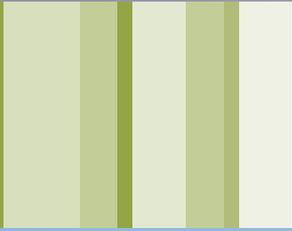


THE ISLANDS OF MACQUARIE HARBOUR

Hamish Saunders Memorial
Island Survey Program 2009

HAMISH SAUNDERS MEMORIAL
TRUST, NEW ZEALAND

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COVER: Narrow cobble beach on the east coast of Neck Island. Photo Paul Donaldson.

INSIDE COVER: Cape Sorell Lighthouse. Photo Brett Littleton.

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DEPARTMENT OF PRIMARY INDUSTRIES,
PARKS, WATER AND ENVIRONMENT

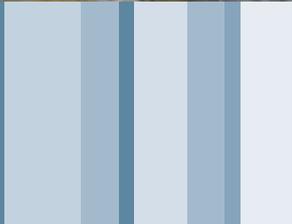
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FOREWORD



The Hamish Saunders Memorial Island Survey Program was established in 2005 as a result of a partnership agreement between the Tasmanian Government and the Hamish Saunders Memorial Trust following the tragic loss of Hamish while assisting in a conservation survey on Pedra Branca, an island about 20 km south of Tasmania in 2003.

The aim of the program is to survey an island each year to collect information on natural values which will contribute to the management and conservation of these islands. The survey conducted in 2009 in Macquarie Harbour was the fourth in a series of multi disciplinary investigations following work on Tasman Island, Three Hummock Island and Prime Seal Island in previous years.

The Hamish Saunders Memorial Island Survey Program provides important information on island conservation but is also a great opportunity for conservation scientists, including two New Zealand volunteers, to visit an island for about a week and work cooperatively to assess the natural diversity of these places.

Islands play an important role in nature conservation given they can be remote and difficult to access providing natural barriers to some threats. Their remoteness also means that there is a lack of data for these places so the Hamish Saunders Memorial Trust Program provides the perfect opportunity to collect information that can contribute to island conservation but also provide a lasting legacy to Hamish Saunders.

Like past surveys the Macquarie Harbour Islands survey has resulted in the collection of a wide range of information which will assist in the future management of these important places.

Alistair Scott

General Manager,
Resource Management and
Conservation
Department of Primary Industries,
Parks, Water and Environment

Hamish Saunders

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

As an explorer, Hamish achieved in his 26 years much of which most only dream. From Antarctica to the Galapagos, Central America, South America, South-East Asia, Europe and Australia, he combined his passion for the

natural world and conservation with that of an interest in local cultures and people. Not only did he travel to these places, but he also took a great interest in the people around him. He touched many lives.

Hamish was a remarkable and talented young man. The passion and enthusiasm he engendered in those whom he met and the gentle leadership he embodied is his legacy. This island survey program is dedicated to the memory of Hamish Saunders and intended as a platform for emerging leaders in marine conservation. The Tasmanian Government's commitment and long-term support for the program was endorsed by the then Minister for Environment and Planning, The Hon. Judy Jackson MHA, on 8 July 2005.

Acknowledgements

The Hamish Saunders Memorial Trust is acknowledged for taking part in the survey. In particular Alan and David Saunders who manage the trust in New Zealand and who assisted with the selection of the two volunteers from New Zealand Briar Hill and Natasha Wilson, thanks to you all.

Chris Arthur, Parks and Reserves Manager, West Coast who suggested the Macquarie Harbour Survey and assisted with the logistics and operational side. His expert boatmanship was also appreciated.

For assistance in the preparation of the geodiversity section, thanks to Mike Comfort, Rolan Eberhard and Jason Bradbury for their editing and comments on drafts; Greg Jordan for his thoughts on plant fossil significance; and all others involved in the islands of Macquarie Harbour expedition.

For flora support thanks to David Storey for his assistance with data analysis, Tim Rudman and Micah Visoiu for their help identifying flora species.

For support in the fauna component, thanks to Bob Mesibov: millipede and centipede identification; Kevin Bonham: snails, collembola identification; Michael Driessen: cave cricket and rodent identification; Lynne Forster: spider and beetle identification;



Fox Eradication Branch for the loan of video cameras; Tracey Hollings for loan of hair tubes; Robert Raven (Queensland Museum): spider identification; Alastair Richardson: isopod and amphipod identification; Michael Rix (Western Australian Museum): *Micropholcomma* and *Hickmanopsis* spider identification; Barbara Triggs: mammalian hair identification; finally Stephen Harris is thanked for his final edit of this report.

Summary of Results

Geodiversity

The islands of Macquarie Harbour are geologically and geomorphologically diverse.

The islands are composed of either poorly consolidated Tertiary gravels, semi-lithified Tertiary sandstone or Cambrian to Precambrian meta-sedimentary basement rocks.

The morphology of the islands are heavily influenced by their lithology, ranging from low-lying gravel islands bound by narrow cobble beaches and extensive marshlands to steep bedrock islands with dominantly cliffed coastlines and rocky shore platforms.

An array of earth features of interest are dispersed throughout the islands, of which a number are to be considered for listing in the Tasmanian Geoconservation Database (TGD).

Biodiversity – Vegetation

A total of fifteen discrete TASVEG vegetation communities were recorded during the survey. Of these 3 were Threatened communities listed on Schedule 3a of the *Nature Conservation Act* (2002). The most significant community was MSP (Sphagnum peatland) as there are only two other known sites for this community at sea level.

A total of 122 vascular flora species from 56 families were recorded across the islands surveyed. The species are comprised of 50 higher plants (7 monocots and 44 dicots) and 13 lower plants. Of the species recorded, 14 are endemic to Australia; 1 occurs only in Tasmania. Eighteen species are considered to be primitive. There were 24 introduced species found with 9 of these being listed weeds. One orchid species was found that was not known to occur in the south west of the state and this discovery has considerably increased the known range of this species. All vascular species recorded are either represented in reserves in each bioregion or are reserved in half the bioregions within which they occur.

Biodiversity - Fauna

One hundred and sixty fauna taxa were recorded during the survey, of which one hundred and thirty-two had not previously

been recorded in Macquarie Harbour. Of the newly recorded taxa, forty-nine were identified to species level and thirty-three were identified as distinct morphospecies, while the rest were identified less precisely. Numerous bird species had previously been recorded in 'Macquarie Harbour', but the survey provided more specific locations for many of these species.

Isopod specimens of the genus *Notoniscus* found on three of the islands were likely to be a new species. The findings also particularly extended the known distribution of two invertebrates: the land snail *Stenacapha vitrinaformis* and the weevil *Mandalotus subterraneus*.

A few exotic species were identified: most significantly, hair tubes collected hair that was confirmed as cat hair on Philips Island, and suspected as cat hair on Cat Island.

A sea eagle's nest was found on Philips Island.

It is recommended that cat eradication is considered, and that disturbance on Philips Island is avoided during eagle breeding season (July to February).



INTRODUCTION



Macquarie Harbour is located on the central west coast of Tasmania. It has a number of islands and islets nine of which were surveyed over a five day period from the 7th to the 11th December 2009.

The overall form and shape of Macquarie Harbour region was probably well developed by about 40 to 50 million years ago in early Tertiary times. Many of the major mountain and valley systems evident today in the area, and in the rest of Tasmania, were probably formed by this time following the breakup of Gondwana. This resulted in the development of the broad valley system now flooded by the harbour's dark waters with sediment provided by the Gordon River and its tributaries eroding highland areas as far away as Lake St Clair and the Vale of Rasselas.

Macquarie Harbour has had a history of being drained and flooded over the last 2 million years as a result of various glaciations and ensuing sea level fluctuations.

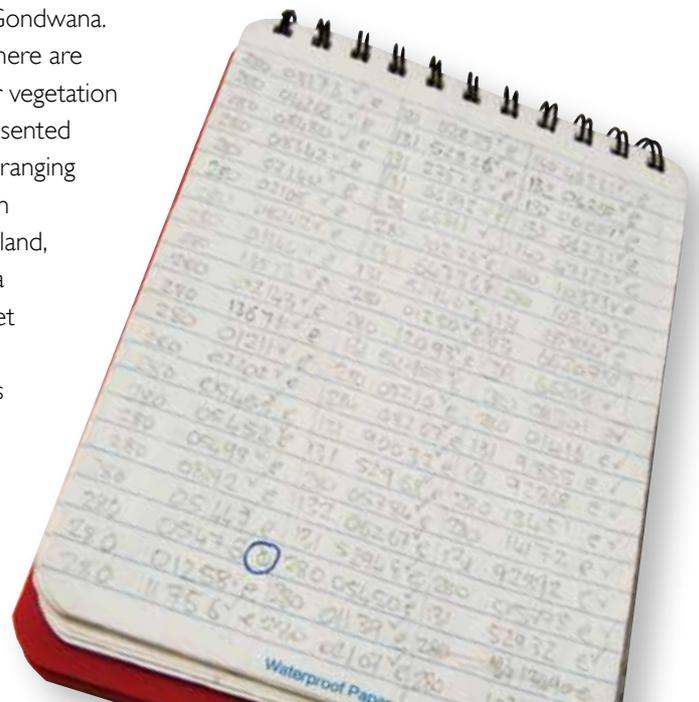
The mouth of the Gordon river was about 20 km out to sea around 20 000 years ago at the height of the last glaciation. Glaciers and small ice caps in the catchment started melting after this and by about 6000 years ago

the harbours current form was in place. This left the islands and coastline we see today.

Many of the plant species in south western Tasmania and around Macquarie Harbour have evolved directly from species that occurred in Gondwana (the southern super continent) about 45 million years ago. The more rugged and mountainous parts of south eastern Australia and in particular Tasmania remained the "most Gondwanan". Here the cool, damp climate remained similar to the temperate forests of Gondwana. However there are many other vegetation types represented in the area ranging from button grass moorland, heathland, a range of wet eucalypt forest types to coastal scrub.

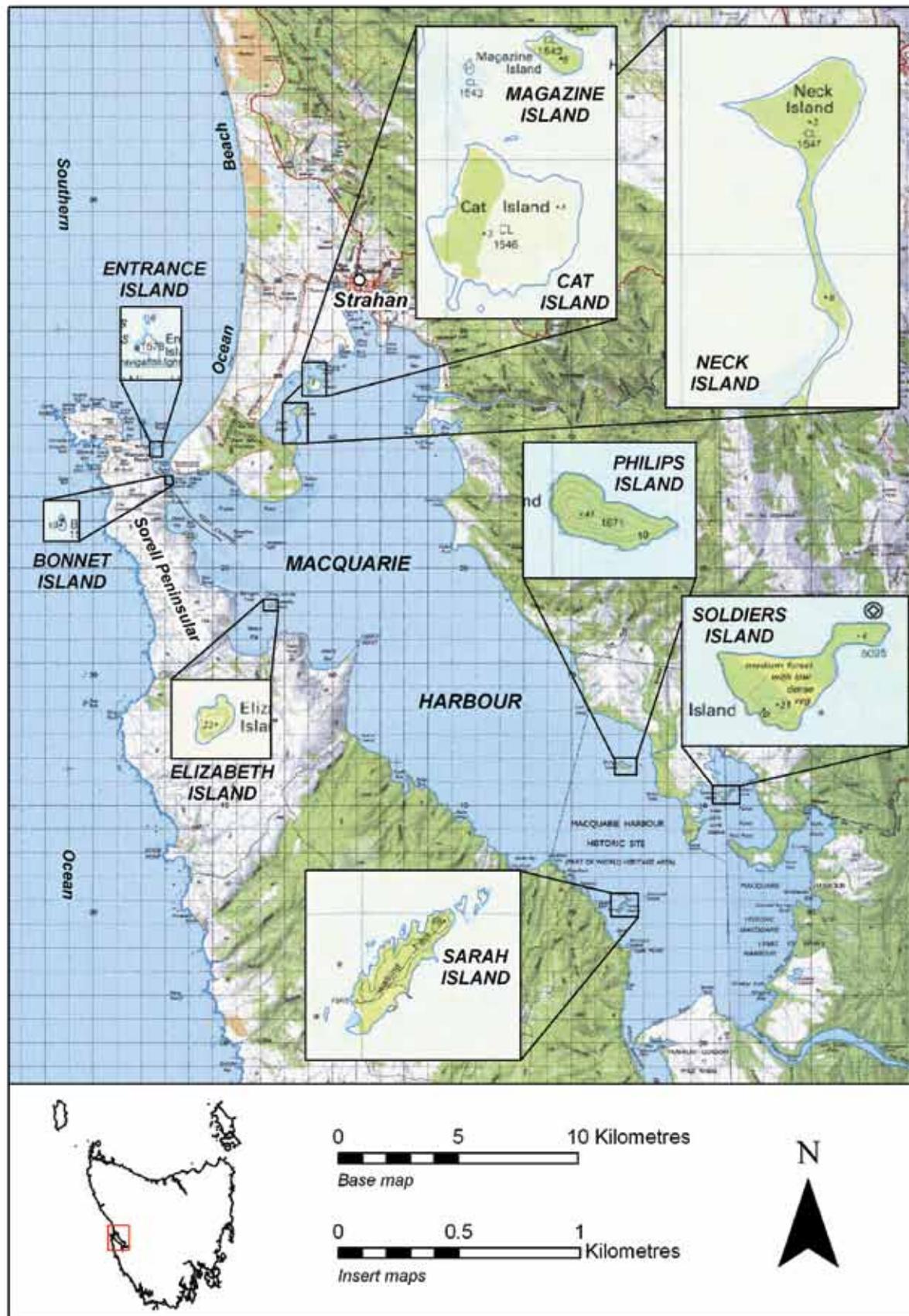
This reflects the complex geology of the area and the climatic variations which occur as a result of proximity to the coast and changing altitudes.

A recent discovery at Port Davey is the Port Davey skate which also occurs in Macquarie Harbour. This species is unique as the world's only brackish water skate, and has its closest relatives in New Zealand and Patagonia again emphasising the Gondwanan link.



Macquarie Harbour islands locality map.

Base map: 1:100,000 map, insert maps: 1:25,000 map (reproduced courtesy of TASMAR, DPIPW).
 Map produced by Paul Donaldson.



With the exception of Sarah Island there has been very limited survey work done on the natural values of the islands in Macquarie Harbour. The Hamish Saunders Memorial Island Survey Program offered an ideal opportunity for a multi-disciplinary group of experts to visit the area to investigate conservation and management needs of these islands.

Macquarie Harbour has a oceanic climate with rainfall spread throughout the year with a mean annual average of about 1500 mm. Daily maximum summer temperatures vary between 18.9 and 21.5°C with overnight minimums averaging between 9.3 and 11.2°C. Winter maximum daily temperatures average between 12.2 and 13.2°C with overnight minimums averaging between 5 and 6.1°C.





NEW ZEALAND
VOLUNTEERS REPORT



Briar Hill

Getting There

I have been studying ecology and conservation for 7 years, and it has always been my plan to take my love for the environment overseas. When I saw an ad for the Hamish Saunders Memorial Ecological Survey, I applied straight away. It was a while before I heard back and as I got more and more distracted with my research, I forgot about the application. This meant that when I did find out that I had been selected for the Macquarie Island trip, it came as a complete and fantastic surprise. At that time I was experiencing some setbacks with my research, and being given the chance to get away and remind myself why it is that I am doing what I'm doing was so invaluable and allowed me to return to my studies full of enthusiasm and with a fresh perspective.

The preparation for the trip happened very quickly, and before I knew it I was landing in Melbourne where I met up with Natasha. We got to know each other before making our way to Hobart, where on arrival we were collected by Mick Illowski and taken back to the DPIWE office to meet everyone and get a briefing on the trip. I was overwhelmed at how welcoming everyone was and how excited they all were about the trip.

We spent the first few days acquainting ourselves with Hobart, including a cruise on the harbour, visiting the weekend markets and going to the movies. We also got taken to the top of Mount Wellington, which allowed us to really appreciate the surrounding landscape. Clare Hawkins, who we were staying with and who



was also organising the trip, got Natasha and I to help with the preparation and packing for the trip; this was fantastic as it gave us a chance to become familiar with the gear that was to be used before getting into the field.

The Island Ecological Survey

Many of the islands within the Macquarie Harbour formed part of the Macquarie Penal Station during the early 19th century, and was known as one of the most notorious and harsh penal settlements. Once closed,



however, the islands were never re-occupied and have been left virtually untouched since the mid 1800's. It is only in recent years that tourism has taken off in the area, with Sarah Island drawing thousands of visitors each year to see the old prisons, and Bonnet Island now open to tourists for penguin viewing. This increase in visitation is a concern as little is known about the ecological, geological and biological value of the islands within the Harbour. The ecological survey undertaken therefore aimed to investigate the flora, fauna and geology of numerous small islands within the Macquarie Harbour. The purpose of this was to establish an inventory to help guide better management and protection of the islands in the face of increasing development.

The weather forecast for the week was not too great, but that didn't dampen anyone's spirits, so on the 7th December the boot clad group of 7 took off from Hobart and drove to Strahan. The drive alone was amazing, getting to travel across Tasmania with some of the most experienced scientists narrating local history, biology and politics in the background. When we arrived in Strahan we were briefed by Chris Arthur (Parks and Reserves Manager; West Coast - the man with ALL the knowledge!), and then it was straight out into the field.

Over a 5 day period eight of the many islands were surveyed by the team of seven scientists. It was the most surreal feeling being on these small islands, knowing that few people had been there and that until then many of the islands had been left untouched by science. Natasha and I were on bug duty. On our first day we were left to it and being New Zealanders, believing that Australia is full of snakes, we walked very slowly and cautiously on that first day. It wasn't until the following day on Philips Island that we observed the others thrashing through the forest and realised we had been a bit too cautious the day before. Lesson learned; we moved a lot faster from then on.

The bush was very similar to New Zealand, with tree ferns creating a canopy above and ground ferns covering the forest floor below, and it was easy to forget where you were until you spotted an enormous *Eucalyptus* tree towering overhead. The bugs also made sure you didn't forget where you were and never in a blue moon did I imagine that I would ever roll around on the forest floor in Australia lifting logs and digging dirt trying to find the biggest blackest spider, and then yelling screams of joy when I did!

By far the most rewarding part of the trip was setting out the motion cameras on numerous islands and then a few days later

collecting them in and finding that we had set them correctly and managed to capture videos to show us what was creeping around at night. The craziest part of the trip was being filmed by ABC, ending up on the news months later, and having an Australian friend of mine call me up to tell me she had just seen me on TV - world famous!

Personal experiences

This trip provided so many amazing experiences, above all meeting the other scientists who participated in the trip from whom I learnt invaluable knowledge and skills; including setting hair traps and camera traps and learning the saying that has now shaped my thesis "*absence of evidence is not evidence of absence*". There was such a vast amount of knowledge, enthusiasm and laughter on the trip that it was impossible not to leave feeling completely rejuvenated and ready to tackle the world. Being a part of this survey has strengthened my desire to take my skills overseas and experience more new and exciting environments beyond New Zealand, and one day to be able to make a significant contribution to the protection of New Zealand's natural heritage.

I owe an enormous thank you to the Hamish Saunders Memorial Trust for continuing Hamish's legacy in this way and

providing this opportunity not only for myself but for those before and after me. It truly is an opportunity of a life time for such young scientists to be able to take their skills and knowledge overseas and expand on them at such an early stage. Thanks are also due to all the people at DPIWE and Chris Arthur who made this trip possible and so enjoyable. In particular to Clare Hawkins for taking us in and making our stay fantastic, and Nick Mooney, who provided us with so much insight into the natural heritage of Tasmania and also the rare opportunity to get up close and personal with devils, quolls and brown falcons. Finally to my volunteer buddy Natasha; thanks for all the laughter on the trip!

Improvements that could be made

It would have been great to have a better brief of the dates for the trip prior to booking the flights. As we were not informed of the survey itinerary until only a couple of days prior to departing New Zealand, we were not able to organise any extended time within Tasmania to explore more after the trip to Macquarie Harbour. This was a shame as it felt very rushed getting back from the field and having only an evening before heading home again. From the Tasmanian end, it also would have been great to have been provided with more resources

on the natural biota to help with identification whilst in the field. Other than that, everything was fantastic!

Natasha Wilson

Six months have passed since I set foot on Tasmania and entered a whole new world. Now whenever I see a stray gum tree or hear an Aussie accent, the memories come flooding back. A whole week was spent going back and forth between islands, collecting specimens and setting traps. As part of the animal species survey team, I helped collect numerous insects in jars (whatever we could find under tree bark, crawling on the ground or flying through the air), searched the ground for burrows and

animal scat (taking photos of any interesting finds and collecting droppings) and set up hair tubes and camera traps.

Every island was unique. With a total of nine islands in the survey of Macquarie Harbour, a diverse array of flora, fauna and topography were found. As part of the animal species survey team, our main priority was to be on the lookout for anything animal, but as our eyes tuned in to all weird and wonderful things we had the pleasure of discovering several delicate tree orchids and observing the amazing bark forms on the various gum tree varieties. Some islands were covered in thick bush that reminded me of any North Island forest, but had the added danger of snakes and spiders.



As foreigners in the land, Briar and I quickly developed a wariness of all moving things. We only saw one small snake on the whole trip though. Spiders kept us on our toes a bit more as we had no idea which ones were poisonous and which weren't. We learnt one thing for certain – never put spiders together in the same specimen jar. Several of our smaller specimens were consumed or well wrapped up by the time we got back to the base in Strahan at night. One particularly large spider attacked its neighbour with its large fangs and we were thankful it hadn't landed on either of us. Who knows what could've happened.

With a full team of zoologists, botanists and geologists it was easy to learn a lot about Tasmanian flora, fauna and topography. Each and every person had something to share. Not only did we learn about the islands, we learnt about Australian wildlife in general. Nick Mooney was particularly keen to show off his nature-bound backyard. We saw Tasmanian devils as part of the breeding program that's in place. We saw wedge-tailed eagles that were preparing for release back into the wild. We saw two different kinds of quoll. And to top it all off, we saw dozens of potoroos and other types of wallaby.

The entire week was one great adventure that guaranteed a wealth of knowledge and conservation ideas for the future. It was a rare insight into the biology of old; the way naturalists made discoveries and documented new lands. Being one of the first to survey an area, like Elizabeth Island, is an amazing thing and not common in the world today. I gained an enormous appreciation for the conservation work that goes on in Tasmania and the difficulties they encounter from both mining and disease.

Clare Hawkins, our lead zoologist, ensured we knew as much as possible about the project at hand and how different trapping methods worked that we hadn't used before. It was my first experience using both hair traps and camera traps but with a quick explanation and demonstration we were ready to go. Many of our camera traps that returned with dark video footage for the night sections were a disappointment but reinforced the need to double-check the setup was working on all cameras.

I learnt many important things from the whole trip. Not only how to set and use new types of traps but also the types of work conservationists may come across in the field. It is exciting to know that there are still places that remain relatively unexplored with

the possibility of extending plant distribution ranges or finding new animal species still exists. With an ongoing interest in conservation and ecological research, I hope to use the knowledge and skills I've learnt to continue the preservation of species for future generations.

Without the support of the Hamish Saunders Memorial Trust, this amazing experience wouldn't have been part of my life. Universities have such a large portion of learning focussed on theories and books that it is easy to forget the field opportunities that lie in wait. What better way is there to understand and expand your knowledge of conservation than to get out in the field and see for yourself? The many differences and similarities that exist between New Zealand and Tasmanian bush make you think that if there are that many different species within similar landscapes, conservation on a global scale really is a diverse field waiting for further exploration, research and management.

I think this program provides the perfect opportunity for young New Zealanders to get out and explore conservation in another part of the world. It is inspirational to work with such a knowledgeable group of people who all share a strong passion for the environment and do their best on a daily basis to preserve it

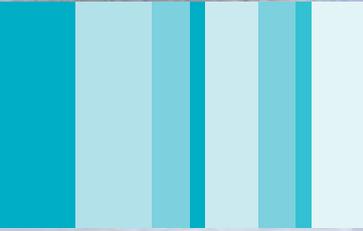
for future generations. It has been a useful and insightful journey that will act as a good foundation for future study and work in the ecological field.

For future volunteers I recommend:

- Providing the opportunity to extend the flight back to New Zealand by a couple of days as many people in the Wildlife Department offered to show us more things and areas of conservation interest if we had time. An agreement could be made for volunteers to meet the costs of any extra day's accommodation and food, and pay for any extra cost incurred with a delayed return.
- Advertising this amazing opportunity in universities, particularly Zoology and Ecology departments

And finally, I would like to thank the Hamish Saunders Memorial Trust, and all of the people involved on the Tasmania side of things as well, for this memorable experience that will set me in good stead for future conservation work and hopefully further research and a life-long career in meeting conservation needs in both Tasmania and further afield. I hope to continue the tradition of passing knowledge onto others in this field, both now and in the future.



A decorative graphic consisting of several vertical bars of varying shades of teal and light blue, arranged in a row.

GEO DIVERSITY



*The Cap Island, Macquarie Harbour.
One of the many small islands
dispersed throughout the harbour.
Photo Paul Donaldson.*

Paul Donaldson

Introduction

Over 25 islands of varying size are dispersed throughout Macquarie Harbour on the west coast of Tasmania. Geologically, the harbour is situated within the Macquarie Graben, a large down faulted structure which formed from regional tectonic activity during the Early Tertiary in association with rifting between Australia and Antarctica (Stacey and Berry, 2004). The Macquarie Graben is bound by uplifted older basement rocks to the south and filled with a thick sequence of semi to unconsolidated Eocene marginal marine sediments (Baillie and Hudspeth, 1989), of an inferred thickness of greater than 500 m (Leaman, 1974). The northwest-southeast trending graben is 10-12 km wide over most of its length. It includes Ocean Beach spit and the general area of Strahan in the north, Macquarie Harbour and its many associated islands within the central basin and extends south of the Harbour, narrowing to 6 km in a southern dog-leg section which includes Birches Inlet (Corbett, 2003). It is both the south-western bedrock boundary of the graben and the sub-aerial exposures of the thick sedimentary infill which comprise the geological base of the Macquarie Harbour islands.

Macquarie Harbour forms Tasmania's largest estuary system with an area greater than 290 km² (Edgar *et al.*, 1999). The mouth of the harbour (Hells Gates) opens into the high energy coastline of the west coast, through a shallow and narrow channel positioned between the northern tip of Cape Sorell Peninsula and the southern end of Ocean Beach spit. The restricted opening results in little ocean swell entering the harbour and a tidal range of less than one metre. The harbour is generally a low energy environment. However a fetch of up to 30 km along the harbours northwest-southeast axis commonly results in the generation of a locally derived choppy wind swell. Currents in the harbour are complex and variable, dominated by the Gordon River in the south and King River in the north (Koehnken, 1996). Evidence for the complex hydrodynamics of the Harbour is seen in the coastal morphology of a number of the harbours island shorelines.

The geomorphology of the Macquarie Harbour islands is variable, ranging from low-lying islands bound by narrow cobble beaches and extensive marshlands, to steep bedrock

islands with dominantly rocky coastlines. The variation between the islands morphology results largely from their geological differences. Broadly, the islands can be divided into three geological groups:

- the suite of north-western islands composed of Tertiary gravels;
- the central-eastern islands composed of semi-lithified Tertiary sandstone; and
- the chain of Cambrian to Precambrian bedrock islands positioned along the south-western shoreline of the Harbour.

Together, these islands comprise an array of geological, geomorphological and soil features of interest, of which only the Sarah Island sea caves are at present recognised for their conservation significance. A number of these features do however warrant consideration for listing in the Tasmanian

Geoconservation Database (TGD).



Methods

A reconnaissance study of the island geology and geomorphology of Macquarie Harbour was undertaken for eight of the harbours largest islands over a period of five days in December 2009. Each island survey consisted of brief field examinations (typically three to five hours for each surveyed island), focussing on the coastline morphology, bedrock exposures, known sites of geoconservation significance (Sarah Island sea caves) and additional features of interest as interpreted through analysis of satellite imagery (e.g. Neck Island tombolo). The islands surveyed were Bonnet, Cat, Elizabeth, Magazine, Neck, Philips, Sarah and Soldiers Island. Access to the islands was by the PWS boat Shearwater.

Results/Discussion

Bonnet Island

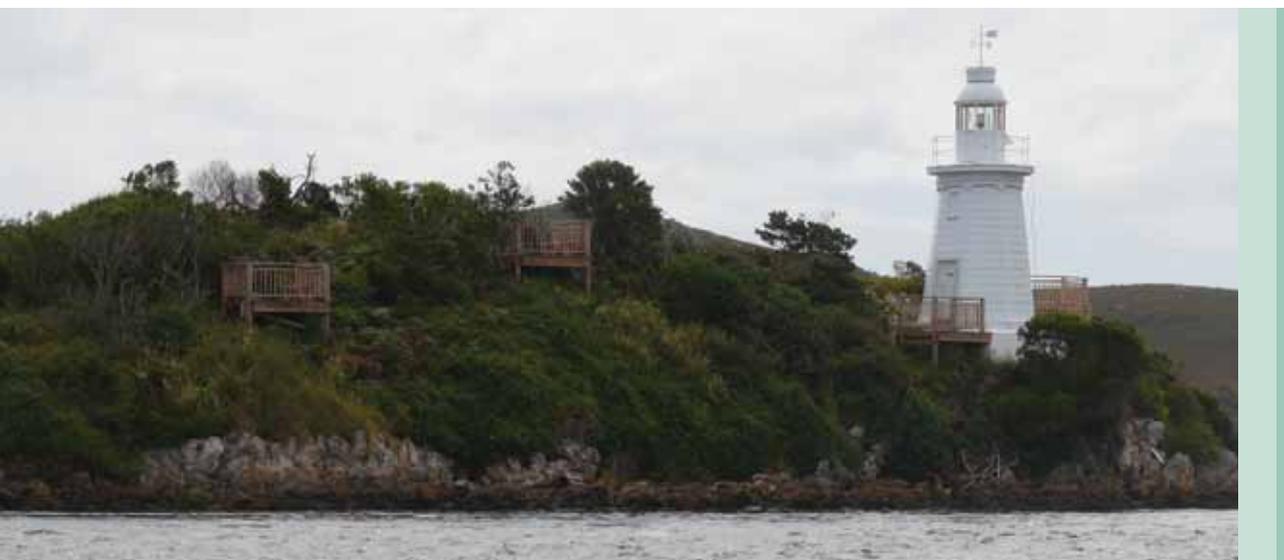
Geology:

Bonnet Island comprises a single outcrop of metamorphosed sedimentary (metasedimentary) rocks. This metasedimentary sequence includes a succession of interbedded metamorphosed quartz sandstone and siltstone, and forms part of the more extensive geological unit that occupies the northern extent of Cape Sorell. This unit is known as the Mesoproterozoic Rocky Cape Group Correlate (Corbett, 2003).

Geomorphology:

Bonnet Island is a small, ovate bedrock island with an approximate north-south axis of 65 m, east-west axis of 30 m and an maximum elevation of 10 m above mean sea-level (MSL). The island's rocky coastline varies from a narrow shore platform with abundant rocky debris, to low-lying cliffs which plunge steeply into the sea. Abundant burrows are found throughout the soils of the island, formed by the resident colony of Little Penguins. The surface morphology of the island centre has undergone both historic and recent anthropogenic modification as a result of historic farming by past resident lighthouse keepers and the recent development of tourist infrastructure that includes multiple viewing platforms and a central gravel pathway.

Bonnet Island, Macquarie Harbour. Photo Paul Donaldson.



Earth features of interest/ significance:

- Herringbone sedimentary structures

Large scale herringbone cross-bedding sedimentary structures are well preserved in the naturally outcropping sequence along the eastern coastline of Bonnet Island. This sedimentary structure formed in a subaqueous environment where tidal currents periodically change direction, thus resulting in the deposition of cross beds dipping in opposite directions. The herringbone

cross-bedding on Bonnet Island was noted by the Geological Survey of Tasmania as “well developed..., large scale (100-300 mm)... and indicative of very shallow water deposition” (Baillie and Corbett, 1985). As such, the outcrop is considered to be of significance for its size, exposure and its representative value for this depositional process. This feature is also indicative of the geological setting for which the metasedimentary Rocky Cape Group Correlate of the Sorell Peninsula was deposited.

Management issues

Observations made across the island suggest that the upgraded walking paths have resulted in the concentration of surface water runoff down slope of the newly gravelled paths. This is likely contributing to the localised erosion which was observed adjacent to the viewing platforms.

Well developed, large scale herringbone cross-stratification on the eastern side of Bonnet Island (note the camera lens cap for scale). Photo Paul Donaldson.



Cat Island

Geology:

Cat Island is composed of a clast supported pebble to cobble conglomerate sequence with a variable sandy component. The unit consists of poorly consolidated, non marine sandy gravels, likely Tertiary in age. Sediments include well rounded, poorly sorted quartzite, sandstone and siliceous gravels. This island forms part of the Macquarie Beds, a thick semi-consolidated sedimentary sequence which occupies much of the Macquarie Graben (Baillie and Corbett, 1985).

Geomorphology:

Cat Island is a low lying irregularly shaped island with an approximate north-south axis of 600 m, east-west axis of 630 m, and a maximum elevation of 4 m above MSL. The island is composed of poorly consolidated sediments, with narrow pebble to cobble beaches to the east and extensive marshland to the west which forms intermittent, irregular marshy embayments. The island's coastline is commonly scarped, providing a local source of sediment to the adjacent cobble beaches. A sandy organic soil layer of varying thickness covers the island. This is well exposed along the scarped shoreline.

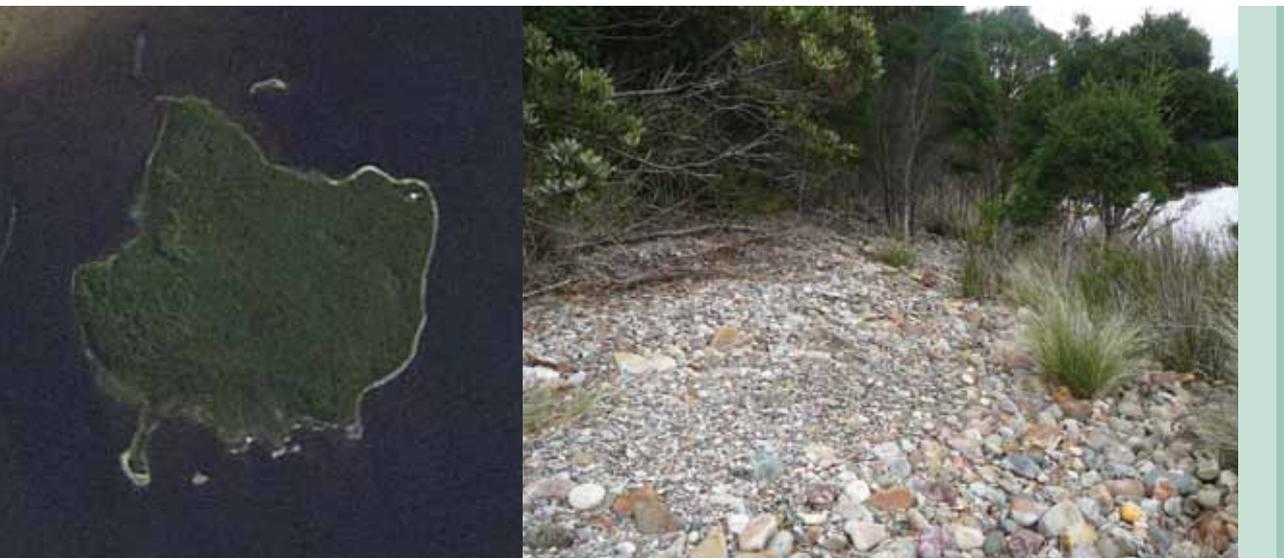
Earth features of interest/significance:

- Cobble spit

A narrow cobble to pebble spit forms at the southern coastline of the island, diverging perpendicularly from the coast for ~100 m. The sediment composition and geomorphic setting of this spit makes this landform unique, as pebble to cobble spits and spits of a sheltered origin are both uncommon landforms in a Tasmanian context.

Left: A satellite image of Cat Island. The non marine cobble spit is located in the south-western corner of the island. (bottom left). 2005 SPOT satellite image, courtesy of TASMAR, DPIPW

Right: Narrow cobble to pebble beach, Cat Island cobble spit. Photo Paul Donaldson.



Elizabeth Island

Geology:

The geology of Elizabeth Island is composed of a deformed siliceous metasedimentary sequence, which forms part of the Cape Sorell Mesoproterozoic Rocky Cape Group Correlate. The geology of Elizabeth Island is structurally complex. The rock sequence is strongly foliated with abundant well formed deformation textures outcropping along the northern coast.

Geomorphology:

Elizabeth Island is a small bedrock island with an approximate north-south axis of 230 m and an east-west axis of 145 m, and rises steadily out of the harbour to an elevation of 23 m above

MSL. The shoreline is mostly steep, descending to a rocky coast with regular boulder size slope deposits. A number of small coves are found around the island, one containing a narrow gravel beach and another housing a small sea cave. The island centre is steep and undulating with a number of well exposed outcrops.

Earth features of interest/ significance:

- Deformation structures

Deformation structures are well exposed on bedrock outcrop throughout the northern coastline. Structures observed include complex folding, quartz vein en echelon arrays and crenulations cleavage. These structures are a striking example of their type and are indicative of

the complex polydeformational history of the region. However, it should be noted that these structures are a common feature of the Rocky Cape Group Correlate (R. Berry 2010, pers. comm.), thus their value is primarily at an aesthetical level.

- Sea cave

The small shallow sea cave on the western coast of the island is a structurally controlled erosional feature. The cave forms a raised and inactive landform at present, with a base of 1 - 2 m above MSL. This erosional feature likely formed at a time when Elizabeth Island was exposed to marine swell and/or at a time of relative higher sea-level.

Elizabeth Island, Macquarie Harbour. Photo Paul Donaldson.





Small, shallow joint controlled sea cave on the west coast of Elizabeth Island (note backpack in left midground for scale). The base of this cave is raised above the high tide mark, indicating that it formed at higher relative sea-level.



Quartz en echelon array at Elizabeth Island. Cavities in the semi-brittle rock form through shear tension as a result of regional deformation. Quartz crystals grow incrementally as cavities are formed. This feature is indicative of a localised shear zone.



Crenulation cleavage development in the metasediments, resulting from multiple deformation events. All photos Paul Donaldson.

Magazine Island

Geology:

Similar to Cat Island, Magazine Island is composed of a poorly sorted conglomerate sequence of the Tertiary Macquarie Beds. Sediments are primarily composed of poorly sorted, well rounded, siliceous pebble to cobble clasts with a variably sandy matrix.

Geomorphology:

Magazine Island is a small, low lying Island with an approximate northwest-southeast axis of 250

m, a northeast-southwest axis of 100 m and an elevation of up to 5 m above MSL. The island coast varies from dominantly narrow south facing cobble to pebble shorelines, to thick organic rich marsh deposits along the northern coast. The island body is largely flat with a thin layer of organic rich soils mantling the surface, interspersed with cobble to gravel size siliceous clasts. These soils are heavily bioturbated in places. Historic shallow earth works and building remains are common in the central west of the island, including handmade bricks and a footing for a building

Neck Island

Geology:

Neck Island is composed of a weakly consolidated pebble to cobble conglomerate sequence within the Tertiary Macquarie Beds. The sequence includes poorly sorted, well rounded, sandstone, quartzite and siliceous conglomerate clasts with a sandy matrix.

Geomorphology:

Neck Island has a unique platform shape, consisting of a central body of approximately 400 m

Left: Narrow cobble beach on the east coast of Neck Island, Macquarie Harbour. Photo Paul Donaldson.

Right: Narrow gravel beach, Magazine Island. Photo Natasha Wilson.



in width, extending south into a narrow neck for over 1200 m. The island is mostly low lying with a maximum elevation of 6 m above MSL. The shoreline line is dominated by long, narrow gravel beaches to the east and thick marsh deposits overlying a gravel base to the west. A blanket of soil and gravel cover the central body of the island.

Neck Island has diverse shoreline morphology. The southern neck of the island forms a thin gravel tombolo which connects the island to the mainland at the distal end of Ocean Beach spit. The northern end of the Island includes a triangular 'cusate foreland' like spit which protrudes west from the islands centre; a set of well developed prograded pebble to cobble beach berms; and a well exposed buried soil horizon, overlain by a gravelly soil mixture. These features are detailed below.

Earth features of interest/ significance:

- Longshore drift derived pebble to cobble coastline.

Neck Island's shoreline comprises two distinctive longshore drift aligned pebble to cobble deposits, including: a narrow, north-south directed tombolo which connects the southerly neck of the island to the mainland; and the near symmetrical, triangular spit like feature, which protrudes west from the main body of the island. The tombolo is approximately 100 m in length, narrows to only a few metres wide and adjoins the recurved hook of Ocean Beach Spit enclosing Swan Basin. This low lying feature is primarily composed of well rounded pebble to cobble sized clasts and is more formally defined as a tie-bar, due to its partial submergence at high-tide (Bird, 2008). The triangular spit like feature has formed by wave/tide action approaching at an angle to

the northeast shore from both a southerly and northerly direction. Individually, these two spit like features are largely uncommon in a Tasmanian context due to their sediment composition (primarily well rounded, siliceous, cobbles), shoreline morphology and formation in sheltered, low energy environments.

- Prograded cobble berm coast.

A set of shore parallel pebble to cobble berms have deposited along the northern coast of Neck Island. The berms form a set of steeply stacked narrow ridges. This depositional feature is a good example of a locally prograding coast, with each berm ridge likely formed in a single depositional (? storm) event.

- Buried soil.

A buried fibrous organic rich soil horizon, overlain by a layer of pebbly soil is well exposed on the eroding west coast of Neck Island. The buried organic soil layer is approximately 15 cm thick and has formed on a pebble to cobble base. This unit is well developed and thus indicative of a significant period of stable paleoenvironmental conditions. The upper boundary of the buried soil forms a sharp, and likely erosional, contact with the overlying deposit, suggesting that the poorly sorted pebbly soil layer was deposited during a high energy (?storm) event. This well

Shoreline erosion at mooring site adjacent the shack at Neck Island.

Photo Paul Donaldson.



Clockwise from top left:

Siliceous cobble to sandy deposits of Neck Island. This poorly consolidated unit comprises a conglomerate sequence of the (? Tertiary) Macquarie Beds. The geology of Cat and Magazine Island comprise the same, or a very similar sequence (note pencil for scale).

Pebble to cobble tombolo, connecting Neck Island to the mainland. Photo is looking south with Neck Island in the foreground, the tie bar in the mid-ground and Ocean Beach spit in background.

Palaeosol overlain by a gravelly soil layer on the north western shore of Neck Island (note pencil for scale).

A set of sub parallel prograded cobble beach berms on the north coast of Neck Island, indicative of a seaward building coastline. All photos Paul Donaldson.



exposed feature is indicative of local paleoenvironmental change.

Management issues

A shack is located within a small cleared area on the island. The human impacts from its use include:

- Local foreshore erosion: A small section of marshy coastline on the west coast

adjacent the shack is obviously used by visitors for mooring boats. This has led to the erosion of the inherently unstable marshy coastline.

- Tree cutting for fire wood. There is evidence for firewood collection within the vicinity of the shack. This is causing degradation of the adjacent bush.

Philips Island

Geology:

Philips Island is primarily composed of a semiconsolidated interbedded sandstone and siltstone sequence with minor coal beds. The basal carbonaceous sandstone unit is well consolidated and highly fossiliferous.

Geomorphology:

Philips Island forms the tallest island within Macquarie Harbour, rising sharply from the shore to a maximum elevation of 41 m above MSL. The island has an ovoid shape with an approximate east-west axis of 530 m and north-south axis of 200m. The northern coast is dominated by a rocky platform composed of fossiliferous carbonaceous sandstone boulders. The southern coastline is dominated by a steep to cliffed shoreline, exposing the semi consolidated sedimentary sequence. Historic earth works and terracing occurs within the island as a result of earlier pig farming practices.

Top: Fossiliferous well consolidated sandstone boulders, with plant stem impressions. North coast of Philips Island. Photo Paul Donaldson.

Bottom: Coalified unit (possible tree stump ?) within a carbonaceous sandstone boulder. North coast of Philips Island. Photo Paul Donaldson.



Earth features of interest/ significance:

- Fossiliferous sandstone boulders

Fossiliferous sandstone boulders form a narrow shore platform along the northern coast of Philips Island. The well consolidated boulders contain fossil flora including plant stems and leaf impressions of which the taxa are unidentified. Tertiary sediments throughout this region are known to be commonly fossiliferous (G. Jordan 2010, pers. comm.), however the age and significance of the plant fossil site at Philips Island is unknown.

Sea caves on the west coast of Sarah Island have developed along plains of weakness within the Cambrian bedrock. Development of this sea cave initiated through preferential erosion of the finer grained (siltstone) sub-vertical sedimentary bed.

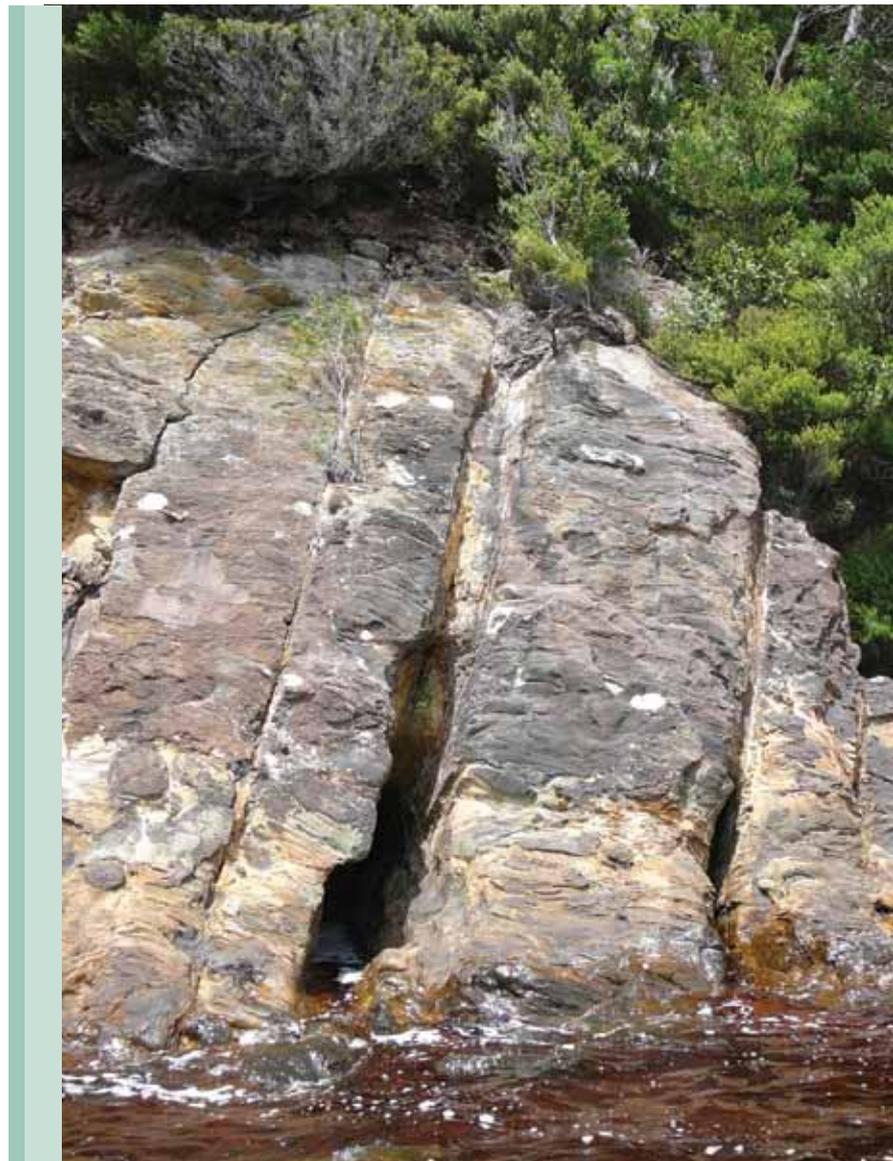
Photo Paul Donaldson.

Sarah Island

Geology:

Geologically Sarah Island is composed of an interbedded siltstone and sandstone sedimentary sequence of Cambrian age (Corbett, 2003). The sequence is predominately

siliclastic, with abundant quartz grains in the sandstone units. The sub-vertical beds are north striking, young to the east and contain regular load structures. Sarah Island forms part of the larger Noddy Creek Volcanics and correlates, a volcano-sedimentary sequence of the eastern Sorell Peninsular region (Corbett, 2003).



Geomorphology:

Sarah Island forms a lensoidal shaped island with an approximately northeast-southwest axis of 650 m, northwest-southeast axis of 165 m and a maximum elevation of 18 m above MSL. The island's morphology is structurally controlled with the north striking, sub-vertical sedimentary beds forming abundant northerly facing coves which back onto a north trending hilly terrain. The island has a predominantly steep rocky coastline, with minor sandy beaches located on the southeast coast. The northeast coast comprises plunging rocky cliffs with interspersed with deep narrow coves, rocky shore platforms and cobble to boulder deposits. A sea arch and multiple sea caves of varying sizes have also formed along this coastline (detailed below).

Sarah Island has the longest history of human occupation of the Macquarie Harbour islands, and as such, exhibits the most modified landscape of the islands visited at Macquarie Harbour. Deforestation, building construction and general earthworks including terracing and quarrying occurred throughout the history of the Sarah Island penal station in the early to mid 1800's. Many historic remains of the infamous settlement are present today.

Earth features of interest/ significance:

- Sarah Island Sea Caves

Multiple sea caves of variable size and morphology are located on the west facing coast of Sarah Island. The geometry of the many caves are structurally controlled, largely forming along the north striking sub vertical bedding plain of the outcropping geological unit. The Sarah Island Sea Caves were initially reported by Bradbury (pers. comm. 1995, in Dixon, 1996) and have been subsequently listed in the Tasmanian Geoconservation Database as an outstanding geomorphological site of local significance (Dixon, 1996). The most well developed cave of the island will be briefly described below.

The largest and most geomorphologically diverse sea cave on Sarah Island is approximately 20 m long, 8 m wide and is located at the foot of a steep sea cliff approximately 1 - 2 m above MSL. Two west facing entrances access a long, linear, low lying passage which is orientated in a northerly direction. Collapse of the outer cliff has partially covered the southern entrance and adjacent floor of the cave. The remainder of the cave floor is mantled by layer of organic matter, including soil and abundant woody debris. Large cave crickets were observed on the roof of the main

passage including species of the genus *Micropathus* (M. Driessen 2010, pers. comm.).

An array of secondary mineral coatings and crystal growths of varying mineralogy, colours and textures have formed throughout the cave, including a ferruginous drip water speleothem, multiple small radiating needle like crystal growths (frostwork speleothem) and abundant small nodular concretions of unknown mineralogy. The formation of these types of secondary features in a non carbonate geological unit is an unusual phenomenon and thus contributes to the conservation significance of the Sarah Island Sea Caves.

- Sea Arch

A sea arch is located within the central western coast Sarah Island. This feature consists of a rounded 2 m wide, 3 m long, opening through the sandstone sea cliffs. Tafone ("honeycomb") weathering has developed on the internal walls of the arch, forming cavernous weathering hollows of variable size. Sedimentary structures are well exposed on the outer wall of the arch. These structures are common throughout the island (discussed below).

- Sedimentary structures

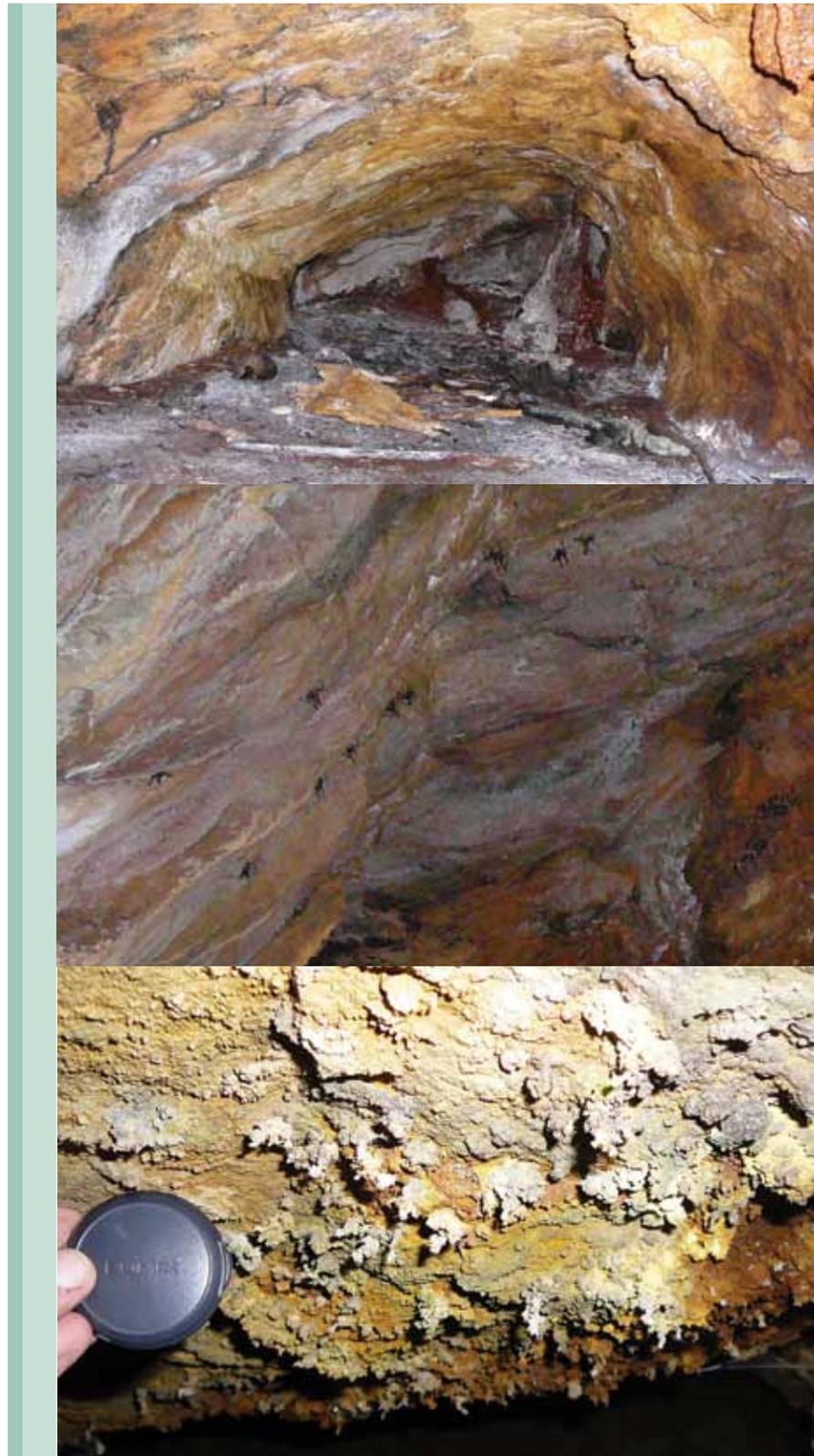
Sedimentary load structures were regularly observed along

the Cambrian interbedded silt to sandstone sequence, on the west coast of Sarah Island. Load structures form at the time of deposition as a result of differential soft sediment compaction. Flame structures are a specific type of load structure which are common throughout the sequence, resulting from an injection of the underlying finer bed up into the overlying coarser bed during compaction. These structures are indicative of both the depositional environment and younging direction of the sedimentary sequence.

Top: Main passage of largest sea cave at Sarah Island. Note the ferruginous speleothem in the top right of the photo.

*Middle: Cave crickets, including the genus *Micropathus*, on the roof of the large sea cave, Sarah Island.*

Bottom: Sub centimetre frostwork speleothems (middle of photo) and nodular concretions (top right of photo) of unknown mineralogy, on the roof of the large Sarah Island sea cave. All photos Paul Donaldson.



Soldiers Island

Geology:

Soldiers Island is composed of semi consolidated sandstone sequence which forms part of the greater Macquarie Beds. The sequence dips slightly to the north and is well exposed along sea cliffs at the southern tip of the island.

Geomorphology:

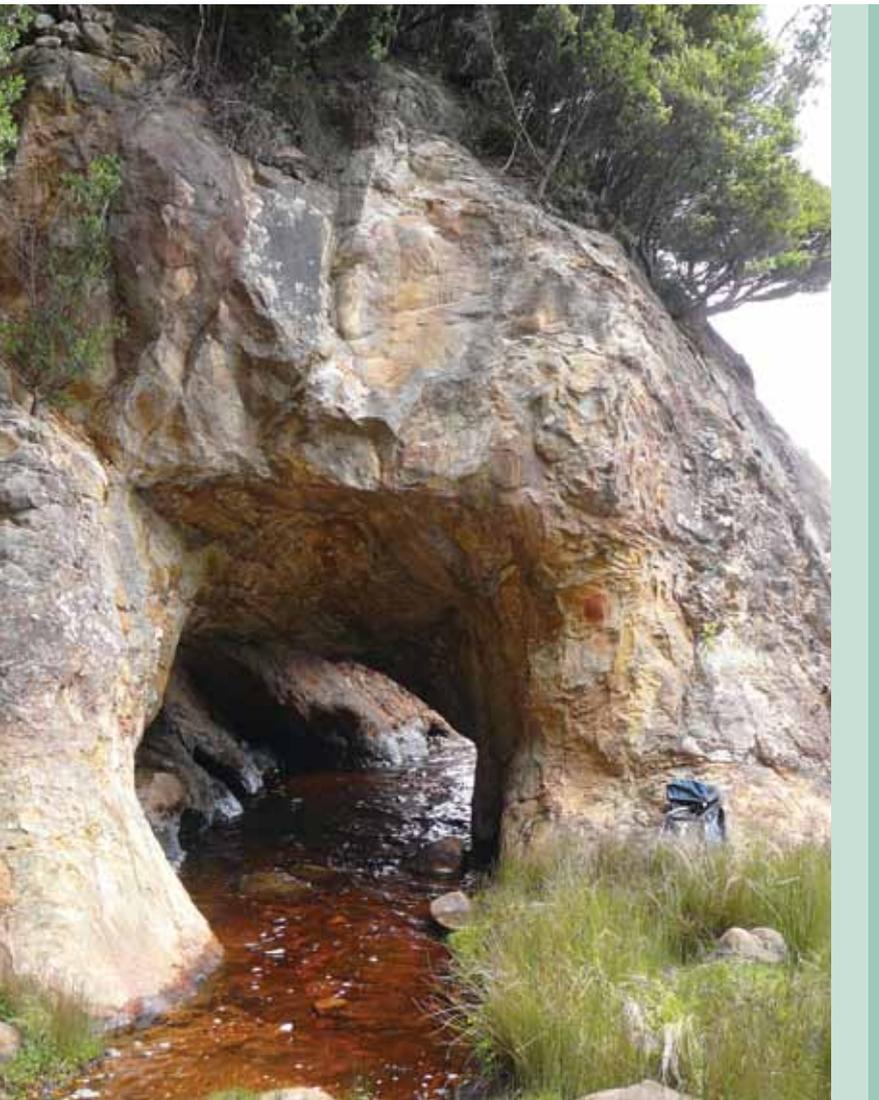
Soldiers Island has a unique duck like planform, up to 700 m long on a northeast–southwest axis and up to 450 m wide. The terrain is low lying in the north and rises steadily in the far south to a maximum elevation of 21 m above MSL. The island is largely fringed by coastal marsh deposits, however, tall sub-vertical sea

cliffs dominate the south west coastline. The semi consolidated sediments which make up the island show signs of structural instability, with wide spread slumping commonly observed along the cliffed shoreline. A number of intertidal sea notches have formed in the south eastern cliffs.

Earth features of interest/ significance:

- Soldiers Island intertidal notches

A number of intertidal notches have been cut into the semi-consolidated sandstone sea-cliffs at Soldier Island. The series of notches were observed locally along the southeast coast at varying levels within the present tidal range. The abundance of notches observed within a small area along the cliffed coast suggests that further notches may be present along the Soldiers Island coast. Intertidal notches have been widely used as a geomorphic indicator of past relative sea-levels. As such, this coastline warrants further investigation.



*Sea arch, Sarah Island.
Photo Paul Donaldson.*

Conclusion

The islands of Macquarie Harbour are geologically and geomorphologically diverse. The geodiversity of the islands are attributed to a combination of variable lithology and structure of the underlying geology and on past and present geomorphic processes. Broad geomorphic similarities are readily observed between the islands of a similar geological composition. These include:

- The longshore drift aligned coastlines have formed in the low lying, unconsolidated Tertiary gravel islands, including Neck, Cat and Magazine Island;
- The gently northerly dipping strata of the semi-lithified Tertiary sandstone Philips and Soldiers Island, has resulted in an east-west strike ridge dominating the topographic highpoints of the island as well as the formation of steep and actively cliffing shorelines along sections of their southern coast.
- The rocky shore platforms steep plunging bedrock cliffs and structurally controlled earth features (e.g. sea caves) are common to the Cambrian to Precambrian bedrock islands, including Bonnet, Elizabeth and Sarah Island.

The similarities within and diversity between each group, highlight the influence of underlying geology on the islands geomorphology, most notably their coastal morphology.



Above: Load structures in the Cambrian sedimentary sequence, resulting from differential soft sediment compaction at the time of deposition. Here the underlying finer unit (bottom) has injected into the overlying coarser sand unit (top) in a flame like pattern (note hand lens for scale).

Left: Intertidal notches cut into the foot of the semi-consolidated sandstone cliffs at Soldiers Island. Photos Paul Donaldson.

The number of features identified during the island survey indicate that the Macquarie Harbour islands have a geomorphic history which includes both past and present processes. For example, the well developed and slightly raised sea cave at Sarah Island suggests that the islands present shoreline morphology has formed over a period which predates the present sea-level. The age of the caves are not known, however their formation presumably dates back to at least the last interglacial stage. Locally raised coastlines are also known to also exist within the greater Macquarie Harbour region, including relic beach deposits within the Ocean Beach spit which have been attributed to a last interglacial age (Banks *et al.*, 1977). The more recent geomorphic features of the islands, including the pebble to cobble beaches and marshy coastlines, have however formed in their present state since the culmination of the rising sea-level to its present level some 6000-7000 years ago (Lambeck and Nakada, 1990; Sloss *et al.*, 2007). Much of this younger coastline shows evidence for continued reworking (e.g. Neck Island buried soil horizon), due to the combination of locally derived waves, tidal fluctuations and variable harbour currents, indicating that the islands coastlines are continuing to evolve.

Management Recommendations

Tasmanian Geoconservation Database (TGD) recommendations:

The geodiversity of the Macquarie Harbour islands include a range of geological and geomorphological features which are well developed, uncommon and/or of potential scientific significance. As such, a number of earth features identified throughout the 2009 Hamish Saunders islands survey are deemed worthy of nomination for listing within the TGD. These features/sites are listed below.

- Neck Island's coastal geomorphology. The island as a whole should be considered for listing due to the diversity of coastal features which have formed in a sheltered environment.
- Fossiliferous sandstone boulders on Philips Island. These fossil rich boulders have the potential to be of geological significance, to help better constrain the deposition history of the Macquarie Harbour Graben.
- Cat Island cobble spit. The Cat Island spit is an uncommon geomorphic feature at the regional scale.

Also, the current Sarah Island sea caves listing should be updated with additional descriptive information as detailed in this report.

The following recommendations are made in relation to a number of the management issues identified in the field:

- The present shoreline erosion observed on Neck Island should be documented/mapped and any further erosion monitored. If erosion continues, consideration should be made into the construction of a low impact mooring structure.
- The impact from surface water runoff from the newly gravelled pathways at Bonnet Island should be monitored, as there is the potential for an erosion issue to develop.

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