LE Jan. 16: 4
4	1883	Hamilton	Malcolm McConnell	boy	setting trap at entrance to burrow	survived	M Mar. 1: 3
5	1892	Eastern Marshes	Harry Williams	not stated	retrieving rabbit from hollow log	survived	LE Nov. 17: 3
6	1898	Ulverstone	Jack Killott	adult	retrieving rabbit from hollow log	survived; amputated own finger with axe	EBT Nov. 15: 2
7	1913	Cluan	surname Cumins	adult	retrieving rabbit from hollow log	died	M Feb. 21: 4
8	1913	Westbury	Lindsay Ricketts	boy	retrieving rabbit from hollow log	died	E Feb. 25: 4
9	1920	Hamilton	W. Horne	12	inserting arm into rabbit burrow	died	M Oct. 5: 4
10	1920	Strickland	George Pearce	17	inserting arm into rabbit burrow	survived; thumb amputated with shotgun	M Feb. 12: 8
11	1921	Fingal	Francis Bosworth	adult	retrieving rabbit from hollow log	died	M Jan. 17: 4
12	1924	Launceston	John Sturzaker	66	inserting arm into rabbit burrow	survived	A Jan. 29: 5
13	1925	Sheffield	surname Williams	7	retrieving rabbit from hollow log	not recorded	A Jan. 29: 4
14	1932	Scottsdale	A.W. McDougall	40	inserting arm into rabbit burrow	died	E Feb. 2: 5
15	1933	Scottsdale	Charles MacKenzie	15	inserting arm into rabbit burrow	not recorded	M Mar. 28: 5

No.	Year	Location	Name	Age	Activity when bitten	Outcome	Source, date and page number
16	1933	Lefroy	surname Coward	boy	retrieving rabbit from clump of ferns	survived; father amputated finger with pocket knife	E Oct. 27: 6
17	1935	Parattah	James Harrison	14	inserting arm into rabbit burrow	survived	M Mar. 6: 10
18	1935	Jericho	George Bowerman	15	setting trap at entrance to burrow	survived	M Jan. 31: 4
19	1935	Antill Ponds	Allan Hall	15	bitten while digging out warren	died	M Jan. 16: 10
20	1936	Weldborough	Kenneth Dobson	15	inserting arm into rabbit burrow	died	E Feb. 20: 6
21	1942	Oatlands	Geoffrey McDermott	13	getting rabbit out of rock pile	survived	M Jan. 28: 6

AMBUCHANANIA LEUCOBRYOIDES (DAISY PAN MOSS) AT MELALEUCA

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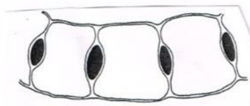
Ambuchanania leucobryoides ('daisy pan moss') is a rare and unusual underground moss endemic to southwest Tasmania, and first found by Alex Buchanan in 1987 (Buchanan 2008; Johnson et al. 2008; TSS 2008). It was originally thought to be an odd type of *Sphagnum*, but was so different in many key ways (Table 1) that at one point, it was proposed that the genus *Ambuchanania* be included in its own family (Ambuchananiaceae), and order (Ambuchananiales)! Now regarded as a species that is related to, but unique from, *Sphagnum* and its allies, it remains in its own genus, but is included with the genus *Sphagnum* in the Family Sphagnaceae (see Glime (2013) and references therein). The discovery of this moss certainly caused a lot of excitement and discussion in the bryological world!

Table 1. Similarities and differences between *Sphagnum* and *Ambuchanania*

Genus Sphagnum	Genus Ambuchanania
Above ground plant, may be immersed in water.	Almost all of the plant grows underground.
Has many branches along the stem, which grow in bunches (called fascicles).	Sparsely branched stems, no development of fascicles.
Has a wood like cylinder of cells in stem centre.	Not present.
Sporophyte capsule spherical.	Sporophyte capsule cylindrical.
Leaves are one cell thick, and composed of two cell types – living green photosynthetic cells and hyaline cells which are non-living, and store water. 	As for sphagnum but different shapes and arrangement. 
Has globose antheridia held on a long stalk.	Antheridia are stalked, and are more elongate
Does not have rhizoids.	Is anchored by rhizoids

Ambuchanania leucobryoides grows underground in sandy washes or 'sand pans', the only parts visible above ground being the tips of the leafy stems, which die off and dry to a wheat coloured tuft.

The known range of *Ambuchanania* is very limited and prior to finding this new site had only been identified in four mostly isolated and hard to get to locations, all of which are in the Tasmanian Wilderness World Heritage Area (Figure 1). These sites are quite far apart including Birchs Inlet at the southern end of Macquarie Harbour, Coffin Creek/Wallaby Bay on the eastern side of Port Davey, and Swallow Creek near Louisa Bay on the south coast. This article is an account of the discovery of another site (Figures 1 & 2), at Melaleuca, a significant range infilling for the species.

Bob and I were at Melaleuca from 25 February to 14 March 2014 as Wildcare volunteers to survey orange-bellied parrots (OBPs) for the Recovery Program. Our duties occupied about two hours morning and night, leaving the middle of the day mainly free. We stayed in the Willson's house which is roughly southwest of the airstrip.

Figure 1. Distribution of *Ambuchanania leucobryoides*, with Melaleuca arrowed in blue (base map: *TheList*; base data: *Natural Values Atlas*)

On Friday 28th February we went for a walk to Kings Knob. We followed a track from the back of the house to the Knob and then walked back cross country via the most southerly of the old mine workings.

This took us across an area of undisturbed, flattish ground that had many sand washed areas where sand is being deposited on the surface. The vegetation was sparse heathland/sedgeland (Plate 1). On the soil surface, in patches, we could see the 'plum pudding' appearance of *Ambuchanania*, (Plate 2), which Alex Buchanan had described to us, and we had seen previously in two small areas that we found near Birchs Inlet in March 2008 when we were also surveying OBPs.

We collected specimens and sent them to the Tasmanian Herbarium for confirmation of identification and for guidance about what they would like us to collect (I also work as a volunteer at the Herbarium). This species is listed as rare under the Tasmanian *Threatened Species Protection Act 1995* and collections were made under a permit issued in accordance with the *Threatened*

Plate 1. Habitat of *Ambuchanania leucobryoides* at Melaleuca

Plate 2. The typical 'plum pudding' appearance of the soil surface of an *Ambuchanania* population; the *Utricularia* flower (1 cm across) provides a scale

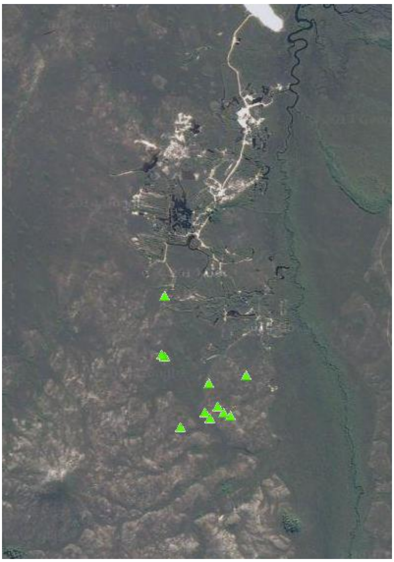


Figure 2. Sites at Melaleuca where *Ambuchanania leucobryoides* has been recorded (base map: *TheList*; base data: *Natural Values Atlas*)

Species Protection Regulations and the *National Parks and Reserved Land Regulations*. Identification was confirmed, and we were asked to collect more specimens of *Ambuchanania* as well as some other moss. Collection was left until 13 March, the day before we were due to leave Melaleuca. Some of the material was needed for DNA analysis in USA and it had to be as fresh as possible.

In the interim we also kayaked down Melaleuca Inlet and walked through similar vegetation across to Loaparte Bay in Bathurst Harbour, walked along the Port Davey track for 2 km, and Bob walked to New Harbour on one day and Pandoras Hill on another, but we spotted no more *Ambuchanania*.

On 13 March, we had about half a day to do two things – collect the requested material, and to try and establish the range of the population. *Ambuchanania* was noted from 12 scattered sites, and specimen material collected from some of them. Only one site was in a disturbed area, in old mine workings where soil to a depth of approx. 750 mm had been removed (Plate 3). The vegetation is recovering. Water and very fine sand was washing over the area. We collected specimens of some other mosses and also saw a patch of what appeared to be very small or fine *Ambuchanania*, some of which was also collected (Plate 4). We did run out of time. But the 12 sites we recorded were scattered over an area of 300 m east-west by 460 m north-south. We didn't record all that we passed and we could see that there is still more to be found in almost every direction.

© Bob Tyson

Plate 3. Collection from the disturbed site 13/3/2014

On return to the Herbarium, the specimens were cleaned to reveal the hidden moss (Plate 5). Its appearance was a great surprise. It was bright green! The very fine specimens collected from the mine workings were the same. I hadn't seen a fresh specimen before: very few have!

It is hard to rationalise the above ground appearance of *Ambuchanania* – a few brownish tufts or less above soil surface, with the bright green photosynthetic plant beneath. The white quartzite soil transmits sufficient light for photosynthesis to occur to a particular depth. The plant is green to that point, and colourless, inactive but probably not dead below that. Above ground, something causes the growing shoot to die off and bleach to the wheat colour. And the plant has to grow upwards to avoid being buried by sand which is constantly deposited over the sand wash area in which it lives.

ACKNOWLEDGEMENTS

We thank Alex Buchanan who in 2008 introduced us to *Ambuchanania*, and said 'keep your eyes open for it…'; Lyn Cave (Tasmanian Herbarium) for advice and encouragement to write this; and Rod Seppelt (Tasmanian Herbarium) for his

help and for the use of his drawings of leaf sections in Table 1.

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Plate 5. *Ambuchanania leucobryoides* revealed

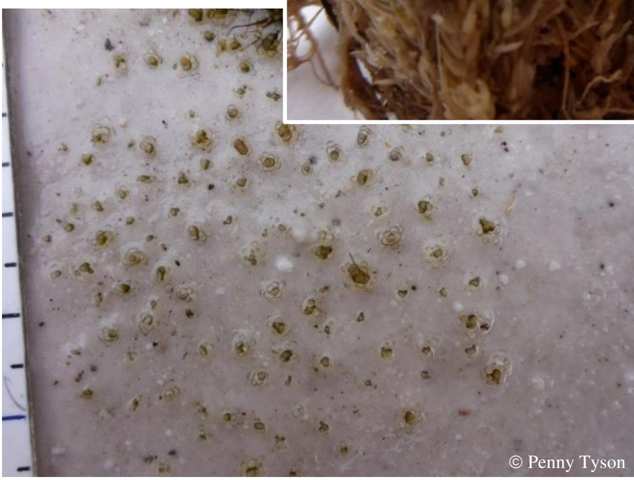

Plate 4. Fine *Ambuchanania* at the disturbed site; each division of the scale is 0.5 cm

ORNITHOLOGICAL OBSERVATIONS FROM A VOYAGE TO SOUTHWEST AND SOUTHEAST TASMANIA 14−19 MARCH 2014 ON *LA GOLONDRINA*

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THE TRIP

The six passengers, Karen Dick, John Lillywhite, Andrew Walter, Hazel Britton, Peter Madvig and I drove down to Kettering, arriving just as *La Golondrina* (Plate 1) pulled up at the public jetty. We met Morrie Wolf, the skipper and Chrissie Rowlands, the only crew member. Chrissie showed us the cabins and we all chose where to sleep – some down below on bunks, others under cover on deck in single fold-up tents. The boat was very stable both for the rough weather and for bird watching as well as tidy, clean and spacious. The toilet and shower were in a combined space, which worked well. Morning tea with Morrie's wife (Christine's) homemade biscuits and fruit cake and then lunch with bread rolls filled with thick slices of Morrie's famous pressed beef tongue and salad were impressive.

Plate 1. *La Golondrina* moving through calm waters (courtesy Morrie Wolf)

Soon we were heading south but from the start, Morrie was concerned about our wish to reach Pedra Branca, as the weather forecast was for gale force winds and 4 m plus swells (for a full summary of the trip's conditions, see Table 1, and for the route, see Figure 1). He decided to head as far around the coast as possible on the first day and so he managed to reach Port Davey that night, a welcome respite from the large, following swell. On the way Morrie caught two tuna, one of which was so large, he was tempted to cut it loose as he struggled to bring it in. The coastal scenery along the way was magnificent with close views of untouched bushland, high cliffs and rugged mountains. Other boats anchored in Bramble Cove were grateful to receive newspapers that Morrie threw to them as we arrived. He seemed to know everyone.

The weather forecast promised deteriorating conditions for the next few days so Morrie felt we could afford a few days pottering around in the inland waters of Port Davey. We motored as far as possible up to Melaleuca and then transferred to the tender dinghy for the last, winding leg up to the home of Jeff and Janet Fenton, greeting them with fresh crayfish as a “passport”. From there we walked to the bird feeding station where we were treated to great views of fifteen Orange-bellied Parrots (Plate 2) and twenty Beautiful Firetails (Plate 3). Also seen in the nearby vicinity were a Striated Fieldwren, Tasmanian Scrubwren, Dusky Robin, a Ground Parrot and a Southern Emu-wren. That night, while watching a Spotted-tailed Quoll on shore, tuna steaks were on the menu followed by Gravenstein apple crumble from the Wolf garden.

Morrie had intended to take us up the Davey River to look for the Azure Kingfisher on day three but during the night there was heavy rain that he knew had flattened out the swell so he made a quick change of plan. The weather forecast was for a 2-3 day gale that would have kept us in Port Davey but we now had a 12-hour window to escape. Leaving early (Plate 4) after hauling up some crayfish, we headed past Maatsuyker Island for Recherche Bay with a dark storm hard on our heels. Here we joined other boats taking shelter but the worst of the weather further south was to come the following day, trapping those who had lingered.

As our passengers were a hardy lot, despite the 3 m swells, Morrie decided to make an attempt at reaching the continental shelf the following morning. He headed due east, past Bruny Island, across the notorious Storm Bay, to Tasman Peninsula and Safety Cove. Here the jetty at Port Arthur was a safe anchorage for an entrée of half a crayfish each followed later by tuna steaks after a group of us had sneaked off to look unsuccessfully for the Masked Owls by the light of a glorious full moon. Others stayed behind to try some squid fishing from the jetty without success except for Morrie who caught a couple while showing them how to do it!

Plate 2. Orange-bellied parrot, *Neophema chrysogaster*, near feeding station at Melaleuca Inlet, 15 March 2014

To Chrissie’s disappointment, these squid proved useful the following day, day five, when we headed out to the edge of the continental shelf east of Tasman Island and then north for several kilometres for a brief berley stop before being chased back by another threatening storm. As there had been no time at Port Davey for Morrie to catch a shark as he had planned, our berley was very limited in quality and quantity,

Plate 3. Beautiful firetail, *Stagonopleura bella*, at Melaleuca Inlet, 15 March 2014

perhaps explaining the lack of diversity of pelagic birds. Morrie timed our return from the shelf perfectly, lingering near Visscher Island while Chrissie managed to bake a batch of savoury scones as we retreated to Blackman Bay and shelter at Dunalley. Here we dined on Chrissie's secret battered fish recipe while tied securely to the jetty.

Dunalley is slowly recovering from the devastating fires, which were still obvious a year later from the water. The passage through the canal, hand-dug by convicts, went smoothly as the traffic was stopped for us to go past the opened bridge. Chrissie served hot scones with homemade apricot and raspberry jams as we crossed Frederick Henry Bay. Travelling past various small islands, extensive beaches and cliffs gave us an interesting perspective on this magnificent, fairly untouched coastline that is not apparent from shore.

From here we slipped around the Iron Pot, the second oldest light in Australia, now clad in scaffolding for restoration work.

Plate 4. Leaving Port Davey, 16 March 2014

Then down the D'Entrecasteaux Channel between Bruny Island and Tinderbox Peninsula, admiring the historic old white and green pilot station houses opposite the entrance to the Derwent River where the old sailing ships arrived from Europe after many months at sea.

Throughout the trip, Chrissie was fantastic, always alert to everyone's needs including the skipper's and quietly working in the background. The high quality of the fresh home produce and the delicious meals prepared by cook Chrissie made every meal a special occasion.

As a group, we all pitched in and helped when needed, looked out for each other and took turns taking notes on the birds.

Arriving safely at Kettering, we knew that we had not reached Pedra Branca but that Morrie had managed to do more than would have otherwise been possible without his clever reading of the prevailing conditions. All were in grateful appreciation of Morrie's amazing seafaring skills learnt from years of experience. In addition his hospitality, warm personality and dedication to offering us a comfortable, interesting and exciting experience made this a trip of a lifetime.

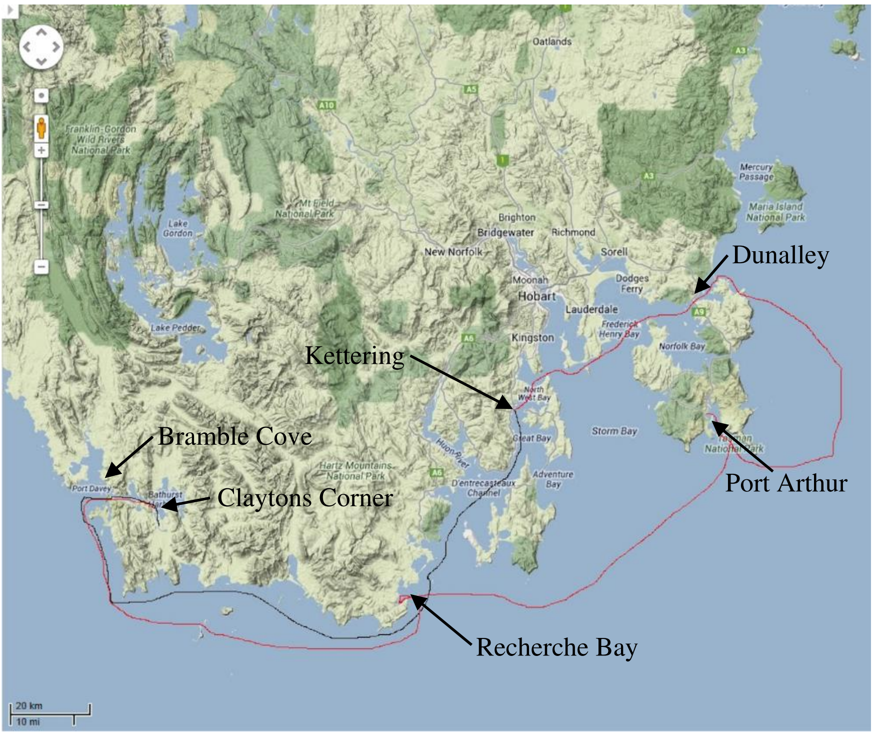

Figure 1. Route of our voyage, with some key locations indicated

THE BIRDS

The original itinerary was planned as a pelagic birding trip with visits to Pedra Branca (35 km south of the Tasmanian mainland) and the waters off South West Cape with a brief side trip into Melaleuca Inlet (Bathurst Harbour). As discussed above, the adverse weather forced the skipper to change our route with a resulting loss of pelagic birding opportunities.

For truly pelagic sea birding, we spent 2 hours traversing the waters between Tasman Head (Bruny Island) and Cape Raoul (Tasman Peninsula) on Day 4 and 2-3 hours on the edge of the continental shelf northeast of Tasman Island (Day 5). The remainder of our sea birding was done in waters generally within 8 km of land. The birds seen were counted and recorded as they were identified and a daily review of sightings was undertaken. Digital photographs aided in the identification of seabirds, especially for the great albatross and petrel species.

From a sea birding perspective, the trip was a moderate success with bird watching opportunities compromised by the often rough seas and the lack of berley on board; and photography was made difficult by the sea conditions. These factors were partly compensated firstly by the very stable boat with good vantage points for observing birds and secondly by the strong southwesterly winds bringing birds closer to the coast than might otherwise have been the case.

Twenty four seabird taxa were identified in offshore and pelagic locations. For comparison, on Eaglehawk Neck pelagic trips from 1996–2013 the trip average is 21 seabird taxa identified in offshore and pelagic locations. The Cook's Petrel was a rare sighting in Tasmanian waters (single bird observed on Day 3, east of Maatsuyker Island and confirmed by digital photograph). The high number of Buller's Albatross observed in offshore waters was also noteworthy. Other highlights were the Wandering-type albatrosses on Day 5 (total 5 birds) (Plate 5); the large numbers of Common Diving-Petrels on Day 3 (c. 500 birds); and the good sightings of Soft-plumaged Petrels on Days 3 & 4 (total 5 birds) (Plate 6).

The two hours birding at Melaleuca Inlet at the Orange-bellied Parrot Feeding Station and the surrounding areas were very successful with a good diversity of birds being observed, including the local 'specialities'. Fifteen Orange-bellied Parrots were observed consisting of first year birds and adults, and including one un-banded individual (Plate 2).

The tally of common terrestrial and shorebird species was increased by overnight stays at Port Arthur (Safety Cove) and Dunalley (Blackman Bay).

For a more detailed listing of the birds observed on the trip, refer to Table 2. Plates 1-6 provide some annotated images of the birding highlights of the trip.

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Plate 5. Snowy form of the Wandering Albatross, *Diomedea exulans*, just landed on waters off Tasman Island, 18 March 2014

Plate 6. Soft-plumaged Petrel, *Pterodroma mollis*, west of Maatsuyker Island, 16 March 2014

Table 1. Summary of sea conditions

CONDITIONS	Day 1 Fri 14 Mar.		Day 2 Sat 15 Mar.		Day 3 Sun 16 Mar.		Day 4 Mon 17 Mar.		Day 5 Tue 18 Ma.		Day 6 Wed 19 Mar.
	am	pm	am	pm	am	pm	am	pm	am	pm	am
Location	Kettering and D'Entrecast-eaux Channel	south and southwest coast inshore to Port Davey	Bramble Cove to Melaleuca (Kings Landing)	Melaleuca to Claytons Corner (Bathurst Harbour)	Bathurst Harbour to Maatsuyker Island	Maatsuyker Island to Recherche Bay	offshore Recherche Bay to Port Arthur crossing Storm Bay		Tasman Island to 'Shelf'	Shelf to Dunalley	Dunalley – Kettering crossing Frederick Henry Bay and inshore Storm Bay
Weather	overcast	fine & sunny becoming overcast	overcast, high cloud	cloudy	overcast with sunny breaks increasing	overcast with sunny breaks	cloudy with long sunny periods		overcast with sunny periods; then becoming cloudy with distant rain		overcast with high cloud
Observing conditions	glary, good visibility	good visibility	moderate	glary, moderate	good	variable with reflection off water	good		good visibility until late day with low cloud and low sun		good
Rain	nil	nil	occasional showers	occasional showers, increasing	light showers in wind gusts	nil	occasional short showers in the afternoon		nil		nil
Wind speed & direction	<10 k, N	15-20 k, E turning southerly 10-15 k	5-15 k, N, warm	5-25 k, gusty NW	15-20 k increasing 25 – 30 k W - NW	20-30 k SW in exposed waters	20-25 k W with periods 30-35 k W-NW		20-25 k NW then < 10 k N	20 k NE then 30-35 k gusty NW	15-20 k NW increasing to 25 k NW
Sea state	calm seas on low S swell	low seas then rougher on 2-3 m W swell	calm in Bathurst Harbour	calm in Bathurst Harbour	1-2 m seas, 2-3 m W swell	1-2 m seas, 1.5-2.5 m SW swell	2-33 m seas, 2.5-3.5 m SW swell plus 1 m NE swell in afternoon		1-2 m seas, 2-3 m SW swell decreasing	2-3 m seas, <1 m SW swell; 0.5-1 m seas in Marion Bay	1 m seas on low SW swell in Storm Bay
Comments	Due to weather forecast for strong winds (30+ k) and high seas (6 m), planned trip to Pedra Branca cancelled; and route changed to go directly to Port Davey; overnight at anchor in Bramble Cove, arriving at ~21.15.		Travelled around Breaksea Island and then travelled to Bathurst Harbour and into Moth Creek; travelled to Melaleuca and the OBP station before returning to Claytons Corner in Bathurst Harbour; overnight on the Claytons Corner jetty.		Weather forecast indicated strong winds (30+ k) and high seas to 8 m from Monday to Wednesday, so decision made to leave Port Davey and travel to Recherche Bay to avoid being forced to remain at Port Davey; travelled via Maatsuyker Is. to overnight at anchor in Recherche Bay.		Travelled to Port Arthur (Tasman Peninsula) to avoid forecast gale force winds in SW Tas; via seaward crossing of Storm Bay; overnight at Port Arthur Jetty.		Travelled east-northeast to the edge of the Continental Shelf past Tasman Island; approx. 2 hours spent in Shelf-edge waters.; proceeded north to Marion Bay and Dunalley; overnight at Dunalley Jetty.		Travelled through the Denison Canal into Frederick Henry Bay and crossed Storm Bay via the Iron Pot light and into Kettering, mooring at the Public Jetty; disembarked at 13.15.

Table 2. Notes on ornithological observations [nomenclature as per BirdLife Australia's Working List v1.1 April 2014]

Species	Total observed	Comments
Black Swan *Cygnus atratus*	85	75 in Blackman Bay
Chestnut Teal *Anas castanea*	2	Bathurst Harbour
Pacific Black Duck *Anas superciliosa*	21	Bathurst Harbour
Hoary-headed Grebe *Poliocephalus poliocephalus*	3	Frederick Henry Bay
Sub-Antarctic Wilson's Storm-Petrel *Oceanites oceanicus oceanicus*	11	
Grey-backed Storm-Petrel *Garrodia nereis*	2	With Gannets in feeding frenzy south of South East Cape
Australian White-faced Storm-Petrel *Pelagodroma marina dulciae*	41	Offshore waters
Wandering Albatross *Diomedea exulans*	2	Pelagic waters off Tasman Island
Auckland Islands Antipodean Albatross (Gibson's Albatross) *Diomedea antipodensis gibsoni*	4	Pelagic waters off Tasman Island
Black-browed Albatross *Thalassarche melanophrys*	6	Both offshore and pelagic waters
Shy Albatross *Thalassarche cauta*	392	Both offshore and pelagic waters
Indian Yellow-nosed Albatross *Thalassarche carteri*	4	Offshore waters
Southern Buller's Albatross *Thalassarche bulleri bulleri*	c. 500	Large numbers inshore, especially west and southeast of South West Cape
Southern Giant-Petrel *Macronectes giganteus*	4	Offshore waters off south coast and pelagic waters east of Tasman Island
Northern Giant-Petrel *Macronectes halli*	6	Offshore waters off south coast and pelagic waters east of Tasman Island
Northern Fairy Prion *Pachyptila turtur turtur*	206	Offshore waters off south coast
White-chinned Petrel *Procellaria aequinoctialis*	14	Pelagic waters off Tasman Island

Species	Total observed	Comments
Sooty Shearwater *Ardenna grisea*	10	Offshore waters off south coast and pelagic waters east of Tasman Island
Short-tailed Shearwater *Ardenna tenuirostris*	c. 7,000	Offshore waters off south coast and pelagic waters east of Tasman Island
Soft-plumaged Petrel *Pterodroma mollis*	5	Offshore waters east and west of Maatsuyker Island
Western Great-winged Petrel *Pterodroma macroptera macroptera*	4	Offshore waters east and west of Maatsuyker Island
Cook's Petrel *Pterodromacookii*	1	Offshore waters east of Maatsuyker Island
Northern Common Diving-Petrel *Pelecanoides urinatrix urinatrix*	630	Offshore waters off the south coast.
Little Penguin *Eudyptula minor*	5	D'Entrecasteaux Channel
Australasian Gannet *Morus serrator*	c. 600	Inshore and offshore waters
Australasian Little Pied Cormorant *Microcarbo melanoleucos melanoleucos*	15	Inshore
Australian Great Cormorant *Phalacrocorax carbo carboides*	20	Inshore
Little Black Cormorant *Phalacrocorax sulcirostris*	6	Inshore
Black-faced Cormorant *Phalacrocorax fuscescens*	1,120	500 + observed on Visscher Island (Marion Bay)
Australian Pelican *Pelecanus conspicillatus*	30	Blackman Bay
Eastern Great Egret *Ardea alba modesta*	28	Blackman Bay
White-faced Heron *Egretta novaehollandiae*	15	
White-bellied Sea-Eagle *Haliaeetus leucogaster*	19	Majority in Port Davey
Tasmanian Wedge-tailed Eagle *Aquila audax fleayi*	1	Over Forestier Peninsula
Tasmanian Native-Hen *Tribonyx mortierii*	5	Port Arthur

Species	Total observed	Comments
Australian Pied Oystercatcher *Haematopus longirostris*	11	Port Arthur and Dunalley
Southern Sooty Oystercatcher *Haematopus fuliginosus fuliginosus*	8	Dunalley
Southern Masked Lapwing *Vanellus miles novaehollandiae*	106	
Brown Skua *Stercorarius lonnbergi*	1	D'Entrecasteaux Channel
Arctic Jaeger *Stercorarius parasiticus*	1	D'Entrecasteaux Channel
Australasian Crested Tern *Thalasseus bergii cristata*	242	Offshore waters and Blackman Bay.
East Coast Pacific Gull* *Larus pacificus pacificus*	260+	200 + observed on Visscher Island (Marion Bay)
Pacific Kelp Gull* *Larus dominicanus dominicanus*	82	* Many large gulls were observed, but were not identifiable
Australian Silver Gull *Chroicocephalus ridibundus*	980	500 on De Witt Island
Tasmanian Green Rosella *Platycercus caledonicus caledonicus*	10	Observed in the Melaleuca Inlet area
Blue-winged Parrot *Neophema chrysostoma*	1	Observed in Melaleuca Inlet area
Orange-bellied Parrot *Neophema chrysogaster*	15	Observed in Melaleuca Inlet area around the feeding station
Tasmanian Eastern Ground Parrot *Pezoporus wallicus leachi*	1	Observed in Melaleuca Inlet area at airstrip
Southern Laughing Kookaburra *Dacelo novaeguineae novaeguineae*	2	Port Arthur
Tasmanian Superb Fairy-wren *Malurus cyaneus cyaneus*	5	Observed in Melaleuca Inlet area
Tasmanian Southern Emu-wren *Stipiturus malachurus littleri*	1	Observed in Melaleuca Inlet area
Southern Tasmanian Scrubwren *Sericornis humilis humilis*	2	Observed in Melaleuca Inlet area
Western Tasmanian Striated Fieldwren *Calamanthus fuliginosus diemenensis*	2	Observed in Melaleuca Inlet area

Species	Total observed	Comments
Yellow-throated Honeyeater *Lichenostomus flavicollis*	4	
Tasmanian Little Wattlebird *Anthochaera chysoptera tasmanica*	1	
Eastern Crescent Honeyeater *Phylidonyris pyrrhopterus pyrrhopterus*	10	
Tasmanian New Holland Honeyeater *Phylidonyris novaehollandiae canescens*	2	
Strong-billed Honeyeater *Melithreptus validirostris*	3	
Tasmanian Grey Shrike-Thrush *Colluricincla harmonica strigata*	1	
Tasmanian Grey Butcherbird *Cracticus torquatus cinereus*	3	
Tasmanian Australian Magpie *Cracticus tibicen hypoleuca*	1	
Tasmanian Black Currawong *Strepera fuliginosa fuliginosa*	18	
Southern Forest Raven *Corvus tasmanicus tasmanicus*	71	
Tasmanian Dusky Robin *Melanodryas vittata vittata*	1	
Eastern Welcome Swallow *Hirundo neoxena neoxena*	1	
Tasmanian Tree Martin *Petrochelidon nigricans nigricans*	20	
South-eastern Bassian Thrush *Zoothera lunulata lunulata*	3	Observed in Melaleuca Inlet area
European Common Blackbird *Turdus merula merula*	2	
European Common Starling *Sturnus vulgaris vulgaris*	15	
South-eastern Beautiful Firetail *Stagonopleura bella bella*	20	Observed at feeding station in Melaleuca Inlet area
European House Sparrow *Passer domesticus domesticus*	2	

ANTI-PREDATION STRATEGIES OF CHOCOLATE WATTLED BATS (*CHALINOLOBUS MORIO*) AFTER A PREDATION EVENT AT A MATERNAL ROOST BY A SOUTHERN BOOBOOK (*TYTO NOVAESEELANDIAE*)

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ABSTRACT

In this paper I report an observation of a southern boobook (*Ninox novaeseelandiae*) predation event on a maternal colony of chocolate wattled bats (*Chalinolobus morio*) and the response of the bats to the predation event. I use this observation as well as anecdotal and published observations to discuss anti-predation strategies used by bats and how predation risk influences roosting behaviour. These observations support the theory that clustering during roost emergence is an anti-predation strategy used by bats.

INTRODUCTION

Predation risk has a major influence on bat behaviour and is considered to be one of the main selection pressures on roost selection by hollow-using bats (Kunz & Lumsden 2003). However, little is understood about how predators influence bat roost site selection and behaviour. Observations of predation on bats at roosts are relatively rare (Twente 1954; Baker 1962; Dwyer 1964; Hammer & Arlettaz 1998; Esberard & Vrcibradic 2007; Borkin & Ludlow 2009) and virtually nothing is known about anti-predation strategies in bats (Petrzelkova & Zukal 2003; Lima & O'Keefe 2013). If predators influence bat behaviour, than an increase in predation risk should generally lead to a change in behaviour favouring a safer behavioural option (anti-predation strategy) most likely at some cost to the bat (i.e. foraging efficiency, thermoregulation) (Lima & O'Keefe 2013).

One might expect that roost selection by individual bats is in part in response to the day-to-day variation in predation risk (Lima & O'Keefe 2013). A range of bat roosting behaviour such as nocturnality, avoidance, coloniality, roost switching, adjusting the times and durations of emergence, changing the hollow of emergence, clustering during emergence, and roost abandonment have been interpreted as an anti-predation strategy (Speakman 1991; Fenton et al. 1994; Petrzelkova & Zukal 2003). However there is little information to support or refute whether bats use these behaviours in response to predation risk, and if so, when and in what situations they are used (Lima & O'Keefe 2013).

Generally, most predation on bats is opportunistic with only a few predators specialising on bats (e.g. the bat hawk, *Macheiramphus alcinus*) (Jones et al. 2012). Opportunistic bat predators include several centipede, frog, snake, bird and mammal species (including humans) (Blainey 1982; Tidemann 1986; Souza et al. 1997; Molinari et al. 2005; Baxter et al. 2006; Esberard & Vrcibradic 2007; de Castro et al. 2011). In most regions, owls are thought to be main predators of bats (Baxter et al. 2006). This is based on bat remains in regurgitated pellets (Hall & Blewett 1964; Green et al. 1986; Garcia et al. 2005; Wiley 2010; Yuan et al. 2010; Rosina & Shokhrin 2011; Khalafalla & Iudica 2012; Lesinski et al. 2012) and several owl predation events that have been reported (Twente 1954; Baker 1962; Borkin & Ludlow 2009; Olsen 2011). Bats can be captured in roosts during the day, presumably while torpid (e.g. by cats) (Scrimgeour et al. 2012) or on the wing as they emerge from roosts at night (e.g. by owls) (Lima & O'Keefe, 2013).

In Australia, bats have a range of nocturnal predators including several owl species such as the southern boobook (Olsen et al. 2008), masked owl (Todd 2012) and barking owl (Stanton 2011); tawny frogmouth (Nick Mooney & Monika Rhodes pers. comm.) and nightjars (Michael Pennay pers. comm.). Other animals observed pursuing or having consumed bats include (but are unlikely not limited to): wedge-tailed eagle, brown falcon, grey goshawk, Australian hobby (Nick Mooney pers. comm.), Tasmanian devils (Jillian Smith pers. comm.), spotted-tailed quolls (Glen & Dickman 2008), cats (Phillips et al. 2001), foxes (Dwyer 1964) and water rats (Woollard et al. 1978). Information on how bats respond to predation risk by different predators (e.g. birds versus mammals), in different situations (e.g. at roosts versus foraging) could provide valuable insights into habitat and roost choice (Lima & O'Keefe 2013).

This short note describes the response of bats to a predation event by a southern boobook (*Ninox novaeseelandiae*) on a maternal colony of chocolate wattled bats (*Chalinolobus morio*). I use this observation and anecdotal and published observations to provide insights into anti-predation strategies used by bats and how predation risk may influence roost use and behaviour.

Plate 1. Female chocolate wattle bat (*Chalinolobus morio*), radio-tracked during the present study

MATERIALS & METHODS

In January 2011, lactating female chocolate wattled bats (Plate 1) with non-volant young were radio-tracked (Plate 2) to their day-time roosts in Woodsdale, southeast Tasmania (552488mE 5293966mN). Roost emergence was monitored by two to three people. Each observation of roost emergence started approximately 30 minutes before the expected onset of emergence. The number of bats emerging, inter-species interactions and emergence behaviour (e.g. emerging in clusters) were recorded by observers. Anabat detectors (SD2, Titley Electronics) were used as a secondary method of monitoring bats during emergence by listening to calls. Moon illumination and sunset times were calculated using the on-line tool timeanddate.com. This study was undertaken under the guidelines of the University of Tasmania Animal Ethics Committee permit #A0010640 and the Department of Primary Industries, Parks, Water & Environment scientific permit (fauna) #FA11226.

RESULTS

On 13 January 2011 a maternal colony of chocolate wattled bats was located in a hollow with a large entrance size (greater than 10 cm) in a *Eucalyptus amygdalina* (black peppermint) tree (Plates 3 & 4). Bats began emerging at 21:02. Bats emerged individually, but more often in clusters of up to 40 individuals. At 21:12, a southern boobook was observed on a nearby branch, approximately 20 m from the roost tree. After several minutes, the boobook flew to the roost entrance, hovering in mid-air in a reared ‘sitting position’, wings out, talons open directed into the roost. Bats continued to emerge and echolocate in clusters despite the presence of the boobook. After a minute, the boobook took flight from the roost and then returned, pursuing emerging bats as they circled the roost tree. After two failed attempts to capture a bat, an individual bat that had circled the roost tree was captured by its wing in the boobook’s talons. The boobook then pecked the bat’s body, the bat became immobile and the boobook flew into nearby forest out of sight.

Plate 2. Radio-tracking bats in dry sclerophyll forest near Woodsdale, with the roost tree depicted in Plates 3 & 4 marked with yellow flagging tape

A total of 299 bats emerged from the roost that night (Table 1), with several bats returning within an hour of the first bat emerging. On the following day, no radio-tracked bats used the tree where the predation event occurred. The individuals radio-tracked were instead found in a small colony of 17 individuals in a nearby tree. Two days later, however, a smaller colony of five individuals, including a least one individual that experienced the predation event, was found roosting in the tree where the predation event occurred. Other radio-tracked individuals were roosting nearby in a roost of 155 individuals (Table 1).

Plate 3. Roost tree showing the typical features of a "good" bat maternal roost including senescent canopy, dead branches with hollow spouts and at least one large trunk hollow (roost hollow circled and depicted in Plate 4)

Plate 4. Close-up of tree depicted in Plates 2 & 3 – note again the multiple hollows which bats exited from in addition to the large main hollow (the lower hollow shows dry rot material deposited by ants)

Table 1. Changes in timing of emergence and colony size of chocolate wattled bats before and after a predation event (bold values indicate observations the night of the predation event)

date	sunset time	roost ID	emergence time	colony size	moon illumination
4/01/2011	19:50	SW26.1	21:11	1	0.1
5/01/2011	19:50	SW26.2	21:24	86	0.6
6/01/2011	19:50	SW26.3	21:18	1	3.2
7/01/2011	19:50	SW26.4	21:10	130	7.8
9/01/2011	19:49	SW26.5	21:22	132	21.3
9/01/2011	19:49	SW6.4	21:14	9	21.3
10/01/2011	19:49	SW26.5	21:09	145	29.8
13/01/2011	**19:48**	**SW24.2**	**21:02**	**299**	**58.5**
14/01/2011	19:48	SW24.3	21:15	17	68.3
15/01/2011	19:47	SW24.2	21:15	5	77.6
15/01/2011	19:47	SW6.6	21:07	155	77.6
16/01/2011	19:47	SW6.6	21:05	341	85.9
18/01/2011	19:46	SW6.7	21:05	220	N/A
19/01/2011	19:45	SW6.7	21:08	1	97.6

DISCUSSION

Bat colonies emerging from a tree-hollow provide a concentrated (albeit fast-moving and small) food resource for nocturnal predators (Petrzelkova & Zukal 2003). As a consequence, it is not surprising that bats feature in the diet of nocturnal predators throughout the world. This is especially so for owls (Hall & Blewett 1964; Green et al. 1986; Garcia et al. 2005; Wiley 2010; Yuan et al. 2010; Rosina & Shokhrin 2011; Khalafalla & Iudica 2012; Lesinski et al. 2012), which are able to access and pursue bats in flight (Olsen 2011). It is therefore not surprising that bats have developed anti-predation strategies. The observations reported in this study demonstrate some of these strategies in use including clustering, delayed emergence and roost switching.

Clustering during emergence is proposed by Speakman (1992) to be increasingly used in the presence of a predator to decrease the probability of predation on the individual (safety in numbers). This strategy appears to be used by several bat species around the world (Fenton et al. 1994; Speakman 1995; Petrazelkova & Zukal 2003), especially in large colonies where it is most likely to be effective (Fenton 1994). This strategy seems to be effective, as owls have been observed to be unsuccessful at predating upon bats when bats emerge in clusters from roosts in this study and by others (Ian Temby pers. comm.; Twente 1954; Baker 1962). Indeed, owls seem more successful predating on individual bats in mid-air (Olsen 2011) rather than directly at a tree hollow roost entrance.

Avoidance is another strategy employed by bats to minimise predation risk. Avoidance may be in the form of roost switching (avoiding the location of the predation event) or fleeing the predator (Kunz & Lumsden 2003). In the present study, bats were observed to switch roosts directly after the predation event. It is difficult to say, however, whether this was in response the predation event, as roost switching was frequently observed during the radio-tracking study (Cawthen et al. unpubl. data). Bats may switch roosts to avoid predators, which may return to the roost tree the following night.

An alternative strategy most likely used when roost-switching or clustering is not effective is delaying the timing of emergence to avoid or reduce the likelihood of predation (Fenton et al. 1994). In my observation, *Chalinolobus morio* did not delay emergence in the presence of a predator but on the following night in an alternative roost with a smaller colony emergence was delayed. This may indicate that *Chalinolobus morio* could not perceive the increased predation risk when the boobook was present or that there was “safety in numbers”. Delayed emergence is not an uncommon strategy in bats in response to predation risk. *Austronomus australis* has also been observed to delay emergence in response to the presence of predators, including humans. This species also stops echolocating and producing social calls in the presence of predators (Monika Rhodes pers. comm.), a strategy not used by *Chalinolobus morio* in this study. However, because insectivorous bats are constrained by the emergence times of insects, they may not be capable of varying their emergence times greatly without effecting foraging efficiency (Jones & Rydell 1994; Baxter et al. 2006).

Bats may not alter their roosting behaviour at all, instead, using evasive manoeuvres in-flight to avoid predators (Lima & O’Keefe 2013). Although this was not observed in this study, several instances of evasive manoeuvres have been observed overseas (Lima & O’Keefe 2013) and in Australia. In Australia, a *Saccolaimus flaviventris* has been observed being pursued by a barking owl and using an aerobatic strategy to avoid predation. As the owl approached, the bat pulled in its wings, dropped out of the owl's flight path and then re-extended its wing and altered direction (Luke Hogan pers. comm.). Bats may also confront their predators in an attempt to avoid predation. For example, *Chalinolobus gouldii* has been observed being pursued by a nightjar and then changing its flight to pursue and harass the nightjar (Michael Pennay pers. comm.).

There are a range of anti-predation strategies used by bats that may influence bat habitat and roost choice, and other bat behaviours, some of which, such as delayed emergence, are likely to reduce the amount of time spent foraging, and may result in changes to habitat selection, potentially reducing bat foraging efficiency. Therefore, understanding anti-predation strategies used by bats is an important component of understanding bat behaviour. Future and previous studies should report movements and habitat selection of bats when exposed to predation events to inform our understanding of anti-predation strategies used by bats.

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A SECOND OBSERVATION OF PREDATION ON RINGTAIL POSSUMS (*PSEUDOCHEIRUS PEREGRINUS*) BY TASMANIAN TIGER SNAKES (*NOTECHIS SCUTATUS*)

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Tiger snakes from the main island of Tasmania are generalist carnivores, predating on a wide range of small and medium vertebrates including amphibians, reptiles, fish, birds and mammals (Fearn et al. 2012). Perhaps reflecting Tasmania's rich small mammal fauna, tiger snakes from the island State display the most diverse diet of any large Australian elapid snakes studied to date (Fearn et al. 2012; Oliver et al. 2010). In a previous work it was speculated that juvenile ringtail possums may be regularly predated upon by adult tiger snakes in districts where possum densities were high, thus increasing encounter rates by foraging snakes (Oliver et al. 2010). In this work we record a further apparent record of a tiger snake predating on a juvenile ringtail possum in Tasmania.

On 27 December 2013 at approximately 10.00AM, a dead ringtail possum of approximately 25 cm in head-body length was observed beside a small tributary creek of Kia Ora Creek while one of us (ET) was engaged in construction work at the old toilet site, Kia Ora Hut (41°53′32″S 146°4′53″E), Cradle Mountain-Lake St Clair National Park. The possum appeared in good condition and displayed no wounds of any kind. The head and fore body up to the level of the shoulders was covered in what appeared to be dried saliva. Assuming the possum had been predated upon by a snake and partially swallowed, it was returned to the ground where it was discovered. At 4.00PM the observer returned to the site to photograph the possum corpse at which time a mature tiger snake of approximately 1.5 m total length was discovered in the act of ingesting the carcass. A photo was taken (Plate 1) and while attempting to get closer for a second photo, the snake took fright and attempted to decamp from the scene by lifting the relatively large possum carcass off the ground and heading towards thick vegetation some 4 m away on the edge of the creek (Plate 2). Not wanting to risk unduly stressing the snake it was left alone at this point. Several hours later at dusk a quick search failed to locate either the possum or the snake.

Plate 1. Adult tiger snake (*Notechis scutatus*) swallowing juvenile ringtail possum (*Pseudocheirus peregrinus*)

This particular observation bears close similarities to those described by Oliver et al. (2010) for tiger snakes predating on ringtail possums in southwest Tasmania. The undamaged carcass of an apparently healthy juvenile possum with its fore body covered in saliva is typical for attempted predation by tiger snakes. The fangs of even maximal sized tiger snakes rarely exceed 6 mm in length (Sutherland & Tibballs

2001) and are extremely sharp, typically leaving no obvious wounds on small animals with a dense pelage. While impossible to know, it is highly likely that the snake that killed the possum was the same individual observed consuming the possum earlier in the day. Captive tiger snakes have been observed to regurgitate partially ingested prey that is at or beyond their swallowing capabilities and, presumably driven by hunger, return to such prey for a second attempt at ingestion (S. Fearn, unpubl. data). While not documented in this case, it would be entirely possible for a mature tiger snake to eventually successfully ingest a juvenile ringtail possum (Oliver et al. 2010). Even if not responsible for the ringtail possum's death, Tasmanian tiger snakes are known to readily take carrion, even material that is well decomposed and fly blown (Fearn 1993).

There is mounting evidence in Tasmania that ringtail possums are commonly predated upon by tiger snakes and these reptiles may represent a common predator of this species. Tiger snakes are primarily diurnal searching foragers and are particularly efficient at capturing small nocturnal mammals in their day time retreats (Fearn 1993; Fearn et al. 2012). Tiger snakes commonly forage above ground in trees and shrubs in search of mammals and nestling birds (Fearn 1993). The dreys built by ringtail possums in dense vegetation would present no impediment to predation by ophidian predators (Fearn & Spencer 1995; Oliver et al. 2010).

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Plate 2. Tiger snake retreating to cover with partially ingested ringtail possum

NEW CARABID DISCOVERIES: *CATADROMUS LACORDAIREI* (GREEN-LINED GROUND BEETLE)

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The fortuitous discovery of egg capsules of unknown origin in December 2013 has led to the documentation of the life stages (from egg to adult) of *Catadromus lacordairei* in Tasmania.

The adult, described by Boisduval in 1835, occurs in every Australian State including Tasmania and is also found on Kangaroo Island; however, the immature stages have never been formally described. In the *Proceedings of the Linnean Society of New South Wales* 1904, Walter Froggatt exhibited larvae of the species that were taken "along the banks at Howlong, and… were observed eating small frogs". In his book, *Australian Insects* (1907) Froggatt states that both *Catadromus australis* and *Catadromus lacordairei* may be found "along the edges of swamps and lagoons in the Murray country living under dead logs, where their black banded larvae may also be found, sometimes feasting on small frogs".

Papers documenting the life history and a formal description of the larval/ pupal stages are in preparation but due to editorial pressure, we offer a single enticing image (Plate 1) as a teaser to interested naturalists. The adult female survives and currently accepts food at weekly intervals.

Plate 1. Captive reared female *Catadromus lacordairei* (insert: larval instar 2)

ORNITHOLOGICAL OBSERVATIONS FROM THE 2013/2014 SEASON OF *THE MARIA ISLAND WALK*

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INTRODUCTION – *THE MARIA ISLAND WALK*

The Maria Island Walk is an international award-winning eco-tourism venture that conducts regular four-day walks along the length of Maria Island from Haunted Cove to Darlington. Two experienced guides accompany up to eight guests and overnight accommodation is provided as well as local food and wine. An important aim of this company is to monitor and preserve the natural values of the island.

In previous years I have been invited to train the guides in the identification of the island's birds and plants and to advise on strategies for their protection from disturbance. In 2010 there were 61 groups that submitted records of all the birds sighted. This season (7 October 2013 to 19 April 2014), the guides for only 33 groups focused their daily records on seven key bird species: Hooded Plover, Red-capped Plover, Pied Oystercatcher, Sooty Oystercatcher, Wedge-tailed Eagle, White-bellied Sea-eagle and Forty-spotted Pardalote. These easily identifiable species were considered to be important indicators for the conservation status of the island.

ANNOTATED LIST OF SPECIES

Hooded Plover (*Thinornis rubricollis*)

A resident species recorded on all the island's beaches over 44 days, these were in numbers ranging from a single bird to a maximum of 12 birds at one location. There were 18 records of 2 birds, the highest number, followed by 10 records of 4 birds. However, numbers were almost halved from those reported in 2010 (Wakefield & Hayward 2010) when there was a maximum of 20+ birds in one location. In 2011, the following year's report, the numbers even reached 33 (Wakefield & Wakefield 2011). There were no chicks or evidence of breeding reported this 2013 season.

Australian Pied Oystercatcher (*Haematopus longirostris*) [Plate 1]

Up to 15 Pied Oystercatchers have been observed with good numbers present throughout the season. Four was the most common number recorded (22 times and throughout the season), followed by 14 records of 2. However, again the numbers present were no more than 15 whereas in 2010 there were up to 30 birds recorded (Wakefield & Hayward 2010) and in 2011 there were 22 (Wakefield & Wakefield 2011). It was noted in 2010 that the high numbers might have been due to double counting when the birds flew from one beach to the other. This season there were no breeding records whereas in 2010 there were three pairs each with two young although there was only a positive sighting of one chick surviving.

Plate 1. Adult and juvenile Pied Oystercatcher

Sooty Oystercatchers (*Haematopus fuliginosus*)

Up to 11 birds with single birds counted on 13 days and pairs recorded on 17 occasions. There were no breeding records but this species has never been recorded as breeding on Maria Island despite the fact that 3 pairs breed on nearby Lachlan Island.

Red-capped Plover (*Charadrius ruficapillus*)

The largest group of Red-capped Plovers reported was 7 with small numbers throughout the season including a possible breeding record. Although no chicks or eggs were recorded, there was a broken wing display from a bird, which would indicate the presence of chicks or eggs in the nest. Numbers were down from 2010 when more than 20 birds were recorded together (Wakefield & Hayward 2010). In 2010 there were chicks present but it is not certain that they had bred on the island and may have flown in from elsewhere. In 2011 only one bird was recorded in the second week of April 2011 (Wakefield & Wakefield 2011).

Wedge-tailed Eagle (*Aquila audax fleayi*)

Single adults were recorded on 15 occasions and on 18 March 2014 there was a single adult with a juvenile bird. A pair was recorded only once on 26 March 2014.

It is likely that these birds are resident. While according to *Birds of Maria Island* (Rounsevell et al. 1977), they have never bred on the island, more recent information (DPIPWE's *Natural Values Atlas* database) indicates a nest in the upper reaches of Bernacchis Creek on the northwest of Mount Pedder. Their presence would at least indicate an adequate food supply in the area.

White-bellied Sea-eagle (*Haliaeetus leucogaster*) [Plate 2]

Sea-eagles were observed as single birds on 25 occasions and as pairs on 5 occasions. A single bird with a juvenile was observed at Haunted Cove on 11 December 2013, and on 17 December 2013 but no location was mentioned for this second record of a juvenile. In 2010 Haunted Cove was the most reliable location to see this species and it was suspected that there were possibly four pairs breeding on the island with eyries at Skipping Ridge, Counsel Creek Whalers Cove as well as at Haunted Cove (Wakefield & Hayward 2010). It would be interesting to hear of any recent surveys of these nesting sites.

Forty-spotted Pardalote (*Pardalotus quadragintus*)

The guides have reported the presence of this, the most endangered bird on Maria Island, with numbers ranging from a single bird in April, February and December to 6 birds being the highest count on 6 February 2014. Two birds were recorded 10 times, 4 birds 4 times and 5 only once. Apart from 10+ birds in later November 2010, numbers were small in that season (Wakefield & Hayward 2010). As Forty-spotted Pardalotes are sometimes ground-nesting as well as tree-nesting, they are vulnerable to predation by cats as well as devils. Young devils have been known to climb trees to find birds nesting in hollows and any ground-nesting birds would be sniffed out as well. Maria and Bruny islands have had the largest remaining numbers of this species that is rapidly disappearing elsewhere.

CONCLUDING REMARKS

Groups walking along the beaches potentially disturb the shore birds in particular. Of the four shore bird species monitored, only the Red-capped Plover had a possible breeding record in the 2013/14 season and maximum numbers present have come down from 20 to 7 over a period of 3 years.

Forty-spotted Pardalotes breed in close proximity to at least two of the overnight camps and their continuing presence may be indicative of good practice by the company and their guests.

As top predators, the presence of raptors indicates the general health of the island and its ability to sustain them. These raptors are now competing with the introduced Tasmanian devil and it will be interesting to see how they manage in the future.

ACKNOWLEDGEMENTS

Special thanks must go to the guides and guests of *The Maria Island Walk* who took the time to complete the record sheets at the end of each day while their memories were fresh.

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Plate 2. Adult White-bellied Sea-eagle – note the eye in the shadow off a branch, a behaviour allowing the bird to better detect prey

DID *CASTIARINA INSCULPTA* (MIENA JEWEL BEETLE) RIDE ON THE SHEEP'S BACK?

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The Miena jewel beetle, *Castiarina insculpta*, is a narrow range endemic, listed as being endangered under the Tasmanian *Threatened Species Protection Act 1995*. The species was originally described from a single female specimen collected from the Great Lake area (Carter 1934). Between then and 2010, only a further five female specimens were found, all of which were dead. Until 2013 no records existed of live animals or a male of the species.

In 2013 field naturalists observed for the first time multiple *Castiarina insculpta* of both sexes active across several locations south and west of Great Lake, the species being found on the composite (Asteraceae) shrub *Ozothamnus hookeri* (Bonham et al. 2013). The present article explores the likely factors contributing to the apparent population increase of *Castiarina insculpta*, hypothesizing that the expansion of *Ozothamnus hookeri* stands across the Central Plateau is the most probable explanation.

The past

The known range of *Castiarina insculpta* (Plate 1) is contained wholly within the upper region of the Central Plateau landscape at elevations above 900 m and confined to an area of approximately 620 km^2 (Figure 1). Parts of this region have been subjected to timber harvesting, although this activity has generally been concentrated in the mid to lower elevations, as forest growth is greater in these areas and the sawlog produced was of a much higher grade (Shepherd 1973). Exploration of the Great Lake catchment resource for hydroelectricity generation began in 1911 (Shepherd 1973), while hunting, rabbit trapping and snaring of wallaby and possum also occurred across the plateau. However, the major land use of the region since European settlement in the 1820s has been grazing (Jackson 1973).

Fossil pollen studies conducted at Camerons Lagoon (Thomas & Hope 1994) have revealed that on a regional basis Liawenee Moor, home to *Castiarina insculpta*, has remained a relatively stable environmental unit for 8,000 years, while also providing evidence of transformation and change in the plant communities. The most obvious of these changes was a recognised slow trend towards increased shrubbiness until about 165 years ago, after which the trend accelerated (Thomas & Hope 1994). Written accounts and oral histories since European settlement support the notion that the vegetation at Liawenee Moor has degraded significantly over the past 165 years from grassland to shrubby grassland (Shepherd 1973; Thomas & Hope 1994).

Historically, grazing activity in the Central Highlands was mostly concentrated on the open grassy plains, much of which may have been attributable to the Aboriginal practice of burning (Ross 1830 and Plomley 1966 in Shepherd 1973) to promote green growth, which encouraged greater concentrations of grazing animals and provided more successful hunting. Early European settlers continued the practice of burning and larger areas of scrub were converted to unimproved pasture. Such seasonal burning promoted fresh growth, encouraging stock to eat the unpalatable *Poa* tussocks (Jackson 1973, Kirkpatrick & Bridle 2007). In the 1830s wool was shipped to the United Kingdom stimulating the growth of pastoralism that led to increases in the number of land grants and leases of Crown land on the Central Plateau (Shepherd 1973). By the 1880s most of the Central Plateau lake country grazing rights were established as freehold or leasehold and by century end flocks of sheep were grazed on the plateau during summer (Scott 1955 in Jackson 1973).

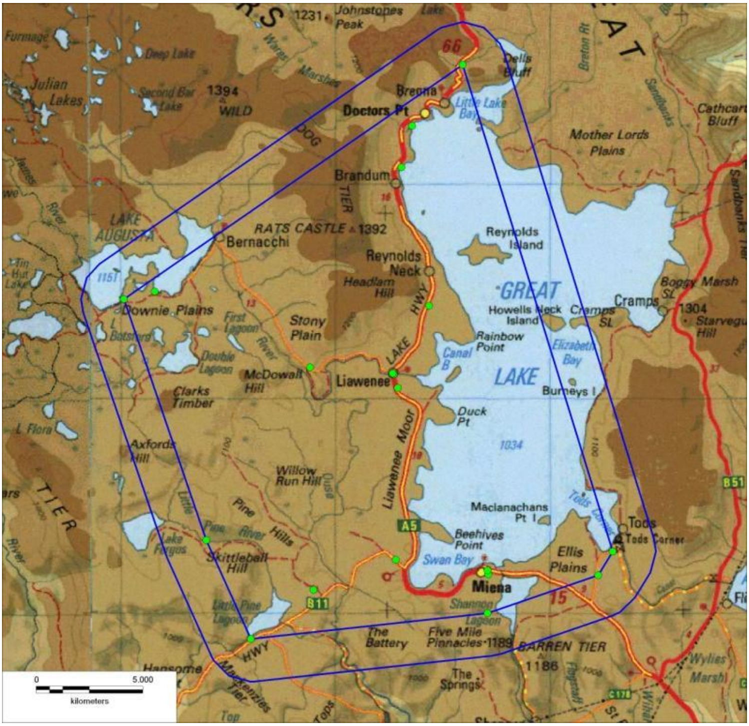

Figure 1. Distribution of *Castiarina insculpta* (green points indicate collection sites; the inner blue line a minimum convex polygon around all known sites; the outer line a nominal 2 km buffer)

In the late 19th century large numbers of stock were transhumanced to the lake country for summer grazing (approximately 350,000 sheep and 6,000 cattle) and small flocks of sheep were overwintered in favourable areas, including parts of the upper region (Scott 1955 in Shepherd 1973). During the 20th century, the decline in stock numbers summered in the upper plateau coincided with a general deterioration of the pasture. Owing to the annual issuing of grazing licenses established in 1965, which were renewed without inspection of the leased land or any regulation of stock numbers, mismanagement of the land by the lessees became evident (Shepherd 1973). Between 1923 and 1973, as the stocking rate per acre decreased in areas where no land improvement was carried out, a number of properties were abandoned (Shepherd 1973). By 1971 the number of summer grazed sheep in the upper plateau had declined to 46,118 and cattle reduced to 5,100 (Shepherd 1973).

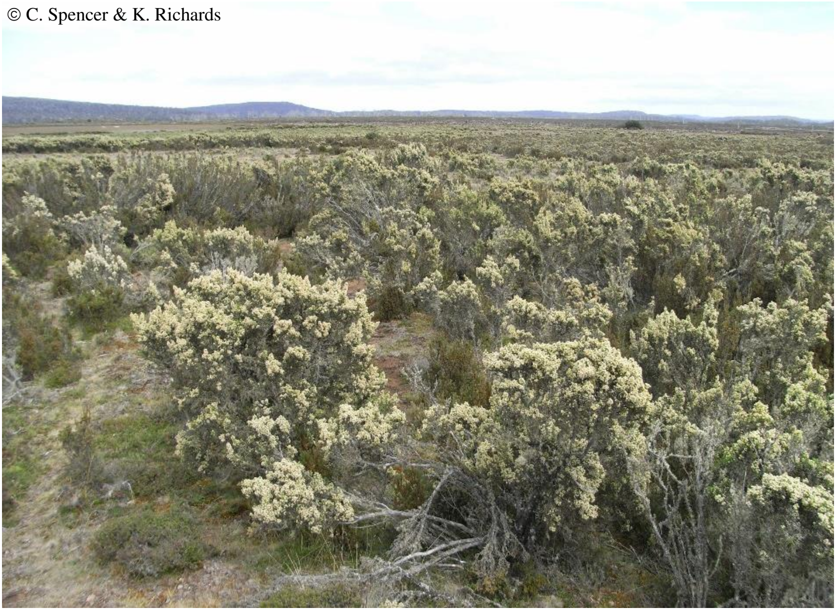

Plate 1. Present vegetation of Skittleball Plains

Plate 2. Present vegetation of Ellis Plains

Coinciding with land degradation associated with the grazing practices, rabbits were first recorded in the Tasmanian Lake District around 1910, and by 1920 numbers of both rabbits and hares had multiplied rapidly (Shepherd 1973). This introduction, combined with grazing pressure resulted in serious damage to the inter-tussock flora (Jackson 1973). Subsequently, dramatic changes to the composition of plant communities have resulted (Jackson 1973, Gibson & Kirkpatrick 1989; Crowden 2005). Denuding of the landscape has been widespread and erosion of the thin skeletal soil has prevented re-establishment of some plant species due to the frequent and severe burning, overstocking and presence of rabbits, which reached plague proportions during the period 1920 to 1953 (Jackson 1973; Shepherd 1973). The legacy of fires on alpine vegetation communities has been documented, indicating lengthy recovery periods are necessary for some species (Kirkpatrick et al. 2002). Bridle & Kirkpatrick (1999), examining the effects of grazing pressure on alpine vegetation, demonstrated that sheep grazing has a far greater impact on the plant composition of alpine pastureland than rabbits and native wildlife. Williams & Ashton (1987 in Bridle & Kirkpatrick 1999) also stated that a decrease in grazing pressure in disturbed alpine environments leads to an increase in shrub cover.

The present

Prior to 1900, Liawenee Moor and Skittleball Plains supported tall tussock grassland consisting of *Poa* species, with a rich inter-tussock herb cover. Due to past land management practices, both of these areas changed remarkably (Jackson 1973). With the cessation of grazing much of the degraded former herb and tussock grassland has become dominated by scrub containing a high proportion of *Ozothamnus hookeri*. This alpine species, a successional shrub, is tolerant of the low nutrient soils, frost heave, waterlogging and the species is able to resprout after fire. It rapidly reaches maturity and produces a prodigious amount of wind-dispersed seed (Kirkpatrick et al. 2002), factors that contribute to its success.

Currently both Skittleball Plains and Ellis Plains are clothed with an ocean of *Ozothamnus hookeri* (Plates 1 & 2); areas of Liawenee Moor also support some dense stands of the plant. It is very likely that the current *Ozothamnus hookeri* density is far greater than ever since the last glacial epoch; however, much of this area contains single-aged cohorts of the species, some of which may be nearing the end of the life expectancy, estimated to be of 30-50 years (Kirkpatrick et al. 2002). Over much of its range, *Ozothamnus hookeri* occurs concurrently with another widely distributed *Ozothamnus* species (*Ozothamnus ericifolius*) (Plates 3 & 4). The two are similar in habit and flower over approximately the same period; however, to date *Castiarina insculpta* has only been recorded utilising *Ozothamnus hookeri*.

Castiarina insculpta (Plate 5), are slow, heavy fliers and activity is restricted to hot weather with little or no wind; these conditions prevail infrequently on the Central Plateau, which must severely limit the opportunity for the species to disperse. *Ozothamnus*, known locally as 'kerosene bush' due to its highly flammable nature, burns fiercely but perhaps quickly and some of the naked stems may not suffer major scorching. With sparse ground cover to generate intense heat, some larvae approaching full-term may still be capable of pupating in the dying stems; although, any emergent beetles would need to fly to the nearest flowering *Ozothamnus hookeri* to feed, but providing the distance is not too great they may survive and breed.

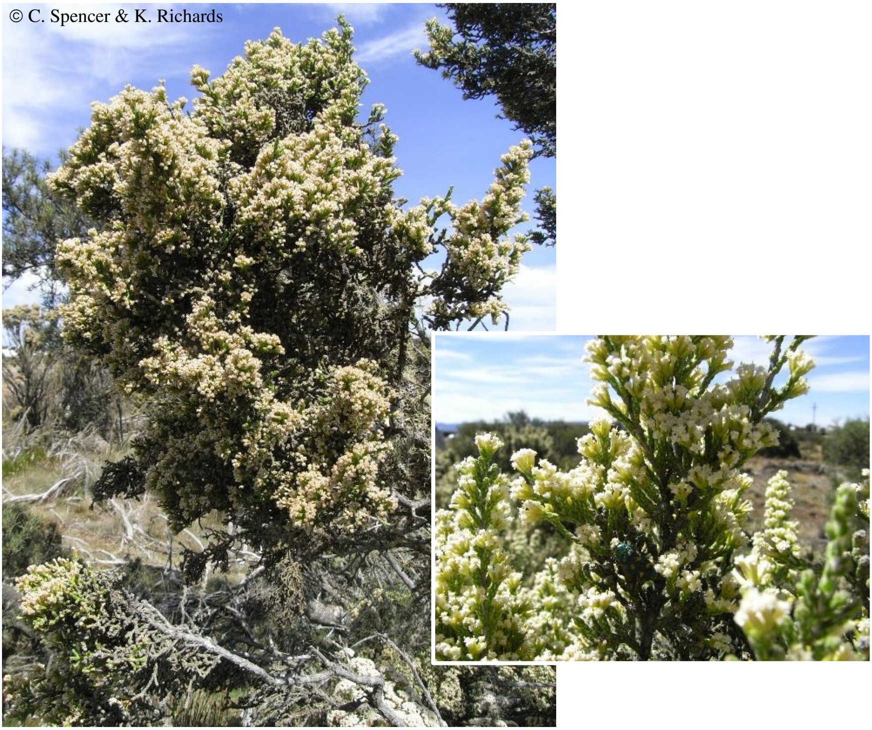

Plate 3. *Ozothamnus hookeri*

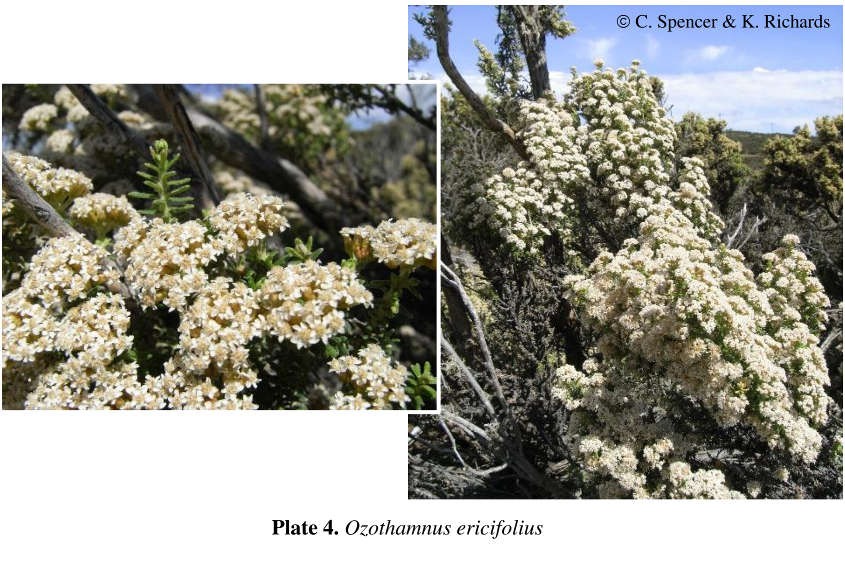

Plate 4. *Ozothamnus ericifolius*

Two co-occurring buprestids, *Castiarina wilsoni* and *Castiarina flavopicta* have been recorded by the authors feeding on *Ozothamnus ericifolius*, but not on *Ozothamnus hookeri*. These two widespread and abundant species are known to feed on the nectar of many genera including *Leptospermum*, *Hakea*, *Helichrysum*, *Olearia*, *Bursaria*, *Callistemon*, *Cassinia*, *Kunzea* and *Baeckea*. Another species, *Castiarina virginea* which belongs to the *Castiarina rectifasciata* species-group, along with *Castiarina insculpta* (Barker 2006), has also been observed (by the authors) feeding on *Ozothamnus hookeri*. However, unlike *Castiarina insculpta*, *Castiarina virginea* has been reported to feed on *Helichrysum* species, *Bursaria* and *Cassinia* (Cowie 2001).

The reported collection of a single specimen of *Castiarina insculpta* from the Great Lake area in 1934 (Carter 1934) suggests the presence of *Ozothamnus hookeri* at that time. Grazing still continued, but land degradation was becoming evident, consequently more *Ozothamnus hookeri* is likely to have been establishing. The initial collection of this species by Critchley Parker occurred at a time when the grazing pressure was declining and presumably tracts of bare 'degraded pasture' were reverting back to heath and shrubland where *Ozothamnus* species dominated. Confirmation of the increase in *Ozothamnus hookeri* at that time is not possible given the vague collection site data; however, it is conceivable that this 'increasing habitat' may have influenced the radiation of *Castiarina insculpta*. This theory is supported by the 2013 surveys showing large concentrations of *Castiarina insculpta* were located at Liawenee Moor, Skittleball Plains and Ellis Plains, where today there are extensive stands of *Ozothamnus hookeri*.

It is unclear if the 2013 search effort was any more intense than the previous surveys (e.g. Smith et al. 2004): what is clear, however, is that the historical search effort was likely to have concentrated on a list of possible food plants based on the known feeding habits of other *Castiarina* species at that time, a list that did not include *Ozothamnus hookeri* or any of the *Ozothamnus* or *Helichrysum* species (Bryant & Jackson 1999; Cowie 2001; Fernandez 2004). Further, the recommended survey method adopted in past surveys probably utilised a sweep net as the preferred means of collecting specimens: Cowie (2001) and Fernandez (2004) reported that sweep netting was necessary to collect flying or feeding adults. In the authors' experience, feeding *Castiarina* species readily drop to the ground as a defence strategy when approached, and in consequence, they are more successfully collected by hand, with stealth and cunning. Irrespective of the survey technique employed, *Castiarina insculpta* numbers may fluctuate significantly between years. Despite a survey effort equal to 2013, in 2014 only a single male specimen was observed by the authors. During this period the flowering of *Ozothamnus hookeri* was recorded to be of intensity less than fifty percent that of the previous year.

Castiarina larvae are root and stem borers exclusive to native trees and shrubs; references detailing aspects of the biology and adult life expectancy of Australian buprestids are infrequent (Barker 2006). One published example, (McMillan 1950a cited in Hawkeswood 2002) recorded that the larvae of *Melobasis sexiplagiata* are known to tunnel in *Eucalyptus rudis* and "extend down the tree and the beetle can be found at the bottom of these tunnels; the adults overwinter from early June to late September before emerging". More often, accounts are limited to observational snapshots remaining as unpublished data. For example, in Tasmania, teneral adults and final instar larvae of *Melobasis costata* have been found in large dead standing *Melaleuca ericifolia* trunks (Spencer & Fearn unpubl. data): teneral adults occupying pupal chambers beneath surface bark and the typically shaped larvae were found within bores in the sapwood up to 1 cm deep immediately beneath the bark.

More detailed accounts of buprestid ecology are recorded in international literature, such as for the species *Agrilus planipennis* (emerald ash borer) native to the Asian region, which has been reported to produce from 30-60 bright yellow eggs, turning tawny brown before the larvae eclose after around two weeks (Spence & Smith 2011). Additionally, the larval cycle of *Anthaxia midas oberthuri*, an Italian buprestid, which feeds on *Acer* (maple) species has been studied and found to extend through two winters, oviposition occurring in April/May, pupation taking place in the following summer, the adult ecloses after a couple of weeks and emergence occurs in the following spring (Izzillo 2010).

Stem characteristics of *Ozothamnus hookeri* supporting *Castiarina insculpta* emergence sites have been investigated by the authors. Findings reveal emergence sites occur in stems of 13-107 mm diameter, but while multiple holes are sometimes present in larger plants, typically only a single site is found on a stem, which is often dying. No preference for shrub height or stem aspect was observed, emergence sites occurring on bushes supporting stems of sufficient dimensions.

Given the information deficit of buprestid life cycles, estimating the time frame of *Castiarina insculpta* life history is problematic. Larvae of differing age cohorts have been observed and data collected on stem characteristics, larval tunnel and emergence hole dimensions (Spencer & Richards, unpubl. data), but the complete life cycle of *Castiarina insculpta* has not yet been reliably established. Given the variability in beetle numbers recorded in 2013 and 2014, it is anticipated that the life cycle will be a minimum of two or three years duration and beetles resulting from 2013 oviposition are thus likely to emerge in February 2015 or 2016. However, the cycle may in fact be much longer, as in the case of the North American species *Buprestis aurlenta*, taking up to 25 years (CSIRO 1970), or opportunistically linked to periods of extreme flowering events.

The future

Into the future, disturbance including fire, will remain imperative to the survival of multi-aged populations of *Ozothamnus hookeri* across the subalpine landscape, this in turn should support a population of *Castiarina insculpta*. The population dynamics of *Castiarina insculpta*, though not currently understood, is suspected to be closely linked to flowering densities of *Ozothamnus* hookeri and thus likely to follow a pattern of boom and bust, as with many other animals dependent on a single host species. The vagaries of high altitude weather are also likely to exert a strong influence on the survival and dispersal of adult *Castiarina insculpta*. Such impacts may be seen in changes affecting the flowering events of *Ozothamnus hookeri* or weather patterns disrupting the breeding opportunities or dispersal activity of the beetle.

Recent land ownership changes may bring about renewed grazing and perhaps burning regimes to a large area presently supporting advanced stands of *Ozothamnus hookeri*. The current density of *Ozothamnus hookeri* across the range of *Castiarina insculpta* provides a bountiful supply of both blossom and stems of sufficient diameter for breeding. Given the survival requirements of *Ozothamnus hookeri* it is evident that a level of disturbance is necessary to maintain the species in the landscape.

While new grazing and burning activity is likely to negatively impact upon *Castiarina insculpta* in the short-term, correctly managed, it may pose a long-term benefit. Management of State reserves and conservation areas in conjunction with private landowners is critical to the survival of both host plant and beetle. Successful management for these species will need to ensure that a landscape-level approach is applied to maintain a mosaic supporting stands of different aged *Ozothamnus hookeri*. To encourage regeneration it will be necessary to implement a low-level disturbance regime using controlled low intensity burning or other mechanisms. Minimising distance between regenerating and senescing *Ozothamnus hookeri* stands will further assist in beetle dispersal.

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Plate 5. Female *Castiarina insculpta* feeding on *Ozothamnus hookeri*

CONFIRMED AT SEA SIGHTING OF A RARE SHEPHERD'S BEAKED WHALE (*TASMACETUS SHEPHERDI*), TASMAN PENINSULA PELAGIC SEABIRD TRIP, FEBRUARY 2014

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THE STORY

[recorded 10 February 2014 on a pelagic seabird trip to the Australian continental shelf off Eaglehawk Neck on board the *Pauletta*, skippered by John Males and led by Phil & Linda Cross]

Pelagic seabird trips are regularly run from Eaglehawk Neck on the Tasman Peninsula for avid bird enthusiasts, for the opportunity to observe many interesting and sometimes rare seabird species. However, the pelagic on 10 February 2014 was a little different. The *Pauletta*, skippered by John Males with his son Brock as deck hand, left from Pirates Bay, Eaglehawk Neck on the Tasman Peninsula at 7 am. We were a small party on board with only four of us from Tasmania to make up group numbers for a party of visiting mainland birders. Phil and Linda Cross led the trip, Rob Hamilton kept notes and wrote the Birding-Aus trip report, and other participants were Bob James, Sandra Harding, Karen Dick, Mona Loofs Samorzewski, Timothy Collins and Els Wakefield.

The previous day there had been a storm, which had produced winds up to 130 km/h in southeast Tasmania. On this day the conditions were light variable winds until 11 am when it strengthened to 10-20 knots from the SSW, gusting to 30 knots. Swell was generally less than 1 m with 1-2 m wind waves (Hamilton 2014).

On our way to our second berley stop (to attract the seabirds) beyond the continental shelf, the skipper commented that we were over a cold water current of 15-16°C, which would normally have been 18°C at this time of year but the seasonal warm current was not extending as far this year. At that moment we saw two mako sharks and a blue shark near the boat. John and Brock were shocked to then see twelve 50-60 kg yellow-fin tuna chasing a mako shark past the boat. They had never witnessed anything like it before.

We were at 43.04819°S, 148.22072°E, about 5 km east of the shelf heading north when a call of "whales" was shouted and a pod of three approached from the west on the port side of the boat, passing in front of the boat and re-appearing some distance away on the starboard side of the boat. We all watched them carefully and tried to take photographs. First suspicions were that they might have been southern bottlenose whales.

But John Males and I recalled the sighting that occurred on a pelagic trip he and I were on board in February 2012 (Wakefield 2012). He said what I was wondering; "Could this be another sighting of Shepherd's beaked whales?" He commented that we were within a mile of the area where the previous sighting had been made. At that time we obtained only one good photo showing the back and dorsal fin with the light pigmentation sloping forward on the flanks below the dorsal fin. On this occasion the whales had obvious beaks and were light coloured around the melon-shaped head. This time we had a much better view and hopefully much better shots for identification.

Excited and anxious to have the whales identified, when I arrived home I sent my images (Plate 1) to Dr Mike Double (Leader, Australian Marine Mammal Centre) who forwarded them on to Dr Paul Ensor (Marine Mammal Observer, Australian Marine Mammal Centre) in New Zealand, who had assisted with identification of the 2012 sighting.

Karen Dick, an international environmental consultant and accredited Marine Mammal Observer, emailed Mike Double with the following description of the sighting:

"I attach some pics, including a full body underwater shot that appears to show paler flanks to the rear of the dorsal fin [Plate 2 of present article]. I did not see any pale pectoral patch coming up behind the melon on any of the individuals that surfaced. Also, there was no sense of a dark cape or of any real patterning on the body, but that may have just been that they were keeping a very low profile. There was very little surfacing and they mainly kept submerged but near the surface, often just barely breaking the surface with the blowhole and top of the melon. Overall, I can provide the following personal description of the three that I saw. Small, loose pod, minimum 2, maximum 5, best guess 3, slow swimming in an easterly /north-easterly direction. Definitely travelling, but calm and unhurried. Individual Size around 4-5 m. Individuals surfaced with only the top of the melon showing, and produced low bushy blow. The beak never broke the surface, nor the pectoral fins. Dorsal fin, moderate size mostly upright, did not break surface with head during blow, only surfaced once the head had submerged. Dorsal fin positioned around two-thirds of the way along body. Slow, rolling dive, tail and tail stock remaining submerged".

Plate 1. *Tasmacetus shepherdi* emerges briefly, allowing identification to be made based on the shape of the melon and length of the rostrum as well as the light head pigmentation

Rob Hamilton sent Mike Double two photos to be considered by Paul Ensor. Rob noted the photographs (Plate 3) "show a definite notch behind the head on one of the three whales we saw and show a more bulbous head than Els' photos".

Paul Ensor's response to Mike Double was: "*Tasmacetus*, based on the melon head shape and length of the rostrum. Light head pigmentation (and hint through the water of the blaze behind the pectoral flipper), also distinctive pigmentation posterior of the dorsal fin. Hope this is another data point for Dr Donnelly to consider for his imminent *Tasmacetus* paper. I can rule out southern bottlenose which have a much more bulbous melon and much shorter rostrum (with impression of an overhanging melon). Younger s. bottlenose do have well delineated lighter head pigmentation as in this example but the remainder of body is uniform brown not light behind the dorsal fin (but sometimes light trailing margin of dorsal fin as in this example)". This was fantastic news and confirmed an important at sea sighting of *Tasmacetus shepherdi*, the second for the pelagic trips to the shelf from Eaglehawk Neck. Shepherd's beaked whales are a rarely seen and poorly known species, with much of the basic knowledge on biology and distribution coming from stranded specimens, some unconfirmed sightings and less than ten confirmed at sea sightings. It occurs in both shelf and deep cold temperate waters of the Southern Ocean (Pitman et al. 2006). It appears that the Tasman Peninsula shelf region may be a favoured habitat, albeit potentially seasonal, for this species (pers. comm. P. Ensor to R. Hamilton). Rachael Alderman of the Threatened Species & Marine Section, Department of Primary Industries, Parks, Water & Environment (DPIPWE) entered the sighting record on the National Marine Mammal Database. Dr David Donnelly is coordinating a thorough publication of sightings in recent years off Western Victoria and Tasmania.

I hope this article will inspire others to join our regular trips from Eaglehawk Neck.

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Plate 2. Full body image of submerged individual, which shows the paler flanks to the rear of the dorsal fin

Plate 3. Closer up image showing the melon head shape with a more definite notch behind the head

SECRETS OF SAFETY COVE: WHY HAVE THESE UNUSUAL MOLLUSCS TURNED UP ON THIS BEAUTIFUL BEACH NEAR PORT ARTHUR?

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As a shell collector and resident of Port Arthur, I walk on Safety Cove Beach (Plate 1) almost daily. Generally speaking it is not a good beach on which to find species of interest, so I usually do little more than cast my eye over a fairly nondescript smattering of bivalves. However, over the years I have made some interesting finds, which lead me to ponder the question: are these just serendipitous, or is climate change bringing our local coastline within range of a new set of warmer water marine species?

Plate 1. Safety Cove Beach, viewed from its southern end

Rare or unusual species are, by implication, ones that are seldom seen. To put my finds into context, I walk the length of Safety Cove regularly. Given that the walk is around 2 km, over the past 6 years or so I have covered more than 3,500 km in pursuit of these elusive finds.

Frequently it isn't initially obvious to me just what I may have picked up, and my curiosity to get to the bottom of the matter has led me to a close association with the Tasmanian Museum and Art Gallery (TMAG) and, in particular, with its curator of invertebrates Dr Simon Grove.

Some of the unusual species that I have come across are noteworthy even though their occurrence may have nothing to do with changing conditions. For instance, the umbilicated cowrie, *Umbilia hesitata* (Plate 2) is by far the largest and most spectacular of the four cowries likely to be found in the southeast of Tasmania. It appears to have a stronghold in the d'Entrecasteaux Channel but on rare occasions may be found elsewhere in Tasmania too, particularly around the Bass Strait islands. Finding a beautiful specimen beached at Safety Cove in 2008 was enough to spark my initial interest in shell collecting – an interest that has developed into a fascinating hobby.

Plate 2. *Umbilia hesitata*, 105 mm (Safety Cove Beach, 2008)

On a similar note, the fragile translucent pen-shell (also known as a fan-shell) *Atrina tasmanica*, is the largest of the bivalves to be found in Tasmania. While it is fairly widespread, it is rare in the south of the State. Ironically, I didn't keep the only one that I have ever seen on Safety Cove Beach, because at that stage in my shell collecting pursuits my main focus was on gastropods. How I now wish that I could turn the clock back! Another surprising find is the enigmatic ruddy crypt-dweller *Petricola rubiginosa*, a small and not especially striking bivalve that proved particularly tricky to identify. It is known from very few scattered records around Tasmania.

One species that does appear to have been moving south over the past few years is the hairy rock-whelk *Monoplex parthenopeum* (Plate 6). This whelk can grow to around 70 mm and is noted for its distinctive hairy periostracum, or outer coating; however, this is frequently worn off beached shells. Perhaps the occurrence on Safety Cove Beach of the large specimen that I found in September 2012 may be attributed to an increase in water temperature. When I had first started collecting shells a few years ago, the southernmost extent of its range appeared to be around Marion Bay (it was previously not recorded from Tasmania at all) but it has now been recorded as far south as Woodbridge. This species has a long-lived planktonic stage, which may help its rapid spread when warmer conditions prevail.

Violet-snails live in open water, floating suspended below a raft of bubbles. There are two species recorded in Tasmanian waters (Plate 3): the common *Janthina janthina* and the smaller and more ornate globose violet-snail *Janthina exigua*. *Janthina janthina* commonly occurs around the State at certain times of the year, and can often be found on Safety Cove Beach. *Janthina exigua* is a much rarer species previously known from scattered records around Flinders Island and (lately) as far south as Schouten Island (see Grove 2010). In February 2012, an unprecedented wash-in of both species occurred at Safety Cove and I was able to collect more than 50 *Janthina exigua*. Subsequently I found further specimens on other beaches around the Tasman Peninsula. Again, these findings suggest some unusual influence of southward-flowing currents along our east coast.

My interest in shell collecting now extends to trying to find and identify microscopic shells. Collecting a cupful of carefully selected tideline grit can produce many species of tiny shells when examined under a microscope. From some grit that I collected in May 2013 from the southern end of Safety Cove, I discovered some beautiful minute species, most of which had not previously been recorded in Tasmanian waters (Plate 4). I identified two species of atlantid snails: Peron's *Atlanta peronii* and rosy atlantid, *Atlanta rosea*. From the same sample came four species of pteropod, or sea-butterfly: a single, almost translucent top-shaped sea-butterfly, *Limacina trochiformis*; some pyramid sea-butterflies, *Clio pyramidata*; a few awl sea-butterflies, *Styliola subula*; numerous planorbid sea-butterflies, *Limacina inflata*; and many Lesueur's sea-butterflies, *Limacina lesueuri*. All of these microscopic creatures live a pelagic life in open water; many occur throughout the world's warmer seas but are rare in cooler waters. So it appears that their deposition on Safety Cove Beach is a further indication of the southwards extension of warm, oceanic waters along our east coast.

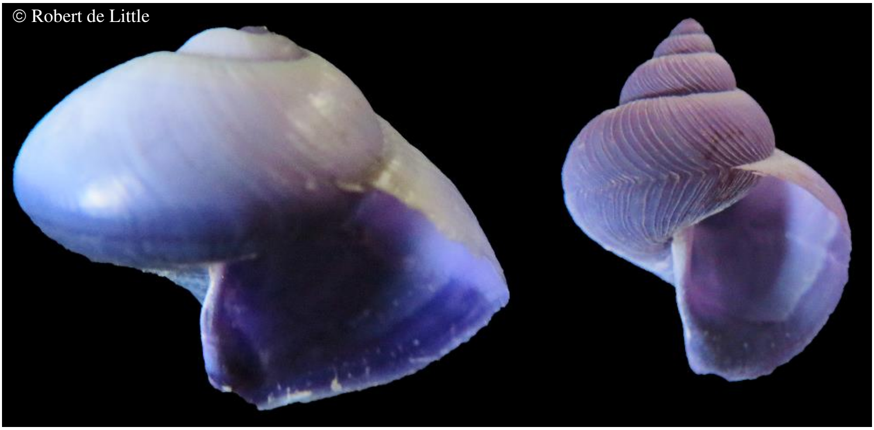

Plate 3. Left to right: *Janthina janthina*, 20 mm; *Janthina exigua*, 13.5 mm (both Safety Cove Beach, 19 Feb. 2012)

Plate 4. Left to right: *Atlanta peronii*, 2.2 mm; *Limacina trochiformis*, 1.8 mm (both Safety Cove Beach, 24 May 2013)

Not all my mollusc finds relate to gastropods or bivalves; various cephalopod species of interest have also been washed up on Safety Cove Beach (Plate 5). A particularly unusual find was a Pacific glass-squid, *Leachia pacifica*. The 160 mm long specimen was alive when I found it on the strandline on 25 August 2012. The remarkable thing about this normally oceanic pelagic animal is that it is transparent, apart from some brown spots and its very evident stomach that is narrow and remains in a vertical orientation regardless of whether the animal is horizontal or vertical. The specimen is now preserved in ethanol at TMAG.

Plate 5. Left to right: *Leachia pacifica*, 160 mm (Safety Cove Beach, 25 Aug. 2012); *Argonauta nodosus* (male), 25 mm (Safety Cove Beach, 13 Jun. 2014)

One of the nicest and most prized shell finds on a beach anywhere is also that of a cephalopod: the paper-nautilus or argonaut. The shells are only secreted by the females of this pelagic octopus; they use the chambers as nurseries for their eggs. The males, on the other hand, are minute octopuses, measuring a mere 25 mm – much smaller than the females. Every few years, shells of the cool-water knobbly paper-nautilus, *Argonauta nodosus*, wash up, and I have been lucky enough to collect one from Safety Cove Beach. I did not find any this year, but, most unusually, on 13 June 2014 I found three live males washed up on the strandline instead. Perhaps they had been weakened by a drop in water temperature? They have been preserved in ethanol, to be deposited at TMAG and Museum Victoria. The warmer water greater paper-nautilus, *Argonauta argo* was previously almost unknown in Tasmania waters. However, during March and April this year reports emerged of finds of this rare species around southern Tasmania, which prompted me to make some early morning trips to Safety Cove in the hope of finding one washed up during the night. I was lucky enough to collect two specimens over a couple of days. One can only wonder if this year's unprecedented occurrence of greater paper-nautilus is also a result of unusually warm currents sweeping down the east coast of Tasmania and into the Storm Bay region – see Grove (2014,a,b – this issue) for further discussion.

Cuttlefish are also cephalopods. Their 'bones' (internal shells) are an easily recognisable and familiar find on Tasmanian beaches around the State, with five species to be found. Bragg's cuttlefish, *Sepia braggi*, is a small species with a narrow cuttlebone, making it readily overlooked. Though largely confined to the north, occasionally I have found it beached on Safety Cove. Finally, there has recently been a considerable wash-in of pumice on beaches right down the east coast of Tasmania, including Safety Cove. Having its origin in the tropical Pacific, it has brought with it a few warm water hitch-hikers – see Grove (2014a,b – this issue). Close examination of pumice collected on Safety Cove Beach on 26 June 2014 produced two specimens of a microscopic bladdersnail litiopa, *Litiopa limnophysa*. Prior to the appearance of the pumice this year this species had not been recorded in Tasmania.

I would like to end this article by recommending that readers contact TMAG – as I have done on many occasions – if you find something that looks interesting, whether or not you know its identity. Not only will you most likely discover what it is you have found, but also, if it turns out to be an unusual species and you a prepared to part with it, TMAG may be pleased to add it to their collection. Contact can be made by email tmagmail@tmag.tas.gov.au.

ACKNOWLEDGEMENTS

I thank Simon Grove, curator of invertebrates at TMAG, for his help and encouragement with my shell collecting and identification endeavours, and in commenting on previous versions of this article. Other experts who have kindly assisted with various identifications of the species mentioned include Lynton Stephens (VIC), who alerted me to the existence of atlantids, and Roger Seapy (US) who was able to identify which species of atlantid I had found. Also thanks to Joan Hale (VIC) who identified the bivalve *Petricola rubiginosa*. Julian Finn (Museum Victoria) confirmed that the small cephalopods were indeed male *Argonauta nodosus*.

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Plate 6. *Monoplex parthenopeum*, 73 mm (Safety Cove Beach, 22 Sep. 2012)

INVASION OF THE ARGONAUTS!

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TASMANIA'S ARGONAUTS

Argonauts or paper-nautilus are pelagic octopuses (Cephalopoda: Argonautidae) whose females secrete a papery shell as a brood-chamber for their eggs. Three species occur in Australian waters (Finn 2013), but only two in Tasmania. The typical Tasmanian species is the tuberculated or knobbly argonaut *Argonauta nodosus* (Plate 1, upper image), a species that inhabits subtropical to temperate waters right around the Southern Hemisphere; the other is the greater argonaut *Argonauta argo* (Plate 1, lower image), a species that inhabits tropical, subtropical and warm temperate waters worldwide. Shells of the two species are readily told apart by their texture: the tuberculated or knobbly argonaut is, well, tuberculated or knobbly, with intersecting radial and transverse series of raised tubercles; while the greater argonaut is adorned with sinuous, branching radial ridges instead. On these characters alone, small specimens of greater argonaut could be confused with knobbly argonauts, because the ridges may not be clearly discernible. A further means of separation is by overall shape: when viewed aperture-on, the knobbly is broad and u-shaped in cross-section; while the greater is narrow and v-shaped; and the whorls of the knobbly form a tighter spiral than those of the greater.

The Bass Strait islands are well known localities for mass autumn strandings of the shells of knobbly argonaut: they have become one of Flinders Island's iconic attractions for visiting naturalists and beachcombers. Individual shells are also regularly found stranded elsewhere around the Tasmanian coast, including the southeast. The Tasmanian Museum and Art Gallery (TMAG) collections contain 22 registered specimens of this species from various parts of the State. By contrast, the greater argonaut has long been considered a very rare visitor to Tasmanian waters. While occasionally washing up on Bass Strait islands, until recently the only specimen known from the Tasmanian mainland was a shell fragment in TMAG's collections found in 1990 at Triabunna.

THE 2014 INVASION

All our assumptions about Tasmanian argonauts went out the window in the autumn of 2014. On 5 April, Suzanne Barrett photographed an argonaut shell collected on Hope Beach at South Arm. She reported it to Julian Finn at Museum Victoria, the national expert on argonauts, who was surprised to find that it was a greater argonaut. Two days later, Janet Potter witnessed the stranding of a female greater argonaut in its shell at Boronia Beach, between Kingston and Blackmans Bay (Plate 2), and lodged the sighting online, on Redmap. A week later, I received an enquiry at TMAG about another greater argonaut shell that had been found at Seven Mile Beach (9 April: Suzanne Hedgecott).

Alerted to the possibility of further strandings, I arranged for some media coverage of the argonaut story on the local ABC radio and in *The Mercury* newspaper. *The Mercury* article specifically requested observers to send in their records to me and to Redmap. There followed a flurry of

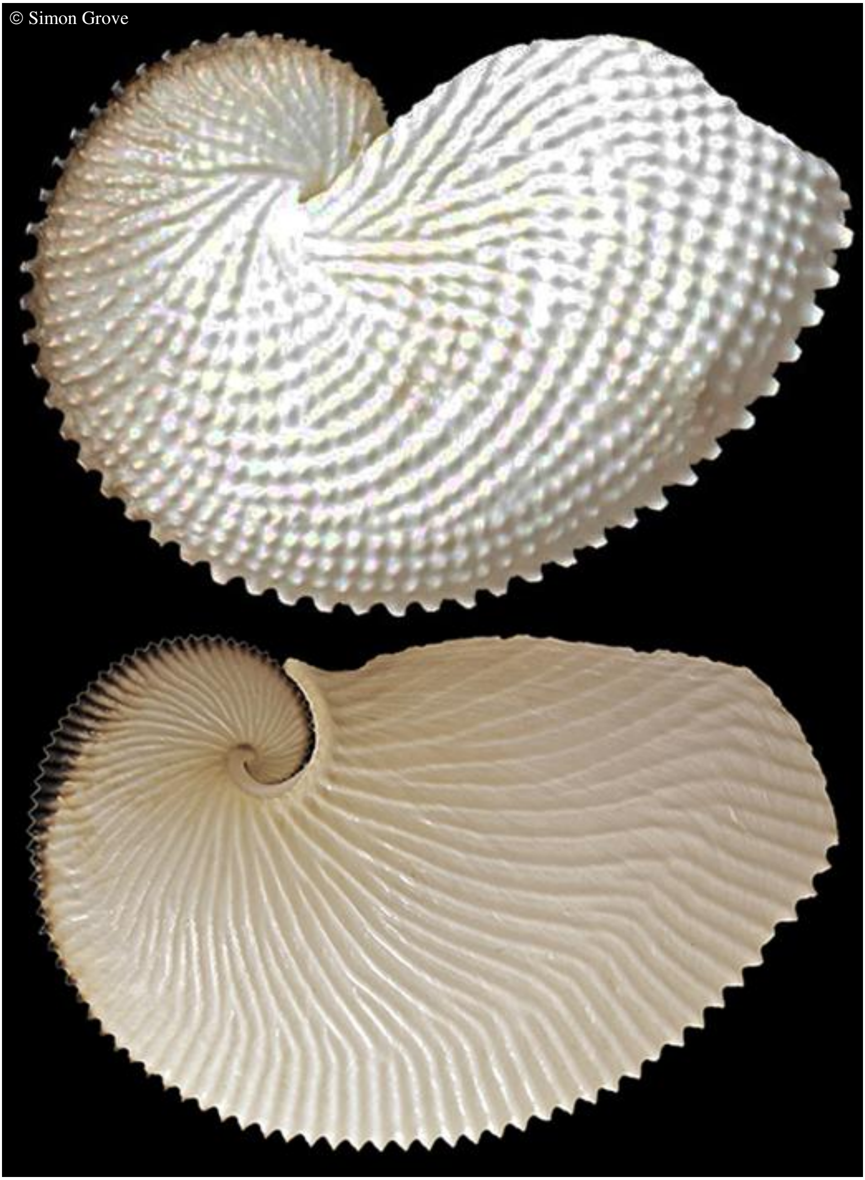

Plate 1. Tasmania's two argonaut species (both about 160 mm across). Upper image: *Argonauta nodosus* from Schouten Island, May 2010, found by the author. Lower image: *Argonauta argo*, from Carlton Beach, March 2013, found by Grant Muir.

records, including several that pre-dated the original observations.

Nearly all of the other records for 2014 were also from within Storm Bay or Frederick Henry Bay, as follows: Seven Mile Beach (21 March: Kim Valentine; early April: Cathy Byrne; 22 April: Bill Bleathman; 4 May: Simon Grove (Plate 3); 8 May: Sarah Bishop; 11 May: Penny Sowter); Clifton Beach (11 February: Robyn Everist; 29 & 30 March and 3 May: Sarah Cameron; 18 April: Ian Woodward); Bellerive Beach (early April: Holly Zeinert); Kingston Beach (early April: Meg Taylor); Howden (22 April: Christine Bickford); Roches Beach (22 April: Peter Watson); Adventure Bay (29 April: Adam Howell).

Geographical outliers include one at Dolphin Sands (26 April: Jane Richardson), and two at Safety Cove (12 & 14 April: see de Little (2014), this issue). Additionally, two southeast Tasmanian strandings from previous years came to light as a result of the publicity: a large and intact specimen found on Carlton Beach (March 2012: Grant Muir); and a smaller one found at Denmans Cove (April 1999: Brendan Baker). The earliest recorded specimen was from 11 February; however the record did not come to light until late April when it was lodged on Redmap, and it remains possible that an incorrect date was entered. The latest record was from 11 May. By contrast, shells of knobbly argonauts only started turning up on select southeastern Tasmanian beaches in mid-May, with sightings continuing into late June.

All known Tasmanian records of greater argonaut (other than some early 'Bass Strait islands' records) are plotted in Figure 1.

What triggered the invasion?

It seems likely that the autumn 2014 strandings in southeast Tasmania are historically unprecedented, at least in the number of animals involved. This begs the question as to what unusual oceanographic or climatological conditions might have triggered the 'invasion'. The Integrated Marine Observing System (IMOS) maintains a website that host colour-coded charts of sea surface temperature (SST) derived from every successful (clear-sky) pass of a NOAA satellite (every few hours on average) (see http://oceancurrent.imos.org.au/Tas/ for the Tasmanian maps). Sea level contours and geotrophic current velocity arrows, derived from drifters and floats, are overlain on these charts. Every month, the charts are compiled into animations, allowing one to visualise changes in SST and current direction over hours, days and weeks. Examining the animations for February to May 2014, I could see that by February 2014, waters in the semi-enclosed coastal bays of southeast Tasmania were much warmer than nearby offshore waters. But that's not the full story. More interestingly, the animations depict the gradual southwards extension of warm water in the East Australian Current (EAC) offshore from Tasmania's east coast, as well as the intermittent wrapping of the Zeehan Current around the southern coast of Tasmania from its origins to the northwest. Neither of these processes is linear, because the currents form eddies and countercurrents; they also gradually mix with the waters into which they penetrate. Nevertheless, the general pattern, for late summer and autumn 2014, seems to have been for a narrow band of water from the Zeehan Current to feed along Tasmania's southern coast towards the southeast, and for intermittent pulses of warmer EAC water to be injected into southeast coastal waters from the northeast and deflected landwards by the Zeehan Current. Several particularly clear but short-lived pulses of warm EAC water are visible being pushed towards Storm Bay, the first on 18 February (Figure 2a) and another on 28 March (Figure 2b).

Plate 2. Stranded greater argonaut at Boronia Beach, Kingston, south of Hobart, on 7 April 2014

Plate 3. One of six beached greater argonauts found by the author at Seven Mile Beach on 4 May 2014

(a)

(b)

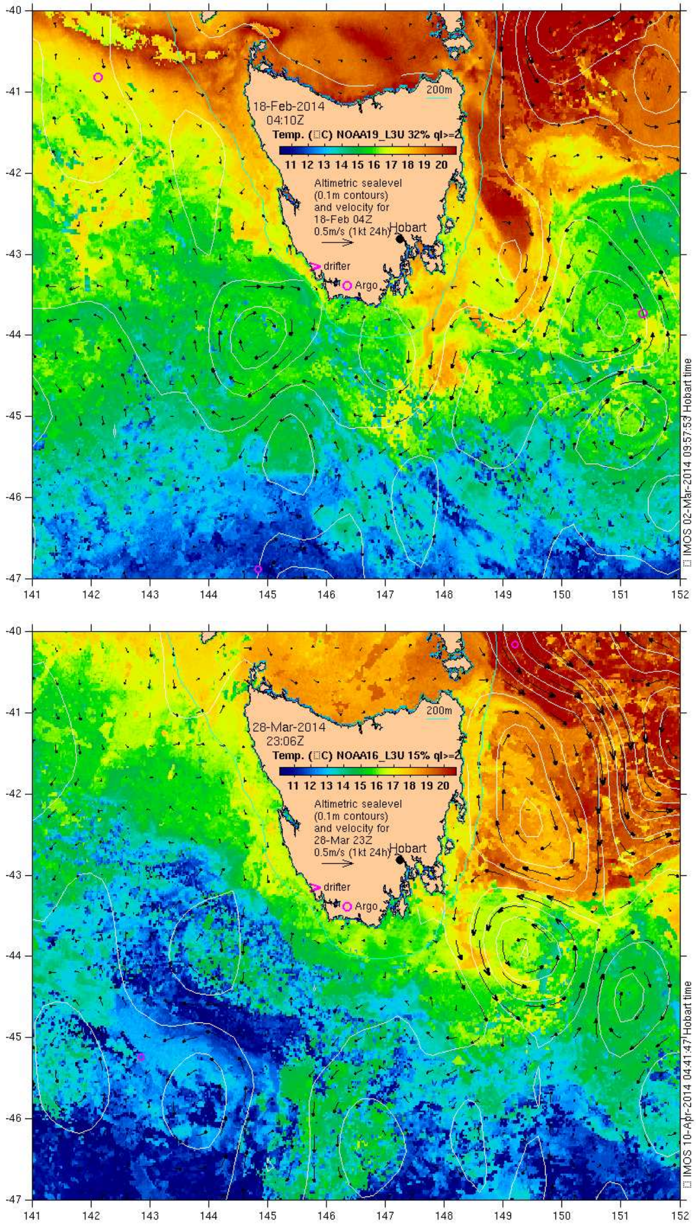

Figure 2. Sea surface temperatures, relative sea levels and currents around Tasmania: (a) 0410 hrs, 19 February 2014; (b) 2306 hrs, 28 March 2014 (source: IMOS)

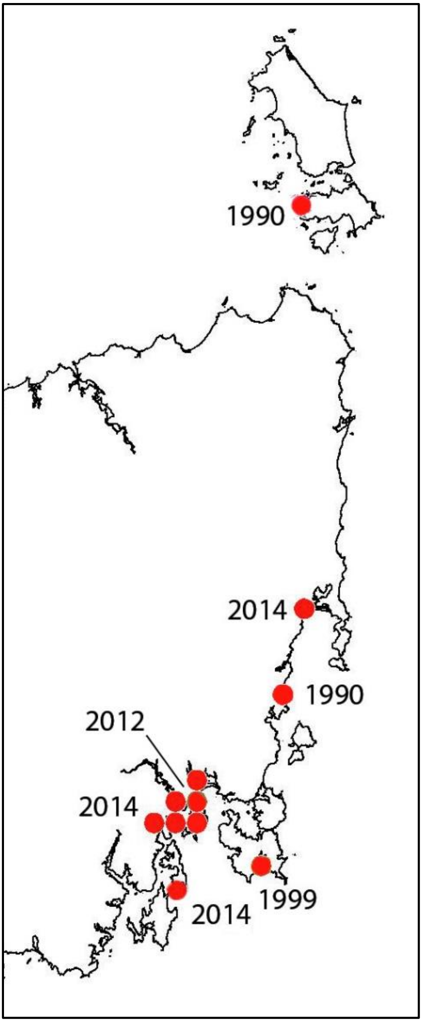

Figure 1. Tasmanian records of greater argonaut grouped by 10 km square, and coloured by date of first known record (the given year and location of the Cape Barren Island record is approximate)

These pulses only correlate very loosely with the spate of greater argonaut strandings. Nevertheless, it makes sense that the occurrence of a warm water species beyond the normal southern limits of its range would depend on injections of warm EAC water originating from within the species' normal range further north. Time will tell whether the pattern will be repeated in future years.

FINALLY…HOW THE ARGONAUT GOT ITS NAME, AND SOME OTHER JUST-SO STORIES

In ancient Greek mythology, Jason set sail in search of the Golden Fleece. His ship was the *Argo*, built by one Argus and crewed by a band of heroes called the Argonauts ('Argus' sailors'). More than two thousand years later, in Linnaeus' magnum opus *Systema Naturae* (tenth edition, 1758), the founding father of modern taxonomy co-opted *Argonauta* as the generic name for the papery-thin shells which in Mediterranean folk taxonomy had long been known as *nautilus* (meaning 'little sailors'); while he co-opted *Nautilus* as the generic name for the tropical, heavy-shelled pearly or chambered nautilus.

We now know that the shell's maker is a female pelagic octopus, who uses two specially adapted webbed tentacles to magically secrete the shell as her brood-chamber; but to the ancient Greeks, and the Minoans before them, the 'little sailors' were enigmas. Their two webbed tentacles were thought to be held aloft to catch the wind, like sails. In Linnaeus' time, the whole octopus was dismissed as some ghastly parasite that had ousted the rightful occupant from its papery shell; while it took until the middle of the 19th century for the detached reproductive arm of the minute male, embedded in the female's mantle, to be recognised for what it is rather than a 'mere' parasite (Finn 2013).

ACKNOWLEDGEMENTS

I thank Julian Finn (Museum Victoria, who co-authored with me an earlier article on argonauts (Grove & Finn 2014) on which this article is based. I thank the many observers who submitted their records of argonauts to me or to Redmap. Thanks also to Janet Potter for permission to reproduce her photo of a beached greater argonaut. The Redmap team is also thanked for allowing me access to the geographical data behind the records. Data on sea surface temperatures, relative sea levels and currents were sourced from the Integrated Marine Observing System (IMOS) - IMOS is supported by the Australian Government through the National Collaborative Research Infrastructure Strategy and the Super Science Initiative.

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SNAIL MAIL: PUMICE DELIVERS TROPICAL MOLLUSCS TO TASMANIA

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On 31 July 2012, an observant passenger on a flight from Samoa to Auckland looked out of the window and noticed that the surface of the tropical Pacific Ocean looked very odd. When her photograph of the phenomenon reached the scientific community, it soon became apparent that she had spotted a vast raft of pumice. The seismological record and follow-up surveys soon identified the source as a major undersea volcanic eruption, about ten days previously, of the Havre Seamount on the Tonga-Kermadec Volcanic Arc, some 800 km northeast of New Zealand (Carey et al. 2014). This region has been hosting major undersea eruptions on a regular basis, spawning pumice rafts every few years (Bryan et al. 2004). Pumice is a sort of glass that forms when super-heated, highly pressurised lava is violently ejected from a volcano. Because it contains dissolved gases and water, it develops tiny bubbles as it expands rapidly through depressurisation; it then solidifies on contact with the surrounding cool air or water. Pumice from an undersea eruption is less dense than seawater, so it floats to the surface. At its maximum extent, the Havre pumice-raft spanned an area of some 23,000 km^2 – about a quarter the size of Tasmania.

Some of the pumice was subsequently carried westwards by the prevailing winds. In December 2013 it blanketed the beaches of Lord Howe Island (Amanda Thomson, pers. comm.). By that time, it had also reached the eastern seaboard of Australia, with records from as far north as Torres Strait (Eleanor Velasquez, pers. comm.). Meanwhile, some of it was diverted south by the East Australian Current, with the Sydney media reporting large quantities washing up on New South Wales beaches. By mid-March 2014 it was being reported from all along Tasmania's east coast, particularly the northeast. Smaller quantities made it into Bass Strait and onto northern Tasmanian beaches as far west as Stanley (pers. obs.).

Pumice provides a convenient settlement substrate for a wide range of marine organisms with a planktonic larval stage, including many species of mollusc, which can be transported vast distances across oceans over the space of just a few months (Bryan et al. 2004, 2012). One such species is the tiny snail *Litiopa limnophysa*. At barely 2 mm long, it's not a species that would easily make much of a splash, but by hitchhiking a lift on Havre pumice that is exactly what it has done – at least in select malacological circles. The species was first described from what is now New Caledonia, but occurs more generally in the warm waters of the southwest Pacific Ocean. Wilson (1993) gives its Australian distribution as North Queensland to central New South Wales, while the Atlas of Living Australia additionally shows a Northern Territory record. As adults, these snails seem to specialise in feeding on algal or bacterial mats growing on floating objects: presumably their planktonic larvae seek out such objects on which to settle. Although the snails can also be found on floating *Sargassum* weed, these opportunistic oceanic wanderers seem to have a particular affinity for floating pumice, perhaps because of its propensity to accumulate algae, and because of all the protective nooks and crannies it offers to a small snail. Hereafter I will call them 'pumice-snails'.

I came across my first three pumice-snail shells (Plate 1) on sorting through some samples of shell-grit that I had collected in late March from two separate beaches on the west coast of Flinders Island (Fotheringate, 21 March and Killiecrankie, 23 March). It was thanks to correspondence with a Victorian malacological colleague, Lynton Stephens, that I eventually got a name for my snails and made the connection with the unfolding pumice phenomenon. Armed with this new understanding, I decided to see if I could find some more, in situ: mine were, after all, the only known Tasmanian records for this primarily tropical species. It transpired that University of Tasmania vulcanologist Rebecca Carey had already been enlisting the help of east coast residents to report and collect pumice for her studies; she put me in touch with these people, and with colleagues in Queensland who were studying the effects of the pumice's arrival on ocean productivity and who had been finding pumice-snails on beaches all the way from Prince of Wales Island (Torres Strait) south at least to northern New South Wales (Eleanor Velasquez & Denis Riek, pers. comm.).

The pumice washing up in Tasmania generally comprised heavily weathered fist-sized to marble-sized balls, encrusted with goose-barnacles and algae (Plate 2); smaller pieces came to dominate as time went on, probably as a result of the break-up of the larger pieces. Thanks to some dedicated local collectors of pumice, I soon mustered samples from up and down Tasmania's east coast, from Flinders Island south to Schouten Island. And I was delighted to find pumice-snails still attached to several of these samples. In chronological order, these were from The Gardens (Lew & Jan Pretorius, 1 April, 2 specimens); Schouten Island (Adrian & Leonie Geard, 7 April, 9 specimens); Bay of Fires (Amanda Thomson, 19 May, 4 specimens – Plate 3); and Scamander (Catherine Deak, 6 June, 1 specimen). Further south and later still, Rob de Little (pers. comm.) found two specimens on pumice from Pirates Bay (26 June).

Plate 1. *Litiopa limnophysa*: a 2 mm shell from Killiecrankie, Flinders Island, 23 March 2014, collected by the author

All these pumice-snails were dead on arrival, but I still find the idea of pumice delivering tropical snails to Tasmania intriguing. And pumice-snails weren't the only malacological surprise: Tasmania can now lay claim to two species of pearl-oyster, albeit on rather tenuous grounds. Pearl-oysters (*Pinctada* species) are a

Plate 2. Several lumps of pumice, collected by Liz Znidersic at Maurouard Beach, St Helens, mid-June 2014 and donated to the Tasmanian Museum and Art Gallery: the largest lump in this collection measures about 12 cm across

primarily tropical Indo-Pacific group, generally absent from southeastern Australia. Yet pumice from Schouten Island (Adrian & Leonie Geard, 7 April) harboured tiny but dead juvenile oysters of two species: *P. margaritifera* (the commercial blacklip pearl-oyster; 3 specimens) and *P. sugillata* (a tentative identification only; 2 specimens). This latter species was also present on a sample from Trousers Point, Flinders Island (Rachel Dallas, 10 June, 1 specimen). Other pumice samples harboured juveniles of our local mud-oyster *Ostrea angasi* and cartrut-snail *Dicathais orbita*, demonstrating that not all hitchhikers had travelled long distances.

While it is unusual for large quantities of pumice to wash up on Tasmanian beaches, it is not the first time, and it won't be the last. It doesn't always originate from warmer seas. For instance, the Tasmanian Field Naturalists Club's notes for May 1965 (TFNC 1965) record that "an unusual amount of pumice stone, the product of volcanoes, has been washed up on Tasmanian beaches lately". In TFNC correspondence later that year, Sutherland (1965) noted that "pumice first started washing up in late 1963, and some was still washing up in early 1965. Mineralogical and chemical analysis of the pumice suggest it is derived from a large underwater pumice eruption that took place off the South Sandwich Islands in March 1962. Besides Tasmania it has also washed up along the length of the Southern Australian coast, on the south coast of New Zealand, and on Antarctic Islands such as Heard and Macquarie Islands". I have no record of anyone examining this pumice for hitchhiking molluscs – but if they had done so, the species that might have colonised would have been very different from those found this year, because of the cool-water origins of the pumice.

ACKNOWLEDGEMENTS

I thank Lynton Stephens for his initial recognition of the photo that I sent him of my first find as a *Litiopa* species. Thanks, too, to Dr Rebecca Carey (University of Tasmania) for providing further information on the pumice raft and its origins, to Dr Scott Bryan and Eleanor Velasquez (Queensland University of Technology) for information and further discussions on the molluscan fauna of southeastern Pacific pumice, and to Denis Riek for more insights into *Litiopa*. Thanks to Amanda Thomson for permission to use her in-situ photo of pumice-snails. Thanks to all those who collected pumice for me, regardless of whether or not it proved to harbour interesting molluscs; also to Mark Wapstra for alerting me to the earlier references to pumice in the Tasmanian Field Naturalists Club's online archives of past issues of *The Tasmanian Naturalist*.

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Plate 3. Two pumice-snails *Litiopa limnophysa*, snuggled next to the much larger shell of a juvenile cartrut-snail *Dicathais orbita* on a piece of pumice collected on 19 May 2014 by Amanda Thomson from the Bay of Fires

MARATUS HARRISI (ARANEAE: SALTICIDAE), A NEWLY RECORDED PEACOCK JUMPING SPIDER FOR TASMANIA

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The jumping spider genus *Maratus* contains some of the most colourful spiders in Australia. These are commonly called peacock spiders from the iridescent hairs covering a decorative flap on the abdomen of the male and the elaborate display dance they perform while wooing the plainly coloured females (Otto & Hill 2011). The flap is raised to a vertical position during courtship and shimmied as the male performs for the female. The third pair of legs is elongated and usually darkly coloured with a white tip. These legs are also raised to the vertical position during the courtship display.

A total of 45 species of *Maratus* are currently recognised in Australia (Otto & Hill 2014). Of these, 28 species are considered to be validly attributable to this genus while the remaining 17 species await reclassification to other genera. Most peacock spiders are distributed in coastal heaths and forests in southeastern Australia and the southwest of Western Australia. A distinctive new species, *Maratus harrisi* was recently described from a single male from Booroomba Rocks in Namadgi National Park, New South Wales 35°33′43.8″S 148°59′35.0″E (Otto & Hill 2011). It was found at an altitude of 1,248 metres on 22 October 2011 by Stuart Harris.

While undertaking the Overland Track between Cradle Mountain and Lake St Clair in March 2013, GH photographed a jumping spider (Salticidae) on the lower flanks of Barn Bluff 41°43′23.21″S 145°55′24.01″E). The spider (Plate 1) was on boulders where low heath grades to vertical rock faces (Plate 2). The exposed rock cap of Barn Bluff is composed of Jurassic dolerite that overlies Permian sedimentary strata (Banks 1973). The site at Barn Bluff is at an elevation of approximately 1,450 metres.

Maratus harrisi is readily distinguished from the other *Maratus* species by the presence of two ivory patches on the dorsal opisthosoma (Plate 1) as well as other features of this flap that is attached to the abdomen (Otto & Hill 2011). The Barn Bluff specimen does vary somewhat from the type specimen in colouration. It is generally more sombre with reduced areas of reddish scales on either end of the opisthosoma as well as behind the eyes. The white band behind the eyes on the ocular quadrangle is also less pronounced. The green flaps at the side of the opisthosoma were substantially darker than those in the type specimen. While these differences relate to only a single individual from both localities, it is possible the Tasmanian populations represent a distinctive insular form to that present on the mainland.

The record of *Maratus harrisi* at Barn Bluff lies c. 735 kilometres to the southwest of the type locality at Booroomba Rocks. While the geology is different with dolerite predominating at Barn Bluff and granitics at Booroomba Rocks, they both offer alpine or subalpine environments. The two other species of *Maratus* previously recorded from Tasmania are *Maratus pavonis* and *Maratus tasmanicus* (Otto & Hill 2011; Otto & Hill 2013; Otto J. Flickr site). The

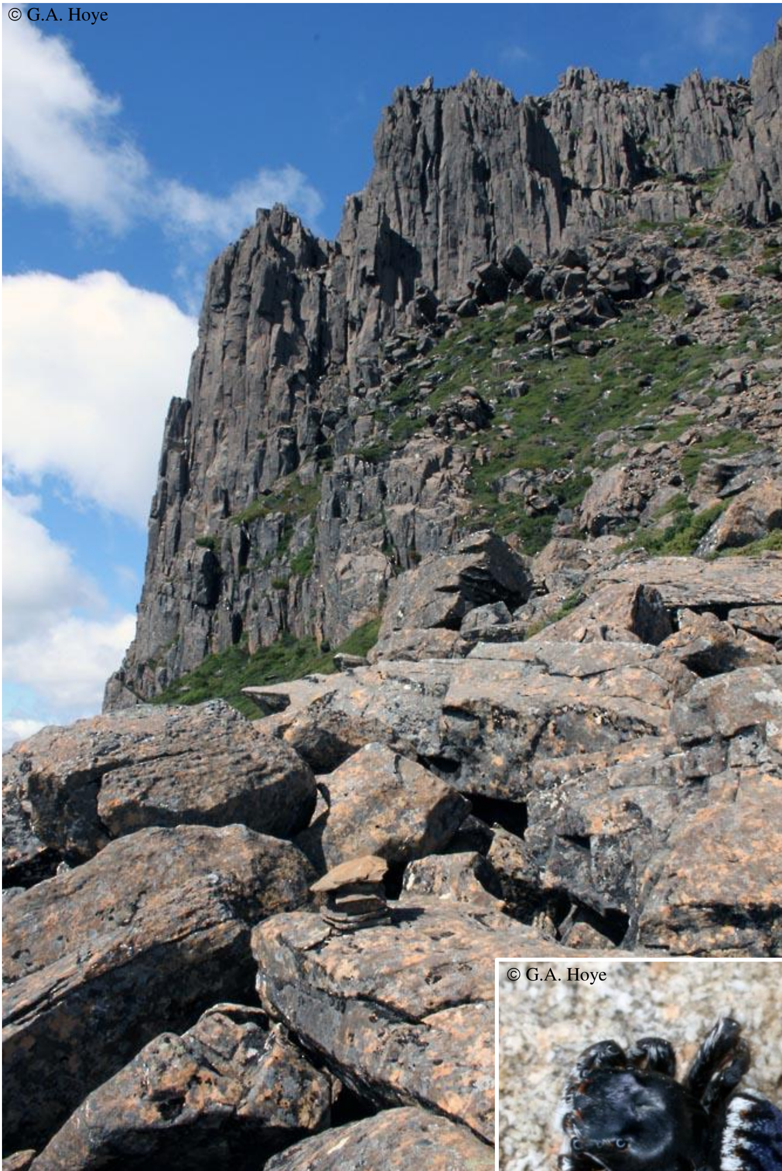

Plate 1. (right) *Maratus harrisi* male from below the summit of Barn Bluff

Plate 2. (above) Barn Bluff with the location of *Maratus harrisi* (c. 4 mm) below the vertical cliffs to the left of the image

known sites for both species are within coastal lowlands in contrast to the site at Barn Bluff. A similar proportion of Tasmanian to mainland species is also apparent in the zodariid spider genus *Habronestes* L.Koch, which are diurnal hunters of ants (Baehr & Raven 2009).

On 27 January 2014, PM came across an adult male *Maratus harrisi* approximately 350 m southwest of the summit of Mount Wellington, near Hobart at 1,245 metres elevation (42°53′54.31″S 147°14′04.64″E) (Plates 3 & 4). The male was foraging on flowers of a prostate mountain teatree *Leptospermum rupestre* (Plate 3), which is locally common on the summit plateau. The dorsal markings on the abdomen of this spider resemble the stamens and anthers of the teatree blossom and it is possible that this is camouflage to facilitate hunting. The nectar-rich flowers were visited by a range of small flies and beetles as well as introduced honeybees and bumblebees. Several *Maratus* juveniles were present within 20 m of the adult male on low *Ozothamnus ledifolius* daisy shrubs, which were in the late flowering stage. The musky smelling flowers of these shrubs were attracting a variety of small flies of a suitable size to serve as prey for the immature spiders. Mild days can persist until early April at these elevations in Tasmania so it is likely that these late instar juveniles will go through to adulthood before the onset of winter (Jürgen Otto, pers. comm.). These were foraging in the company of a larger salticid spider (*Opisthoncus* sp.).

Plate 3. (above) Male *Maratus harrisi* (c. 4 mm) from near the summit of Mount Wellington

Plate 4. (right) Habitat of *Maratus harrisi* near the summit of Mount Wellington, looking southeast from pinnacle

Figure 1 shows the three known localities for *Maratus harrisi* as well as the boundary of the Tasmanian Wilderness World Heritage Area (TWWHA) and areas in Tasmania above 1,000 metres elevation. Prior to sighting at Barn Bluff, no spiders of the genus *Maratus* had been recorded from this large area (15,800 km^2) of reserved land. This record highlights the potential for currently unrecorded spiders and other invertebrates to be present within the TWWHA. Mallick & Driessen (2005a,b) list 97 spiders within the TWWHA, only eight of which are jumping spiders (Salticidae). Substantial areas of potential habitat lie both within and outside the TWWHA. Based on the two sites detailed here, heath within proximity to dolerite extrusions above 1,000 metres elevation would be the most suitable habitat to search for further localities for this species.

ACKNOWLEDGEMENTS

We would like to thank Jürgen Otto for verifying the identity of the records, background information on the genus *Maratus* and the pleasure of his stunning images of these spiders. GH would like to thank his wife Margaret who provided excellent company and support during the walk.

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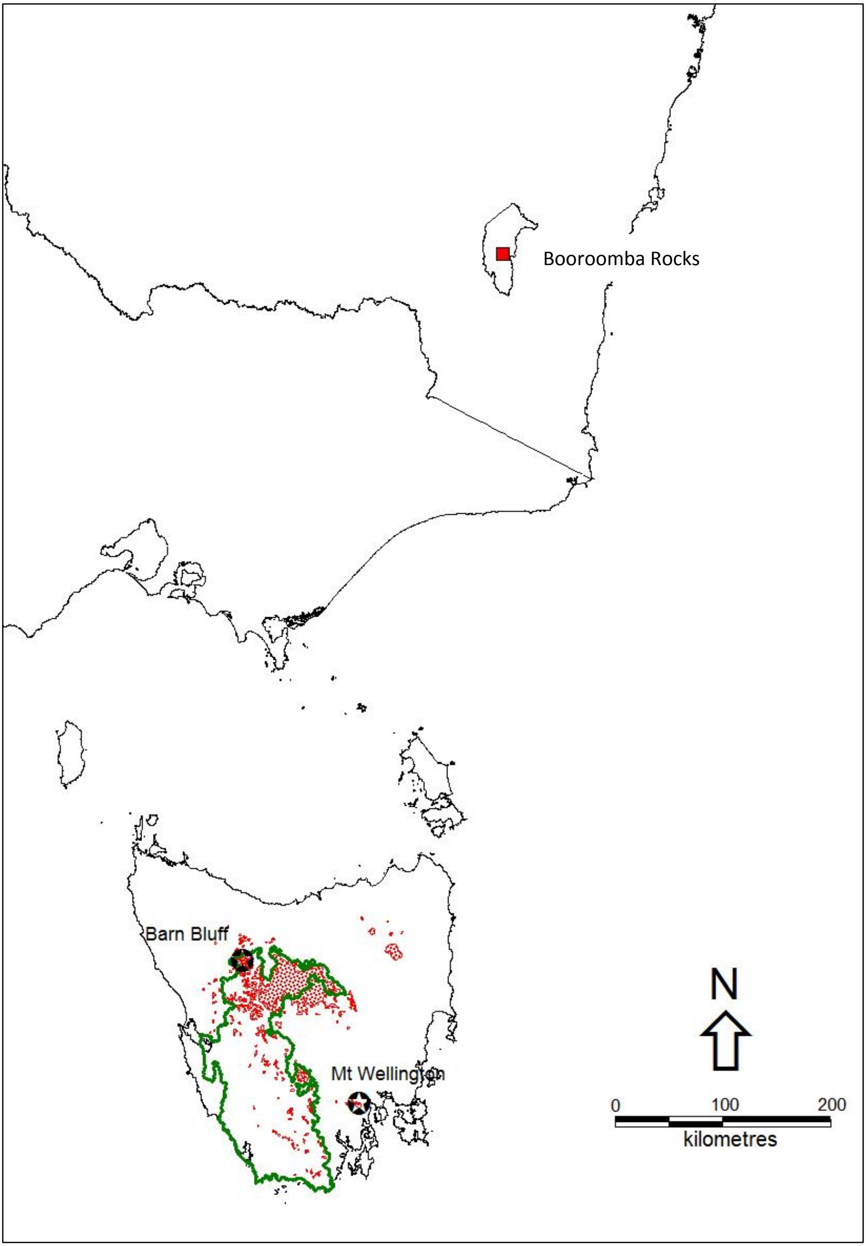

Figure 1. Location of the Barn Bluff, Mount Wellington and Booroomba Rock sites, with the Tasmanian World Heritage Area shown in green and areas above 1,000 m a.s.l. shown in red

NEW HOST RECORDS FOR SOME BEETLE SPECIES REARED FROM POLYPORE BRACKET FUNGI COLLECTED IN SOUTHERN TASMANIA, AUSTRALIA

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INTRODUCTION

Many species of beetles in the families Ciidae and Erotylidae utilise bracket fungi as both a food source and as a habitat. In Tasmania little is known of the number of species inhabiting bracket fungi, or the relationships between species of beetles and species of bracket fungi.

The *Cis* species of beetles from the family Ciidae are minute beetles averaging 20 mm in length. Most species have ornate horns and plates on their heads used to tunnel through the fungal host. The Erotylidae are brightly coloured beetles up to a centimetre in length.

The first Tasmanian species of *Cis* was recorded by Blair (1940) as collected during Walker's voyage in *HMS Penguin* 1890-1891. *Cis walkeri*, *C. cervus* and *C. tasmanicus* are described. The *Catalogue of the Insects of Tasmania* (Semmens et al. 1992) lists two species of Ciidae: *Cis bilamellatus* Fowler and *Orthocis leanus* (Blackburn); and seven species of Erotylidae: *Cnecosa insueta* (Crotch), *Episcaphula australis* (Boisduval), *Thallis compta* Erichson, *T. dentipes* Blackburn, *T. femoralis* Blackburn, *T. janthina* Erichson, and *T. vinula* Erichson.

The Australian polypore beetle fauna has received little attention apart from observations by Hawkeswood (1986) for two species of Erotylidae (*Episcaphula australis* and *E. rufolineata*) and Hawkeswood (2003) on fungal host records for Zopheridae (*Zopherosis georgei*), Tenebrionidae (*Byrsax macleayi*), Scaphidiidae (*Scaphidium exornatum* and *S. punctipennis*), Ciidae (*Cis victoriensis*) and Erotylidae (*Thallis erichsoni*). Hawkeswood et al. (1997) summarised known fungal host records for Australian Erotylidae including the Tasmanian species *Episcaphula australis*, *Thallis compta*, *Thallis janthina*, *Thallis vinula* and *Cnecosa insueta*.

Ciid and erotylid beetles complete their life cycle within the fungal bracket and several generations may occur before the adults migrate to find a fresh food source (Entwistle 1955). This paper also demonstrated that populations of *Cis bilamellatus* could inhabit a single polypore for several years until the food source was exhausted.

There have been few studies where beetles have been reared from polypores. Rearing studies have, for example, been documented from Europe: England (Paviour-Smith 1960), Russia (Nikitsky & Schigel 2004) and Finland (Komonen & Kouki 2005). A description of collection methods and rearing techniques is provided by Schigel (2008).

The present paper records the beetle species reared from a number of bracket fungus species collected from sites in the wet forests of southern Tasmania.

METHODS

Forty three undamaged polypore specimens, comprising five species having perennial fruiting bodies, were collected and held individually in rearing boxes. (Table 1). The species of basidiomycete fungi were *Australoporus tasmanicus* (Berk.) P.K. Buchanan & Hoad; *Ganoderma applanatum* (Pers.) Pat.; *Phellinus wahlbergii* (Fr.) D.A.Reid; *Ryvardenia campyla* (Berk.) Rajchenb.; and *Ryvardenia cretacea* (Lloyd) Rajchenb.

The bracket fungi were collected at three sites in southern Tasmania: Warra Long-term Ecological Research site (43°06′E 146°41′S), Scotts Peak (42°55′E 146°20′S) and Styx Valley (42°49′E 146°38′S). All collections were made in August 2006. The fungi were photographed and identifications made from those photos by specialists at University of Tasmania. The fungi were placed individually in cardboard boxes and placed in a controlled temperature room at 20°C. The boxes were checked every two weeks, between 15 September 2006 and 18 January 2008, for emerging insects. A card mounted voucher series of emerging beetle species has been lodged in the Tasmanian Forest Insect Collection (TFIC) held in the Tasmanian Museum & Art Gallery in Hobart. Identifications were initially made using Blair's (1940) key to the Australian Ciidae then compared with specimens in the Australian National Insect Collection in Canberra. Some unnamed specimens were then sent to Dr John Lawrence for comparison with his undescribed species.

RESULTS

A total of 2,835 individuals of six *Cis/Xylographus* species emerged along with 198 specimens of three *Thallis* species (Erotylidae) (Table 2). Several generations of *Cis* species utilised the fungal food substrate rendering the inside material of the brackets to a fine powder leaving an outer bracket shell dotted with emergence holes (Plate 1) Larvae and adults were present together at all times so no attempt was made to distinguish the number of generations during the 16 months of emergence. However research by Paviour-Smith (1968) has demonstrated that *Cis bilamellatus* can complete its life cycle from egg to adult during summer between 9 and 14 weeks. Clearly numerous generations can occur within large brackets when occupied for up to two years.

Cis bilamellatus was the dominant species, emerging from all fungi except *Ryvardenia campithyla*, the preferred hosts being *A. tasmanicus* and *P. wahbergii*. *Cis* TFIC sp 04 emerged only from *G. applanatum*. *Xylographus* Lawrence 697 emerged only from *P. wahbergii*. *Cis cervus* emerged in small numbers from *A. tasmanicus* and *G. applanatum*, and *Cis* Lawrence 783 was similar with the additional host record of *P. wahlbergii*.

The erotylid species *Thallis vinula* and *T. janina* emerged only from *R. cretacea*. *Thallis femoralis* emerged in large numbers from *R. cretacea* with a few individuals emerging from *R. campyla* and *P. wahlbergii* (Plate 2). This family of beetles spend only one generation within a fungal host with emerging adults readily flying to locate new hosts.

DISCUSSION

A number of other species of Ciidae and Erotylidae are held in the Tasmanian Forest Insect Collection (TFIC). These species have been included in Plate 2. This paper records twelve species of Ciidae from Tasmania and confirms the presence of five species of Erotylidae. Most of these species have been caught in biodiversity studies conducted in the high rainfall, 1500+ mm annual, wet eucalypt forests of southern Tasmania. *Thallis compta* was commonly collected in static traps in low rainfall areas, below 1000 mm, in northeastern Tasmania. Collections of polypores from drier woodland sites in Tasmania would markedly increase the fauna records for Ciidae and Erotylidae in Tasmania.

The dispersal ability of several fungivorous beetles, including *Cis* species, have been examined by Komonen (2005) in eastern Finland. The results suggest that dispersal of some *Cis* species is good (up to 1.5 km). The Ciidae species in Tasmania are seldom caught in flight intercept traps unlike the Erotylidae, which are caught sometimes in large numbers during the warmer summer months. It would appear that *Cis* species go through several generations within large bracket fungi, only leaving to migrate to new hosts at any time of the year after completely hollowing out the host brackets. In northern Europe up to 70% of polypore fruiting bodies are colonised by *Cis* species. (Komonen et al. 2004). Of the 49 polypore samples collected in this study only three, all *A. tasmanicum*, were not attacked by fungus beetles.

Of special interest is the ciid *Cis bilamellatus*, the most common species reared from brackets in this study. This Australian species is now established in Britain and southern France where it was recorded from the fruiting bodies of twelve genera of polypore fungi by Paviour-Smith (1968). The species was first recorded in southern England in 1884 and is thought to have entered the country in fungal specimens sent to Kew Gardens for identification (Wood 1884). The pattern and rate of spread from introduction till 2007 has been documented by Orledge et al. (2010) making this species one of the most intensively studied of the fungus beetles known in Tasmania. These studies confirm that *Cis bilamellatus* colonises 'dead' fruiting bodies i.e. those that have shed their spores. They therefore have no impact on the reproductive potential of the host species but do increase the rate of recycling of host tissue to the soil.

The Tasmanian beetle fauna utilising polypore fungi seem rather depauperate when compared to northern hemisphere records. Jonsell & Nordlander (2002) recorded 19 species from four families from Sweden; Komonen & Konki (2005) twelve Ciidae species from Finland; and Komonen (1998) 37 species of Coleoptera inhabiting one species of polypore *Amylocystis lapponica* from Finland. The host records for nearctic ciids is well known (Lawrence 1973).

In *Insects of Australia* (CSIRO 1970) 13 species of Ciidae are recorded and 81 species of Erotylidae.

It has been shown that the Ciidae include both specialist and generalist species but all members of the family are fungivores (Guevara et al. 2000). Very little is known about the life history of Tasmanian fungivore beetles both in terms of numbers of species and host associations yet they may be a vital component in the continued vitality of our native forests.

ACKNOWLEDGEMENTS

My thanks to Lynne Forster (University of Tasmania) for her assistance in photographing the Erotylidae and Ciidae specimens in the Tasmanian Forest Insect Collection. John Lawrence kindly compared some of the Tasmanian specimens with his collection and applied his species code to the undescribed species. Genevieve Gates kindly identified the polypore fungi for me.

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Table 1. Details of collections of bracket fungi

Species	Site	Host plant	Date collected	Specimens	Size of bracket (cm^3)
Phellinius wahlbergii	Warra, SST control site	*Eucalyptus obliqua* stump felled 1996	8/08/2006	2	528, 798
Phellinius wahlbergii	Warra, SST control site	*Eucalyptus obliqua* stump felled 1996	8/08/2006	2	1750, 780
Phellinius wahlbergii	Warra, SST control site	*Eucalyptus obliqua* stump felled 1996	8/08/2006	3	756, 792, 648
Phellinius wahlbergii	Warra, SST control site	*Eucalyptus obliqua* stump felled 1996	8/08/2006	2	532, 561
Phellinius wahlbergii	Warra, End Manuka Road	Live *Eucalyptus obliqua*	29/08/2006	2	858, 513
Phellinius wahlbergii	Warra, End Manuka Road	Live *Eucalyptus obliqua*	13/09/2006	4	900, 360
Phellinius wahlbergii	Warra, Bird Track	*Eucalyptus obliqua* stag	13/09/2006	2	590, 611
Phellinius wahlbergii	Warra, Horseshoe Track	*Eucalyptus obliqua*	2/07/2007	3	192, 192, 150
Ryvardenia campyla	Scotts Peak	*E. obliqua* stump	29/08/2006	1	360
Ryvardenia cretacea	Scotts Peak		29/08/2006	2	840
Ryvardenia cretacea	Warra, End Manuka Rd	Live *Eucalyptus obliqua*	8/08/2006	1	2724
Ryvardenia cretacea	Warra, End Manuka Rd	Live *Eucalyptus obliqua*	8/08/2006	1	933
Ryvardenia cretacea	Styx Valley		29/08/2006	3	740, 633, 690
Ganoderma applanatum	Warra, End Manuka Rd	*Eucalyptus obliqua* log	8/08/2006	1	1224
Ganoderma applanatum	Warra, End Manuka Rd	*Eucalyptus obliqua* log	8/08/2006	3	800, 769, 932
Australoporus tasmanicum	Warra, Log decay site	Dead *Nothofagus cunninghamii* stag	8/08/2006	11	104, 77

Table 2. Emergence of beetles from bracket fungi

Bracket fungi species	*Cis bilamellatus*	*Cis cervus*	*Cis Lawrence 783*	*Cis TFIC sp 04*	*Cis Lawrence 784*	*Xylographus Lawrence 697*	*Thallis femoralis*	*Thallis vinula*	*Thallis janthina*	**TOTALS**
Ryvardenia campyla	0	0	0	0	0	0	5	0	0	**5**
Australoporus tasmanicum	1,238	2	1	0	0	0	0	0	0	**1,241**
Phellinus wahlbergii	1,223	0	4	0	2	153	2	0	0	**1,384**
Ganoderma applanatum	14	11	11	143	0	0	0	0	0	**179**
Ryvardenia cretacea	33	0	0	0	0	0	127	1	63	**224**
TOTALS	**2,508**	**13**	**16**	**143**	**2**	**153**	**134**	**1**	**63**	**3,033**

Plate 1. Upper surface of bracket fungus (*Ganoderma applanatum*) colonised by *Cis* beetles

A **B** **C** **D** **E**

Plate 2a. Tasmanian species of Ciidae and Erotylidae beetles reared from bracket fungi or collected in flight intercept traps [all images © Lynne Forster]

EROTYLIDAE (scale bars: 1 mm): **A** *Thallis compta*, **B** *Thallis femoralis*, **C** *Thallis janthina*, **D** *Thallis vinula*, **E** *Cnecosa insueta*

F **G** **H**

I **J**

Plate 2b. Tasmanian species of Ciidae and Erotylidae beetles reared from bracket fungi or collected in flight intercept traps [all images © Lynne Forster]

CIIDAE from this study (scale bars: 10 mm): **F** *Cis bilamellatus*, **G** *Cis cervus*, **H** *Cis* TFIC sp 04, **I** *Cis* ‘Lawrence sp 783’, **J** *Xylographus* ‘Lawrence sp 697’

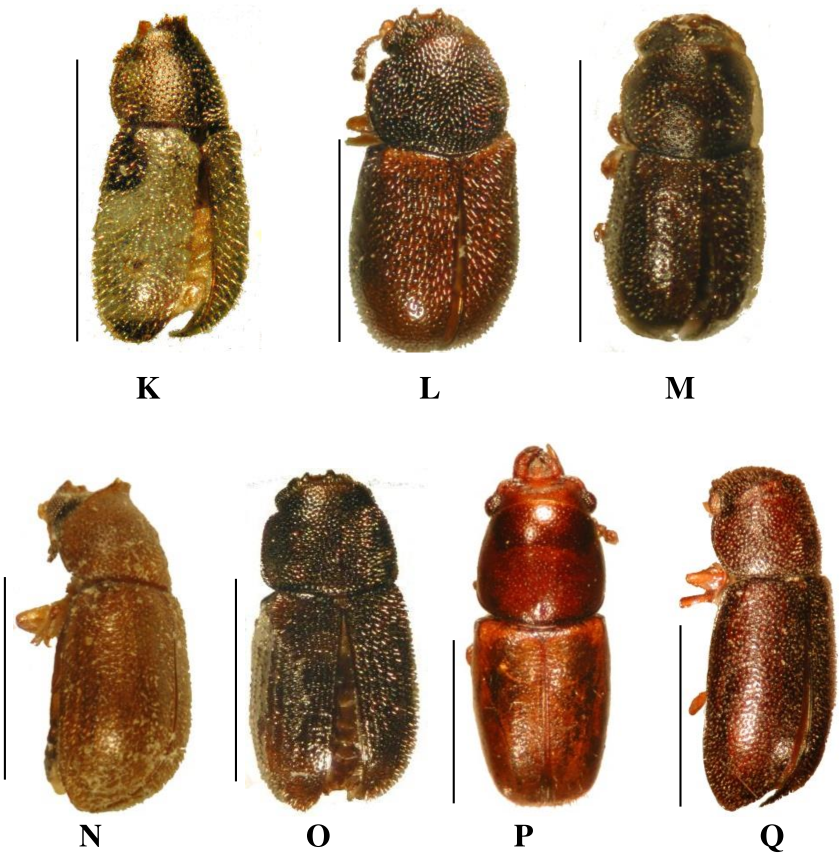

Plate 2b. Tasmanian species of Ciidae and Erotylidae beetles reared from bracket fungi or collected in flight intercept traps [all images © Lynne Forster]

CIIDAE other Tasmanian species (scale bars: 10 mm): **K** *Cis* sp. nr *clarki*, **L** *Cis* TFIC sp 02, **M** *Cis* TFIC sp 05, **N** *Cis* TFIC sp 06, **O** *Cis* 'Lawrence sp 784', **P** *Octotemnus dilutipes*, **Q** *Orthocis* TFIC sp 01

AN INCIDENTAL SHOREBIRD SURVEY OF A REMOTE AREA OF THE SOUTHWEST COAST OF TASMANIA IN APRIL 2014

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INTRODUCTION

The coast between Wreck Bay and Sandblow Bay was traversed between 2-6 April 2014 whilst undertaking flora monitoring and inventorying work as part of the DPIPWE flora climate change monitoring project. This is one of the most remote areas of coastline in Tasmania being rarely visited by intrepid bushwalkers and even rarer still by those with an inclination to note down natural history observations. As such the opportunity was taken to record a diverse range of observations. One facet of this was the systematic noting of shorebirds. Although April is outside of the breeding season and not an ideal time for surveying populations of shorebirds, it would make a potentially useful comparison with surveys conducted at other times of year.

The main target species of the survey was the Hooded Plover (*Thinornis rubricollis*). However, other species were also noted and counted when they were observed, the exception being gulls, which were only noted where in large congregations.

SURVEY AREA & METHODS

All areas of sandy shoreline were walked between Wreck Bay and Sandblow Bay at least once. This includes the beaches in Wreck Bay, Towterer Beach and those of Alfhild Bight, Dennis Gulch and Sandblow Bay (Figure 1). The accessible areas of rocky coastline between these areas were also traversed. This totals approximately 4 km of sandy coast along a 12 km stretch of shoreline. The largest individual beaches in the area are the two beaches of Wreck Bay, which are divided by a narrow rocky point with a combined length of 1.6 km; Towterer Beach 1.4 km and Paradise Lagoon Beach at about 350 m.

The main base for our field work was Towterer Beach, which is named after the head man of the Lowrenne people in the 1830s and father of Mathinna. The beach was walked up to three times a day over a three day stretch from the 2-4 April (Plate 1). A comparatively large beach for this part of Tasmania, it is located 12 km north of North Head, which bounds the northern end of Port Davey. The beach gains some slight protection from the prevailing swell due to its slightly northerly orientation and the presence of Hobbs Island (one of the many also called Green Island by fishermen) and Horseshoe Reef, which lie offshore to the west and south. As such the beach is wide and flat – up to 100 m at low tide – with several rows of submerged sandbars offshore and a large steep dune system behind that contains several sandblows, the largest of which is located in the southern section of the beach and is over 30 ha in size (Plate 2). The large Towterer Creek flows into the northern end of the beach via a mobile channel. At the time of visiting it flowed approximately 300 m south along the beach before breaching to the sea.

Northward the beaches of Wreck Bay were walked each way on 5 April. Still marked by the wreck of the *Svenor*, an iron barque

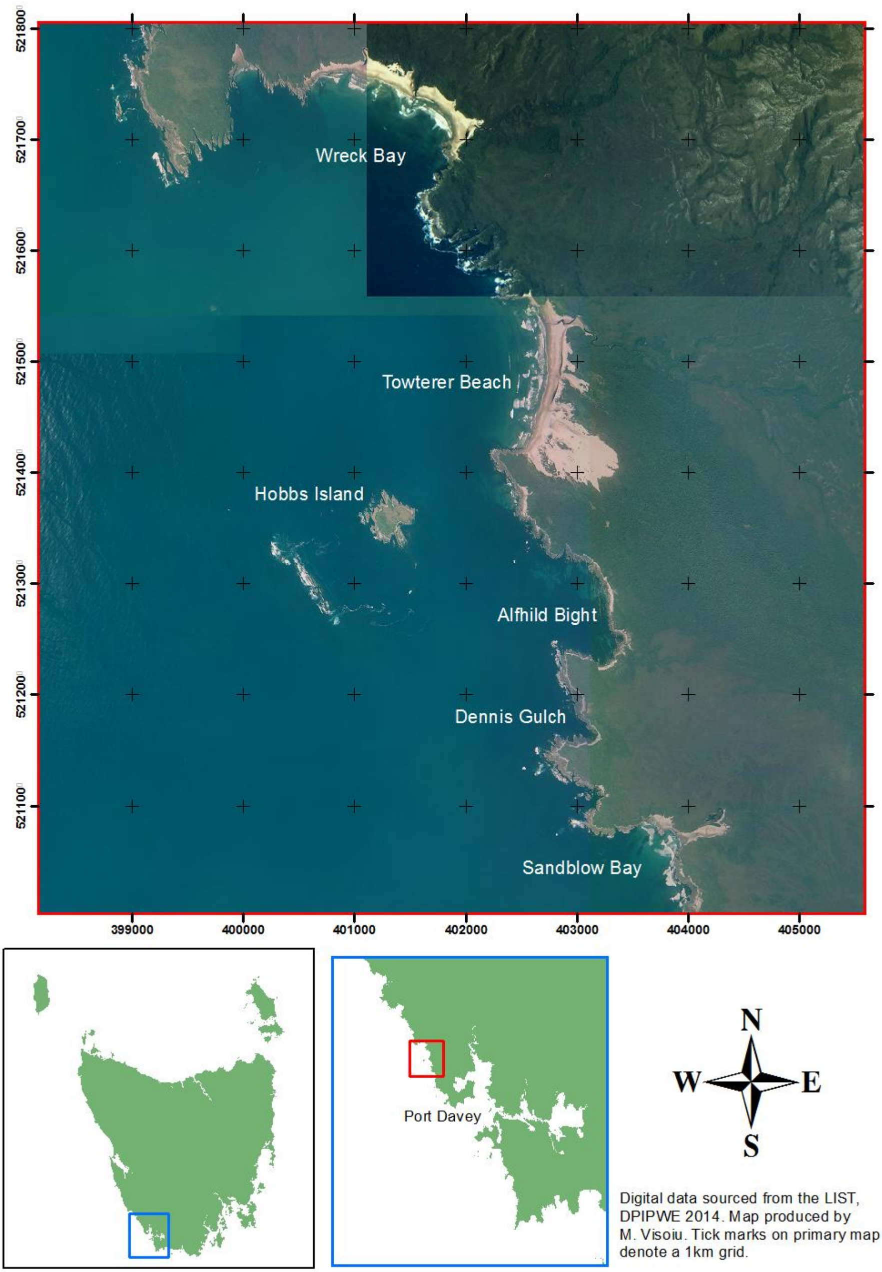

Figure 1. Location of the study area

that came aground on the eastern beach in May 1914, Wreck Bay contains a large beach that is divided in two by a narrow rocky point at about its midpoint. The beaches are orientated southwest and are protected to the west by Svenor Point and its outlying reefs. Both beaches have wide flat sections, which are wave-washed at times, and have steep dune systems behind. The eastern beach is punctuated by the large Trepanners Creek whilst the western beach has two smaller unnamed creeks.

South of Towterer Beach the coast was walked one way on 6 April, encompassing short areas of sandy shoreline in Alfhild Bight, Dennis Gulch and Sandblow Bay as well as longer areas of cobble beach and rocky shoreline. Paradise Lagoon Beach, which fronts the sandblow after which Sandblow Bay is named, is the most extensive area of sandy coast in this stretch, being approximately 350 m long and stretching 350 m inland up a long narrow sandblow, which is wave-washed at times and forms the outflow of an unnamed creek.

For observations Minox 8.5 x 43 binoculars were used.

OBSERVATIONS

Hooded Plovers were encountered at the three largest beaches traversed, with the number counted on this section of coast being 27 with adult plumage and 4 with juvenile plumage (total 31). It is likely that this number represents the total present on this section of coast at this time as all available habitat was comprehensively surveyed, and travel between beaches by birds during the survey period, whilst possible, seems unlikely. In addition, Double Banded Plover (*Charadrius bicinctus*), Sooty Oystercatcher (*Haematopus fuliginosus*), Silver Gull (*Chroicocephalus novaehollandiae*) and Pacific Gull (*Larus pacificus*) were observed along with a range of non-coastal obligate species utilising the littoral environment. Counts by location are shown in Table 1. Data collected by Schultz & Kristensen (1993a,b) in February 1993 have been included for comparison.

The numbers of shorebirds seen on Towterer Beach suggests that this is the most significant site for beach species on this section of coast. The opportunity to re-survey the beach several times over a three day period provided insight into the reliability of one-off surveys for these species. Towterer Beach provides more complex habitat than do the other beaches surveyed due to a number of sandblows. Table 2 provides all observations of Hooded and Double Banded Plovers over this period, showing that by walking the beach and counting birds, numbers of Hooded Plovers observed fluctuated between one and 19. Double Banded Plovers were even less reliably observed with only two seen on the beach on one occasion. The discrepancy in count numbers was due to birds utilising a large sandblow, which was the focus for populations of both species. Few beach observations were made more than 300 m away from the mouth of this sandblow.

Unlike the other sandblows, the one used by the birds had eroded down to a hard iron oxide cemented paleosol covered in the skeletons of long dead bushes and numerous ancient periwinkle shell middens (Plates 2 & 3). A small stream flowed through it down a narrow gully and fanned out into a wet soak at the top of the beach. Both species of plover spent large amounts of their time 70-100 m off the beach up the sandblow milling around. No birds were seen feeding; rather it appeared to be a safe resting area, with birds congregated in loose mixed flocks around higher vantage points. On several occasions Hooded Plovers disturbed near the mouth of the sandblow ran up into the blow rather than along the

Plate 1. Gulls beginning to build up at the outflow of Towterer Creek, where they bathed and roosted each evening

Plate 2. Hooded and Double Banded Plovers favoured the hard paleosol surface near the mouth of this sandblow on Towterer Beach

Plate 3. (inset) Sandblow seen from the beach

beach. If they ran along the beach they would take flight and circle back to the mouth of the sandblow after a couple of hundred metres.

Only two Double Banded Plovers were seen on the beach on one occasion, when they were actively feeding on the edge of the sandblow at dusk. They were, however, present in the sandblow area on both occasions it was visited. The colouration of this species, individuals of which were in non-breeding plumage, and 'run and freeze' way of moving amongst the dead bushes made it hard to accurately count numbers, however at least six individuals were present.

DISCUSSION

Tasmania is known to be home to over half of the eastern Australian population of Hooded Plovers with an estimated 1700–2000 birds (Newman & Patterson 1984; Bryant 2002). Holdsworth & Park (1993) found an average of 1.73 birds per kilometre over a 500 km subset of Tasmanian beaches surveyed in 1992. The section of coast between Port Davey and Macquarie Heads has previously been shown to have higher densities than this with 6.6 birds per kilometre 1993 (Schultz & Kristensen 1993b). The total observed individuals in April 2014 is surprisingly high equating to approximately 7.75 birds per kilometre of beach.

The breeding season for Hooded Plover in Tasmanian is protracted between late August and early April (Bryant 2002). No birds were observed that were thought to be breeding during this survey and the four birds that retained juvenile plumage on Towterer Beach were all fledged. Hooded Plovers moult from juvenile to their first adult plumage during their first summer or autumn, after which they are difficult to distinguish from adult birds (Marchant & Higgins 1993). It is possible therefore that the four birds retaining juvenile plumage were hatched late in the breeding season, and an unknown number of those recorded as having adult plumage may have been earlier hatchings from the present breeding season already moulted to first adult plumage.

The numbers and distribution of birds in April 2014 were remarkably similar to the February 1993 survey. Wreck Bay and Sandblow Bay had identical numbers whilst Towterer Beach had five extra birds. A pair of Hooded Plovers was present in Alfhild Bight in 1993, whilst none were encountered in 2014. Overall 28 birds were present in this area of coast in February 1993. No detailed breakdown of adult/juvenile is available by beach, however, 27 of the 242 total recorded between North Head and Macquarie Heads had juvenile plumage (Shultz & Kristensen 1993b), suggesting three or four of the number counted in the present study area had juvenile plumage. Thirty one were present in April 2014, 27 adult and four juvenile.

Hooded Plovers have been noted to congregate outside of the breeding season in Tasmania (Thomas 1968; Bryant 2002), with some of the 19 birds present on Towterer Beach in April 2014 potentially taking advantage of the abundant foraging habitat present on this beach rather than being breeding residents. The birds were seen singularly in pairs or in larger groups, however all birds were often focused in the same area so could be regarded as comprising a loose flock. This could account for the absence of birds from Alfhild Bight, where a pair was present in February 1993, and where habitat, albeit fairly marginal, remains.

The other beaches surveyed were occupied by Hooded Plovers in pairs or threes and were well-spaced along those beaches. A proportion of the population has been noted to remain in, or close to, their breeding territories year round (Thomas 1968). It is reasonable to assume that this is the case with these birds as each pair – or pair with a likely first season young still in attendance – was occupying stretches of beach which appeared to provide a suitable extent of breeding habitat.

The inconsistent numbers counted on Towterer Beach over a four day period was likely due solely to the use of the sandblow by the birds rather than birds flying to and from other beaches in the area. The use of dune systems as retreat areas for this species has been noted in Victoria as a possible issue for conducting one-off beach counts (Weston 2003). Potentially the variability in counts would be lower during the peak breeding season when pairs are maintaining territories.

Of the other species of shorebird encountered during the survey, notable was the presence of a small number of Double Banded Plovers in the Towterer Beach sandblow. A single individual was also recorded from Towterer Beach during the February 1993 survey, indicating this species may have a regular seasonal presence in the area. A surprising absence during the 2014 survey was Pied Oystercatcher (*Haematopus longirostris*). No individuals were encountered during the survey despite a number of apparently suitable beaches being surveyed and past records of breeding at Wreck Beach and Towterer beach (records from DPIPWE's *Natural Values Atlas*). The lateness of the 2014 survey means that birds that breed on this section of coast are likely to have been congregating in small flocks in productive foraging areas at this time of year. Coincidentally, or due to some hitherto unremarked on localised annual movement, these birds must have been outside of the survey area in April 2014.

Shorebirds such as Hooded Plovers, which are reliant on beaches with suitable nesting and foraging habitat, are identified as being highly exposed to impact from climate change caused sea level rise (Garbett et al. 2013; Mallick 2013). Investigating the populations of these species in areas where anthropogenic disturbance is not further compounding stresses on the birds may prove valuable in the coming decades. This is because any opportunities for species such as Hooded Plovers to successfully adapt to these changes will be maximised in these remote environments.

ACKNOWLEDGMENTS

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Table 1. Totals shorebirds observed by location with some incidental observations of other birds utilising the littoral environment (also included are the numbers of plovers recorded by Schultz & Kristensen in February 1993)

<table>
<tr><th>Location</th><th>Date</th><th>Hooded Plover</th><th>Other observations</th><th>Feb. 1993</th></tr>
<tr><td>Towterer Beach
(55 G 402800 5214500)</td><td>2-5 April</td><td>15 adult
4 juvenile</td><td>Two pairs of Sooty Oystercatchers seen together twice.
Up to 300 Silver Gulls and 30 Pacific Gulls roosting on beach and washing in creek mouth each night.
Single White bellied Sea-eagle seen twice.
Peregrine Falcon seen flying south along beach once.
Up to 6 Double Banded Plovers in non-breeding plumage seen in, or at mouth of large sandblow on three occasions.</td><td>14 Hooded Plover
1 Double Banded Plover</td></tr>
<tr><td>Wreck Beach (east)
(55 G 401898 5217308)</td><td>5 April</td><td>3 adult (together)</td><td></td><td rowspan="2">Total of 7 Hooded Plovers (whole of Wreck Bay i.e. both beaches)</td></tr>
<tr><td>Wreck Beach (west)
(55 G 401478 5217520)</td><td>5 April</td><td>4 adult (two pairs)</td><td></td></tr>
<tr><td>Rocky coast landward side of Hobbs Island
(55 G 402484 5213869)</td><td>6 April</td><td></td><td>One pair of Sooty Oystercatchers (likely same as seen on Towterer Beach as they flew off north).</td><td></td></tr>
</table>

Location	Date	Hooded Plover	Other observations	Feb. 1993
Alfhild Bight (55 G 403004 5212352)	6 April		One pair of Sooty Oystercatchers (likely same as seen on Towterer Beach as they flew off north). Two immature White bellied Sea-eagles sitting in tree and then circling.	2 Hooded Plovers
Dennis Gulch (55 G 403117 5211742)	6 April		Flock of 20 Sooty Oystercatchers. Many Forest Ravens (>20) and Black Currawongs (>10) and 15 White-faced Herons, all on rocky shoreline in small gulch. Mixed flock of ~60-80 Chestnut Teal and Pacific Black Duck, which flew of water near shore.	
Paradise Lagoon Beach (55 G 403686 5210904)	6 April	5 adult (one pair, one group of three)		5 Hooded Plovers

Table 2. Shorebirds observed on Towterer Beach during six surveys over a three day period

Date	Time (half hour either side)	Location	Hooded Plover (adult plumage)	Hooded Plover (juvenile plumage)	Double Banded Plover
2/4/14	1830	beach	15 (1,5,1,4,1,3)	2	
3/4/14	0900	beach	1		
3/4/14	1110	beach	3		
		large sandblow	10	4	~5
3/4/14	1930	beach	15 (all around mouth of big sandblow)	4	2
4/4/14	0900	beach	3	1	
4/4/14	1700	beach	5	3	
		large sandblow	10		~6

RANGE EXTENSION OR WAS IT ALWAYS THERE AND WE WEREN'T LOOKING?

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INTRODUCTION

Potential range extensions (REs) of tropical and subtropical marine fauna and flora into Tasmanian coastal waters are being recorded for a growing number of species. Examples of these are available on websites such as Redmap (Range Extension Database and Mapping project; http://www.redmap.org.au/region/tas/). This site identifies and records species that are sighted in Tasmanian waters and are considered to be outside their historical range. Examples of these phenomena are the increasing number of sightings and interactions with tropical game fish species, such as a striped marlin, *Tetrapturus audax* (Philippi 1887), off Tasmania's east coast. Other examples of potential REs have also been reported in *The Tasmanian Naturalist*. "Blow-ins from the Blue Fleet" (Grove 2010) and "Jimbles in the Derwent" (Grove 2013) relate the arrival of a variety of warm water invertebrates into Tasmania's eastern and southeastern coastal waters.

Shifts in the distribution of marine species have been related to ocean warming, with greater changes in distribution appearing in regions with a greater rate of warming. The southeast Australian region is one of these global marine 'hotspots', where ocean warming is fastest (Hobday & Pecl 2014). For Tasmania, the seasonal arrival of mobile pelagic species is primarily facilitated by the warm waters of the East Australian Current (EAC), which can extend well down Tasmania's east coast during summer in warm years (Figure 1). The ocean temperature east of Tasmania has risen by about 0.8°C since the 1960s compared to the long-term average, while on the west coast, which is influenced by the Zeehan Current, the temperature has increased by about 0.4°C above the long-term average (e.g. Cresswell 2000; Warman & Bryan 2004; Li et al. 2007).

The ocean currents also carry with them a 'soup' of tropical and subtropical fish and invertebrate larvae. These tropical larvae typically have a long dispersal phase (Edgar 2008) allowing them to travel long distances on currents. During the peak strength of the EAC, waters off Sydney can reach Flinders Island in about seven to ten days. These larvae may settle out in Tasmanian waters during these favourable summer conditions but would not persist through the unfavourable cold conditions of winter. In some respects, Bass Strait has been a frontier for many northern species. However, the persistence of the normally warm-water species, the long-spined urchin, *Centrostephanus rodgersii* (A. Agassiz, 1863), is one example that something has changed in Tasmania's marine environment in recent decades, and naturally occurring arrivals of other species is only likely to increase. There is no denying climate change, particularly off Tasmania's east coast where the sea is warming at three to four times the global average (Hobday & Pecl 2014).

The waters in Bass Strait appear to be warming also. Data acquired from GHRSST and the US National Oceanographic Data Centre appears in Figure 2. This shows: 1. the combined daily

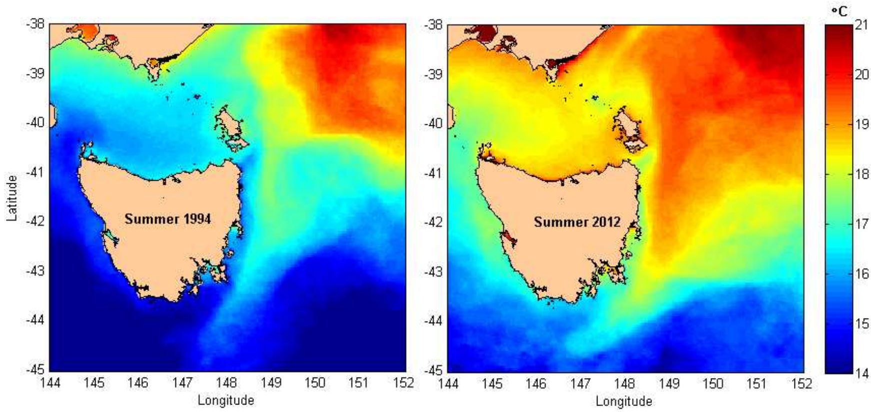

Figure 1. The mean sea surface temperature of southeast Australian waters during the summers of 1994 and 2012 (image provided to QVMAG by Alistair Hobday, CSIRO in 2013)

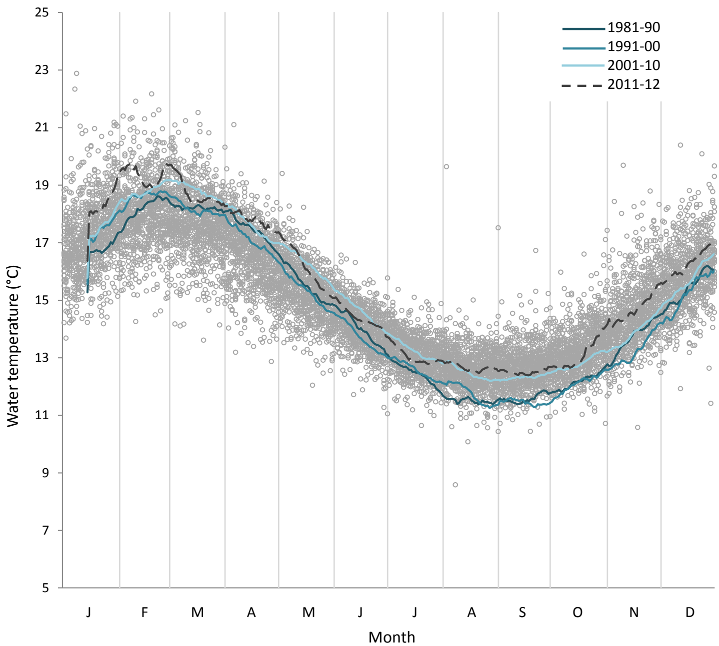

Figure 2. Combined daily mean sea surface temperature for all of Bass Strait from 1 November 1981 to 31 December 2012 (grey circles) and the mean decadal temperatures (running average of 14 days) for 1981-90 (dark blue), 1991-2000 (mid blue) and 2001-10 (light blue); similarly manipulated data appears for 2011-12 (black, dashed line). The vertical position of these four lines was manipulated manually to correct for the change in vertical position caused by the running average calculation. Sea surface temperature data were provided by GHRSST and the US National Oceanographic Data Centre. This project was supported in part by a grant from the NOAA Climate Data Record (CDR) Program for satellites.

mean sea surface temperature for all of Bass Strait; and 2. the decadal mean daily temperatures, as a running average over 14 days, from November 1981 to December 2012. The data reflects the annual temperature cycle and its variability in Bass Strait, and indicates that the decade from 2001-10 was not as cold through the winter months as previous decades. For example, the water temperature from mid-August to mid-September has increased by over 0.6°C. The most up-to-date data available is for 2011-12, and it suggests that this trend is continuing. Further analysis of the data is required, but the increased winter water temperature suggested here may make it possible for warmer water species to persist through the cold months, something that may not have been possible in previous decades.

Climate change is real and this paper does not dispute its role in warm-water species REs into Tasmania. In fact, the primary role of temperature in setting distributional limits has long been recognised for marine species, and the mechanics of climate-related range extensions and contractions is well understood (Bates et al. 2014). Instead, it is our lack of knowledge of southern Australian marine biodiversity, particularly invertebrates, that is highlighted here. On a global scale, an estimated 68-77% of the possible one million marine species has yet to be discovered (Appeltans et al. 2012). On top of this, one only need look at general identification resources such as *Australian Marine Life* (Edgar 2008) and *A Field Guide to the Marine Invertebrates of South Australia* (Gowlett-Holmes 2008), or more specific identification guides such as *Marine Decapod Crustacea of Southern Australia* (Poore 2004), to appreciate how many commonly observed species are yet to be described. This would suggest the need for more, not less, biodiversity surveys, for without understanding species diversity, particularly at a regional level, we are unable to adequately manage our environment, or more correctly our impacts on the environment.

This leads me to the purpose of this paper. We simply don't know all the species that exist and have always existed in Tasmania's marine environment, as opposed to those that have recently arrived here as a result of anthropogenic vectors or climate change. It is likely that some known 'mainland' species have so far gone unobserved in Tasmanian waters, perhaps because they are seasonal vagrants or appear only when ocean conditions are favourable, or perhaps they have very restricted Tasmanian ranges or very low densities; or more likely, there is a lack of expertise looking for them – dive surveys are very expensive, particularly in remote Tasmanian locations. Equally, we know more about the biodiversity of Tasmania's near shore environment now than was known in previous decades; maybe some species were always here but we didn't know to look for them. Perhaps it's time to re-survey previously assessed sites using our newfound knowledge. But would we be improving our knowledge of 'Tasmanian' species' presence and distribution or would we be finding 'mainland' species arrivals? Here I present observations of six marine invertebrates not previously recorded in Tasmania and ask the question: are these examples of range extensions or were they always here and we weren't looking?

NUDIBRANCHS

Nudibranchs, sometimes known as seaslugs (Mollusca: Gastropoda: Opisthobranchia: Nudibranchia), are some of the most visually striking animals in the sea, and Tasmania has a rich seaslug diversity (see *Molluscs of Tasmania* website; www.molluscsoftasmania.net).

Their colours and shapes immediately attract the attention of divers and yet some are so well camouflaged they are generally overlooked. In the complex and continually moving rocky reef environment even the largest, most colourful specimens can go unnoticed. However, the trained eye may spot unexpected colours, shapes and movement against the familiar reef backdrop. Not surprisingly the relatively large (60 mm) and brightly-coloured red lace chromodorid, *Goniobranchus tinctorius* (Rüppell & Leuckart, 1828), caught my eye (Plate 1).

The red lace chromodorid is widespread in the Indo-Pacific and along the mainland Australian coastlines of Queensland, New South Wales, Victoria and Western Australia but not known from Tasmanian waters (Burn 2006; Cobb & Willan 2006; Edgar 2008; Gowlett-Holmes 2008; Museum Australia 2014). So, my question is: does this sighting represent an extension of this species' range, or was it always there and divers simply haven't come across it?

Similarly, another nudibranch, the red-lined flabellina, *Flabellina rubrolineata* (O'Donoghue, 1929), has a similar Indo-Pacific and Australian distribution to *Goniobranchus tinctorius* i.e. is it has not been recorded in Tasmania waters (Burn 2006; Cobb & Willan 2006; Edgar 2008; Gowlett-Holmes 2008; Museum Australia 2014).

Five specimens of *Flabellina rubrolineata* have been photographed on three separate occasions in northwest Tasmanian waters: a pair on 24 April 2011 and an individual on 8 April 2012 at Sisters Beach (Plate 2), and a pair at Three Hummock Island on 14 January 2014. One of these is now in the collections of the Queen Victoria Museum & Art Gallery (QVMAG; QVM.9.23312).

This species is known to reach 42 mm long; however, the five specimens mentioned here were no longer than 10 mm. The life span of different nudibranch species varies between a few weeks and two years (Karlsson 2001). Perhaps these small nudibranchs are fair-weather visitors, arriving on currents in summer when the mean daily water temperature in Bass Strait is as high as 20°C. They may be able to survive and slowly grow until at least April, as evidenced by this photograph, when the water temperature has dropped to around 17°C (Figure 2).

So, do these sightings represent an extension of this species range, or have these tiny animals always been here and we hadn't noticed?

Plate 1. The red lace chromodorid (*Goniobranchus tinctorius*) photographed at Sisters Island, east of Rocky Cape in northwest Tasmania on 3 April 2009 in 8 m of water (unfortunately this animal was not collected)

Plate 2. The red-lined flabellina (*Flabellina rubrolineata*) photographed at Sisters Beach, northwest Tasmania (this specimen is registered into the QVMAG collections as QVM.9.23312)

ANEMONES

Anemones (Cnidaria: Anthozoa: Actiniaria) are one of the most diverse and conspicuous groups of invertebrates inhabiting temperate waters, yet their taxonomy is not well resolved and little is known of their distribution. One example appears in Plate 3: this is currently thought to be a tube anemone in the family Cerianthidae, possibly cf. *Pachycerianthus delwynae* (Carter, 1995). It was located in approximately 20 m of water at Kelso, in the River Tamar estuary, on 5 October 2004 and is now in the collections of the QVMAG (QVM.20.54665). This species is only recorded from New South Wales (Edgar 2008). However, a number of yet to be described species exist (Gowlett-Holmes 2008; P. Alderslade pers. comm). This specimen was hard to miss: it has tentacles about 100 mm long and when removed from the sand was c. 300 mm long.

Another example of a questionable anemone appears in Plate 4. This cluster of 10-20 mm high individuals may be what Edgar (2008) refers to as Actiniid sp. 3, or Gowlett-Holmes (2008) refers to as an undescribed species of the family Diadumenidae, only known from South Australia. Perhaps it's a new species altogether. These were photographed at Three Hummock Island in the Hunter Group, northwest Tasmania on 8 January 2014 in 8 m of water and a few now reside in the QVMAG collection (QVM.2014.20.0001).

Are these two anemone species examples of REs? How are we to determine this if we don't know what they are or if they have always resided at these locations?

SOFT CORALS

Tasmania has a rich but poorly known suite of soft corals (Cnidaria: Anthozoa: Alcyonacea) inhabiting the near shore and estuarine environments of Tasmania.

The Gabo Island soft coral, *Capnella gaboensis* (Verseveldt, 1977), is a large (150 mm high) colonial octocoral that is recorded from South Australia to New South Wales, extending south to Erith Island in Bass Strait (Edgar 2008). Yet this species, or what I assume to be this species, is well represented around Rocky Cape (Plate 5a) and has been found in the River Tamar estuary (Plate 5b).

Plate 3. The tube anemone (cf. *Pachycerianthus delwynae*), specimen was collected from the River Tamar estuary now registered into the QVMAG collections (QVM.20.54665)

Plate 4. An unidentified anemone photographed in Hope Channel, Three Hummock Island (some specimens are registered into the QVMAG collections as QVM.2014.20.0001)

Plates 5a & 5b. Specimens of the soft coral *Capnella gaboensis* photographed at Rocky Cape (top) and the Tamar River estuary (bottom)

Plate 6. A soft coral, possibly *Capnella* sp. 1 photographed at Three Hummock Island (this specimen is registered into the QVMAG collections as QVM.20.23315)

Similarly, the western soft coral (*Capnella* sp. 1) is known from southwest Western Australia (Edgar 2008), yet the 75 mm high colony in Plate 6, located in Hope Channel, Three Hummock Island, looks suspiciously similar.

It is possible that larvae from Western Australia were delivered into western Bass Strait from the Leeuwin Current, via the Zeehan Current. In winter the Zeehan and Flinders currents form the Bass Strait Cascade, which creates an easterly flow along northern Tasmania's coastline (Li et al. 2007).

Soft coral taxonomy is poorly understood; however research is underway at QVMAG that combines *in situ* photography, DNA and sclerite (hard part) imagery to better understand the species that are present in northern Tasmanian waters. However, this work won't answer the key question, are these evidence of REs, or weren't we looking?

CONCLUSION

We know very little about marine biodiversity. Globally, just ¼ to ⅓ of the estimated one million species living in the oceans may have been discovered (Appeltans et al. 2012) and of those, we know little of their biology, ecology and distribution. Equally, a better understanding of the relationship between coastal, shelf and open ocean currents is needed to understand larval delivery from northern and western regions to Tasmania. Anthropogenic activities have led to broad environmental changes that are impacting biodiversity and species distributions. In the marine environment there is a generally southerly shift, with species typical of lower latitudes becoming established around Tasmania. However, our lack of knowledge of species' presence/absence, particularly marine invertebrates, makes it difficult to establish whether some sightings are range extensions or new records of species that have possibly always resided in poorly surveyed locations.

So, are the above examples evidence of range extensions or were they always here and we weren't looking? Unfortunately, we will never know, because we lack any workable benchmark from past that allows us to compare present distributions. However, all is not lost. If thorough surveys of coastal marine life were conducted today, we would be in a much better position to identify and measure any future range extensions.

ACKNOWLEDGEMENTS

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DISTRIBUTION OF *XEROCHRYSUM VISCOSUM* (STICKY PAPERDAISY) IN TASMANIA

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INTRODUCTION

Xerochrysum is a genus of spectacular paperdaisies represented by seven formally described species, all of which occur in Tasmania, with only one endemic to the State (de Salas & Baker 2014). Many readers will know these species by the older generic names of *Helichrysum* or *Bracteantha*.

Xerochrysum papillosum ('cliff paperdaisy') is white-flowered and occurs mainly on coastal cliffs and dunes in eastern and northern Tasmania. *Xerochrysum subundulatum* ('orange paperdaisy') is orange- to yellow-flowered and occurs at moderate to high elevations in subalpine grasslands and grassy woodlands. *Xerochrysum bracteatum* ('golden paperdaisy') and *Xerochrysum bicolor* ('eastcoast paperdaisy') are yellow-flowered and mainly coastal in occurrence, although the species are somewhat taxonomically confused. *Xerochrysum palustre* ('swamp paperdaisy') occurs in sedgy-grassy swampy habitats from the lowlands of the northeast to the Central Highlands and Midlands. *Xerochrysum collerianum* ('quartzite paperdaisy') is the most recently recognised species in Tasmania (Buchanan 2004), and is the only species endemic to Tasmania, occurring on the higher quartzite-based peaks of the west of the State.

Along with our six native species of *Xerochrysum*, Tasmania also supports a population of a naturalised species, *Xerochrysum viscosum* ('sticky paperdaisy'). How this species arrived in Tasmania, and its current distribution, is the subject of this short paper.

XEROCHRYSUM VISCOSUM

Xerochrysum viscosum (Plates 1-3) is an annual, sometimes perennial, herb with erect stems. Plants are typically 20-90 cm tall, much-branched, with bright green linear to elliptic leaves (mostly 2-8 cm long and 1-5 mm wide) that have a sticky (viscid) rough surface.

The bright yellow flowerheads (capitula) are in terminal panicle-like or corymbose inflorescences, and are about 1-3.5 cm across and long-lasting. Flowering in Tasmania starts around late August/early September with the appearance of new leafy growth and bright yellow budding capitula: flowerheads persist until at least end of February.

Distribution and habitat outside Tasmania

Xerochrysum viscosum occurs naturally in Victoria, New South Wales, Australian Capital Territory, and southern Queensland (Figure 1), where its distribution and habitat is described as "dryish, often rocky areas" (Flann 1999), "open woodland and sclerophyll forest, usually on sandy to sandy loam soils" (Brown 2014), and "opportunist in disturbed areas such as roadsides and goldfields" (Carr 2010).

Occurrence in Tasmania

The Tasmanian Herbarium holds two collections of *Xerochrysum viscosum* from Tasmania. The first was collected by David Marrison (Royal Tasmania Botanic Gardens) from the Southern Outlet in

Plate 1. Growth habit of *Xerochrysum viscosum* on the Southern Outlet

Plate 2. Morphology of *Xerochrysum viscosum*. (A) flowerheads at the end of leafy branches; (B) individual flowerhead showing bright yellow papery bracts; (C) stem and leaves showing how the species obtained its name

December 2000. At the time, the material was used to plant out in the Australian Section of the Gardens and is still present. The source was investigated informally, and acknowledged that it was "probably a component of hydro seed mix" (note on herbarium sheet). The second collection was provided to the Tasmanian Herbarium in December 2002 by Hans and Annie Wapstra, and was also from the verges of the Southern Outlet between Mount Nelson and Kingston. While these collections are technically the first and second for the State, the occurrence of the species from this section of State-owned road had been known by field botanists for several years, perhaps dating back to the early 1990s (Andrew North pers. comm.; B. French pers. comm.). The species has been considered "naturalised" in the *Census of Vascular Plants of Tasmania* (de Salas & Baker 2014).

Figure 1. Australian distribution of *Xerochrysum viscosum* (extract from Atlas of Living Australia)

Current extent

As part of the preparation of this manuscript, we drove and walked the verges of the Southern Outlet between the Mount Nelson-Tolmans Hill overpass (northern end) and the Firthside overpass (southern end) on 12 February 2014, recording the extent of patches of *Xerochrysum viscosum* on the highway batters and adjacent batter tops. We also searched the vegetated median strip between the northbound and southbound lanes, where potential habitat was present. Where the species was encountered, the approximate area occupied was estimated using hand-held GPS-waypointing of the start and end of the patch. Notes were also made of the approximate downslope and upslope extent of the patch on the batter and estimates were made of the abundance within each patch, although the counts were by no means rigorous.

The start and end points of the survey are somewhat nominal but are based on familiarity gained over many years of driving the route between Hobart and the suburbs of Kingborough, supplemented with numerous surveys of native vegetation in the Mount Nelson-Ridgeway-Kingborough region, and actual road verge surveys of several sections of the Southern Outlet. Based on these surveys, it has become clear that *Xerochrysum viscosum* is restricted to the verges of the Southern Outlet and has not extended into surrounding native vegetation by more than a matter of metres.

Figures 2-4 provide details of the distribution of the species along the Southern Outlet. The species occurs in ten distinct patches, on both southbound and northbound lanes on both sides of the road (with one patch allocated to the median strip of vegetation). The approximate linear extent is 830 m. Very roughly speaking, the total population abundance of mature individuals is around 1,220 (most on northbound lanes). The species is usually an annual but can be perennial. Our abundance count may be a snapshot for just one year but it is noted that the 2013-2014 spring-summer period was conducive to herbaceous growth of "weeds" in southern Tasmania, so the 2014 count is probably at the upper limit of individuals present in any particular year. However, we were unable to count every individual due to safety reasons (banks too steep to climb so some counts are visual estimates from top or bottom of batter, which may under-estimate the number of smaller plants).

Habitat

Xerochrysum viscosum is most strongly associated with highly modified environments such as areas of bare ground on steep roadside batters, but also extends slightly into open dry eucalypt woodland, usually dominated by *Eucalyptus pulchella* (Plates 3 & 4), and weed-dominated low roadside banks (Plate 5).

Where did it come from?

The Southern Outlet was constructed by 1968, prior to which there was little access to the forested hills between Mount Nelson and Kingston. It was upgraded to a dual carriageway in 1985 (although works went on for many years before both lanes in both directions were completely opened).

Xerochrysum viscosum co-occurs with putatively threatened flora species such as *Rytidosperma indutum* (tall wallabygrass) and *Vittadinia muelleri* (narrowleaf new-holland-daisy) and amongst several weed species. It was long-assumed by many field workers that *Xerochrysum viscosum* was an accidental introduction from discarded garden waste, had escaped from a garden setting, or was accidentally introduced during road works by contaminated machinery.

Following completion of road works, the new batters were hydro-mulched under direction of the then Department of Transport. The recommended seed mix included an indigenous species of *Xerochrysum* (at the time *Bracteantha*) but apparently local provenance seed of the genus was not available and seed from NSW was included (J. Gillian pers. comm.). This turned out to be *Xerochrysum viscosum*. Unfortunately, records from the mid to late 1980s are no longer held by the State government, so it is not known which batters were hydro-mulched with a mix containing the Victorian seed. Whether the species has spread significantly since the late 1980s is not known, but personal observations suggest occasional new patches every so often.

The Southern Outlet is perhaps one of the most diverse weed sites in southern Tasmania, with many deliberate plantings of "environmental weeds" (mainly species of *Acacia*) and many patches of invasive herbaceous and grass species. Interestingly, *Xerochrysum viscosum* is essentially restricted to the roadside batters, only extending to adjacent areas on the immediate fringes of the top of the batter or where the median strip is very narrow between the southbound and northbound lanes. We have not seen *Xerochrysum viscosum* used in Tasmanian gardens as an ornamental, and it is apparently not widely cultivated (ANPS 2008), although cultivars of *Xerochrysum* "*bracteatum*" are popular as ornamental (and even roadside/roundabout) plantings, including in southern Tasmania. Species of *Xerochrysum* can become weedy, including the *Xerochrysum bracteatum* species-complex, and this has already been observed in southern Tasmania, including on the Queens Domain and Rokeby area (A. Muyt pers. comm.; A. North pers. comm.; M. Wapstra pers. obs.).

Plate 3. Habitat of *Xerochrysum viscosum* along the Southern Outlet: the species is locally dense over most of this steep rocky batter, less frequent on the cut ledge where the shrubs start and absent from the forested area on the slope behind

Plate 4. Habitat of *Xerochrysum viscosum* along the Southern Outlet: the species is less frequent in this shrubbier and flatter habitat

What should we do now?

It is clear that *Xerochrysum viscosum* is an exotic species to Tasmania, unintentionally introduced to the Southern Outlet, and as such attempting eradication sooner rather than later is suggested to prevent further spread. However, weed management on some of steep batters will be problematic and resource-hungry due to the steep and inaccessible slopes and proximity to high-flow and high-speed traffic. In addition, any herbicide use will need to consider the presence of other plants with a high priority for conservation management (some formally listed as threatened on the Tasmanian *Threatened Species Protection Act 1995*). The species also occurs in two municipalities (limited patches and numbers in City of Hobart; majority in Kingborough), meaning coordination between land managers (councils, road authorities) may be needed.

In the short- to medium-term there seems a low risk of the species spreading significantly, especially into adjacent grassy forest and woodland, but with a steadily warming climate a "northern" species such as *Xerochrysum viscosum*, already adapted to rapid colonisation of dry habitats, could pose a significant risk to the Tasmanian environment. In its natural range, seedlings colonise large areas after fire (Carr 2010). Several massive fire events have occurred across the Southern Outlet between Mount Nelson and Kingston in the last two decades, and it is probably quite fortunate that *Xerochrysum viscosum* has not spread further.

ACKNOWLEDGEMENTS

Andrew North and Brian French provided insights into the distribution of the species in southern Tasmania. David Marrison and Natalie Tapson (Royal Tasmania Botanic Gardens) provided information on early collections. Jed Gillian (ex DIER) provided information on the history of the Southern Outlet, particularly on the hydro-mulching event, and provided useful commentary on a draft of this paper. Selena Dixon (Department of State Growth) hunted down history (thanks also to Isobel Clark, librarian with the department, for chasing documents and people), and commented on the draft manuscript.

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Plate 5. Habitat of *Xerochrysum viscosum* along the Southern Outlet: large plants growing amongst ornamental plantings and weeds

Table 1. Details of patches of *Xerochrysum viscosum* along the Southern Outlet

Lane (S)outhbound (N)orthbound (M)edian	Side (E)astern (W)estern	Easting/northing	Patch type	Number
S	E	525006mE 5247009mN	POINT	2
	W	525514mE 5246119mN to 525526mE 5246034mN	LINEAR	45
		525532mE 5245903mN	POINT	1
		525529mE 5245858mN to 525510mE 5245750mN	LINEAR	152
N	E	525478mE 5246165mN to 5254468mE 5245909mN	LINEAR	335
		525488mE 5245849mN to 525478mE 5245780mN	LINEAR	72
		524968mE 5246998mN	POINT	1
	W	525470mE 5245851mN	POINT	8
		525457mE 5246167mN to 525476mE 5245906mN	LINEAR	460
M	n/a	524973mE 5247029mN to 524944mE 5247076mN	LINEAR	147

Figure 2. Distribution of *Xerochrysum viscosum* along the Southern Outlet (base data: TheList)

Figure 3. Distribution of *Xerochrysum viscosum* along the Southern Outlet – southern section (aerial imagery: GoogleEarth)

Figure 4. Distribution of *Xerochrysum viscosum* along the Southern Outlet – northern section (aerial imagery: GoogleEarth)

OBSERVATIONS OF THE LEWIN'S RAIL (*LEWINIA PECTORALIS*) AT OYSTER COVE, TASMANIA, JULY 2014

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When I saw my first Lewin's Rail (*Lewinia pectoralis*), it was late in the afternoon of 27 July 2014. My friend Karen who lives at Oyster Cove and I went for a walk from her house along the coastal track that leads through Putalina, the land owned and managed by the Tasmanian Aboriginal community. As we approached a footbridge, Karen spotted a small rail fossicking below the tussocks near a fallen tree that spanned the small creek. I could not see many details due to the low light so took some photographs hoping to identify the bird later.

On downloading the shots, I discovered that the bird was a Lewin's Rail. I was thrilled, knowing that these rails are usually almost impossible to see amongst the undergrowth. I reported the rare sighting to the Eremaea Birds website immediately in order that others might manage to see the bird while it was still there.

The following morning I returned to the site hoping that the rail would still be in the area. To my surprise, it was again feeding along the creek at low tide and this time it was in the morning sun. During the following days up to three birds were reported seen together and possibly more were heard calling. Over the next few months the area attracted many twitchers, birders and photographers from Tasmania, interstate and overseas, most seeing their first ever Lewin's Rail (Plates 1 & 2).

Plate 1. The elusive Lewin's Rail on mud at Oyster Cove, 3 Aug. 2014

Plate 2. Another glimpse of the elusive Lewin's Rail at Oyster Cove, 14 Aug. 2014

Lewin's Rail can be heard on most of the islands around Tasmania but they are usually extremely secretive. On Goose Island in Bass Strait I have heard up to three pairs calling and two years ago I found and photographed a tiny black fluffy, but dead, chick with strangely long legs (Wakefield & Robertson 2013). This proved beyond doubt that the adult calls had not just come from the local mimicking Starling.

The Lewin's Rail is divided into several subspecies, with the Tasmanian population described as subspecies *brachipus*. Pizzey & Knight (2010) describe their range and status as "patchy in suitable habitat in coastal e. Aust., from c. Port Douglas (Q) to se. SA, Mt Lofty Ras. and Kangaroo I. (SA); casual, s. Eyre Pen.; inland to w. slopes of Divide: mostly in se. Aust. and Tas. Vagrant Top End (NT). Presumed extinct in s. WA. Uncommon, seasonally dispersive or nomadic. Also Philippines, PNG; NZ sub-Antarctic islands".

The Lewin's Rail is a "tubby, dark rail with a longish pink, dark-tipped bill and fiery chestnut nape and shoulders; breast plain olive-grey; part of wing, underparts and undertail black, finely barred whitish", with the female described as "duller, crown more streaked" (Pizzey & Knight 2010). Despite my numerous images, I find it difficult to distinguish between the males and females.

At Oyster Cove I have heard the Lewin's Rail make varying calls that seem to emanate from different spots where they are hidden among the grass tussocks. Initially I heard only deep grumbling growls often responded to by other rails. In mid September, the birds began to call a sharp 'kek kek' sound. These calls are described in Pizzey & Knight (2010) as "loud, sustained chorus of 'pluke pluke' or 'crek crek crek'; answered by others, accelerating and becoming louder, declining; ringing, anvil-like 'jik-jik-jik', almost a song; also rapid thudding grunts, like galloping horse; sharp alarm note".

During many hours of observation during various times of day, types of weather and stages of tide, I have observed and photographed the rails as they walk carefully out of the undergrowth to feed on the mud, rushing back for cover at an alarm call from other birds or at the snap of a twig (Plates 3-7). I have recorded them digging up crabs and running for cover to eat them in safety (Plates 8 & 9). As the tide recedes completely and the rails seem to disappear, the crabs come onto the surface of the mud where they can be photographed. On a few occasions as the tide was almost high, a rail took a long, pink worm (yet to be identified) from the mud.

Plate 3. Occasionally a rail will swim across the creek

Plate 4. Sometimes one flies across to the opposite bank, trailing its legs vertically

Plate 5. Now and then a rail stops feeding to rest in the shade below an overhanging tussock or on top of a tussock in the sun

Plate 6. After watching a rail walking below one of the footbridges in the area, I could positively identify its prints in the wet mud

Plate 7. Once I watched one do a wing and leg stretch

Plate 8. Southern sentinel crab (*Macrothalmus latifrons*), a shy species that normally stays in its burrow in the mud (S. Grove pers. comm.)

Plate 9. Semaphore crabs (*Heloecius cordiformis*), so called because the males often stand near the entrance to their burrows waving their big purple and white claws (S. Grove pers. comm.)

As Lewin's Rails are usually very secretive, their social behaviour is poorly known. Because the population at Oyster Cove is more easily observable, it is an ideal subject for long-term study. With the breeding season now in progress, it will be interesting to see if they breed here and whether any chicks or young can also be observed in the open. For me, this has been one of the most exciting species of the year.

ACKNOWLEDGEMENTS

Thanks to Simon Grove (Tasmanian Museum & Art Gallery) for identifying the crabs.

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FREE-RANGING RAINBOW LORIKEET HYBRIDS FOUND IN TASMANIA

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INTRODUCTION

The Rainbow Lorikeet, *Trichoglossus haematodus* (Linnaeus, 1771), is not native to Tasmania (except as an occasional vagrant from mainland Australia) and is considered an invasive species that presents a major threat to the island's economy and environment. The species now persists in Tasmania, probably as a result of natural dispersal from mainland Australia, and through the deliberate and accidental release of pet birds. Of particular concern are what appear to be cross-bred lorikeet specimens amongst a batch of wild-captured Rainbow Lorikeets. These hybrids are most probably the offspring of the Rainbow Lorikeet and the native Musk Lorikeet, *Glossopsitta concinna* (Shaw, 1791). The presence of the Rainbow Lorikeet and the wild-caught hybrids, as well as the potential for cross-breeding in the wild, may impact Tasmania's local species, ecosystems and agriculture, and further study is needed.

DESCRIPTION

The Rainbow Lorikeet is a small to medium size brightly coloured parrot measuring about 30 cm long and weighing around 130 g. It is a distinctive bird with a bright red beak, blue head and belly, orange-yellow breast and green back, upper wings and tail (Plate 1).

Males, females and immature birds look alike, although young birds are slightly duller. It is the only parrot in Tasmania with a blue head, making it easy to identify.

Rainbow Lorikeets feed mostly on nectar and pollen from both native and exotic plants. They also eat a wide variety of fruits and seeds, and sometimes insects and their larvae. They occur in a wide range of treed habitats including woodland, rainforest and urban areas.

They are often seen in noisy fast-moving flocks or gathered together in communal roosts at dusk. A detailed overview of the species can be found in Crome & Shields (1992).

Plate 1. Adult Rainbow Lorikeet from near Kingston Beach, southeast Tasmania

NATURAL RANGE

The natural range of the Rainbow Lorikeet includes south and east Indonesia, New

Guinea, the Solomon Islands, Vanuatu, New Caledonia and the north and east of Australia. In Australia its natural range extends from northern Queensland to the Eyre Peninsula in South Australia. Feral populations are found in Hong Kong, Singapore, New Zealand, Perth (Western Australia), and Tasmania (Chapman & Massam 2006; Latitude 42 2011; BirdLife International 2014).

TASMANIAN POPULATION

The Rainbow Lorikeet has been recognised as an occasional vagrant in Tasmania represented by infrequent sightings of single birds or pairs (Forshaw 2002). Green (1989) lists the species as 'accidental' and notes three old records for the species in Tasmania and King Island, the earliest from 1842. Also mentioned is a bird seen feeding on pears with Musk Lorikeets in Launceston in 1977 (Green 1989). Some of these vagrants are assumed to have arrived naturally from mainland Australia. Others are thought to be aviary birds that have escaped or been released (Crome & Shields 1992; ISB 2014a).

In the last few years the population of Rainbow Lorikeets in Tasmania has increased to noticeable levels, with numerous birds now being observed in the north, northwest, northeast and south of the State (ISB 2014b). Numerous sightings have been reported to the Wildlife Management Branch (WMB) and Invasive Species Branch (ISB) of the Department of Primary Industries, Parks, Water & Environment (DPIPWE), and the Queen Victoria Museum & Art Gallery (QVMAG); over 350 birds have now been removed from the wild under the ISB control program, yet the species continues to be observed and reported by the general public.

Regardless of how the species arrived, the persistence of the Rainbow Lorikeet in Tasmania suggests its range has extended to permanently include Tasmania.

POTENTIAL RISKS

Rainbow Lorikeets are considered a pest in many parts of their range and pose a significant threat to Tasmania's economy and ecology. The fruit-growing industry is particularly at risk, with a wide variety of commercial crops likely to be targeted including apples, pears, stone fruit, cherries and grapes. Rainbow Lorikeets have the potential to compete for food and nesting sites with local bird species including the Musk Lorikeet, Green Rosella, *Platycercus caledonicus* (Gmelin, 1788), and the endangered Swift Parrot, *Lathamus discolor* (Shaw, 1790). They also carry disease that may spread to domestic and wild birds (Latitude 42 2011). In Western Australia, Rainbow Lorikeets have caused additional problems including noise, damage to backyard fruit and fouling of vehicles and outdoor areas with droppings. A large flock that roosted at Perth Airport was identified as a potential bird-strike risk to aircraft (Chapman & Massam 2006).

The Rainbow Lorikeet's generalised feeding and breeding requirements, as well as its ability to quickly exploit new resources, make it an adaptable, and potentially destructive, species. As a result, the importation of Rainbow Lorikeets into Tasmania is now prohibited and the Tasmanian Government's WMB and ISB have undertaken a control program in an attempt to reduce Rainbow Lorikeet numbers.

THE PRESENCE OF WILD HYBRIDS

In 2013, the QVMAG received a donation of 73 frozen Rainbow Lorikeets from the WMB and ISB. These birds were taken at various localities around Tasmania as part of DPIPWE's control program during 2011 and 2012. These birds represent the first formal record (registered physical evidence) of the species' presence in the State.

Control programs such as these present a valuable opportunity for the Museum to 'salvage' specimens that would otherwise be destroyed, resulting in important scientific data being lost. These birds have been added to the QVMAG research collection, where they are available to researchers, and will provide an ongoing record of the arrival and spread of this species in Tasmania.

Rainbow Lorikeets show considerable variation across their natural range and several subspecies are recognised. Mutations resulting in colour variations have also been developed in captivity (Forshaw 2002). Among these Tasmanian-caught birds donated by the DPIPWE are some unusual-looking individuals that do not conform with these known natural variations, subspecies or mutations. They appear to be hybrids.

Rainbow Lorikeets hybridise, in the wild and in captivity, with a range of species including the Scaly-breasted Lorikeet, *Trichoglossus chlorolepidotus* (Kuhl, 1820) and the Musk Lorikeet (Forshaw 2002). At least five of the 73 specimens, donated by the ISB to QVMAG, are consistent with hybrids between Rainbow Lorikeets and another species. Based on both my examination of the specimens and my understanding of these species, these are likely to be Rainbow-Musk Lorikeet hybrids, an opinion shared by aviculturalists (B. Price pers. comm.). DNA analysis would be useful for confirming this and tissue samples have been retained for testing. Both species share similar habitats and are often seen feeding together. This indicates the potential for hybridisation, as reports of hybrids often follow observations of such associations (McCarthy 2006).

An example of the Musk, Rainbow and one of the five hybrid birds appears in Plate 2.

Plate 2. Study skins from the QVMAG collection (same specimens in front and side views). From left to right: Musk Lorikeet (QVM:1969:2:21), lorikeet hybrid (QVM:2014:2:2), Rainbow Lorikeet (QVM:2013:2:3). The hybrid was one of two seen together at Prospect in Launceston. The hybrid (centre) has the red forehead, blue crown and red eye marking of the Musk Lorikeet but lacks the blue head and belly of the Rainbow Lorikeet. It is intermediate in size between the two species.

The Musk Lorikeet is a small parrot about 23 cm long and weighing around 70 g. The plumage is mostly green with small streaks of yellow on each side of the breast. The forehead is red with a pale blue crown and there is a red marking behind each eye. The beak has a reddish tip.

Musk Lorikeets are endemic to parts of southeastern Australia. In Tasmania, the species is a breeding resident. They have a similar diet to Rainbow lorikeets, feeding mainly on pollen and nectar but also fruits, seeds and insects (PWS 2011). Musk Lorikeets are known to hybridise with Rainbow Lorikeets in the wild and in captivity (Forshaw & Cooper 2002; McCarthy 2006).

IMPLICATIONS AND FURTHER RESEARCH

The persistence of the Rainbow Lorikeet in Tasmania, and presence of hybrids in the wild, may compromise the genetic distinctiveness of native species if breeding were to occur. It also raises some interesting questions. Are the hybrids the result of Rainbow-Musk Lorikeet cross-breeding? Are these hybrids the result of wild breeding or, alternatively, escaped captive birds? Can these hybrids breed? What impacts could these have on Tasmania's Musk Lorikeet population, overall ecology and agriculture?

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HIGHLIGHTS OF PELAGIC SEABIRDING FOR 2014

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INTRODUCTION

This article is the third in a series providing reports on the ornithological highlights of pelagic seabirding trips off the east coast of Tasmania (Wakefield 2012; Wakefield & Brooks 2013). This year, all Tasmanian pelagic seabird trips leaving from Pirates Bay, Eaglehawk Neck, were on the *Pauletta*, skippered by John Males.

January to July

Paul Brooks led the first trip on 25 January 2014. A Pomarine Jaeger (*Stercorarius pomarinus*) south of the Hippolytes was sighted in the morning, always an exciting bird but not rare. Other highlights were a White-headed Petrel (*Pterodroma lessonii*) and a Black-bellied Storm-Petrel (*Fregetta tropica*).

On 10 February 2014 the biggest highlight of the trip led by Phil & Linda Cross and reported by Rob Hamilton was the group of Shepherd's Beaked Whales causing great excitement (Wakefield 2014, this issue). Interesting birds were a White-headed Petrel (Plate 1) and a Fluttering Shearwater (*Puffinus gavia*).

Plate 1. White-headed Petrel (*Pterodroma lessonii*) seen on 30 August 2014

The trip on 16 February 2014, led by Rohan Clarke showed up a Flesh-footed Shearwater (*Ardenna carneipes*), as Rohan commented in his report: "generally scarce off Eaglehawk Neck" (Plate 2). In addition there were two Providence Petrel (*Pterodroma solandri*), 21 Gould's Petrel (*Pterodroma leucoptera*), one Soft-plumaged Petrel (*Pterodroma mollis*), one White-headed Petrel and a Mottled Petrel (*Pterodroma inexpectata*).

Plate 2. Flesh-footed Shearwater (*Ardenna carneipes*) seen on 16 February 2014

Paul Brooks led the following trip on 24 May 2014. This was the trip of the Southern Fulmar (*Fulmaris glacialoides*), which gave great views as it flew by, unfortunately then disappearing into the east out of sight. There were two White-headed Petrel, three Providence Petrel and five White-fronted Tern (*Sterna striata*). Of note also was a Peregrine Falcon (*Falco peregrinus*) flying west from the

Hippolytes, possibly carrying a Common Diving-Petrel (*Pelecanoides urinatrix*).

Paul Brooks led the trip on 13 July 2014, with three major highlights: two Blue Petrel (*Halobaena caerulea*), a Grey Petrel (*Procellaria cinerea*) and a Slender-billed Prion (*Pachyptila belcheri*). The Blue Petrel is the only small petrel with a square, white tail tip. The bird's pale blue-grey back with a conspicuous dark M-band stands out from other small petrels. The white belly, wings, forehead and throat contrast with the blackish crown extending below the eye, down nape and forming a large dark patch on the side of the neck, separated from the ear mark by a white notch (Plate 3). Pizzey & Knight (2010) describe the Slender-billed Prion as an uncommon winter and spring visitor to Tasmania. This bird was only identified from photographs taken as it flew close to the boat, as prions are notoriously difficult to separate in the field (Plate 4). The Grey Petrel is a robust, slender-winged shearwater-like petrel that is ashy grey above, washed brownish, darker on head, wings and tail (Plate 5).

Plate 3. Blue Petrel (*Halobaena caerulea*) seen on 13 July 2014

Plate 4. Slender-billed Prion (*Pachyptila belcheri*) seen on 13 July 2014

Plate 5. Grey Petrel (*Procellaria cinerea*) seen on 19 July 2014

Rohan Clarke led two trips on 19 & 20 July 2014. On the 19th there were three White-headed Petrel, five Grey Petrel, and a single Blue Petrel that stayed over the berley trail for more than 20 minutes but mostly remained rather distant. That trip also had four Southern Royal Albatross (*Diomedea epomophora*).

The following day turned up a White-headed Petrel, a Providence Petrel and a stunning white morph of the Southern Giant-Petrel (*Macronectes giganteus*) that joined us at the second berley stop and stayed with us for almost two hours (Plate 6). In addition there were five Southern Royal Albatross and a Northern Royal Albatross (*Diomedea sanfordi*).

Plate 6. Southern Giant-Petrel (*Macronectes giganteus*) seen on 20 July 2014

August to October

On 30 & 31 August 2014 there were two pelagics organised by Dan Mantle and led by Nikolas Haass. Saturday's (30th) highlights were a Blue Petrel, an Antarctic Prion (*Pachyptila desolata*) and a Grey Petrel although the Antarctic Prion and the Grey Petrel were again only identified from photographs after the trip. On the Saturday a personal highlight was a close approach of a Soft-plumaged Petrel (Plate 7). On both days there were unusually high numbers of Wandering-type Albatross with up to 23 on the Saturday and 25 on the Sunday around the boat.

Plate 7. Soft-plumaged Petrel (*Pterodroma mollis*) seen on 31 August 2014

Two further back-to-back trips were led by Rohan Clarke on 13 & 14 of September 2014. On Saturday (13th) the highlight was both species of Royal Albatross together in flight but there were only 20 species, a low number for a spring pelagic. Sunday showed up only 21 species with a White-headed Petrel as a highlight. This was in stark contrast to the two trips during the same period on 14 & 15 September 2013 that had a huge variety and great numbers of birds (Wakefield & Brooks 2013). Rohan reported strong, cold southwesterly winds gusting up to 40 knots with swell of up to 4 m at a tide line at the shelf. The only person who dared to use a camera had it rinsed by a large wave and the skipper was unable to brew hot drinks for fear of losing control of the vessel.

Throughout the past two years, the Blue Petrel has been a lifer for most observers, and many participants who have been coming on pelagics off eastern Australia in the hope of seeing them for the first time have been rewarded. This year's numbers have been far less than the 30 seen in September 2013 but there have been good views as some stayed feeding in the slick behind the boat.

ACKNOWLEDGEMENTS

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ECOLOGY OF *THELYMITRA* (SUN-ORCHIDS) AT RUBICON (PORT SORELL), TASMANIA

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INTRODUCTION

Native orchid literature tends to span a spectrum from taxonomic (scientific) descriptions to popular field guides. The taxonomic literature is usually based on a collection of plant specimens lodged at herbaria, and is focused on describing the characteristics of plants that belong to a specific species. Field guides tend to present summarised taxonomic information in a more digestible form, to enable people in the field to recognise individual species. Field guides also provide some glimpses into native orchid ecology, for example with discussion about recent burns being associated with enhanced orchid flowering and specialised methods of pollination.

In this paper, we tease out the effect of several ecological process, flowering vs. non-flowering vs. dormant plants, habitat disturbance and grazing. We use observations and measurements from a large collection of tagged plants with known time since disturbance. With many *Thelymitra* species growing on our property Rubicon in northern Tasmania, we are uniquely placed to provide broad insights into this genus in Tasmania. In particular, we find some inconsistencies between the taxonomic literature and our own observations. As we investigate how time since disturbance affects the population of plants, we are able identify a possible explanation for these inconsistencies.

BACKGROUND

At Rubicon, near Port Sorell in northern Tasmania, we have an active demographic monitoring program, based on the protocols of Duncan & Coates (2006). While the majority of records relate to threatened species or species that we consider to be poorly known, we have also recruited specimens from all *Thelymitra* species at this location because of their high level of diversity. We have made every effort to accurately identify the species of *Thelymitra* present at Rubicon (e.g. Collier 2013), but some species remain problematic. We currently recognise 22 species at Rubicon including *Thelymitra peniculata* "green" (*T. peniculataG*) that we believe is undescribed.

Our analysis is based on six years of monitoring data (2008 to 2013) in the context of seven years of planned disturbance (2007 to 2013). With the planned disturbance at Rubicon, we have taken careful note of when each of our monitored orchids are affected by a burn or a slash, including if the disturbance missed any monitored specimens.

ECOLOGICAL CONSIDERATIONS

An adult *Thelymitra* plant has an annual life cycle. In autumn and winter an underground tuber may produce a single leaf and/or flower stem, or may remain dormant with no visible above-ground growth. A leaf and/or flower stem reaches maturity in the spring, with any fruit maturing about four to six weeks after flowering. In early to mid-summer the above-ground growth will shrivel, leaving only a replacement tuber to sustain the plant until the coming autumn.

A feature of many *Thelymitra* species is that leaves of flowering and non-flowering plants are morphologically different. In most species, the leaves of flowering plants form an obvious short tube at the base from which the flower stem emerges, typically with a wider segment of leaf, sometimes strongly channelled, immediately above this tube. This tube is absent in non-flowering plants and their leaves tend to be narrower and fleshier.

Orchid plants are subject to grazing by invertebrates and/or vertebrates. Because leaves and flower stems are more-or-less linear and not branched or divided, grazing is typically recognised when the top of the leaf or flower stem is missing. Occasionally a leaf is laterally grazed, which is recorded separately, but this does not constitute grazing in the analysis that follows. Orchid tubers are also subject to being excavated and presumably eaten. Small holes are occasionally found where orchid plants were known to be growing previously.

Disturbance, whether by fire, slashing or less frequently grazing in Australia, is a significant feature of an adult plant's life cycle. Many orchid field guides describe how flowering plants of various orchid species are typically seen after fires in their habitat. Because of the densely vegetated habitat of most species of *Thelymitra* at Rubicon, disturbance is a key consideration. Planned disturbance is conducted in early to mid-autumn, with the peak of flowering in late October to mid November. Because of this near six month gap, we describe the year of disturbance as "year 0.5", and subsequent years after disturbance as year 1.5, year 2.5, etc.

METHODS

This analysis is based on monitoring data collected from 892 tagged *Thelymitra* plants that have contributed 3,664 records of annual data about plant emergence, flowering and/or fruiting. 264 records relate to plants that have an undetermined period since the most recent disturbance, and these records are excluded from most of the analysis. All of the remaining 3,502 records are associated with a specific period since the last disturbance, with 565 of these records relating to plants that failed to emerge in a specific year.

Using the data collected, we can classify plants as having:

- **emerged**: evidence of a leaf or flower stem is seen above ground;
- **attempted to flower**: with careful observation it can be determined whether an emerged plant has produced an infertile leaf, or whether it had the potential to produce a flower stem; plants that do not go on to flower are recorded as having a grazed, aborted or shrivelled flower stem;
- **flowered**: a fertile plant with one or more flowers that open, or are capable of opening; and/or
- **fruited**: a fully expanded capsule is observed 4–6 weeks after flowering.

Within the complete data set, there are up to six annual records for a single plant, depending upon when each plant was first tagged. With the repeated measurements from many tagged plants, we are able to conduct longitudinal and cross-sectional analyses. A cross-sectional analysis will typically allocate data from an individual plant into different partitions of the data that is defined by the number of years since disturbance.

At times we focus on plants that have been discovered after the most recent disturbance. Such plants are most often discovered in flower, or if in leaf then they are located very close to another known plant. A second group of records relate to plants that were known prior to the most recent disturbance, i.e. they were discovered after a previous disturbance.

There is no certainty that these plants were alive at the time of the most recent disturbance, and they may not be seen in flower, or at all, after this disturbance.

The flowers of different *Thelymitra* species are familiar to many students of Tasmanian orchids because they provide the primary features that are used to identify plants. However, there is very little discussion of infertile plants in the taxonomic literature. When considering leaf characteristics, we need to consider four potential classes of plants, which we can analyse separately:

- grazed leaf, attempted flowering;
- grazed leaf, non-flowering;
- ungrazed leaf, attempted flowering;
- ungrazed leaf, non-flowering.

RESULTS

Individual plants

Amongst our 2,937 records of emerged *Thelymitra* plants, 1,348 of these records relate to plants that flowered or attempted to flower; leaving 1,589 records of non-flowering plants. For plants that attempted to flower, the mean length of grazed leaves is 38% shorter than those of ungrazed leaves but the mean width is 8% greater. For non-flowering plants, the mean length of grazed leaves is 31% shorter but the mean width is 7% greater. This suggests that grazed leaves are more robust than ungrazed leaves or that a plant can grow the breadth of leaves to partially compensate when the tip of the leaf has been grazed off, or a mixture of these two effects.

Considering only ungrazed leaves and plants that attempted to flower, the mean width of leaves is 2.12 times greater, and mean length is 1.45 times greater than the respective means for non-flowering plants. A two-tailed distribution t-test assuming unequal variance confirms that the distributions of leaf widths and leaf lengths for flowering and non-flowering plants are very significantly different ($p<0.001$).

Herbaria usually do not welcome infertile plant material, and without systematic observations over several seasons, it is impossible to collect leaves from non-flowering plants of *Thelymitra* species while being certain of their identity. It is therefore highly likely that the leaf measurements given in taxonomic descriptions refer only to flowering plants. We are grateful to Malcolm Wells (pers. comm.) for pointing out that, in many cases, the means leaf widths from plants that attempt to flower at Rubicon are outside the range of published leaf widths (Table 1). The authorities in Table 1 for the published leaf width dimensions are selected in priority order from first Jeanes (2004), second Jones & Clements (1998), and lastly Jones et al. (1999). This ranking prioritises species' descriptions over more popular works. Some *Thelymitra* species were described over a century ago, when little or no quantitative information was provided (e.g. Lindley 1840), and for these species we rely upon the most recent descriptions that are Tasmanian specific.

Inspection of Table 1 shows that mean leaf width for plants that attempt to flower equals or exceeds the published minimum leaf width for only five species: *T. brevifolia*, *T. mucida*, *T. pauciflora*, *T. peniculata* and *T. spadicea*. Table 1 also shows the percentage of leaves that exceed the published minimum. The overall average for all *Thelymitra* species is 36%, and for many species it is less than 50%. This suggests that plants at Rubicon tend to be systematically smaller than those elsewhere, or that specimens available to taxonomists are systematically larger than average, or a combination of both. Given that the mean width of infertile leaves is less than half the mean width of leaves from

Table 1. Comparison of the means of measured leaf widths of *Thelymitra* plants that attempt to flower with those in species' descriptions

Species	Rubicon	Species' description	Species' description	Authority	Rubicon
	Mean flowering leaf width (mm)	Leaf width minimum (mm)	Leaf width maximum (mm)		% leaves exceeding minimum
T. arenaria	7.78	8	18	1	50%
T. aristata	8.54	20	30	2	0%
T. brevifolia	5.42	(3–)7	20	1	97%
T. carnea	2.42	4	5	2	18%
T. circumsepta	12.72	15	25	2	44%
T. cyanea	4.74	5	7	2	43%
T. erosa	5.11	8	12	3	12%
T. flexuosa	1.85	3	4	2	4%
T. holmesii	2.59	3	10	1	34%
T. ixioides	3.43	10	15	2	0%
T. juncifolia	3.23	8	10	2	0%
T. longiloba	4.10	5	10	3	32%
T. mucida	2.08	2	8	1	95%
T. pauciflora	3.54	3	6	1	71%
T. peniculataG	4.98	5	12(–20)	1	48%
T. peniculata	7.20	5	12(–20)	1	76%
T. polychroma	2.89	4	8	3	19%
T. simulata	3.50	4	8	3	31%
T. spadicea	4.29	4	8	3	56%
T. sparsa	1.92	2	5	3	67%
T. viridis	4.25	5	12	1	29%

1 – Jeanes (2004); 2 – Jones et al. (1999); 3 – Jones & Clements (1998)

plants that attempt to flower, it is clear that species' descriptions are not inclusive of infertile leaves.

Repeating the analysis in Table 1 for leaf length reveals that published descriptions are more inclusive of ungrazed leaf lengths from plants that attempt to flower. Overall 70% of these ungrazed leaf lengths are within the stated range using the same sources as shown in Table 1. In the case of leaf length, the mean lengths of ungrazed leaves of *T. arenaria*, *T. erosa*, and *T. simulata* are greater than the stated maximum. Using the same method for the height of flower stems reveals a 66% fit within the minimum and maximum lengths stated, with mean heights of *T. carnea*, and *T. flexuosa* being shorter than the specified minimum height, and the mean height of *T. cyanea* being greater than the specified maximum height. A few species are specified to have a minimum of more than one flower. While 94% of flower spikes fit within the stated range of flowers per spike, more than 50% of *T. aristata* spikes at Rubicon fail to meet the specified minimum of five flowers.

Perhaps surprisingly, flowering plants with grazed leaves are able to allocate similar resources to their flowers compared to plants with ungrazed leaves. Mean flower stem height of plants with grazed leaves is reduced by 9%, but the mean number of flowers and flower size, as measured by the mean length of the ovary and sepal, are near identical to plants with grazed leaves.

Peak flowering

The habitat of most *Thelymitra* species at Rubicon is "wet heathland" (code: SHW) using TASVEG 3.0 classification and nomenclature (Kitchener & Harris 2013), on soil that contains a high proportion of peat or organic matter with a relatively high water table all year. A small minority of species prefer the drier "*Eucalyptus amygdalina* coastal forest and woodland" (code: DAC). The wet heathland in particular becomes very thick by 3–5 years following disturbance, with the canopy of the vegetation being at least 500 mm tall. Most plants of *Thelymitra* species at Rubicon have leaves and flower stems that are shorter than 500 mm. In the woodland, the bracken and shrubby understorey is more open but taller than 500 mm. Again, orchid plants cannot easily overtop this vegetation layer, although they have more space to flower within it.

We profile the overall emergence and flowering of *Thelymitra* species at Rubicon by time since disturbance. To provide a reasonably homogenous sample, we focus on the 2,737 records that relate to observations of plants that were discovered since the most recent disturbance. When these plants were discovered they were necessarily alive, and mostly in flower. Following discovery, each plant contributes a record in every subsequent year until there is renewed disturbance. For each year we calculate the proportion of plants seen to emerge, attempt to flower, flower and/or fruit.

Emergence declines gradually over the years post disturbance, with a sharp decline at 6.5 years following disturbance (Figure 1). The rate of flowering and fruiting drops off more sharply than emergence. In particular, in the fifth year following disturbance, 5.4% of plants are flowering, compared with a benchmark of 87% in the first year after disturbance. With the much thicker surrounding vegetation in later years after disturbance, it is not surprising that field guides frequently mention that orchid flowering is best seen soon after a fire.

Figure 2 shows the response of tagged plants that were known prior to (renewed) disturbance. Most records relate to the burning of an orchid "hot-spot" in 2012, and data for years 3.5 and 4.5 in Figure 2 are particularly sparse. The reduction in the rate of emergence in years 0.5 and 1.5 between Figures 1 & 2 provides an upper bound on the number of plants that have died. The death rate is therefore approximately 20% of tagged plants. Figure 2 illustrates that the peak rate of flowering is in the second spring season after disturbance. The 42.6% attempted flowering rate in year 1.5 in Figure 2 is greater than that achieved in year 3.5 in Figure 1. To maximise plant flowering, based on this aggregate data, repeat disturbance can be considered from about the fourth year after previous disturbance.

Dormancy

A total of 600 plants of *Thelymitra* emerged in 2010 and were still usable by 2013 in a longitudinal analysis to examine the

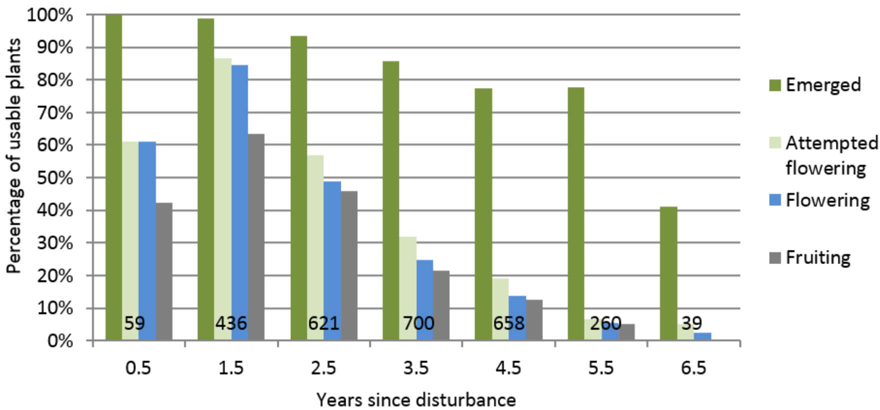

Figure 1. Aggregate emergence, attempted flowering, flowering and fruiting for records of *Thelymitra* species at Rubicon that were discovered since the most recent disturbance (numbers overlaying the bars represent the number of records that relate to each year)

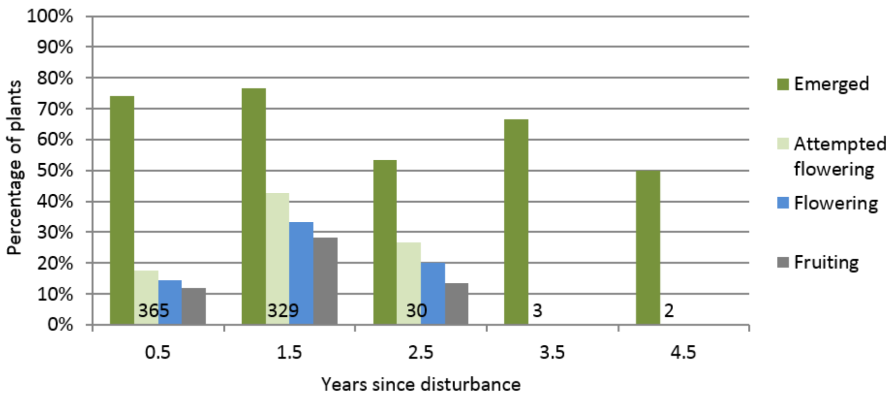

Figure 2. Aggregate emergence, attempted flowering, flowering and fruiting for records of *Thelymitra* species at Rubicon that were tagged and known prior to the most recent disturbance (numbers overlaying the bars represent the number of records that relate to each year)

breaking of dormancy. 242 of the 600 plants were in the area burnt in 2012, leaving 358 plants unaffected by disturbance after 2010. Of those plants that emerged in 2010, 103 (17.1%) were dormant (failed to emerge) in 2011, with 40 (16.5%) of these being in the burnt area. We consider two scenarios: (1) a three-year break of dormancy, i.e. plants that emerged in 2010, failed to emerge in 2011 and then emerged in 2012; and (2) a four-year break of dormancy, i.e. plants that emerged in 2010, failed to emerge in 2011 and then emerged in 2012 or 2013.

Table 2 shows the results of the dormancy analyses. 5.3% of *Thelymitra* plants have their dormancy broken in 2012 and 8.5%, or nearly half of the plants that were dormant in 2011, had emerged by 2013.

Table 2. Number of plants (% of emerged plants in the first year) for plants known in 2010 and usable in 2013. Two scenarios are considered: (1) breaking of dormancy over three years: plants that emerged in 2010, failed to emerge in 2011 and then emerged in 2012; and (2) breaking of dormancy over four years: plants that that emerged in 2010, failed to emerge in 2011 and then emerged 2012 or 2013. Species with no breaking of dormancy events are omitted.

Species	**Number of plants emerged in 2010, usable in 2013**	**Three-year break of dormancy**	**Three-year break of dormancy; disturbed in 2012**	**Four-year break of dormancy**	**Four-year break of dormancy; disturbed in 2012**
T. carnea	12	1 (8%)	1 (8%)	1 (8%)	1 (8%)
T. flexuosa	13	2 (15%)	2 (15%)	2 (15%)	2 (15%)
T. holmesii	104	5 (5%)	4 (5%)	7 (7%)	6 (9%)
T. longiloba	10	1 (9%)	0	1 (10%)	0
T. pauciflora	14	1 (7%)	1 (25%)	1 (7%)	1 (25%)
T. peniculataG	10	1 (10%)	N/A	2 (20%)	N/A
T. polychroma	157	8 (5%)	5 (7%)	19 (12%)	9 (13%)
T. simulata	81	5 (5%)	2 (5%)	7 (9%)	4 (12%)
T. spadicea	105	8 (7%)	1 (5%)	11 (10%)	1 (6%)
T. viridis	17	0	N/A	1 (6%)	N/A
Total	600 (all species)	32 (5.3%)	16 (6.6%)	51 (8.5%)	23 (9.5%)

However, a χ^2 test reveals no significant difference ($p>0.1$) between the breaking of dormancy in burnt vs. undisturbed places over the three or four year period.

While the flowering of *Thelymitra* plants appears to be strongly promoted by disturbance, this is not due to the disturbance breaking plant dormancy. Unless they are marked, infertile *Thelymitra* plants are very difficult to detect in their natural environment, so it is easy to form a view that enhanced flowering is also associated with breaking of dormancy.

Plant size

It is not easy to gain an insight into what is happening to the “average” plant in the years following disturbance because there are two potential state transitions involved: attempted flowering to non-flowering and non-flowering to dormant or dead. As previously discussed there are no above-ground parts of the plant that are directly comparable across these two state transitions, so our analysis has several parts.

Figure 3 illustrates the trend of mean ungrazed leaf width and ungrazed leaf length for non-flowering plants by years since disturbance. Unsurprisingly, leaves tend to increase in length by about 35% over these six years, possibly in an effort to compete with surrounding vegetation for access to light. Leaf width is more variable, for reasons that are not immediately obvious.

Replicating Figure 3 for flowering plants is problematic because the number of flowering plants tends to drop rapidly following year 1.5 after disturbance

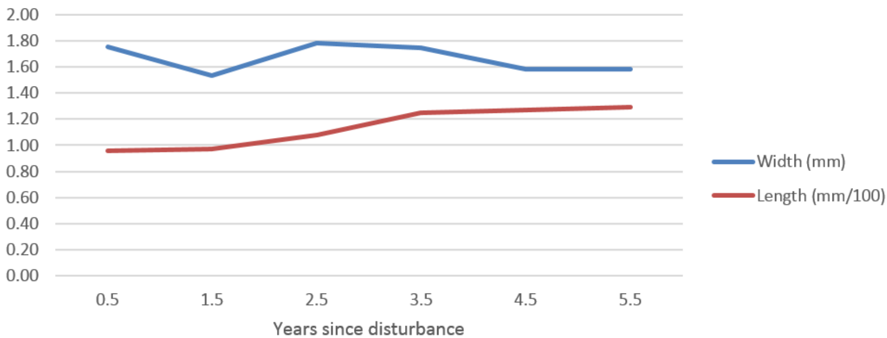

Figure 3. Aggregate data for records of non-flowering *Thelymitra* plants at Rubicon, showing means of ungrazed leaf width and length (x 0.001) by years since disturbance (there are between 56 and 140 records for each data point)

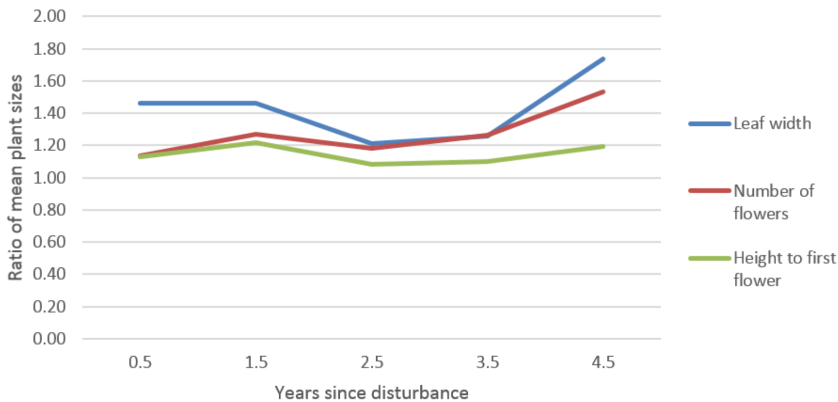

Figure 4. Ratios of the means of plant stature in year n-1, calculated by considering separately those plants that attempted to flower and did not attempt to flower in year n; plant stature is measured by leaf width, number of flowers and height of flower stem to the first flower

(Figure 2). Therefore, the sample of flowering plants is changing rapidly from one year to the next. We propose that the more robust plants in year n following disturbance are more likely to flower in year n+1. We can examine this proposition by considering a partition of plants that attempt to flower in year n+1 separately from a partition of plants that did not attempt to flower in that year. We can then look back one year at the same two partitions in year n. There are three possibilities for each plant in year n: (1) the plant was newly tagged in year n+1 and we therefore have no data for year n in which case it is dropped from its partition; (2) it failed to emerge (we have very few records of plants that fail to emerge in year n and then attempt to flower in year n+1) in year n, in which case it is dropped from its partition; or (3) it emerged and/or flowered in year n, in which case it is included in the analyses for which data is available.

We use leaf width, flower stem height up to the first flower (we prefer this to measuring the overall height of the flower stem, because the total height is likely to be partially dependent on the number of flowers, which we analyse separately) and number of flowers as proxies for the vigour of flowering plants. To determine whether the larger plants in year n are those that are more likely to attempt to flower in year n+1, we calculate the means of leaf widths, number of flowers and height to first flower for the two partitions in year n. We then calculate the ratio of the means by dividing the mean for those plants that attempted to flower in the following year by the mean of those did not attempt to flower in the following year. This ratio will be greater than 1 if the more vigorous plants in year n are those that go onto flower in year n+1.

Figure 4 shows the results of these calculations for 0.5 to 4.5 years after disturbance. The ratio is consistently greater than 1 for each year and each proxy for plant vigour. Two of the ratios rise sharply in year 4.5, which suggests the effect becomes more pronounced at this stage.

We use two-tailed t-tests assuming unequal variance to determine whether the ratios depicted in Figure 4 reflect significant differences between the distribution of values in the two partitions of plants in year n. Table 3 shows the calculated levels of significance for this t-test. Increased leaf width in year n is consistently and significantly associated with attempted flowering in year n+1. This reflects an increased likelihood that plants flowering in year n+1 also attempted to flower in year n. Greater height to first flower and a greater number of flowers in the year prior to disturbance are not significantly associated with attempted flowering in year 0.5 immediately after disturbance. For years 1 and beyond, there is a significant to very significant association between these factors and enhanced flowering in the following year.

Figure 4 and Table 3 demonstrate unequivocally that the more robust plants in year n tend to be those that attempt to flower in year n+1. This applies strongly for years 2.5, 3.5 and 4.5 since disturbance, and only slightly less strongly for year 1.5. Any comparison between the ever-decreasing numbers of flowering plants by years since disturbance (Figure 1) should be interpreted in this light. Figure 5 shows that the mean ungrazed leaf length and flower stem height for flowering plants both tend to increase as the number of years since disturbance increases. Meanwhile, Figure 6 reveals few obvious trends in means of ungrazed leaf width, total number of flowers, ovary length and sepal length. The overall results for plants that (attempt to) flower are consistent with those for infertile plants, see Figure 3, with leaf length increasing but width showing no obvious trend.

Table 3. p values for two-tailed t-tests assuming unequal variance to determine whether there are significant differences in two partitions of plants in year n, based on whether they attempted to flower or not in year n+1

Years since disturbance	*Leaf width (mm)*	*Height to 1st flower (mm)*	*Total no. flower*
0.50	<0.001	>0.1	>0.1
1.50	<0.001	<0.01	>0.05
2.50	<0.001	<0.01	<0.01
3.50	<0.001	<0.01	<0.001
4.50	<0.001	<0.001	<0.001

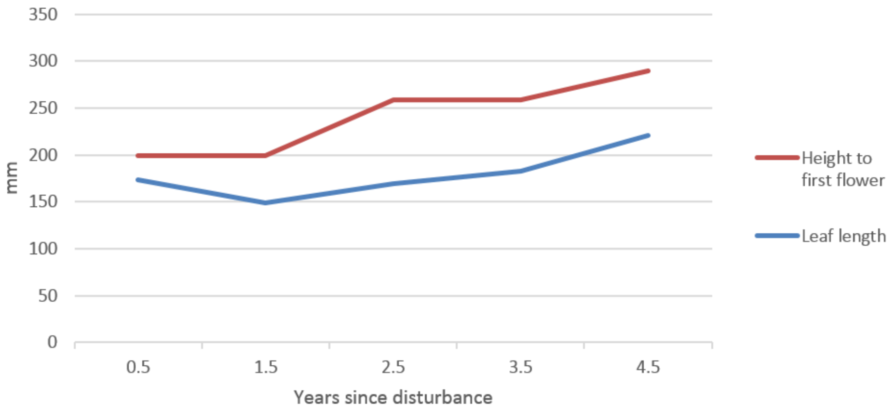

Figure 5. Aggregate data for records of *Thelymitra* plants at Rubicon, showing means of ungrazed leaf length (for plants that attempt to flower) and flower stem height to first flower (for flowering plants) by years since disturbance

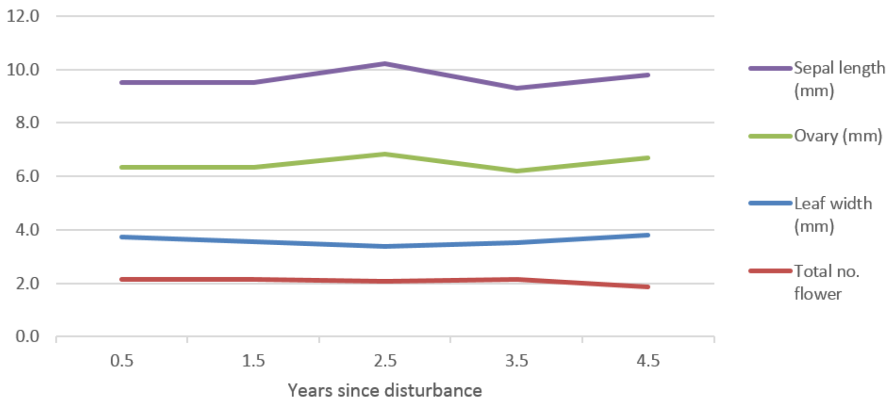

Figure 6. Aggregate data for records of *Thelymitra* plants at Rubicon, showing means of ungrazed leaf width (for plants that attempt to flower), total number of flowers, ovary length and sepal length (all for flowering plants) by years since disturbance

CONCLUSIONS

For a suite of 22 *Thelymitra* species we notice that taxonomic descriptions are not fully inclusive of some measurements made from plants at Rubicon. This is especially pronounced for leaf width, even after discounting all infertile leaves, which are on average less than half as wide as fertile leaves.

On the other hand, we find very strong support for remarks in field guides about the association between disturbance by fire and enhanced flowering of *Thelymitra* plants. Not only is there a strong peak in the number of flowering plants in year 1.5 following disturbance, the ever fewer flowering in plants in successive years are growing amongst an ever increasing density of surrounding vegetation, which make them ever more difficult to detect.

Interestingly, it is not through breaking of dormancy that flowering plants become more numerous. In year 0.5 after disturbance, we have some evidence that it is the more robust plants prior to disturbance that flourish and flower. In subsequent years after disturbance, we have stronger evidence that it is the more robust plants that are more likely to flower in the following season. These plants also grow longer leaves and flower stems, probably to compete with the ever growing surrounding vegetation. However, other metrics of plant stature, including leaf width, show no sustained trends over time since disturbance. These results tend to assuage the sentiment, sometimes expressed, that flowering plants may become exhausted and die.

We are left with no clear explanation for why taxonomic descriptions of *Thelymitra* species appear to overstate leaf width in particular. Unlike leaf length and flower stem height, leaf width is one of the measurements that show no sustained trend in relation to years since disturbance. It may simply be that, within the larger sample of more visible flowering plants immediately following disturbance, collectors have tended to select the larger more impressive specimens. Or it may be that Rubicon systematically supports smaller plant specimens for many species.

LIMITATIONS

There are numerous limitations to this study. Firstly it attempts to generalise to the genus *Thelymitra* with a selection of specimens from 22 species. The selected specimens are strongly biased towards threatened and poorly known species. Secondly, the species considered and the plant specimens used are strongly biased towards a wet heathland habitat, and therefore biased against a drier woodland habitat. Thirdly, there is a large variation in sizes of typical plants from the diminutive *T. carnea* and *T. mucida* to the relatively large *T. circumsepta* and *T. aristata*. Fourthly, these limitations will tend to increase and decrease in significance relative to the different ways that the data set is sliced and diced. However, in order to conduct this analysis with reasonable statistical validity, we need a large amount of data and aggregating all available data provides a suitable resource.

On another dimension, the data is biased by the fact that nearly all plants were recruited into the monitoring program when in flower after a recent disturbance. Ideally we would have data about plants that have been through multiple cycles of disturbance. This ideal is impacted by the fact that plants tend to die over time, but with no reliable formula to determine when this has happened because of plant dormancy.

In short, if we had much more data collected over a much longer time frame, we would undoubtedly have more robust results, potentially disaggregated species by species. In the meantime, we hope that our results are more insightful than misleading.

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Some *Thelymitra* species from Rubicon (all images © P. Collier)

A. *T. mucida* (plum sun-orchid)
B. *T. simulata* (collared sun-orchid)
C. *T. polychroma* (rainbow sun-orchid)
D. *T. longiloba* (lobed sun-orchid)
E. *T. arenaria* (forest sun-orchid)

A NEW NATIVE SPECIES RECORD FOR TASMANIA: *LOBELIA DENTATA* CAV.

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Tasmania had, at the time of publication of the 2014 edition of the *Census of the Vascular Plants of Tasmania* (de Salas & Baker 2014), ten recognised species of *Lobelia*, including the three species previously treated under *Pratia* (*L. irrigua*, *L. pedunculata* and *L. surrepens*), and the sparingly naturalised exotic *L. erinus*. The rare species *L. rhombifolia* has been recorded in isolated localities in the northeast of the State, from Beaconsfield to the Freycinet Peninsula area, as well as perhaps the northern Midlands, although there is some doubt about the reliability of the latter record (TS&MS 2014). Tasmanian Herbarium collections of this species were on loan to the National Herbarium of Victoria, and had been recently returned to Tasmania. Among the return loans were two specimens re-determined by Victorian botanist Neville Walsh as *Lobelia dentata*, a species not previously recorded in Tasmania (the specimens were previously catalogued as *L. rhombifolia*). A careful search in the authors' and the Tasmanian Herbarium collections turned up two additional specimens, from the Freycinet Peninsula and Friendly Beaches area (Figure 1). Elsewhere in Australia, *L. dentata* occurs in Victoria, where its habitat is described as "open forest on sandy or rocky substrates" (Albrecht 1999), and New South Wales, where its habitat is described as "woodland and dry sclerophyll forest on sandy soils" (Wiecek 2014).

The recognition of *Lobelia dentata* from Tasmania came shortly after surveys, in late March 2014, of the Cusicks Hill section of Freycinet National Park by staff of the Threatened Species & Marine Section (DPIPWE) and members of the Wildcare group Threatened Plants Tasmania. Plants of *Lobelia* were abundant after a hot wildfire in January 2013, and assigned to *L. rhombifolia* by surveyors prior to *L. dentata* being recognised as part of the Tasmanian flora. Whether the site also supported *L. rhombifolia* is now not known and warrants further investigation.

Lobelia dentata, like its relative *L. rhombifolia*, appears opportunistically and often profusely after fire, bulldozing, and other types of soil disturbance (Albrecht 1999). While the two species are similar looking, and occur in the same type of habitat, there are some differences that make it relatively straightforward to tell them apart (Table 1).

There are also collections of *Lobelia rhombifolia* from the same general area of Freycinet National Park, indicating that the range of the two species overlap. The two species both respond to fire by growing and flowering profusely (Albrecht 1999; Wiecek 2014), and while there are no collections of *L. dentata* from the farther northeast of Tasmania, the possibility remains that its range is larger than currently documented. Plate 1 shows the typical post-burn habitat of *L. dentata*, as well as its flowers, and non-elongating pedicels.

Tasmanian field botanists are urged to make collections of members of the *Lobelia rhombifolia*-*L. dentata* group (under appropriate permits), during the late-summer to mid-autumn period, to better clarify the range of the two species. *Lobelia rhombifolia* is currently listed as rare (Schedule 5) on the Tasmanian *Threatened Species Protection Act 1995* but its conservation status may warrant review due to the paucity of collections and the fact that some records may refer to *L. dentata*. The conservation status of *L. dentata* should also be considered: at present it is only known from a small number of collections from Freycinet Peninsula.

ACKNOWLEDGEMENTS

Richard Schahinger (DPIPWE) and Wildcare volunteers undertook the initial post-fire surveys at Cusicks Hill in late February 2014, and the former also mapped occurrences of *Lobelia* "*rhombifolia*", supplied site details to MW that allowed follow-up collections of specimens to be made, and provided useful comments on a draft of this paper.

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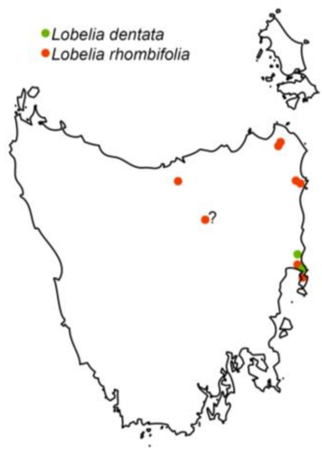

Figure 1. Tasmanian distribution of *Lobelia dentata* (green) within the broader distribution of *Lobelia rhombifolia* (red)

Table 1. Key characters separating *Lobelia dentata* and *Lobelia rhombifolia*

Character	*Lobelia dentata*	*Lobelia rhombifolia*
plant habit	erect plant to 60 cm tall; solitary stem, or few erect branches, often as a response to browsing	low plant to 35 cm tall; branching from the base
inflorescence	4–13-flowered, raceme-like	1–4-flowered cyme
pedicel	not or only slightly elongating after flowering; 5–35 mm long	elongating after flowering, as long as 120 mm
corolla	13–28 mm long	10–15 mm long

Plate 1. Habitat, habit and flower details of *Lobelia dentata*

A. Typical post-burn habitat of *Lobelia dentata* in the Cusicks Hill area of Freycinet National Park, with an overstorey of *Eucalyptus amygdalina* over *Allocasuarina* spp. and a sedgy-heathy understorey on granite-derived soils. **B.** *Lobelia dentata* growing among *Allocasuarina* branches, sheltered from browsing mammals. **C.** Detail of the erect base of the stem in *L. dentata*. In contrast, *L. rhombifolia* has a higher number of branches that are ascending, rather than erect. **D.** Erect growth and flowers of *L. dentata*. **E.** Flower of *L. dentata* with fingers for scale. **F.** Raceme-like inflorescence of *L. dentata* (in contrast, the inflorescence of *L. rhombifolia* is cymose), showing the ripening fruit on non-elongating pedicels (in contrast, the pedicels of *L. rhombifolia* elongate to as long as 120 mm).

NATURAL RESOURCE MANAGEMENT VOLUNTEERING IN TASMANIA

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INTRODUCTION

In Tasmania we are fortunate to have an extraordinarily dedicated, passionate and highly skilled volunteering network, working to protect, enhance and understand our natural environment. The level of volunteerism in Tasmania is higher than the national average with 41% of Tasmanian adults engaged in formal volunteering i.e. through an organisation or group, in comparison to 36% Australia-wide (Volunteering Australia 2010). There are an estimated 140 community groups involved in natural resource management activities in the southern region alone (NRM South 2012) and Landcare Tasmania supports more than 200 Landcare and community groups around the State (Landcare Tasmania 2014).

Perhaps this level of passion and dedication is due to our outstanding natural environment and the people that are attracted to live, work and retire here. It also reflects the need of people to give something back to the environment and places they love and enjoy. Tasmania's wild places are home to some fascinating species and communities, and it is likely that these assets encourage our love of the outdoor lifestyle and motivate people's desire to care for our unique island home.

One of the things that is immediately obvious when becoming involved in natural resource management in Tasmania is the level of specialised expertise and local knowledge within the environmental volunteering network. Many people who volunteer bring specialist knowledge and skills that have been built through years of experience either through professional careers or self-motivated study. BirdLife Tasmania, Threatened Plants Tasmania, the Tasmanian Land Conservancy (TLC), the Landcare and Coastcare movement, field naturalists clubs and the Understorey Network all make significant contributions to volunteering, environmental education and the science behind our understanding of our natural environment. Not only do they educate, they actively manage their local environments either entirely through the work of volunteers or with a significant volunteer contribution. For example, the Tasmanian Field Naturalists Club have been encouraging the study of all aspects of Tasmanian natural history and advocating the conservation of our natural heritage since 1904.

Volunteers are an integral part of many natural resource management projects, most of which could not proceed without the time and effort invested by volunteers. They are at the forefront of delivering on-ground action as well as raising awareness in the broader community. Hundreds of diverse Landcare, Coastcare and Wildcare groups contribute to the protection, understanding and awareness of the natural values of our local reserves and islands. There is a wide range of ways that volunteers contribute to NRM outcomes including:

- rehabilitation of native habitat via revegetation and native plant propagation;

- threat abatement and restoration e.g. weed management and marine debris removal;
- threatened species recovery;
- advocacy and lobbying on conservation and natural resource management issues;
- community education and awareness;
- increasing our understanding of species and communities; and
- research to improve environmental management.

This special edition of *The Tasmanian Naturalist* showcases some of the diverse ways that volunteers and community groups contribute to natural resource management in Tasmania.

MAKING A POSITIVE DIFFERENCE

Volunteers and community groups play a crucial role in the management of threats in their local community reserves, largely due to a passion for, and connection with, their local area. Landcare, Coastcare and Wildcare groups manage and control weeds, rehabilitate riverbanks, protect coastline, remove litter and marine debris, monitor and survey for plants and animals including threatened species, propagate native plants, revegetate degraded areas and raise awareness of the values and threats in their local area.

There is significant support and funding provided to community groups to achieve these outcomes by various organisations including NRM South, Landcare Tasmania and Wildcare.

NRM South's primary mechanism for financially supporting community groups is via a devolved grants program, the Naturally Inspired grants. Over the first six grant rounds, from 2009-2013, volunteers managed over 400 ha of weeds; protected 21 km of coastline and waterways; propagated nearly 10,000 plants for revegetation works; supported over 200 field days or workshops and directly engaged over 8,000 people. These figures represent only a portion of the substantial efforts and positive impact made by volunteers to our environment.

Landcare groups represent a major portion of the volunteering community across the State and make significant contributions to address and manage a range of agricultural, natural resource management and environmental issues on behalf of the Tasmanian community. Landcare Tasmania has been running the (philanthropic) Tasmanian Landcare Fund for the past eleven years and has delivered over $300,000 for practical on-ground works across the State to more than 80 community groups and individuals as well as more than $1.5 million in devolved grants under the Landcare Biodiversity Fund and previous Tasmanian Landcaring grants.

Not only do volunteers and community groups play an important role in protecting local reserves from threats such as weeds (e.g. Skabo 2014, this issue), they also contribute to the protection of high conservation areas through advocacy, lobbying and activism. Some of the most significant conservation reserves in southern Tasmania, including the Peter Murrell Reserve in Kingston and Waverly Flora Park in Bellerive, were protected from development through the passion and advocacy of local communities. These conservation wins were achieved through careful documentation of the significant natural values of these places by a passionate and persistent volunteer community.

In addition to immense environmental benefits, volunteering also provides immeasurable social and emotional benefits to many people. Consideration to the benefits gained by volunteers is considered key to the sustainability of volunteering programs. According to Volunteering Australia's *National Survey of Volunteering Issues 2011*, the main reasons Australians volunteer are because of the difference they make to the community and the sense of purpose it gives people to volunteer. This is supported by some recent surveys of conservation based volunteers, where the sense of 'making a difference' or 'contributing to something useful' placed in the top three reasons for volunteering in recent BirdLife Australia (2012) and Threatened Plants Tasmania surveys (Collier et al. 2014, this issue). Other motivations that ranked highly in these surveys were an interest in conservation and targeted natural values e.g. birds or threatened plants (BirdLife Australia 2012; Collier et al. 2014).

Volunteering provides opportunities to meet like-minded people, gain new skills, and make meaningful, positive contributions to the community. People who volunteer even appear to be happier than those that don't – 82% of volunteers reported that they were delighted, pleased or mostly satisfied with their lives compared with 75% of non-volunteers (Volunteering Australia 2012).

A recent report on the economic contribution of volunteering in Tasmania (MMC Link 2014) concluded that volunteering was the eighth largest industry, employing more people than the hospitality, arts and recreation sectors put together and bigger than the agriculture, forestry, fishing and mining industries combined.

MMC Link (2014) suggested that approximately 9% of all volunteers in Tasmania were involved in environmental volunteering. A significant portion of these (>25%) are involved in Landcare related activities with the movement having more than 3000 Landcare volunteers across the State.

SUPPORTING VOLUNTEER EFFORT

The significant effort contributed by volunteers and community groups in natural resource management is assisted by Commonwealth, State and local governments and not-for-profit organisations who devolve government and philanthropic funds as well as providing a range of support to groups and individuals. There are a variety of organisations in Tasmania that support volunteer input into natural resource management outcomes and they do this through a range of mechanisms and models of engagement. Some of the types of support that are common to these organisations include:

- funding through community grant programs such as the Naturally Inspired grants and philanthropic Tasmanian Landcare Fund;
- providing training opportunities;
- information on best practice e.g. Southern Coastcare Association of Tasmania (SCAT)'s *Coastcare Handbook*;
- assistance with group formation e.g. Landcare Tasmania's Action Planning Workshops;
- networking events for groups such as the Tasmanian State Landcare Conference; and
- provision of bulk insurance i.e. Landcare Tasmania and Wildcare.

Funding is essential for many volunteer-driven natural resource management projects to allow for the purchase of materials and equipment for on-ground works, to reimburse volunteers for remote travel and accommodation, for contractor input into on-ground works, and for capacity building of volunteers such as workshop delivery or training. During 2010-2012, over $500,000 was devolved by a range of organisations to 113 groups and individuals to support natural resource management volunteer efforts in Tasmania's southern region (NRM South 2012). Landcare Tasmania's Landcare Assistance Program (LAP) provides Landcare and Community groups with funding for public liability and volunteer insurance to more than 110 groups.

Over seven rounds, NRM South's devolved grants program, the Naturally Inspired grants, have provided over $360,000 in funding, which has enabled 92 community groups to deliver 107 projects improving community skills, knowledge and engagement around environmental themes and issues. The latest Tasmanian Landcare Fund round was run in conjunction with NRM North's Community grants and provided $50,000 to 10 projects across the State (Landcare Tasmania 2014). The next round of Naturally Inspired grants will be opened in February 2015 and we're looking forward to supporting many more volunteer projects in southern Tasmania. The Tasmanian Landcare Fund will also open in May 2015 at Agfest. For funding opportunities in other parts of Tasmania, get in touch with Cradle Coast NRM, NRM North, Landcare Tasmania, SCAT, or your local council to see what they have available.

Among Tasmanian volunteers there is a resounding call for more training with nearly one third of volunteers surveyed requesting more training opportunities (Volunteering Tasmania 2010). It is easy to make assumptions about the training needs of volunteer groups, however involving volunteers in training program design is important to their success. Collier et al. (2014) found that one size doesn't fit all with survey respondents having different training aspirations associated with age. Their results also highlighted the benefits of sharing skills between group members with survey respondents calling for 'a skill set bank' to help field trip planning and a 'buddy' system to help reinforce skills learnt in training.

Skabo (2014) raises a very important point that most volunteers want to contribute 100% of their volunteered time to positive action on the ground, rather than spend too much time applying for funding, administering successfully funded projects, organising events and recruiting new members. In January 2012, the new National Work Health and Safety (WH&S) legislation ensured volunteers have the same rights as employees and was a positive step forward for volunteering. However, it also brought an unfortunate consequence of increasing the administrative load on groups (Volunteering Australia 2012). For the Friends of Punchbowl Reserve this administrative support is provided by Launceston City Council, which has allowed the group to thrive as they focus all their time and efforts in the field (Skabo 2014). This is also the case for several community and Landcare groups south of Hobart with the Kingborough Council also providing this administrative support for public liability and insurance in conjunction with Landcare Tasmania.

Ensuring volunteers get to spend the majority of their time doing what they are passionate about is essential in maintaining motivation and ensuring longevity of groups. Threatened Flora Link, a new project partnership between the NRM regions, the State Government's Threatened Species and Marine Section, Threatened Plants Tasmania (TPT), the Royal Tasmanian Botanical Gardens (RTBG) and the Friends of the RTBG, provides a model where staff from the NRM regions assist with specialised training, volunteer recruitment and WH&S procedures to support TPT and Friends of the RTBG. Similarly, the Volunteer Training Consortium is a successful collaboration between NRM South, Parks and Wildlife Service, Landcare Tasmania, SCAT, Crown Land Services and various southern Tasmanian councils. The consortium funds accredited training for volunteers such as first aid, brushcutter use and safe use of chemicals. The consortium partners also provide in-kind training to further support volunteers in skills such as plant and weed identification, seed propagation, understanding fire ecology, photo-point monitoring, grant writing and map creation.

MEASURING VOLUNTEER CONTRIBUTION

Community groups and volunteers contribute significantly to the delivery of natural resource management outcomes in Tasmania, providing between 4-8 fold return on investment by Commonwealth and State governments. A recent report commissioned by the Australian Landcare Council (GHD 2013) on the multiple benefits of Landcare and natural resource management suggested that there were significant other benefits that exist beyond the biophysical domain. The report draws out that Landcare can generate an economic return in the order of 3-5 times the original investment and potentially higher.

Measuring volunteer contribution in financial terms is important for attracting funding to natural resource management initiatives, however volunteer input is often underestimated and it is difficult to collate data across organisations and groups to provide a Statewide estimate. NRM South were unable to quantify the economic value of volunteer contribution to natural resource management outcomes across the southern region when reporting on the progress of the Natural Resource Management Strategy for southern Tasmania (NRM South 2012), as each project or organisation collected data in a different form. However, in 2013, Landcare Tasmania members volunteered more than 105,000 community hours addressing a range of environmental and agricultural issues and contributed in excess of $3.5 million to the State economy.

The data collected by individual organisations provides a telling story that natural resource management investment in Tasmania would not achieve even a quarter of the current environmental outcomes without the enormous contribution of volunteers and community groups. Over the first six rounds of Naturally Inspired grants, for every dollar of grant money provided, groups reported an in-kind return of $4.70. An even higher in-kind return was reported by the Tasmanian Landcare Fund with a six-fold annual return on directly invested funds during 2010-2012 (NRM South 2012). In the two financial years from 2011 to 2013, the Southern Beaches Landcare/Coastcare group contributed more than 1,385 hours on natural resource management activities in their local coastal area at an estimated value of $48,475 based on a volunteer hourly rate of approximately $35/hour (Ironmonger 2012).

This high level of volunteer contribution is not unusual. An award-winning project that achieved significant environmental outcomes while measuring volunteer contribution using a systematic approach to collecting data on volunteer input is Wildcare's Sea Spurge Remote Area Teams (SPRATS). In their first season in 2007, eight volunteers were confronted with as many as a million individual sea spurge (*Euphorbia paralias*) plants on a single beach. In 2013, 10 groups and over 80 volunteers were scouring Tasmania's rugged and beautiful South West in an informal competition to find the last individual sea spurge plant (NRM South

2012). This project engaged over 300 volunteers who contributed in excess of 3,500 person-days to remove 10 million sea spurge plants at over 560 sites and reported a $7.70 return on government investment with $1,300,000 of volunteer input for the approximately $168,000 spent (NRM South 2012). This novel 'adventure volunteering' approach of SPRATS effectively addresses several common issues facing volunteer groups of diminishing resources, recruitment, increasing administrative duties and also tackled the once intractable problem of remote area weed infestation (Marsden-Smedley 2014).

The TLC recently conducted a survey of terrestrial mammals in their Five Rivers Reserve as part of the National Bush Blitz, in which volunteers contributed 37% of the total time and labour costs (Bryant & Keble-Williams 2014, this issue). This data will be critical in helping inform the future management of the Five Rivers Reserve. In 2013-2014, volunteers from Threatened Plants Tasmania contributed over 480 hours to increasing our knowledge of the distribution, threats to and/or population dynamics of 26 threatened plant species in the southern region alone. This data has been entered into the *Natural Values Atlas* and is used to inform threatened species management on both public and private land.

From weeding adventures in the remote South West to science boffin volunteers collecting data to help land managers protect threatened species, it is clear that volunteers make an overwhelmingly positive contribution to natural resource management outcomes in Tasmania. They protect our natural environment, contribute significantly to our understanding of how best to manage our landscapes to retain biodiversity and provide the local expertise and passion that make each part of Tasmania so special. It is important to remember why volunteers get involved in the first place and support them in maintaining their motivation, as keeping this passion alight is essential to managing our precious natural resources for the long term.

ACKNOWLEDGMENTS

We would firstly and most importantly like to thank all the volunteers that contribute to environmental outcomes in Tasmania. We would also like to acknowledge the Australian and State governments for proving funding that allows NRM South and Landcare Tasmania to support volunteers and community groups.

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SNAILS ROCK. POOLS: INTERTIDAL REEF MONITORING IN NORTHERN TASMANIA

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INTRODUCTION

Many of us have, at some time in our lives, spent an hour or two at the beach peering into rock pools and exploring the micro-habitats of the intertidal zone. Intertidal reefs harbour flora and fauna adapted to both the environmental extremes that the inhabitants endure, and the influx of oxygen and nutrients that make this a worthwhile habitat to call home. The range of life form types – squishy, armoured, leathery, buoyant, anchored – reflect these adaptations, and make healthy intertidal reefs relatively productive and biodiverse coastal habitats, as well as engaging study subjects. Monitoring the health of these habitats has been developed as part of interstate programs for some years, and NRM North has begun taking a look at intertidal reefs in the northern region during summer 2013/14.

THE NEED TO MONITOR

Despite their resilience to natural environmental extremes, intertidal reefs are vulnerable to human impact, either direct (trampling, bait collection, invasive species, pollution) or large-scale and indirect (sea temperature and level rise, acidification). In 1998, intertidal reefs and their flora and fauna species were identified as being among the key indicators for estuaries and seas for national environmental reporting (Ward et al. 1998). Building on the successful volunteer diver Reef Watch surveys, Reef Watch South Australia has developed monitoring protocols for community volunteers to record habitat condition information for intertidal sites (Conservation Council of South Australia 2007). Parks Victoria has also included intertidal zone monitoring as part of its volunteer-engaging Sea Search program (Parks Victoria 2013).

To date, similar programs have not operated beyond localised surveys in the northern region of Tasmania (at least, that we know of). However, with a need to understand what's happening to our coastal environment, and to establish a reference point for the future, this summer, NRM North drew from interstate approaches to pilot an intertidal monitoring program with volunteers across northern beaches. Under the banner of 'Snails Rock. Pools.' five intertidal reefs were surveyed with approximately 50 volunteers from a range of backgrounds.

THE TASSIE EXPERIENCE AND OUTCOMES (SO FAR)

Using 1 m^2 circular 'quadrats', records are made of surface cover by algae and sessile organisms, and counts are taken of molluscs and other common invertebrates. Timed searches along the lower intertidal zone allow for counts of organisms not captured during the quadrat observations. With only one season's worth of data, there are few lessons to be drawn from the program's results so far. However, NRM North plans to continue the program over the next few summers to enable comparison between survey seasons and sites.

The Snails Rock. Pools. program has multiple aims though, with data collection only being one of these (albeit an important one). With a citizen science approach, shared participation with community volunteers is a key component of the program as well. Participants this summer have generally fallen into one of two, overlapping, categories – those with an interest in the data itself, its collection and future use, and the importance of their contribution to habitat management; and those who are perhaps starting with a more basic understanding of intertidal ecology, and seeking to know a bit more about it. Volunteers in the first group often have some familiarity with scientific or environmental skills and knowledge, while those in the second group tend to be more of the 'rock pool rambler' background, not always aware of the snail-eat-snail world at their feet, but enthusiastic to learn more. In both cases, the activity increases first-hand awareness of the issues at play on our coasts.

Plate 1. A randomly placed circular 'quadrat' used for sample coverage and count recording

In addition to this, activities that have the ability to immerse participants in a sensory experience have social and health benefits. Rock pooling is an activity that helps develop mindfulness, a state of attentiveness free of judgement that can result in improved mental health and emotional resilience. (If you've ever been so engrossed in what you were doing, seeing, feeling, hearing, smelling while rock pooling, birdwatching, wildflower-spotting etc. and lost track of time, you've probably experienced a 'flow state', indicative of mindful activities). Research demonstrates that many nature-based activities in our beautiful outdoors can contribute to other positive mental health benefits as well (Townsend & Weerasuriya 2010) including management of childhood ADHD (Landscape and Human Health Laboratory 2014).

While these impacts were not measured for participants in the Snails Rock. Pools. program, the nature of the monitoring activity did allow for a range of ages and, aside from the need for general fitness to negotiate rocks underfoot, abilities. It was a satisfying outcome to have this range of participants engaged, and to see families and social groups using the surveys as sharing, social activities.

Plate 2. One of our younger participants experiences the pleasures of intertidal reef exploration first-hand

NEXT STEPS

NRM North will continue intertidal reef surveys next summer, and plans to expand this coastal resource assessment to include saltmarsh monitoring as well. As a keystone to the program, volunteers will again be sought to lend a hand. Data is being collated by NRM North for future analysis, and this is available on request (until new information technology allows easier sharing). Anyone interested in the program is encouraged to contact NRM North, or look at the Snails Rock. Pools. program's Facebook page https://www.facebook.com/snailsrockpools – see below for extracts from site.

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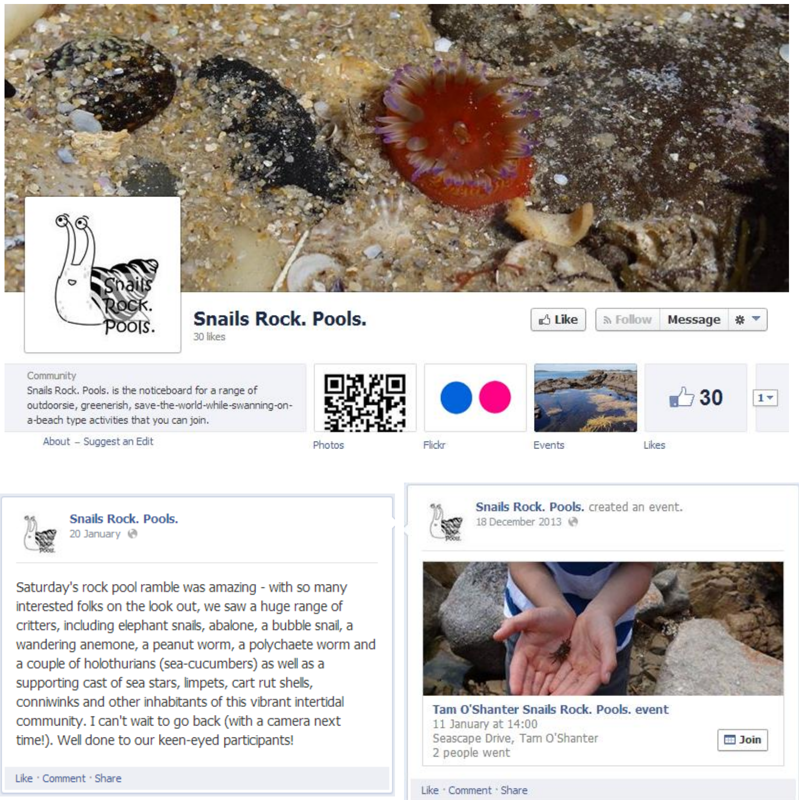

GOING DEEPER – EXPLORING OUR MARINE ENVIRONMENT

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The diverse and unique marine life of Tasmania, found between the high tide mark and the three nautical mile limit, are as unexplored and unknown to many in our community as the geology of the moon. Beside leatherjacket and whale, what wildlife exists beneath the thin blue line? What invertebrates survive inundation each day? Is any of it important or even worthwhile conserving?

Environment Tasmania is running a 'Tasmanian Marine Discoveries' program to bring people closer to our marine environment – to help them understand what is there, why it is important, how to enjoy it, and what we can do to help conserve it. Through exploring this truly incredible environment, we learn to appreciate it and how to care for it better.

The Marine Discovery Weekend at Bicheno was held on the ANZAC Day long weekend, 2014 (Plate 1), following a similar event at Maria Island earlier in March. Over twenty adults and children attended the Maria Discovery event and over 30 people explored Bicheno through the program.

With the assistance of volunteers, discovery rangers, and local business operators, we took a group of intrepid explorers into the intertidal zone, and then beyond. On Maria Island, we explored the rock pools adjacent to the Painted Cliffs and then snorkelled into the chilly water surrounding the cliffs to find leatherjackets, banded morwong, jewel anemones, crayfish, sponges and lots of glorious seaweed. The Maria Island Marine Discovery event also included a presentation from Bec Hubbard on what makes Tasmania's marine environment so unique, and what benefits the Marine Reserve have bestowed to our scientific understanding of marine ecosystems and biodiversity.

Plate 1. Attendees prove that the venue for these sorts of events can be anywhere

Bicheno is the gateway to the Governor Island Marine Reserve and so many different activities associated with the ocean. Across the weekend, our group – from toddlers to retirees – was exposed to a magnificent array of marine wildlife. We explored the different rock pools of the south-facing blowhole platform and the northeast-facing platforms near the break wall at Waubs Bay, described in the next article by Tasmanian Field Naturalist Club member Jane Elek. We had BBQs about birds, puppies and policy with the local Glamorgan Spring Bay Council, workshops on citizen science with Redmap founder Dr Gretta Pecl, and a very informative film night and presentation about how we live with the sea/life and what's shifting due to climate change.

Sunday of the ANZAC weekend brought sun and calm seas, so we set off to explore deeper into the underwater world. The chilly water temperature didn't discourage our group of a dozen snorkelers from launching off the boat ramp to investigate the marine life of Waubs Bay. There was a bundle of comb jellyfish – beautiful, clear little jellies with iridescent lights flashing up and down their bodies. Amongst the ubiquitous kelp, we saw plenty of life including mackerel, cowfish, mullet and sponges. To finish off the Bicheno Marine Discovery Weekend, we rode the Glass Bottom Boat (Plate 2) through the gulch next to Governor Island – the only one of its kind in Tasmania! We saw a school of mullet, banded morwong, snails, abalone, banded stingarees, a huge sting ray, draughtboard shark, kelp, seals and dolphins. What a brilliant, accessible (and warm) way to appreciate our oceans!

The Tasmanian Marine Discoveries Program will be exploring the Bay of Fires later in 2014, as we continue to take people a little deeper into our marine environment, and a little closer to the wildlife that inhabits 70% of our planet.

Visit www.marinediscover.com for more information on this program.

Plate 2. Participants experience the wonders of the underwater world at Bicheno through the glass-bottomed boat

EXPLORING BICHENO ROCK PLATFORMS, APRIL 2014

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Rock pool rambles during low tide were one of the many activities on the Marine Discovery Weekend at Bicheno on the ANZAC Day long weekend 2014. The guides for the very popular Rockpool Rambles were Jane Elek and Lynne Maher, both formerly members of the Tasmanian Marine Naturalists Association and current members of the Tasmanian Field Naturalist Club, with assistance from volunteers from Environment Tasmania.

On Saturday we assembled at the Blow Hole car park on the southern side of the headland. A pre-event briefing alerted people to be wary of the possible presence of blue-ringed octopus (*Hapalochlaena maculosa*) and the anemone cone shell (*Conus anemone*), both of which can inject an extremely strong poison when handled, and reminded people to leave the animals and habitat as we found them. We then walked behind the shore to a large granite mound, which we scrambled over and down to the rocks just south of Rice Pebble Beach (see Plate 1).

Plate 1. Participants explore the granite rcokpools around Bicheno

There were numerous crevices and pools in the shelter of rocks that protected the shore from the main force of the waves. A large, recently 'uprooted' plant of bull kelp (*Durvillea potatorum*) was lying in the shallows, washed in from the dense stand just offshore, indicating that the outer edge of the rock platform was a very exposed shore. Neptunes necklace (*Hormosira banksia*) was the main seaweed in the pools, with some calcareous red algae (*Haliptilon roseum*), although some dark, greeny-brown bladder weed was found, possibly *Colpomenia peregrina*. The rock pools sheltered abundant eight-armed seastars (*Meridiastra calcar*), and a few native small seastars (*Parvulastra exigua*) were seen in a small pool high on the platform. In the deeper water near the exposed edge of the platform, one large specimen of the seven-armed seastar (*Astrostole scaber*) with long grey spiky arms was found (Plate 4). Red waratah anemones (*Actinia tenebrosa*) were prominent around the edges of the pools, and deep in the crevices were some shell grit anemones (*Oulactis muscosa*), with blotched grey tentacles and columns covered with shell grit. One specimen each of a swimming anemone (*Phlyctenanthus tuberculosa*), looking like a flaccid bag of baked beans, and a bubble anemone (*Phlyctenanthus australis*), similar but more grey than orange, attracted attention. Some small shrimps were seen in one pool that happily proceeded to do their cleaning activities on the toes offered, and one well-camouflaged small fish was photographed but not identified.

The most notable aspect of the platform in this area was the abundant herbivorous snail populations: at the top of the platform furthest from the water were banded periwinkles (*Austrolittorina unifasciata*), lower down were striped conniwinks (*Bembicium nanum*), ribbed top shells (*Austrocochlea constricta*) and in the pools were lots of black crows with brown opercula (*Nerita melanotragus*), wavy top shells (*Diloma concamerata*), black and white striped top shells, probably zebra winkles (*Austrocochlea porcata*). Only occasional serpent chitons (*Sypharochiton pelliserpentis*) and orange-edged limpets (*Cellana solida*) were seen although numerous dead shells of tall-ribbed limpets (*Patelloida alticostata*) were found. Some elephant snail (*Scutus antipodes*) and small black-lipped abalone (*Haliotis rubris*) shells were also found. The main predatory snails in the rock pools seemed to be the wine-mouthed lepsiella (*Haustrum vinosum*) and lineated cominella (*Cominella lineolata*). Few crabs were found: a couple of small native shore crabs – one with white legs and the other with white markings on its carapace, too small to be identified easily. No introduced half crabs were seen but, sadly, one European green crab was found (*Carcinus maenas*). Some bristle worms were found under some rocks. There was a good collection of shells washed up above in the crevices that would have yielded a lot more species from the area if they had been examined. Notable for their rarity were mussels, oysters, barnacles and galeolaria worms.

Plate 2. Handing over to the next generation – adults and children explore rock pools

The following day the wind had changed direction so we were able to explore the more exposed rock platform the northern side of the headland. We assembled at the car park near the sea wall in Waubs Bay and walked a short distance behind the shore towards the Gulch before heading across the granite down onto the rock platform. The differences in this area from the shore explored the previous day were immediately noted. The rocks sloped gently down into the water with no outlying rocks to buffer the high impact of the waves. The outer edge of the rocks was fringed with bull kelp, with an inner ring of slender brown dagger weed (*Xiphophora gladiata*). The sloping surface of the rocks was devoid of snails, being almost entirely covered instead by little black horse mussels (*Limnoperna pulex*), white galeolaria worms (*Galeolaria caespitosa*) and at least four species of barnacles in their respective zones up the slope. Lowest down were the chimney-like imperial barnacles (*Austraobalanus imperator*) that are invading from the north, then the flattened surf barnacles (*Catomerus polymerus*), and higher up the high tide barnacle (*Chthamalus antennatus*), then the clusters of tiny honeycomb barnacle (*Chamaesipho tasmanica*). Scattered among the imperial and surf barnacles were some limpets and cunjevoi sea squirts (*Pyura stolonifera*). In the crevices we found at least five species of anemones: the ubiquitous shell grit and waratah anemones, a good collection of small white-striped anemones on the sides of the crevices (*Anthothoe albocincta*), some of which seemed to have white rather than the usual orange discs, and other crevices had green anemones (*Aulactinia veratra*) and also some with brown tentacles, possibly the mudflat anemone (*Anthopleura aureoradiana*) which is described as also occurring in rock pools (Edgar 2008). A few eight-armed seastars were seen but no other seastar species, nor were any crabs caught before they disappeared into the crevices. A few large hairy shore chitins (*Acanthopleura hirtosa*) attracted attention but other molluscs were well hidden in crevices. In the shallow depressions were small representatives of green sea lettuce (*Ulva australis*), brown and red algae. Using a hand lens, we could see the barnacles in the pool with their legs out feeding, and the twin black fans of tentacles extended by the serpulid galeolaria worms feeding. Other black spots on the rocks were found to be tiny limpets or siphon shells nestling among the grains of the rock.

The children were enthralled (Plates 2 & 3) by descriptions of the feeding habits of many of the animals: barnacles lying on their backs kicking food into their mouths, seastars extruding their stomachs and 'eating out', predatory snails boring holes into other snails or bivalves and sucking up the digested contents and the sticky tentacles of pretty anemones actually trying to fire little darts into your skin to haul you into their mouth.

Plate 3. Children peer into the crystal clear waters of rock pools around Bicheno

It was satisfying to see so few introduced species – only the green crab (*Carcinus maenas*); no Japanese seaweed (*Undaria pinnatifida*), no Pacific oysters (*Crassostrea gigas*) and no half crabs (*Petrolistes elongatus*), although they may be elsewhere in the area.

These were not exhaustive or systematic surveys (cf. Williams (2014) – this edition of *The Tasmanian Naturalist*) of the inhabitants of the rock platforms since the main aims of the rambles were to explore, identify the common organisms and explain something of their life history to the participants of the Marine Discovery Weekend. This was but one of the activities over the Discovery Weekend aimed at imparting a sense of wonder and appreciation of our rich marine life, especially close to the existing Marine Protected Area around Governors Island.

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Plate 4. *Astrostole scaber* (seven-armed seastar) from one of the rock pools

REDMAP: ECOLOGICAL MONITORING AND COMMUNITY ENGAGEMENT THROUGH CITIZEN SCIENCE

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INTRODUCTION

Waters around Australia are warming at between 2-4 times the global average, facilitating polewards shifts in the distribution of many marine species. Monitoring for such changes in the distribution of species along the 60,000 km of Australia's coastline presents several ongoing challenges. These include a lack of historical data to determine accurate historical distributions and significant funding constraints that limit the extent of contemporary monitoring programs. However, there are a large number of people collectively spending significant time in, on or around our seas, often with meaningful knowledge of their local species and environments, yet their observations are not routinely recorded, verified, collated, stored and therefore made accessible. Additionally, many people now have the capacity to record their observations with high precision and accuracy via digital technology even if their personal knowledge is not complete. Redmap (Range Extension Database and Mapping Project) is a website-based citizen science initiative where community members submit photographic observations of 'out-of-range' species that are then verified post-hoc by an Australia-wide network of scientists. Redmap began as a pilot project in Tasmania at the end of 2009 before expanding across Australia three years later. Here, we give an overview of Redmap to date, concentrating on the Tasmanian aspects of the project.

Shifts in the geographical distribution of species, or 'range-shifts', are globally some of the most frequently reported impacts of climate change as species alter their distributional limits to keep pace with changing environmental conditions (Burrows et al. 2014). Detailed examination of whole assemblages or ecosystems suggest that between 20-85% of species are shifting where they live in response to changes in temperature (Dulvy et al. 2008; Chen et al. 2011; Wernberg et al. 2011). Redmap is a citizen science initiative designed to provide an early indication of what species may be changing their distributions in our coastal marine environments, and may therefore require additional concerted research effort or management focus. The project invites members of the public to submit photographs and data about unusual observations of marine species made while undertaking marine activities like fishing, diving, boating, and beachcombing. Redmap has two main discrete but linked objectives: 1. ecological monitoring for the early detection of species that may be extending their geographic distribution as our climate changes; and 2. engaging with the public on the ecological impacts of climate change, using their own data. Community members can either use region-specific lists of 'target' species available on the website or smartphone app to help identify which species are unusual to their particular area before logging a sighting; or they can submit photographs of any species they consider unusual for a given area. Photographs of observations are sent to one of a panel of over 80 expert scientists from many different institutions from across the country to verify the species' identification.

After verification, sightings are displayed on the website and the observer is sent detailed feedback on their observation via email.

To date, divers, fishers and beachgoers around Australia have reported 1060+ sightings on Redmap, via the smartphone app or directly to the website (www.redmap.org.au), with over half of these sightings made around the Tasmanian coastline (Figure 1). Most of the sightings submitted are observations of only one individual; however, many are of schools or groups of animals and so the actual number of individuals observed is much higher. Nearly a third of the verified observations were considered uncommon where they were spotted i.e. they were south of their known home ranges. Many of the sightings that were not designated as technically 'out-of-range' have been valuable for improving our knowledge of the distribution of poorly known or rare species.

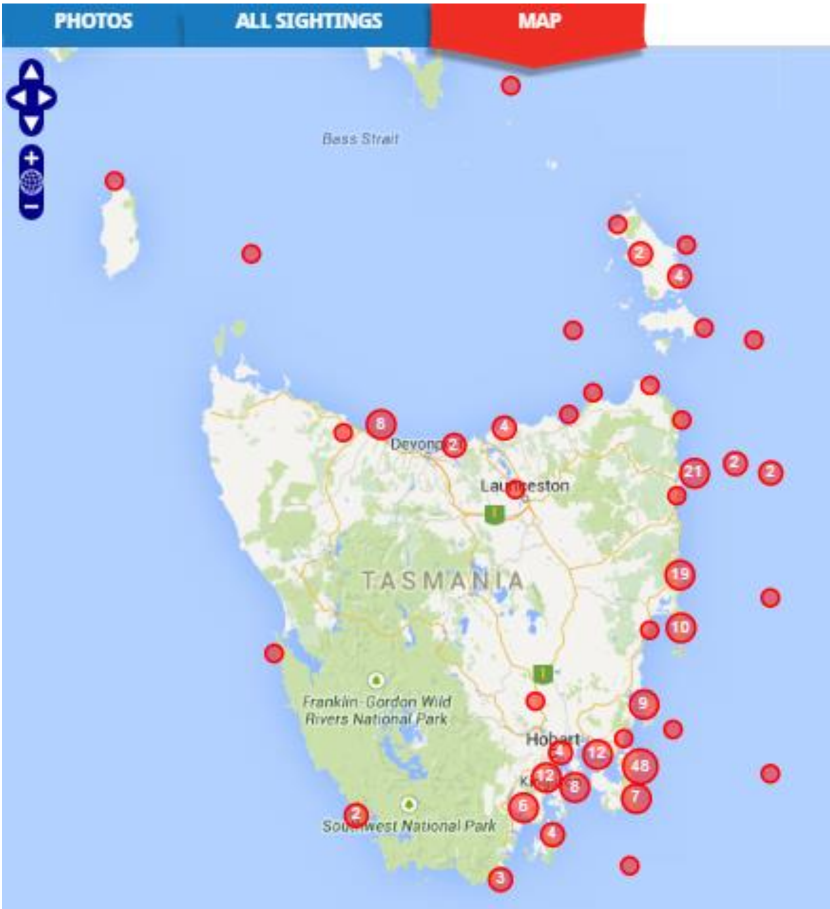

Figure 7. Map highlighting the locations of community observations submitted to Redmap within Tasmania

Plate 1. The eastern rock lobster (*Sagmariasus verreauxi*) is the most reported species on the Redmap website, observed in areas along the Tasmanian east coast that are not considered part of its historical range

Plate 2. A juvenile mosaic leatherjacket (*Eubalichthys mosaicus*) was spotted off Maria Island by Redmap member Antonia Cooper in June this year

The eastern rock lobster *Sagmariasus verreauxi* (Plate 1) – venturing down Tasmania's east coast – is to date the most logged species on Redmap and is thus far showing "high" confidence as potential range extending species (Robinson et al. in press). This species has been recorded intermittently in Tasmanian waters over several decades; however, we are now seeing groups of 35+ adults and sub-adults on the east coast, as well as frequent observations of individuals. Other commonly reported 'out-of-range' species in Tasmania include zebrafish (*Girella zebra*), yellowtail kingfish (*Seriola lalandi*), white-ear (*Parma microlepis*), herring cale (*Olisthops cyanomelas*), luderick (*Girella tricuspidata*), old wife (*Enoplosus armatus*), and snapper (*Pagrus auratus*). To confidently quantify how far a species has shifted its marine postcode south we need to collate more data over a longer time frame. However, a qualitative level of confidence in potential range extensions in Tasmanian species was estimated (Robinson et al. in press) and information on the raw data that is submitted to Redmap shows some individual sightings logged in Tasmania (Figure 1) and how far south they were spotted from their usual poleward range boundary (Table 1). Some observations are clearly significant: for example, the juvenile mosaic leatherjacket (*Eubalichthys mosaicus*) spotted off Maria Island by Redmap member Antonia Cooper in June this year (Plate 2). This species is not normally found in southern Tasmania in mid-winter. Juveniles of potential range-extending species recorded in colder months are particularly important as they indicate the prospect of species being able to survive (and therefore reproduce) throughout the year, increasing their likelihood of establishing a population (Bates et al. 2014).

Species		Month spotted ...	Where	Distance (km) south of southerly range
	Onespot puller (*Chromis hypsilepis*)	August	St Helens	68km
	Mosaic leatherjacket (*Eubalichthys mosaicus*)	June	Maria Island	127km
	Snapper (*Pagrus auratus*)	March	Blackmans Bay	173km
	Eastern rock lobster (*Sagmariasus verreauxi*)	Feb	Tasman Peninsula	190km
	Green moray (*Gymnothorax prasinus*)	May	St Helens	195km
	White-ear (*Parma microlepis*)	March	Freycinet	203km
	Eastern King Prawn (*Melicertus plebejus*)	April	Hobart	273km

Table 4. Examples of sightings submitted to Redmap Tasmania that were 'out-of-range' i.e. south of their expected distributions

To synthesise what the out-of-range observations submitted to Redmap may mean in terms of potential range shifts of species, the Redmap team developed a qualitative rapid assessment tool to classify levels of confidence (i.e. high, medium and low) in potential range extensions for a variety of Redmap-listed species in Tasmania. This method was adapted from those used in the early detection of invasive species, and included data submitted by Redmap contributors over a three year time period (2009-2012). The assessment considered the confidence with which we could determine the historical range limits, factors that would influence detectability of species, and the temporal consistency of out-of-range observations. In consultation with many of the fishers and divers that submitted their observations to Redmap, this assessment was drafted and published as a 'report card' for public dissemination of the project results (www.redmap.org.au/article/the-redmap-tasmania-report-card/). The process behind the report card was quite novel and so the report card has been extended and drafted as a journal article for scientific dissemination (Robinson et al. in press). Additionally, Redmap has contributed small but influential contributions to a number of significant studies (Johnson et al. 2011; Last et al. 2011; Madin et al. 2012; Ramos et al. in press; Ramos et al. 2014).

CONCLUSION

Ocean temperatures around most parts of the Australian coast have warmed at over twice the global average, and even faster off the eastern coast of Tasmania (Hobday & Pecl 2014). This increase in temperature is facilitating a significant change in the distribution of Tasmania's marine species (Last et al. 2011; Johnson et al. 2011). Through Redmap we are hoping to develop a longer-term record of verified observations of out-of-range species in Tasmanian waters to add to the data available from traditional scientific surveys, and also the growing database of Reef Life Survey (reeflifesurvey.com).

Citizen science is becoming an important tool for monitoring and evaluating local and global environmental change (Parmesan & Yohe 2003; Silvertown 2009). Through the interest and dedication of Tasmanian fishers, divers and beachcombers, Redmap data can make significant contributions to our growing understanding of how Tasmanian marine ecosystems are changing over time. Importantly, Redmap is also playing a major role in communicating with the general public about the importance of Tasmania's marine ecosystem, and how this may be changing over time.

HOW YOU CAN HELP!

If you catch or see a fish that you find "unusual" in your local seas, share your sighting and photo on the Redmap app or redmap.org.au. The continued support of fishers and divers will, over time, allow Redmap to better understand and predict changes in the distributions of Australia's marine life. There are however many other ways you can assist Redmap, and you don't even have to get wet. For more information visit this page:

http://www.redmap.org.au/about/how-you-can-help-redmap/

ACKNOWLEDGEMENTS

We extend our sincere thanks to the many Tasmanian 'Redmappers' who have contributed valuable data to Redmap, as well as the many scientists who contribute their time 'inkind' to verify every observation submitted. We are grateful to the many different community and industry groups that have supported Redmap extensively over the last few years, as have several small businesses and government departments. Funding for Redmap Tasmania was initially through the Tasmanian Community Fund, but has also included Inspiring Australia, Australian National Data Service, Fishwise, Department of Agriculture Fisheries and Forestry, Climate Connect and the Institute for Marine and Antarctic Studies at the University of Tasmania.

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FRIENDS OF PUNCHBOWL RESERVE

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Residents of Launceston and nearby areas are very fortunate in having access to several bushland reserves within a few kilometres of the city centre. In spring these reserves offer magnificent displays of native wildflowers, including many which are listed on Tasmania's *Threatened Species Protection Act 1995*.

Members of the Australian Plant Society Tasmania (APST) and the Launceston Field Naturalists Club visit these reserves frequently to enjoy the native plants. One of the reserves we visit most frequently is the aptly named Punchbowl Reserve where bushland-covered slopes form the sides of the bowl. The bottom of the "punchbowl" is an attractive picnic and recreation area with lawns, a children's playground and barbecues (Figure 1). The bushland areas comprise about 60% (18 ha) of the 29 ha reserve.

Figure 1. Map of Punchbowl Reserve (insets show the manicured picnic area and the grassy woodlands) (map: courtesy Launceston City Council)

Surveys of the flora in the reserve have been conducted by Ratkowsky & Ratkowsky (1994) and Batchelor (1989). Ratkowsky & Ratkowsky (1994) identified 142 species of native flowering plants of which eight are listed under the Tasmanian *Threatened Species Protection Act 1995*.

On a visit to Punchbowl Reserve about three years ago I noted that exotic plants seemed to be more prevalent in the bushland area than they had been only a couple of years earlier. Fairly large isolated shrubs of gorse (*Ulex europaeus*) were dotted throughout much of the bushland (and I later found that there were some areas where this species was dominant). In another area there was an infestation of english ivy (*Hedera helix*) and numerous seedlings and larger plants of a *Cotoneaster* species. I could see that some action was needed if the bushland was not to become severely degraded as has happened in another local reserve, the Kate Reed Reserve.

Plate 1. Members of the Friends of Punchbowl Reserve tackle gorse

It seemed unlikely that the manager of the reserve, the Launceston City Council (LCC), would have the resources to undertake the necessary work, especially as most of the visitor activity in the reserve takes place in the central grassy picnic area, which is beautifully maintained by a council employee. I decided that the most practical solution would be the formation of a group of volunteers who could take responsibility for the bushland area.

I had been active for some years in the Friends of Trevallyn Reserve, a group that had very successfully undertaken weeding and other maintenance work in the Trevallyn Nature Recreation Area (TNRA) in cooperation with the managers of that reserve, the LCC and the Parks and Wildlife Service.

With all this in mind, I approached the LCC with a proposal to establish a "Friends of Punchbowl Reserve" group and the suggestion was very well received. The Council offered assistance with publicity and the supply of equipment when the group became operational.

I suggested to the LCC that to attract the attention of the public we should offer a day of "flower walks" to be conducted by people with a good knowledge of the native flora. We agreed on a weekend in early October when many of the native plants would be in full flower and we obtained the agreement of the gardening columnist for *The Examiner* to publish a story on the flower walks a week before the event. I supplied information and photographs and the article attracted considerable attention.

In preparation for the day I made up attendance lists with space for attendees to write in their names, phone numbers, email addresses and preferences for a suitable day each month for a working bee. Members of the Friends of Trevallyn Reserve and of the APST volunteered to assist on the day.

Despite poor weather we had an excellent turnout on the day and ended up with a list of about 30 people interested in joining the new group (as well as many more who attended but did not necessarily want to join the group).

Since then we have had a working bee or other activity each month, on the first

Saturday from 9.30 am until 11.30 am. Attendance at these has averaged about 14 people and we continue to attract new members (and of course to lose one or two for various reasons).

At first we borrowed tools and other necessities from the Friends of Trevallyn Reserve but when it became clear that the group would succeed, the LCC bought us everything we asked for in the way of equipment and supplied us with glyphosate that we use on the cut stumps of weed species (the "cut and paint" method).

Apart from weeding targeted areas we use flagging tape to mark out areas that need professional spraying. We have also had one tree-planting day and a second public "flower walk" day in October 2013, with a third open day scheduled for November this year (so that a slightly different group of native plants will be in flower).

On the flower walk days the LCC's volunteer coordinator has organised a barbecue for visitors and volunteers.

Most of our weeds, as might be expected, result from seeds and cuttings introduced from neighbouring properties. Punchbowl Reserve is surrounded on three sides by housing and on the other by the Launceston Golf Club. We have spoken to many of the neighbours and one householder went to a considerable effort and expense to rid his garden of a huge quantity of english ivy that was the obvious major source of an infestation in the nearby part of the reserve. The golf club was clearly a major source of gorse seeds. We had weeded several patches of gorse just downhill from where it was growing inside the golf course. The golf club gave us permission to enter their grounds and remove gorse and cotoneasters from the boundary area next to the reserve.

After nearly two years of monthly working bees we have cleared much of the bushland of weed species although we recognise the need to follow up regularly to remove seedlings germinating from the existing seed bank and to monitor incursions from neighbouring properties.

Many of our enthusiastic members live within a kilometre or so of the reserve and have visited it often over many years. Others are members of the Australian Plant Society and the Launceston Field Naturalists Club who recognise the reserve's natural values and the need to preserve these values.

There are many reasons for the success of the group including the decision to conduct activities at a fixed time and on a fixed day each month, allowing people to schedule their participation well in advance.

Most of our members want to contribute to their community without the need to be involved in lots of paperwork or red tape. The LCC enables this to happen with a simple procedure for insuring our volunteers and by providing our equipment so we do not have to raise money and have a bank account, constitution, audit, and so on. As a result, 100% of our time is productive.

All of our members seem to enjoy each other's company and the learning experience provided within the group. And, of course, our workplace environment is wonderful and, through our efforts, getting better by the month.

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THE VALUE OF MAMMAL MONITORING ON THE FIVE RIVERS RESERVE, BRONTE

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ABSTRACT

A survey of terrestrial mammals was undertaken on the Five Rivers Reserve as part of the 2014 National Bush Blitz program and Save The Tasmanian Devil Program. Motion sensor cameras were installed at 46 sites on roads and tracks across the reserve and collected six weeks later. Camera images were scored according to species presence; their detection rate and a determination of the number of individual Tasmania devils, feral cats, eastern quoll and spotted-tailed quoll was made. A total of 24 vertebrate species were identified from 4,375 fauna images collected over 1,669 trap nights. Of these 15 were mammal species.

A total of 96 days were required to deliver this program at an estimate cost of over $78,378. Volunteers played a critical role in nearly every aspect of program delivery with ten individuals contributing 37% of the total time and labour costs. The challenge is to ensure this monitoring program continues long-term to maximise its conservation value therefore ongoing volunteer involvement will be critical to its success.

INTRODUCTION

The Five Rivers Reserve in Tasmania's Central Highlands is located approximately 15 km northwest of Bronte Park and spans over 11,000 ha. The reserve is owned and managed by the Tasmanian Land Conservancy and protected in perpetuity by a conservation covenant under the Tasmanian *Nature Conservation Act 2002*. It is predominantly eucalypt forest interspersed with a rich and diverse range of alpine and sub-alpine vegetation communities and habitats of high conservation value. In the past the reserve has been subject to various intensities of commercial timber harvesting but retains substantial areas of un-logged and regenerating forest plus many other priority vegetation types, all in varying size and condition (TLC 2014).

To date, 239 fauna species have been recorded on the Five Rivers Reserve, which includes 22 species of mammal, 44 bird, 8 reptile and 3 amphibian species (CofA 2014; TLC 2014). Since the outbreak of devil facial tumour disease the Bronte region, including parts of the Five Rivers Reserve, has become an important monitoring site for the nationally endangered Tasmanian devil (*Sarcophilus harrisii*) by staff from the Save The Tasmanian Devil Program (Devil Facial Tumour Disease Newsletter March 2006, p4). The Tasmanian Land Conservancy seeks to contribute to this program by establishing permanent monitoring sites across its reserve and to help address key questions about the status of Tasmanian devils and other carnivorous mammals in the Central Highlands region.

Nowadays the contribution made by volunteers is critical to the ongoing operation of many non-government and government organisations. Volunteers are integral to the success of the Tasmanian Land Conservancy and collectively their efforts help the organisation protect Tasmania's biodiversity and high conservation value places. In 2012-13 volunteers generously contributed 869 volunteer days to the TLC toward tasks such as managing invasive pests, improving knowledge on threatened species, producing strategic documents, communications, and governance of the organisation (TLC 2013). This paper is an example of the real cost of implementing a fauna research program and the importance of volunteer input.

SURVEY METHODS

In February 2014, 46 Scout Guard SG560Z Zero Glow cameras were installed at sites along roads and tracks across the Five Rivers Reserve. They were positioned 1-2 m above the ground (Plate 1) and a mixture of oats saturated in fish oil and canned fish was used to attract animals to the desired site where a photo could be taken (Plate 2). Cameras were collected in April 2014 and were operational for up to a maximum of 48 nights.

Plate 1. Camera mounted on ultra minipod bracket

After collection, cameras were downloaded, images were catalogued and photos were scored for species presence and their detection rate at each site. The number of different individual Tasmanian devils, feral cats, eastern quoll and spotted-tailed quoll was determined by manually studying images of these species to assess their body markings and other body characteristics at comparable focal lengths and image time sequences. This process is problematic and results in animals of 'known and unknown' identity.

Plate 2. Camera being set up by BHP volunteer with bait pod in the foreground

PROGRAM COMPONENTS

The monitoring program was divided into stages and each stage was evaluated in terms of delivery time and labour required. A day was calculated as 7.6 hours and labour was costed at $35.21 per hour for TLC staff and volunteers based on the current standard volunteer rate endorsed by the Tasmanian government (MMC Link 2014).

RESULTS

Fauna

A total of 24 vertebrate species including a range of mammals, birds and reptiles were identified during the survey from 4,375 fauna images collected over 1,669 trap nights (Bryant 2014). Fifteen species of mammal (Table 1) were recorded including one previously unrecorded species – the long-nosed potoroo *Potorous tridactylus* (Plate 3). The four most commonly recorded species were Bennett's wallaby (46 sites, 558 detections), brushtail possum (42 sites, 364 detections), Tasmanian devil (35 sites, 157 detections) and common wombat (35 sites, 128 detections).

Plate 3. Long-nosed potoroo captured on camera

Tasmanian devils were widely distributed across the reserve at 35 sites, in 383 images and 157 detections. At least 48 individual devils were identified with a further 31 images of animals of unknown status. Tasmanian devil facial tumour disease was detected in devils at six sites by the appearance of large facial swellings beyond what would be considered normal facial scarring (Plate 4). Eastern quoll were captured at 13 sites, on 50 images and an assessment of coat patterns estimated 15 individuals with a further seven animals of unknown status. Spotted-tailed quoll were captured at two sites, on four images and two individual animals were identified. Fourteen individual feral cats (Plate 5) were identified at 14 sites, on 50 images and 31 detections. No evidence was obtained of the presence of the European red fox.

Plate 4. Tasmanian devil with facial tumour disease

Project costs

Table 2 shows the time and labour value invested in the first year of this monitoring program. The project spanned a total of 96 days and 10 different volunteers participated: 8 with camera deployment, 1 with camera retrieval and 1 with photo and data analysis.

It is standard accounting practice to calculate project overheads by taking the cost of labour ($25,689) and doubling the amount ($51,378) to account for expenses such as salary add-ons, office facilities, management costs, travel, accommodation, field consumables and so on. The main equipment cost of the project was the cameras, which were funded by a $27,000 community grant from Save the Tasmanian Devil UTAS Foundation. This means the total cost of delivering the monitoring program in its first year was $78,378. Volunteers contributed 37% of the total time and labour and the UTAS grant supplement the overall project costs by 34%.

Table 1. Mammals recorded during the Five Rivers Reserve survey (e = endemic)

Species	This survey 2014	Total no of detections	Total sites recorded n=46
Tachyglossus aculeatus echidna	photo, seen	10	7
Sarcophilus harrisii Tasmanian devil (e)	photo, scats, den, latrine	157	35
Dasyurus maculatus spotted-tailed quoll	photo, scats	2	2
Dasyurus viverrinus eastern quoll (e)	photo, scats	36	13
Vombatus ursinus common wombat	photo, seen, scats, burrow	128	35
Pseudocheirus peregrinus common ringtail possum	photo	1	1
Trichosurus vulpecula fuliginosus common brushtail possum	photo, scats	364	42
Macropus rufogriseus Bennett's wallaby	photo, seen, scats	558	46
Thylogale billardieri Tasmanian pademelon (e)	photo, seen, scats	171	27
Bettongia gaimardi Tasmanian bettong	photo	2	1
Potorous tridactylus long nosed potoroo	photo	1	1
Rattus lutreolus swamp rat	photo	3	3
Oryctolagus cuniculus European rabbit	photo, seen, diggings, scats	5	2
Dama dama fallow deer	photo, seen, prints, scats	7	3
Felis cattus cat	photo, seen, scats	31	14

Table 2. Monitoring program component costs

Monitoring program component	TLC staff days	Volunteer days
Planning, grant application, equipment purchase and assembly	7	-
Camera deployment (including site travel)	10	20
Camera retrieval (including site travel)	9	2
Equipment cleaning, storage, battery recharge	1	-
Image download, scoring and data entry	18	2
Carnivore pattern recognition - 4 species	1	9
Data collation, maps and reporting	14	3
Total labour investment days ($25,689)	**60 ($16,056)**	**36 ($9,633)**

DISCUSSION

The information collected during this survey has added to the growing knowledge on the vertebrate fauna of the Five Rivers Reserve (CofA 2014; TLC 2014). A diversity of 15 mammal species is typical of Tasmania's high country in areas where mixed forest types, marshland and riparian habitats are interconnected by a network of roads and tracks. However, some obvious gaps in knowledge remain especially for the medium to smaller weight range mammals and particularly arboreal species.

Plate 5. Feral cat captured on camera

The most significant outcome of this work was gaining insight into the abundance and distribution of four of Tasmania's carnivorous mammals. The Tasmanian devil was found to be widespread across the reserve despite the ongoing persistence of the fatal devil facial tumour disease (www.tassiedevil.com.au/tasdevil.nsf/Publications/). The identification of a relatively large number of devils supports the view that a breeding population occurs on the reserve, which is sustained by the expanse of habitat but ongoing monitoring will help track their persistence and conservation status into the future. Fifteen individual eastern quoll were detected during the survey, which is an important finding given this species has recently been nominated for listing on Tasmania's threatened species legislation due to concerns about Statewide population declines (Fancourt et al. 2013). The low number of spotted-tailed quoll detected may reflect either the natural rarity of this species in the area, its large territory size or that its arboreal habits limit it being captured more frequently at ground level. Ongoing monitoring of both quoll species should continue to yield valuable information. The finding of at least 15 feral cats on the reserve provides a start to decision making about the feasibility and most cost effective way of reducing cat numbers and their impacts.

The information obtained during the first year of this program provides a solid framework for ongoing work assuming the program can be maintained. A total of 96 days and over $78,000 of value were invested into establishing this project and even though remote cameras have significantly improved the efficiencies of fauna monitoring (Meek et al. 2014), the time and cost of undertaking this work is not insignificant. Volunteers played a critical role in nearly every aspect of program delivery by contributing 37% of the total time and labour costs and a community grant supplemented the overall project costs by 34%. While some of the procedures will be refined over time, the analysis of images and communication of results will probably remain time consuming. Often the time needed to complete these latter components is underestimated in survey work yet the communication and reporting of results are essential if ongoing investment is to be supported. Volunteers provide an invaluable service by easing the workload and devoting the time needed to complete core tasks. They also invest intellectual capital and wisdom that goes beyond a dollar figure. Without their input, programs such as this would be difficult to deliver let alone sustain in the future.

ACKNOWLEDGEMENTS

The Tasmanian Land Conservancy sincerely thanks the Australian Government for undertaking the ABBRS Bush Blitz 2014 on the Five Rivers Reserve, and also the many scientists and volunteers who participated on that program. We gratefully acknowledge the grant received from the Save The Tasmanian Devil Program UTAS Foundation, which enabled the purchase of the equipment to kick-start this program and to BHP Billiton and the Purves Environment Fund for their sustained support of the Five Rivers Reserve. A great collective effort; sincere thanks to all.

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STIMULATING WHITE GUM REGENERATION IN AGRICULTURAL LANDSCAPES: CAN WE INCREASE HABITAT FOR THE FORTY-SPOTTED PARDALOTE WITHOUT PLANTING?

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INTRODUCTION

The endangered Forty-spotted Pardalote (*Pardalotus quadragintus*) relies almost exclusively on white gum (*Eucalyptus viminalis*) for food and shelter. The decline of this eucalypt species has been identified as a factor in the estimated 60% population reduction of the Forty-spotted Pardalote in the 17 year period between survey efforts (Bryant 2010). Bryant's conservation assessment revealed that a range of age structures, especially senescing trees, are missing from landscapes supporting Forty-spotted Pardalote habitat, especially on North Bruny Island. Hollows in mature white gums provide nesting habitat and young trees contribute to the bird's food in the form of lerps and manna and ensure the long term persistence of its habitat.

This work focused on investigating practical methods for stimulating natural regeneration of white gum to replace young trees in agricultural landscapes. To understand the factors limiting white gum regeneration in the Forty-spotted Pardalote's range, we established two long term studies on North Bruny Island in 2012-2013 (Figure 1).

These studies investigated the following questions:

- can we stimulate white gum regeneration in fragmented woodland remnants?
- can we stimulate white gum regeneration around isolated paddock trees and how far from these trees can seedlings germinate?

Along with filling important knowledge gaps on white gum life history, the first study was designed to offer insights into remnant restoration and improve the set of tools available to land managers for managing eucalypt dominated woodlands. In this study we investigated the application of grazing exclusion (sheep alone, and sheep and native browsers) and a range of competition manipulation treatments including scalping (removing the top layer of soil and plant roots), burning, herbicide spray and addition of wetting agent (to mimic some of the effects of burning when burning cannot be safely undertaken).

The second study was designed to investigate the effectiveness of isolated paddock trees as regeneration nodes in largely cleared landscapes. Encouraging natural regeneration from isolated paddock trees has potential to reduce restoration costs, whilst also increasing restoration success through exploiting local genetic material (Dorrough & Moxham 2005). Isolated paddock trees can act as stepping stones between patches (Fischer & Lindenmayer 2002), particularly for birds with poor dispersal ability, such as the Forty-spotted Pardalote (Woinarski & Bulman 1985). By understanding the distance from the canopy that seedlings are

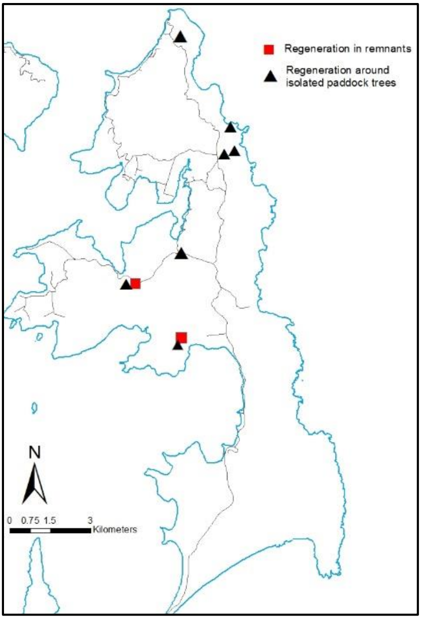

Figure 1. Sites for the regeneration of *Eucalyptus viminalis* in remnants experiment (red squares) and regeneration around isolated paddock trees experiment (black triangles) on North Bruny Island

likely to germinate and establish we can minimise the area taken out of production for restoration whilst maximising white gum recruitment.

In addition to the competition manipulation treatments (tested in the first study), another restoration technique with the potential to assist natural regeneration, harvesting water runoff through micro catchments (Rango & Havstad 2009) or creation of swales was tested in the second study.

Though it is early days yet, 2-3 years into these studies we are able to report trends (rather than recommendations) that can help inform land mangers planning low-cost activities to improve the condition and extent of Forty-spotted Pardalote habitat.

METHODS IN SUMMARY

Regeneration in remnants

To understand factors limiting white gum regeneration in the range of the Forty-spotted Pardalote, a long-term study was established on North Bruny Island in early 2012. In this experiment, we investigated the effect of different grazing exclosure levels (none – the control, sheep only, and complete exclosure) on white gum regeneration in a randomised block experimental design across a total of 30 plots over two sites. In addition, the 30 plots were divided into 120 sub-plots within which we investigated the effect of a range of different competition manipulation methods (none – the control, burning – Plate 1, scalping, spraying herbicide and applying wetting agent) on white gum regeneration at the same sites. In the second year, the burning treatment was applied to 15 of the 30 subplots that were slashed in the first year. Wetting agent was applied once to the remaining 15 sub-plots in year 3.

Regeneration around isolated paddock trees

To understand the capacity of individual isolated paddock trees to function as regenerative nodes, long-term exclosure fences preventing stock and some native herbivore grazing (they were not possum proof) were established downslope from seven isolated white gums across North Bruny Island (Plate 2). In this experiment, we investigated the distance from the canopy edge (0-30 m) that recruitment of white gum seedlings can occur. It also investigated the creation of swales and soil disturbance via cultivation to increase regeneration. The experiment was set up in December 2012.

Along with measuring seedling regeneration (number, height species of

Plate 1. Applying the burning treatment to a stock grazing exclosure

Plate 2. Isolated *Eucalyptus viminalis* in paddock two years after experimental set up

seedlings) we also collected data on life form cover and a number of other variables.

More detailed information on the methods can be obtained from the authors. A map of the locations of experimental sites is provided at Figure 1.

THE RESULTS SO FAR

Regeneration in remnants

In the first year of monitoring (4 months after establishment) 15 white gum seedlings germinated in the trial plots.

However, they were not the most common species observed with a total of 54 eucalypt seedlings observed (including *E. pulchella*, *E. ovata* and *E. globulus*). The average height of the white gum seedlings was 1.0 cm (Plate 3) in comparison to 1.8 cm for other eucalypt species. Of the four competition manipulation methods, scalping resulted in the highest number of eucalypt seedlings and there were no white gum seedlings observed in the treatments with no grazing exclusion.

Plate 3. A *Eucalyptus viminalis* seedling, with cotyledon and the first true leaves, in a stock only exclosure and scalping competition manipulation method treatment combination four months after experimental establishment (image taken June 2012)

In the second year (15 months after establishment) none of the eucalypt seedlings of any species from the first year remained and 13 new seedlings were observed of which ten were white gum. The white gum seedlings had an average height of 2.2 cm (Plate 4). The burning treatment resulted in the highest number of eucalypt seedlings, followed by the scalping treatment. During this monitoring event there were no eucalypt seedlings observed in the plots without the exclusion of grazing.

Three years on, white gum was the most common species observed across all treatments (25 of the 34 seedlings). The white gum seedlings were considerable taller than those observed in the first two monitoring events with an average height of 9.4 cm (Plate 5) and one of the seedlings present at 15 months was observed to have survived between monitoring events. It is likely that many of these white gum seedlings germinated in the spring of 2013, as they were considerably taller than those observed in previous years, suggesting that they had a longer growing period than those observed in the earlier monitoring events.

Plate 4. One of the largest *Eucalyptus viminalis* seedlings observed at 15 months, which was found in a total exclosure and burning competition manipulation method treatment combination (image taken May 2013)

Plate 5. The same *Eucalyptus viminalis* seedling as in Plate 4, in a total exclosure and burning competition manipulation method treatment combination (image taken June 2014)

There were no white gum seedlings observed in plots with no animal exclusion. Interestingly, the highest number of white gum seedlings was observed in the stock exclusion rather than the plots with exclusion of both stock and native browsers (Table 1), although total eucalypt seedling height was higher in the total exclusion. Of the four competition manipulation methods, burning and then scalping resulted in the highest number of eucalypt seedlings of all species (Table 2).

The experiment will be monitored again in 2015, which will allow the survival of the seedlings observed so far to be followed. This monitoring period will also capture any additional eucalypt germination in spring 2014.

Regeneration around isolated paddock trees

There were no new seedlings observed in the first year monitoring (five months after experimental establishment). In the second year, only three of the seven paddock trees had white gum germination, with one tree accounting for 17 of the 21 seedlings. Excluding the one tree that had the most regeneration, the other seedlings were only found in plots with swales. Seedlings were only found in the plots that were within 15 m of the canopy, with the majority found in the first 10 m.

TRENDS RATHER THAN RECOMMENDATIONS

For both studies, low seedling numbers and the high number of plots lacking seedling germination mean that it has been difficult to obtain statistically significant results thus far.

Trends so far suggest that grazing exclusion is essential to reduce browsing pressure and allow for eucalypt germination though interestingly there is no (significant) difference between exclusion of stock and native browsers and stock exclusion alone. While the results to date lack overall significant effect of competition manipulation treatment, the scalping and burning treatment has consistently shown the highest level of regeneration.

These results still tell us little about white gum establishment, as a high level of seedling mortality is apparent between monitoring events. However, the monitoring conducted in 2014 suggests that patience is the key, with the first observation of seedlings that are likely to have survived a summer season. Time will tell if these seedlings do in fact go on to establish in the long-term.

It appears that isolated paddock trees can be used as regeneration nodes, by excluding stock from small areas immediately surrounding the trees. Early results suggest that exclosures that surround isolated paddock trees 10-15 m from the canopy can be used to reduce fencing costs. Results so far indicate that paddock trees surrounded by more native, rather than exotic or modified, ground cover should be targeted as regeneration nodes, to encourage white gum recruitment in the short-term.

NEXT STEPS

The experiment will be monitored again in 2015, which will allow the survival of the seedlings observed so far to be followed. This monitoring period will also capture any additional eucalypt germination in spring 2014.

For practical recommendations to be developed, at least five years of data will need to be collected as land managers are interested in treatments that lead to an increase in the number of eucalypt seedlings surviving over time, not just seedling germination, which has been observed not to be a reliable indicator. For these results to provide information on the best treatment to increase habitat for Forty-spotted Pardalote, monitoring the survival of *Eucalyptus viminalis* up to ten years after experimental set up will be the most informative, as this is the timeframe that *E. viminalis* begin to support this threatened species. The experimental sites are all within close proximity of extant Forty-

Table 1. The total (and mean) number of total eucalypt seedlings, *E. viminalis* seedlings and eucalypt height for each grazing exclusion treatment (n=40) 27 months after establishment (*P*-values were determined by analysing data using ANOVA; means sharing the same superscripted letter are not significantly different at significance level 0.05 using pair-wise t-tests)

Competition manipulation treatments	**Mean number of eucalypt seedlings** (P=0.0348)	**Mean number of *E. viminalis* seedlings** (P=0.0369)	**Mean height of eucalypt seedlings (cm)** (P=0.0206)
Open	0 (0.00^{b})	0 (0.00^{b})	0.00^{b}
Stock exclusion	18 (0.53^{a})	18 (0.45^{a})	$1.35^{a,b}$
Total exclusion	10 ($0.33^{a,b}$)	7 ($0.18^{a,b}$)	3.08^{a}

Table 2. Total (and mean) number of *E. viminalis* seedlings in each treatment in the third year after experimental set up (Regeneration in Remnants)

Treatment	**Open**	**Stock exclosure**	**Total exclosure**	**Total no. seedlings**
Burning	0	4 (0.8)	6 (1.2)	**10 (0.67)**
Wetting agent	0	0	0	**0**
Scalping	0	14 (1.4)	0	**14 (0.47)**
Herbicide	0	0	1 (0.1)	**1 (0.03)**
Control	0	1 (0.1)	2 (0.2)	**3 (0.1)**
Total no. seedlings	**0**	**18 (0.45)**	**7 (0.18)**	**25 (0.21)**

Table 3. Total (and mean) number of *E. viminalis* seedlings in each treatment (Isolated Paddock trees) [n=7]

Distance from canopy	**Cultivation**	**Swales**	**Control**	**Total**
0-5 m	4 (0.57)	2 (0.29)	2 (0.29)	**8 (0.38)**
5-10 m	3 (0.43)	2 (0.29)	6 (0.86)	**11 (0.52)**
10-15 m	0	2 (0.29)	0	**2 (0.1)**
15-20 m	0	0	0	**0**
20-25 m	0	0	0	**0**
25-30 m	0	0	0	**0**
Total	**7 (0.17)**	**6 (0.14)**	**8 (0.19)**	**21 (0.17)**

spotted Pardalote colonies so any establishing *E. viminalis* within the study area will also have the potential to provide habitat for these birds in the future.

ACKNOWLEDGEMENTS

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VOLUNTEER PARTICIPATION WITH THREATENED PLANTS TASMANIA

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INTRODUCTION

Threatened Plants Tasmania (TPT) is a group of volunteers who actively help with the conservation and recovery of Tasmania's threatened plant species. TPT was established in 2008 as a Wildcare Inc. group to assist the threatened species botanists in the Tasmanian Department of Primary Industry, Parks, Water & Environment (DPIPWE). TPT organises and runs a seasonal field trip program within the broad categories of (1) on-ground works; (2) extension surveys; and (3) population monitoring. Recently some volunteers have been involved in *ex situ* orchid propagation at the Seed Conservation Centre at the Royal Tasmanian Botanical Gardens.

TPT has materially improved the resources for its activities by (1) several successful funding applications; (2) partnering with the three Tasmanian NRM Regions; and (3) recent involvement in a Statewide MOU formalising a "Threatened Flora Link" collaboration. Whilst TPT has developed a sense of purpose and key partnerships with related organisations, its success depends critically on the continued participation of a group of volunteers. The TPT organisation also plays a pivotal role in facilitating safe, well organised activities, which requires committed volunteers and a close relationship with our professional partners.

In this paper we compare insights from previous research about volunteer perceptions with results from a survey of TPT volunteers. This leads to discussion about ways that TPT can enhance its policies and activities to encourage greater participation from group members.

BACKGROUND

The *State of Volunteering in Australia 2012* (Volunteering Australia 2012) reports that 36% of the adult population had volunteered in 2010, based on data from the Australian Bureau of Statistics. The number of volunteers had almost doubled in the previous 15 years. However, the total volunteer effort has probably increased by less than 50% because of a decrease in the median number of hours per volunteer in the period 1995 to 2006 (Volunteering Australia 2012).

With such a large amount of volunteer effort available, what are the factors that motivate volunteers to continue their participation with an organisation? Galindo-Kuhn & Guzley (2001) provide a Volunteer Satisfaction Index that identified four factors based on an analysis of 40 measurement items. These factors are: *organizational support*, *participation efficacy*, *empowerment*, and *group integration*. Participation efficacy (i.e. personal ability to make a difference) and group integration (i.e. relationship and time spent with other volunteers) are correlated with an intention to remain with a volunteer organisation.

The *State of Volunteering Report: Tasmania 2010* adopts "the 'three-legged stool' framework, which positions *willing volunteers*, *meaningful roles* and *effective leadership and management* as inter-related and equal elements in a successful volunteer sector" (Volunteering Tasmania 2010). The primary motivation to start volunteering (willing volunteers) in the Environment/Animal Welfare category is "A passion for the activities or services of the organisation". A similar sentiment is highly ranked in the decision to continue volunteering (meaningful roles), together with "making a difference" and "social connections/friendship/networks".

Training was one of three areas selected for in-depth investigation within the third leg of effective leadership and management. Overall, 30% of volunteers expressed a desire for more training than they currently receive, opposed to only 1% who wanted less. There is also discussion about how training is becoming more formal in some sectors, including an aim to provide transferable skills or accredited qualifications.

Ryan et al. (2001) consider volunteers' motivations for continued participation in environmental stewardship programmes in the USA. They find that *helping the environment* and *learning* are the two top-rated motivations, with *good project organisation* and *social benefits* (i.e. meeting new and old friends, having fun) as lesser motivations. BirdLife Australia's *Volunteer Satisfaction Survey Report 2012* (BirdLife Australia 2012) examines voluntary participation in a 'Beach-nesting Birds' project. The factors that drive involvement, in rank order, are (1) interest in conservation and beach birds; (2) learning new skills; and (3) meeting new people.

The literature summarised above focuses on different aspects of a volunteer's life cycle with an organisation, from the initial decision to volunteer, to initial and on-going engagement, to commitment, until the decision is made to end their service. The scope of the literature, varies from the general volunteer to a specific environmental project. Within this broad base, there are broad themes that emerge. Volunteers need to feel that they are making a contribution, with guidance from effective leadership, all the while gaining new knowledge and/or skills within a supportive social context.

METHODS

A sub-group of the TPT committee led the project that resulted in this paper. Having considered some of the prior literature, a survey was developed by three people and subsequently critiqued by an additional two people. The aim of the survey was to seek insights from existing TPT volunteers about their perceptions of participating in TPT activities. The survey sought (1) basic demographic information, including age, gender, number of activities attended, and committee membership; (2) perception of volunteering with TPT overall and of the four types of TPT activity, plus intention to participate in future; and (3) perceptions of personal benefits, leadership attributes and the desirability of potential training topics. The survey was deployed using SurveyMonkey and was only available electronically.

Invitations to participate in the survey were sent to all 209 people on the TPT email list that were not involved in survey development. From TPT records, 46 of these people attended TPT field trips in 2013-14. This group is likely to contain the most useful informants. The five additional members who were involved in developing the survey were asked to complete a separate but identical survey hosted on SurveyMonkey, but these responses have not been used in the analysis.

Participants were provided with a five-level Likert scale to use when answering many of the survey questions, plus a "not applicable" option. In the analyses presented here, the "rating average" is a weighted mean based on the weight assigned to each answer choice on the five-level scale. For example, "Strongly disagree" is weighted 1, "Disagree" is weighted 2, "Neither disagree nor agree" is weighted 3, "Agree" is weighted 4 and "Strongly agree" is weighted 5. In this example, the maximum rating average possible is 5, which indicates that all participants "Strongly agree" and the minimum is 1 when all participants "Strongly disagree".

RESULTS

The respondents

There were 45 responses to the survey from the 209 requests sent out, which is a 21.5% response rate. 40/44 (90.9%) respondents had attended one or more field trips and 36/45 (80%) had attended one or more TPT meetings or other events including training. A large proportion of the 46 people who attended field trips in 2013-14 appear to have responded. Note: Some questions were left unanswered by some respondents, in addition to the explicit "not applicable" response. We use the notation 40/44 to indicate that 44 respondents answered the question and that 40 answered them in a particular way.

The age of respondents (Figure 1) exhibits a bimodal distribution with peaks in the age brackets 35-44 (22.2%) and 65-74 (31.1%). This distribution invites an investigation of differences between *younger* respondents, up to age 54, and *older* respondents aged 55 and older. Overall 26/45 (57.8%) respondents were female and 19/45 (42.2%). were male (Figure 1). 7/41 (17.1%) respondents had served as TPT committee members at some stage (the five people who created the survey instrument have all served on the committee, which explains why the number of committee respondents appears to be low). The majority of respondents, 31/45, (68.9%) belong to Wildcare Inc., the 'parent' body that administers TPT finances and provides insurance.

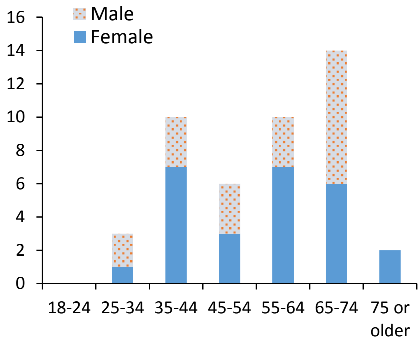

Figure 1. Age and gender of survey respondents

Participation and satisfaction with TPT activities

Respondents were appreciative of their experience of TPT field trips, meetings and other events with 41/41 (100%) rating them as good, very good or excellent and 19/41 (46.3%) rating them as excellent.

On the 5-point scale about perception of enjoyment, the two most positive options are "a lot" or "a great deal". Grouping these two options, the most popular TPT activity recorded was "Extension surveys e.g. searching for plants, counting plants", which was enjoyed by 35/38 (92.1%) of respondents. "Population monitoring i.e. returning to marked plants to make new measurements and observations" was ranked second, with 23/32 (71.9%) enjoying this activity. "On ground works e.g. weeding, installing cages" was enjoyed by 16/33 (48.5%). Laboratory work is a specialised activity carried out by, at most, six TPT members. Since ten people responded to the question, some of them are perhaps indicating how much they would like lab work rather than how much they are enjoying actively participating in it. The equivocal response to lab work is difficult to interpret in this context. Overall, the younger respondents were more positive in their responses to all activities, but the ranking was the same for both age groups.

Reasons for participating in TPT events

Three reasons for participating in TPT events, out of the seven options provided, had the highest rating average (Table 1). In order of rating average, these are: "I feel I am contributing to something useful", "I learn more about the native flora of Tasmania and its conservation", and thirdly "I enjoy being with a group of people who have shared interests". When invited to mention any other benefits from TPT activities, three were provided: photographing plants/orchids, accessing interesting species on private land and countering the aging process.

The effectiveness of TPT leadership

Nearly all TPT respondents 38/39 (97.4%) agree or strongly agree both (1) that their leaders provide adequate support to enable effective participation and (2) that their leaders provide adequate management of risks, hazards and personal safely. There is slightly less support for the statement that TPT leaders "acknowledge my preferences, knowledge and/or skills" with 34/39 (87.2%) agreeing. The six people who did not answer this question had been on no or very few field trips. The overall scores were backed by three comments of appreciation for TPT leaders, such as "*The appreciative attitude of management and crew are all I could wish for!*" One comment referred to a safety procedure that is frequently contentious: "*OHS could be better tailored to individual circumstances – no need for highlighter jackets when working in 50 m*^{2}".

Training and/or mentoring

Respondents differed widely in the extent that they would value training and/or monitoring in the four skills listed. A stand-out 33/41 (80.5%) respondents are positive about possible training in threatened plant recognition/identification. Overall 23/41 (56.1%) are positive about training in the use of a GPS device, but this is much more highly favoured by the older respondents than the younger respondents, who ranked this as their lowest need. Post-trip "paperwork", in the form of collating records for entry into Tasmania's *Natural Values Atlas* and reporting, are the least favoured training options.

When asked if there is any other training, mentoring or recognition TPT volunteers would like TPT to provide, many respondents 9/23 (39.1%) were satisfied with the status quo: "*As long as we continue to keep going in the field with experienced botanists I am happy!*" and "*No I love things the way they are*". Two kinds of extra training were wanted. The first kind, requested by five older respondents, is technical training that enhances computer skills, the use of GPS, geographic information software, data management and the *Natural Values Atlas*. One person made the point that their new skills needed to be reinforced through repetition and that a 'buddy" system might help. The second kind of training, mentioned by four respondents, is in aspects of plant identification: weed recognition and eradication, eucalypt identification and using keys.

The formal recognition of knowledge and skills

Asked whether they would like to see TPT develop a process for formally recognising knowledge and skills like those named above, the majority of those who answered the question, 21/31 (67.7%) said they definitely would, 5/31 (16.1%) said they definitely would not, and 5/31 (16.1%) had reservations. Of the supporters of formal recognition of knowledge and skills for volunteers, one thought that "*a skill set*

Table 1. Survey respondent's reasons for participating in TPT events

Answer Options	Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree	Rating Average	Response Count
I feel I am contributing to something useful	0	0	1	16	22	4.54	39
I learn more about the native flora of Tasmania and its conservation	0	1	1	13	23	4.53	38
I enjoy being with a group of people who have shared interests	0	0	3	15	21	4.46	39
I have a chance to be away from my normal routine.	1	2	10	17	8	3.76	38
It helps with my personal growth	0	1	17	14	7	3.69	39
It helps with my physical fitness	0	4	14	18	3	3.51	39
It helps with my professional development	1	4	16	9	8	3.50	38

bank of some kind would be handy for the committee – to know who they can draw on". Three people thought that formal accreditation might benefit younger volunteers or people who were studying rather than themselves. More of the younger respondents were in favour of having formal qualifications 10/13 (76.9%) than the older respondents 11/18 (61.1%).

Future participation in TPT events or field trips

All 39/39 (100%) respondents said that they would like to take part in future TPT events or field trips. Many were very enthusiastic in their responses, with comments such as "*Yes. Because I feel I am doing something worthwhile and enjoying myself at the same time*" and "*Yes. Nothing beats appreciating and conserving flora in one go like TPT field trips*". Eleven respondents gave reasons why their participation was not greater. Seven of them, spread across the age groups, said their time was limited due to work and/or family commitments.

DISCUSSION

Comparison with related research

The survey respondents from TPT identified three statements that particularly applied to their participation in TPT events: (1) "I feel I am contributing to something useful"; (2) "I learn more about the native flora of Tasmania and its conservation"; and (3) "I enjoy being with a group of people who have shared interests". These correspond closely with the findings from BirdLife Australia's *Volunteer Satisfaction Survey Report 2012*, which also found that a conservation component, a learning component and a social component influence volunteers' participation, albeit with different wording in the survey questions.

Ryan et al. (2001) found three similar factors to be important for ongoing involvement in environmental programs in USA, with 'project organisation' as a fourth factor. TPT volunteers were not explicitly asked whether project organisation played a part in their ongoing involvement with TPT although 97.4% TPT respondents said that leaders provide adequate support to enable effective participation and adequate management of risks, hazards and personal safely. All 45 TPT respondents intend to continue to volunteer with TPT so it is not possible to isolate the factors that promote continuation as Galindo-Kuhn & Guzley (2001) did in their study. However, factors mentioned by TPT respondents for their continued participation in TPT events and field trips include the combination of an enjoyable and a worthwhile activity; the combination of learning experiences and networking opportunities, and the chance to learn more about Tasmanian flora, particularly threatened plants.

Implications for TPT

While there are no obvious causes for concern from the survey results, there are indications of possible areas for improvement or change. TPT leaders can be alerted to explicitly acknowledge volunteers' preferences, knowledge and/or skills. They can also have greater awareness of the prime motivations of TPT volunteers: to contribute usefully, to learn about Tasmanian plants and to be with a group of people with shared interests. With this awareness, TPT leaders can purposefully enhance the experiences of volunteers by, for example, pointing out the results and achievements of each field trip afterwards, by encouraging the botanist on each trip to help participants with the identification of plants in general, and not just those that are the target of the field trip.

The responses about training needs show that there is a lot of individual variation in training needs and it cannot be assumed that "one size fits all". If the survey had asked people to give their current level of expertise it would have given a more meaningful context for their perceived training requirements. The most widely held training need stated, across all age groups, is in plant identification and recognition. For the older age groups, technical skills in the use of GPS, GIS software and the *Natural Values Atlas* were wanted, with plenty of repetition to reinforce the skill.

Plate 5. TPT volunteers lined up to do a population count of juvenile plants of the tasmanian smokebush, *Conospermum hookeri*, at Coles Bay

21/31 (67.7%) respondents, and particularly younger ones, thought that it would be good for TPT to have a process for formally recognising knowledge and skills. The TPT committee ensures that there is a technical leader on each field trip, who is either a professional botanist or the best available amateur botanist. At present, the selection of an amateur botanist is made using an informal process. Formal accreditation for amateur botanists would help in the provision of this much-needed skill for field trips. The other "skills" mentioned in the training question relate to tasks, such as use of GPS that are needed regularly. Again they are provided informally by volunteers at present but formal accreditation would give the committee more confidence in assigning tasks that require these skills.

A precedent for the provision of formal training to accredit specific skills has been set by other volunteer organisations, such as Australian Red Cross and Surf Lifesaving Australia. This has created a desire for this type of accreditation within the volunteer community. The advantage of formal accreditation is that these skills and their recognition form a transparent process that all volunteers can aspire towards. There is a potential spin-off benefit of upskilling more people, who might otherwise sit on the sidelines, and some professional development advantages that transfer to other work situations.

Plate 2. TPT volunteers looking for threatened ephemeral plants including the tiny clustered bowflower, *Millotia muelleri*, at Narawntapu National Park

The mechanism to develop and provide accredited training is problematic. It may be that this could be achieved on the basis of on-going and formal mentoring to gain "experience" rather than "expertise" that is established by formal testing. This is probably the only feasible option for a small organisation like TPT operating alone. Established training organisations may already provide training programs similar to what is needed. Or if the needs are very specific, a national body, like Australian Network for Plant Conservation, is likely to be better placed to invest in any formal training materials and methods that would need a much wider reach to be economically viable. With the ever-growing population of retired baby-boomers, this may be an opportune time to explore the idea of accredited training, especially in a context where paid effort for plant conservation seems to be on an ever decreasing spiral.

CONCLUSION

The results of this survey show that volunteers of Threatened Plants Tasmania who responded are generally very enthusiastic (Plates 1 & 2) about working with other volunteers to conserve Tasmania's native plants. Consistent with the survey and discussion by Volunteering Tasmania, there is significant interest in additional training, especially in plant identification and to a lesser extent in appropriate technical skills. Formal recognition of their knowledge and skills appeal to a majority and this idea could be investigated further.

These results do not raise alarm bells about the leadership and management of TPT and its activities. However, because this issue has been found by other researchers to be of crucial importance for the ongoing satisfaction of volunteers, a future survey could explore questions of leadership and management in greater depth. In the meantime, the TPT committee should keep this issue in mind as a priority for future development of the organisation.

ACKNOWLEDGEMENTS

The authors thank the two other members of the TPT committee, Richard White and

Alison van den Berg, who assisted with the development of the survey. We also thank Dr Magali Wright who provided useful and constructive comments as referee.

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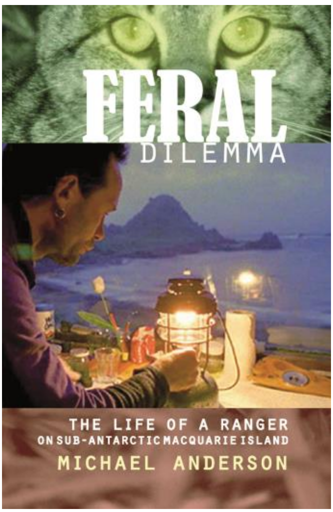
BOOK REVIEWS

Feral Dilemma: The Life of a Ranger on Sub-Antarctic Macquarie Island *by Michael Anderson, Forty South Publishing (2014), softback, 320 pages (ISBN 978-0-9925513-0-8)*

REVIEWED BY: **Janet Fenton**, 102 Wiggins Road, Longley, Tasmania 7150

Macquarie Island, beset by ice-laden gales and pounding seas, was until recently, also beset by feral pests—death to wildlife inhabiting this sub-Antarctic wilderness. Do we have a human responsibility to redress the damage imposed by our past history? If so, how could this be achieved on an island so rugged, remote and inhospitable?



This book is both the personal response of a ranger working to eliminate feral cats in a most challenging environment, and a philosophical probing into this 'feral dilemma'. The book immerses the reader in a world of sub-zero temperatures, gales, stink and struggle contrasted with the glory of an aurora or the majesty of an albatross. The narrative is immediate, raw and colourful, yet sometimes also lyrical. It is a marriage of science and poetry, told by a man who has fallen in love with a wild island.

At times the narrative is an intensely personal memoir. A born field naturalist, Anderson spent many hours as a child lying on his stomach in leaf litter observing nature close at hand. From childhood in Glasgow and Dumfriesshire in Scotland, the experience of the Australian outback for Anderson as a young man was a 'baptism of fire in a world beyond the pale'. He was, nevertheless, drawn to landscapes of even greater extremes: Macquarie Island, followed by the Antarctic. The book 'pays homage to the wild in all its forms' wherever we may find it.

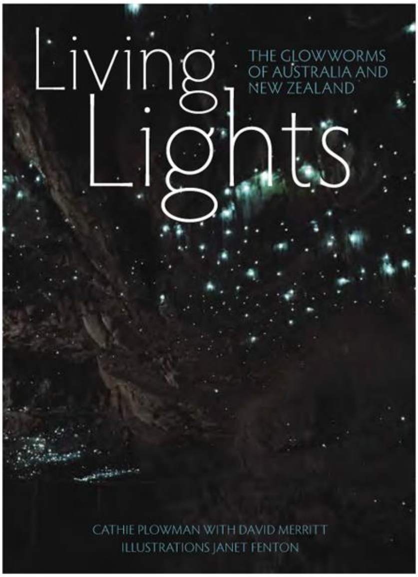
The author's musings are leavened by earthy observations of station life and fieldwork on Macquarie Island on a job that must have seemed next to impossible most of the time. Anderson's observations of wildlife and landscape are brought to life with his own stunning colour photographs. The book is plentifully illustrated, well referenced and indexed.

Living Lights: The Glowworms of Australia and New Zealand *by Cathie Plowman with David Merritt, Deviot (2013), paperback, 44 pages (ISBN 9780646913353)*

REVIEWED BY: **Anna McEldowney**, 'Aberdale', Longley, Tasmania 7150

My first real sighting of glowworms was at Waitomo Caves in New Zealand where you drift silently down the stream in the dark and while I have since seen them at Exit Cave, the Waitomo experience stands out. They don't like crowds and the rules are strict at Waitomo where too much noise can ruin the experience for everyone in the boat.

In *Living Lights: The Glowworms of Australia and New Zealand* Cathie Plowman introduces us to the world of the glowworm. I didn't know for instance that there are different species in different parts of Australia but that the New Zealand glowworm is a single species.



Photographs show spectacular glowworm displays in their cave environment and Janet Fenton continues her special interest in natural history illustration with wonderful drawings of glowworm life cycles, their prey and their habitats.

Directed particularly toward the New Zealand audience (hence the spelling of glowworm) where glowworm tourism is important and interest is high, it also has examples of Queensland caves and Tasmanian glowworm environments where much of the glowworm light research has been done in Marakoopa Cave near Mole Creek.

This book concludes with a section on some of the people who are passionate about glowworms and who either study them or introduce people to their beauty by managing the cave systems where they can be seen.

It is a book for anyone who has seen the lights of glowworms and been entranced.

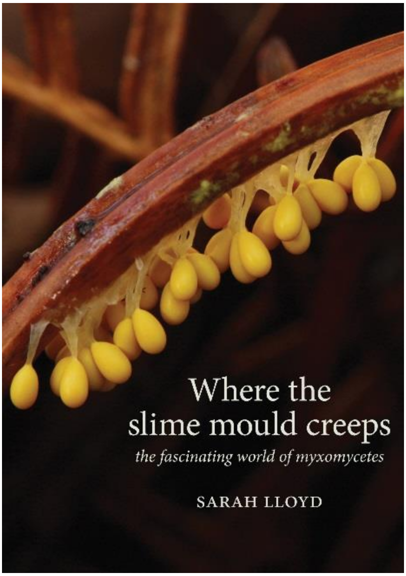
Where the Slime Mould Creeps: The Fascinating World of Myxomycetes *by Sarah Lloyd, Tympanocryptis Press (2014), paperback, 102 pages (ISBN 978-0-646-92451-9)*

REVIEWED BY: **Tom Thekathyil**, Lottah Road, Lottah, Tasmania 7216

Slime moulds would have to rank amongst the most obscure of the common forms of life on earth. Although widely prevalent in most parts of the habitable world they are rarely seen by other than the initiated, and few ever recognise what may be before their very eyes.

The best explanation for this ignorance is the paucity of literature for the beginner. Apart from a short section on myxomycetes in *A Field Guide to Australian Fungi* (Fuhrer 2005) the rest of the available literature is highly technical and forbidding. There has been no widely available hand-held guide available for a complete novice to understand slime moulds.

Lloyd is to be commended for filling this vacuum by publishing what is hoped to be the first of her books on myxomycetes. I have to confess that despite having been familiar with slime moulds for several years it took a draft version of the present book to realise that the plasmodium originates from a single zygote and was not an aggregation of millions of amoeba having a corroboree of sorts.



As the author points out early on, classification of these organisms has long been confusing, variously appearing under botany as well as under zoology. Myxomycota is now accepted as falling under the kingdom Protista, which includes algae (and seaweeds which are not plants).

I found the most useful section of the book to be Part 1, which discusses the biology of these organisms. It makes for slow reading because the unfamiliar terminology requires constant reference to the glossary. However, we have also been provided with images with superimposed text explaining the structure of the fruiting bodies. Part 2 (pp. 45-62) with its informal discussion on various related topics, and the image gallery in Part 3 (pp. 63-90) make for easier reading.

The book is illustrated with a large number of high quality macro- and micrographs. Despite their small size, mainly 55 x 45 mm, the details are very clear.

Having read the book I need to make a second confession, that I am still in the dark about what makes these critters tick. They lack brains but demonstrate forms of intelligence in avoiding obstacles when searching for food in a maze. Researchers have found that the optimal paths used by *Physarum polycephalum* in searching for food in contrived situations are not dissimilar to the network of roads connecting major cities in several countries. This is of course no reflection on the book, merely an observation that we are dealing with complex organisms of which we know little.

The main criticism of the book is the lack of scale for images. Something along the lines of *Mosses and Other Bryophytes, An Illustrated Glossary* (Malcolm & Malcolm 2006) showing scale bars with caption would have been very desirable.

Lloyd's modesty has inhibited her from revealing that one of her discoveries is new to science and has been named after her - *Alwisia lloydiae* Leontyev, Stephenson & Schnittler (publication pending).

The author maintains a log at the http://www.disjunctnaturalists.com/slime-mould-log/ website where further and updated information is available.

This book has the promise of becoming the standard work for beginners in the same way *A Field Guide to Australian Fungi* (Fuhrer 2005) has been for fungi and *A Field Guide to the Mosses & Allied Plants of Southern Australia* (Meagher & Fuhrer 2003) has been for bryophytes. Appendices provide information on classification, a glossary, bibliography and a checklist of Australian myxomycetes.

The book is available from Fullers, Petrarchs and the Devonport Bookstore as well as online through Fungimap.

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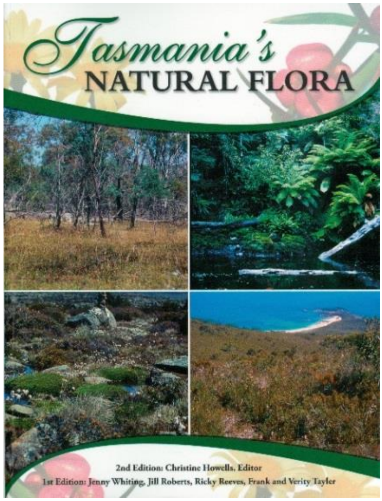
Tasmania's Natural Flora (2nd edition) *Edited by Christine Howells, Australian Plants Society Tasmania Inc., Hobart Group (2012), softback, 431 pages (ISBN 9780909830663)*

REVIEWED BY: **Keith Corbett**, 35 Pillinger Drive, Fern Tree, Tasmania 7054

Tasmania's plant enthusiasts are reasonably well served with books on our flora, with the excellent *Guide to Flowers and Plants of Tasmania* by the Launceston Field Naturalists (now in its fourth edition, 2008), and the useful series of pocket Identikit booklets produced by the Australian Plants Society Tasmania, amongst them. But the *Tasmania's Natural Flora* volume, first produced in 2004 and now available in the Second Edition (2012), is by far the most comprehensive. It is an attractive volume, fairly weighty at 431 pages but still quite 'packable', and is likely to cover all the flowering shrubs and trees you will meet in the wild. It has been carefully edited and updated by Christine Howells – a huge labour of love for the Plants Society.

The volume contains descriptions and colour photos of some 700 species, comprising all 11 of the gymnosperms (conifers), 37 monocots and 652 dicots. Of the monocots, the lilies and irises are covered, but not the grasses, sedges, reeds or orchids (see Mark Wapstra's comments in the previous issue of *The Tasmanian Naturalist* on the books available on our ever-changing orchids).



The species are grouped into families, which are arranged alphabetically, and each family is introduced with a brief description giving its main features and worldwide context. With four species per double page, there are excellent photos and good descriptions of each plant, with details of leaves, flowers, flowering time, fruit, habitat/distribution, cultivation, and distinguishing features. A good summary of the main plant communities/habitats is given at the front of the book, with an excellent version of the vegetation map of Tasmania. There is also a comprehensive index of common and botanical names, and a useful glossary and bibliography.

RRP for the volume is $59.95, and it is available in Hobart at Fullers, Hobart Bookshop, Tasmanian Map Shop, Wild Island Tasmania and the Botanic Gardens Shop; in Launceston at Petrarchs, Fullers, Birchalls and Queen Victoria Museum; Devonport Bookshop; and Not Just Books in Burnie.

The Corbetts use this book constantly, and find it the most useful of the Tasmanian plant books. It's always a pleasure to open and read, and we recommend it to all.

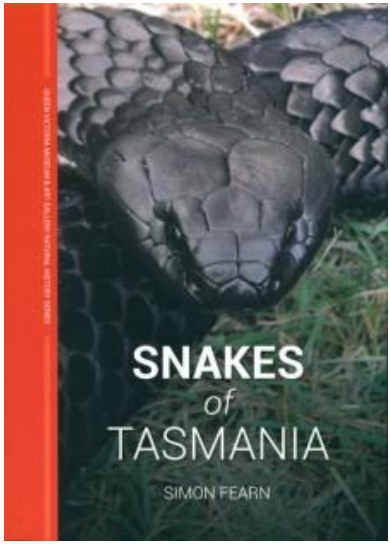
Snakes of Tasmania *by Simon Fearn, Queen Victoria Museum & Art Gallery (2014), softback, 58 pages (ISBN 9780958620307)*

REVIEWED BY: **Mark Wapstra**, 28 Suncrest Avenue, Lenah Valley, Tasmania 7008

I suspect one's natural history persuasion has an element of genetic coding to it. My parents are into orchids and so am I but my twin brother is a world-renowned herpetologist. I think the gene has a switch: reptiles or orchids! Not being able to recognise an orchid may not land one in danger but failing to identify a snake could. At least in Tasmania, this risk is evenly spread as all our snakes are venomous.

The snakes of Tasmania have been included in previous Australia- and Tasmania-based field guides, but have never received their own dedicated book. One might think that with just three species present in Tasmania, a book dedicated to the group would be a bit superfluous. As it turns out, this is far from the case and Simon Fearn's long-awaited *Snakes of Tasmania* fills a niche very well.

Simon is a life-long scientist, naturalist and writer, and many would know him from his various roles in government agencies, museums and his writings in scientific and popular journals and newsletters. His passion for the snakes of Tasmania is obvious in this new book and he has provided the reader with his years of experience and knowledge in an easy-to-read and highly informative product.



Snakes of Tasmania has an excellent section on identification: in fact, I've now correctly labelled some of my snake images! At the end of the day, in the absence of experience, identification can still come down to getting a good look at the head scales but with digital zooms on cameras these days, one need not approach snakes too closely to achieve this. With only three snake species, rather than being laid out species-by-species, the book is divided into logical chapters such as distribution, diet (particularly fascinating), size, and reproduction. There is also of course a section on living with snakes and treatment of bites, although in the preface, Fearn notes that apart from the death of a snake handler with a history of bites, who died of anaphylactic shock at the Brighton show in 1977, there has not been a snake-related death in the State since 1944.

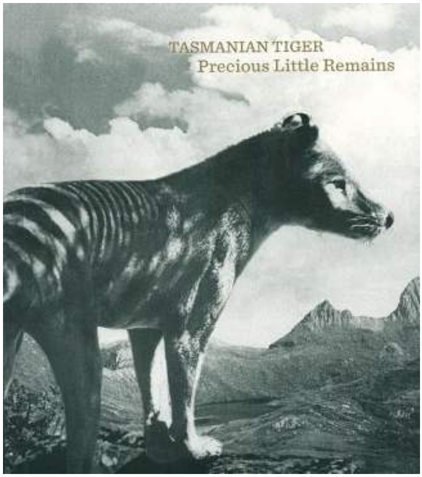
The book is nicely laid out, field guide-sized, and amply illustrated with line drawings (for identification) and colour plates of species, behaviour and habitat. Simon Fearn's writing style is easy and flows well between the useful plates: by the end of the book one has a very good overview of Tasmania's snakes and their role in our ecosystem. I strongly recommend this very well-priced (c. $20) book to field naturalists and visitors to Tasmania.

Tasmanian Tiger: Precious Little Remains *by David Maynard & Tammy Gordon, Queen Victoria Museum & Art Gallery (2014), paperback, 127 pages (ISBN 9780646919638)*

REVIEWED BY: **Amanda Thomson**, 22 Coolamon Road, Taroona, Tasmania 7053

Natural Sciences Curator David Maynard and the Collections Officer Tammy Gordon from the Queen Victoria Museum & Art Gallery present a fascinating journey of thylacine or Tasmanian tiger (*Thylacinus cynocephalus*) knowledge and history.

Compelling graphics, from the front cover thylacine dominating the iconic Tasmanian landscape, to the final ignominious image of an inverted 'tiger' body, dangled by its killers, sum the demise of this once leading predator. Statistics weave together the relationships between diminishing thylacine numbers, the eradication of the Tasmanian Aboriginal people and the rise in number of European settlers and sheep. This is a story of ecological management and balance. Images, poetry, stories and historical material paint a vivid picture of Tasmanian colonial years and struggle in the bush.



From *Precious Little Remains* something precious does remain – a lasting image of the Tasmanian tiger, sadly and recently removed from our land. A sad, poignant story about the loss of what is now a Tasmanian icon.

Recommended? Absolutely!

SPONSORSHIP OF *THE TASMANIAN NATURALIST*

The Tasmanian Naturalist is published annually, with printing and distribution costs sourced directly from membership fees. With ever increasing costs to production and the Club's recent shift to a higher quality presentation of the journal, which includes perfect binding, better quality paper and full colour, the Club now looks for support to offset the higher costs of production each year. In addition, the Club undertook a major project to scan in all articles from *The Tasmanian Naturalist* since its inception in 1907, creating pdf files now available for free from the Club's website – this project was wholly unfunded.

Historically the journal included advertising, and some natural history clubs around Australia do this. However, our Club has preferred to look for sponsorship from individuals, organisation and government departments. The Editor usually discusses potential sponsorship with authors and their affiliated organisations as a matter of opportunity i.e. after articles are accepted for publication following the review process, such that any sponsorship is clearly independent of the review. As such, sponsorship in the last few years has been from groups closely related to some authors, although sponsorship from a broader base is sought.

For any individuals or organisations seeking to support the Tasmanian Field Naturalists Club Inc. through sponsorship of its annual scientific journal, please contact the Editor in the first instance. All sponsors are acknowledged in the Editorial Note at the beginning of the issue and in this sponsor statement (usually with a link to the sponsor's website), and receive hard copies of the journal for their own promotion.

The 2014 edition of *The Tasmanian Naturalist* has been generously supported by the following individuals and organisations (in no particular order or value).

Queen Victoria Museum and Art Gallery [www.qvmag.tas.gov.au]

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ADVICE TO CONTRIBUTORS

The Tasmanian Naturalist publishes articles on all aspects of natural history and the conservation, management and sustainable use of natural resources, with a focus on Tasmania and Tasmanian naturalists. These can be either in a formal or informal style. Articles need not be written in a traditional scientific format unless appropriate for the content. A wide range of types of articles is accepted. For instance, the journal will publish articles that:

- summarise or review relevant scientific studies, in language that can be appreciated by field naturalists;
- stimulate interest in, or facilitate in identifying, studying or recording particular taxa or habitats;
- record interesting observations of behaviour, phenology, natural variation or biogeography;
- stimulate thinking and discussion on points of interest or contention to naturalists;
- put the study of natural history today into context through comparisons with past writings, archives, etc.;
- review recent publications that are relevant to the study of Tasmanian natural history.

Book reviews, web site reviews, poetry and prose and other informal natural-history related content are also accepted. If you are thinking of submitting such material, please check with the Editor first (to avoid duplication of items such as book reviews and for appropriateness of content).

Submission of manuscripts

Manuscripts should be sent to the editor, either emailed to nat.editor@tasfieldnats.org.au or mailed to the Club's address. Feel free to contact the Editor (see the Club's website for current contact details) prior to submission to discuss the format, style and content, or any particular submission issues (such as provision of large illustrations). Formal articles should follow the style of similar articles in recent issues. Informal articles need not fit any particular format (abstract needed only for formal articles). Please refer to the *Guidelines for Authors*, available on the Club's website.

Submissions should be provided in standard word processing format (i.e. .doc file). Please ensure all pages are numbered. Graphs, illustrations or maps should also be provided electronically by preference, generally in TIFF or JPEG format. Figures, especially photographs, should be supplied in high resolution (ideally 300 dpi) to ensure high quality reproduction. The Editor can assist with scanning of illustrations if originals are provided.

The Tasmanian Naturalist is printed in October and distributed to the Club membership and libraries during November/December. Articles, especially those that may require formal review by an external referee, need to be submitted by the end of July to ensure inclusion in the current year's edition. Please contact the Editor to discuss possible articles and the need for review, which may affect how much time is available.

Tasmanian Field Naturalists Club

G.P.O. Box 68, Hobart, Tasmania 7001

Founded 1904

OBJECTIVES

The Tasmanian Field Naturalists Club aims to encourage the study of all aspects of natural history and to advocate the conservation of our natural heritage. The club is comprised of both amateurs and professionals who share a common interest in the natural world.

ACTIVITIES

Members meet on the first Thursday of each month in the Life Sciences Lecture Theatre 1 at the University of Tasmania at Sandy Bay. These meetings include a guest speaker who provides an illustrated talk. An excursion is usually held on the following weekend to a suitable site to allow field observations of the subject of that week's talk. The Club's committee coordinates input from members of the Club into natural area management plans and other issues of interest to members.

THE TASMANIAN NATURALIST

The Club publishes the journal *The Tasmanian Naturalist*. This annual journal provides a forum for the presentation of observations on natural history, and views on the management of natural values, in both formal and informal styles.

MEMBERSHIP

Membership of the Tasmanian Field Naturalists Club is open to any person interested in natural history. Members receive *The Tasmanian Naturalist* annually, plus a quarterly bulletin with information covering forthcoming activities, and the Club's library is available for use.

Prospective members should either write to the Secretary at the above address, phone our President (details on website), or visit our website at: http://www.tasfieldnats.org.au/.

Membership rates

Adults	$30
Families	$35
Concession	$25
Junior	$25

Subscription rates for *The Tasmanian Naturalist*

Australia	$20
Overseas	$25

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