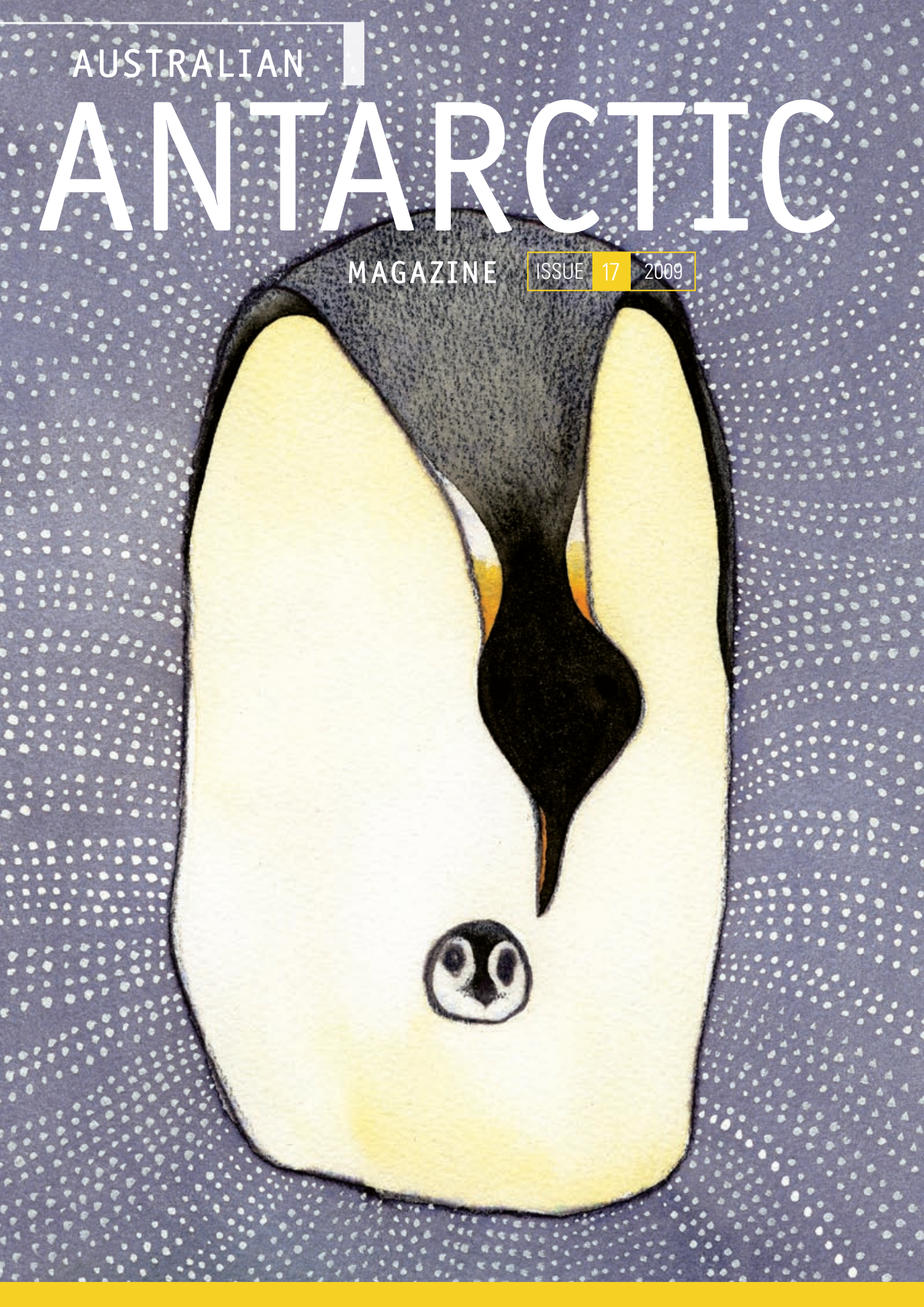
AUSTRALIAN

ANTARCTIC

MAGAZINE

ISSUE 17 2009



AUSTRALIAN
ANTARCTIC
MAGAZINE

ISSUE 17 2009

CONTENTS

The Australian Antarctic Division, a Division of the Department of the Environment, Water, Heritage and the Arts, 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 four Antarctic goals are:

- To maintain the Antarctic Treaty System and enhance Australia's influence in it;
- To protect the Antarctic environment;
- To understand the role of Antarctica in the global climate system; and
- To undertake scientific work of practical, economic and national significance.

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.

The Editor
Australian Antarctic Magazine
Australian Antarctic Division
203 Channel Highway
Kingston, 7050
Tasmania, Australia.

Australian Antarctic Division
Telephone: (03) 6232 3209
(International 61 3 6232 3209)
Email: magazine@aad.gov.au
Facsimile: (03) 6232 3288
(International 61 3 6232 3288)

Editor: Wendy Pyper

Editorial Advisory Committee: Sally Chambers, John Gunn
Production: Jonothan Davis, Jessica Fitzpatrick, Glenn Jacobson, Mathew Oakes

Graphic Design: Red Jelly

ISSN 1445-1735 (print version)

Australian Antarctic Magazine can be viewed online: <http://www.aad.gov.au/magazine>.

FRONT COVER: ALISON LESTER AND PEARL NABEGEYO
Australian Antarctic Arts Fellow, Alison Lester, asked school children around Australia to draw their visions of her Antarctic adventure in 2005. Pearl Nabegeyo from Gunbalanya in east Arnhem Land sent Alison a 2 cm high drawing of an emperor penguin and chick. Alison enlarged the image on watercolour paper and says 'I painted the dark indigo of an Antarctic sky and swirled snow across it in spirals that echoed indigenous dot painting'.

Australian Government
Department of the Environment, Water, Heritage and the Arts
Australian Antarctic Division

AAD9614rj

Ice breaking off ice cliffs in Geoffrey Bay at Casey.

IAN PHILLIPS

MANAGING HUMAN IMPACTS

A number of scientific research projects conducted in Antarctica focus on particular species or ecosystems that can act as early warning systems for environmental change as a result of human activities.

Due to their significant appetite for krill, Adélie penguins, for example, have played a major role in helping scientists develop a system to monitor the potential impacts of the Southern Ocean krill fishery for almost 20 years (page 6). More recently, this research has revealed the close relationship between the sea ice environment and the birds' breeding success and survival, which also makes them a potentially useful 'indicator' of the impacts of climate change, before more widespread effects unfold.

Such indicator species provide important information for conservation and management in Antarctica and elsewhere. Their study also provides a window of opportunity to initiate management measures that help protect other species or ecosystems from the consequences of human activities, or to manage or reduce the impacts on them.

This issue of the *Australian Antarctic Magazine* looks at some of the different ways species or ecosystems can be used to help understand and manage human impacts on a number of scales. This includes, on page 20, an environmental assessment of the sewage outfall at Australia's Davis station. Various biological, physico-chemical and ecotoxicological studies on microbial communities and invertebrates such as worms, crustaceans and algae, will help scientists determine the effect, if any, of sewage on the environment and inform the installation of an effective replacement wastewater treatment system for the station.

Taking a slightly different tack, scientists are building up a picture of the relationships between organisms' life history characteristics (e.g. reproduction and life span) and their environment, to predict whether they are vulnerable to bottom fishing in the Southern Ocean (page 10). Maps of geophysical features, ocean depth and currents are also being used to predict the location of environments likely to support vulnerable organisms. Through the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), the work is helping to safeguard these 'vulnerable marine ecosystems' by preventing fishing in susceptible areas until appropriate management actions are established.

To avoid a repeat of past mistakes, scientists are conducting detailed scientific research on the biology, distribution and movement of Patagonian toothfish to ensure a sustainable fishery in Australia's Exclusive Economic Zone (page 12). As well as enabling CCAMLR to set sustainable catch limits for the fishery, the work is revealing some interesting facts about this mysterious monster of the deep.

This issue also focuses on some of the new technology making Antarctic work and life easier. Casey and Davis stations are undergoing significant infrastructure improvements, with energy efficiency and flexibility critical requirements (page 26). Antarctic doctors are also benefiting from a new three-dimensional ultrasound machine (page 29), while a new reverse osmosis plant is allowing Davis expeditioners to enjoy an experience most people take for granted – daily showers (page 27).

Finally, we celebrate the achievements of two talented and dedicated individuals: Antarctic Medal winner David Pullinger, whose work as a helicopter pilot has supported scientific research in Antarctica for 20 years (page 30); and Eureka Prize winner and mathematician, Dr Ian Ball, whose Marxan software is contributing to marine and land conservation planning around the world (page 32).

Enjoy your reading.

W. R. Pyper

WENDY PYPER
Editor

Only groups of penguins with chicks, such as this population at Auster Rookery, can be classified as a 'breeding colony'.

FREDERIQUE OLIVIER

PENGUINS IN PRESS

Penguin research made the scientific spotlight this year, as Australian Antarctic Division scientists clarified how many emperor penguin colonies call the Australian Antarctic Territory home, and revealed some good news on the resurgence of king penguins on Macquarie Island, after their encounter with near-extinction.

Counting emperor penguin colonies

When is a cluster of emperor penguins not a colony? According to Australian Antarctic Division penguin biologist, Dr Barbara Wienecke, emperor penguins (*Aptenodytes forsteri*) congregate when they moult or mate. However, it is only groups of penguins with chicks that can be truly identified as a breeding colony. This distinction has contributed to confusion over how many emperor penguin colonies there are in the Australian Antarctic Territory (AAT), with estimates of 13, 15 and 17 colonies. In addition, some reported colony sightings have never been confirmed.

To try and reduce the uncertainty over the number of emperor penguin colonies in the AAT, Dr Wienecke collated observations from expedition narratives, log book entries, published literature, maps, photographs and satellite images, from the 1950s to today. She then excluded sightings of birds without chicks, airborne sightings not confirmed by a ground visit, and sightings that were never confirmed on subsequent visits.

'When emperor penguins are observed in January/February, there is a possibility that they have gathered at a moult location, which is not necessarily the same as their breeding site,' Dr Wienecke says.

'Even in winter, a group of emperor penguins is not immediately indicative of a breeding colony unless breeding activities are observed – such as incubation or the presence of chicks. Juveniles and sub-adults are rarely seen at the colonies and it is likely that they congregate anywhere on the ice.'

Dr Wienecke's review identified 11 confirmed breeding colonies in the AAT and 8 unconfirmed breeding colonies. Two of the confirmed colonies, at Taylor Glacier and Auster, are part of long-term population studies. As a result of this study Dr Wienecke recommends a change to the listing status of emperor penguins by the International Union for the Conservation of Nature, from 'of least concern' to 'data deficient'.

'As we have no firm understanding of the number of existing breeding colonies, we cannot estimate the size or trends of the global population of emperor penguins. We need to explore the coastline of the AAT in detail to help resolve this,' she says.

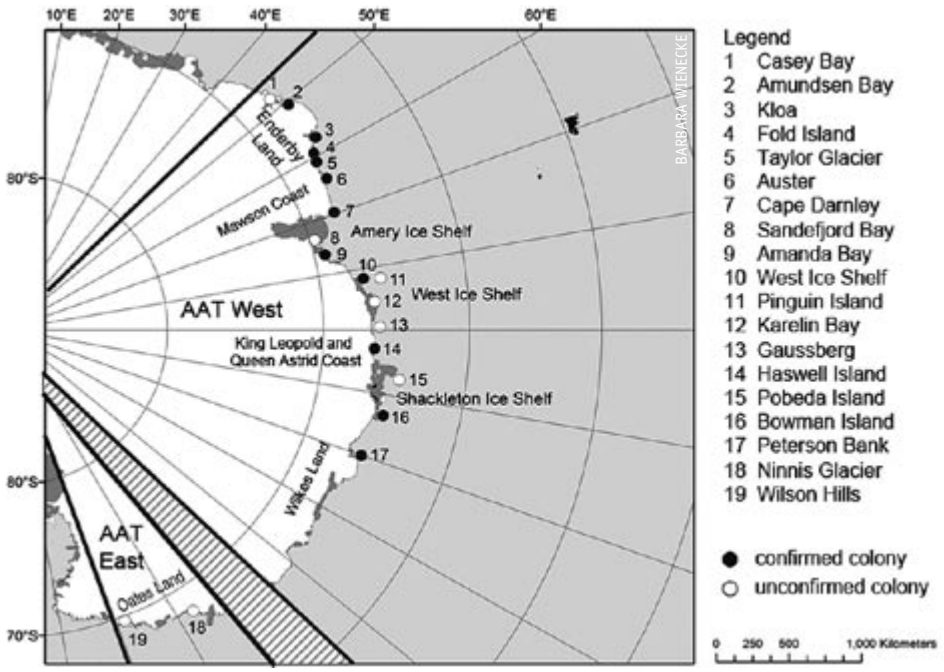
The application of remote sensing technology may prove an efficient and effective way to do this. Recently, the British Antarctic Survey used satellite images of the Antarctic coastline to identify likely emperor penguin colonies, based on faecal stains. Ground visits or high resolution images can now be used to confirm these sightings.

'This is an exciting new development that has brought us one step closer to assessing how many colonies there really are, both in the AAT and right around Antarctica,' Dr Wienecke says.

More information:

Barbara Wienecke. Emperor penguin colonies in the Australian Antarctic Territory: how many are there? *Polar Record*, **45**(0): 1–9, 2009.

Barbara Wienecke. The history of the discovery of emperor penguin colonies, 190–2004. *Polar Record*, (in press).



Locations of confirmed and unconfirmed colonies of emperor penguins in the Australian Antarctic Territory.

Location of past and present king penguin colony sites on Macquarie Island.

King penguin populations bounce back from the brink

Macquarie Island king penguins came close to extinction in the late 19th and early 20th centuries, as blubber oil gangs supplied a commercial oil market and collected eggs for food. At least two breeding colonies, thought to number in the hundreds of thousands of birds, were reduced to piles of bones or a few thousand birds between 1810, when the island was discovered, and 1912. However, once exploitation ceased in 1918 and the island became protected, there was a resurgence in the population of these resilient birds.

In 1995 scientists from the Australian Antarctic Division observed the first eggs laid near the site of one mass slaughter, at Gadget Gully on The Isthmus (see map). The first chick was fledged in 1996. Over the next five years the colony increased on average 66% per year.

A second colony at Lusitania Bay increased from a remnant population of about 3400 birds, in 1930, to about 170 000 breeding pairs in 2000. This population has begun to spill over into nearby breeding ground, which includes The Isthmus.

'Currently there are four king penguin colonies on the east coast of Macquarie Island: one each at Lusitania Bay, Green Gorge, Sandy Bay and now The Isthmus,' Antarctic Division biologist, Dr John van den Hoff, says.

Evidence of local king penguin population fluctuations prior to human interference is also apparent on the island, possibly due to landslips, storm events, volcanic activity, food availability, and a 'catastrophic mid-Holocene event'.

Dr van den Hoff says the ability of king penguin populations to overcome such odds suggests that they are resilient to catastrophic events.

'This may be because their breeding cycle ensures that some proportion of the breeding and non-breeding populations are absent from breeding islands during the year, providing a buffer and continued potential for population growth,' he says.

Dr van den Hoff proposes that a non-invasive study of the Gadget Gully colony be established, to help scientists understand the breeding cycle of king penguins at Macquarie Island and clarify how this cycle responds to changes in food availability, due to climate variability.

More information:

John van den Hoff, Clive R. McMahon and Iain Field. Tipping back the balance: recolonization of the Macquarie Island isthmus by king penguins (*Aptenodytes patagonicus*) following extermination for human gain. *Antarctic Science*, **21(3)**: 237–241, 2009.

King penguins at Gadget Gully in 2008.

EVE MERFIELD

Researchers uncovering ancient penguin remains at Inexpressible Island, Antarctica.

PROFESSOR CARLO BARONI, UNIVERSITY OF PIZA

EVOLUTION IN THE ANTARCTIC

Adélie penguins in Antarctica are an ideal species on which to study the speed and mechanisms of evolution. Recent research using modern and ancient samples of the birds' DNA has shown that mutation rates in the DNA can be used as a proxy for the rate of evolution. The discovery could improve the dating of evolutionary events, such as the divergence of species from a common ancestor.

Studying evolution is not always easy. You need a lot of time and the opportunity to study many individuals. Also, it's preferable to work on a species that has been unaffected by humans and that has lived in one place for a long time, in an environment that has changed a lot. If you're interested in ancient DNA, you'd prefer them to be 'stored' in cold conditions. Adélie penguins in Antarctica are ideal!

To most people evolution is the idea that the composition of the earth's biodiversity has changed over long periods of time. To biologists it also means something more specific; namely changes in populations or species over shorter periods of time. At a practical level it usually comes down to changes in the 'frequency' (occurrence) of particular genes or DNA sequences over time.

How, precisely, might we go about detecting evolutionary changes in the frequencies of genes in populations over time? We decided to study the large numbers of Adélie penguins nesting around the Antarctic coastline during summer, and the bones of their ancestors buried beneath these colonies.

At Inexpressible Island (so named because the early explorers could not think of a word bad enough to describe it), our research team took blood samples from a large number of penguins in the colony there. With the help of our collaborator, Professor Carlo Baroni from the University of Piza, we also collected sub-fossil penguin bones and radiocarbon dated some of these to determine their age – estimated to be around 6000 years old.

Next, we isolated nine sets of nuclear DNA sequences from both the modern and the ancient samples and examined the sequences for changes in the frequencies of different gene variants ('alleles'). In fact, we did record some changes in the frequencies of alleles over time. This was the first demonstration of evolution in the sense of gene frequency shifts over a 6000 year period. Other studies have shown changes over much shorter time periods.

As part of our study we also wanted to measure the speed or rate of evolution; that is, how fast changes in the genetic composition of the penguin population occurs. We took a new approach to the problem by comparing


DAVID LAMBERT

Adélie penguins nest in ice-free areas around the coast of Antarctica during summer. Underlying these colonies are bones of their ancestors that harbour some of the best ancient DNA yet discovered.


PROFESSOR CARLO BARONI, UNIVERSITY OF PIZA

Excavation of a long-abandoned penguin colony in search of sub-fossil bones for DNA work.

mitochondrial DNA sequences from living birds, with those from sub-fossil bones up to 44 000 years old, excavated from beneath the colonies. (Mitochondria are small structures within cells that provide most of a cell's energy.)

By comparing the modern and ancient mitochondrial DNA sequences, we were able to directly measure changes in DNA lineages over time and estimate the speed of evolution. Surprisingly, we were able to show that the rate of mitochondrial evolution is about six times faster than has been estimated using other methods.

Why might DNA sequence evolution be so fast? One possibility is that Adélie penguins have a very high rate of molecular evolution, simply because they have a high rate of mutation for this part of the mitochondrial genome?

To answer this question, we spent four summers in the Antarctic collecting samples from pairs of breeding penguins. Then, using blood samples from mothers and their chicks, we sequenced the same piece of mitochondrial DNA for which we had measured the speed of evolution using the 44 000 year old sub-fossil bones.

Mitochondrial DNA is inherited quite differently to the nuclear DNA of chromosomes. While offspring inherit nuclear DNA from both parents, they typically inherit mitochondrial DNA only from their mother. So in this experiment, we expected to find the same mitochondrial DNA sequence in all chicks as we found in mother Adélie penguins; except of course for any mutations. As mutations are rare, we did not expect to find many of them.

However, we were surprised to find a large number of mutations. Using new analytical methods developed by Professor Mike Hendy and his colleagues from the Allan Wilson Centre for Molecular Ecology and Evolution in New Zealand, we were able to use this large number of observed mutations to estimate the overall rate of mutation in penguins. This mutation rate turned out to be the same, statistically speaking, as the rate of evolution that we had determined using old penguin bones. Our findings suggest that mutations are the driving force for the high evolutionary rate in Adélie penguins.

These findings suggest that estimates of both mutation and evolution might well be similar in other species and that we can use rates of 'neutral' mutation (where there are no differences between the original gene and the mutant) as a proxy for evolutionary rates, when these data are available. Finally, our findings mean that these new molecular techniques can be reliably used to time at least relatively recent divergence events; that is, the genetic separation of related organisms from a common ancestor.

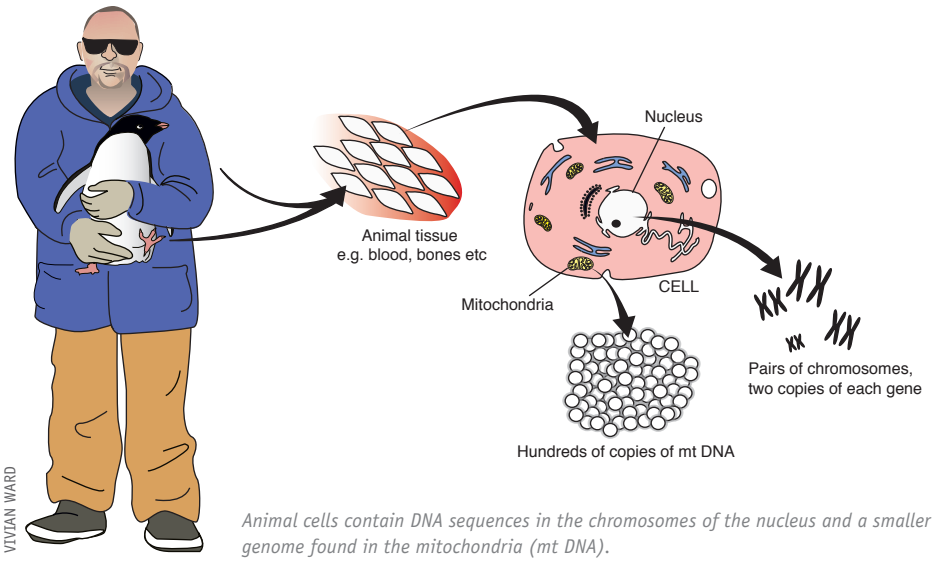
For more information and a list of scientific publications see:

www.griffith.edu.au/environment-planning-architecture/griffith-school-environment/staff/professor-david-lambert and www.sbs.auckland.ac.nz

DAVID LAMBERT[1] and CRAIG MILLAR[2]

1 Professor of Evolutionary Biology, Griffith University, Nathan, Brisbane, Australia

2 Allan Wilson Centre for Molecular Ecology and Evolution, School of Biological Sciences, University of Auckland, New Zealand



VIVIAN WARD

Animal cells contain DNA sequences in the chromosomes of the nucleus and a smaller genome found in the mitochondria (mt DNA).

Adélie penguins are an important indicator species for the CCAMLR Ecosystem Monitoring Program which aims to monitor and detect changes in the marine ecosystem due to environmental variability and human activities (such as krill fishing). As the pink staining demonstrates, this colony has been enjoying a diet rich in krill.

ADÉLIE PENGUIN POPULATION DY

Antarctica's population of Adélie penguins (*Pygoscelis adeliae*), which numbers approximately 2.5 million breeding pairs, closely reflects underlying changes in the lower levels of the food web and the ice environment on which they are dependent.

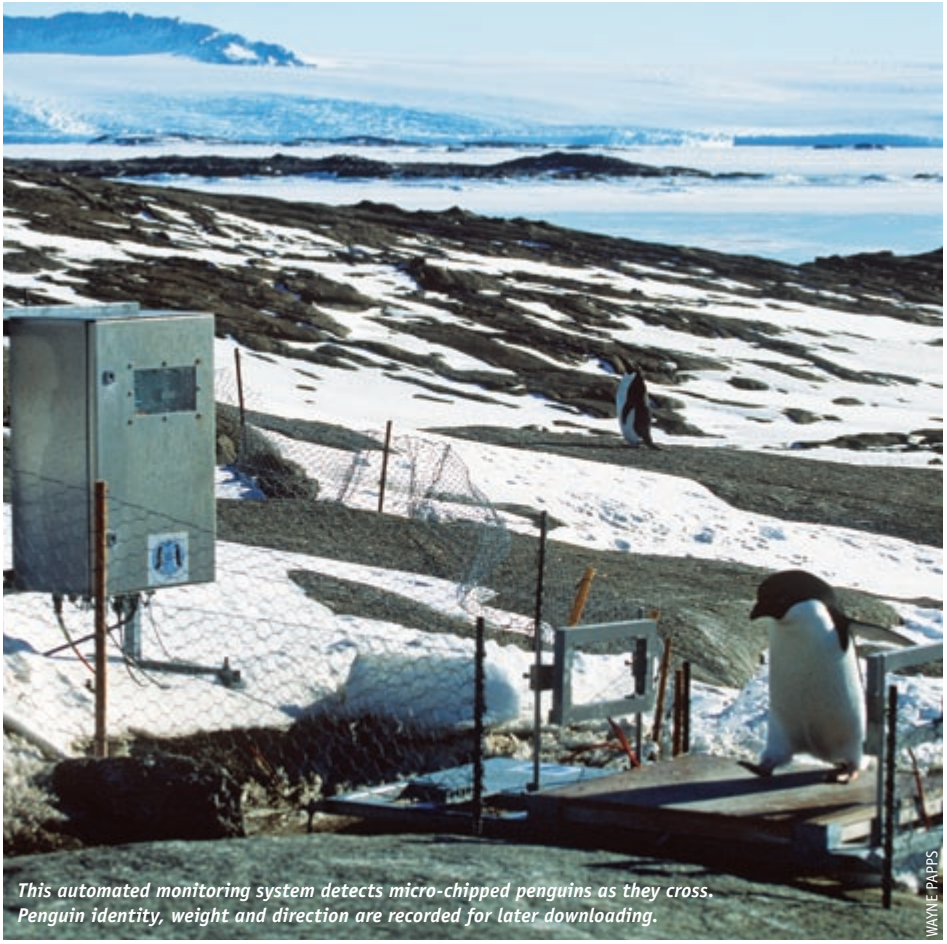
For example, their notable decrease on the Antarctic Peninsula is thought to be a direct response to a reduction in sea ice as a consequence of climate change. Across their distribution of ice free breeding sites along the Antarctic coastline and offshore islands, their population trends vary, with some populations decreasing, some remaining stable and others increasing.

Although Adélie penguins have a varied diet that includes fish, squid, amphipods and jellyfish, they eat large quantities of Antarctic krill – which is the subject of a major Antarctic fishery. This penchant for krill and their dependence on the sea ice environment makes Adélie penguins an important 'indicator' species for the CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources) Ecosystem Monitoring Program (CEMP).

The Australian Antarctic Division has played a key role in CEMP since it was established in the mid-1980s, when nations were encouraged to monitor indicator species to detect potential negative impacts from the fishing industry. Back then, CCAMLR recognised that monitoring would need to distinguish between fisheries' impacts and change due to 'natural' environmental variability, but climate change was not then seen as a potential confounding influence. Now there is much discussion within CCAMLR about how to distinguish between climate change and fisheries' impacts; an incredibly difficult task.

Béchervaise Island, near Mawson station, was established as a CEMP site in 1989 and the data collected from this site forms the basis of Australia's contribution to the CEMP. Although a krill fishery was operating in this area then, it has subsequently concentrated in the South Atlantic, and there has been no krill fishery off East Antarctica since the early 1990s. This has provided an opportunity to examine variability in CEMP parameters in the absence of fisheries' impacts, to provide baseline data and the ability to explain the cause of natural variation, particularly the links with the environment. We now have up to 18 years of consistently collected data with which to assess population trends and the underlying processes that influence population dynamics. Here we describe results for two important factors contributing to population change: penguin reproductive success and penguin survival.

LOUISE EMMERSON



This automated monitoring system detects micro-chipped penguins as they cross. Penguin identity, weight and direction are recorded for later downloading.

WAYNE PAPPS

NAMICS: 18 YEARS IN A COLONY

Reproductive success

For some years we were aware that the ability of parents to feed their offspring was related to the extent of ice around a breeding colony. However, it wasn't apparent what type of ice was important (fast ice[1] or sea ice, for example) or where or when the presence of ice mattered. To address this we examined annual penguin reproductive success in relation to the ice environment obtained from satellite images. Through a series of statistical analyses we found that reproductive success is clearly related to the amount of ice present, particularly the area immediately adjacent to the breeding site (Figure 1). Extensive fast ice during the 'guard stage' of the chick rearing period, when chicks require at least one parent to remain at the nest with them, meant that few chicks survived. Additionally, having some sea ice further away from the colony, but still within their foraging range, improved breeding success when fast ice close to the breeding colony was limited.

Reproductive success was low in years with extensive fast ice, in part because of the forced traverse across the ice to reach open water to forage. It was clear that the presence of extensive fast ice increased the duration of foraging trips, thereby reducing the frequency of feeding chicks, and ultimately leading to their demise. But there were other factors at work too. Many foraging trips in some years weren't long enough to reach the fast ice edge, indicating that penguins were able to forage within the fast ice area in some years but not in others. Furthermore, extensive fast and sea ice, or the oceanographic processes driving the timing of sea ice break-out, may also be associated with reduced prey availability near Béchervaise Island.

Adélie penguin survival

In stark contrast to the relative ease with which we can examine the summer-based activities of reproduction by deploying field biologists to measure population parameters, measuring mortality directly is near-impossible. To make matters worse, most mortality is thought to occur during the inter-breeding period when Béchervaise Island penguins travel up to 1500 km away from their breeding site. This nine month period also sees a dramatic change in the marine environment, as the sea ice transforms from its minimal extent in March through to its maximal extent in September.

Estimating survival requires the detection of individuals over multiple years through a 'mark-recapture study'. Each year at Béchervaise Island up to 300 chicks are tagged with micro-chips and their presence at the island in subsequent years is determined by manual tag readers and an automated monitoring system. Through these detection methods we can generate a series of detection histories for every bird that has been tagged over the last 18 years and use them to estimate penguin survival. Our results indicate that young penguins have highly variable survival over their first winter, while survival of the older birds is more consistent through time (Figure 2).

Understanding the processes driving Adélie penguin survival is challenging. Statistical analyses suggest a link between penguin survival and the ice environment at their presumed winter foraging grounds, some 1500 km away from their breeding site (Figure 3). This influence was most apparent during the deep austral winter when the sea

1 Fast ice is ice attached to the continent.

ice changes rapidly. For fledgling penguins, too much ice was detrimental to their survival, whereas for the older birds either too much or too little sea ice was detrimental. While survival of the older birds was strongly associated with the environment, there was a large amount of variability in the survival of the younger birds that we are yet to explain. Understanding the underlying mechanisms which result in this association between penguin survival and the environment requires further examination of the specific interactions between penguins and their ice environment through satellite tracking and finer resolution satellite imagery.

What does this mean for CEMP?

Although there has been no krill fishery in the Mawson region in recent years, notifications to CCAMLR suggest that the krill fishery is likely to expand in tonnage and to new areas. Monitoring and assessment procedures need to be available or in place for this eventuality. The impacts of climate change in the Southern Ocean will be complex, but the sea ice environment is likely to be affected. From our work it is clear that this, in turn, is likely to impact directly and indirectly on Adélie penguins. Interpreting the causes of future changes will always be difficult and subject to some doubt. Knowing the nature and extent of the linkages between Adélie penguin reproduction and survival and important environmental features such as sea ice, will improve CCAMLR's ability to make the correct interpretation and from that, take the appropriate management actions, if the krill fishery resumes in east Antarctica.

The future

Expectations of how climate change is likely to affect different localities around the Antarctic continent need to be considered along with our understanding of the interaction between penguins and the ice environment, to determine likely population change in the future and to detect change as it occurs. This is best done through long-term studies such as the Béchervaise Island monitoring program, in conjunction with detailed studies on the foraging locations of predators and environmental conditions at those locations. We intend to continue the long-term monitoring of Adélie penguins at Béchervaise Island and expand the regular monitoring of a selected suite of parameters for populations in the Australian Antarctic Territory through surveys. New technologies will allow us to determine their broader status and trends and to relate this to changes in the environment. Future tracking studies are also planned to determine where and under what environmental conditions the penguins are foraging during the austral summer and winter months.

LOUISE EMMERSON and COLIN SOUTHWELL
Southern Ocean Ecosystems program, Australian Antarctic Division

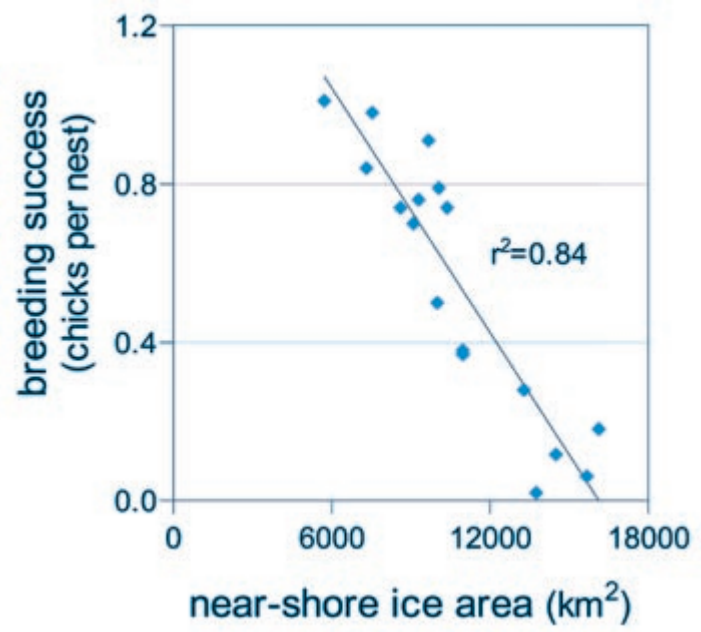


Figure 1: *Breeding success plotted against ice area during the guard period; ice area calculated between 60–65°E to around 70 km north of the coastline which is the area typically covered by fast ice around Béchervaise Island. Breeding success varies between 0, representing total reproductive failure, and a maximum of 2, representing an average of two chicks crèching per nest. As the ice extent increases, chick survival decreases.*

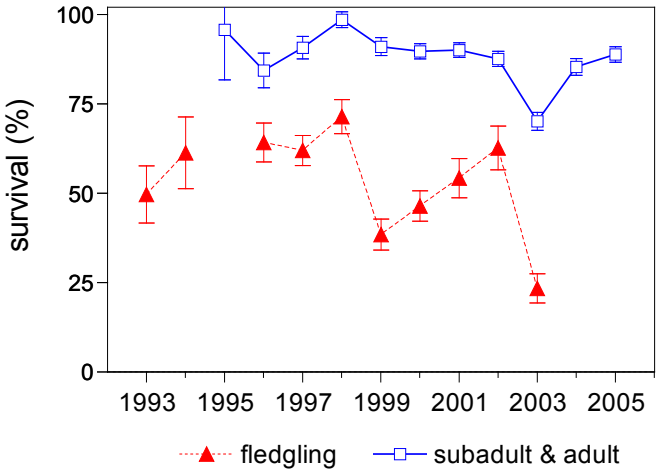


Figure 2: *Estimates of annual Adélie penguin survival for fledglings in their first winter and older birds based on mark-recapture studies at Béchervaise Island. Over winter survival of young penguins is highly variable, while older birds demonstrate a more consistent survival pattern.*

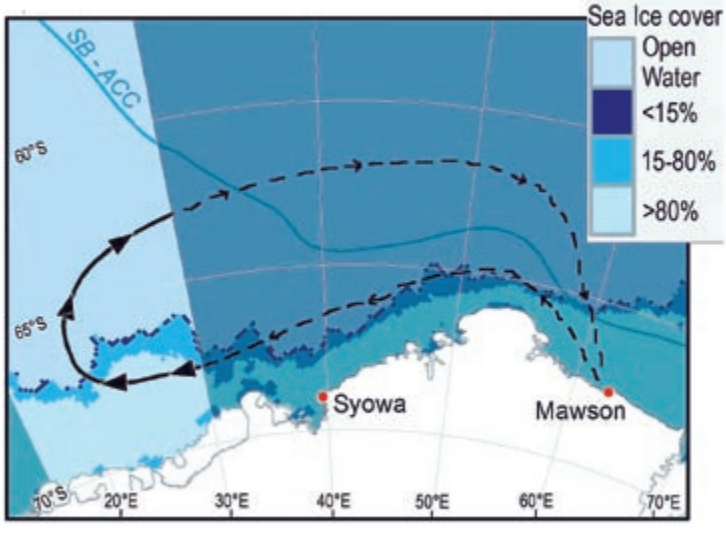


Figure 3: *Expected Adélie penguin travel route for Béchervaise Island penguins during their winter migration, based on previous satellite tracking studies. The region highlighted (left of graphic) shows an area where ice is thought to influence the survival of adult and fledgling Adélie penguins. Ice conditions presented here are based on satellite images from May 1993.*

DARKNESS SHEDS LIGHT ON KRILL REPRODUCTION

When it comes to reproduction, Antarctic krill like the lights off.

Preliminary research at the Australian Antarctic Division's krill aquarium has shown that the annual cycle of krill maturation and reproduction can be altered by a period of darkness immediately after spawning.

'We've been able to reset the animals' internal clocks, so that they become sexually mature three months earlier than if they were exposed to a natural Antarctic light cycle,' principal researcher, Dr So Kawaguchi says.

The research promises to allow scientists to control when different groups of krill spawn, so that they have access to all phases of the life cycle (larvae, juveniles, sub-adults and adults) all year round. It will also spread the effort of collecting millions of krill eggs for the breeding program, over the year, rather than all at once.

In Antarctica, krill experience four months of darkness over winter, between June and September. During this time they actually shrink in size and lose their mature reproductive characteristics – a process known as 'regression'. As spring approaches and the day length and food supply increases, they begin to grow and become sexually mature again, before mating begins in December and continues until about February.

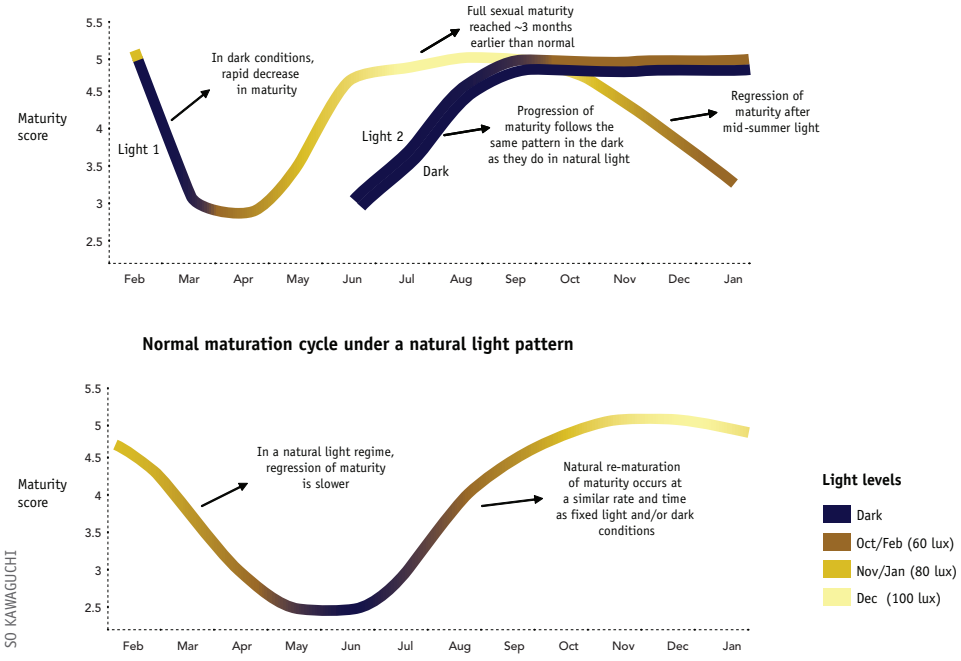
Research at the Antarctic Division in the late 1980s showed that krill would steadily progress through their reproductive cycle regardless of whether they were exposed to constant darkness, constant light, or a natural Antarctic light cycle.

'This research suggested that the cycle of regression, maturation and reproduction was controlled by an internal biorhythm rather than environmental factors,' Dr Kawaguchi says.

But in 2003, Japanese research showed that abrupt changes in the daily cycle of light and dark could trigger maturation and spawning.

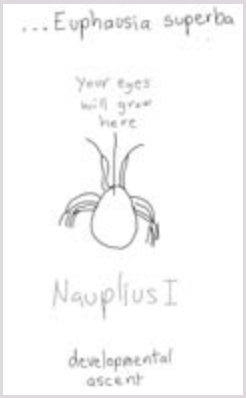
Dr Kawaguchi's research, however, shows that it is the timing of darkness, not light, that alters the reproductive cycle in krill – a paradigm shift in scientific thinking.

'For many crustaceans and other animals, environmental cues like changes in light and temperature, influence when they reproduce, so previous research has only focused on the timings of changes in light, not darkness,' he says.



This figure shows the maturation cycle of krill under three different light treatments (top graph) and the natural cycle of maturation of wild krill (lower graph). Krill in the 'light 2' treatment received four months of the natural Antarctic light cycle, followed by four months of darkness and four months of light. Krill in the 'dark' treatment received four months of the Antarctic light cycle and eight months of darkness. Krill in the 'light 1' treatment received one month of the Antarctic light cycle followed by two months of darkness and nine months of light. These krill reached sexual maturity three months earlier than the other groups.

Krill animation



Artist, Lisa Roberts, has created an online animation of the krill life cycle for her PhD in Fine Arts at the University of New South Wales. Lisa spent two days at the Australian Antarctic Division in January 2009, studying and drawing krill. On her return to her Sydney studio she consulted with scientists, Dr Steve Nicol and Dr So Kawaguchi, on many aspects of krill development and the Antarctic environment. To see more of this animation visit www.antarcticanimation.com/.

Read more about Lisa Roberts' work at www.lisaroberts.com.au/index.html

In the recent study, three groups of krill were kept under different light/dark regimes. One group was exposed to four months of the natural Antarctic light cycle, followed by four months of darkness and four months of light. A second group experienced four months of the Antarctic light cycle followed by eight months of darkness. These two groups followed the same cycle of regression, maturation and reproduction as wild krill.

The third group of krill experienced one month of the natural Antarctic light cycle, followed by two months of darkness, and nine months of light. These krill reached sexual maturity three months earlier than the other groups – observed by changes in their exoskeleton (shell), which they shed as they grow.

'This study has shown that the transition from light to dark to light is important in controlling the timing of spawning under laboratory conditions,' Dr Kawaguchi says.

The research team is now working to reproduce the results of this experiment. In theory, if the 'reset' krill are again exposed to a period of darkness immediately after spawning, their reproductive cycle should advance another three months, putting them six months ahead of the krill running on 'Antarctic time'.

'We have more work to do to fine tune our methods and repeat our results. We also need to look at any physiological changes in krill that might result from this "resetting" process,' Dr Kawaguchi says.

WENDY PYPER
Corporate Communications, Australian Antarctic Division

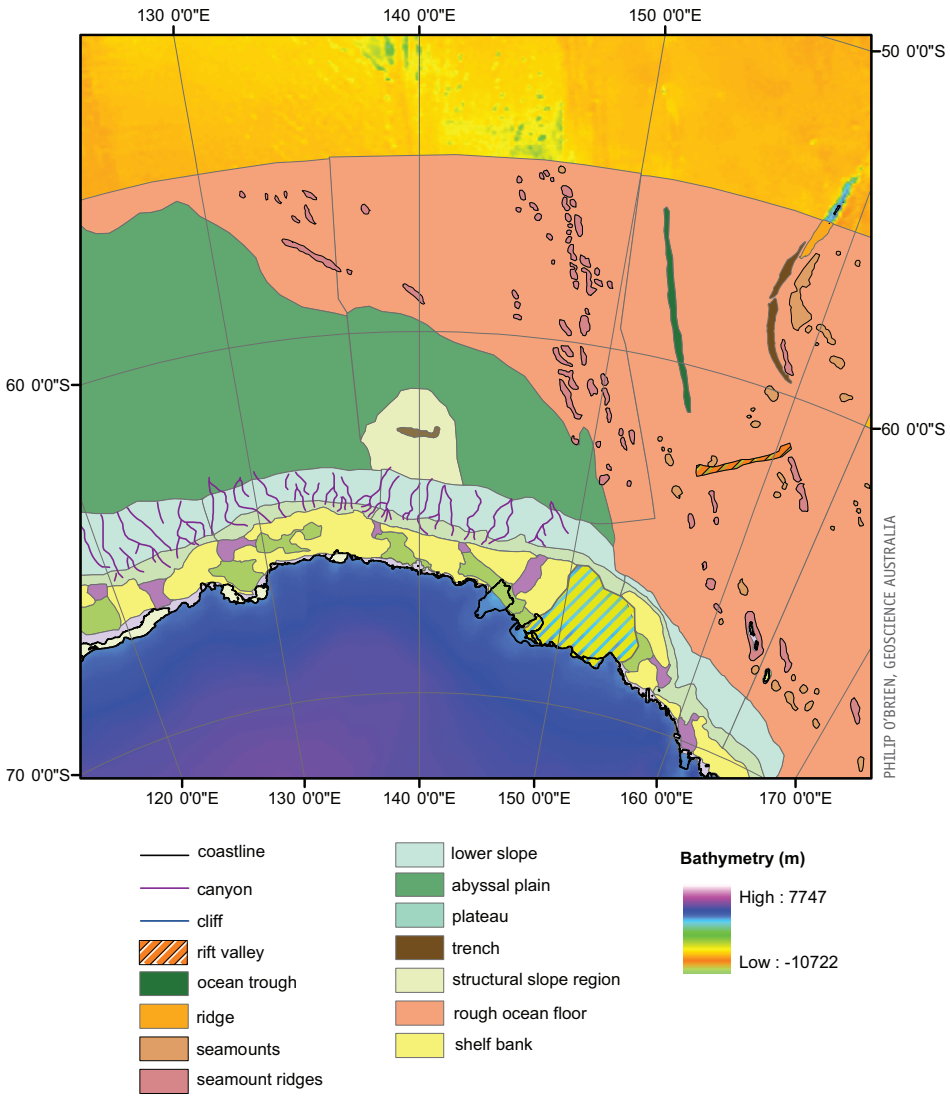
PREDICTING THE LOCATION OF VULNERABLE MARINE ECOSYSTEMS

New research is helping to predict the location of marine ecosystems vulnerable to bottom fishing and how different organisms within them respond to and recover from damaging impacts.

The Southern Ocean sea floor, off East Antarctica, is home to some of the world's most ancient marine organisms, including slow growing sea fans and bamboo corals hundreds to thousands of years old. These and other habitat-forming denizens of the deep (such as sponges, sea whips, anemones, sea pens and bryozoans) have particular life history characteristics that make them vulnerable to bottom fishing (longlining and trawling). These characteristics include long life spans, slow growth rates and reproductive strategies that limit the number and dispersal of offspring.

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) has had conservation measures in place for benthic (sea floor) organisms for decades, to ensure sustainable use and conservation of Southern Ocean marine resources. In 2007 it added conservation measures for 'vulnerable marine ecosystems' (VMEs). Such ecosystems include fields of cold water corals and sponges, seamount communities (found on the slopes and tops of undersea mountains), and hydrothermal vent communities (where heated water, flowing through fissures in the earth's crust, supports unique microorganisms). The measures help safeguard VMEs from bottom fishing impacts (longlining in CCAMLR waters) by requiring fishing vessels to cease operation if they encounter evidence of a VME (pulling up more than 10 kg of material on one section of longline), and preventing future fishing in the area until appropriate management actions have been established.

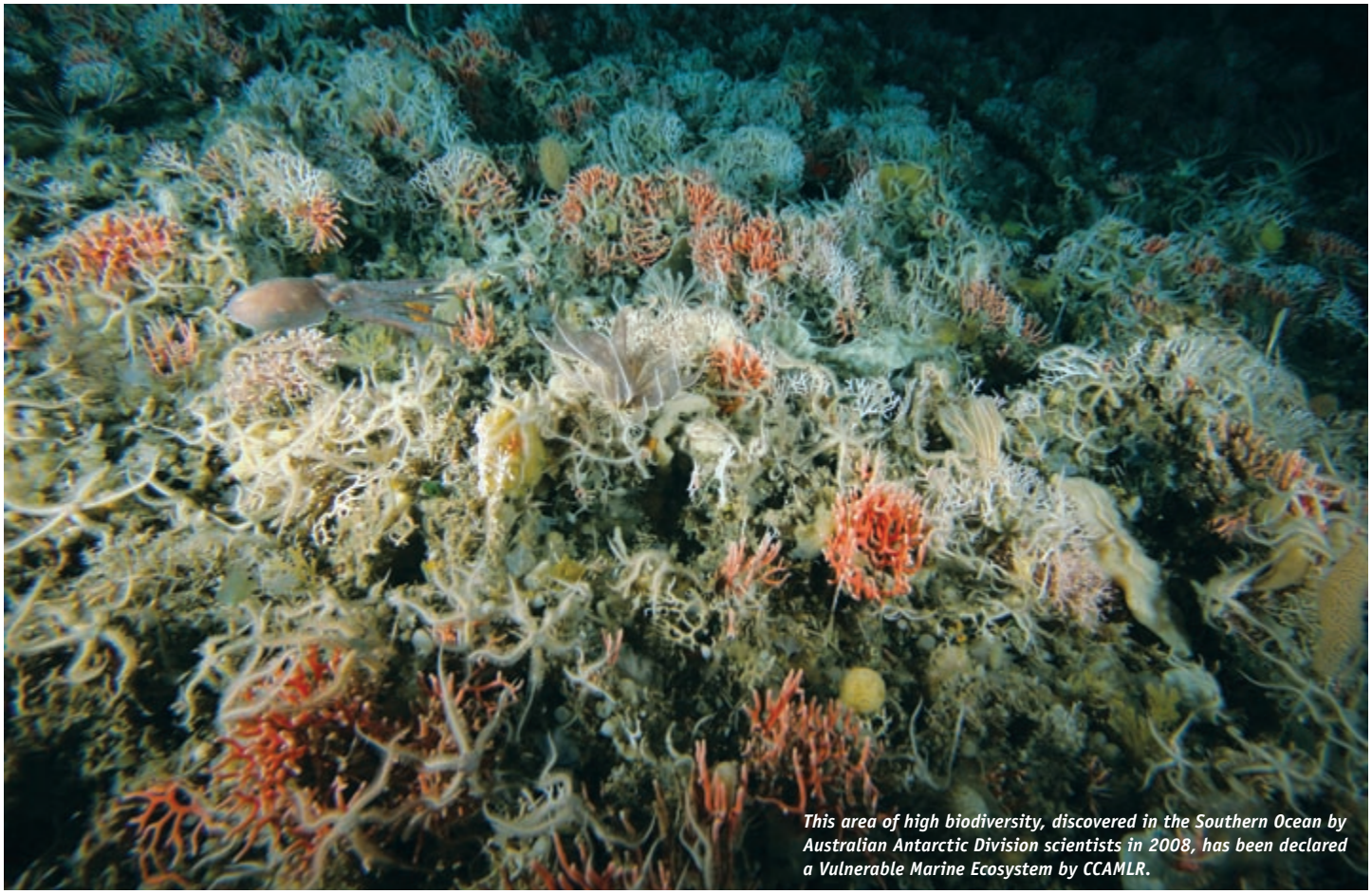
In 2008 two 400 km^2 regions of the Southern Ocean sea floor were declared VMEs (*Australian Antarctic Magazine* 15: 19), after large areas of high biodiversity were captured on a trawl-mounted camera. Another 28 areas are pending assessment by CCAMLR. However, there remains a vast lack of information about where such



Scientists from Geoscience Australia have developed large-scale maps of the Antarctic continental margin and adjoining ocean basins using publicly available bathymetry and geophysical data. These define large geomorphic features such as seamounts, trenches, deep canyons, ridges and plains. As vulnerable marine ecosystems are often associated with some features, such as seamounts, likely locations for vulnerable marine ecosystems can be identified.

regions of biodiversity might occur in the Southern Ocean and how 'resistant' and 'resilient' the ecosystems are to disturbance. Answers to these questions are critical in helping CCAMLR manage fishing and conservation in its areas of responsibility in the Southern Ocean.

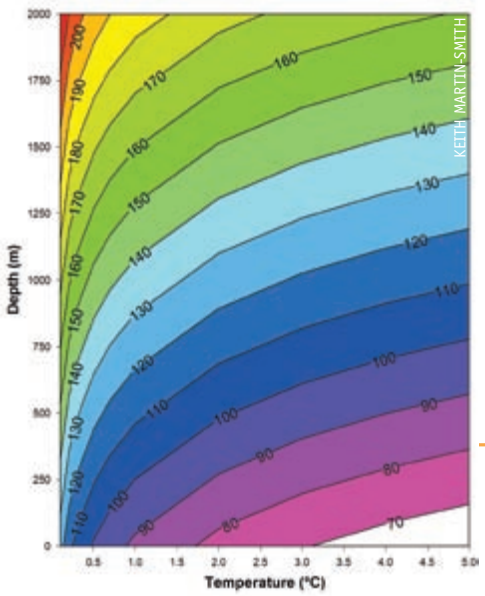
To determine where VMEs are likely to occur in the Southern Ocean, scientists from Geoscience Australia have used publicly available bathymetry and geophysical data to develop large-scale maps (1:1-5 million) of the Antarctic continental margin and adjoining ocean basins (see map). These maps enable identification of features often associated with VMEs; for example, seamounts over a certain size and submarine canyons and mid-ocean ridge valleys, which harbour hydrothermal vents. A knowledge of the nature of these and other large geomorphic features (based on physical and biological sampling in some areas) can then be used to predict sea floor characteristics, such as whether it is hard or soft, and whether processes that affect sea floor characteristics are at work, such as iceberg scouring, sediment deposition or erosion, and ocean currents. This information can then be used to predict the location of VME habitat.



This area of high biodiversity, discovered in the Southern Ocean by Australian Antarctic Division scientists in 2008, has been declared a Vulnerable Marine Ecosystem by CCAMLR.

The next knowledge gap to be addressed is how different organisms within a VME respond to bottom fishing (resistance) and how long they take to recover (resilience).

'Resistance is the ability of an ecosystem to withstand interactions with bottom fishing gear, and depends on the physical and behavioural attributes of individual organisms and the spatial scale of fishing,' Australian Antarctic Division biologist, Dr Keith Martin-Smith says.



This graph shows the predicted age of gorgonians found at different depths and temperature. For example, gorgonians growing at a depth of 1500 m in 2°C water would likely be at least 160 years old.

'Resilience is the ability of the ecosystem to recover structure and function following changes caused by bottom fishing activities.'

To measure resistance and resilience, Dr Martin-Smith and his colleagues collated a database of life-history characteristics for 28 groups of benthic, habitat-forming organisms, based on research from around the world. These characteristics included growth rate, life span, maximum size, and reproductive strategies. The database also included information on physical and chemical variables of the organisms' habitats, such as depth, temperature, oxygen concentration, salinity and nutrients.

Analysis of the data found consistent relationships in all the groups between life-history characteristics and between life-history characteristics and physical or chemical variables. For example, long-lived organisms grew very slowly while shorter-lived organisms grew more quickly; organisms living in warmer water grew faster than those living in cold water; and organisms growing in deep water grew slower than those in shallower water.

Application of this information to questions of resistance and resilience in gorgonians (sea fans), some species of which have been aged at more than 700 years old, indicated that in ambient Southern Ocean conditions the organisms would likely take at least 130–200 years to recover from bottom fishing damage, depending on the depth at which they grew. (The deeper they grow, the more likely they will be to grow and recover slowly.) Bryozoan colonies, which can live for an estimated 40–60 years, were predicted to take more than 50 years to recover.

Dr Martin-Smith says the research demonstrates that the relationships between life-history characteristics, and life-history and environment, can be used as predictive tools to provide plausible values for resistance and resilience, where very few data are available.

'This means that the relative vulnerability of taxa can be predicted from currently available data, for use in risk management,' he says.

The work has been discussed at CCAMLR Working Groups and at a recent CCAMLR Workshop on Vulnerable Marine Ecosystems. The results are being used to inform further development of CCAMLR Conservation Measures.

WENDY PYPER
Corporate Communications, Australian Antarctic Division

SEEKING ANSWERS TO

Aesthetically speaking the Patagonian toothfish (*Dissostichus eleginoides*) has little going for it. But in some countries this deep sea monster, which can exceed 200 kg in weight and live for some 50 years, is highly prized for its flavoursome flesh.

A lucrative black market trade in the fish – known variously as 'Chilean sea bass', 'merluza negra' and 'mero' – has led to illegal overfishing in the high seas and several high profile arrests and fines, including in Australian waters around Heard Island and McDonald Islands (HIMI).

The spectre of illegal fishing threatens the sustainability of the toothfish fishery. Increased patrols for illegal vessels and the work of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) are helping reduce the problem in the Southern Ocean. However, basic biological research is also important in helping conserve the toothfish population and manage the legal fishery.

Since 1997, collaborative work between the Australian fishing industry and scientists has been helping CCAMLR set sustainable quotas for toothfish catches (currently about 2500 tonnes for the HIMI fishery). Sustainable catch quotas rely in part on understanding the toothfish life cycle and behaviour, including when the fish reach sexual maturity, how fast they grow, how long they live, and whether different populations of toothfish interact. Australian scientists are investigating these questions in four main ways:

- data collection during an annual trawl survey;
- data collection by scientific observers on commercial fishing vessels;
- analysis of toothfish ear bones (otoliths); and
- scientific tagging.

This work is being conducted in the HIMI fishery in CCAMLR sector 58.5.2

The annual trawl survey around HIMI was designed by Australian Antarctic Division scientists to study the biology and stock structure of toothfish. Using commercial vessels, the trawls sample 160 points around the survey region (about 84 000 km^2) over 20 days to depths of 1000 m (Figure 1). Observers from the Australian Fisheries Management Authority (AFMA) record the location, number and total weight of fish caught, their size and weight, sex, and evidence of spawning (Figure 2).

'We've developed software and equipment called "Fishlog", which includes a measuring board that records a fish's length directly into the database and an electronic scale that automatically records the weight when the fish is placed on it,' Australian Antarctic Division fisheries biologist, Dr Dirk Welsford, says.

'This makes it easy for the observers to record information quickly and accurately, and in a format suitable for research and analysis by CCAMLR, AFMA and the Australian Antarctic Division.'

As the survey trawls are conducted in relatively shallow water, they tend to capture pre-adult fish (small juveniles and adolescents). The

AFMA OBSERVER PROGRAM

FISHY QUESTIONS

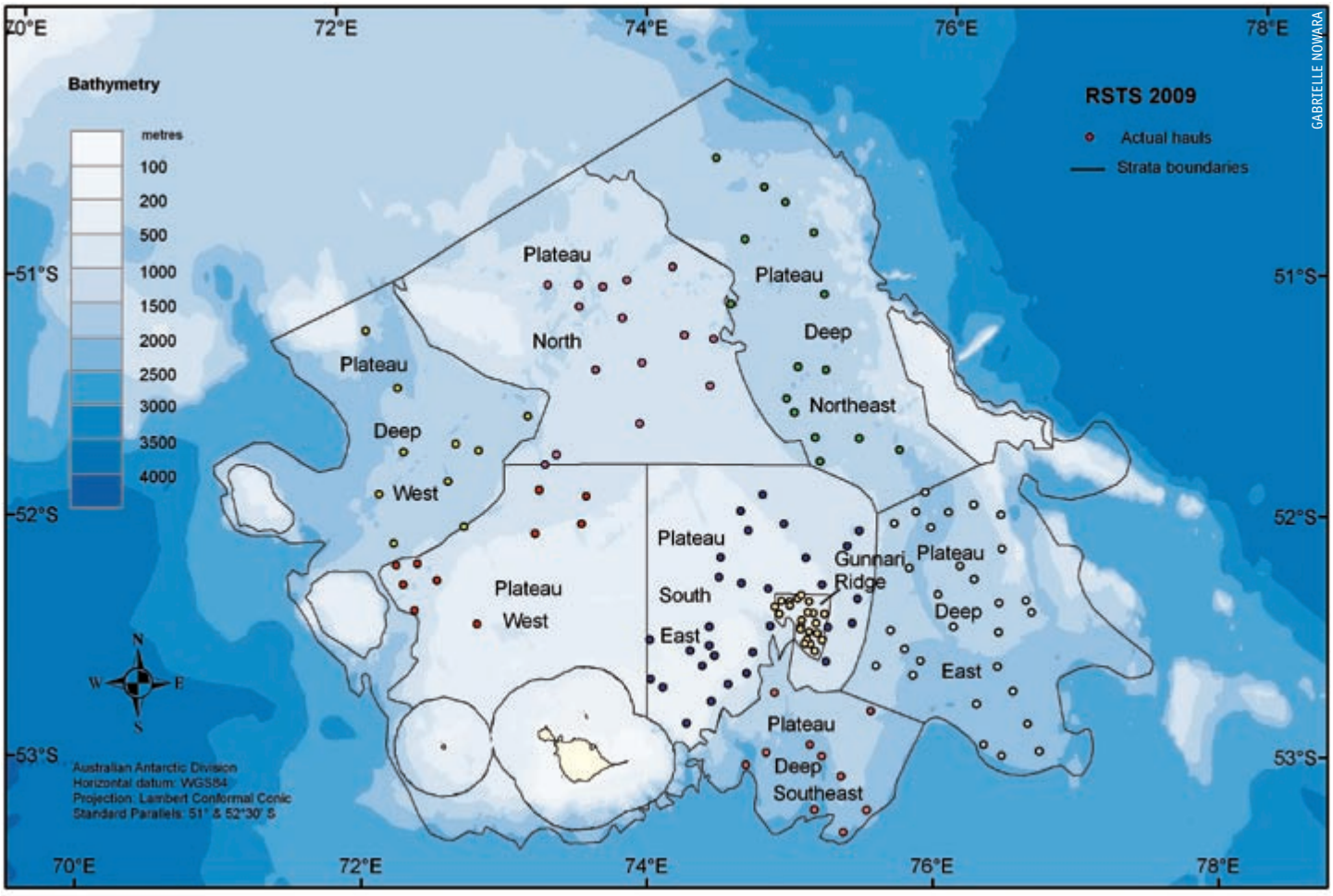


Figure 1: *This map shows the location of random trawl samples over an area of 84 000 km², in Australia's Exclusive Economic Zone around Heard Island, during the annual trawl survey in 2009. Heard Island is coloured yellow at the bottom centre of the map, while the much smaller McDonald Islands can be seen to its left. The Antarctic continent lies to the south (not shown). Trawl samples were taken at different depths, down to 1000 m, across this part of the Kerguelen plateau.*

larger, older fish are more often found in deeper water, up to 2500 m.

'A focus on the smaller fish allows us to see what stock will be coming into the fishery in future years and how the numbers vary each year,' Dr Welsford says.

'This allows us to accommodate peaks and troughs in the population and set catch quotas that should remain reasonably stable over the long term.'

The surveys have found that fish less than 250 mm in size are rare, which suggests that they may be residing outside Australia's Exclusive Economic Zone (EEZ), where the surveys occur, and inside the neighbouring French EEZ.

'We're working with French scientists now to set up a similar survey in the French EEZ,' Dr Welsford says.

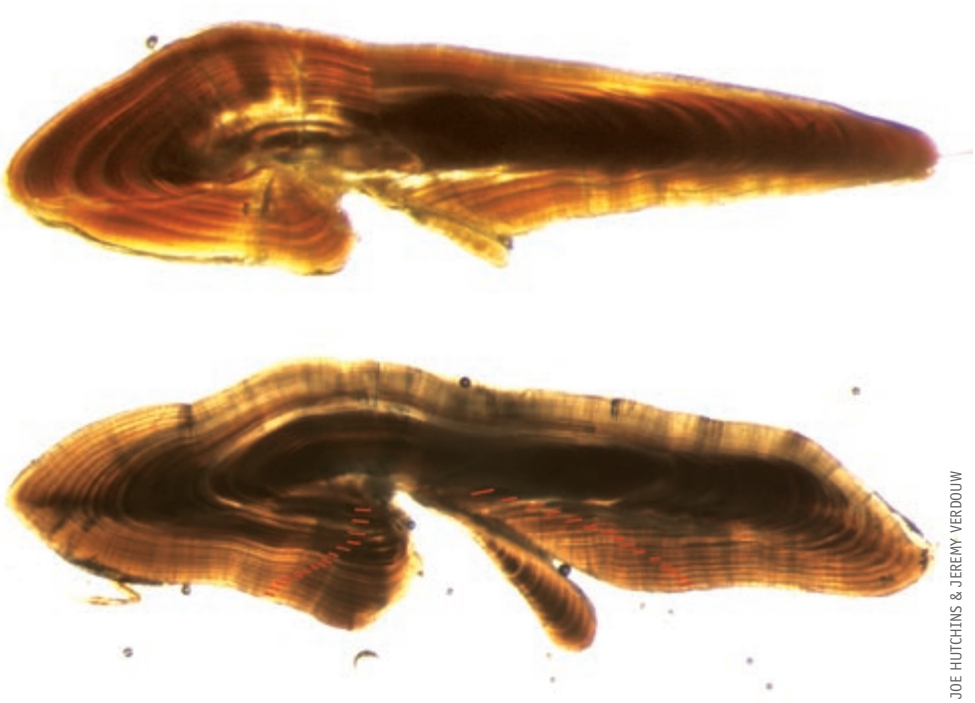
The surveys have also found that the occurrence of small juveniles is patchy. For stock assessment purposes, this means that fish abundance across the whole region cannot be extrapolated from a small area. Rather, fish numbers need to be measured at different sites around HIMI, and at different depths, to provide an absolute population measure.

Data collected during the annual trawl survey overlaps that collected by scientific observers on commercial vessels throughout the year. As well as collecting biological data the AFMA observers collect toothfish otoliths and conduct the scientific tagging program.

More than 22 000 otoliths have been collected in the past 12 years and about 6000 of these have been analysed at the Australian Antarctic Division. Like tree rings, otoliths record every year of toothfish life as a thin band (Figure 3). Analysis has shown that most toothfish caught at HIMI are 3–14 years old, although fish as old as 28 years have been captured. Most of the older, large fish are female.

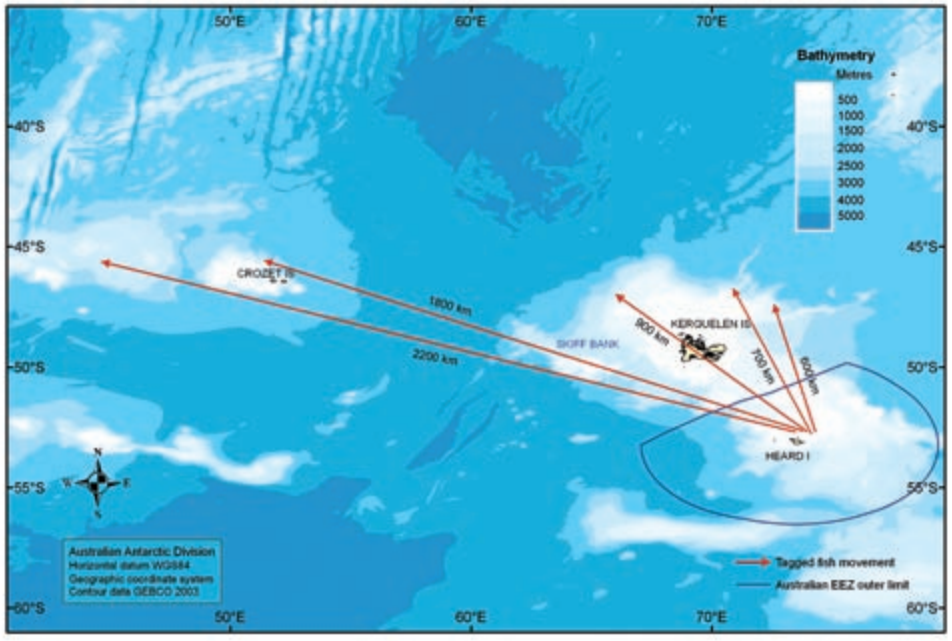
The scientific tagging program involves tagging about 1000 fish a year with two types of tags; a simple external plastic tag and a microchip inserted into its flesh – much like that used to identify cats and dogs. Both tags provide the fish with a unique identifying number, which can be matched against records made when it was originally released.

Figure 2: *The Fishlog system developed by the Australian Antarctic Division includes an electronic measuring board used to record a toothfish's length (shown) and a motion-compensated scale to record weight.*



JOE HUTCHINS & JEREMY VERDOUW

Figure 3: *Like tree rings, the ear bones of fish (otoliths) record each year of life as a distinctive ring of calcium carbonate, allowing scientists to age individual fish. These otoliths are from a five year old fish (top) and a 15 year old fish (bottom, showing red lines where the rings are counted).*



GABRIELLE NOWARA & DAVID SMITH

Figure 4: *While the majority of toothfish are captured within about 30 km from where they were tagged and released (not shown) in Australia's Exclusive Economic Zone (EEZ), tag data shows that some fish travel great distances.*

'If the fish are recaptured after they're tagged, they provide us with information about how much they have grown – so we can determine growth rates – and how far they can swim,' Dr Welsford says.

About 20% of tagged fish are recaptured. The work has shown that most fish are sedentary, moving no more than 30 km from where they were released. However, they occasionally move great distances – over 2000 km. The reason for this is not clear, but appears to correspond to a movement towards a known spawning ground at Skiff Bank, in the French EEZ (Figure 4).

Dr Welsford hopes that future collaborative research with French scientists and a continuation of the multi-faceted approach to toothfish research, taken by Australian Antarctic Division scientists, will unlock more secrets of these enigmatic fish.

WENDY PYPER
Corporate Communications, Australian Antarctic Division

Australian toothfish fishery facts

AFMA

In the Australian Fishing Zone around Heard Island and McDonald Islands, up to three commercial vessels fish for Patagonian toothfish and mackerel icefish using trawls and longlines. The fishery is managed by the Australian Fisheries Management Authority using principles set by the Commission for the Conservation of Antarctic Marine Living Resources. The Australian Antarctic Division coordinates Australian fisheries research and assessments in the region (*Australian Antarctic Magazine* 13: 9, 2007).

The total allowable catch set for the toothfish fishery has varied from 297 t in its first year (1994–95) to a maximum of 3800 t in 1996–97, and down to 2500 t in 2008-09. Illegal, unregulated and unreported fishing was a significant problem in the late 1990s, with catches of some 7000 t estimated in 1996–97 and 3500 t in 2001–02. However, illegal catches declined from 2003–04 and there have been no reports of illegal fishing since 2006–07.

Bycatch mitigation measures and research are helping to reduce seabird and other bycatch in the fishery. Fish species caught as bycatch include unicorn icefish, grenadiers, grey rockcod and skates and rays. Sixteen seabirds have been killed in the trawl fishery since 2000–01 but no seabird deaths have been reported in the longline fishery.

SEABIRD SAVING DEVICE WINS AWARD

Australian Antarctic Division seabird ecologist, Dr Graham Robertson, and Queensland company, Amerro Engineering, have won the WWF's $45 000 International Smart Gear Competition for designing a longline fishing device that reduces seabird bycatch.

The Underwater Bait Launcher is designed for use on deep sea, longline fishing vessels such as tuna and swordfish boats. It uses a capsule which carries baited hooks six metres underwater, out of reach of seabirds.

Each year more than 300 000 seabirds, including albatrosses, petrels and shearwaters, are drowned on longlines when they dive after baited hooks. Dr Robertson says many species of seabirds are threatened with extinction because of longline fishing practices.

'Hundreds of millions of hooks are set off tuna boats each year, so if a new system to stop seabird mortality is not widely used soon, it may be too late for some bird species,' he says.

The machine cost almost $500 000 to develop and is expected to retail for about $25 000. The Launcher is currently being trialed in Queensland waters and will undergo further tests in longlining hot spots off South America in 2010.

The Underwater Bait Launcher on a fishing boat in Queensland, with engineers (l-r) Ian Carlyle, Phil Ashworth and Peter Ashworth.

The International Smart Gear Competition (www.smartgear.org) has been running since 2004 and this year there were 71 entries from 27 countries.

NISHA HARRIS
Corporate Communications, Australian Antarctic Division

Seabird ecologist Dr Graham Robertson.

AWARD FOR ZOOPLANKTON WEBSITE

An online and CD-ROM Guide to the Marine Zooplankton of south eastern Australia, developed by Australian Antarctic Division and University of Tasmania scientists, has won a Royal Zoological Society of New South Wales 2009 Whitley Award (Commendation Certificate) for best Electronic Guide.

The Whitley awards recognise outstanding publications (in printed or electronic form) that contain a significant amount of information relating to the fauna of the Australasian region.

Antarctic Division biologist, Dr Graham Hosie, and his University of Tasmania colleagues, Dr Kerrie Swadling, Anita Slotwinski, Associate Professor David Ritz and Dr John Gibson, developed the interactive guide to enable rapid identification of over 50 zooplankton taxa in south eastern Australia. The guide also includes fact sheets covering taxonomic information, descriptions, photographs, diagrams, distribution information and ecology.

'This is just the beginning of the guide,' Dr Hosie says.

'We have the framework in place to easily add other species from around Australia and extend the guide further into Antarctic waters. We may even get the guide onto personal digital assistants and smart phones.'

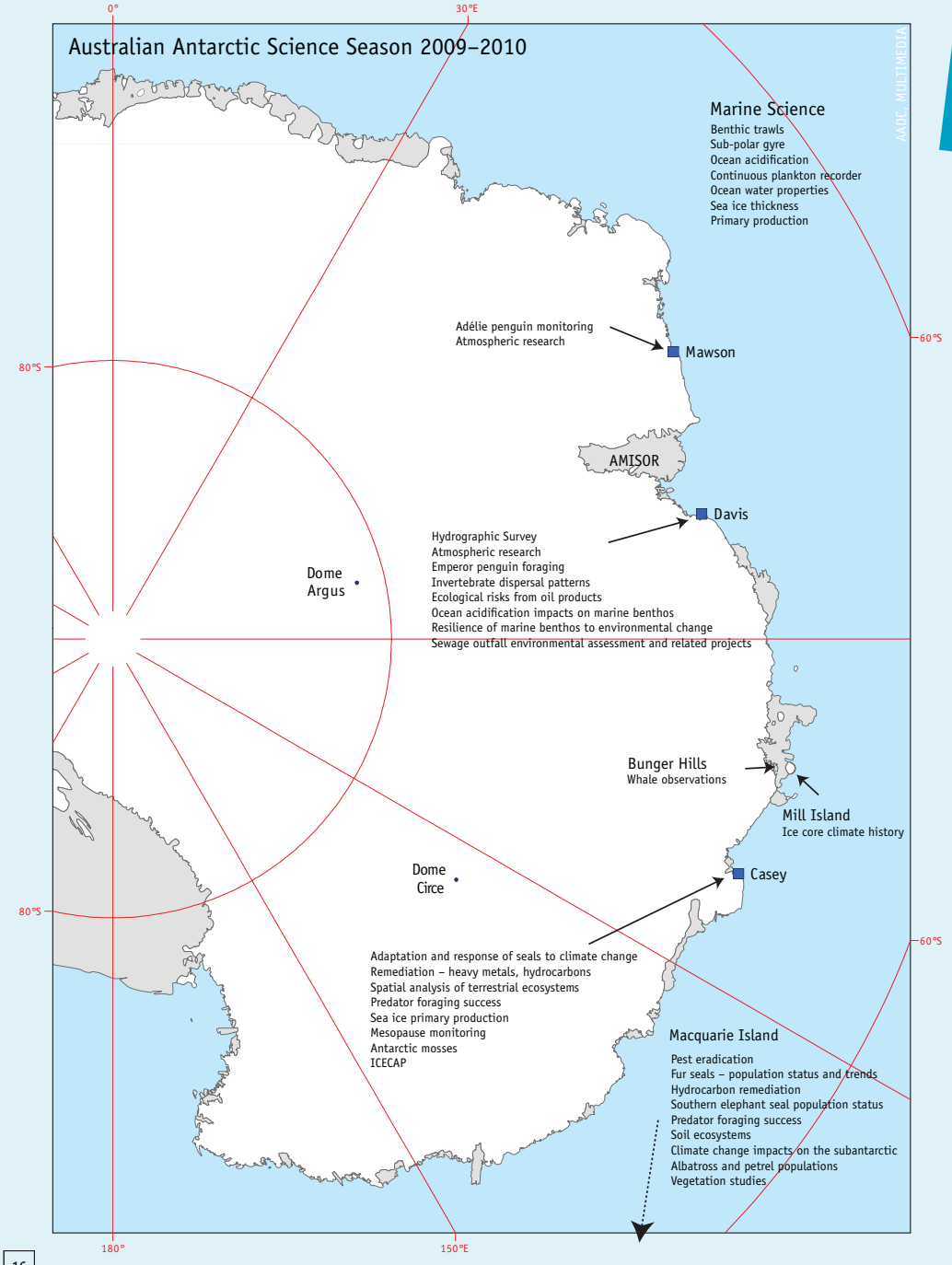
Components of the zooplankton, such as this 10 mm long amphipod, are an important food source for larger ocean-going animals. The interactive online guide to marine zooplankton provides a simple and rapid way of identifying members of this diverse group of animals.

Zooplankton constitute a diverse and abundant group of animals living in water bodies throughout the world. As they are the principal diet of many larger ocean-going animals, including commercially important fish, their study is essential to forming a more complete understanding of the functioning of marine ecosystems. While traditional identification keys have usually been designed for users with a high level of expertise, the new interactive guide allows both expert and novice users to identify their specimen to major group and species level, via an image-based key or diagnostic key.

The development of the guide was supported by the Tasmanian Aquaculture and Fisheries Institute, Australian Biological Resources Study and the Australian Antarctic Division. To access the interactive guide visit www.tafi.org.au/zooplankton/index.html or contact australianzooplankton@gmail.com.

AUSTRALIAN ANTARCTIC SCIENCE SEASON

2009–10



Many scientific research projects will be conducted at Davis this season and during a marine science voyage between December and January. Casey station and Wilkins Runway will see significant infrastructure work in support of the Airlink, while a rabbit and rodent eradication program and long-term environmental monitoring will continue on Macquarie Island.

This summary provides a snap-shot of some of the science activities this season. Other projects not mentioned here are listed on the continental map. View the full list of Australian Antarctic science grants for 2009–10 at www.aad.gov.au/default.asp?casid=36657

MAWSON

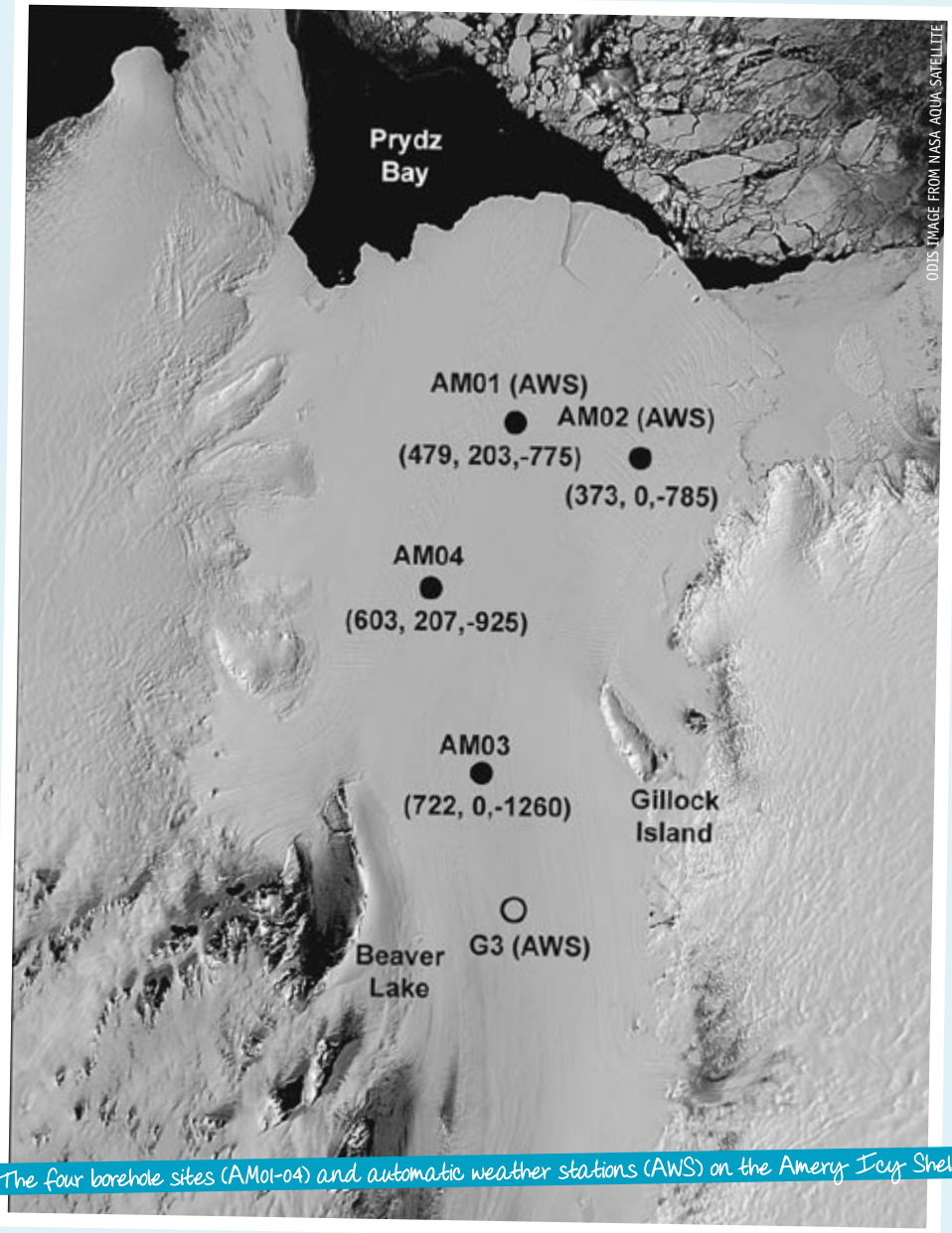
Adélie penguin monitoring: A long-term monitoring program of Adélie penguins is conducted on Béchervaise Island each summer to provide information required by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) for the sustainable management of the krill fishery (see page 6).

Atmospheric research: A range of atmospheric research projects are conducted at Mawson each year and the results feed into climate research and models. Projects include looking at vertical mixing of the atmosphere above 100 km altitude, which could play a role in coupling the upper atmosphere to Earth's weather and climate; and observing small-scale upper-atmospheric wind and weather systems, and monitoring their response during auroral and magnetic storms.

DAVIS

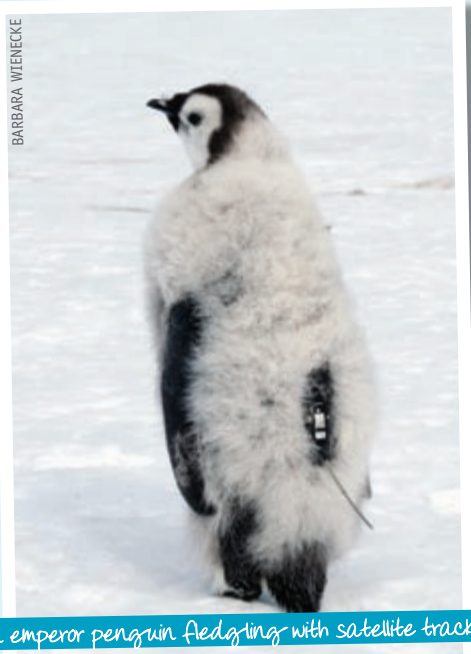
The Amery Ice Shelf Ocean Research (AMISOR) project is the major field project at Davis this season. AMISOR is part of a broad umbrella study of the entire Lambert Glacier Basin–Amery Ice Shelf system, to understand both the climatic history of the region and its probable response to global warming. The project has been running since 2000 and involves hot water drilling of four boreholes through the ice shelf to measure ocean characteristics, ocean currents and basal melting and freezing processes. Freezing processes produce marine (jade) ice attached to the base of the ice shelf, which is permeable at depth and therefore vulnerable to changes in ocean properties beneath the shelf. The project is closely linked with a systematic seismic survey of the north-central shelf region and monitoring of the 'Loose Tooth' – a series of developing rifts at the front of the shelf that will lead to an iceberg calving event. Data from the research feeds into coupled ice shelf-ocean models that predict the patterns of melting and freezing at the base of the shelf, the modifications to water masses circulating below the shelf, and examine the way iceberg-forming rifts propagate into the body of the shelf. Previous research findings have been reported in *Australian Antarctic Magazine* 12: 32–33, 2007.

Atmospheric research: A new $270 000 laser for the Light Detection and Ranging (LIDAR) instrument will be installed at Davis this year. The new laser will enable the gathering of more detailed information on aerosol particles in the lower atmosphere. The LIDAR is used to measure atmospheric density, temperature, wind speed and aerosols from the ground to the edge of space. This season the LIDAR, in combination with radar, will be used to probe ice-aerosol cloud formations in the mesosphere (85 km altitude). In the Arctic, these ice clouds are occurring more frequently and over a greater



The four borehole sites (AM01-04) and automatic weather stations (AWS) on the Amery Icy Shelf.

Testing the new laser in the laboratory.



BARBARA WIENECKE

An emperor penguin fledgling with satellite tracker.

area than in the past. Australian scientists aim to determine whether similar changes are occurring over Antarctica and to examine the properties of these ice-aerosols. Changes in the properties of mesosphere ice-aerosol clouds may be linked to human activities or anthropogenic climate change.

Environmental monitoring of the Davis sewage outfall: Untreated, macerated sewage effluent is currently discharged to the sea at Davis, after the breakdown of the secondary wastewater treatment plant. This project will undertake environmental assessments in support of the planned installation of new sewage treatment facilities at Davis (see page 20). A multitude of other marine ecology projects will feed into this work including:

- **Trophic ecology of the near-shore zone:** 'TRENZ' aims to understand the structure and function of the food web in coastal, benthic (sea floor) communities in Antarctica, and their response to human activities and climate change, so as to better manage and protect them and the broader environment. Work this season will look at the effect of sewage on food webs (such as changes in the number or type of organisms in benthic communities) and uptake of sewage nutrients by marine organisms.
- **Developing sediment and water quality guidelines for Antarctica:** It is generally thought that Antarctic organisms are highly sensitive to pollution, but there is little data to support or disprove this. This project will look at the effects of common contaminants, such as petroleum hydrocarbons, metals and sewage effluents, and their interactions with climate change variables, including temperature and salinity, on a range of Antarctic organisms; from micro-algae to macro-invertebrates. From this work, risk assessment techniques and environmental guidelines for the protection and remediation of sites will be developed.
- **Change in near-shore benthic communities:** This project is investigating natural variability in coastal, benthic ecosystems; the impact of contaminants on them; and biological responses to human activity. The work will lead to improved bio-monitoring and development of an appropriate design system for near-shore marine protected areas.
- **Antibiotic resistance** is common in bacteria associated with humans and is often used to identify sources of environmental contamination. This project will track the dissemination of antibiotic resistance genes in bacteria collected from sewage, sediment, ice and marine invertebrates around the Davis sewage outfall, and wider environment.
- **Contamination impacts on boulder communities:** This project will look at the ecotoxicological effect of contaminated sediments on the growth, survival and recruitment of marine plants and animals living on hard substrates (particularly boulders) in the sediment at Davis. The work will contribute to the development of sediment quality guidelines for Antarctica.

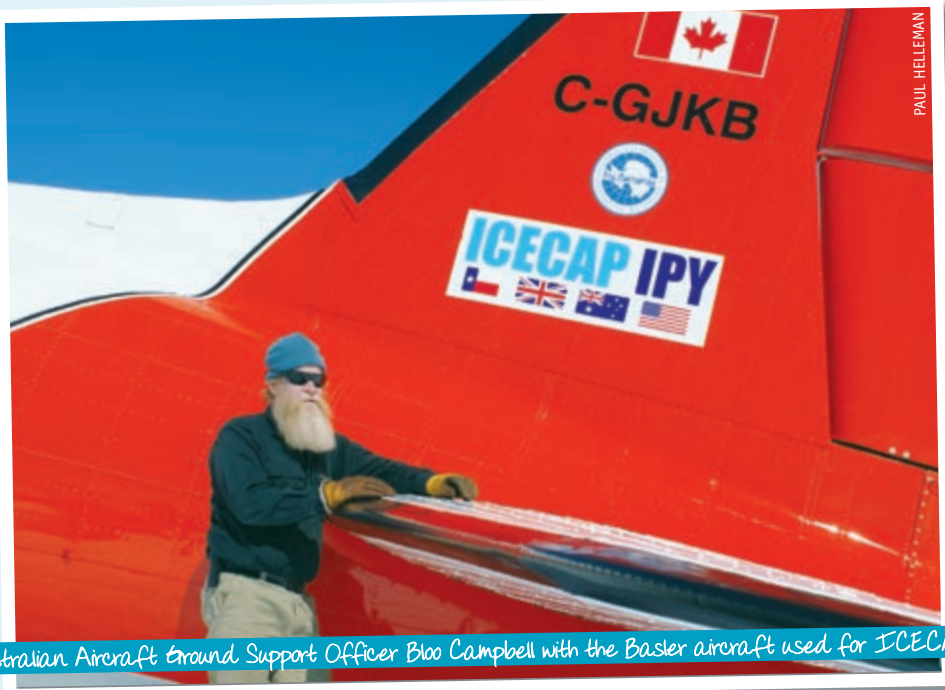
Emperor penguins: This season scientists will deploy satellite trackers on emperor penguin fledglings to monitor the birds' location and diving activities, to see how they change over time (about four months). As mortality is very high in the first year of life only the fattest chicks, and therefore the most likely to survive, will be tracked. Previous tracking work has shown that fledgling emperor penguins travel enormous distances *(Australian Antarctic Magazine* 15: 11, 2008) and pass several other emperor penguin colonies. Scientists will collect genetic material from dead chicks for DNA analysis, to see whether different populations of penguins interbreed and how similar or dissimilar emperor penguins are in other parts of Antarctica.

CASEY

Remediation projects: These include ongoing research into the cost-effective clean up of petroleum spills in the Antarctic and other cold regions, and development and application of technologies to clean up heavy metal contaminants from abandoned waste disposal sites.

Whale observations: Some aerial observations will be conducted from a base in the Bunger Hills, while other work will be undertaken on the RV *Tangaroa* through the Southern Ocean Research Partnership (see page 22).

ICECAP: The second field season for 'Investigating the Cryospheric Evolution of the Central Antarctic Plate' (ICECAP) will see an instrumented aircraft flying survey lines to probe the structure of the ice and underlying geology of the Aurora Subglacial Basin and Law Dome and Totten Glaciers, near Casey. The aircraft will also fly survey lines from McMurdo Station and Dumont d'Urville (see page 24).



PAUL HELLEMAN

Australian Aircraft Ground Support Officer Bloo Campbell with the Basler aircraft used for ICECAP.

MACQUARIE ISLAND

Environmental change: A number of projects are looking at how subantarctic organisms and ecosystems respond to change caused by global warming, feral animals and weedy plant species. The work will contribute to the conservation and restoration of the island once the feral animals have been removed. Researchers are also investigating why an endemic cushion plant appears to be suffering from a rapid die back on the plateau of the island.

Rabbit and rodent eradication: Helicopter pilots and sharpshooters are being recruited for the aerial baiting program and on-ground hunting of rabbits and rodents, while dogs (springer spaniels and labradors) are being trained to detect and flush out remaining rabbit survivors. The Antarctic Division is providing logistic support to this Tasmanian Government-run program. Details are available at www.parks.tas.gov.au/index.aspx?base=12997.

Fuel spill remediation: Low-risk, low-cost, on-site remediation techniques are being used to clean up fuel spills at three sites by 2014. Risk assessment guidelines and target hydrocarbon levels for remediation are also being developed. Full details are reported in *Australian Antarctic Magazine* 16: 21, 2009.

Fur seals: This project is providing key information on the status and trends of recovering fur seal populations in the Southern Ocean, including information on the distribution of foraging effort, food and energy requirements and interactions with commercial fisheries.

JIM WALWORTH

The remediation team in the field.

MARINE SCIENCE

Benthic trawls: Benthic (sea-bed) trawls will be conducted off the East Antarctic coast (near Davis) to understand the impact of bottom fishing gear (longline, trawl and traps) on different habitat types. This will include identifying the characteristics of benthic communities vulnerable to bottom fishing, for use in modelling the effects of fishing. Images taken by trawl-mounted video and still cameras will be used to develop habitat maps and capture footage of the trawl-benthos interactions. The work will assist both Australia and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) to manage high latitude fisheries, including the development of mitigation strategies, such as avoidance of an area or gear modifications. The specially developed camera technology is designed for easy deployment during commercial fishing operations.

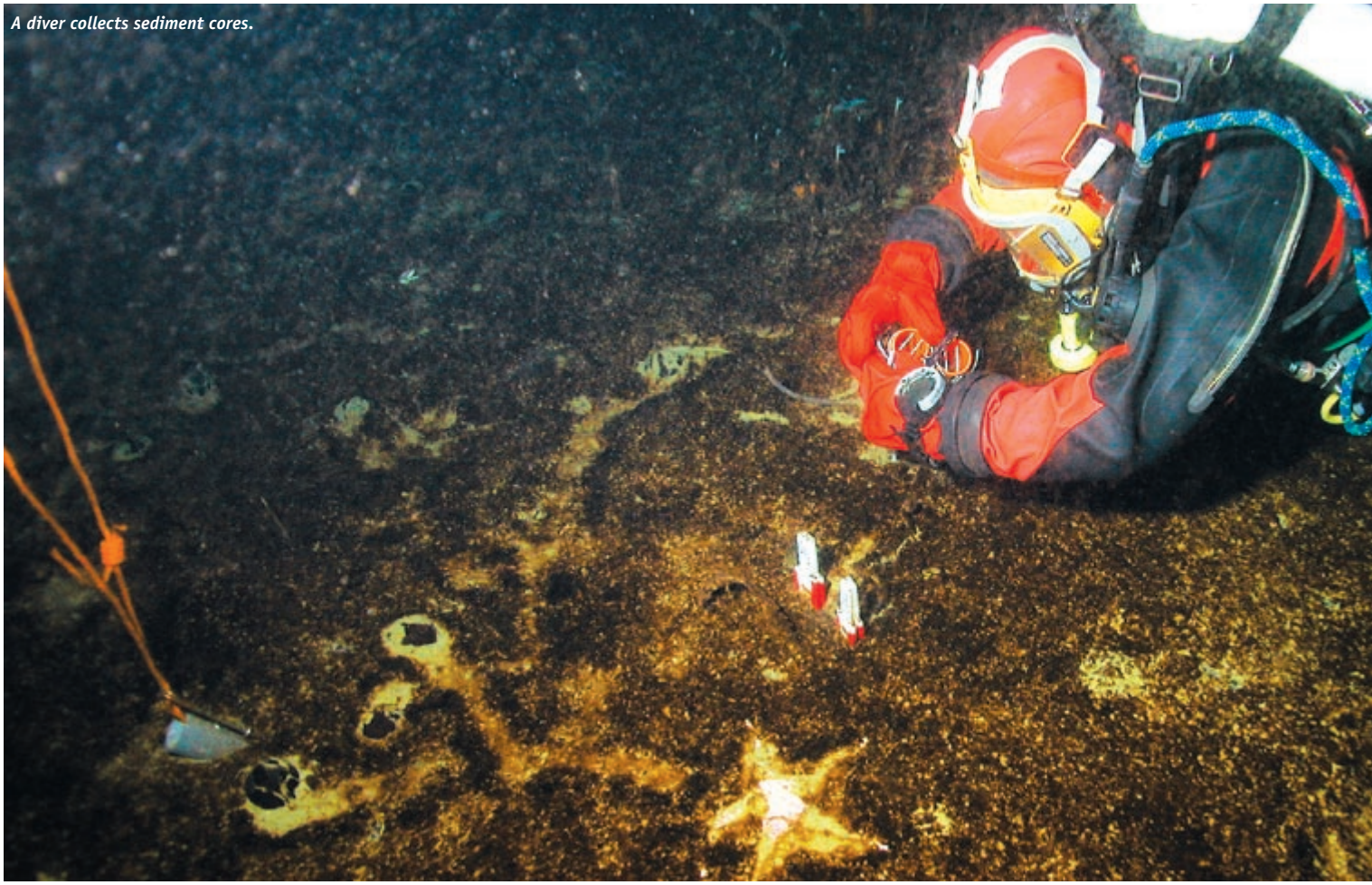
Sea ice research will be conducted by an international team from Australia, Canada and France. An airborne sea ice thickness survey, from the ice edge to the continent, will be undertaken using a helicopter (from the ship) equipped with: a scanning light detection and ranging (LIDAR) system, to measure sea ice 'freeboard' (height above the ocean surface); a medium format digital still camera to measure floe size and surface characteristics; and an infra-red pyrometer for 'skin surface' (snow, ice and open water) temperature measurements. The data will be used for satellite calibration and validation and will continue a record of airborne sea ice measurements in the East Antarctic.

A second project will test a safety feature for operation of the Memorial University of Newfoundland Explorer class Autonomous Underwater Vehicle (AUV), for its planned missions under the Antarctic sea ice. The 'beacon system' provides an acoustic 'heartbeat' during normal operation; warns of a major fault; and uses a range-meter for emergency location. During under-ice operations the AUV will carry an upward looking sonar, to map the underside of sea ice; a hyper-spectral radiometer for measuring light passing through the ice and snow cover (under-ice irradiance); and a fish echo sounder to detect the presence of fish.

Other marine science projects include: mapping of plankton biodiversity with a continuous plankton recorder; studying the response of zooplankton to ocean acidification; and measuring the westward recirculation of the subpolar gyre of the south-eastern Indian Ocean – to monitor changes in this important ocean current and determine their implications.

AAD

A trawl mounted video camera (pictured) will allow marine scientists to observe the effect of bottom fishing gear on different benthic habitats, to depths up to 2000 m.



A diver collects sediment cores.

SCIENCE DIVES INTO DIRTY

Sewage may seem an unlikely conversation starter. But the issue recently grabbed the media spotlight after a Swedish study, which surveyed 71 stations around Antarctica, found that more than half lack any kind of sewage treatment.

Australia's Casey and Mawson stations have functioning secondary treatment plants, which remove biodegradable organic material before discharging liquid waste to the ocean (sludge is returned to Australia). The secondary wastewater treatment system at Davis, however, failed several years ago, and sewage has since been macerated and discharged to the ocean. This practice meets the minimum requirements set out by the Protocol on environmental protection to the Antarctic Treaty, provided conditions exist for the outflow's rapid dilution and dispersal.

This season, to meet the needs of the Australian Antarctic Division's managers, Antarctic Division scientists will lead a number of studies assessing the biological, physico-chemical and ecotoxicological impacts of the sewage to answer three questions:

- How well does the sewage disperse in the vicinity of the outfall and are there better, alternative locations for the outfall?
- What are the nature and extent of the impacts of the present sewage outfall?
- How toxic is the sewage effluent to local species?

Their findings, in addition to operational and policy requirements, will help managers determine what level of treatment is appropriate; whether the existing treatment is suitable or if moving the outfall to another site is a viable option; or whether a new treatment system (and what type of system) is required. Regardless of the scientific results, any treatment system will need to be easily maintained, cost effective, capable of coping with seasonal variations in the station population, able to meet the expectations of the Australian and Antarctic communities and fulfil Australia's obligations under the Environmental Protocol to the Antarctic Treaty.

The scientific work will see seven divers and 11 associated support and research personnel immerse themselves in the waters around the outfall area over the summer season. For the biological survey, divers will compare fish and organisms from microbial and soft sediment communities (such as invertebrates and algae) living in the outfall zone, with organisms living in 'reference' sites away from the outfall area. This comparison will allow scientists to understand the natural variation in communities away from the outfall, and to detect any difference, beyond natural variation, at the outfall site.

'Sewage contamination can cause changes in soft sediment communities, resulting in a loss of biodiversity and the domination of these communities by one or two species, such as opportunistic polychaete worms,' says benthic

Divers and support crew prepare for a dive.

Algae (pictured) will be among the benthic (sea-bed) organisms collected during a biological survey of the Davis sewage outfall site, to look for sewage-related changes.

ISSUE

(sea-bed) ecologist and dive team leader, Dr Jonny Stark.

'The abundance of nutrients could also lead to algal blooms or, alternatively, the sediments could become anoxic and uninhabitable for anything except specialised microbes.'

During the physico-chemical studies, the team will collect up to 300 sediment cores for analysis of sediment grain size and the presence of metals and sewage 'biomarkers' – such as particular organisms and nitrogen and sulphur isotopes associated with sewage. They will also look for the presence of pharmaceutical markers from medicines and personal care products, such as shampoos.

The ecotoxicology work will examine the impact of different concentrations of effluent on invertebrates (such as worms, crustaceans and molluscs), which will be collected and housed in a specially designed field aquarium (see page 25).

'We'll look at the uptake of sewage nutrients, such as the sewage-specific sulphur and nitrogen isotopes, in the tissues of invertebrates, and at the effect of sewage on local food webs,' Dr Stark says.

'We'll also examine fish collected for the biological survey, to see what they've been eating and to look for any pathology in their gills and gonads, which may provide an early warning of sewage-related problems.'

A number of other scientific projects involving researchers from the University of New England, Macquarie University, University of New South Wales, CSIRO and Deakin University, will also feed into the environmental assessment work (see page 16). These include:

- Investigating the distribution of antibiotic resistance genes from sewage through the Antarctic environment.
- Studying the effects of sewage on the food web near the outfall site, in comparison to sites away from the outfall.
- Developing water quality guidelines for Antarctica.
- Looking at the growth, survival and recruitment of marine plants and animals living on hard substrates (particularly boulders) in the sediment at Davis.

The work will provide the first comprehensive environmental assessment of sewage impacts in Antarctica and may help inform wastewater disposal practices amongst other nations active in Antarctica. For Australia's purposes, it will assist in identifying the best engineering solution and the most suitable discharge site for the treated wastewater. An appropriate wastewater treatment solution is expected to be in place at Davis by 2012. The studies will also contribute to research on biodiversity for the 2010 International Year of Biodiversity, and will provide an important baseline assessment of benthic ecosystems against which future changes can be measured.

WENDY PYPER
Corporate Communications,
Australian Antarctic Division

More information:

Gröndahl F, Sidenmark J and Thomsen A. Survey of waste water disposal practices at Antarctic research stations. *Polar Research* **28**: 298–306, 2009.

Southern Ocean Research Partnership

In March 2009 a Southern Ocean Research Partnership (SORP) was established to enhance cetacean conservation and the delivery of non-lethal whale research to the International Whaling Commission (IWC).

The partners – including Australia, Argentina, Brazil, Chile, France, Italy, Mexico, New Zealand, South Africa and the United States – aim to maximise conservation results through research into the status, health, dynamics and environmental linkages of whale populations and the threats they face. The main focus of the partnership is the large whale species managed by the IWC, including the humpback, blue, fin, Antarctic minke, sei, southern right and sperm whales. Killer whales will also be considered as an important component of the Southern Ocean ecosystem.

Research will be conducted under two main themes:

- post-exploitation whale population structure, health and status; and
- changing atmosphere and oceans: Southern Ocean whales and their ecosystems.

Research conducted under the first theme will focus on improving understanding of how whale populations have recovered since the cessation of commercial whaling. It will include data collection for existing long-term population studies on some whale species (such as humpback and southern right) and the collection of new data that addresses important unknowns, such as how endangered fin whales have responded to protection.


DAVE & FIONA HARVEY

Under the second theme research will look at, for example, the importance of sea ice habitat for whales, how the environment affects the movement of whales in the Southern Ocean, the response of whale populations to climate processes in contrasting oceanic regions (such as the Antarctic Peninsula and the southwest Atlantic Ocean), and the interaction of baleen whales with their feeding ground environment.

The SORP research plan is expected to develop over the course of the collaboration, particularly in response to IWC requirements.

For more information about SORP, including reports on the structure and function of the partnership see: www.marinemammals.gov.au/iwc-initiatives/southern-ocean-research-partnerships-sorp

SIMON CHILDERHOUSE
Australian Marine Mammal Centre, Australian Antarctic Division

Australia-New Zealand whale study

The first research project to be conducted under the banner of the Southern Ocean Research Partnership will be a six-week expedition in Antarctic waters in February-March 2010, on board New Zealand's ice-strengthened ship RV *Tangaroa*. The Australia-New Zealand collaboration will involve the collection of data on the movement of whales, population genetics and their interaction with the sea ice ecosystem, using non-lethal research techniques such as biopsy sampling, satellite tracking and acoustic surveys. The data will contribute to an understanding of the population structure, abundance, trends, distribution and ecological role of whales in the Southern Ocean.


PETER MARRIOTT, NZ IPY-CAML

The National Institute of Water and Atmospheric Research's deep-water research vessel, Tangaroa, *working in heavy pack ice in the Ross Sea. The ship will provide a platform for the first whale study to be conducted through the Southern Ocean Research Partnership.*

Grey-headed albatross receives greater protection

The threatened status of the grey-headed albatross has been upgraded from vulnerable to endangered under national environmental law, as the species continues to face threats from fishing and habitat degradation.

Globally, the greatest threat to the species is accidental bycatch from longline, trawl, drift netting and trolling fisheries, and from degradation of breeding habitat by introduced species (such as rabbits on Macquarie Island).

Within Australian waters, the threat abatement plan has significantly reduced albatross bycatch in Australian Government-managed longline fisheries. But the species remains at high risk from other fisheries, especially those operating on the high seas, outside Australian jurisdiction.

The threatened status up-listing gives the species greater protection, because activities that adversely affect the birds are more likely to trigger national environment law. A new recovery plan is also being prepared.


GRAHAM ROBERTSON


ROGER KIRKWOOD

Cameras to spy on petrels

For the first time, automated cameras are being used on a remote island off the Australian Antarctic Territory (AAT) to record the breeding success and population size of southern giant petrels and the duration of their breeding season.

Southern giant petrels (*Macronectes giganteus*) inhabit at least three sites in the AAT: Hawker Island, near Davis; Frazier Island, near Casey; and Giganteus Island, near Mawson. Since the 1950s sporadic attempts have been made to record the number of breeding pairs, and the numbers of eggs and chicks on the islands. However, the major focus of earlier visits was to band chicks to determine their distribution once fledged. As a result, the data collected have been inconsistent within and between sites, due to different survey methods and the difficulty of accessing the colonies regularly and at the same time each year. Surveys also have the potential to disturb the birds, causing some to abandon their nests.


KYM NEWBERRY

The automated cameras are custom designed and manufactured by the Science Technical Support group at the Australian Antarctic Division and have previously been used to monitor Adélie penguin colonies near Mawson station (pictured).

To solve these problems, the Australian Antarctic Division is trialling the use of digital cameras to spy on the Hawker Island colony. Hawker Island was recently declared an Antarctic Specially Protected Area to help protect the southern giant petrel (*Australian Antarctic Magazine* 11: 33). The species is also protected under the Agreement on the Conservation of Albatrosses and Petrels (ACAP) and Australia's *Environmental Protection and Biodiversity Conservation* (EPBC) *Act*.

Australia has an obligation through ACAP and the EPBC Act's national Recovery Plan, to monitor southern giant petrel populations and assess population trends. As it is difficult and expensive to get to the breeding islands each year, our hope is that the cameras will offer a cheap and effective way of obtaining accurate and consistent baseline information that will help us better understand population levels and trends for the breeding colonies in the AAT.

The digital cameras, which have been used successfully to monitor Adélie penguins in Antarctica, have been mounted on tripods at each end of the colony and programmed to take a series of photos of the nest sites each day for about six months. The cameras were set up this spring before the birds returned from their oceanic feeding grounds, and will be removed by the Davis wintering party next April, when the birds have left and the sea ice allows easy access to the island. Images from each camera will be downloaded at Davis station and forwarded to the seabird team in Hobart.

Because the Hawker Island colony is small, two cameras should be able to observe the entire colony. We hope that after three to five years of observations it will be possible to define a breeding chronology and population trend. If the 2008–09 trial on Hawker Island is successful, the intention is to progressively establish other cameras on Frazier and Giganteus Islands.

IAN HAY
Senior Policy Officer, Australian Antarctic Division

Protecting southern giant petrels

Southern giant petrels breed on the Antarctic continent and subantarctic islands, including Heard Island (above), Macquarie Island, South Georgia, Marion Island, and Îles Crozet. The largest colonies on the Antarctic continent are found on the Antarctic Peninsula. The birds nest in ice-free coastal areas, rocky bluffs, open flats, edges of plateaux or offshore rocks. Outside the breeding season they can migrate and disperse great distances over the Southern Ocean.

A recent review of southern giant petrel numbers conducted by the Scientific Committee on Antarctic Research estimated a global population of around 54 000 pairs. While there are uncertainties with much of the population data, Parties at the 2008 Antarctic Treaty Consultative Meeting agreed the southern giant petrel population south of 60°S did not warrant special protection under the Environmental Protocol to the Antarctic Treaty. The small colonies of birds in the Australian Antarctic Territory, however, remain protected by Australian legislation and international agreements.

The Basler BT-67 aircraft with wing-mounted ice penetrating radar antennae, approaching the Casey ski-way.

JACK HOLT

SEEING THROUGH DEEP ICE

Casey station saw some Big Science last summer as the ICECAP project (Investigating the Cryospheric Evolution of the Central Antarctic Plate) used its Basler aircraft to explore the ice sheet and bedrock of East Antarctica. In this first field season over 33 000 km of aerogeophysical survey were flown, including 14 long flights radiating out from Casey for over 1000 km, gathering over a terabyte of data.

The focus was the heart of the Aurora Basin – a region of deep ice directly inland from Law Dome, where the Totten Glacier begins. Previously, south and west of Casey, almost nothing was known beyond three Australian ground traverses in the 1970s and 1980s. Each ICECAP flight covered in a few hours what previously took entire seasons on the ground.

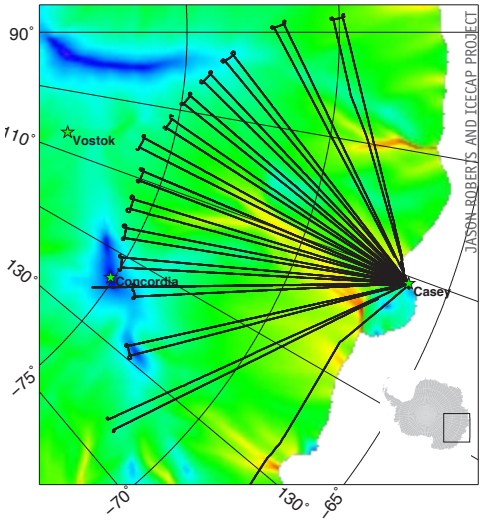
ICECAP began as an International Polar Year collaborative project involving the Jackson School of Geosciences at the University of Texas, Austin; the University of Edinburgh; and the Australian Antarctic Division. It aims to uncover information critical to ice sheet modeling and an understanding of the role of the East Antarctic ice sheet in global climate and sea level rise (*Australian Antarctic Magazine* 15: 15, 2008).

In late January 2009 'JKB', a turboprop make-over of a DC3, operated by Kenn Borek Air of Canada, was an almost nightly sight flying out of the Casey ski-way. At 66 years young the Basler BT-67 shaded pilot Ray Cameron by one year and the rest of the ICECAP team by many more. Flying almost every night that weather allowed, the instrument operators on board kept those back on the ground fully occupied with route planning and data download and evaluation. Pre-dawn flights to minimise solar magnetic noise put much of the station into 24/7 mode for a hectic three weeks – especially for communications, air ground support and other helping hands.

The ice penetrating radar system generates the bulk of the data – imaging the bedrock through more than four kilometres of ice and building a picture of internal reflecting layers in the ice sheet at a resolution of a couple of metres (see image). Initial processing of the first season's radar shows a wide variety of landscapes beneath the ice, from smoothly rolling plains in the deep basins, to large mountain ranges cut by deep valleys, and many indications of wet subglacial conditions and new lakes beneath the ice. Combined with the magnetic field and gravity measurements this will keep geologists busy for quite some time.

ROLAND WARNER AND JASON ROBERTS

This 60 km section of radar signals over the Aurora Basin shows the lower half of the East Antarctic ice sheet. The strong bedrock reflection is seen through about four kilometres of ice, and internal layers in the ice can be seen sweeping over an 800 m change in bedrock height.



JASON ROBERTS AND ICECAP PROJECT

The flight tracks of the 2009 ICECAP season, radiating out from Casey station over the Aurora Subglacial Basin and the Totten Glacier and superimposed on computer modeling of ice sheet flow – from very low flows in blue to major glacial flows in yellow and red.

Mapping out the internal layers structure within the ice will also assist in understanding present and past ice flow, and in searching for good sites for deep ice core drilling.

In December 2009 ICECAP will be back at Casey, following the first major survey season out of McMurdo station in November. In addition to the original survey plans, this year ICECAP is joining NASA's Operation ICE Bridge, making extra flights along the regular satellite tracks of the satellite ICESat-I, to keep up the records of surface elevation changes in East Antarctica.

ICECAP's horizons are growing in other ways too. New French participation brings major surveys of George V Land and Eastern Wilkes Land, from Dumont d'Urville, after this year's Casey-based work. Renewal of the Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC) in Hobart will enable a third season of operations out of Casey in 2010–11, to explore the Denman Glacier and search for sea floor channels on the continental shelf as evidence of past ice streams.

ROLAND WARNER and JASON ROBERTS
ACE CRC and Australian Antarctic Division

MARINE ANIMALS DOWNSIZE IN SEA CHANGE

Just like the Tardis in the *Dr Who* sci-fi series, a new state-of-the-art field aquarium, designed for Antarctic use, packs a lot of kit into a seemingly tiny space.

Constructed inside a shipping container, the aquarium consists of a compact plant and four seawater tanks and associated experimental equipment.

The aquarium was recently shipped to Davis to house marine creatures involved in physiological and ecotoxicological experiments. This season, research is focusing on the effect of ocean acidification, elevated temperatures, and metal and fuel contaminant exposure, on a range of marine organisms.

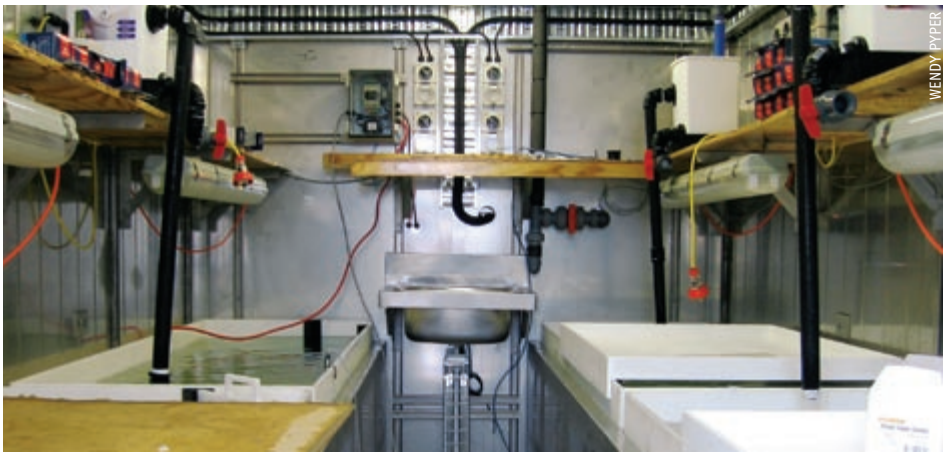
The technical specifications for the aquarium were developed by Australian Antarctic Division marine research facility specialist, Rob King, based on the needs of marine scientists and his knowledge of what works and what doesn't. It was then up to instrument technician, Steven Whiteside, to fit the equipment into the space; which he did with the help of Computer-Aided Design software.

'This is the first time anyone has built a self-contained aquarium for Antarctic use with this level of filtration and experimental capacity, in such a small space,' Mr King says.

'While all the component technology is proven, the completed facility is very experimental.'

To keep the marine animals healthy, seawater from the tanks is constantly cycled through the plant. Mechanical and biological filters first remove solids and metabolic waste products, such as ammonia, while an ultraviolet steriliser destroys any bacteria and viruses. The water then passes through a heat exchanger to cool it to -1°C (the temperature of Antarctic seawater), before it is piped back into the tanks. Depending on the experiments being conducted, the water may be heated to 0°C or 1°C, for Antarctic experiments, and up to 8°C for subantarctic experiments, through small heaters above each tank. Equipment to modify and monitor the carbon dioxide and salinity levels of the water is also available if required. Finally, a small container mounted on a stand outside the aquarium holds seawater to automatically replace water that is removed from the system and for periodical water changes.

The containerised aquarium squeezes plant into one quarter of the total available space (behind the open door at left) and includes a separate seawater tank on a stand, to top up water levels.



Inside the shipping container are four seawater tanks, and small heaters on the shelves above, which regulate the temperature of the water depending on the experiments being conducted. Other experimental equipment can be installed on the shelves as required.

The whole system is controlled through a computer that is hooked in to the station network, for 24 hour temperature monitoring. If problems arise, the computer sends a message to the appropriate person.

Research scientist, Dr Catherine King, says the aquarium's modular design will allow it to be easily adapted for different experiments, and to support a huge range of science projects in Antarctica, including freshwater experiments for Antarctic lake organisms.

Right now though, it's up to the crustaceans, echinoderms, gastropods, isopods, worms, fish, and a myriad of other marine species, to prove the success of their new home and its creators.

WENDY PYPER
Corporate Communications,
Australian Antarctic Division

The aquarium plant includes a biological filter and degassing unit (white cylinders at left), a sump to distribute wastewater from the tanks to the various filters (white box at centre) and a chiller (bottom right) containing antifreeze used in the heat exchanger.


MARK PEKIN

The steel framework of the new living quarters is in place at Davis.


GRAHAM COOK

BUILDING TECHNOLOGY IN ANTARCTICA

Davis and Casey stations are a focal point for Australia's scientific research in Antarctica, whose populations will increasingly grow over summer as the operational capacity of the new Airlink reaches its full potential.

To accommodate this population and attend to more general maintenance issues, the past few Antarctic seasons have seen some old buildings and associated fittings upgraded, or removed and replaced with modern ones. Energy efficiency and flexibility are key requirements of any upgrade or replacement.

The construction of new living quarters at Davis station, for example, will utilise some of the latest in insulation technology. The steel frame of the building was erected in the 2008–09 summer and will be clad in 150 mm fire retardant, fibre composite insulation panels this season. The pièce de résistance of the building, however, will be the large picture windows, 2100 mm high and 1800 mm wide, fronting the communal heart of the building.

Using standard glass windows would drain the building of heat, but the new 'Superglass Quad' windows will provide a view without the energy cost. The super-insulated windows consist of two standard glass panels, separated by two tough plastic sheets known as 'heat mirrors'. These four layers create three spaces that are filled with krypton gas. This moisture-free gas prevents the formation of condensation on the glass and heat loss to the outside. Altogether, the windows have a thermal insulation rating equivalent to a wall insulated with Pink Batts (an R-value of about 2.6).

The living quarters will also include a heat exchanger that will transfer the heat from stale air exiting the building, to fresh air being pumped in. The heat exchanger and a heating coil will warm incoming air, which could be as cold as -40°C, to about 15°C. This air will then be pumped directly to warm areas of the building, such as the kitchen, or heated slightly, to about 19°C, for cooler areas, such as the cinema.

Casey station is also being revamped with an extension to its living quarters, known as the Red Shed, to accommodate more short-term visitors from the Airlink over summer.


DEBORAH RIEWESTAHL

Drafter's impression of the Wilkins Runway living quarters, mounted on a sled. The structure contains the mess, kitchen, lounge, laundry, shower and toilet facilities, a plant room and a multi-purpose room for computers, gym and emergency accommodation.


JEREMY BONNICE

Top: *An example of a bedroom in the new extension to the Casey Red Shed.*

Bottom: *The new kitchen, destined for the Wilkins Runway living quarters, under construction.*

The extension, consisting of 14 x 40 foot-long shipping containers, on two levels, will replace existing shipping containers that are situated external to the Red Shed. The existing containers provide dormitory-style accommodation and require residents to 'brave the elements' when they need to use the Red Shed facilities.

The extension will provide 36 individual rooms, while new ablution facilities will be installed in the existing Red Shed. As no water pipes will be installed in the extension, the building can be shut down over winter, while the Red Shed continues to operate normally. The extension is expected to be operational in 2010–11.

More comfortable infrastructure is also being assembled from insulated shipping containers, to replace the camp-style accommodation at the Wilkins Runway. The new infrastructure will accommodate eight people over summer, with emergency accommodation for another 30 people. The buildings will be shut down over winter. All buildings are mounted on sleds so that they can be moved on to 'berms' (raised platforms of snow) for the winter, to avoid a summer of digging them out of the snow. The sleds are painted white to reflect sunlight and prevent the snow beneath them from melting, refreezing and fixing the buildings to the spot.

WENDY PYPER
Corporate Communications, Australian Antarctic Division

DAVE ROUNSEVELL

A snow melter installed in 1973.

WATER FINALLY FLOWS AT DAVIS

When the Australian National Antarctic Research Expeditions established its second Antarctic station at Davis in 1957, there was just one problem…no water. Water issues have continued to dog engineers and expeditioners, but a new reverse osmosis plant, installed in 2009, heralds a new level of luxury; as Australian Antarctic Division engineer, *Mark Pekin*, explains.

The initial approach to a water supply at Davis – as with all the original Australian stations – was to install a snow melter. Filling the melter with snow for daily water needs was one of the station duties and over time, as the population on station grew, this began to involve days of effort using loaders and trucks.

To improve the reliability of the water supply a nearby natural depression was modified in 1982–83 to form two tarns, with a total storage capacity of some 4.5 million litres. In years of average to high snow falls this system yielded adequate water volumes (estimated at 3 million litres). But in low snowfall seasons little water was produced and the water quality deteriorated due to increased salinity.

MARK PEKIN

The new reverse osmosis unit installed at Davis station.

A desalination unit was subsequently installed. However, the unit failed to function effectively due to the lack of available expertise for commissioning and ongoing maintenance.

In 1990, drinking water was obtained from a new snow melter, and snow collection sometimes required taking heavy earth-moving equipment beyond the station limits in search of suitable snow. Tarn water was used for ablutions and washing, while high quality water for laboratory work was taken from inland lakes, using either helicopters in summer or over-snow vehicles in winter. Water conservation measures were strictly employed, including restricting showers to two per week.

In 1994–95 two reverse osmosis (RO) units (which purify water) were installed, each producing 12 000 litres per day, along with two 600 000 litre storage tanks. Despite these additions water shortages continued, with expeditioners restricted to about 50 litres per person per day, compared to 170 litres on other stations. Two three-minute showers a week became the norm. The crunch came when the RO units exceeded their design life and required constant attention to coax them to produce less and less water each year. For the past three years, during the resupply of the station, water had to be carted from the ship to augment station supplies.

A new RO unit was purchased from the United States in 2007, capable of producing 100 000 litres per day. However, during transport to Davis it was badly damaged during a 40 degree roll of the ship and was found to be unserviceable once on station. The old RO unit was coaxed out of retirement and produced enough water to get the station through winter.

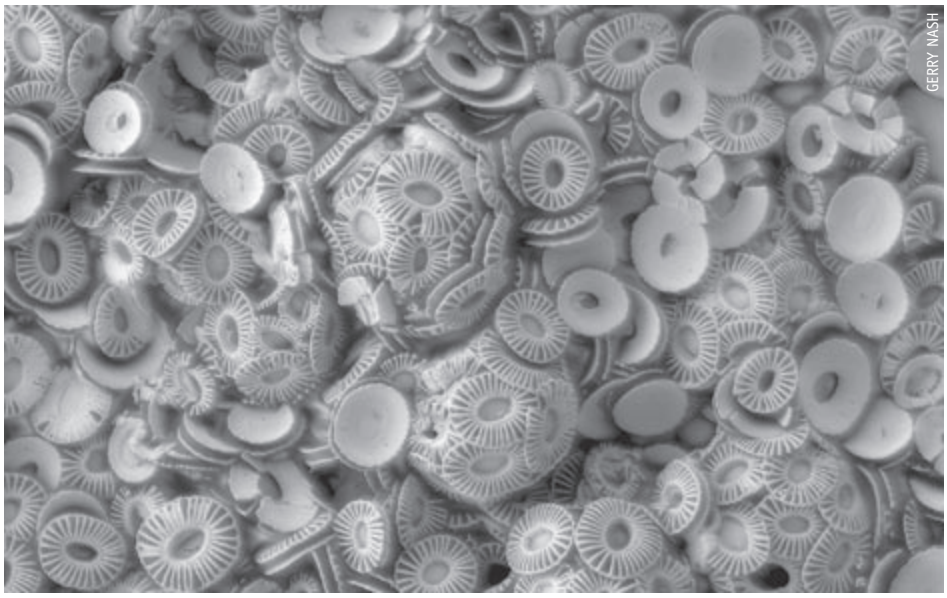
A replacement RO unit made it to Davis intact and after 10 weeks of installing the machine and kilometres of wiring, piping and brackets, it started producing water in January 2009. However, the machine could only run for short periods of time before shutting down, due to over-pressure faults. The fault was found when the manufacturer finally approved dismantling of the pressure exchanger. This unit is like a turbo-charger on a vehicle, with the outlet pressure being used to assist in providing inlet pressure. The rotor within the pressure exchanger had a large crack in the external wall, which caused a tiny (200–300 micron) displacement that, as a result of the fine tolerance between the rotor and its sleeve, prevented the rotor from spinning.

A new rotor was ordered and appeared in time to catch a flight to Wilkins aerodrome. It then made its way by oversnow transport to Casey station and on to the last resupply ship, waiting to depart for Davis.

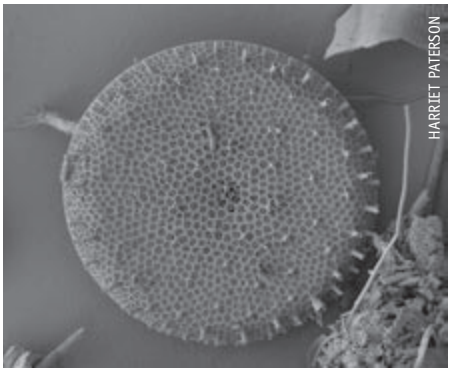
Since the new rotor was installed the RO unit has been operating flawlessly, producing 75 000 litres of water per day. Every storage tank on station is full, holding more than 1.4 ML of water. More than 50 years since the station was established, Davis expeditioners can finally enjoy what most people take for granted…daily showers.

FREEZING THE NATURAL MOMENT

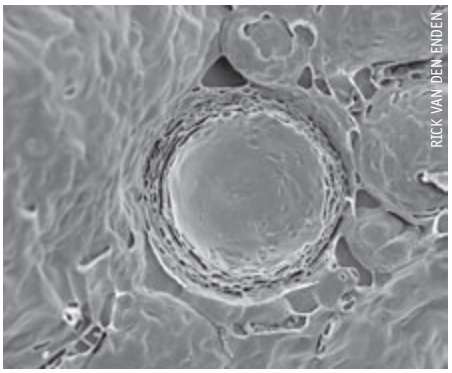
A new 'field emission' scanning electron microscope (FESEM) is providing Australian Antarctic Division scientists with a clearer and more natural view of the microscopic world.


GERRY NASH

*These 6 µm (0.006mm) calcium shell-forming 'coccolithophorids' (*Emiliania huxleyi*) are a keystone species of the plankton in the ocean. They are one of the first organisms to be affected by ocean acidification and are currently under investigation as a marker for climate change. Antarctic scientists are studying changes in the structure of the delicate calcium carbonate plates that make up these soccer-ball shaped organisms using the FESEM. A number of intact coccolithophorids (magnified 3300X) can be seen amongst the individual plates.*


HARRIET PATERSON

*This tiny member of the phytoplankton captured by the FESEM is an Antarctic marine centric diatom (*Thalassiosira gravida*) some 220 µm in size (0.22 mm).*


RICK VAN DEN ENDEN

A 'gritty' globule in a hand cream is revealed using the cryo attachment on the FESEM.

The FESEM, which images in three dimensions the surface of cells, microbes and other small structures using a high-energy electron beam, has a special sample preparation attachment (a 'cryo' preparation chamber and stage) that effectively snap freezes specimens and liquids without altering their natural structure.

Traditional SEM preparation techniques involve dehydrating biological specimens using a series of increasing alcohol solutions and liquid carbon dioxide (called 'critical point drying'). As well as taking hours or days to prepare the specimen, this technique may shrink cells and may damage or alter cell structures.


WENDY PYPER

Electron microscopist Rick van den Enden at the controls of the new FESEM; a JEOL JSM-6701F, with a Gatan Alto 2500 cryo chamber.

The cryo attachment on the new FESEM, however, uses super-cooled liquid nitrogen to snap freeze a specimen at -210°C. Preparation time varies from 10 minutes to one hour, depending on the specimen. This rapid freezing process retains the moisture content within the specimen, leaving it in its natural state.

The Antarctic Division's FESEM can magnify specimens up to 650 000X and reveal structures as small as one nanometre (1 billionth of a metre). It also uses a lower energy electron beam that is cooler than previous scanning electron microscopes. These provide a gentler analysis and a clearer image of the surface detail of the specimen. When combined with the cryo preparation technique, the microscope provides scientists with a never-before-seen view of specimens vulnerable to dehydration (such as delicate seaweeds, mosses, fungi and liquids) in their natural state.

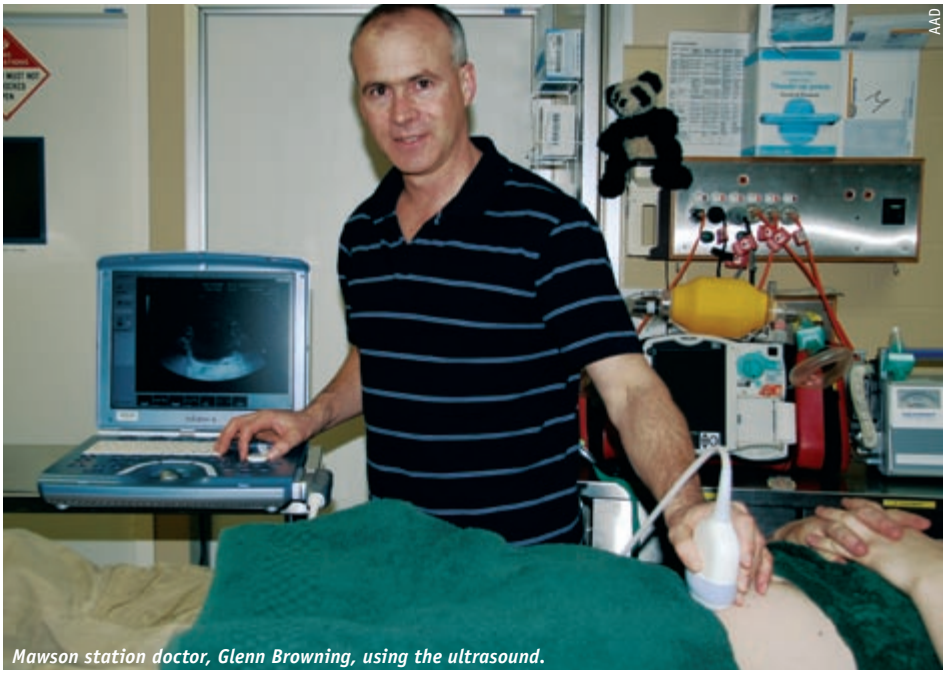
The microscope also allows scientists to examine the chemical elements (such as calcium, magnesium and nitrogen) that are present in a specimen. Different elements give off characteristic X-rays when exposed to the microscope's electron beam and these are used to analyse the chemical composition of a specimen. This capability will allow scientists to study, for example, the effects of ocean acidification on shell-forming organisms. As the oceans absorb more anthropogenic carbon dioxide from the atmosphere, shell-forming organisms such as zooplankton and certain phytoplankton species will find it increasingly difficult to incorporate calcium carbonate into their shells. Using the FESEM, scientists can look at changes in the calcium content of these shells formed under different carbon dioxide concentrations observed in the Southern Ocean. Of course, the ability to visualise any changes in the physical structure of the shells will also be possible.

This latest model FESEM is the only one of its kind in Tasmania and one of three in Australia with the new cryo attachment. With this new instrumentation, Antarctic Division electron microscopist Rick van den Enden expects that collaborative opportunities with other research organisations, nationally and internationally, will become more frequent.

WENDY PYPER
Corporate Communications, Australian Antarctic Division

Three-dimensional medicine

Three-dimensional diagnostic ultrasound machines are set to help Antarctic doctors improve the accuracy of patient diagnosis in the event of serious illness or trauma.


AAD

Mawson station doctor, Glenn Browning, using the ultrasound.

Unlike conventional ultrasound machines, which produce two-dimensional images of the body, the new machines collect a larger and more detailed three-dimensional block of data.

The data can then be sent to a specialist radiologist back in Australia, who can 'virtually scan' through the block in all three planes to find the problem and make a diagnosis.

The machines were recently installed at Australia's Antarctic and subantarctic stations as part of a collaborative effort by doctors from the Australian Antarctic Division, radiographers from the Royal Perth Hospital in Western Australia, and medical equipment manufacturer GE Healthcare.

While the new machines make it easier for general practitioners to collect images for specialist diagnosis, they are complex pieces of equipment to learn to use. Simplified protocols are now being developed which detail the steps required to collect an accurate image, including the correct positioning of the ultrasound probe and recording and sending the data.

'It's impossible to train our doctors in all facets of medical care, so we decided to develop new protocols for the ultrasound machine to enable personnel with minimal training to use the equipment,' Antarctic Division Medical Officer, Graham Denyer, says.

The new protocols will be finalised, validated by a blinded medical research study, and implemented by the end of the year. It is hoped the protocols can be used in other remote areas in Australia and even in space.

NISHA HARRIS
Corporate Communications, Australian Antarctic Division

Subantarctic resupply a LARC

Ex-Army amphibious landing craft have been given a new lease on life at the Australian Antarctic Division.

Eight Lighter Amphibious Resupply Cargo (LARC) vehicles were purchased from the Australian Army recently and two have undergone a $100 000 overhaul for subantarctic service.

The amphibious vehicles will be used for ship-to-shore transfer of cargo and passengers and, unlike helicopters or jet barges, will be able to operate in the inclement weather conditions common around Macquarie and Heard islands.

'LARCs can make surf landings in all types of weather, unlike jet barges, which are unable to get close to shore in rough seas,' says Australian Antarctic Division shipping officer, Mick Davidson.

The two LARCs will be deployed at Macquarie Island this season for twice the usual ship-to-shore capacity, and one vehicle will remain on the island over winter. Another two LARCs are expected to be similarly refitted, while the remaining four will be used for parts. The fleet will also be used in Antarctica in the future.

WENDY PYPER

One of the two newly refurbished LARCs at the Australian Antarctic Division.

The Australian Antarctic Division has used LARCs and crew from the Australian Army and P&O Maritime Services for its resupply missions in the past (at an annual cost of $50–100 000), but this is the first time the vehicles will be owned and operated by the Division. The vehicles are expected to have a service life of up to 12 years and cost $5000 annually to maintain; a significant saving on previous years.

LARCs were originally developed by the United States Army in the 1960s and used to ferry supplies from ship to shore.

NISHA HARRIS
Corporate Communications, Australian Antarctic Division

ROB ROGELLE

ANTARCTIC MEDAL WINNER FLYING HIGH

Flying over large expanses of ice, water and weather-making mountains, in an unlikely collaboration of nuts, bolts and rotors, is not everyone's idea of a good time. But it's made an enviable living for helicopter pilot David Pullinger.


ROB ROGELLE

For 40 years David has travelled to some of the most beautiful places in the world, mucked in with scientists in the field, helped rescue lost or injured bushwalkers and mariners, water-bombed fire fronts, and saved precious fruit from frost. His work in Antarctica, however, as a pilot for the Tasmanian-based company Helicopter Resources, has provided some of his most memorable, satisfying and exhilarating experiences. This year, his 20 years of service to the Australian Antarctic program was rewarded with an Antarctic Medal.

'I was really thrilled and surprised when I received the letter from Government House; my family were very excited,' David says of his award.

'It's an honour and a humbling experience. It's recognition for me, and for the pilots and engineers of Helicopter Resources who contribute to making these expeditions a success. This medal also recognises my wife Mona, who has always been so supportive and enthusiastic of my frequent trips south and who looked after our two young sons, Mark and Lars, when I was away.'

David's flight path to Antarctica followed 20 years of working in Canada, Iran and Nigeria, supporting work in mineral exploration and on oil rigs. After emigrating from England to Australia in 1979, he flew geologists around the Northern Territory and Western Australia, and worked for the Department of Aboriginal and Islander Affairs on Thursday Island. When a position in Tasmania opened up, he jumped at the chance.

'Helicopter Resources had the Antarctic contract when I joined, and I got my first trip south in 1987,' David says.

After a 'lively' trip on the icebreaker, *Icebird*, with a group of other young 'first timers', David got his first glimpse of Mawson's Rumdoodle mountain range.

'I was over-awed by the sheer magnitude of the place; being surrounded by a cold, icy world with the imposing peaks of Rumdoodle rising above the plateau,' he says.

So began a long career supporting the Australian Antarctic program and including stints with the German and Japanese programs. While flying equipment and people between ships, stations and the field is his primary role, David and the other helicopter pilots and engineers spend a lot of time assisting with scientific field work.

'Working in the field is probably the most enjoyable part of the job for me. We've helped out a lot on the Amery Ice Shelf project in the Lambert Glacier Basin (which aims to understand the climatic history of the region and its response to global warming), installing GPS stations and doing other jobs that help the scientists achieve their goals – it's a great buzz for me,' he says.

Communication and planning are also a huge part of his work.

'Flying is exhilarating and at times challenging. Safety is the bottom line, and talking tasks through with meteorologists, the station leader and scientists is so important. If you have good weather then most tasks are achievable. But there's a big mix of personalities, so you have to be a team player, and you have to be flexible. Things change so quickly. There could be a failure in a critical piece of scientific equipment, for example, and we'll need to work with the scientists to make sure a project can continue, rather than be cancelled.'

An average day sees the helicopter pilots up at 6am to check the weather. At the 8am air operations briefing the pilots meet with the scientists, station leader, aircraft ground support officers and meteorologists to review the tasks and achievability. If everything looks okay it's time to check the helicopters, refuel and depart. After anywhere up to nine hours of flying, the pilots return to station, shut down, secure the helicopters, do the paperwork, eat and go to bed.

Helicopter pilots always fly in company with a minimum of two aircraft for safety, and there is always a senior pilot, like David, to assist those with less Antarctic experience.

'We do a lot of landings on snow and ice and you need to be able to read it – its colour and thickness. Whiteout is the biggest threat and one to be avoided without compromise. This comes with experience. You also need to be able to understand and read the weather, and we work closely with meteorologists.'

In all his years David has experienced only a few heart-in-the-mouth moments, with engine failures, which pilots are trained to deal with. He also rates the 'mechanical' turbulence generated by Heard Island's volcano, Big Ben, as memorable, as was the night a bear ransacked the kitchen tent when he was camped in the Canadian wilderness.

The 2009 summer season will be one of the few times in 20 years that David won't be heading to Antarctica. While he will miss going south, there will be plenty of other work to keep him busy. Transporting equipment, supplies and personnel to lighthouses around Tasmania is one 'perk' of the job, which allows him to indulge his other passions.

'I fly maintenance crews into lighthouses, which are often in beautiful parts of the world, like Flinders Island and Maatsuyker Island,' he says.

'There's not a lot I can help with on these occasions, so I usually go for long walks and take photos.'

He expects another busy season of fire reconnaissance, mapping and water bombing, and work for the Tasmanian Parks and Wildlife service transporting personnel and supplies for track work.

Perhaps one of his more unusual winter-time jobs is frost control for apricot and cherry farmers.

'The farmer will call us up if a frost is forecast and we'll sit on site until the temperature drops – usually about 2am. We'll then hover over the crop to stir up the air and keep the temperature right.'

While David says he plans to enjoy 'a few years of retirement', he hopes to keep flying for as long as he is certified medically fit. His passion for his work is unwavering.

'You never get bored with helicopters,' he says; 'they keep you on your toes'.

WENDY PYPER
Corporate Communications, Australian Antarctic Division

MATHEMATICS AND CONS COMBINE FOR A EUREKA

At first glance, computer software may not appear to embody the definition of science communication. But for Australian Antarctic Division mathematician, Dr Ian Ball, software is science communication in its purest form.

'When you encapsulate scientific ideas in software, those ideas can then be communicated between scientists and between scientists and everyone else,' he says.

In fact, Ian and his colleagues have been so successful in capturing and sharing conservation planning knowledge through software, that they won the $10 000 Sherman Eureka Prize for Environmental Research in August.

The prize is one of several prestigious Australian Museum Eureka Prizes which are awarded annually for research and innovation, scientific leadership, school science, and science communication and journalism.

Dr Ball, in collaboration with Professor Hugh Possingham and Mr Matthew Watts, both from the University of Queensland, won the award for their 'Marxan' software, which is being used to design land and marine reserves in 110 countries and counting. This global spread can be attributed to Marxan's strength as a conservation planning tool, its free availability online (www.uq.edu.au/marxan), and its capacity to be used as a stand-alone product or attached to other software.

Marxan has been used to assist a range of conservation planning activities, including: establishing management zones for the Great Barrier Reef that accommodate social, economic

AUSTRALIAN MUSEUM EUREKA PRIZES; STEVE LUNAM

ERVATION PLANNING MOMENT


NISHA HARRIS

Dr Ian Ball in his office at the Australian Antarctic Division.

and conservation needs; to help The Nature Conservancy in the United States conserve California's Channel Islands; and to assist the Australian Government to develop marine protected areas in Commonwealth waters.

The software was developed as part of Dr Ball's PhD thesis in 2000, under the supervision of Professor Possingham. Dr Ball's task was to apply new mathematical techniques to the problem of designing land or marine conservation reserves, to find a method that would provide the best outcome. The problem is mathematically similar to that faced by hospitals or airports when planning staff rosters. Just as rosters need to ensure that people with the right mix of skills are working together, while complying with rules and restrictions about when people can work, conservation reserves need to incorporate representative habitats and animal and plant species, while accommodating social and economic needs. The effects of any changes to rosters or reserves also need to be easily identifiable.

'Computers allow us to mathematically optimise these sorts of problems now, because they can grind through so many permutations quickly and score the relative merits of different solutions against your objectives,' Dr Ball says.

'However, some mathematical techniques are better than others at coping with complexity and changes.'

Dr Ball found a method called 'simulated annealing' provided the best result. He describes the way it works using a physical analogy: 'Suppose you want to find the lowest point on a relief map. If you drop a marble on it, it will roll down hill, but it won't necessarily end up in the deepest valley. With simulated annealing, you shake the relief map so that the marble bounces around a bit, and you shake it less and less as time goes on. It will tend to get stuck in the deepest valley. In terms of reserve design, this will give you a good solution, but not necessarily the optimal one. However, you can keep track of all the places the marble stopped along the way, and choose the best option.'

Dr Ball says the quality of the options will be affected by the quality of the data used and the length of time the software is run for. However, one of the major benefits of the automated process is that the effect of changes in reserve variables (such as the addition of a species or a new land parcel) can be quickly assessed.

'The Nature Conservancy produced maps of their proposed reserves and took them to their stakeholders for feedback, then ran the changes through the software and produced new maps overnight,' Dr Ball says.

While Marxan continues to evolve and disperse across the globe, Dr Ball has moved on to new and different challenges at the Australian Antarctic Division. He is currently undertaking data analysis relating to whale distribution and habitat use, as part of the new Southern Ocean Research Partnership (see story page 22). Prior to this, he developed a fisheries simulator that has been used for fisheries management by the Commission for the Conservation of Antarctic Marine Living Resources.

'I always thought I'd be toiling with numbers and obscura in the background, but my recent work has taken me in quite a different direction,' he reflects.

As for the flow-on effect of the Eureka Award, Dr Ball hopes the heightened profile of the software will help raise funds to support students to attend a Marxan training program and conference, planned for 2010. For Dr Ball, the impact is more personal.

'It will probably be the high watermark of my career,' he says.

WENDY PYPER
Corporate Communications, Australian Antarctic Division

Recipients and presenters of the Sherman Eureka Prize for Environmental Research (L–R): Professor Hugh Possingham, Mr Brian Sherman AM, Governor General Her Excellency Ms Quentin Bryce AC, Dr Ian Ball, Mr Matthew Watts.

IN BRIEF

Funding extended for ACE CRC

The Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC) has received $20.1 million for a further five years of research. The funding will enable the CRC to build on its research into the role of Antarctica and the Southern Ocean in global climate and the impact of climate change on the region, and to provide policy- and decision-makers with scientific information. The ACE CRC was one of 10 successful bidders for $243 million in CRC program funding, announced in August 2009. The ACE CRC is a collaboration between four core partners – the Australian Antarctic Division, CSIRO, the University of Tasmania and the Bureau of Meteorology – and a number of supporting partners. More information about its research can be found at www.acecrc.org.au

Bravery awards

Former Australian Antarctic expeditioners involved in the rescue of passengers from the stricken resupply ship, *Nella Dan*, at Macquarie Island 22 years ago, have been honoured with an Australian Bravery Decoration.

The Group Citation for Bravery has been awarded to five men: Kenneth Stanley Barrington, Dudley Raymond Crowe, Timothy Gay, Gregory Dale Kenny and Alistair Andrew Scott. The men were members of the 35th Water Transport Squadron, attached to the Australian National Antarctic Research Expeditions, when the accident occurred on the evening of December 3, 1987.

The *Nella Dan* was anchored off the station at Macquarie Island when strong winds and huge seas caused her to drag anchor. The ship's hull ploughed into the rocky sea floor, bursting a fuel tank. The members of the Squadron sprang into action, sailing three Light Amphibious Resupply Craft into the huge seas to evacuate almost 80 Antarctic expeditioners and ship's crew.

The awards will be presented to the recipients by Her Excellency Governor General Ms Quentin Bryce AC at ceremonies in early 2010.

AAD

The Nella Dan *is scuttled after running aground off Macquarie Island; 24 December 1987.*

Director's Awards 2009

During midwinter celebrations this year Australian Antarctic Division Director, Lyn Maddock, presented Director's Awards to:

- Simon Langdon, for exemplary attitude and work ethic in providing high quality support for air and seas cargo operations, and for Antarctic and subantarctic voyages and flights.
- Matthew Sutton, for excellence in financial advice and support. Matthew was instrumental in preparing the new policy proposal for additional funding for the Antarctic Division, announced in the 2009 Federal budget.
- Ian Phillips, for commitment and professional support to station life, in particular science-related communications.

GLENN JACOBSON

Simon Langdon

GLENN JACOBSON

Matthew Sutton

EXPEDITIONER PHOTO

Ian Phillips

Antarctic doctor heads rural and remote medicine college

GLENN JACOBSON

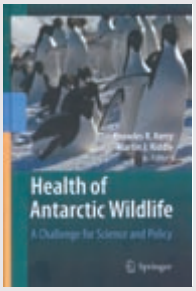
Dr Jeff Ayton

The Australian Antarctic Division's Chief Medical Officer, Dr Jeff Ayton, has been elected the new President of the Australian College of Rural and Remote Medicine (ACRRM). Dr Ayton has been ACRRM's Tasmanian Director since 2008 and will take over the national role from Associate Professor Dennis Pashen.

Dr Ayton is a rural GP, obstetrician and anaesthetist and has been Chief Medical Officer at the Antarctic Division for seven years.

The College is the peak professional organisation for rural and remote medicine, providing training and education. It represents about 2500 Fellows, Registrars, practitioners and students across Australia.

Health of Antarctic Wildlife



Health of Antarctic Wildlife: A challenge for Science and Policy is a new book published by Springer and edited by Australian Antarctic Division scientists Dr Knowles Kerry and Dr Martin Riddle. The book provides a broad assessment of the health of Antarctica's birds and seals, set against the background of available scientific and environmental information and the political and administrative processes in place.

The book was conceived during an international workshop on diseases of Antarctic wildlife held in Hobart. The workshop acknowledged that there had not been a disease outbreak in Antarctica that was positively attributed to human activity, but found that 'there was a significant risk of the introduction of (exotic) diseases to Antarctic wildlife species and should it occur the consequences are likely to be serious and a response will be required'. The book is based on the papers presented at the workshop and also chronicles subsequent developments within the Antarctic Treaty and responses by Government and non-Government operators in Antarctica to protect wildlife against disease introduction. The 17 chapters are divided into two parts: *Wildlife disease*, which consists of reviews, case studies and health assessments; and *External factors*, which covers the environmental, administrative and legal aspects. The Appendices include methods for sample collection and analysis, response plans,

reviews and other documents that are referred to in the book but are not readily available.

The book aims to cover the essential issues necessary for understanding health and disease relating to Antarctic wildlife and to provide 'wise council' in the management of human activities in Antarctica. It is targeted at veterinary and biological scientists, policy makers and administrators involved in protecting the health of Antarctic wildlife.

The book is available through a range of online outlets including Springer, or by contacting martin.riddle@aad.gov.au

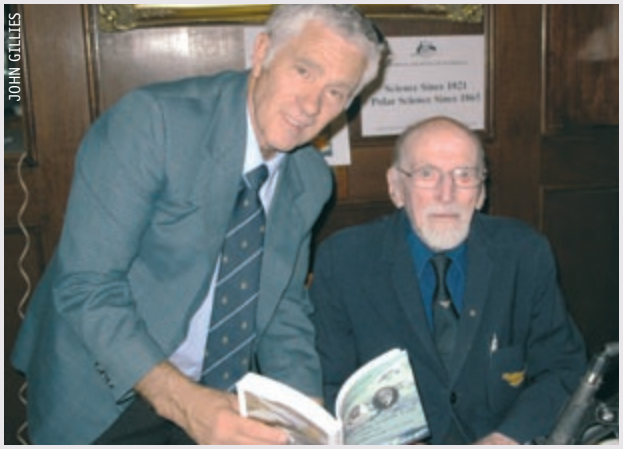
Who saved Antarctica?

Twenty years ago the course of Antarctic history was changed when Australia announced it could not support the prospect of mining in Antarctica. Its May 1989 decision rejected the Antarctic minerals convention painstakingly negotiated by the Antarctic Treaty over the preceding six years. This action triggered a two-year diplomatic campaign resulting in adoption of the Madrid Protocol, which banned mining and ensured protection of the Antarctic environment. Various people and organisations have claimed credit for this turn of events, and others have pointed to the influence of external events such as the catastrophic loss of the *Exxon Valdez* in the Arctic. In *Saving the Antarctic Wilderness* Geoff Mosley tells the story from the perspective of one arm of the environment movement. The book makes the case that action to protect Antarctica is not complete until the continent is World Heritage listed. But that issue, which many would argue is politically unachievable and legally unnecessary, does not detract from the book. Mosley's revealing insights into how domestic environmental politics contributed to changing management of Antarctica is a story well worth telling. *Saving the Antarctic Wilderness – the Pivotal Role in its Complete Protection* (Envirobook, 2009) is available from www.envirobook.com.au for $19.95.

Andrew Jackson, Honorary Fellow, ACE CRC

Oral history of Dr Phillip Law's life published

The extraordinary life and times of Antarctic explorer and former Director of the Australian Antarctic Division, Dr Phillip Law, has been recorded in a new book published by The Royal Societies of Australia and author, Major Ian Toohill. *Dr Phillip Garth Law: his extraordinary life and times* is based on many recorded interviews with Dr Law and his wife Nel between 1984 and 2007. Among his many achievements, the now 97-year old Dr Law led the Antarctic Division for 19 years and established Australia's three Antarctic stations. Major Toohill's book focuses particularly on this time and Dr Law's formative years, with a briefer section covering his later years. The original sound tapes and later videotapes have been deposited in the National Library of Australia. The book joins a growing collection published by Dr Law and others about his life and Antarctica. The book can be ordered from The Royal Societies of Australia for $45 (fax +61 (0)3 5489 3295) and is available at selected book shops. Electronic order forms are available at http://www.scienceaustralia.org.au/dr-law-book.pdf



Major Ian Toohill (left) and Dr Phillip Law at the launch of the new book.

Novel research

Former Antarctic expeditioner, Robyn Mundy, has published her first novel, *The Nature of Ice*, which tells the story of modern-day summer expeditioners at Davis, alongside the hardships and tragedies encountered by Douglas Mawson and his men. The two eras are linked by reproductions of Frank Hurley's iconic photographs from 1911–13 and extracts from early expeditioners' diaries and Mawson's letters.

Robyn's research for the novel included a visit to Mawson's Huts, and reading Xavier Mertz's journal and archived journals and papers from the Australasian Antarctic Expedition.

Robyn recently spent a year as a field assistant at the Auster emperor penguin rookery (near Mawson). Her stunning photograph of an emperor penguin huddle featured on the cover of issue 15 of this magazine. In this issue, one of her photos is featured in Freeze Frame (page 37). Robyn has made some 40 trips to Antarctica and her book draws on her impressions, observations and experiences of the continent. *The Nature of Ice* is published by Allen & Unwin and costs $26.99.

Funding for Mawson's Huts conservation

The ongoing conservation of Mawson's Huts at Cape Denison received a boost in October with $486 000 in funding from the Federal Government's Australia Jobs Fund. The money will fund two long-term and nine short-term jobs to remove ice and snow from the interior of the huts and recover, conserve and catalogue historic artefacts.

Australian Antarctic Arts Fellow wins PM's Prize

Former Australian Antarctic Arts Fellow, Tom Griffiths, was jointly awarded the Prime Minister's Prize for Australian History for 2008. Professor Griffiths won the $100 000 award for his book *Slicing the Silence: Voyaging to Antarctica*, written after his trip to Antarctica in 2002–03. The prize recognises outstanding publications which contribute significantly to the understanding of Australia's history.

First flight to Casey via McMurdo

Australia's Antarctic summer season began with a flight to Casey station via the United States' McMurdo station in October.

Forty-nine Australian Antarctic Division personnel were on the flight, including runway construction crew, station support and scientists.

The Antarctic Division's Aviation Manager, Steve Daw, said the idea behind the early flight was to get Wilkins Runway operational early.

'It takes about four weeks to get the runway prepared, so being able to get our construction crew in there early means our summer season can start sooner,' Mr Daw said.

'It also means the shipping program can be more flexible as the *Aurora Australis* doesn't have to go to Casey and we are able to get station support staff in early to help prepare for the upcoming season.'

MICKY LOEDEMAN

McMurdo Station.

Antarctic conference

The University of Tasmania will host 'Antarctic Visions', a conference examining Antarctica from a cultural perspective, from 21–23 June 2010. Drawing on the arts, social sciences and humanities, the conference will focus attention on the ways we perceive and represent Antarctica. Connections with other disciplines – particularly scientific disciplines – are encouraged, as are new approaches to familiar challenges, such as the whaling and climate change debates. While the primary focus of the conference is on Antarctica, papers which combine Antarctic and Arctic material are welcome. Please email your paper (with short abstract) and panel proposals (including a brief biography for each participant) to Ralph.Crane@utas.edu.au by Friday 26 February 2010. Further information and registration is available at www.utas.edu.au/ejel/antarctic%20visions/

Station Leaders 2009–10

Casey – Narelle Campbell

NARELLE CAMPBELL

Narelle has 23 years experience in print media, covering logistics, sales and marketing in senior management roles. She began her career at Rural Press Limited before moving to Fairfax Media where she was National Circulation Manager for Fairfax Business Media for seven years. In 2005 she became National Manager, Income Development, for Mission Australia. Narelle has degrees in social science and counselling and has worked as a volunteer for Missionbeat in Sydney, providing support to homeless people. Narelle has walked the Kokoda Track and completed high altitude climbs in Nepal, India, Africa and Chile. She was the Station Leader at Mawson in 2007–08.

CLARE WOOLRIDGE

Davis – Mike Woolridge (summer)

Mike is originally from the United Kingdom and has degrees in electrical and electronic engineering and environmental science and a Diploma in Mountain Guiding. He has worked at the Australian Antarctic Division since 2002 in a support and coordination role, working closely with station leaders. Mike has been south several times since 1993 and has worked at all of Australia's Antarctic and subantarctic stations. He was the Senior Field Training Officer at Davis for four summers between 2002 and 2006. Before joining the Division he worked in outdoor and tertiary education in Victoria. He met his wife in Antarctica and they have two children.

Mawson – Mike Craven

WAYNE PAPPS

Mike (aka 'Duk') studied chemistry and physics at university and spent four years as a teacher and five years as a co-manager in the hotel industry in Ipswich (Queensland). He first went to Macquarie Island in 1983 as the upper atmospheric physicist and followed this experience with winters at Macquarie Island (1985), Davis (1988) and Mawson (1991). In 1994 he joined the Australian Antarctic Division as a member of the Lambert Glacier Basin traverse team. This was followed by six summers on the Amery Ice Shelf as leader of the AMISOR hot water drilling teams. He was part of the Wilkins Runway management team in 2008–09. Mike and his wife Chris have undertaken several cruises to the Ross Sea and Antarctic Peninsula, where Mike acted as guide and lecturer aboard tourist vessels.

JESSICA FITZPATRICK

Macquarie Island – Jeremy Smith (winter)

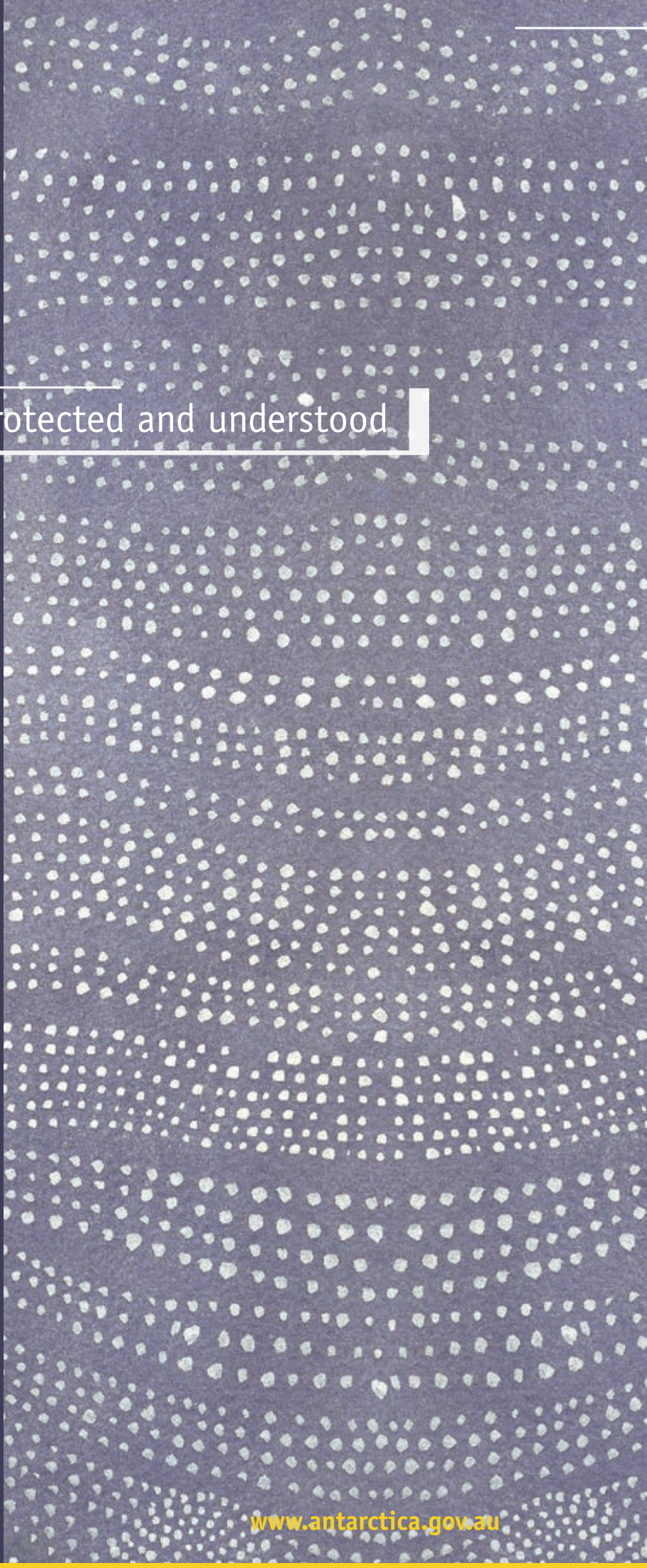
Jeremy spent 26 years in academia as a lecturer and later, Associate Professor at the University of New England in Armidale, NSW, where he specialised in biogeography and environmental studies. He has undertaken field research in Papua New Guinea, Sabah, Venezuela and eastern Australia and has authored more than 100 scientific publications in biogeography. This year marks Jeremy's sixth year as a station leader, after previous stints on Macquarie Island in 1996, Davis in 2001 and 2003, and Casey in 2005 and 2007.

I love the look of Australian Antarctic stations with their vibrant colours, sharp lines and angles. The Rosella Shed – the workshop for Mawson station 'chippies' (carpenters) – is aptly named for its array of brilliant colours. As I understand it, the wonderful colours of Rosella were inspired as much by economy as design – the building is clad with off-cut materials. One Sunday at Mawson, when the sun was shining and the wind wasn't howling, I spent a few hours wandering about the station with my camera, and this was the result.

FREEZE FRAME

Robyn Mundy has been travelling to the polar regions for 14 years, working on ship-based tours for Aurora Expeditions. In 2003–04 she worked at Davis as a field assistant for a project investigating diseases in skuas. In 2008 she wintered at Mawson station, working with Dr Gary Miller at Auster Rookery to research the presence of avian viruses in emperor penguins, an experience she describes as one of the best years of her life.

ANTARCTICA valued, protected and understood



Australian Government
Department of the Environment, Water, Heritage and the Arts
Australian Antarctic Division

www.antarctica.gov.au