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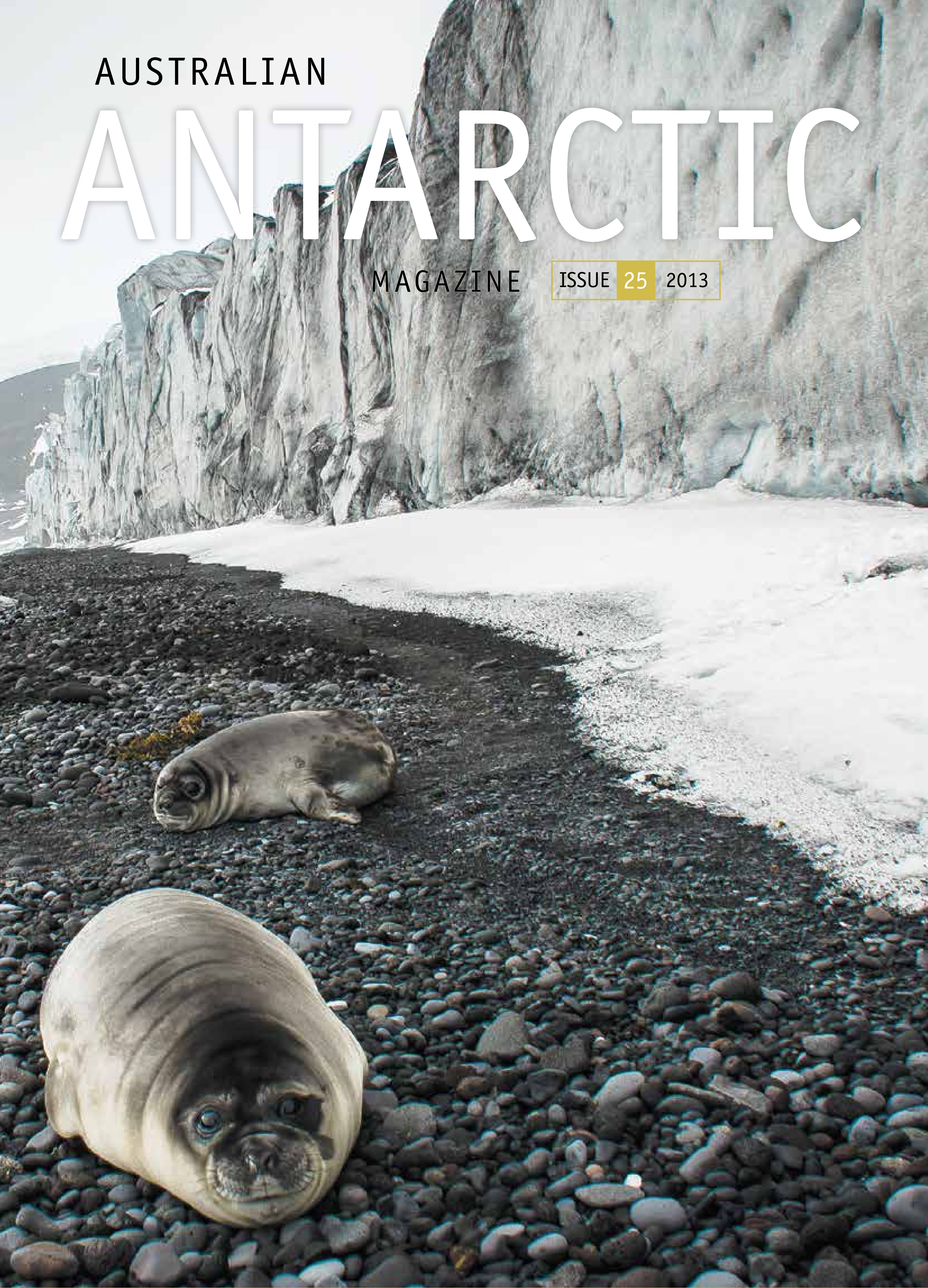

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The Australian Antarctic Division, a Division of the Department of the Environment, leads Australia's Antarctic program and seeks to advance Australia's Antarctic interests in pursuit of its vision of having 'Antarctica valued, protected and understood'. It does this by managing Australian government activity in Antarctica, providing transport and logistic support to Australia's Antarctic research program, maintaining four permanent Australian research stations, and conducting scientific research programs both on land and in the Southern Ocean.

Australia's Antarctic national interests are to:

- Preserve our sovereignty over the Australian Antarctic Territory, including our sovereign rights over the adjacent offshore areas.
- Take advantage of the special opportunities Antarctica offers for scientific research.
- Protect the Antarctic environment, having regard to its special qualities and effects on our region.
- Maintain Antarctica's freedom from strategic and/or political confrontation.
- Be informed about and able to influence developments in a region geographically proximate to Australia.
- Derive any reasonable economic benefits from living and non-living resources of the Antarctic (excluding deriving such benefits from mining and oil drilling).

Australian Antarctic Magazine seeks to inform the Australian and international Antarctic community about the activities of the Australian Antarctic program. Opinions expressed in *Australian Antarctic Magazine* do not necessarily represent the position of the Australian Government.

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Australian Antarctic Division

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ABOUT THE COVER

These two young elephant seals were photographed on Heard Island in November 2012 by Dr Matt Curnock, a research officer with CSIRO Ecosystem Sciences, based in Townsville. Matt was part of a tour group visiting the island with Heritage Expeditions. The young seals (weaners) are pictured on the volcanic rocky shore of Corinthian Bay, in front of the retreated edge of the Baudissin Glacier. Read more about the Heard Island trip on page 27 and see more of Matt's photographic work in Freeze Frame on page 37.

Speeding towards an acid ocean

Ocean acidification is occurring faster than expected in Antarctic coastal waters, according to new research by PhD student Nick Roden from the Institute for Marine and Antarctic Studies (IMAS) and CSIRO.

The study, published in the journal of *Marine Chemistry* in August, is the first to observe changes in seawater acidity over decadal time-scales (16 years) in East Antarctica.

Ocean acidification results when atmospheric carbon dioxide (CO_2) is absorbed by the ocean, causing chemical changes in the seawater. These changes affect the ability of some marine organisms to form shells or other hard structures made of calcium carbonate ($CaCO_3$).

Nick's research shows that changes in acidity over the past 16 years are nearly twice as large as those expected from atmospheric CO_2 uptake alone.

'The surprise was that the change in the acidity level was so large, indicating that natural and human induced changes have combined to amplify ocean acidification in this region,' he said.

Nick spent a year at Davis station in 2010–11 collecting seawater samples from Prydz Bay. He then compared the chemistry of these samples with samples collected at the same location between 1993 and 1995 by former Australian Antarctic Division scientist Dr John Gibson.

To measure changes in acidity between the sample years, Nick compared winter pH values. Winter measurements were used because of the high variability in water chemistry in spring and summer, caused by rapid and large-scale phytoplankton growth as light increases and sea ice breaks up.

'The mean winter pH value in 2010 was 0.11 pH units lower (more acidic) than the mean winter value in 1994,' Nick said.

'The expected decrease in pH from 1994 values, if the surface ocean CO_2 uptake tracks the atmospheric CO_2 increase, should be 0.04. This indicates that ocean CO_2 uptake is not the only process affecting carbon cycle dynamics on the shelf environment and driving pH changes between 1994 and 2010.'

Because the coastal waters around Antarctica support iconic ecosystems of great conservation value, the change observed in this study is concerning, as it may accelerate the impact that ocean acidification will have on food webs in this environment.

Previous studies have suggested that if future CO_2 emissions continue unabated, Southern Ocean waters could become corrosive to some calcifying organisms by the year 2030.

'The study highlights the importance of long-term observational programs and the need to understand how future climate related changes will influence ocean chemistry in this area,' Nick said.

Read more in *Marine Chemistry* at www.sciencedirect.com/science/article/pii/S0304420313001370

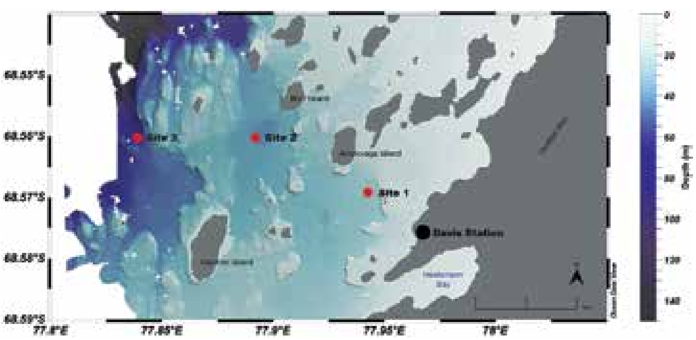
WENDY PYPER[1] and CRAIG MACAULAY[2]

1 Australian Antarctic Division

2 CSIRO

1. This map shows the location of Nick's three seawater sample sites in Prydz Bay. The samples were collected after drilling through 1.5 m of sea ice, at depths of 20, 30 and 75 m below the ice. Site 1 was previously sampled by Australian Antarctic Division scientist John Gibson between 1993 and 1995. (Roden et al. *Marine Chemistry* 155: 135–147, 2013)

2. This graphic shows changes in the pH of seawater in samples collected in 1993–95 (blue line) and 2010–11 (red line). The dashed line shows the predicted response of pH assuming that ocean acidification was the only process controlling carbonate chemistry in Prydz Bay. (Roden et al. *Marine Chemistry* 155: 135–147, 2013)



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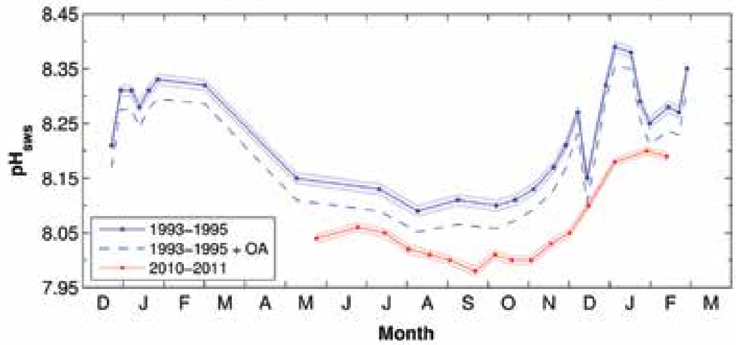


2

Symphony of science

Nick Roden's Southern Ocean research (see previous story), and that of fellow PhD student Rob Johnson, has been the inspiration for a symphony, written by Tasmanian composer Matthew Dewey, and recorded by the Czech National Symphony Orchestra.

Both Nick and Rob are the 2012–13 Lynchpin Scholars – a private scholarship program developed to promote the significance of the ocean to life on the planet.

The 45 minute symphony, *ex Oceano – we are from the ocean – the ocean sustains us*, is central to Lynchpin's program of arts/ocean science collaborations, which aim to bring ocean science to the wider community in new ways. The recording will be available in early 2014 on iTunes and by limited edition CD.

Inspiration for the symphony came from a series of essays written by Rob, about how the Southern Ocean works, its importance to the planet and to humans, and how the function of the ocean will change as a result of climate change. These essays included findings from Rob's research on Southern Ocean phytoplankton (see next story) and Nick's work on ocean acidification. Matthew was also given a recording of Rob reading one of his essays. Using these materials Matthew was able to respond to the Southern Ocean story in musical form.

In September Nick and Matthew visited Prague to film the recording by the Czech National Symphony Orchestra in the famous Rudolfinum Concert Hall. Nick is now working on a short film, *The Making of a Symphony.* He will also use his own spectacular video footage from Antarctica and the Southern Ocean, along with aspects of the symphonic work and a range of visual arts responses and scientific images, to create a lengthier arts/science film.

'There are some important messages that science needs to convey to the wider world and I feel a social responsibility to do that in the best way I can, which at the moment is through science and video,' Nick said.

The symphony CD will include a booklet containing a short essay by Rob on the science behind the symphony, as well as an artist's statement from Matthew and Lynchpin coordinator Sue Anderson's rationale for the project.

The emotional impact of the symphony may be best summed up by an excerpt from an email Rob wrote to Matthew after hearing the Czech recording for the first time: 'You have touched me. You have scared me. You have moved me. You have given the world a piece of your soul and I thank you.'

WENDY PYPER

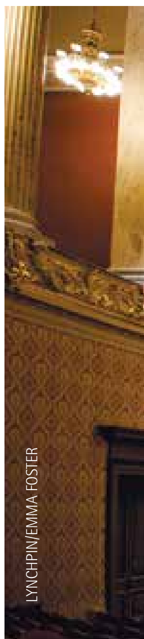
Corporate Communications, Australian Antarctic Division

1

BEN O'LEARY

2

LYNCHPIN/NICK RODEN

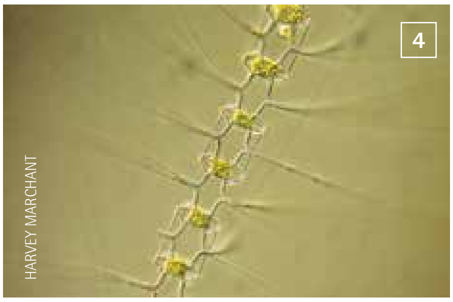


LYNCHPIN/EMMA FOSTER

1. PhD student Nick Roden spent a year in Antarctica collecting seawater samples for his research. He also developed a passion for photography and filmmaking while he was there.
2. Musicians play composer Matthew Dewey's symphony.

Measuring phytoplankton from space

Satellites can now more accurately measure phytoplankton populations in the Southern Ocean from space, thanks to three improved 'satellite chlorophyll algorithms' that account for some unique Southern Ocean characteristics.



The Southern Ocean is different from other oceans. It's windy, it's cold, it's covered in ice and clouds most of the time. When the sun does come out, it remains low in the sky and distant. These factors make it a difficult environment for organisms like phytoplankton (microscopic marine plants) that use light to photosynthesise, and they make it difficult for us to measure these phytoplankton from space. So difficult in fact that NASA's ocean colour satellites have missed more than 50% of Southern Ocean phytoplankton over the last two decades.

Phytoplankton are the lynchpin of the Southern Ocean ecosystem. They take up the carbon we emit into the atmosphere, they produce the oxygen we breathe, and they form the foundation of the food chain, by feeding everything from bacteria to krill. So it is really important that we find out more about them and how they flourish in this hostile domain.

As a PhD student at the University of Tasmania's Institute for Marine and Antarctic Studies, under Associate Professor Peter Strutton, I am investigating how the Southern Ocean is bio-optically different and how phytoplankton have adapted to deal with these differences.

My most recent work has been to correct NASA's satellite algorithms for the Southern Ocean. We discovered that the standard NASA ocean colour algorithms, which were developed largely for measurements in the Pacific Ocean, performed poorly in the Southern Ocean and underestimated phytoplankton by more than 50% and sometimes up to 100%.

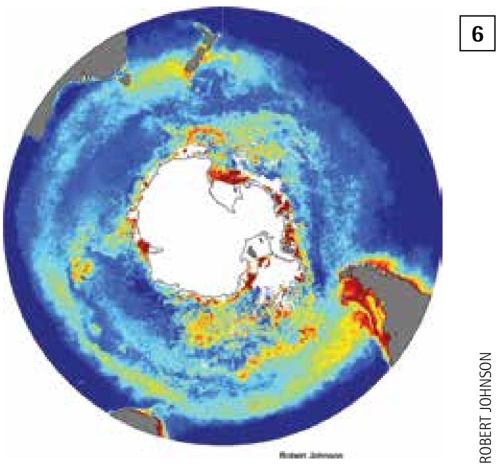
This is because high winds create huge waves with long-lived white caps that tend to disperse the light we're trying to measure. The sea ice and clouds also reflect so much sunlight that it blinds the satellite as it flies over. In addition, cold water, a shortage of vital micronutrients, huge seasonality, and extreme isolation, change the way phytoplankton photosynthesise and the relationship between light and biomass that we use to measure them from space.

To correct these algorithms we used more than 1000 samples of chlorophyll (a photosynthetic pigment) from Southern Ocean phytoplankton, collected over 10 years, and compared them with NASA's satellite-derived chlorophyll measured at the same place and time. The majority of the samples were collected for a long-term monitoring program through a collaborative effort between the CSIRO, the Australian Antarctic Division, and the French Antarctic Program.

Our improved satellite chlorophyll algorithms can now be used to produce high-accuracy observations of phytoplankton, and will go a long way towards improving our understanding of how the Southern Ocean works and how the movement of carbon is changing in these remote waters.

The improved data are freely available through the Integrated Marine Observing System. You can read more about this work in the *Journal of Geophysical Research*, 'Three improved satellite chlorophyll algorithms for the Southern Ocean' (doi:10.1002/jgrc.20270).

ROBERT JOHNSON
Institute for Marine and Antarctic Studies



3. The Czech National Symphony Orchestra in the Rudolfinum Concert Hall in Prague.

4. This chain-forming diatom is a component of the Southern Ocean phytoplankton. It consists of seven individual cells joined together, to increase their surface area, and the golden brown colour within each cell is the chlorophyll that is measured from space.

5. Robert measures chlorophyll concentrations of Southern Ocean phytoplankton using high performance liquid chromatography.

6. Corrected concentrations of phytoplankton chlorophyll observed by satellites in the Southern Ocean averaged over summer from 2002 to 2012. Red and yellow indicates regions of high chlorophyll and blue indicates regions of low chlorophyll.

Risk maps chart krill's demise

By the end of this century important krill habitats in the Southern Ocean off East Antarctica are likely to be unsuitable for krill reproduction, if carbon dioxide (CO_2) emissions continue unabated.

Worse still, the entire Southern Ocean krill population could collapse by 2300 if ocean acidification, caused by increasing amounts of CO_2 dissolving in seawater, extends throughout the crustaceans' habitat.

These grim projections, along with risk maps showing krill reproductive success under different CO_2 emission scenarios, were published in *Nature Climate Change* in July by Australian Antarctic Division scientists and their Japanese colleagues.

The findings are not only disastrous for krill; they have negative implications for the survival of marine mammals and seabirds that rely on them for food.

For more than five years the Antarctic Division's krill biologists, So Kawaguchi and Rob King, have been studying the effect of ocean acidification and other climate-change related stressors on Antarctic krill (*Euphausia superba*) reproduction and development.

For this study they exposed Antarctic krill eggs to six different CO_2 levels (equivalent to 380, 1000, 1250, 1500, 1750, 2000 parts per million or ppm*) until they hatched.

The current atmospheric CO_2 concentration is about 400 ppm, but in some regions of the Southern Ocean the current maximum CO_2 concentration below 200 m depth reaches 550 ppm. CO_2 levels in deep water will continue to increase as atmospheric CO_2 increases, changing the chemistry of the water and increasing its acidity.

'We found egg hatch rates significantly decreased at CO_2 levels of or above 1250 ppm, with almost no hatching at 1750 and 2000 ppm,' Dr Kawaguchi said.

'We also found that embryonic development was significantly impaired if the eggs were exposed to 1750 ppm CO_2 during the first three days following spawning, even if the eggs were returned to lower CO_2 conditions after three days.'

This finding is particularly critical as krill eggs sink from the surface and hatch at 700–1000 m, where CO_2 levels are higher than surface waters and current atmospheric levels. The larvae then have to swim back to the surface to feed. A delay in their development would compromise their ability to do this or even prevent them from reaching the surface before their energy reserves were exhausted.

To find out what sort of ocean CO_2 profile we can expect in the future, Dr Kawaguchi's Japanese colleagues used a three-dimensional ocean circulation model to project CO_2 levels in the Southern Ocean under the Intergovernmental Panel on Climate Change's four Representative Concentration Pathway (RCP) atmospheric CO_2 scenarios (RCP 8.5, 6.0, 4.5 and 3.0 – from no emission mitigation to strong mitigation).

'The resulting risk maps showed that much of the present habitat for krill will be at damagingly high CO_2 levels of above 1000 ppm by 2100 under RCP 8.5, or by 2300 under RCP 6.0,' Dr Kawaguchi said.

'Under RCP 4.5 and 3.0 the risks were minimal, with a reduction in hatching success of less than 10% by 2300.'

Dr Kawguchi said the results of the study should be incorporated into existing models of the dynamics of krill populations, to allow assessment of the regional impacts of ocean acidification on the reproductive success of these populations. These results can then be used to inform ecosystem and krill fishery management models under different carbon emission scenarios.

However, Dr Kawaguchi warned that the findings might well be conservative due to the cumulative effects of increased CO_2 across life stages and generations, and other stressors such as increasing seawater temperature and sea ice decline in some parts of the Southern Ocean.

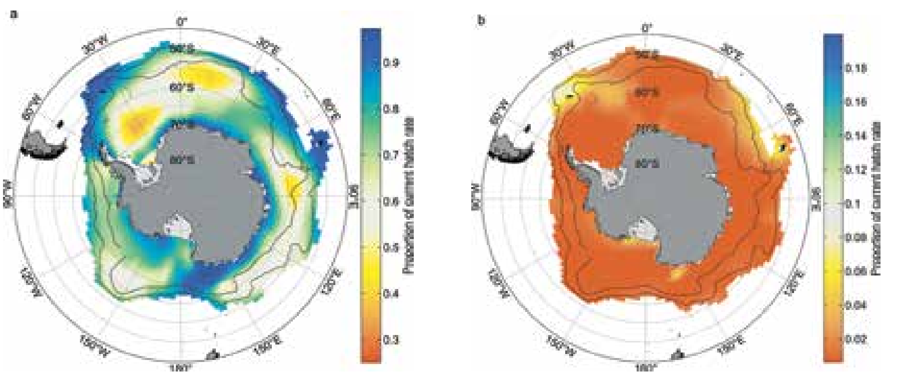
WENDY PYPER

Corporate Communications, Australian Antarctic Division

In seawater CO_2 is measured in micro-atmospheres (μatm). When seawater is bubbled by air containing a certain concentration of CO_2 in parts per million (e.g. 400 ppm) the seawater bubbled by that air will equate to the same value expressed in micro-atmospheres (i.e. 400 μatm).

More information

Kawaguchi S., Ishida A., King R. et al. Risk maps for Antarctic krill under projected Southern Ocean acidification. *Nature Climate Change* 7 July 2013. doi:10.1038/nclimate1937



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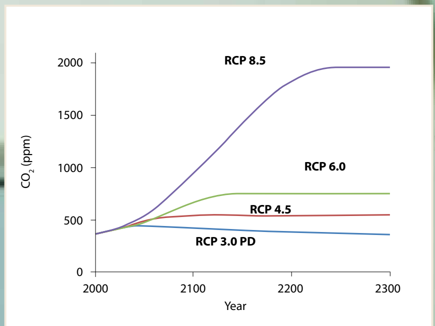
1

1. Risk maps for hatching success under RCP 8.5 for 2100 (far left) and 2300 (left). The Weddell Sea and the Haakon VII Sea are identified as the first areas where krill egg hatching success is most likely to be at risk (yellow-orange patches in far left map).

2



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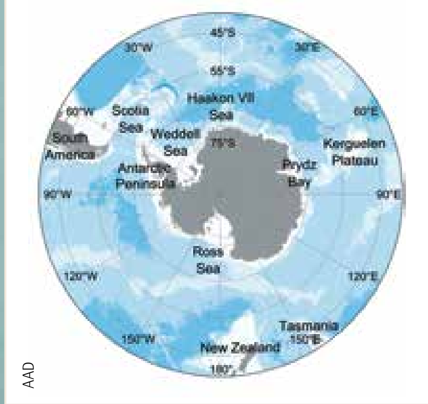

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2. Trajectories of CO_2 concentration under the Representative Concentration Pathway (RCP) scenarios of the Intergovernmental Panel on Climate Change. RCP 8.5 assumes a high energy demand and greenhouse gas emissions in the absence of climate change policies; RCP6.0 is a medium-high emission scenario with a smooth transition towards concentration stabilization levels after 2150, achieved by linear adjustment of emissions between 2100 and 2150.

3. Important krill habitat in the Weddell Sea and the Haakon VII Sea are likely to become high-risk areas for krill recruitment by 2100.

4. Dr So Kawaguchi (right) and Mr Rob King in the Australian Antarctic Division's krill aquarium.

STEPHENIE CAHALAN

4

Winter Ice Study on Key Species

Six Australian Antarctic Division personnel have recently returned from a 60-day voyage to the Weddell Sea, where they joined the international *Winter Ice Study on Key Species*.

This German-led multi-disciplinary project onboard the icebreaker *Polarstern* brought together a team of 47 scientists and support engineers from eight countries.

The goal of the voyage was to learn more about sea ice and the key species associated with it. Antarctic krill were the main focus because this is the most abundant animal species in the sea ice zone and they play a central role in Antarctic marine food webs.

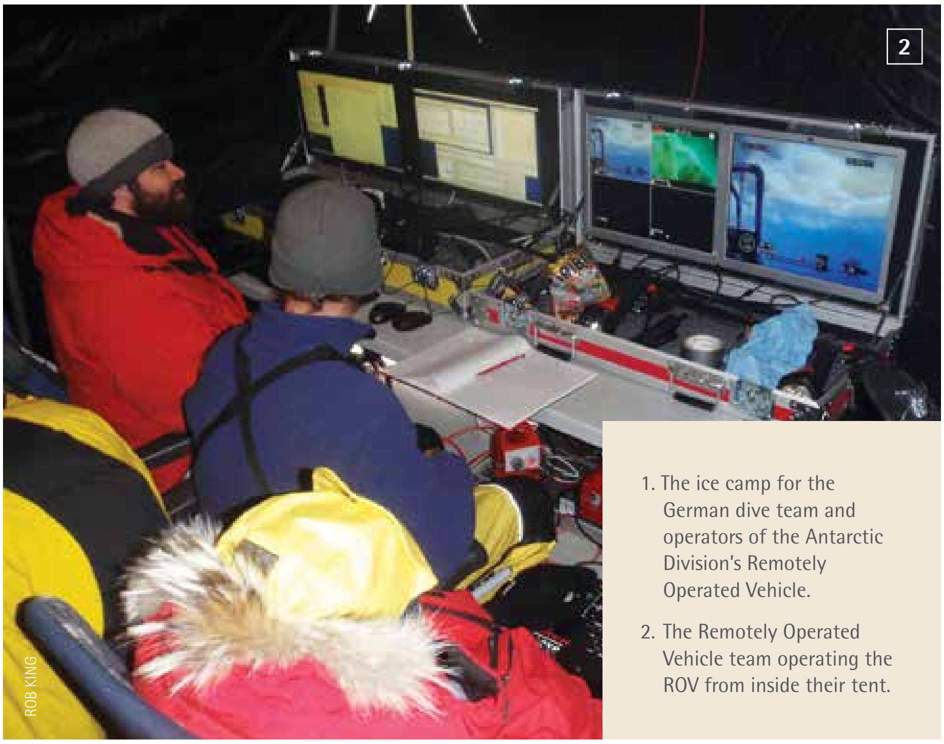
Much of the work of the Antarctic Division team built on research conducted during the Australian-led *Sea Ice Physics and Ecosystem eXperiment-II* (SIPEX-II) in 2012 and reported in Issue 23 of *Australian Antarctic Magazine*.

The Antarctic Division team was led by sea ice ecologist Dr Klaus Meiners, whose main aim was to measure physical and biological sea ice properties using an instrumented Remotely Operated Vehicle (ROV). The ROV was first used successfully for this purpose during SIPEX-II.

Assisting Klaus were electrical engineers Peter Mantel and Mark Milnes, who were primarily responsible for maintaining and operating the ROV, as well as its instrument payload, consisting of a sonar, accurate depth sensor and a spectral radiometer. These instruments were fitted to the vehicle before the voyage, by the Antarctic Division's Science Technical Support team. The combination of these sensors allows the determination of ice thickness and ice algal biomass simultaneously.

Ice algae are a critical food supply for krill and other organisms living under the ice. Using video and a newly developed upward-looking stills camera, the ROV was also used to determine the number of krill larvae living under the ice. ROV measurements were conducted in tandem with the collection of live krill larvae by a German dive team. The data will be compared to independently determined measurements of ice and snow thickness collected from the ice surface by a German sea ice physics team. Together, this information will provide insights into the relationship of sea ice thickness, snow thickness, ice algal biomass and krill larval density.

Mr Rob King also collected krill using nets and a modified fish pump, which proved to be a key tool to catch krill for various physiological



1. The ice camp for the German dive team and operators of the Antarctic Division's Remotely Operated Vehicle.
2. The Remotely Operated Vehicle team operating the ROV from inside their tent.

KLAUS MEINERS

WENDY PYPER

measurements carried out by the Antarctic Division and other groups. Rob also deployed deep sea light traps and cameras (with critical engineering support from Mark and Peter) to determine if krill were feeding at the sea floor, up to 5800 m below, and to bring a sample of live krill to the surface. However, preliminary data from these deployments suggest that feeding at the sea floor might not be a key strategy for krill during this period, at least around the locations where the camera was deployed.

Also onboard was Dr Simon Jarman, who is leading the molecular genetics work that will be performed at the Antarctic Division after the voyage. This work is part of a newly established European-Australian effort to investigate the role of so-called 'clock genes' in polar zooplankton species (*Australian Antarctic Magazine* 23: 10–11, 2012).

Antarctic zooplankton are attuned to the daily and seasonal cycles of their environment. The new project attempts to identify internal molecular clocks that help the organisms to synchronize their physiology and life cycle to the changes in their environment on daily and seasonal time scales. Molecular genetic analysis of DNA in krill stomachs will also be used to identify the food that krill consume from the underside of the ice and from the open sea.

University of Tasmania and Quantitative Antarctic Program student Roland Proud completed the six-member team. Roland

ROB KING

ULRICH FREIER

calibrated and operated the ship's echosounders to improve acoustic methods to determine krill biomass. Echolocation of krill targets allowed efficient and effective trawl deployment, providing samples for biological analysis. The acoustic data recorded on the voyage will enable the team to estimate the density of krill along the ship's path and will be key to understanding the temporal and spatial variability in krill distribution on large scales.

The Australian team will now spend months collating, analysing, and interpreting all their data and samples in order to better understand the dynamics of the under-ice habitat. Initial results indicate a high spatial patchiness in sea ice thickness, algal biomass and krill larval distribution, with the latter also strongly influenced by daily migration patterns.

ROB KING[1], SIMON JARMAN[1] and
KLAUS MEINERS[1,2]

1 Australian Antarctic Division

2 Antarctic Climate and Ecosystems Cooperative Research Centre

3. A crabeater seal checks out the Remotely Operated Vehicle deployment.
4. Rob King collects krill using a modified fish pump.
5. Antarctic krill were a focus of the German-led *Winter Ice Study on Key Species* in the Weddell Sea.
6. The Remotely Operated Vehicle under the ice.

Digging up penguin history

Scientists will excavate ancient Adélie penguin colony remains at sites near Davis station this Antarctic season, to learn more about the birds' history of occupation and their diets.

The research could also reveal more about the climatic conditions in the region during the penguins' occupation.

Seabird ecologist Dr Barbara Wienecke and PhD student Jane Younger aim to excavate at least 20 sites in the Vestfold Hills and Windmill Islands. They'll be looking for 'ornithogenic' soils – soils resulting from bird activity – comprised of guano, prey remains, eggs, bones and feathers.

'We're looking mainly for bones, which can be easily carbon dated to determine how long ago a colony existed on the site,' Dr Wienecke says.

'Previous studies in the Ross Sea region of Antarctica have found Adélie penguin bones dating back 45 000 years.

'If we also find egg shells, we'll know the area was a breeding site, while the presence of a lot of feathers will indicate a site used for moulting.'

When a suitable site is found the pair will set up pits of between 0.5 and 1 m^2 and excavate in 5 cm levels until they reach bedrock or the bottom of the ornithogenic component of the soil. They'll remove and document all the hard parts and then sieve the remaining soil for fish bones, squid beaks and other prey remains.

Previous palaeodiet studies of abandoned penguin colonies have identified fluctuations in prey abundance and diversity that correlate with changes in climate.

'If we find evidence of prey shifting it's likely to be related to significant changes in the environment; for example, glaciation of colony areas that forced the penguins to move somewhere else to breed and possibly feed,' Dr Wienecke says.

'If we find anything like that, it will be a matter of examining what is known from palaeoclimate records, to see if we can reconstruct the local history.'

Carbon dating of bones will also help to identify any gaps in a site's occupation history that might correlate with these climate records.

WENDY PYPER
Corporate Communications, Australian Antarctic Division

Adélie penguins rely on rocky, ice-free areas to raise their chicks.

Australian Antarctic Medal Awards

Seabird ecologist Dr Barbara Wienecke and master mariner Captain Scott Laughlin were awarded the Australian Antarctic Medal in June.

Former Federal Environment Minister, Tony Burke, said the pair's focus and dedication over many years had made a significant contribution to Australia's work in Antarctica and the Southern Ocean.

Dr Wienecke's medal was awarded for her exemplary research into seabirds and the effect of commercial fishing operations on seabird populations (see story on page 10).

'Dr Wienecke is highly regarded on the world stage and should be applauded for her long-term work with seabirds, particularly penguins, often at remote field locations in cramped and uncomfortable conditions and at the mercy of extreme weather conditions,' Mr Burke said.

During two decades of research at the Australian Antarctic Division, Dr Wienecke has also participated in several studies on longline fishing vessels, working to decrease the bycatch of seabirds.

Much of her research has been considered by the Scientific Committee of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) and supported Government objectives in that forum.

Captain Scott Laughlin's name is synonymous with Antarctic voyages stretching back to 1990; first as a crew member of the *Aurora Australis*, then as ship's master from 2002.

Minister Burke said that Captain Laughlin's deep appreciation of, and affinity with, Australia's Antarctic program, has resulted in broad respect across the Antarctic community.

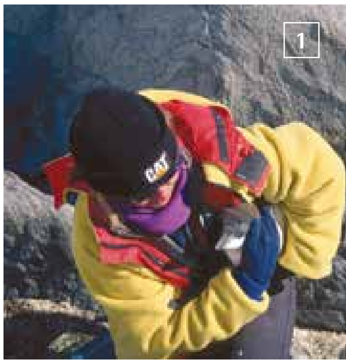
'Over more than 20 years he has demonstrated a commitment to working closely with the Australian Antarctic Division to improve policy, procedures and process relating to maritime operations,' he said.

'Captain Laughlin's attention to safety and keen understanding of sea ice conditions, have proved invaluable to operations in often very difficult conditions at sea.'

CORPORATE COMMUNICATIONS
Australian Antarctic Division

1. An emperor penguin chick scolds Barbara after being weighed.
2. Scott Laughlin at the helm of the *Aurora Australis.*

Penguin Barb



It was a relief for Australian Antarctic Division penguin ecologist, Dr Barbara Wienecke, to finally find a career that she was passionate about. After 'happily stumbling' through odd jobs in tourism, pharmacy and horticulture, half-finished degrees in agriculture and an interest in anthropology, she found her niche in seabird research, and particularly penguins. Now, 20 years later, her passion and dedication to her research, and the birds she studies, has been recognised with an Australian Antarctic Medal.

'It's extraordinary and humbling that my colleagues thought it was worthwhile putting my name forward for an Antarctic Medal,' she says

'Personal glory is not what I'm after. I hope that whatever we find out about these beautiful birds will help convince decisions-makers that they're worth protecting.'

It's not hard to see why Barbara struggled to find a niche; with her enthusiastic wonder of the natural world, her willingness to give anything a go, and her ability to stride through challenges with a cheerful and positive disposition. When life is endlessly fascinating, it's hard to settle on one thing.

One thing was certain though; when she left Germany two days after finishing high school, Barbara knew she wanted a career in the outdoors. She headed to Israel to work in a Kibbutz for 13 months, and here she developed an interest in agriculture. She returned to Germany to study agricultural science at the University of Bonn, but when the Dean went purple and raged at her suggestion that she spend a year in Namibia – her birthplace – undertaking practical work on a farm, Barbara quit.

She moved to the Netherlands in pursuit of a more suitable agricultural course and ended up working at Floriade; a flower and garden show. An encounter with an Australian rose grower while she was there saw her move to Sydney to work. A few months later she moved to Western Australia and began a Bachelor of Science at Murdoch University.

'I'd worked out by then that I wanted to study biology and I promised myself that I'd finish my degree this time, even if it killed me,' she says.

True to her word she completed her degree and promptly packed her bags for Europe. After a dalliance in tourism she returned to Murdoch University to begin an Honours project on little penguins on Penguin Island.

'The first thing my supervisor said to me was that I should not fall in love with the birds because I would not be able to do my PhD on them,' Barbara says.

Within weeks Barbara was not only in love with the penguins, she had, unknowingly, established the course of her future. At the end of her Honours year Barbara walked into her supervisor's office and said: 'Ron, you will write a research proposal and when you get the money you will hire me as your assistant and I'm going to continue to work on the birds. They still need my help and we need to fix up the island.'

This determination to champion the protection of seabirds and their habitat from humans and later, climate change, was to become the defining theme throughout Barbara's career.

In 1993, immediately after she'd completed her PhD, Barbara got a job at the Australian Antarctic Division, working with fellow Australian Antarctic Medal winner Dr Graham Robertson. Her first job was to investigate the foraging (feeding) ecology of emperor penguins at Auster Rookery, near Mawson, using satellite tags and dive recorders.

'It was the first time we successfully followed 12 females for the entire period of their winter absence,' Barbara says.

'The breeding biology of emperor penguins was reasonably well understood but we'd never been able to observe the birds outside their colonies, and satellite tracking was really useful for that.'

Barbara has lost count of the number of times she returned to Antarctica, but 20 years on she continues her satellite tracking work on emperor penguin colonies at Auster, Taylor Rookery (also near Mawson) and Amanda Bay at Davis. She has also spent time tracking Adélie penguins and snow petrels on the continent, King penguins on Macquarie and Heard islands and black-browed albatrosses in southern Chile.

Like all fields of science, Barbara's research has thrown up more questions than it's answered. When we think we know a 'truth' about something, along comes the exception to the rule.

For example, emperor penguin colonies are known to inhabit the fast ice – ice attached to the continent – which provides a habitat suitable for raising chicks. However, Barbara and other penguin ecologists have recently confirmed the existence of colonies on a giant iceberg that calved off the West Antarctic Ice Shelf many years ago. The physical nature of the berg is such that the colony can survive. Rather than sheer ice cliffs, it has an 'ablated'(eroded) area that stretches gently down to the sea ice, providing a link similar to that between fast ice and sea ice.

'I could not believe there were chicks on top of the iceberg. I would have fallen out of the helicopter if I hadn't been strapped in,' Barbara recalls.

Barbara also relates a story about a Russian scientific party who set up a tent on the Shackleton Ice Shelf in the 1970s. They were surprised by a group of 30 penguins surrounding them the next morning.

'We observe penguins in certain situations and think we understand what they are doing,' she says

'But we really have to look beyond what we know. Why haven't we seen emperor penguins on ice shelves before? Because we've never looked!

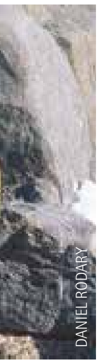
'It's fantastic when the unexpected happens because that's when you learn things.'

In between her trips to Antarctica Barbara has also spent time in the Argentine subantarctic and on longline ships in New Zealand, studying black-browed albatross interactions with longline fisheries. Her longline work in the ling fishery off New Zealand was particularly challenging because she knew birds would be killed during line-weighting experiments. But with albatross populations in freefall as a result of fisheries bycatch, it was research that had to be done.

As a result of Barbara's and her colleague Dr Graham Robertson's research, subsequent technological developments with industry, and policy decisions through the Commission for the Conservation of Antarctic Marine Living Resources, seabird bycatch has been reduced to almost zero in the longlining fisheries that overlap with the birds' foraging and migratory patterns.

'Sometimes individuals have to pay a price to save the population as a whole,' Barbara says.

Barbara has also paid a price, of sorts. She's been bitten, scratched and rebuked by her research



subjects, she's spent sleepless weeks on cramped, wet fishing vessels, and years of her life in field huts and tents, battered by blizzards, rain and bone-chilling cold.

She recalls the six weeks she spent tracking black-browed albatross on the Argentine island Diego de Almagro, which receives some eight metres of rain a year. Barbara and two colleagues had to regularly climb 600 m up a mountainside covered in vegetation so dense they had to crawl over it. It was bitterly cold, incredibly windy and constantly wet.

'But the wildlife was incredible. There were resident sea otters, seals, orcas and steamer ducks. We saw Andean condors, snipes and hummingbirds — who would have thought! I was sitting outside my tent in my yellow rain jacket one day when a hummingbird came right up to me and buzzed me for a few seconds.'

Barbara has lost none of her enthusiasm for field work or her research subjects and plans to continue the long-term monitoring of emperor penguin colonies, teasing out natural variability in populations and the birds' response to climate change.

'We don't know the consequences of climate change,' she says.

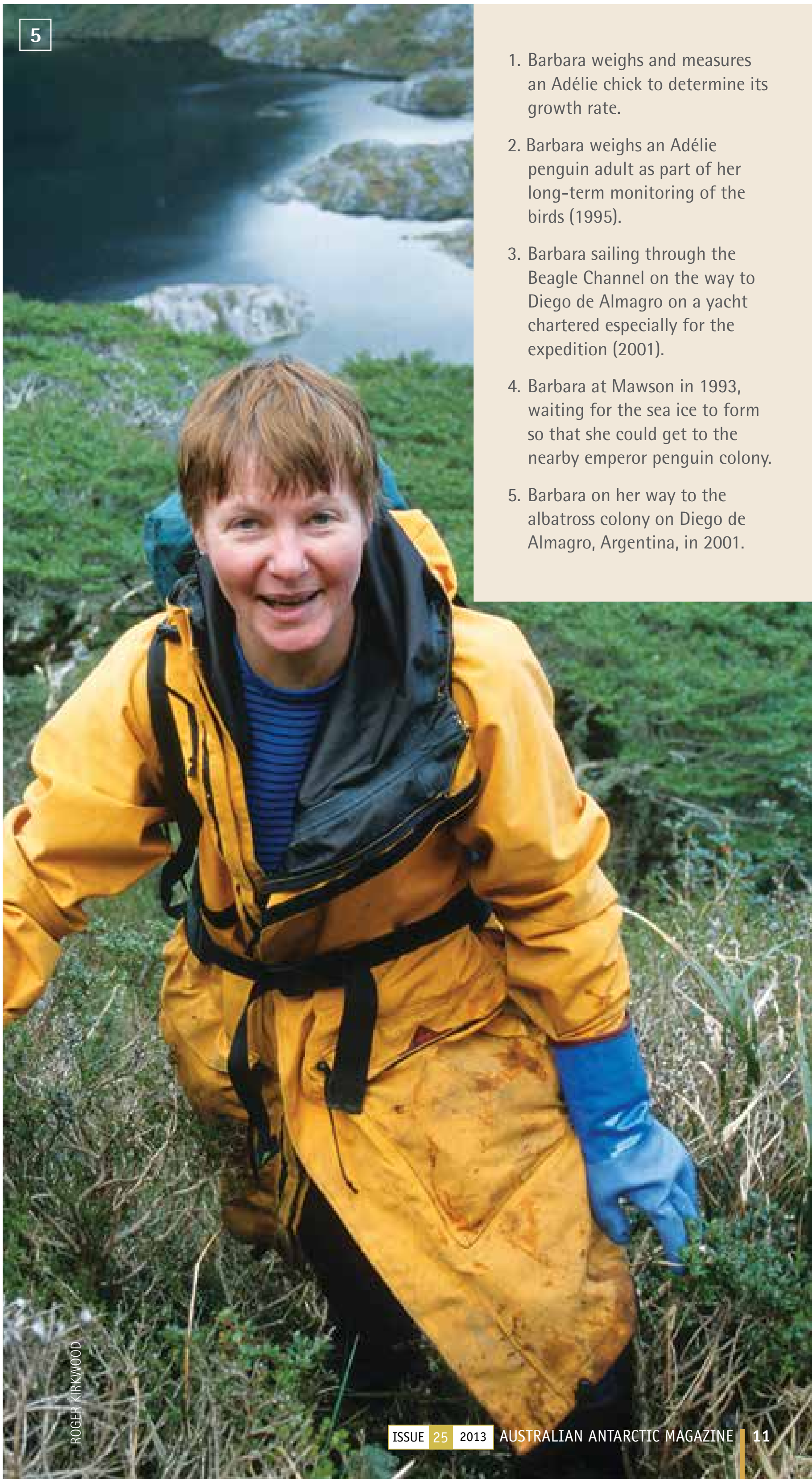
'It's not just that the fast ice will deteriorate; it may impact on their food supply. Emperors have a wide variety of prey but we don't know which fish species will be affected. It's all very well to say the penguins may be able to prey switch, but is the prey even there in the first place?'

She is also excited to have a student commencing a study of the genetic differences between birds from different colonies.

'We're beginning to wonder how faithful emperors are to their natal colonies. When you see the distances they travel and overlay the tracks of birds from different colonies, there's a massive overlap. They are gregarious birds so it's not inconceivable that they could join another group.'

Perhaps her dedication to her chosen path is best put by one of the tourists Barbara befriended during one of her many trips on tourist vessels as a bird expert. When she encountered her friend out on deck smoking a fine cigar and contemplating life he told her: 'I've been talking to the big man up there and he said to me that we really need people to make sure that we don't stuff up this planet. And you, Penguin Barb, are one of the people who are doing just that.'

WENDY PYPER
Corporate Communications, Australian Antarctic Division



1. Barbara weighs and measures an Adélie chick to determine its growth rate.
2. Barbara weighs an Adélie penguin adult as part of her long-term monitoring of the birds (1995).
3. Barbara sailing through the Beagle Channel on the way to Diego de Almagro on a yacht chartered especially for the expedition (2001).
4. Barbara at Mawson in 1993, waiting for the sea ice to form so that she could get to the nearby emperor penguin colony.
5. Barbara on her way to the albatross colony on Diego de Almagro, Argentina, in 2001.

Promiscuous community reveals hidden values

Molecular genetic techniques are providing Antarctic scientists with novel ways of investigating global questions about ecosystem structure and function.

The techniques allow scientists to unlock previously hidden values in Antarctic ecosystems, providing information that will assist in their future protection. They could also lead to new discoveries relevant to human health, industries such as food production or cleaning, and our search for life on other planets.

A case in point is the recent work of a team led by Professor Rick Cavicchioli, from the University of New South Wales, in collaboration with other Australian and American research institutions and support from the Australian Antarctic Division.

Using 'metagenomics' (genome sequencing of an entire environmental sample, such as a lake or marine microbial community), Professor Cavicchioli has created a detailed ecological picture of the microbial community in the isolated and hypersaline Deep Lake in the Vestfold Hills near Davis.

Deep Lake was formed about 3500 years ago when the Antarctic continent rose, isolating a section of the ocean. The water is now so salty it remains liquid down to -20°C and almost nothing is able to grow in it.

Research by Antarctic Division scientists and others at Deep Lake in the 1980s identified halophilic (salt-loving) 'archaea' using culturing techniques. (Archaea represent a third 'domain of life' that evolved billions of years ago, which is distinct from the Bacteria and Eucarya domains). Individual genomes of these archaea species, and other species isolated more recently, were DNA sequenced. However, metagenomics enables a more rapid and expanded view of microbial diversity and the function of entire mixed communities. It also enables genome analysis of organisms that won't grow in the laboratory.

Professor Cavicchioli's team took water samples from Deep Lake at depths of 5, 13, 24 and 36 metres and performed metagenomics analysis of each sample, to learn about the microbial communities throughout the depth of the lake.

They found that the lake was completely and uniformly dominated by 'haloarchaea', with four distinct isolates comprising 72% of the microbial community. The isolates demonstrated a high rate of DNA exchange between each other, but retained genomic characteristics indicative of niche adaptation.

'The Deep Lake community structure differs greatly from temperate and tropical hypersaline environments,' Professor Cavicchioli said.

'Not only are the types of haloarchaea different, but gene swapping occurs frequently between haloarchaea that are quite unrelated to each other; that is, gene exchange occurs between different genera, and not just between different species.

'Despite this promiscuity, the dominant members of the community retain their own identity as a species and coexist with others, exploiting different niches without impinging on each other.'

Professor Cavicchioli said some of the microbes survive by consuming proteins in the water, while others consume sugars like glycerol, which is a by-product of algae living in the upper waters of the lake.

'By choosing different food sources they can coexist and continue to reproduce and eke out a living in relative harmony,' he said.

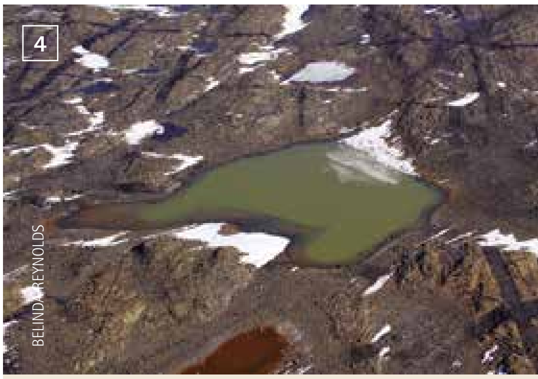
And the sharing of large amounts of genetic material could confer benefits such as resistance to viruses or an improved ability of the haloarchaea to respond to their environment.

Senior Australian Antarctic Division scientist Dr Martin Riddle, who leads a program that Professor Cavicchioli's work contributes to, said the research has realised the value of Antarctic lakes as model systems for understanding ecosystem processes.

'For decades, scientists have spoken of the potential value of Antarctic lakes as model systems for understanding global questions about biodiversity, its spread and its ubiquity or rarity, across the planet,' Dr Riddle said.

'Compared to penguins or mosses, the scientific value of a body of water is not obvious. But now metagenomics allows us to see how these types of ecosystems are structured and how they function. Now we can articulate the value of these lakes and how unique or common they are.

'This information will also help us work out how to best protect these ecosystems and to select representative areas for protection.'



Dr Riddle said the work could also provide a reason for leaving some areas of Antarctica untouched.

'The techniques Professor Cavicchioli is using were beyond our imaginings 15 years ago, so where will technology take us in another 15 or 50 years time?

'Some areas of Antarctica may have scientific potential that we can't access right now, but that new technologies will enable in the future. We don't want to accidently disturb what we can't understand.'

Meanwhile, further research into extreme environments like Deep Lake could provide insights of relevance to astrobiology. As well as the haloarchaea in Deep Lake, which have adapted to life at low temperature, under highly saline and dehydrating conditions, another group of Archaea known as 'methanogens' grow in Ace Lake in the Vestfold Hills. Methanogens have been proposed as a kind of life that could live on Mars, due to their ability to grow under cold conditions, devoid of oxygen.

Professor Cavicchioli said enzymes from both haloarchaea and methanogens could be valuable for use in biosensors to assess whether biological reactions are occurring on other planets. The enzymes could also have value in industrial processes that need to occur at cold temperatures – such as food production or the clean-up of pollutants from contaminated sites in Antarctica.

'Every time we poke an "-omics stick" into these amazing Antarctic systems we find things we never expected,' he said.

The University of New South Wales scientific team is spending the next 12 months in Antarctica to continue research on microbial communities in three Vestfold Hills lakes – Ace Lake, Organic Lake and Deep Lake – and a nearshore marine location. The team will investigate how microbial communities change throughout a complete annual cycle.

'Establishing what microbes do in different seasons will reveal which microbial processes change and how environmental perturbation will impact on normal ecological cycles in Antarctica,' Professor Cavicchioli said.

'This essential evidence-based knowledge will form the underpinnings for evaluating the effects of climate change on sensitive ecosystems in the Antarctic.'

WENDY PYPER
Corporate Communications, Australian Antarctic Division

More information

DeMaere MZ, Williams TJ et al. High level of intergenera gene exchange shapes the evolution of haloarchaea in an isolated Antarctic lake. *PNAS* (2013). www.pnas.org/cgi/doi/10.1073/pnas.1307090110

1. A panorama of the Deep Lake campsite where the University of New South Wales scientific team discovered a community of promiscuous haloarchaea.
2. Professor Rick Cavicchioli takes samples from Deep Lake in the Vestfold Hills.
3. Rick Cavicchioli (left) and Torsten Thomas, both from UNSW, process microbial samples collected at Ace Lake – a source of cold-loving methanogens.
4. Professor Cavicchioli and his team are spending a year in Antarctica, from late October 2013, to study changes in microbial communities throughout a complete annual cycle in Deep Lake, Ace Lake and Organic Lake (pictured).

Trans-Tasman meeting of Antarctic minds

Some of the best minds in Antarctic research in Australia and New Zealand met at the 'Strategic Science in Antarctica' conference in Hobart in June.

The inaugural joint conference was a collaboration between the Australian Antarctic Division and Antarctica New Zealand, who have a shared vision for Antarctica and the Southern Ocean of 'Valued, Protected and Understood'.

Over five days 300 delegates, including 48 from New Zealand and several researchers from the USA and UK, exchanged ideas and information on topics relating to the Antarctic ice sheet, marine and terrestrial ecosystems and human impacts in Antarctica. Fourteen workshops were also held on topics including how science informs policy, specific research program ideas, science communication, and leadership in science.

A major aim of the conference was to showcase the quality of science within the Australian and New Zealand Antarctic programs, and to enable scientists and policy-makers to discuss priorities and opportunities for delivering strategic science into the future. In this respect it was a great success.

More than 250 abstracts were submitted prior to the conference, and after much discussion the conference committee decided on a program format of plenary presentations and concurrent sessions. The three-day program included eight invited keynote speakers, 23 plenary presentations, 71 concurrent presentations and 90 posters; as well as presentations on the Australian and New Zealand science programs. The conference was followed by two days of workshops, attended by 278 people.

On the opening day of the conference, delegates were welcomed by Australian Antarctic Division Director Tony Fleming and Antarctica New Zealand (former) Chief Executive Lou Sanson, followed by a pre-recorded welcome video from (former) Federal Environment Minister, the Hon. Tony Burke.

The conference began with keynote presentations from Professor Will Steffen of the Australian National University and Professor Tim Naish of Victoria University of Wellington. This session concluded with one of the most talked about moments of the conference. As Acting Chief Scientist Dr Martin Riddle summed up the talks, he commented on the need to reduce our carbon footprint. As if planned for dramatic effect the lights went out… and stayed out. All power to the conference venue was lost.

1

STEPHENIE CAHALAN

While conference organisers scurried around trying to find out where the problem was and when it would be resolved, delegates enjoyed an extended morning tea, taking the opportunity to catch up with old acquaintances and discuss the posters on display with presenters. Power was restored after an hour and the conference continued with a slight change to schedule for the day.

The success of any conference will ultimately be determined by the quality of the presentations. The feedback from participants has been overwhelmingly positive, with many noting the exceptional quality of the presentations, particularly those of the keynote speakers, as a real highlight.

The conference also successfully showcased the outstanding quality of Australian and New Zealand Antarctic science, and highlighted the strength and resilience of the relationships the Australian Antarctic Division has with key partners in delivering that science.

The conference received generous support from Tasmania's marine and Antarctic science organisations including from the University of Tasmania's Institute for Marine and Antarctic Studies, the Antarctic Climate and Ecosystems Cooperative Research Centre, Antarctic Tasmania, CSIRO Marine and Atmospheric Research, and the Tasmanian Polar Network. The quality and number of presenters affiliated with these partners justifies Hobart's reputation as a centre of excellence in Antarctic and Southern Ocean science and Australia's Antarctic Gateway.

2

STEPHENIE CAHALAN

1. Professor Tim Naish fronts the media after his keynote presentation. Professor Naish spoke about using paleoclimate approaches to help make sea-level rise projections.
2. Professor Will Steffen spoke about the challenges of climate change to science and policy.

The conference program, including presentation, poster and workshop abstracts, is available on the conference website www.conference.antarctica.gov.au.

ANDY SHARMAN
Science Conference Program Manager, Australian Antarctic Division

JASON MUNDY

From science to policy

As a keynote speaker at the 'Strategic Science in Antarctica' conference, **Jason Mundy**, General Manager of the Australian Antarctic Division's Strategies Branch, shared his insights on the broad theme of the conference; the interface between science and policy. Jason is a former diplomat and Ministerial adviser, with a background in public policy, international relations, diplomacy and strategy. He provided conference delegates with a thought-provoking 'end user' perspective. Following is an edited excerpt of his presentation.

What are Australia's — and the world's — Antarctic policy priorities? And how, from a policy maker's perspective, can science best work to inform and influence the governance, management and stewardship of Antarctica?

For the Australian Antarctic Division, particularly the Strategies Branch, resolving these questions is crucial to the shaping and delivery of genuinely 'strategic science'. Antarctic policy includes the administration of the Australian Antarctic Territory, environmental management, and our involvement in the Antarctic Treaty System — mainly through the Antarctic Treaty Consultative Meeting (ATCM) and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). In both of those forums, science input — and close relationships between researchers and policy officers — is vital to achieving Australia's outcomes.

The interplay between science and strategy in Antarctica is intimate and well-established. For Australia, it can be traced back to the early explorations by geologist Douglas Mawson.

Unlike other explorers from the heroic age, who were focused on the South Pole, Mawson made a clear decision to devote his Australasian Antarctic Expedition (1911–14) to conducting science and surveying the coastline of eastern Antarctica. He understood, and didn't hesitate to tell his financial backers, that his explorations had broader strategic implications, writing in *The Home of the Blizzard*:

> *What will be the role of the South in the progress of civilization and in the development of the arts and sciences, is not now obvious. As sure as there is here a vast mass of land with potentialities, strictly limited at present, so surely will it be cemented some day within the universal plinth of things.*

The Australasian Antarctic Expedition was of tremendous strategic and historical significance for Australia. It was Australia's first major scientific undertaking following Federation, and it was a key precursor to Australia's eventual assertion of sovereignty over the Australian Antarctic Territory.

Despite a huge evolution in the world's understanding of Antarctica, the continent continues today to attract attention in part because of those vast potentialities that Mawson observed a hundred years ago.

Australia's policy priorities

Australia's key policy priorities in Antarctica today are well defined, and captured in the Australian Antarctic Science Strategic Plan. They have been endorsed by a series of Australian Governments in something like their current form for about 20 years.

Australia's top-tier objectives in Antarctica cut across six key themes. Science is one of these,

1. Australian Antarctic Division Strategies Branch Manager, Jason Mundy, on Macquarie Island.

but so too is physical presence in the Australian Antarctic Territory; influence in the Antarctic Treaty system; environmental management; collaborative relationships with other national programs; and pursuit of reasonable economic benefits (not including mining or oil drilling). It's important to understand that these themes don't exist in isolation from one another; they are cross cutting.

It's important that the Antarctic science community keeps an eye to the broader strategic horizon when considering and framing proposals for science research in Antarctica. Research that aligns with, and achieves outcomes against, a number of these broader goals in Antarctica, will often look more attractive to a policy decision-maker than research that doesn't.

Pathways to policy – some triumphs

Both Australia and New Zealand punch above their weight when it comes to exerting influence in the Antarctic Treaty system, due to the quality and targeted nature of the science produced specifically to support our effectiveness in international forums.

Australia benefits from having a structure in which Antarctic science, policy and operations are all integrated under one roof, in the Australian Antarctic Division. In an international context this configuration is relatively rare. Of course, a huge amount of critical and high quality Antarctic science is also contributed from universities and other scientific institutions outside the Antarctic Division. But there is no question that advantages derive to the national program from having an integrated structure, which encourages an intimate and flexible relationship between scientists, policy-makers and operators.

The following Australian examples, from CCAMLR and the ATCM's Committee for Environmental Protection (CEP), highlight the importance of close relationships between science and policy, and the benefits of getting it right.

Committee for Environmental Protection

The CEP's main role is to provide advice and develop tools to assist Antarctic Treaty Parties to meet their goal of comprehensively protecting the Antarctic environment. It isn't a scientific body, but it needs high quality scientific information to do its work well.

The types of questions that the CEP deals with include:

- What is the state of the Antarctic environment, or environments?
- What is changing – or is likely to change – and by how much?
- How should we respond to the changes?
- How do human activities in the Antarctic – national Antarctic programs, tourism and other non-government activities – interact with the environment?
- Can the interactions be managed, and if so how?
- How do external pressures, such as climate change, need to be considered in all this?

Scientific information is critical when considering each of these questions, and in making sure that the international community's work is focused on addressing the most important issues. In many ways this resembles an environmental risk assessment approach. But it's one that's conducted through the lens of

1. Work by science, industry and CCAMLR Parties has helped reduce the bycatch of albatross (such as this black-browed albatross) and petrel species threatened by some longline fishing practices.
2. Science input and close relationships between researchers and policy officers is vital to achieving Australia's objectives in Antarctica.
3. The Antarctic Conservation Biogeographic Regions analysis was a collaborative effort between scientists from Australia, South Africa, New Zealand and the United Kingdom. The 15 biologically distinct, ice-free bioregions have been endorsed by the Committee for Environmental Protection as a sound basis for informing its decision making.

a multilateral forum that operates by consensus; so political science can also play a role. The CEP really is one of the closest interfaces between science and policy in the Antarctic world.

The recent identification of Antarctic Conservation Biogeographic Regions is a great example of policy-relevant science feeding into the CEP. Dr Aleks Terauds and other contributors drew together all the available terrestrial biodiversity data, to identify 15 biologically distinct ice-free areas in Antarctica (*Australian Antarctic Magazine* 23: 19, 2012). This built on excellent work by New Zealand researchers to identify 21 discrete Environmental Domains based on physical parameters.

This scientific understanding of how biological diversity varies across Antarctica will be fundamental to shaping future environmental protection efforts there.

For example, the Environmental Protocol asks us to protect representative examples of major terrestrial ecosystems, so we need to know what these ecosystems are and where they are. Similarly, if we want to prevent species being transferred to areas where they are not naturally found, we need to understand the differences between one bioregion and another.

The bioregions have been endorsed by the CEP as a sound basis for informing its decision making and they're going to be an influential tool for policy-makers in the years ahead.

Commission for the Conservation of Antarctic Marine Living Resources

CCAMLR is another example of an intimate and extremely productive relationship between science and policy. The very structure and foundation of the Commission is based on a linear relationship between scientific advice, provided by a Scientific Committee, which feeds directly into decisions in the policy-oriented Commission in the form of management measures.

Most recently we have seen this play out in the development and promotion of marine protected area proposals in the CCAMLR domain. Establishing marine protected areas in East Antarctica is Australia's number one priority in CCAMLR at the moment (*Australian Antarctic Magazine* 24: 28, 2013).

A cornerstone of the development of these proposals has been rigorous consideration of the scientific basis and merit of the proposals by CCAMLR's Scientific Committee. The success of a measure as ambitious as marine protected areas in East Antarctica is completely reliant on the twin streams of science and policy and our ability as representatives of Australia to draw them together effectively.

Through CCAMLR we also have the example of work to reduce bycatch of albatrosses and petrels — species which are iconic, long-lived and threatened by some types of fishing practices such as longlining.

This work has involved scientific research to identify and test mitigation techniques; industry cooperation and a willingness to work with scientists to implement mitigation technologies; and international cooperation among CCAMLR Parties to develop and refine binding conservation measures.

The results have been dramatic. Seabird mortalities from longline fishing in one key CCAMLR division fell from 6000 birds per year in 1996 to just 21 seabirds in 2000. That's just one division of the CCAMLR fishery, but it's a snapshot of a bigger success story, and an example of what can be achieved through a highly effective interface between science and policy.

International policy

Any discussion of science informing Antarctic policy wouldn't be complete without reference to the Scientific Committee on Antarctic Research, or SCAR, which plays an important role in facilitating international cooperation on high quality science in the Antarctic region.

SCAR is older than the Antarctic Treaty system itself and it's been a major and influential contributor to the ATCM since the Antarctic Treaty was signed in 1959. The scientific advice provided by SCAR regularly forms the basis for ATCM Parties' discussions and decisions on a wide range of issues.

A current initiative is the first SCAR Antarctic and Southern Ocean Horizon Scan, which aims to draw together the best thinking on the top Antarctic scientific questions for the next two decades. This work will provide an excellent basis for the nations active in the Antarctic region to discuss how they can work together to tackle the big Antarctic science questions; consistent with the cooperation on scientific endeavour that is at the heart of the Antarctic Treaty.

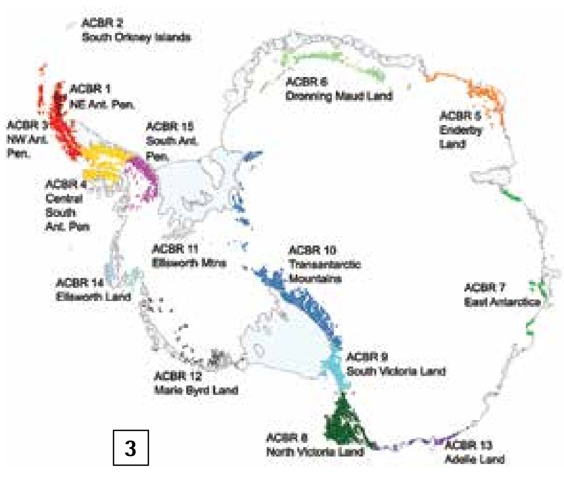
Also noteworthy in the international Antarctic policy space is the recent adoption by the ATCM of a Multi-Year Strategic Work Plan. This initiative, promoted by Australia, was adopted at this year's ATCM as an agreed list of collective priorities for the Antarctic treaty parties, and it's a great guide and reference point for anyone who wants to know where the work of the Antarctic nations is headed in the future, including the science community.

Finally, it's worth noting the role that scientific collaborations can play as fundamental tools of what's known as 'soft diplomacy' — a concept very familiar to politicians, strategists, diplomats and foreign policy makers, including those who are not experts on the science itself.

Science collaborations are great for building links between people, and they're often excellent ways to build some resilience and positive elements into otherwise thin or unsettled bilateral relationship. They are also tools of economic diplomacy which can help to promote Australia's image as an innovative and technologically advanced country in ways that boost our overall attractiveness as an investment destination or trading partner.

One example of this being recognised at the strategic level in Australia is the Asian Century White Paper released by the Australian Government in October 2012. One of the identified pathways towards achieving closer integration between Australia and Asia over the coming decades is for the government to: 'Support Australian researchers to broaden and strengthen their partnerships with the region as Asia grows as a global science and innovation hub'. Antarctic science is one of the most prospective avenues through which this pathway can be advanced, particularly given the close links between Australian researchers and counterparts in China, Japan, India and Korea, four of the five key Asian partners identified in the White Paper.

Finally, I'd like to reflect on the words of former UK Foreign Secretary David Miliband, speaking at the 2010 Inter-Academy Panel of the British Royal Society: 'The scientific world is fast becoming interdisciplinary, but the biggest interdisciplinary leap needed is to connect the worlds of science and politics'. That's a nexus we in Australia have been working hard to strengthen, and which will be bolstered further through the exchanges at this conference.



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Managing the cost of pest eradication

Seabird biologist Dr Rachael Alderman coordinates a long-term seabird monitoring program on Macquarie Island for the Department of Primary Industries, Parks, Water and Environment (DPIPWE), based in Tasmania. During the 'Strategic Science in Antarctica' conference she described the impact of poison baiting on giant petrels, during the rabbit, rat and mouse eradication project on the island. A 30% decline in the population of both northern and southern giant petrels has been observed, but there is optimism that populations will bounce back.

FREDERIQUE OLIVIER

1

The introduction of alien species to subantarctic Macquarie Island began in the 1800s with the first human visitors, the sealers, to the island. The most conspicuous aliens, however, are the vertebrate pests, of which a variety have been introduced, deliberately and by accident, by sealers and the early research expeditions. Five species established feral populations on the island: wekas *(Gallirallus australis)*, cats *(Felis catus)*, European rabbits *(Oryctolagus cuniculus)*, black rats *(Rattus rattus)* and house mice *(Mus musculus)*. Collectively, these five have contributed to the extinction of endemic species (the Macquarie Island parakeet), the localised extinction of burrowing petrel species, and a decline in the abundance and breeding performance of a range of seabird species through predation and habitat degradation.

The Parks and Wildlife Service commenced management programs in the 1970s, with myxomatosis virus introduced to control rabbit numbers in the mid 1970s, eradication of wekas in 1989 and cats in 2000, and ad hoc baiting, trapping and shooting of rabbits and rodents.

Rabbit numbers have fluctuated over the years due to a range of factors. However, a recent peak in numbers at an estimated 150 000 in 2005, saw the island exposed to devastating grazing pressure. In response to lobbying, state and federal governments committed to funding the eradication of rabbits, rats and mice. The resulting Macquarie Island Pest Eradication Project (MIPEP) began in 2007.

The MIPEP plan involved aerial baiting of the island followed by on-ground hunting for survivors by specially trained dogs and their handlers (*Australian Antarctic Magazine* 23: 12–13, 2012). While this method has so far proved a success — with no rabbit and rodent sightings since 2011 — what was the cost to non-target species?

The aerial baiting posed two potentially significant impacts to native wildlife: disturbance of bird colonies by helicopters, and non-target poisoning, particularly of scavenging seabird species such as the northern and southern giant petrels, skua and kelp gulls.

The primary mitigation measure for both impacts was to conduct the aerial baiting between May and August, when the majority of seals and seabirds had left the island in between breeding attempts. This would not be effective for king penguins, which are present in large colonies year-round and have been known to stampede with fatal consequences in the past. Instead, specific over-flight protocols were developed for helicopter activities around the king penguin colonies.

The risk of poisoning non-breeding birds that would be present over the baiting period was recognised. However, the plan considered what was generally known about the spatial and temporal abundance and foraging behaviours of these susceptible species and concluded that population-level impacts of any mortality were likely to be limited and the risk was acceptably low.

In the first half of the aerial baiting phase in 2010, with less than 8% of the required bait dispersed due to weather, the first birds to to die of primary, secondary and even tertiary poisoning were detected. Due to delays in the baiting program, a decision was made to postpone further baiting until the following season.

Ad hoc searching over the next six months recovered 960 dead birds, including 323 giant petrels, 230 skuas, 385 kelp gulls and 22 ducks. These numbers are likely conservative as many carcasses would not have been detected if the birds had already been scavenged, or had died at sea. However, they are substantially higher than many anticipated.

For the giant petrels, listed as threatened under both our national and state legislations, this high mortality caused significant concern and triggered a review of the eradication and the non-target mitigation actions. It was widely agreed that the eradication needed to continue and two additional mitigation measures were identified.

The primary mitigation measure was the novel release of rabbit calicivirus, to reduce the rabbit population prior to baiting and subsequently limit the number of poisoned rabbit carcasses available to scavengers. When it was released in February 2011, the virus was spectacularly successful. By the end of April it had killed an estimated 90% of the rabbit population.

The secondary mitigation measure was to provide additional team members during the baiting phase, whose task was to systematically search for poisoned carcasses – both target and non-target species – and remove them.

By the end of the second aerial baiting attempt in 2011, in which all the bait was distributed, nearly 1500 birds were recorded dead; approximately 1.5 times more than in the previous baiting attempt. However, two things need to be remembered. Firstly, the search effort in 2010 was substantially less comprehensive than in 2011. Secondly, over 10 times the volume of bait was distributed in 2011 compared to 2010, but this was not matched by a proportionately similar increase in non-target mortality. Under these two criteria, the mitigation actions implemented for the 2011 aerial baiting were highly successful.

Nonetheless, at least 2500 birds died over the two baiting periods. 760 of these were threatened giant petrels, which has significant impacts on their populations.

Genetic analysis of samples collected from the giant petrel carcasses that were recovered on the island indicated that the majority were northern giant petrels (40:1 northern:southern). This is despite the fact that southern giant petrels are more abundant than northern giant petrels on Macquarie Island. We also found a very strong gender bias, with 80% of all giant petrels found on the island being male. Giant petrels form long-term monogamous pair bonds and it takes both birds of a pair to successfully rear a chick, so male biased mortality such as this exacerbates the effects on the population.

DPIPWE have been monitoring giant petrels breeding on Macquarie Island since 1994. Prior to the commencement of baiting, breeding populations of both species were increasing. Not surprisingly, a substantial decline of about 30% has been observed in northern giant petrel breeding numbers as a result of the baiting. Annual monitoring is continuing and it will take several more years before we can say how the population is responding conclusively. To date, there is no indication that the decline has continued beyond the initial mortality event and we can be cautiously optimistic that the increase will resume and numbers will return to those prior to the MIPEP baiting.

Monitoring of the southern giant petrels has provided some unexpected results. Although very few deaths of this species were documented, a decline in the breeding population of a similar magnitude as the northern giant petrels has been observed. A likely explanation, based on known intra-specific differences in foraging behaviour, is that mortality of this species was not detected because they died at sea. Ongoing monitoring is similarly required to understand how this population has been affected and if and when it will recover.

RACHAEL ALDERMAN
Senior wildlife biologist, DPIPWE

1. The northern giant petrel (*Macronectes halli*) feeds primarily on carrion, putting it at risk from scavenging poisoned rabbit carcasses.
2. The southern giant petrel (*Macronectes giganteus*) tends to feed more in coastal and pelagic waters than its northern counterpart, which feeds primarily on carrion.
3. Light and dark morphs of both southern and northern giant petrels on Macquarie Island.
4. Dr Rachael Alderman reads band numbers of breeding shy albatrosses on Albatross Island (off Tasmania's north-west coast), as part of a long-term population monitoring project.

Hot rocks add heat to ice sheet models

Incorporating the distribution of 'hot rocks' in East Antarctica into ice sheet models, will improve predictions of ice sheet behaviour and potential sea-level change, according to new Australian research.

Speaking at the 'Strategic Science in Antarctica' conference in June, Dr Chris Carson from Geoscience Australia, said naturally occurring 'heat-producing elements' – mainly uranium, thorium and potassium – present in certain rock types found in Antarctica, contribute to local and regional-scale variation in heat flow underneath the ice sheet. They do this by generating tiny amounts of heat by radioactive decay.

'These regions of elevated heat flow potentially can contribute to ice surging and ice stream flow,' Dr Carson said.

Sub-glacial heat flow under the West Antarctic ice sheet has been measured at a number of sites and found to be elevated due to active rifting and volcanism. However, crustal heat flow beneath the East Antarctic ice sheet is poorly understood, and instead, a broadly uniform heat flow across much of the region is often assumed in ice sheet models. Such assumptions ignore the natural variability of heat flow due to variations in the sub-glacial geology.

To illustrate the scale and importance of this variability, Dr Carson and colleagues from the Australian Antarctic Division, Antarctic Climate and Ecosystems Cooperative Research Centre, University of Melbourne and the University of Texas, recently published a paper in the *Journal of the Geological Society, London*, describing the distribution of hot rocks, and their impact on regional heat flow, in different parts of the Australian Antarctic Territory.

In a 275 km transect along the Prydz Bay coastline – running from the Vestfold Hills to the Amery Ice Shelf – heat production values for individual rock types (derived from geochemical analysis of the rocks) ranged from 0.02 µW per cubic metre to almost 66 µW per cubic metre (1 µW [micro Watt] is 0.000001 Watts).

'Rocks of the northern Prydz Bay region – the Vestfold Hills and Rauer Group – have generally low heat production,' Dr Carson said.

'However, in southern Prydz Bay, there are numerous outcrops of Cambrian-aged granites which are characterised by elevated heat production. The presence of these hot rocks fundamentally affects the regional heat flow in the region.'

Available aeromagnetic data suggests that these hot granites may be more widespread underneath the ice sheet in southern Prydz Bay.

Dr Carson said a better knowledge of the sub-glacial location and distribution of such granites across East Antarctica is essential for understanding regional heat flow characteristics of the Antarctic crust. This information can then be factored into ice modelling studies.

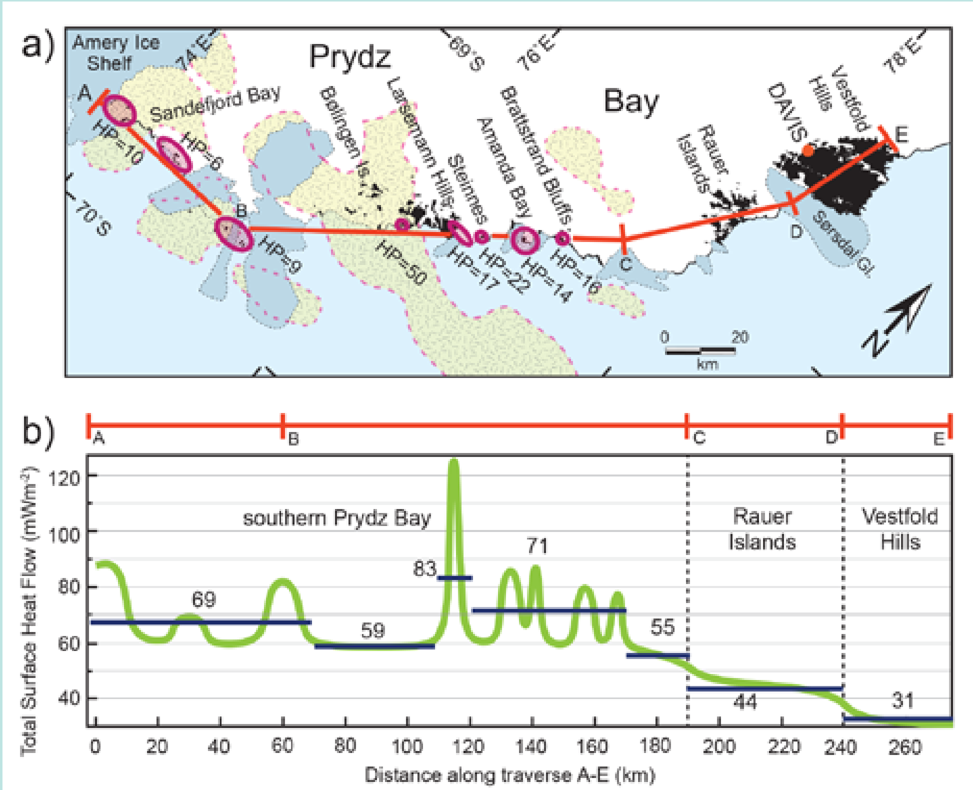
'The assumption that the crust of East Antarctica is thermally homogenous is inappropriate and it is critical that both local and regional geology are considered in ice modelling studies,' he said.

'As elevated and variable heat flow would have a fundamental effect on ice sheet behaviour, incorporating geological controls on heat flow into models could refine predictions of ice mass balance and sea-level change.'

WENDY PYPER
Corporate Communications, Australian Antarctic Division

Dr Carson and his colleagues undertook heat flow modelling of a 275 km section of the Prydz Bay coastline, using measurements of naturally occurring uranium, thorium and potassium present in rock outcrops. In figure 'a' the ellipses along the transect line show the location and extent of known high heat-producing Cambrian granites, with the average heat production (HP) for each outcrop in µW per cubic metre. Dashed pink lines show the possible sub-glacial extent of 'hot' granites inferred from geomagnetic surveys. The light blue area represents the East Antarctic ice sheet and the dark blue areas show glaciers and floating ice shelves.

Figure 'b' shows the modelled heat flow profile across the transect, showing the impact of high heat-producing Cambrian granites of southern Prydz Bay on sub-glacial heat flow. The green line shows modelled surface heat flow along the transect and the blue horizontal lines are average heat flow values for selected areas. The modelling predicted a background heat flow of about 60–70 mW (milli Watts) per square metre in southern Prydz Bay. However, the occurrence of hot granites delivers local 'hotspots' of heat flow of 80-90 mW/m² and up to 120 mW/m².



GEOSCIENCE AUSTRALIA

For more details see *Journal of the Geological Society, London*, 2013.
http://dx.doi.org/10.1144/jgs2013-030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EDWARD GREW


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GEOSCIENCE AUSTRALIA

1. Rocks in the Rauer Group of islands in northern Prydz Bay have generally low heat production.
2. Cambrian-aged granites, such as this outcrop near Landing Bluff, Sandefjiord Bay, contain radioactive heat producing elements which contribute to regionally elevated sub-glacial heat flow in East Antarctica.
3. Detail of a Cambrian-aged granite in Antarctica. The Cambrian period lasted from about 542 to 488 million years ago.

DON BUTLING

Aneata: the 'Ice Maiden of Antarctica'

The Australian Antarctic Division possesses many heritage items, to which are attached fascinating stories of Australia's social, cultural and scientific history in Antarctica. One such item is 'Aneata', a little wooden caravan mounted on a surplus US Navy cargo sledge. Former Antarctic expeditioner Bill Burch tells 'her' story.

Unique in the annals of Antarctic history, Aneata was designed and built from spare timber and plywood at Wilkes station by Don Butling, the plumber for the 1960 Australian National Antarctic Research Expeditions (ANARE) party. He had been asked by the boss, Harry Black, if he could do it as a preferred option to using tents on extended trips.

Don designed and assembled the shell from Oregon framing timbers and plywood, then fitted her out and painted her in the spacious garage at Wilkes station. As there was no insulation material spare at the station, only a 50 mm air gap separated the occupants from the chill of Antarctica. On Tuesday September 13, 1960, the completed van was duly towed out into the open and a short ceremony, with a bottle of Champagne, endowed her with the name of Don's wife, Aneata.

She was quickly pressed into service, housing nominally three men during trips out to the plateau some 80 km inland from Wilkes – a place known as 'S2', where the Americans had dug a 30 m deep pit into the ice for glaciological observations back in 1957. It was on just one of those trips a year later when I had cause to share Aneata with three others.

It was a clear, calm, windless night and the temperature dropped below -40°C. We stayed fully clothed and climbed inside two down sleeping bags each, yet we all reported a tooth-chattering, bone-chilling night with little sleep. I became the 'butt' – pardon the pun – of the camp next morning on attempting to complete a call of nature. Having loosened all the appropriate clothing fastenings, I grabbed the toilet roll from above the stove, jumped out of Aneata and did the necessary. Then, on reaching for the paper, I was confronted by a cylinder of solid ice! Steam from our breakfast cooking had permeated the roll, which had rapidly frozen solid.

But the highlight of Aneata's travels was in 1962 on a journey from Wilkes to the 'Pole of Inaccessibility' – the Russian base, Vostok; a distance of 1500 km and rising to an altitude of 2500 m. This is where she earned the sobriquet 'Ice Maiden of Antarctica', as temperatures plummeted to -80°C. Even a small flask of overproof brandy stored on a shelf froze solid.

Late in 1963 Aneata was already nearing the end of her touring life. The sledge runners were wearing thin and the sand blasting effects of numerous icy blizzards whipping across her skin had peeled back so much paint that a fresh paint job was called for at the very least. The only problem was that the only paint left at Wilkes was two large tins of red and white. The two were combined and a hideous pink colour was summarily slapped all over her, whereupon she

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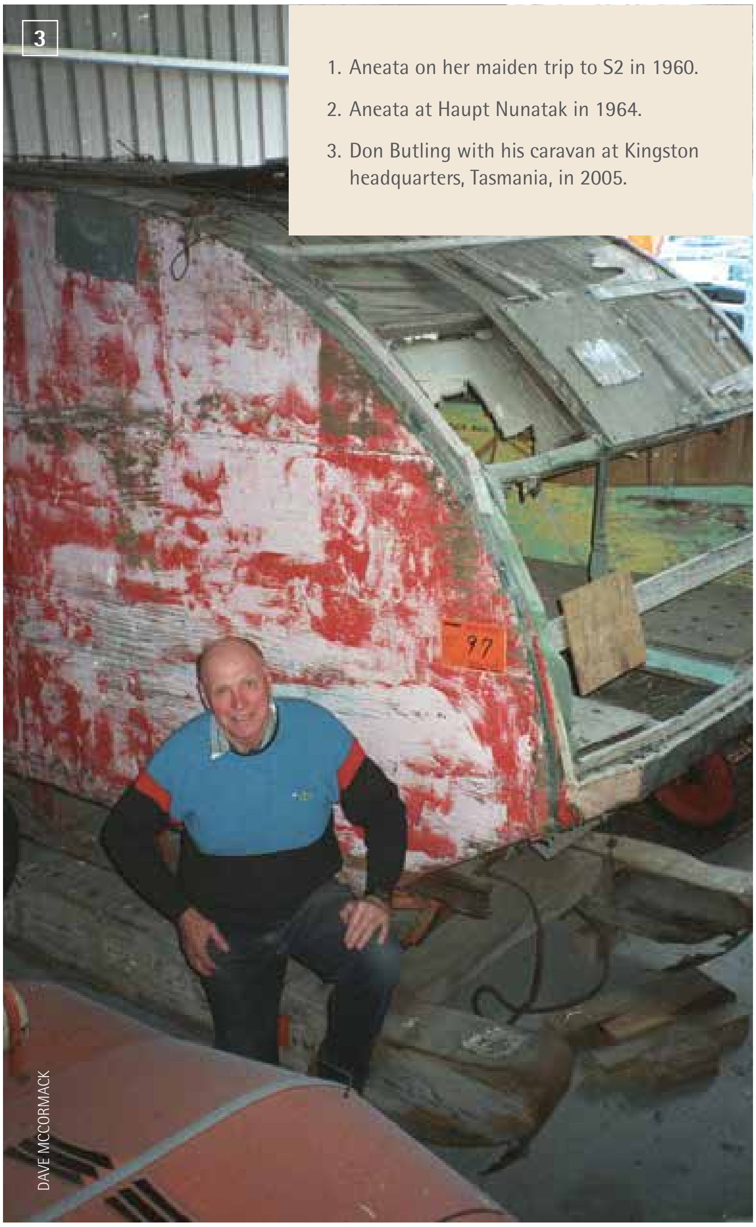
ALEX CAMPBELL-DRURY



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DAVE MCCORMACK

1. Aneata on her maiden trip to S2 in 1960.
2. Aneata at Haupt Nunatak in 1964.
3. Don Butling with his caravan at Kingston headquarters, Tasmania, in 2005.

was renamed 'Passion Pink People's Palace'. She was then taken some 20 km south-west down the coast to an observation point near the large Vanderford Glacier, where she became a refuge field hut for glaciologists. Here, she was firmly guyed down with stainless steel wires onto a rocky outcrop known as the Haupt Nunatak.

In 1964 three expeditioners were trapped in her for several days during a ferocious blizzard. The wind tore up rocks, gouged ice from the hills nearby and hurled them at Aneata and her cocooned men. They'd been reported missing as there had been no radio contact, but the guy wires held, the blizzard eventually ran out of puff and the three made it safely back to Wilkes.

Aneata or 'The Vostok Van', as she was now known, rather prosaically, continued to be just a field refuge for several years, during which time Wilkes station was abandoned and replaced by Casey station, a few kilometres around the headland.

At some point, a particularly fierce king blizzard succeeded in tearing off some of her plywood skin, so she became uninhabitable. Yet through all this the stainless steel guy wires held her fast to the rock. By 1982, her unique Antarctic heritage was deemed worthy of conservation. Late in that year she was cleared of most of the ice and snow, put up onto a large sled and taken back to Casey. She was eventually returned to Australia.

Aneata now sits just as she was rescued, in a storage shed at the Australia's Antarctic Division's Kingston headquarters. She shares the shed with some of the vehicles which escorted her on her many travels, and together they all exude an aura of our proud Antarctic history from the past half-century or so.

But Aneata is very special; indeed unique. She was conceived and built at an ANARE base 53 years ago and travelled over thousands of kilometres, providing refuge, if not exactly comfort, to many ANARE personnel. I am now in discussions with the Australian Antarctic Division and others about restoring her to her former glory. She, and her intrepid story, would be a worthy addition to any future Antarctic museum.

BILL BURCH

Former geophysicist, Wilkes 1961

ANARE Club, New South Wales

Australian Antarctic Medal celebrates 25 years

The Australian Antarctic Medal, established in 1987, is an award in the Meritorious Service Awards category of the Australian Honours System. The Australian Antarctic Medal replaced the (British) Imperial Polar Medal and its variations which date back to 1857 for service in the Arctic and Antarctic regions.

Prior to 1982 there were two Australian committees set up by Ministerial appointment to cover the award of the Polar Medal and the naming of places and features in the Australian Antarctic Territory. The medal committee worked in close liaison with the Polar Medal committees of the United Kingdom and New Zealand to ensure that the standards being applied for awards of the medal were consistent between the three nations. 1982 saw the creation of a combined committee – the Australian Antarctic Names and Medal Committee – to administer both Antarctic place names and the Polar Medal.

The first meeting of the new committee, chaired by Sir Russel Madigan (son of Dr Cecil Thomas Madigan from the Australasian Antarctic Expedition) considered awards of the Polar Medal for the 1982 expedition year. However, shortly after coming to power on 11 March 1983, the first Hawke Ministry declared that the Australian Government would no longer recommend anyone for an Imperial award.

At its meeting on 3 December 1984, the Committee noted that the Government had agreed to examine a proposal for an Australian award for service in Polar Regions. The Committee agreed 'that there should be an Australian Award to honour outstanding achievement in the Australian Antarctic Territory ... (and) that the award could also be given for scientific achievement and exploration'.

There was some discussion about the design of the medal: 'The medal shall be of silver and octagonal in shape, bearing on the obverse the Australian coat of arms and on the reverse a representation of the hut at Commonwealth Bay with a figure leaning on an ice-axe in the foreground'. This represented a departure from the Imperial medals in that the Sovereign's head was not to form the obverse of the medal.

On Australia Day 1986 Prime Minister Bob Hawke announced that: 'The Federal Government has agreed on a number of new awards to enhance and develop the Australian Honours System... They will include medals for exceptional service by Antarctic expeditioners'.

By this stage Mr Michael Tracey of Colonial Fine Arts Gallery, Queensland, had submitted several designs for the medal and the Committee decided that

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AAD

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3

STEVEN BROWN

the obverse of the medal should be based on the current Antarctic Service Medallion; a map showing Australia and Antarctica.

It was agreed that the design should not include New Zealand or topography (as did the Service Medallion) but should identify the Australian Antarctic Territory clearly by stippling. The medal should be inscribed 'For outstanding service in the Antarctic' with the year or years of service shown on a clasp in the ribbon. Second and subsequent awards would be identified by placing an ice crystal pin on the ribbon when worn on uniform. The same ice crystal design would be used for a lapel badge to be worn by recipients.

There appeared to be some dissatisfaction with Mr Tracey's designs and the Committee asked Mr Stuart Devlin to submit designs as well. Mr Devlin had designed the insignia for the Order of Australia as well as the decimal coinage. While Mr Tracey's map was approved by the Minister for use on the obverse of the medal, the Committee decided to terminate Mr Tracey's design involvement. Mr Devlin's final design was submitted to the Minister and approved on 21 January 1987.

Some years later, in 1992, an article appeared in the *Australian Coin Review* which noted: 'It is disappointing to record that the Medal is, like most Australian awards, poorly manufactured and unattractive...when compared to the Polar Medal, the Antarctic Medal, in the words of one of the recipients, "looks like a Woolworths job – the difference is like chalk and cheese"'.

On 2nd June 1987 Her Majesty the Queen signed the Letters Patent which established the 'Antarctic Medal', and on 22nd June the first recipients were announced. Sixteen awards were made, covering 1981 to 1986. Unfortunately, the medals were not finished in time for presentation, nor had the ribbon been manufactured – neither of these deficiencies were remedied until 1989.

The 1990 meeting of the Committee noted that the medal had finally been minted and that investitures were held around Australia. Sir Russel Madigan and Dr Phillip Law (the Director of the Australian Antarctic Division from 1947–1966) attended the Melbourne ceremony.

The 1996 meeting of the Committee was held at the Australian Antarctic Division's headquarters in Tasmania for the first time. The Committee noted the proposal that the Antarctic Medal be re-named the 'Australian Antarctic Medal' and that all recipients of the medal would be granted the post-nominal letters AAM.

In 2003, Parliamentary Secretary Dr Sharman Stone, permitted the Committee to nominate candidates for the medal if, in its opinion, the nominations provided to it did not measure up to the requirements. This move recognised that the strength or weakness of an Honour depended on the quality of nominations it received.

By 2011 the regulations for the Honour had been widened to enable the medal to be granted to Australian scientists or supporting officers attached to scientific research expeditions undertaken by other Treaty Nations; providing, of course, that the normal requirements of the medal were met.

Unique among the Meritorious Service Awards, the Australian Antarctic Medal can be awarded to the same person for a second and subsequent occasion, and there is no quota imposed on the number of awards per year. The medal can be awarded posthumously and it may also be withdrawn.

Any person may nominate an expeditioner for the award of the medal and all recommendations are considered by the Australian Antarctic Names and Medal Committee. The Committee makes recommendations to the responsible Minister or Parliamentary Secretary who then provides his or her recommendations to the Governor-General by the end of May each year. The Governor-General announces the awards in a special Honours List on Midwinter's Day (21 June); a time of traditional significance to all who have worked in the Antarctic.

Except in exceptional circumstances, the recipient of a medal will have worked for not less than 12 months (may be an aggregate) in the Antarctic climate south of latitude 60° south, or elsewhere in the Antarctic region where 'the rigours of Antarctic climate and terrain prevail'.

2012 was a significant year in that it saw the first award of an additional clasp being made – to Australian Antarctic Division seabird ecologist Dr Graham Robertson – and the first posthumous award to the late Dr Neil Adams of the Bureau of Meteorology (*Australian Antarctic Magazine* 23: 33–34, 2012). It also saw the first award of the medal to a person under the 'special circumstances' clause – to Dr James Doube for his outstanding contributions to polar medicine. Dr Doube had not wintered below 60° south, but had spent two winters at Macquarie Island. These high notes ended the first 25 years of the Australian Antarctic Medal.

JOE JOHNSON

Chair, Australian Antarctic Names and Medal Committee

1. The Australian Antarctic Medal is presented in a box containing: a 'ribbon bar', for those in the uniformed services to wear on their uniforms; a miniature medal for wearing with formal evening dress; a lapel badge for everyday wear; and the full-sized medal for wearing on appropriate occasions during the day. The full sized medal has the recipient's name stamped on the rim.
2. The obverse of the octagonal-shaped medal bears a stylized map of Australia and Antarctica, surrounded by the inscription 'For Outstanding Service in the Antarctic'. On the reverse of the medal is a depiction of an expeditioner walking in to drifting snow, with Mawson's Hut in the background. Surmounting the medal is a small six-sided ice-crystal device linking the medal to its suspension bar. The medal is suspended by a 32 mm-wide white moiré ribbon, edged on each side with three narrow stripes of blue, representing the transition of water to ice as one approaches Antarctica. A date bar attached to the ribbon indicates the period of service in Antarctica for which the medal has been awarded, or, in the case of consecutive years, the year in which the award was made.
3. The obverse of the Polar Medal.

Managing ecotourism on Heard Island

Ecotourism has escalated in the last decade as more people seek exotic locations in which to spend their recreational time and increase their ecological understanding of the world.

The phenomenon divides those responsible for the management of these exotic, often threatened, natural environments, into those who fear the impacts that increased tourist numbers have on these remote environments, and those who embrace the opportunities — such as the ability to develop strong community advocacy for the ongoing role management plays in protecting such special places.

Among the destinations that have captured ecotourists' imaginations is Heard Island, managed on behalf of the Australian Government by the Australian Antarctic Division. As one of the most remote, non-populated locations on earth, the issues associated with managing ecotourism risks are complicated. At this stage, the number of visitors is comparatively low. Sea travel remains the only viable method of accessing the island, and the 8–10 day sail in often hostile oceanic conditions deters most commercial operators, reducing the need for active management.

However, Heritage Expeditions from New Zealand, has made Heard Island a tourist destination twice in the last 10 years. The latest trip left Fremantle on 8 November 2012 and returned to Albany, Western Australia some 24 days later (see next story). The voyage enabled the Australian Antarctic Division to test its capacity to deal effectively with the risks of tourism in this pristine and dynamic environment, and to test quarantine restrictions that form the basis of biosecurity measures used for more complex scientific expeditions to the territory.

The 2002 Heard Island and McDonald Islands (HIMI) Marine Reserve Management Plan, which is currently being updated by the Australian Antarctic Division, provides administrative interpretation to legislation that protects the HIMI Marine Reserve. The document sets out the Antarctic Division's expectations for tourism operators, or any other visitor. Through a permit system, stipulating adherence to this document, visitors are bound to implement the conditions of entry.

The requirements aim to minimise the impact of visitation. Primary focus is given to implementing strict quarantine controls that have been developed over the past 10–15 years by the Antarctic Division to prevent the introduction of alien species to the Reserve's pristine environment. These controls are underpinned by scientific research carried out as part of the International Polar Year *Aliens in Antarctica* project.

Protective measures include the placement of rat guards on all vessel berthing ropes while they are in port prior to departure; monitoring of the vessel for signs of rodents; vacuuming of clothing, day packs and equipment taken ashore; restriction on the types of foods that can be taken ashore; and the cleaning and sterilisation of boots as people disembark.

But how can management be sure that operators are undertaking all that is required to protect the environment?

Written into the Management Plan is the discretionary appointment of an onboard Inspector — someone appointed on behalf of the Antarctic Division to ensure compliance with the issued permit, and to provide educational support to the tourist groups, explaining the significance of maintaining a near-pristine environment.

The inspector's role is critical to maintaining the biosecurity barrier that is naturally formed by the island's remote location. As Inspector for the 2012 voyage, I was able to monitor the biosecurity operations undertaken by Heritage Expeditions and involve myself in the educational aspects of the process.

This process involves building up the layers of knowledge amongst expeditioners. It begins with introductory lectures about the impact of introduced species on island communities, highlighting the expensive lessons that have been learnt from past biosecurity transgressions (such as on Macquarie Island). It progresses to pre-disembarkation briefings and clothing inspections. Expeditioners are immersed into a

world where the expectations of maintaining biosecurity vigilance becomes second nature — one of the few advantages to spending so much time at sea prior to arrival.

In 2002, on their last voyage to Heard Island, Heritage Expeditions allowed me, as the appointed Inspector, to run the first pilot of the biosecurity process on a tourist vessel. The pilot was part of a scientific study to identify the primary pathways for alien species introduction into the Antarctic region. The study, led by Australian Antarctic Division Principal Research Scientist Dr Dana Bergstrom, was the precursor of the international *Aliens in Antarctica* project. Information collected during these early studies led to the development of biosecurity procedures that were later adopted by IAATO (International Association of Antarctic Tourist Operators) and are now implemented by most vessels operating in the Antarctic area. As such, Heritage Expeditions has been an advocate of the biosecurity process, making the role of the inspector considerably easier than it might otherwise have been.

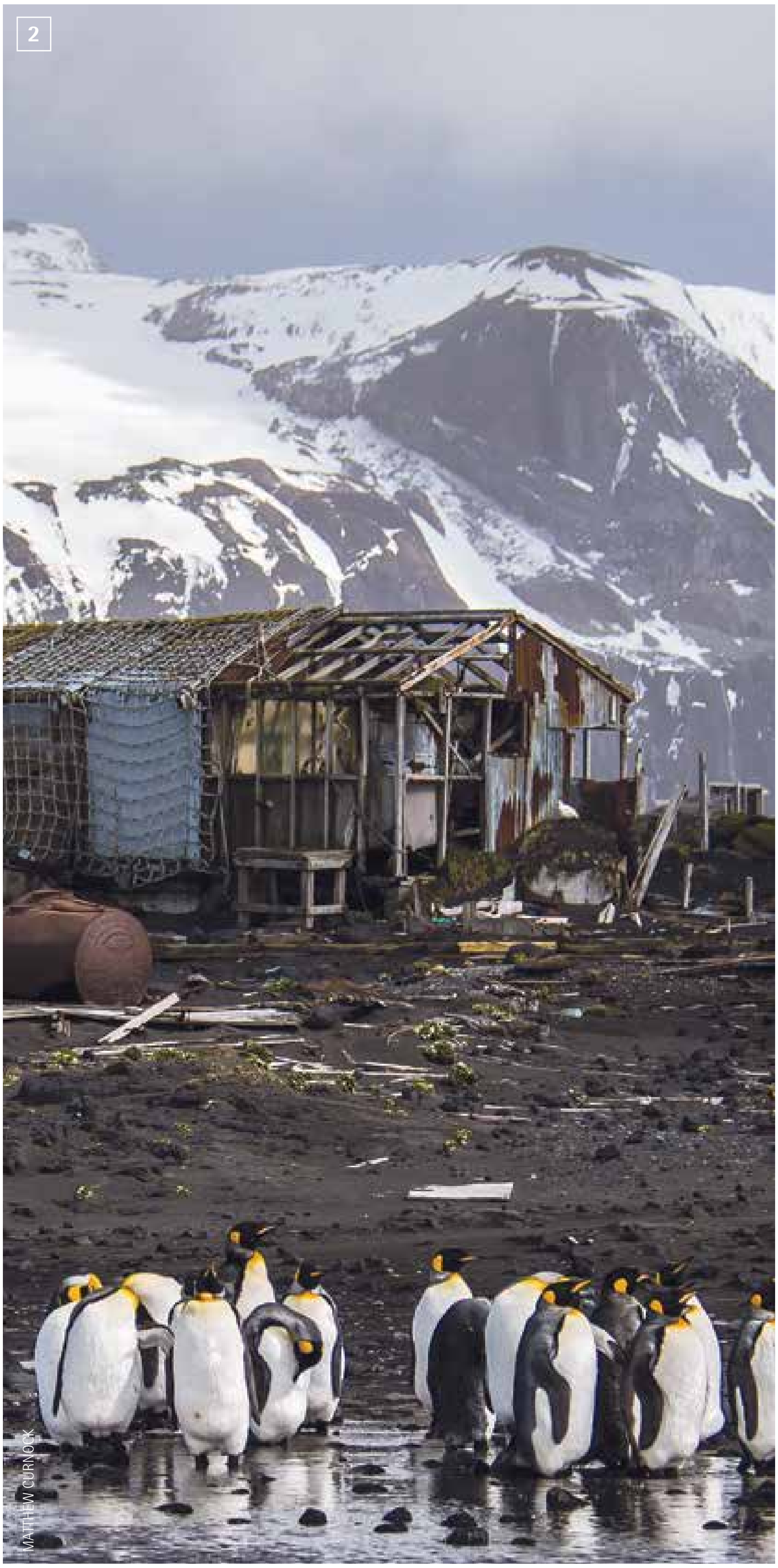
The result for the 2012 tourist voyage was a landing at one of the most amazing, pristine places on the planet, where all participants could rest easy in the knowledge that the greatest impact they will have left on the ground was the impression left by their feet.

KATE KIEFER
Australian Antarctic Division

1. Small boats ferry tourists from ship to shore.
2. King penguins preen amongst the relics of human occupation on Heard Island.

Heard Island lifts her skirts

As is typical of the Southern Ocean, the trip from Fremantle to Heard Island, into the prevailing direction of the weather systems that sweep monotonously over this vast stretch of ocean, was a challenging one for all involved. Nine days of unrelenting pounding by the waves had all on board wondering why they would sign themselves up for such torture, let alone pay good money for the privilege.



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MATTHEW CORNOCK

A brief respite was found in the lee of Ilê Amsterdam, a minute speck of land in the roaring 40s, home to a small population of French scientists and support staff, and of the legendary, rare Amsterdam Island albatross — the object of desire on the 'must see' list for the multitude of 'birders' on board Heritage Expeditions Voyage 1262 (see previous story).

The following three days saw favourable weather conditions producing strong northerly winds, pushing the ship quickly towards our ultimate destination. But what was seen as a blessing while at sea rapidly became the enemy as the island drew closer — the northerly swell whipped up by the winds was running straight into Atlas Cove — the island's only safe and usually protected anchorage.

Despite the blizzard-like conditions on the day of arrival, the bridge was swarmed by those wanting to get their first glimpse of the island. However, the temperamental mistress had other ideas...the island was typically shrouded in low cloud, visibility was down to about 200 m and ice particles flew through the air, driven by 65–70 knot winds that were now whirling relentlessly into Atlas Cove from the south-west. All that effort undertaken in the previous 24 hours — vacuuming clothing, inspecting boots and carefully packing gear into the cleanest backpacks in existence would be for naught today; there would be no landing.

After an unpromising start to our second day at Heard, the first decent sights of the island were had as the shrouding skirts of cloud slowly rose to reveal the coastal flanks of the island. Eventually, the predictions of the weather bureau came roaring into reality, with Atlas Cove finally providing favourable landing conditions. There was a mad scurry as people clambered to eat their lunch, dress themselves warmly, gather their gear and pass through the biosecurity foot baths. Within half an hour their dreams were realised, as they waded ashore in the frigid shallows of Atlas Cove, staring in disbelief at the vista that spread before their eyes — elephant seals making horrendous noises in the shallows, wind whistling across the barren sands of the Nullarbor, ice jammed up against the windward side of plants that were clinging to the edge of their existence, light mantled sooty albatross gliding across wind-blown skies, and the smell — that distinctive mix of something freshly maritime mixed with the deep organics of a land dominated by animal life.

Standing on the beach, each group of tourists surrounding me in a tight huddle, I gave one final briefing to orient everyone and reinforce the rules, before they were off on their own Heard Island adventure, scattering to the far corners of the Atlas Cove visitor zone. Many headed towards the nearest penguin colony, keen to add the southern rockhopper to their list of observed species. Others sought the solitude of a vast plain of black sand that stretched between the landing point

3. A 'birder' captures another prize photo.
4. Heard Island bathed in a sun-drenched colour palette.

KATE KIEFER

and the Baudisson Glacier. After 12 days in the confines of a small, rolling ship, this was heaven!

As the day wore on the weather conditions improved, until by 5 pm, a rare spectacle was witnessed. The cloud completely dissipated and the island was lit by glaring sunlight bouncing off the great sheets of ice that dominate the landscape above 300 m. And there it was — Big Ben, the massive dome that tops the island, so rarely seen without cloud from Atlas Cove, bathed in bright sunshine. The sun's rays filtered through the steam that slowly wafted from the volcanic fumaroles close to the summit. It was only now that the enormity of this island became apparent to most…the 2745 m pinnacle of Big Ben — known as Mawson Peak — is the highest point in the Commonwealth of Australia outside the Australian Antarctic Territory.

An exhausted mob slowly made their way back to the ship as the setting sun bathed the island in the purples, oranges and reds, so often not considered part of the colour palette in ice-dominated environments. Dinner was eaten amongst a cacophony of chatter about the experiences just had, the things witnessed and the amazement at the raw beauty of a place they'd only ever seen in pictures. Most had sated their appetite, been blessed with the most spectacular day Heard Island had to offer. For Rodney Russ, Expedition Leader, the pressure had visibly lifted from his shoulders — if another landing was not possible, at least everyone was happy, so he was happy!

The following day, rough conditions again foiled plans of a day ashore, so a visit to the rarely observed McDonald Islands was planned. A beautiful clear day ensured that the island group was fully visible, although the recent volcanic activity, including the formation of under-sea reefs, piqued the nerves of the Captain enough to make him keep his distance. Still, from about two kilometres away, telephoto lenses came into their own, with digital imagery confirming the return of breeding penguins and albatross to the island, notably absent some 10 years prior, due to a huge amount of habitat destruction through volcanic activity.

Upon return to Atlas Cove in the late afternoon the seas had calmed, enabling a second landing the following morning. By lunchtime it was all over. The dream of Heard Island had become a reality for this group, something to be talked about for the rest of their lives. For some, this had been a totally new experience, something invigorating, enlivening, exciting. For me, that familiar pang of leaving behind a place I love, with no idea of when or if I will ever see her again kicked in. On our slow journey home, the experience reinforced my understanding of how important the Australian Antarctic Division's role is in managing this special place: why we go to such lengths to protect it from accidental introduction of alien species; why the role of a HIMI inspector is so important, not only in enforcing the permit conditions, but also being able to take such a privileged group of expeditioners on that journey of understanding of environmental protection. And why the science we undertake at Heard Island is so integrally important for management.

The risk of tourism had been mitigated — we'd just had the most fantastic experience without leaving any negligible impact on this fragile, beautiful natural environment.

KATE KIEFER

Australian Antarctic Division

KATE KIEFER

A strategic plan for the Antarctic Treaty Consultative Meeting

As an original signatory to the Antarctic Treaty and a committed member of the Antarctic Treaty system, Australia actively participates in Antarctic governance arrangements through the annual Antarctic Treaty Consultative Meetings (ATCMs).

Over the course of the last two meetings, Australia has worked closely with other Consultative Parties to further focus the work of the key Antarctic governance forum through the creation of a Multi-Year Strategic Work Plan for the meeting.

At the 36th ATCM, in Brussels in May 2013, Consultative Parties agreed to adopt such a Plan (see text box) to help the ATCM focus on matters of priority and timely importance, operate more effectively and efficiently and schedule the meeting's work. By identifying a limited number of priority subjects, ATCM Parties can better prepare for focused discussions on key issues in advance of annual meetings.

While Parties remain free to raise matters on any of the regular ATCM agenda items, the 2014 meeting will focus on sharing information about strategic science priorities, cooperation on air and marine safety, land-based and adventure tourism and arrangements for information exchange between parties.

JASON MUNDY
Manager, Strategies Branch, Australian Antarctic Division

Under the Multi-Year Strategic Work Plan, Antarctic Treaty Consultative Parties agreed to undertake cooperation in three key work areas:

Ensuring a robust and effective Antarctic Treaty System

- Conduct a comprehensive review of existing requirements for information exchange and of the functioning of the Electronic Information Exchange System, and the identification of any additional requirements.
- Consider coordinated outreach to non-party states whose nationals or assets are active in Antarctica.
- Share and discuss strategic science priorities in order to identify and pursue opportunities for collaboration, as well as capacity building in science, particularly in relation to climate change.

Strengthening protection of the Antarctic environment

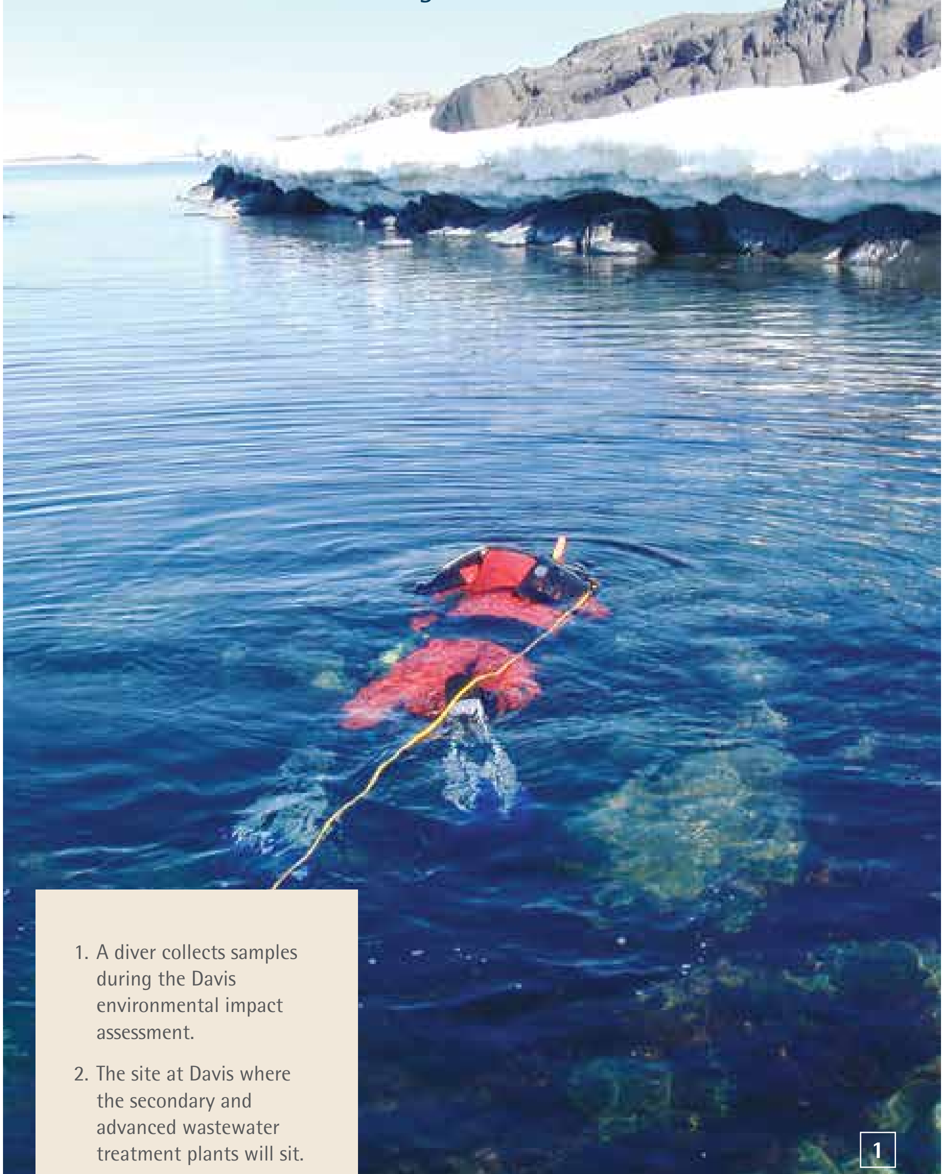
- Consider the advice of the Committee for Environmental Protection (CEP) on addressing repair and remediation of environmental damage and consider, for example, appropriate follow-up actions with regard to liability.
- Assess the progress of the CEP on its ongoing work to reflect best practices and to improve existing tools, and develop further tools for environmental protection, including environmental impact assessment procedures (and consider, if appropriate, further development of the tools).

The effective management and regulation of human activities

- Address the recommendations of the Antarctic Treaty Meeting of Experts on Implications of Climate Change for Antarctic Management and Governance.
- Strengthen cooperation among Parties on current Antarctic specific air and marine operations and safety practices, and identify any issues that may be brought forward to the International Maritime Organisation and International Civil Aviation Organisation, as appropriate.
- Review and assess the need for additional actions regarding area management and permanent infrastructure related to tourism, as well as issues related to land-based and adventure tourism, and address the recommendations of the CEP tourism study.

Grand wastewater designs

A state-of-the-art wastewater treatment system planned for Davis station, will convert effluent into some of the cleanest water in the world. This effluent will have minimal impact on the marine environment when it's discharged to the ocean.



GLENN JOHNSTONE

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MARK PEKIN

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1. A diver collects samples during the Davis environmental impact assessment.
2. The site at Davis where the secondary and advanced wastewater treatment plants will sit.
3. Welder, Stuart Norris, assists with the construction of the advanced treatment plant at the Australian Antarctic Division.
4. Components of the secondary treatment plant being built and tested in Germany.

Since 2005, when Davis station's original secondary treatment plant failed, effluent has been macerated and discharged to the ocean from a pipe at the water's edge near the station's wharf. While this disposal method meets the minimum requirements specified in the Madrid Protocol and the *Antarctic Treaty (Environmental Protection) Act 1980*, an environmental impact assessment conducted by Antarctic Division scientists in 2009–10, identified a need for enhanced secondary or tertiary sewage treatment.

'The environmental impact assessment showed that while the effluent was reasonably dispersed during the period of our study, it was not dispersed rapidly enough to prevent accumulation of some contaminants in the environment, and related adverse impacts,' says the assessment leader and marine biologist, Dr Jonny Stark.

To address these issues the Australian Antarctic Division established a project led by engineer, Michael Packer, to install both secondary and advanced wastewater treatment systems.* The first step was a request for tender for construction of a secondary sewage treatment plant that would meet Antarctic-specific requirements.

'The problem with sewage treatment in Antarctica is that there are significant technological requirements to process the water to a high level, but limited available knowledge to run the plants at the stations,' Michael says.

'When we prepared our specifications for tender, we picked components and processes that have a long history of operation in rugged conditions, that are simple to operate and that have low maintenance needs. We then put them together in a novel fashion that balanced maintenance, reliability and state-of the art features.'

They found part of their answer in German company Martin Membrane Systems, who has successfully provided secondary treatment plants for the German and Norwegian Antarctic programs.

Over the next three years the company will deliver secondary treatment plants to Davis, as well as Casey and Mawson, whose plants have reached their expected lifespan.

One of the Antarctic-specific operational requirements for the secondary treatment plants was that they accommodate large flows in summer, for up to 150 people, and significantly smaller flows in winter. To achieve this, Martin Membrane Systems designed the plants so that one of the tanks in the three-tank system can be switched off over winter.

The secondary plants will use a standard biological nutrient reduction process,

MICHAEL PACKER

3

MARTIN MEMBRANE SYSTEMS

4

where the effluent is digested by microbes in aerobic (oxygenated) and anaerobic (no oxygen) processes, before being filtered to remove the solids and microbes. A centrifuge will then reduce the solids to a cake for return to Australia.

Because the Madrid Protocol prohibits the introduction of non-native organisms into Antarctica, microbes from Casey's and Mawson's existing plants will seed the new systems. As Davis has no existing plant, effluent direct from the kitchen, bathrooms and other sources, will provide the seed culture for the system. This will extend the start-up time of the Davis system by about six months, as a healthy population of microbes becomes established.

The secondary treatment plants will also be able to process kitchen waste, improving the effluent quality before it enters the system. While the processing of multiple waste streams through treatment plants is quite common in Australia, it hasn't been attempted in Antarctica on this scale.

'Our Antarctic wastewater is very concentrated as there's no external addition of water, such as rainwater,' Michael says.

'So the plants have a high biological load, which affects the biochemistry to the point that there may not be enough carbon relative to the amount of nitrogen. Kitchen scraps will help rebalance this equation and improve the effectiveness of the plants. It also means we won't have to incinerate the kitchen waste anymore.

'At the end of the secondary treatment we expect to get good quality effluent by world standards. We'll improve on that further with the advanced treatment plant at Davis, so that we can address the issues that arose out of that station's environmental assessment.'

The advanced treatment plant is being built at the Australian Antarctic Division, with funding, research, design and testing input from academia and industry partners, including the Australian Water Recycling Centre of Excellence, Victoria University, the University of Melbourne, Veolia Water and AECOM.

The advanced treatment plant will employ an arsenal of germ-killing technologies to achieve an astounding 13 'log reduction' in pathogens. A one log reduction kills 90% of pathogens; a two log reduction kills 99%; and so on to 11 decimal places. The average log reduction from a freshwater treatment plant in Australia is four to five.

To achieve this kill rate the treated effluent will undergo ozone disinfection, ultrafiltration, passage through a biologically activated carbon filter, reverse osmosis, ultraviolet disinfection and chlorination.

The result will be some of the cleanest water in the world. In fact, it will be so low in salt, it will corrode metal pipes, so lime will have to be added to replace the salts and ions characteristic of normal tap water.

While there are no immediate plans to use the purified water for drinking, the project partners are researching the level of processing needed to achieve potable reuse using their methods, based on the *Australian Drinking Water Guidelines* and *World Health Organisation Guidelines*.

Once built, the advanced treatment plant will fit inside two shipping containers. This will include space for a laboratory for regular water quality testing. The plant will then be shipped to Victoria for extensive testing by academic and industry partners at an urban water site.

'The plant will be run for two years to iron out any problems and give our academic partners an opportunity to conduct a range of research and improvement projects, some of which will continue in Antarctica,' Michael says.

Once in Antarctica, the advanced treatment plant will be removed from the shipping containers and installed in a purpose-designed building alongside the secondary treatment plant. The combination of the two treatment plants will provide an exciting new chapter in wastewater treatment.

'This project is an opportunity to develop a secondary level wastewater treatment plant that has application far beyond Antarctica,' Michael says.

'A wastewater treatment plant of this size and capacity would potentially find applications in a wide range of remote communities. When coupled to the advanced treatment plant, it will offer a complete, self contained, small scale solution to produce purified recycled water for drinking or non-drinking purposes.'

WENDY PYPER

Corporate Communications, Australian Antarctic Division

**Secondary treatment removes solids and some dissolved contaminants. Tertiary treatment uses a range of technologies to produce a higher quality water suitable for discharge into oceans and other sensitive environments. Advanced treatment adds further disinfection technologies to tertiary treatment to produce drinking quality water.*

Moon bounce from Antarctica

Amateur radio operator Craig Hayhow has used the moon to bounce a radio signal 742 000 km, from Mawson station in Antarctica to Cornwall in England.

Proving the feat was no accident, two nights later he performed another 'moon bounce' to communicate with radio operators in Sweden and New Zealand.

'The "Holy Grail" for many serious amateur radio operators is bouncing a radio signal off the moon and reflecting it back to Earth to have a conversation with another station on the other side of the world,' Craig says.

'The technical challenges are immense, but with modern high speed computers and sophisticated software, it has become a lot easier in recent years.'

Craig, who is wintering at Mawson station as a Senior Communications Technical Officer, says his first moon bounce on May 4 this year, was the first time it had been achieved from an Australian Antarctic station and only the third time from the Antarctic continent.

Until recently, the technique was only possible using the largest, most powerful and expensive amateur radio stations. This is because of the distance the signal has to travel, the amount of power needed to send a strong signal and the loss of signal as it travels through space.

'The moon has to be lined up perfectly between the two stations to achieve an adequate reflection, so we use computer programs to find the optimum time to communicate,' Craig explains.

'However, most of the transmitted signal is lost into free space and only about seven per cent of the signal that strikes the moon is reflected; the rest is absorbed.

'The Earth's atmosphere distorts and attenuates the signal even further so that by the time the signal reaches the receiving station it is very weak.'

As Craig is operating from a small, 'home-made' station, he can only communicate with receiving stations that use multiple, 'high gain' antennas and vast amounts of power.

Craig built his own radio station using an off-the-shelf antenna that is small enough not to get blown away in a blizzard, but large enough to generate a signal that can reach the moon. He also built an amplifier to boost his transmitting signal from 4 watts to 500 watts.

To bounce a signal off the moon he uses customised software to target it. Objects other than the moon can also be used and Craig has targeted commercial aircraft and meteor trails.

'The software is tailored for each application,' he says.

'It takes around 2.7 seconds for a signal to be bounced off the moon, while it is virtually instantaneous from an aircraft. If a signal comes back, you can be sure it's reflected off the object you are targeting.'

Craig passed the exams to become an amateur radio operator when he was 17 and some 30 years later he still enjoys the surprise of chatting to people from around the world, sometimes in remote or unusual places. As Antarctica is also considered 'remote' and 'unusual', Craig says he is often bombarded by operators clamouring to add his unique call sign to their log books.

Craig's moon bounce achievement comes 100 years after the first radio communication between Antarctica and Australia, via Macquarie Island, was established by the Australasian Antarctic Expedition (AAE, 1911–1914), led by Douglas Mawson. The AAE was the first Antarctic expedition to use radio communications, using ground waves (Very Low Frequency or VLF). Sadly, Mawson's first use of the radio, on 24 February 1913, was to relay news of the deaths of his companions, Xavier Mertz and Belgrave Ninnis, during the Far Eastern sledging journey.

Fortunately, Craig's experiences are happier.

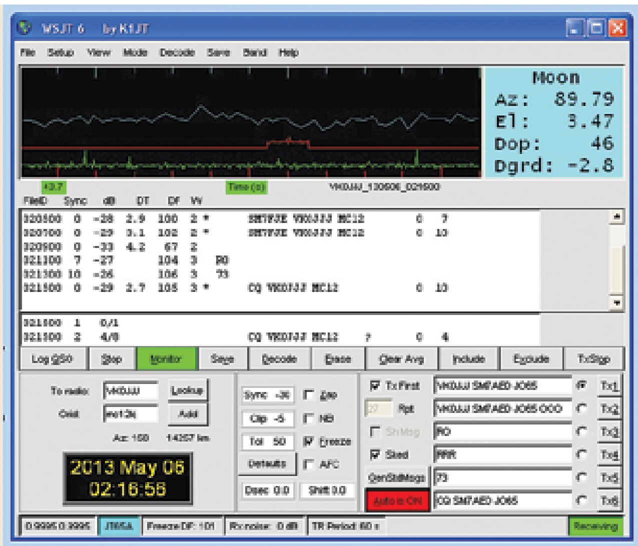
'Usually the talk is of a technical nature, but we also talk about work, family and the places we live,' he says.

'However, amateur radio is mostly about furthering the science of radio by testing, research and development, and sharing ideas within the radio community.'

WENDY PYPER

Australian Antarctic Division

1. A screen shot showing communications between SM7FJE and VK0JJJ (Craig's call sign) via the moon.
2. Mawson Senior Communications Technical Officer, Craig Hayhow, at his radio.
3. Craig's radio antenna is large and powerful enough to send signals to the moon, but small enough to withstand the blizzard conditions at Mawson.



CRAIG HAYHOW

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KELDYN FRANCIS

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KELDYN FRANCIS

Climate change as art

Tasmanian artist Melissa Smith describes the scientific inspiration behind a series of her artworks on display around Australia. For more information visit her website at www.melissasmith.net.au

Holding my breath, I gazed down the microscope to experience my first view of a collection of pteropod shells. They had been gathered in silk nets dragged through the Southern Ocean. They were so much smaller than I had anticipated. This was a pivotal moment for me, sitting in Dr Donna Roberts's office at the Antarctic Climate and Ecosystems Cooperative Research Centre in Hobart. Suddenly the reality of these creatures and their existence and in contrast, their potential demise, was driven home.

I first read about the pteropod, more commonly known as the sea butterfly, in an article co-authored by my artist friend Dr Lisa Roberts, and scientist Dr Steve Nicol (formerly of the Australian Antarctic Division). Lisa and I often share interesting snippets about our research, investigations or artistic explorations. This particular article resonated with me in its reference to the pteropod (*Limacina helicina antarctica*). It appeared as this romantic creature fluttering amongst the ocean currents. However, the fantasy was short lived, as the impact of ocean acidification on its future existence was clearly stated.

At the time, in early 2012, I was exploring the use of new technology in combination with more traditional print making practices I have used in the production of my artwork. The opportunity to utilize the pteropod and its plight as a theme for this work seemed obvious. As I searched the net looking for local sources of information, Donna Roberts's name surfaced. When her enthusiastic response to my first email came via the *Aurora Australis*, on a return trip from Antarctica, I was hooked. This was a world I had no previous experience of. My artwork has always referenced the terrestrial landscape and the fact it is shifting out of balance as a consequence of climate change. The impact on the oceans and their life was a new dimension to me.

Meeting Donna inspired me to learn more about the pteropod. Through her research she introduced me to other scientists in Canberra. Dr Jodie Bradby and Professor Tim Senden were instrumental in providing electronic data of the pteropod shell that I could transform into 3D prints as part of my first *Dissolve* exhibition. The exchange of data, information and, as a consequence, a greater understanding of the science associated with ocean acidification, has allowed me to project a more informed voice through my work.

My collaborations with these two scientists continue and I have since connected with scientists overseas — Dr Nina Bednaršek and Dr Richard Feely in Seattle. My recent *Dissolve II* exhibition included an image

1. A 'midden' of pteropod shells (*Midden*, 2013) made of polylactide and acrylonitrile butadiene styrene.

MELISSA SMITH

PETER WHYTE

TIM SENDEN

MELISSA SMITH

of a dissolving pteropod shell. It was hand printed onto organza and rice paper from a CNC (computer numeric controlled) routered MDF (medium density fibreboard). Nina provided the image, taken with a scanning electron microscope.

I also used new media to communicate my concern for the pteropod, by generating prints of QR codes (Quick Response codes) as part of the *Dissolve* series. Using their smart devices, viewers can scan the code and link to sites that provide information about the pteropod and ocean acidification. These artistic options provide alternative entry points for a new audience to issues of climate change.

My most recent work, which epitomizes collaboration between artists and scientists, is titled *Dispel*. It consists of an animation by Professor Tim Senden and a soundtrack by emerging composer Hannah Wolfhagen; creatively directed by myself (http://vimeo.com/70832194). This work is emotively charged both visually and aurally. The cascading image of an X-Ray microCT scanned pteropod shell, rotates and reveals its beauty before falling away to its demise. The soundtrack extends the viewer's perception of the visual to evoke an even deeper sense of loss.

The production of my work for *Dissolve* and *Dissolve II* is a consequence of a greater awareness for me as an artist reflecting on global issues. My subsequent connection with sites such as Living Data (www.livingdata.net.au), which represents climate science through art, has introduced me to a like-minded network of fellow artists working with a similar vision.

The opportunity to work as an artist, with scientists researching ocean acidification, has allowed me to share data, knowledge, images and a greater understanding of the impact on the Southern Ocean; to inspire and enable action for change. It is a meeting of minds – where the combination of scientific effort and of artworks, recognised as products of practice-based research, can communicate, in unison, the impact of climate change on our natural world. I am inspired as a consequence to create, to educate and to conserve.

'In the end we will conserve only what we love; we will love only what we understand; and we will understand only what we have been taught.' (*Baber Dioum – Senegalese conservationist, 1968*).

MELISSA SMITH

Roving Curator, Arts Tasmania and Program Officer, Public Art – arts@work

JENNIFER DICKENS

1. *Adrift* (2013) depicts a dissolving shell on organza, hanging in front of a relief print on rice paper.
2. Part of the animation *Dispel* by Professor Tim Senden.
3. Dr Donna Roberts, pictured here at artist Melissa Smith's *Dissolve* exhibition in Launceston in 2012, inspired Melissa to learn more about pteropods and establish networks with other climate change scientists studying these marine creatures.
4. A series of QR (Quick Response) codes printed on rice paper, as part of the *Dissolve* exhibition, allows viewers to scan the codes with their smart devices and link to web sites about pteropods and ocean acidification. Here Melissa stands in front of a code entitled *Under Threat*.

Correction

On page 35 of Issue 24 of this magazine a photo of a Kenn Borek Basler aircraft was incorrectly captioned as a twin otter. The company name was also incorrectly spelt in some places. The editor apologises for these oversights. Corrections have been made to our online magazine.

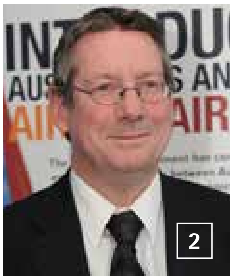
Antarctic initiatives

DEPARTMENT OF THE ENVIRONMENT

Following the Australian federal elections in September the Australian Antarctic Division is now part of the Department of the Environment under Federal Environment Minister the Hon. Greg Hunt, MP. The new government has commissioned a 20 year Australian Antarctic Strategic Plan, which will be developed by Dr Tony Press, CEO of the Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC). The government has also promised $24 million over three years to fund a new centre for Antarctic and Southern Ocean research, based in Tasmania. A further $38 million will extend the runway at Hobart Airport, increasing the capacity for long range logistical supply.

JUSTIN CHAMBERS

20 year Antarctic Strategic Plan



GLENN JACOBSON

Environment Minister Greg Hunt launched the Terms of Reference for the 20 year Australian Antarctic Strategic Plan during a visit to Hobart in October. The plan, to be developed by Dr Tony Press, CEO of the ACE CRC, will address the following issues:

- The strategic importance of Australia's Antarctic interests.
- Expanding the role of Tasmania as the gateway for Antarctic expeditions and scientific research.
- Ensuring robust and reliable access to the Australian Antarctic Territory (AAT) and extending Australia's reach across the AAT.
- Undertaking nationally and globally significant science.
- Exercising influence in the region through the Antarctic Treaty system.

'The Government is committed to building on Australia's proud Antarctic legacy by ensuring we remain engaged, active and visible as a leading Antarctic nation and by further expanding Tasmania's position as a centre for research and Antarctic services,' Minister Hunt said.

'With a leading presence in Antarctica for more than 100 years it is a critical time to look at how we strengthen Australia's scientific research and maintain our strong presence.

'Hobart is already a major hub of Antarctic research. Dr Press will recommend options to build on this and further stimulate economic, social, research and policy benefits deriving from Tasmania's status as an Antarctic gateway.'

Dr Press is due to complete the report by July 2014. View the Terms of Reference at www.antarctica.gov.au

Antarctic funding

The Antarctic Climate and Ecosystems Cooperative Research Centre received $25 million in funding in this year's Federal Government budget to continue its world class climate change research. The funding will be provided over five years from 1 July 2014. The Australian Government also provided $9.4 million for the operation of Australia's Antarctic and subantarctic stations, and $7.9 million to maintain the ageing icebreaking ship, *Aurora Australis*, and explore options for her replacement.

1. Federal Environment Minister Greg Hunt.
2. Dr Tony Press.
3. The Australian Government has provided funding to investigate replacement options for the *Aurora Australis*.

Replicating history

A replica of Douglas Mawson's historic Main Hut at Cape Denison opened on Hobart's waterfront in December (2013), as part of the Australasian Antarctic Expedition (AAE, 1911–1914) centenary celebration. The replica venture is a collaboration between the Mawson's Huts Foundation and the Australian Geographic Society, with $350 000 in assistance from the Australian Government.

The hut was constructed in Hobart by a team of heritage carpenters who have worked on the actual huts at Cape Denison, as well as students. It was then transported in three sections to its final location near the Hobart waterfront and the interior was fitted out to replicate the hut as it was when occupied by the AAE. The replica is expected to be a major tourist attraction that will help fund future conservation of the original huts.

Conservation of the original huts received a further boost, after the Australian Government this year provided $472 725 in funding through the *Your Community Heritage* grants program, for conservation expeditions to Cape Denison.

The main priorities for the conservation work in Antarctica, conducted by the Mawson's Huts Foundation and the Australian Antarctic Division, are the stabilisation of the Main Hut and associated structures, removal of interior ice and the prevention of snow getting inside the structures.

For more information about the replica project see www.mawsons-huts.org.au/replica/

Antarctica en plein air

Australian painter and sculptor, John Kelly, will spend three months in Antarctica as the 2013 Australian Antarctic Arts Fellow, where he will create a series of paintings depicting the Antarctic environment.

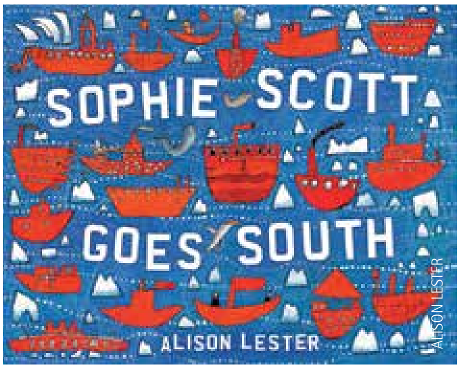
'My project will be a direct painterly response to the unique, wild and beautiful Antarctic landscape,' he said.

'The work will all be done *en plein air* with a field easel and oil paint on linen, using what I call a "look and put" method, where I attempt to bring back a record of my visual response to the landscapes without embellishment.'

Mr Kelly currently lives in Ireland, but spent most of his life in Australia after his family emigrated from England the year he was born. He has exhibited around the world, in many prestigious festivals and galleries and his work is held in art institutions in Australia and France.

He is best known for his paintings and large sculptures of William Dobell's cows — papier-mâché animals used during World War II to confuse enemy aircraft as to the location of Australian airbases.

Mr Kelly plans to exhibit the work from his fellowship at galleries in Australia, England and Ireland. He will also share his Antarctic experience through newspaper articles and speaking engagements.



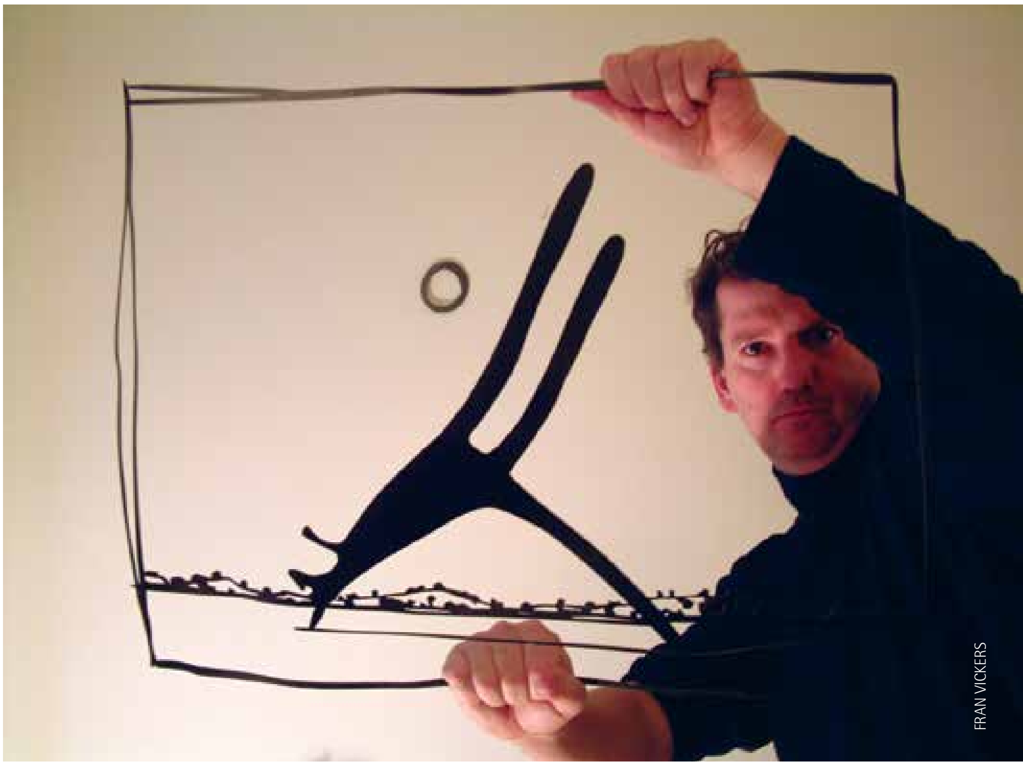
ALISON LESTER

Sophie Scott Goes South

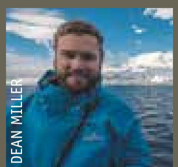
Former Australian Antarctic Arts Fellow, Alison Lester's latest book, *Sophie Scott Goes South*, published by Penguin Australia (2012), has won a string of awards and short-listings. The book draws on Alison's own travels to Antarctica and tells a story of adventure through the eyes and diary of nine year old Sophie, whose father is the captain of the ship, *Aurora Australis*.

The book won the Australian Publisher's Association best designed children's book (2013), Speech Pathology Australia's best book for language and literacy development, lower primary, and a Children's Book Council of Australia Honour for Picture Book of the Year (2013). The book was also a finalist for the Australian Book Industry Awards (2013) Book of the Year for younger children, and was shortlisted for the Western Australian Premier's Book Awards (2012) for best children's book. It is also listed in the White Ravens international catalogue for exceptional children's books.

DEAN LEWINS



FRAN VICKERS



FREEZE FRAME

MATT CURNOCK is a researcher with CSIRO Ecosystem Sciences, specialising in social-ecological science for the sustainable management of natural resources, with a particular interest in the marine environment and cetaceans (www.minkewhaleproject.org). He participated in an expedition to Heard Island in November 2012, providing film and photographic support for an upcoming documentary by filmmaker Dean Miller. This was his first foray into the Southern Ocean.

This photo was taken towards the end of our first day of only two shore visits to Heard Island, permitted by brief gaps in the formidable weather. After six to seven hours documenting and filming the wildlife around Atlas Cove, the cloud base dissipated and Big Ben revealed itself in full splendour in the warm light of the setting sun. This group of king penguins seemed to appreciate the brief respite from the wind chill, and were wonderful subjects to photograph against the magnificent backdrop of the mountain. (Nikon D7000, 18-300mm DX lens).

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