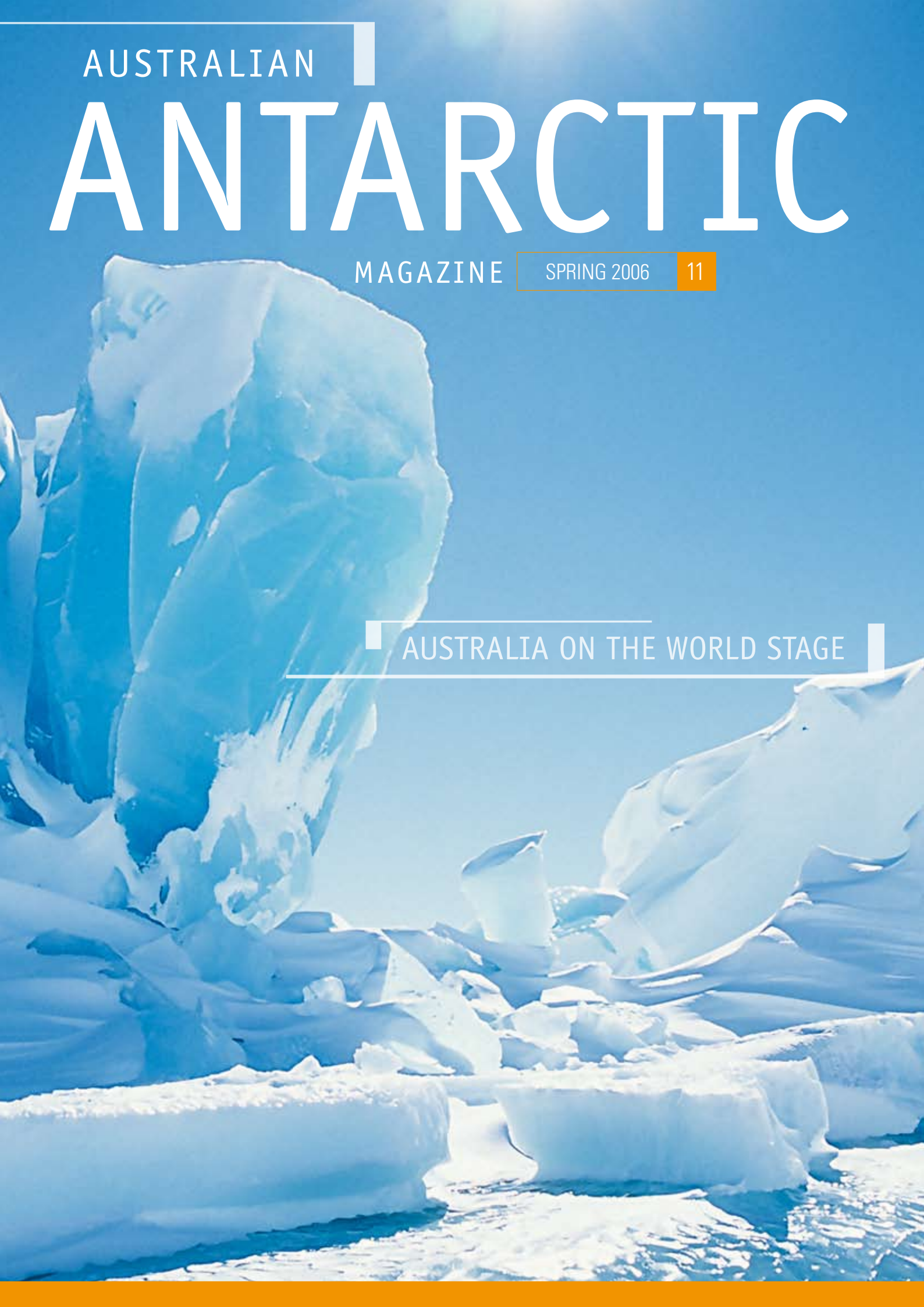
AUSTRALIAN

ANTARCTIC

MAGAZINE

SPRING 2006 11



AUSTRALIA ON THE WORLD STAGE

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The Australian Government Antarctic Division (AGAD), a Division of the Department of the Environment and Heritage, leads Australia's Antarctic programme 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 programme, maintaining four permanent Australian research stations, and conducting scientific research programmes 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 programme. Opinions expressed in Australian Antarctic Magazine do not necessarily represent the position of the Australian Government.

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ISSN 1445-1735

Australian Antarctic Magazine can be viewed online:
<http://w zine>.

Australian Government
Antarctic Division

FRONT COVER:KARL ROLLINGS

AUSTRALIA ON THE WORLD STAGE.

The Australian Government Antarctic Division this year played its part as a contributor to international Antarctic science, policy and operations.


KIERAN LAWTON

In July, Australia hosted the Open Science Conference of the Scientific Committee on Antarctic Research and the annual meeting of the Council of Managers of National Antarctic Programs, which attracted close to 900 delegates from around the world, to Hobart. The Australian Government Antarctic Division's involvement in these international organisations ensures Australia has a say in scientific, policy and operational issues and decisions affecting the whole of Antarctica. Antarctic Division staff also took the opportunity to showcase their work to an international audience, contributing 17% of the talks and posters presented. The combined Australian Antarctic programme made up 30% of the presentation effort.

Among the research presented was Jason Gedamke's work on passive acoustic technology to study the seasonal distribution of whales (page 5). This work is important if we are to understand as much as possible about the populations and life histories of these important animals and their place in the Antarctic ecosystem. Jason and his colleagues' poster was selected as the Best Open Science Conference Poster from some 350 on display.

Building on the important marine mammal research being conducted at the Australian Government Antarctic Division, the Division was this year awarded $2.5 million over four years to establish the Australian Centre for Applied Marine Mammal Science. In collaboration with researchers and institutions around Australia, the Centre will contribute to the development and implementation of management and policy relating to whales, dolphins, seals and dugongs.

The Australian-Antarctic Airlink is again making headlines, with the new aircraft, an Airbus A319, contracted recently. The aircraft has a range of 6500 nautical miles, allowing it to fly from Hobart to Antarctica and return without refuelling. The Airlink will help attract international scientists to the Australian Antarctic programme and expand the research opportunities for our own scientists.

As we approach this new operational era the Australian Government Antarctic Division is proactively addressing new and imposing challenges that will influence our work in Antarctica – including climate change and the global escalation in the price of oil. Through the new Antarctic Futures Project, the Antarctic Division will present a vision of Australia's role in Antarctica to 2020, providing context for short, medium and long-term decision-making.

One thing is already certain; Australia, through the Antarctic Division, will continue to undertake globally important Antarctic science, such as that committed to in our new Environmental Protection and Change programme (page 28). We will also continue to help protect the Antarctic and Southern Ocean environment and its resources through the Antarctic Treaty, the Committee for Environmental Protection and the Commission for the Conservation of Antarctic Marine Living Resources.

As you read this a new Antarctic season is well underway, as are preparations for the start of the International Polar Year (IPY) in March 2007. The Australian Government Antarctic Division will host four IPY projects covering the broad themes of biological diversity, alien species, solar variability and climate, and human health, in Antarctica. The international projects will leave a legacy of collaboration that will support Antarctic research into the future and inspire and encourage a new generation of scientists.

Finally, you may have noticed our new name. The Australian Antarctic Division is now known as the Australian Government Antarctic Division, reflecting the importance the Australian Government places in Australia's Antarctic interests.

TONY PRESS
Director, AGAD

BRINGING ANTARCTIC INTERESTS TOGETHER.

The world event of Antarctic science and logistics came to Hobart last July with the first joint meeting of the Scientific Committee on Antarctic Research (SCAR) and the Council of Managers of National Antarctic Programs (COMNAP).


DAN WEAVELL

Posters lined the halls and walls of the SCAR/COMNAP venue.


DAN WEAVELL

Conference delegates check their emails and browse the trade display.

Some 900 delegates from around the world converged on Hobart for a range of business meetings, the SCAR Open Science Conference – on the broad theme Antarctica in the Earth System – and a concurrent symposium of COMNAP's advisory committee – the Standing Committee on Antarctic Logistics and Operations (SCALOP) – which addressed the theme Going forward together, efficiently and safely.

Australian Government Antarctic Division scientists were well represented at the SCAR and SCALOP events. Of some 625 talks and posters presented during the week the Division contributed 15 (24%) of the 62 SCALOP presentations and 89 (13%) of more than 560 SCAR presentations. Overall, Australia was responsible for approximately 30% of the presentation effort.

The SCAR Open Science Conference covered 45 themes, including evolution, climate, glaciology, atmospherics, astronomy, marine ecosystems, ecology, geology, environmental impacts, human health and oceanography. Keynote speakers also provided an overview of each of SCAR's five recently established scientific research programmes (page 3).

The SCALOP symposium featured talks on safety and new directions in stations, infrastructure, shipping and energy reduction. Leading international oil expert, Dr Ali Samsam Bakhtiari of the University of Tehran, painted a worrying picture of the inevitable decline in oil production and rising fuel prices (page 10). A number of lightweight, energy efficient station designs were also previewed, including the British Antarctic Survey's replacement for Halley V, which will be the first Antarctic station on skis (page 17).

COMNAP delegates also participated in a range of working groups and workshops covering shipping, air transport, energy management, medicine, environmental issues, tourism, expeditioner training, waste management, incident reporting, and safety. Over the coming year COMNAP agreed to develop a range of initiatives including an information paper on contingency planning and emergency response, reducing the environmental footprint in Antarctica, and a working paper on best practice energy management. Throughout the year working groups will also focus on supporting initiatives to enhance hydrographic surveys of Antarctic waters, conducting a workshop on improved weather forecasting in Antarctica, developing guidelines for training, response to emergencies and fuel handling and storage, and taking advantage of communications technologies such as Iridium telephony.

The combined meetings provided delegates with an important opportunity to discuss future collaborative ventures as they approach the start of the International Polar Year in March 2007. The following pages provide a snapshot of some of the topics covered at the meetings by the Australian Government Antarctic Division and other Antarctic institutions.

The Scientific Committee on Antarctic Research initiates, develops and coordinates high quality international scientific research in Antarctica, and on the role of Antarctica in the Earth system.

PETER BOWER

SCAR makes its mark in Antarctic science

Australia was a founding member of SCAR when it was established in 1958 to advance international scientific activity in Antarctica during the International Geophysical Year of 1957-58. Since then Australia has played an active role in the key SCAR activities of initiating, developing and coordinating international scientific research in Antarctica.

In 2004 SCAR defined five new strategic scientific programmes that will provide a research focus in the coming decade. The programmes are also playing a leading role in the research planned for the International Polar Year beginning in March 2007. Australian scientists are involved in all five programmes.

Antarctica and the Global Climate System

This programme investigates the atmospheric and oceanic linkages between the Antarctic climate and global climate. It has four closely linked themes of research investigating Antarctic climate variability over decadal time spans, global and regional climate signals in ice cores, natural and human influences on the Antarctic climate, and the influence of Antarctic climate processes on global climate (Australian Antarctic Magazine 9: 4).

Antarctic Climate Evolution

The Antarctic Climate Evolution programme promotes the exchange of data and ideas between research groups focussing on the evolution of Antarctica's climate system and ice sheet. Information on climate change and ice thickness variation will come from cores drilled through the ice sheet and through rocks and sediments under the ice, from cores in offshore marine sediments and from changes in the landscape (such as the exposure of past moraines, when ice melts). Data will be used in models to improve our understanding of how climate changed in the past and to better forecast how climate may change in the future.

Evolution and Biodiversity in the Antarctic

Evolution and Biodiversity in the Antarctic: the response of life to change will explore the evolutionary history of selected modern Antarctic biota, how biological diversity in the Antarctic influences ecosystem function, and how the biota will respond to environmental change. The programme will integrate work on marine, terrestrial and freshwater systems and bring together a wide range of disciplines such as plate tectonics, climatology, glaciology, molecular biology, palaeontology and ecology. The programme incorporates the five-year Census of Antarctic Marine Life, being led by the Australian Government Antarctic Division.

Inter-Hemispheric Conjugacy Effects in Solar-Terrestrial and Aeronomy Research

Also known as ICESTAR, this programme investigates the effects of the solar wind and radiation on the structure and dynamics of the upper atmosphere at the poles. Research focuses on the interaction between the magnetosphere (the Earth's magnetic field), the ionosphere (the layer of the Earth's atmosphere that is ionized by solar radiation) and the solar wind. A network of ground-based instruments will be used to study the similarities and differences between these interactions at each pole. The research will help improve predictions of space weather phenomena that adversely affect spacecraft operations, radio communications and satellite-based positioning systems, and provide scientists with new insights into, and ways of studying, the near-Earth space environment.

Subglacial Antarctic Lake Environments

More than 150 subglacial lakes have been discovered under the Antarctic ice sheet, the largest being Lake Vostok in the Australian Antarctic Territory, four kilometres below the ice. The Subglacial Antarctic Lake Environments programme is coordinating several efforts to drill through the ice sheet into some of these subglacial lakes, which appear to be part of a much larger subglacial hydrological system. The programme will advance understanding of the evolution of subglacial environments and processes, their physical, chemical and biological characteristics and the interconnectivity of subglacial networks.

LOOKING TO ICE LAYERS FOR CLIMATE SECRETS

Two atmospheric phenomena, thought to foretell the progression of climate change, have been detected simultaneously by sensitive scientific instruments probing the night sky above Antarctica.

Polar mesospheric clouds (PMC) and polar mesosphere summer echoes (PMSE), caused by water vapour crystallising in the coldest region of the Earth's atmosphere – the mesosphere – 50 to 92 km up, were observed together for the first time by Australian Government Antarctic Division scientists at Davis station last summer.

The simultaneous observation, using a radar for PMSE and a lidar – light detection and ranging instrument – for PMC, is the first in the Southern Hemisphere and will allow scientists to compare differences between the phenomena in the southern and northern hemispheres and to better predict the effects of climate change.

'These phenomena have been well recorded and studied in the Northern Hemisphere but we've only recently detected them above Antarctica,' radar physicist, Dr Ray Morris, told delegates at the Scientific Committee on Antarctic Research Open Science Conference.

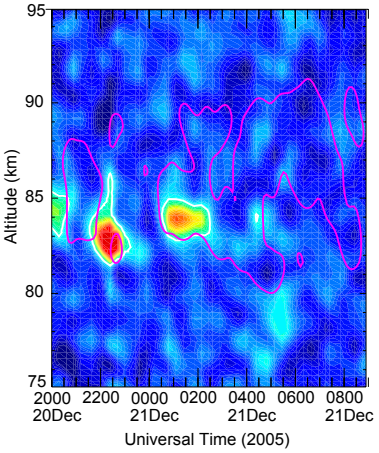
'In the 2005-2006 austral summer we identified PMC and PMSE at the same latitude as our northern counterparts – 68.6° south versus 69° north – using similar equipment, allowing us to compare the intensity and extent of these phenomena in each hemisphere.

'Our results show that the occurrence and brightness of Southern Hemisphere PMC and PMSE are lower than those reported in the Northern Hemisphere, and that the ice clouds peak about one kilometre higher in the Southern Hemisphere. Further observation is needed to explain these differences.'

These comparisons will help scientists understand the connections between mesosphere processes in the northern and southern hemispheres and provide a baseline against which changes in PMSE and PMC can be measured. This is important if we are to better understand and model climate change.

'The mesosphere is more sensitive to climate change than other parts of the atmosphere, and there is evidence to suggest that a warming of 1.9°C at the Earth's surface would result in a 20°C cooling in the mesosphere,' lidar physicist Dr Andrew Klekociuk said.

'If this happens, we could see changes in the extent, duration and intensity of PMSE and PMC, well before we see any effects in the lower atmosphere. So we may be able to use these phenomena to monitor climate change.'



A. KLEKOCIUK, R. MORRIS & J. INNIS

Polar mesosphere summer echoes (pink contour) were detected by radar 80-92 km above Davis station, at the same time as the lidar detected polar mesospheric clouds (colour).

New Airlink aircraft selected

The A319.

Australia's new Antarctic Airlink aircraft is an Airbus A319. Minister for the Department of the Environment and Heritage, Senator Ian Campbell, said the new aircraft would increase Australia's access to Antarctica, improve logistical flexibility and create new opportunities, including new international collaborations.

The Airbus has a range of 6500 nautical miles and can fly from Hobart to Antarctica and return without refuelling. The aircraft's internal configuration can be arranged to accommodate different combinations of passengers and cargo. Initially, 19 passengers will be accommodated, but there is capacity for up to 40. Each passenger can take 50 kg of stowed luggage and 5 kg of carry on luggage. Demonstration flights of a jet aircraft are scheduled for this Antarctic summer at Wilkins Runway, 70 km southeast of Casey station. Regular continent to continent flights of the A319 will commence in 2007-08.

More information: www.aad.gov.au/airlink

The internal configuration of the spacious A319 can be arranged to accommodate different combinations of passengers and cargo.

Listening for whales

The underwater calls of six whale species – some of which are rarely seen let alone heard – were recorded using remote listening devices during a recent survey of the Southern Ocean.

Marine biologist Dr Jason Gedamke, of the Australian Government Antarctic Division, used 142 drifting sonobuoys and two acoustic recording packages – moored to the sea floor near the Antarctic coast – to survey a one million square kilometre ocean region for the presence and distribution of whales.

Whales were recorded at 64 sites. While endangered blue whales were recorded at 47 of these sites not one was sighted during the survey. At the other end of the spectrum, minke whales were recorded at only one site, despite numerous visual observations. Other recorded species included sperm whales at 44 sites, fin whales at 14, humpback and sei whales at two sites each, and leopard and Ross seals at 14 sites each.

The research demonstrates that these remote recording devices are valuable tools for surveying marine mammals in difficult to study areas such as the Southern Ocean.

'They have great potential to help us understand the distribution patterns of whales and other marine mammals across geographic locations and seasons,' Dr Gedamke said.

'This is important if we are to understand as much as possible about the populations and life histories of these animals, given the increasing pressure from 'scientific' whaling and moves to reintroduce commercial whaling.'

The drifting sonobuoys, which detect a wide range of sound (5-2500 Hz) and the direction it came from, can be used over large areas for short time periods. This provides information on the presence and relative numbers of different whale species in a region at a particular time. The acoustic recording packages, which detect low frequency sounds (less than 250Hz) produced by baleen whales, are anchored to the sea floor for up to one year and provide information on the seasonal occurrence of whales.

'In this study we were able to see a seasonal acoustic presence of both blue and fin whales, with peaks in relative abundance occurring between April and June,' Dr Gedamke said.

During the study Dr Gedamke also deployed three new acoustic recording packages in a line between south-west Tasmania and the Antarctic coastline, just off the French Antarctic station Dumont d'Urville.

Dr Gedamke hopes to record whales as they migrate north later this year.

This research was presented in a poster entitled Use of passive acoustic techniques to assess relative distribution and seasonality of Antarctic marine mammals, at the Scientific Committee on Antarctic Research Open Science Conference in July. The poster was selected as the Best Open Science Conference Poster from 350 scientific posters displayed. Congratulations to the authors, Jason Gedamke, Sarah Robinson and Nick Gales, of the Australian Government Antarctic Division, and John Hildebrand and Sean Wiggins of the Scripps Institute of Oceanography.

Dr Jason Gedamke deploys a sonobuoy.

OZONE DEPLETION MAY LEAVE A HOL

New research suggests that the growth of phytoplankton is reduced by 56% when stratospheric ozone drops below 17% or less than 300 Dobson Units (DU).

The research, conducted by scientists from the Australian Government Antarctic Division, the Antarctic Climate and Ecosystems Cooperative Research Centre, and the University of Tasmania, sounds a warning that ozone depletion over Antarctica could have a bigger impact on marine life in the Southern Ocean than previously thought.

Antarctic Division biologist, Dr Andrew Davidson, Honours student Nina Cadman, and their colleagues*, used satellite data to determine concentrations of ozone and phytoplankton chlorophyll over 10 million square kilometres of the marginal ice zone around the East Antarctic coast during November and December, between 1997 and 2000.

Ozone depletion affects living organisms by allowing more damaging solar ultraviolet-B radiation (UVBR) to reach Earth. Since the mid-1970s, man-made chlorofluorocarbons and halons have caused a profound decline in stratospheric ozone over Antarctica. As a result, ozone concentrationsduringspring(September-November) commonly fall below 50% (around 180 DU) and may decline below 30% of pre-ozone depletion levels – more than doubling the amount of UVBR reaching the Earth's surface. Some ozone depletion even persists until February, leading to a 50-100% increase in UVBR around the height of summer.

'Thus, UVBR is enhanced throughout the period of greatest biological production in Antarctic waters,' Dr Davidson said.

Comparing satellite measurements of chlorophyll and ozone, the research team found that the rate of chlorophyll accumulation at ozone concentrations less than 300 DU was around half that at higher ozone concentrations. This resulted in 56% less chlorophyll being accumulated in the marginal ice zone over November and December at low ozone concentrations.

'Interestingly, the 56% inhibition we obtained equated to around a six percent inhibition of each phytoplankton generation over the two months of our study,' Dr Davidson said.

'Previous studies suggest Antarctic phytoplankton are inhibited around six percent by ozone depletion in the marginal ice zone but, crucially, have neglected to consider any cumulative effect of UV-induced inhibition of successive generations.'

Phytoplankton is the base of the marine food web, acting either directly or indirectly as a food source for all other organisms. As a result, Dr Davidson said such marked inhibition would profoundly reduce the amount of food available for other organisms in Antarctic waters. It could also affect global climate, as phytoplankton production facilitates the transfer of carbon from the atmosphere to the deep ocean for geological time periods, thereby reducing the accumulation rate of greenhouse gas and global warming.

However, Dr Davidson cautions that there are limitations associated with this preliminary research.

'Ozone rarely falls below 300 DU around the height of summer and we require more information at this critical time. In addition, changes in ozone concentration coincide with changes in a range of environmental variables. So we cannot exclude the possibility that the ozone acts, partly or wholly, as a proxy for another unmeasured environmental factor that influences chlorophyll accumulation,' he said.

The team is addressing this, and other questions, through continued research.

*Kelvin Michael, Manuel Nunez, Simon Wotherspoon and Ben Raymond

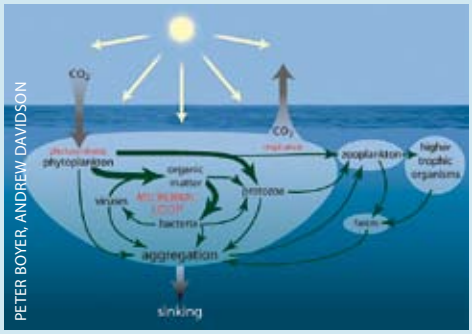
Krill school takes shape

Shape matters to Antarctic krill – it may affect where they swim in a school and could have implications for the estimation of krill biomass in the Southern Ocean.

LUKE FINLEY

The shapes of 220 krill were digitised (using the yellow reference points) and a mathematical technique, geometric morphometrics, was used to generate an average krill shape.

LE IN PHYTOPLANKTON GROWTH

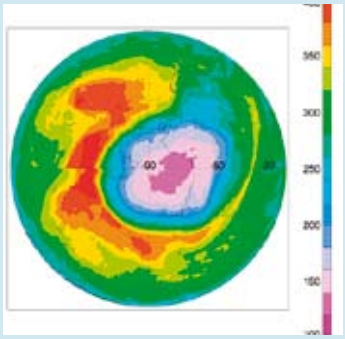


PETER BOYER, ANDREW DAVIDSON

This schematic illustrates the role of marine microbes in the Southern Ocean carbon (energy) cycle. Arrows show the main directions of carbon flow and thicknesses indicate the magnitude of flow. Carbon dioxide (CO_2) from the atmosphere dissolves in seawater and is converted into living matter by phytoplankton, providing the energy that fuels the Antarctic food web. Respiration of this carbon releases CO_2. Most of this matter is consumed by protozoa or bacteria, with only a small proportion reaching higher trophic levels (such as zooplankton, fish, squid, penguins, seals and whales). However, large, heavy particles sink, carrying carbon derived from the atmosphere to the interior of the ocean, where it remains for geological periods of time.

AADC, ANDREW DAVIDSON – MAP 13324

This map shows the regions around the east Antarctic coastline from which satellite-derived measurements of chlorophyll and ozone were obtained.



Stratospheric ozone concentrations over Antarctica and the Southern Ocean on the 1st November 1999. Measurements from TOMS (Total Ozone Mapping Spectrometer) and TOVS (TIROS Operational Vehicle Sounder) satellites. Both data sets merged and grided by Andrew Klekociuk, AGAD.

Dr Luke Finley of the Australian Government Antarctic Division used digital photography and computer software to digitise the shapes of 220 male, female and juvenile krill. Using geometric morphometrics, a mathematical technique for visualising and quantifying shape, he generated a generic krill shape – the average shape of all the krill photographed.

By comparing individual krill shapes with the generic krill shape, Dr Finley found that mature female krill had a larger upper body (thorax) than males or juveniles, which they use to store their eggs. Male krill, however, appear to be built for speed with more streamlined bodies and longer more powerful tails. These differences are most apparent during the krill breeding season in the Antarctic summer.

'Female krill breed near the continental shelf of Antarctica and then swim out into the open ocean to lay their eggs. They are more interested in conserving energy and investing in the production and safety of their eggs, than speed, and their shape reflects this behaviour,' Dr Finley said.

'Males, on the other hand, may sacrifice their safety and physical condition for speed and increasing their chance of mating with females – a live fast, die young strategy.'

Dr Finley used these shape measurements and other research to hypothesise what a school of krill might look like.

'My theory is that a school is comprised of a dense core of female, sub-adult and juvenile krill, and that these individuals cycle through to the edge of this core to feed, defecate or release eggs. In contrast, males tend to stay on the outside of the school and use their superior speed to dart into the edges of the school to mate.'

This theory is difficult to prove as there are limits to how effectively a school can be sampled in the open ocean. However, trawl samples taken through a krill school by other researchers, found that krill caught near the edge of a school were predominantly males, while those caught in the middle of a school were predominantly females.

Dr Finley's research could have implications for how precautionary krill catch limits are set in the Southern Ocean by the Commission for the Conservation of Antarctic Marine Living Resources.

Currently, acoustic scientists at the Antarctic Division are working on improving the procedure for the estimation of krill biomass. There are certain parameters used in the estimation that could be improved, and integrating the diversity of krill shapes observed during Dr Finley's study may help this process.

'It leads to the question of whether we should split krill into different shapes when we do these estimates, such as adult males and females, rather than using a generic krill shape,' Dr Finley said.

'Also, different geographic regions could be characterised by different krill shapes. For example, juvenile krill are more likely to be found inshore, while egg-bearing females are present in the open ocean. These are some of the questions we will be investigating to see if they have any effect on biomass estimates.'

JACQUI FOSTER

Dr Luke Finley on board the Aurora Australis.

SEASONAL CHANGES IN THE EFFECTS OF UV RADIATIONONANTARCTIC MARINE MICROBES

Scientists have shown that the effects of damaging ultraviolet light on microscopic marine organisms, changes with changing ozone concentrations.

PAUL THOMSON

Marine protists were incubated for 13 or 14 days in these 650 L tanks. Reflective tubes conducted sunlight from the domes in the container roof. Screens on the top of each tank removed different amounts of UV radiation from the sunlight.

Stratospheric ozone protects life on Earth from ultraviolet B radiation (UVBR, 280-320 nm wavelength). However, ozone depletion over Antarctica results in 50 to 130% more UVBR reaching the Earth's surface. High energy UVBR is especially damaging, reducing the growth, production and survival of marine protists (microscopic marine plants and animals). Ultraviolet-A radiation (UVAR, 320-400 nm) can also be damaging, and causes most of the UV-induced reduction of photosynthesis in the ocean.

Marine protists possess diverse means of tolerating and repairing UV-induced damage, and the effectiveness of these tolerance mechanisms determines a protist's susceptibility to UVBR. Large differences in the susceptibility of different species to UVBR result in changes in the composition of protist communities, favouring species that can tolerate and repair the damage they sustain.

Over a summer at Davis, in east Antarctica, we assessed the impacts of UV radiation on marine protists. In three experiments, natural communities were incubated for 13 or 14 days in 6 x 650 L tanks. Each tank was exposed to sunlight with different amounts of UV radiation removed by screens. The results were surprising, showing a transition from UVAR to UVBR-induced effects over the summer.

A shipping container at Davis station housed the experimental tanks with UV-transmissive domes that allowed sunlight to enter.

PAUL THOMSON

UVB is considered the most damaging of solar wavelengths, but our first experiment in November indicated that UVBR was beneficial for the protist community. At this time, ozone concentrations were high – 363 to 316 Dobson units (DU) – and extensive areas of the coastline off Davis were covered by fast ice. These high ozone concentrations meant the protist community was exposed to relatively low UVB radiation.

In contrast, UVAR reduced chlorophyll concentrations by up to 71% and strongly inhibited the growth of the most abundant phytoplankton species. Recent research shows UVA radiation reduces the survival of Antarctic protists that are physiologically adapted to low light. Thus, the UVA-induced effects we observed appear to result from the sudden exposure of our community – which was obtained from beneath the sea ice – to full sunlight. This is a significant finding as this sudden exposure is a widespread, natural occurrence when the sea ice breaks out, or when currents carry protists from beneath the sea ice into open water.

The second experiment in December showed that UVAR and UVBR had little effect on the protist community. By this time, stratospheric ozone concentrations had declined to between 341 and 306 DU, causing phytoplankton to be exposed to more damaging UVBR. In addition, the extent of fast ice in the region had declined. Thus, phytoplankton carried by currents to the site where the community was obtained were likely to be accustomed to a higher light climate, reducing the shock of exposure to full sunlight during the experiment.

The final experiment in January, however, showed UVBR inhibited overall chlorophyll biomass by 22% and severely inhibited concentrations of the most abundant diatom species. This experiment was performed when the ozone concentrations had declined to 313-288 DU, exposing phytoplankton to further damaging short wavelength UVBR. However, fast ice had completely disappeared from the sample site and, as for experiment two, UVAR had a little effect on the phytoplankton.

This finding agrees with recent research showing adverse effects of UVBR at ozone concentrations less than 300 DU. A synoptic-scale study (see page 6) found that the growth of phytoplankton was reduced by up to 56% when ozone concentrations fell below 300 DU. Furthermore, models of UVB-induced impacts at Davis showed a 300 DU threshold, below which UVB caused substantial changes to the structure and function of marine microbial communities.

Why is this significant? Using the Total Ozone Mapping Spectrophotometer (TOMS) satellite data, we found that thin summer ozone (less than or equal to 300 DU) is an annual, widespread event over the Southern Ocean from January to April. This period sees up to 47% of the annual primary production in the Southern Ocean. Therefore, enhanced UVBR at this time may be exerting widespread negative impacts on the protist communities of the Southern Ocean, potentially reducing the food available for higher organisms.

Most UVR research has concentrated on the impacts of ozone depletion in spring, when the Antarctic ozone hole is large. In contrast, the consequences of thinning ozone from January each year appears to be largely unrecognised by the scientific community. When coupled with mounting evidence for a 300 DU threshold for negative UVB impacts, it appears that the effects of UVB on Antarctic protists may have been underestimated. However, our field data are limited to only one summer at Davis and further studies are needed between January and April to more precisely determine the effect of declining ozone on these ecologically important organisms.

PAUL THOMSON, ANDREW DAVIDSON and NINA CADMAN
Environmental Protection and Change Programme, AGAD

ALISON LESTER

Will our thirst for oil see the dawn of a new type of Antarctic exploration?

CRUDE IDEAS

Antarctica could become the last frontier for the insatiable oil industry according to international oil expert Dr Ali Samsam Bakhtiari of the University of Tehran. His warning comes as the oil-addicted, developed world faces the reality of 'peak oil' – the point at which maximum oil production is reached and demand for oil starts to outstrip production capacity.

'I developed a mathematical model which showed that oil consumption would peak at 81 million barrels per day in 2006 and then decline, and I believe we are seeing this now,' Dr Bakhtiari told delegates at the symposium of the Standing Committee on Antarctic Logistics and Operations.

'In 2020 I predict production will drop to 55 million barrels per day, so that in the next 14 years one third of today's oil supply will be gone.'

Dr Bakhtiari said the total global oil resource was estimated at 1900 billion barrels, 1000 billion of which have already been produced. This means that there are only 900 billion barrels left and these will be more difficult and more expensive to produce. Discoveries of new oil fields have also declined, with only 4-6 billion barrels discovered on average each year in the past 10 years.

'We've explored the Middle East, America and Russia, shallow water and deep water, and we are now in the Arctic. The only place left to explore is Antarctica,' Dr Bakhtiari said.

However, Antarctic Treaty Parties have signed the Madrid Protocol, which prohibits mineral exploration in Antarctica. There are also significant practical barriers to oil and gas exploration in Antarctica; notably the extremes of temperature and wind, and limited time to construct drilling infrastructure after the long period of winter darkness.

'Drilling into ice is a messy and cumbersome affair and it is no easier in the icy Antarctica waters,' Dr Bakhtiari said.

'Not to mention exploitation, with its continuous production imperatives and downstream logistics of pipelines, storage tanks and transport by ice-breaking tankers.'

Despite these barriers, Dr Bakhtiari's comments raised concerns that public opinion could change as the domino effect of reduced oil supply increased.

'In a world thirsty for oil nothing looks impossible, especially when oil prices have skyrocketed to those stratospheric heights which are difficult to visualize today, but will leave us yearning for any benign two-digit prices,' he said. 'At $US150 or $US200 it would make economic sense to exploit even Antarctic energy.'

However, according to Dr. Colin Campbell, whom Dr Bakhtiari describes as the world's pre-eminent oil reserves specialist, so-called polar oil reserves are estimated at only 52 billion barrels – less than two years' supply of current global consumption.

Many people would share Dr Bakhtiari's view that oil exploration in Antarctica would be a 'tragedy for mankind'. Australia's federal Minister for the Environment and Heritage, Senator Ian Campbell, reiterated the Australian Government's long-standing position against oil exploration and mining in Antarctica.

'The Australian Government is implacably opposed to mining in the Australian Antarctic Territory,' he said.

The immediate concern for Antarctic operators is how to minimise the pain of the transition from peak oil to reduced supply.

Dr Bakhtiari has put forward a 'to do' list of 'five Rs':

- Re-program - throw out business-as-usual thinking;
- Reduce - cut waste, debt, travel, consumption;
- Reuse;
- Recycle;
- Reward - reward significant actions to reduce, reuse or recycle.

He also cautioned that energy, not economics, will be the driving concern of such projects.

'We need to plan today so that tomorrow won't be a problem,' he said.

More information:
<http://www.samsambakhtiari.com>

Penguins and oceanographers work together

Penguins have helped oceanographers construct a picture of the structure and location of ocean fronts near Macquarie Island. The research will help improve our understanding of how climate-induced changes in the Antarctic Circumpolar Current, which connects oceans around the world, could impact on ocean productivity.

In the late 1990s, Australian Government Antarctic Division researchers were asked to provide information on king penguins that would assist in the preparation of a management plan for the Macquarie Island Marine Protected Area. An area east of the island was earmarked for the highest level of protection – was this part of the foraging area of king penguins, and would its protection benefit the birds?

To find out, we used satellites to track 21 king penguins on their foraging trips from Macquarie Island, during the incubation stage of their breeding cycle. Fifteen of these birds also carried sensors that collected pressure and temperature data. The pressure data tell researchers how frequently and how deep the penguins dive while hunting for food, while the temperature data help identify to what extent king penguins use ocean fronts (interfaces between water masses of different temperatures) at this time of year.

Fronts, such as the Subantarctic and the Polar fronts (both part of the Antarctic Circumpolar Current or ACC), can be highly productive areas, making them popular feeding grounds for marine mammals and seabirds. Penguins (and other marine animals) carrying electronic sensors that gather information on location and subsurface temperatures, provide large numbers of ocean profiles in a cost-effective manner. This is particularly important in areas where the ability to collect oceanographic measurements during scientific cruises is difficult or limited.

The data showed that over a three-week period the penguins performed nearly 83 000 individual dives. Most of those were 'travelling' dives, but on some 36 000 dives the penguins searched for food. Temperatures sampled during the dives helped to identify where the penguins were located relative to the Southern Ocean fronts. By combining the temperature data from the dive recorders and the penguin locations obtained via satellite, we established the structure and location of the fronts east of Macquarie Island. Together with our CSIRO colleague Steve Rintoul, we used these data to track changes in the frontal systems, and determine how the branches of the ACC form and differ in their temperature profiles. This knowledge is important for understanding changes in food production, which is heavily influenced by the ACC frontal system.

Using satellite measurements of sea surface height, CSIRO had previously discovered that Southern Ocean fronts, such as the Subantarctic Front and Polar Front, could split into multiple branches, which can be tracked for many months before they merge again. With the help of the penguins, it was confirmed that the multiple frontal branches seen on the satellite maps are also apparent in the ocean's subsurface temperature data collected by the penguins.

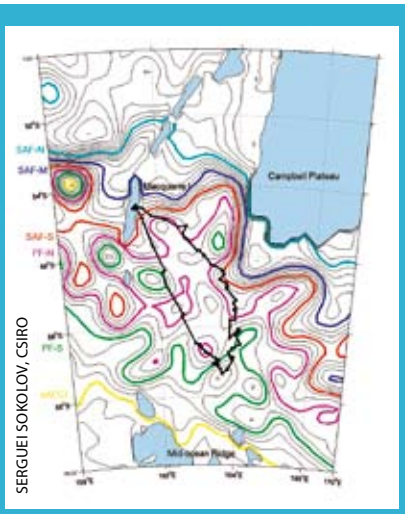
Meanwhile, the foraging strategy of the penguins appeared to be greatly influenced by the regional currents. Upon leaving the island, the penguins consistently hitched a ride on one of the fastest flowing branches of the ACC – the southern branch of the Subantarctic Front. They travelled clockwise, first east and then south-east, reaching distances of up to 620 km from the island.

Most of their diving activity occurred close to the northern and southern branches of the Polar Front in an area of approximately 36 500 km^2 at the eastern border of the Marine Protected Area. Based on the satellite measurements of chlorophyll concentration, this area is more biologically productive than the Subantarctic Front zone located to the north. The king penguins chiefly explored the top 150 m of the water column.

When it was time to return to the colony, the penguins chose a southerly route across a region rich in eddies, where the currents were comparatively weak. Thus, the penguins utilise the currents in a most energy effective manner - they travel downstream when leaving the island and choose the path of least resistance when they return.

BARBARA WIENECKE[1] and SERGUEI SOKOLOV[2]

1 Southern Ocean Ecosystems programme, AGAD
2 CSIRO Marine and Atmospheric Research



SERGUEI SOKOLOV, CSIRO

This snapshot in time shows the approximate structure and location of the ocean fronts east of Macquarie Island, derived from the temperature data from the dive recorders and the penguin locations obtained via satellite. A typical foraging track of a king penguin can also be seen. When penguins leave the island, they catch a ride on the Subantarctic Front (red line), in a clockwise direction, and then return through areas of weaker current. Black dots indicate reliable satellite measurement points. Widely spaced contours on the map indicate areas of weaker, slow moving current, while closely spaced contours highlight areas of fast current.

SAF-N, SAF-S: Subantarctic Front, north and south branches of the current.
PF-N, PF-S: Polar Front, north and south.
sACCF: southern Antarctic Circumpolar Current Front

MEASURING SEA ICE THICKNESS

Antarctica is surrounded by a zone of sea ice which covers an area nearly three times the size of Australia at its maximum extent in spring. This sea ice zone is important in the global climate system as it helps drive the ocean circulation that redistributes heat from the equator to the poles.

Variations in sea ice extent, concentration and thickness are of interest to climate scientists, as together they provide the total ice volume, which can be monitored for the effects of climate change. Sea ice extent and concentration can be determined daily from satellites. However, the technology to accurately measure sea ice thickness is still developing, requiring scientists to compile information from a wide range of instruments, and rely on numerical models to help them understand how it might be varying.

In July 2006, the Australian Government Antarctic Division co-hosted a three day workshop of international experts on Antarctic sea ice to discuss ways to better measure and monitor sea ice thickness. The workshop brought together 60 participants from 13 countries, including observational scientists, modelers and members of the satellite remote sensing community. The group assessed the current state of knowledge on Antarctic sea ice thickness and examined emerging technologies to measure sea ice thickness from the surface, ships, under-ice vehicles and moorings, airborne sensors and satellite sensors.


TONY WORBY

Sea ice workshop participants in Hobar

In the northern hemisphere, de-classified data from US and British navy submarines has shown conclusively that there has been a significant reduction (10% per decade) in Arctic sea ice thickness over the past several decades. There are no long-term submarine records in the Antarctic. However, in greenhouse scenarios, climate models indicate that Antarctic sea ice thickness decreases more rapidly than sea ice extent (suggesting that thickness may be a better indicator of climate change), and predict that these changes should already have started. In the absence of sufficient data, however, we do not know whether important changes in the thickness of Antarctic sea ice are currently going unnoticed.

International efforts to obtain widespread Antarctic sea ice thickness information are progressing. However the goal of a circumpolar baseline of high resolution Antarctic sea ice thickness data is yet to be achieved. The workshop outlined future collaborative programmes that will aim to achieve this in coming years, in particular during the International Polar Year, during which Australia has a leading programme of sea ice zone research.

ANTHONY WORBY
Antarctic Climate and Ecosystems Cooperative Research Centre and Ice, Ocean, Atmosphere and Climate Programme, AGAD.

Aliens in Antarctica

The introduction of non-native species to Antarctica poses a threat to Antarctic animals and plants through disease.

Now a new Alien Invertebrate Collection Kit, developed by environmental officers at the Australian Government Antarctic Division, is available on ships and stations to enable expeditioners to collect anything suspicious.

Alien invertebrates include insects, slugs and spiders, which can stow away on personal clothing, baggage, food and in ships' cargo.

A recent outbreak of mushroom gnats (Lycoriella ingenua) at Casey station, for example, was thought to originate from tiny eggs deposited on fresh vegetables delivered on a resupply voyage. The eggs were then washed down the kitchen sink and into the waste treatment plant where they hatched.

Despite strict quarantine procedures for food, vacuuming of clothing and baggage, and the scrubbing and sterilisation of footwear, aliens will still find their way into Antarctica. As tourist and research visits increase, so will the risk.

Operations Safety and Environment Advisor, Leslie Frost, said many people visiting Antarctica may have visited other cold or polar regions and could bring alien species with them that are well adapted to cold environments.

'These alien invertebrate kits provide an efficient collection and cataloguing process that will allow us to identify the most common aliens carried into Antarctica and where they are coming from.'

The kits include collection vials, bar codes and instructions for reporting the find on the Antarctic Division's incident reporting system, which enables tracking of the samples in an alien invertebrate database.


KATE KIEFER

The adult mushroom gnat, Lycoriella ingenua, found in the Casey waste treatment plant.

SIMON GOLDSWORT

The subantarctic islands have an identity all their own

Spotlight on the Subantarctic

Humans have exploited the subantarctic islands for centuries, but conservation of these special areas is now a priority, delegates at the first International Forum on the Subantarctic were told.

Organised by Antarctic Tasmania, the forum was held as a satellite to the larger scientific and operational meetings held in Hobart in July. Sir Guy Green, Honorary Antarctic Ambassador for Tasmania, chaired the forum which was attended by 96 delegates from 12 countries.

Over two days, delegates were treated to an overview of the geological structure and formation of the subantarctic islands, their terrestrial biological diversity, and the oceanography, climatology and biodiversity of their surrounding seas. This was followed by a more detailed investigation of their physical environments and ecology. What emerged from this is that the islands, for the most part, are small and young – not over 10 million years old – and have had an unstable existence in recent geological time. Only South Georgia, being an extension of the Andes/Trans-Antarctic mountain spine, has existed into the distant past. All subantarctic islands have low species richness, in sharp contrast with the relative luxuriance of subarctic islands, and many appear to rely on bird guano as their only source of nutrient input.

The history of human use of the islands revealed a sorry tale of butchery of seals from the mid-19th Century, and later bay-whaling and penguin-rendering. With sealers came cats, rats, mice and other unwelcome introductions which are causing great conservation problems today. A few islands have had permanent human inhabitants and nowadays most have seasonal occupation, usually for research purposes. Several are frequently visited by tourists.

Delegates agreed that the subantarctic region is a special part of the world with an identity and characteristics of its own. The existence of common values in and around the islands, and the changing human usage of the islands, may see future forums convened. Long-term monitoring of the environment is critical to future best-practice management, and international collaboration and information exchange will be an important route towards this.

Antarctic Tasmania and Sir Guy Green's drive and enthusiasm, are to be commended for hosting this worthwhile and valuable meeting.

MICHAEL STODDART
Chief Scientist, AGAD

MANAGING FUEL SPILLS IN ANTARCTICA

Technology developed to clean up polluted groundwater – typically from mining or agricultural activities – is being modified to work in Antarctica to halt the flow of a large plume of diesel spilt at Casey in 1999.

A permeable reactive barrier has been built downhill of the spill and will be trialled over the next five to eight years for its ability to remove the fuel, which is released from its ice prison each summer when the snow melts.

The work is being led by the Australian Government Antarctic Division in collaboration with the University of Melbourne, Macquarie University and BP Alaska.

'Each summer fuel from the original 5000 litre spill percolates down into a nearby melt lake and eventually into the sea,' contaminants geochemist, Dr Ian Snape, said.

'In 2005-06 we installed a permeable reactive barrier to help remove the fuel, but also to slow its flow so that we can apply other low-cost, on-site remediation techniques to treat the contaminated soil.'

The permeable reactive barrier was built by digging a trench 5.5 m wide, 2 m long and 1 m deep, in the path of the polluted melt water, with wings on either side to funnel the water into the trench. The trench was then filled with metal pallets containing three different layers of permeable, reactive materials.

'The first layer contains nutrients which, when mixed with the water, stimulates naturally occurring microbes that will do the hard work of digesting the diesel hydrocarbons,' Dr Snape said.

'The second layer contains a reactive material that captures the hydrocarbons and holds them long enough for the microbes to break them down into harmless by-products – water and carbon dioxide. The third layer catches any excess nutrients before the filtered water passes back out into the soil.'

The team is testing different combinations of material in each of the three layers to identify the optimal combination for removing hydrocarbons, while ensuring the environment is not negatively affected. An array of sensors and probes have been inserted into each layer to monitor what goes into the barrier, the conditions inside the barrier, such as temperature, water flow, oxygen levels, nutrient and hydrocarbon concentrations, and what comes out.

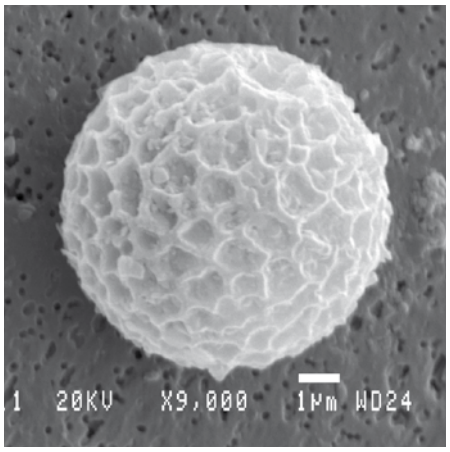
'We have worked closely with tradespeople and other staff on station to develop and install these barriers and set up the monitoring equipment,' Dr Snape said.

'We have also worked with policy makers to ensure our experimental protocols and the materials we use comply with environmental guidelines.'

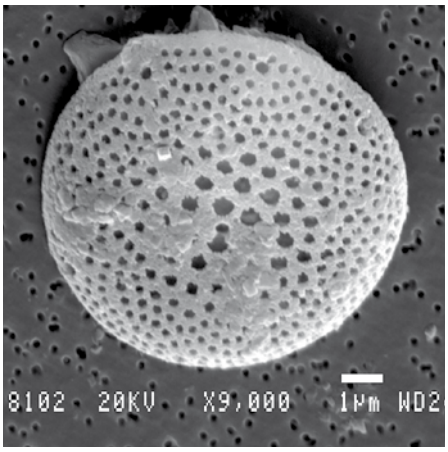
Over the past decade the Australian Government Antarctic Divison has been proactive in introducing improved fuel clean-up and spill prevention measures as part of its Environmental Management System. These include improved operational procedures for fuel handling and spill response, new spill equipment, and new response protocols and reporting procedures.

The permeable reactive barrier is in place in the trench, which directs contaminated water from the site through the barrier. Probes and sensors which monitor conditions inside the barrier are visible.

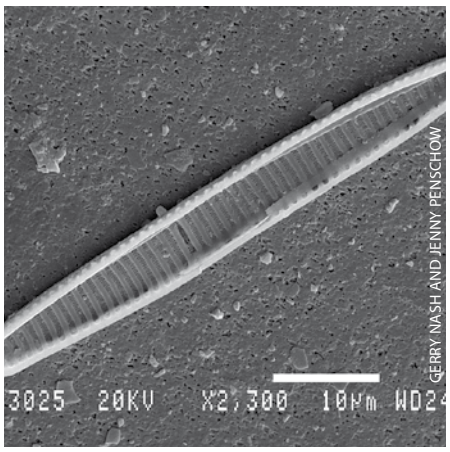
JOHN RAYNER



A chrysophyte stomatocyst (resting stage)



This cold, open water diatom, cf. Thalassiosira frenguellii was found at 290 and 360 m depth.



The diatom Fragilariopsis cf. obliquecostata was found between 277 and 360 m.

Protists in marine ice

Marine ice cores drilled from deep within the Amery Ice Shelf in East Antarctica have been found to contain some 30 species of protists – microscopic marine plants and animals.

The protists were identified at four core depths – 277, 290, 360 and 390 m – in a band of thick marine ice about 90 km from the calving front of the ice shelf.

The discovery has enabled scientists from the Australian Government Antarctic Division, the Antarctic Climate and Ecosystems Cooperative Research Centre and the Polar Research Institute of China, to identify the parent water from which the marine ice formed, providing an insight into the ocean currents in the region and the movement of warm and cold water beneath the 550 km-long floating ice shelf.

Marine ice forms when ice at the deep base of the ice shelf, near the grounding zone, melts and ascends the sloping underside of the shelf. As the less salty, cold water rises, the pressure decreases and the water begins to freeze again. The ice crystals adhere to the underside of the ice shelf and, as they do so, may scavenge marine organisms or detritus in the water column and incorporate this material into the marine ice.

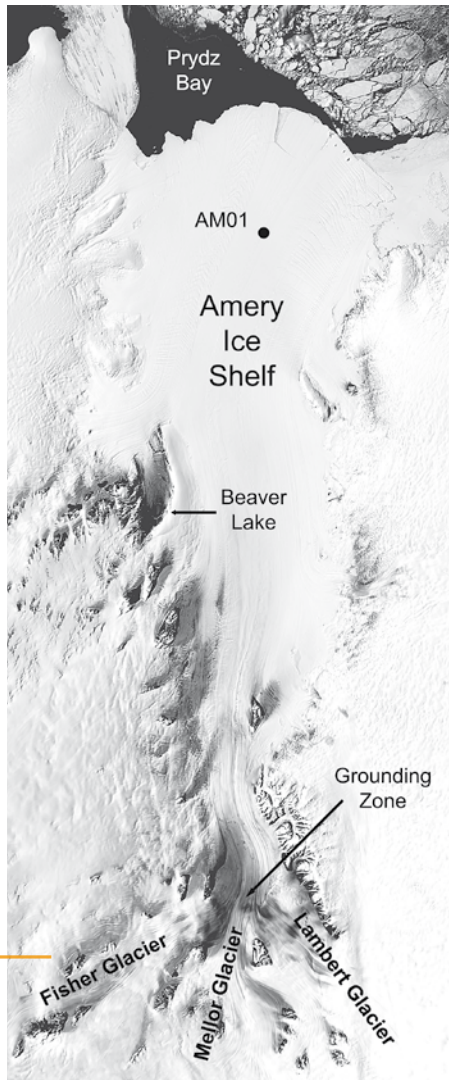
These electron micrographs show two of the four taxonomic groups of protists found trapped in the marine ice cores – diatoms, chrysophytes, silicoflagellates and dinoflagellates.

As different protists are found in different environments (open water or sea ice-dominated regions, for example), the presence, distribution and abundance of individual taxa enable scientists to infer the origin of parent water masses from which the marine ice is formed, and to gain an insight into water temperature, salinity and sea ice proximity.

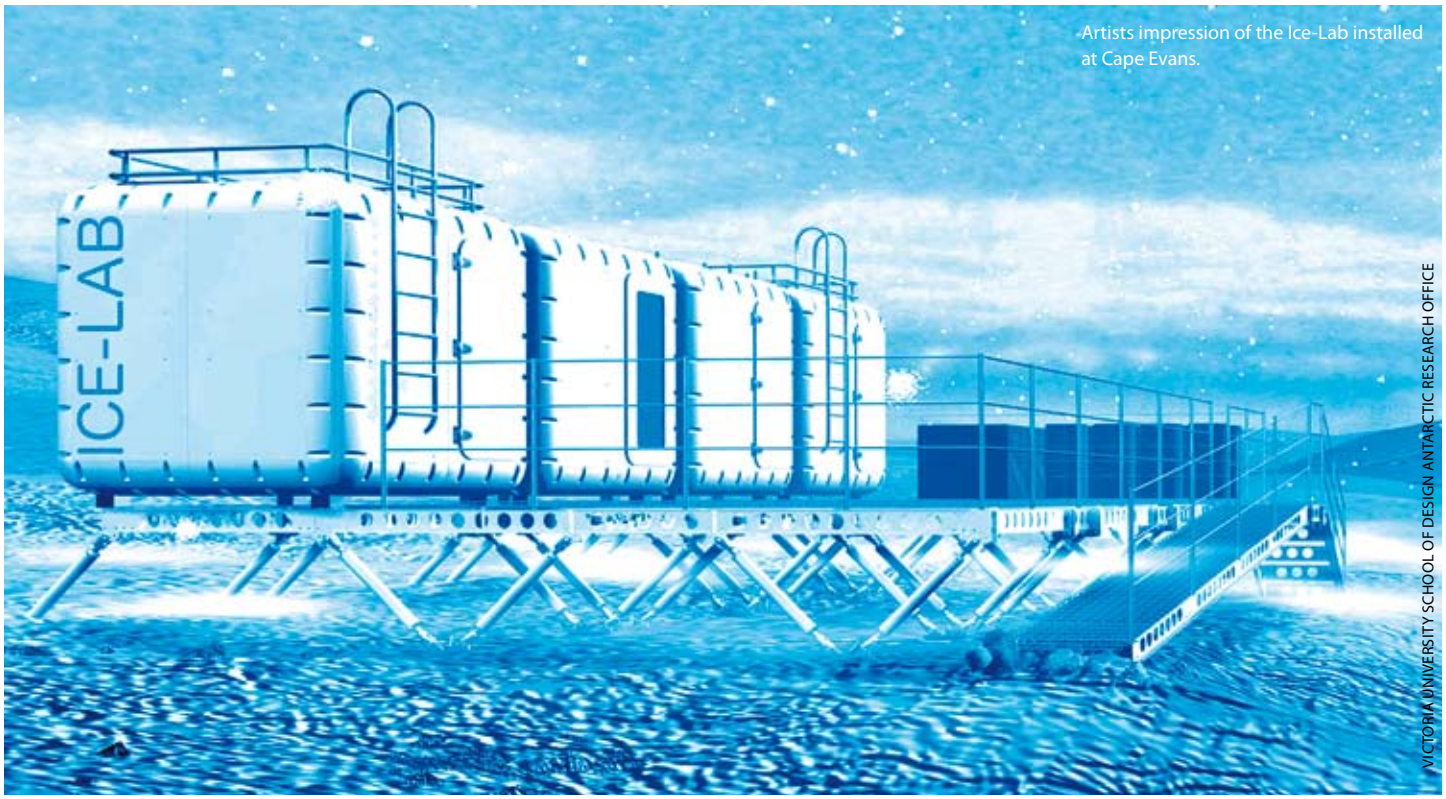
As sea ice diatoms and cold, open water diatoms dominated the marine ice of the Amery Ice Shelf, scientists concluded that the ice was seeded from melting pack and/or fast ice protist communities in the highly productive waters of Prydz Bay to the north of the shelf.

More information:

D Roberts et al (2006). Protists in the marine ice of the Amery Ice Shelf, East Antarctica. Polar Biology. DOI 10.1007/s00300-006-0169-7.



The Amery Ice Shelf region showing the site where the marine ice core was drilled.



Artists impression of the Ice-Lab installed at Cape Evans.

VICTORIA UNIVERSITY SCHOOL OF DESIGN ANTARCTIC RESEARCH OFFICE

ICE-LAB

Antarctica New Zealand and Victoria University of Wellington School of Design have joined forces to design and build a portable field research station that can run predominantly on renewable energy.

During the International Polar Year (2007-08) a prototype of the station, known as Ice-Lab will be trialled at Cape Evans, site of Scott's Hut. The station will be used by a number of remote scientific field programmes and the Antarctic Heritage Trust, which is undertaking restoration of historic huts on Ross Island.

Students from the School of Design came up with the concept for a modular, cubed structure, whose main components – panels, windows, doors and the supporting structure – are interchangeable and re-configureable, to accommodate the range of living and working needs. Lightweight materials used in the yachting industry were selected so that each module is light enough to be towed by a Hägglund or lifted by a Bell helicopter. Module components can also fit inside a Twin Otter aircraft.

The cubed modules can be linked together in any number of configurations and will withstand wind gusts up to 300 km/hr. Infrastructure for mounting photovoltaics and wind turbines is also included – Ice-Lab will act as a test rig on which to trial existing and future renewable energy solutions on an ongoing basis.

For more information on sustainable solutions for extreme environments contact Professor Roy Fleetwood, School of Design Antarctic Research Office, Victoria University of Wellington – roy.fleetwood@vuw.ac.nz.

Antarctica New Zealand – info@antarcticanz.govt.nz.

The architectural features of the Ice-Lab enable it to be transported by Bell 212 helicopter or Hägglund (pictured) or inside a Twin Otter aircraft.

Station on skis

Sometime in the next decade the British Antarctic Survey (BAS) research station, Halley V, could float off into the Southern Ocean, when the Brunt Ice Shelf, on which it is situated, calves off the Antarctic continent.

To prevent this scenario, BAS and the Royal Institute of British Architects launched a competition to design a new, relocatable station, to be situated 16 km further inland. Out of 86 entries worldwide, Hugh Broughton Architects and engineering firm, Faber Maunsell, emerged victorious, with the first Antarctic station on skis.

Construction of the modular, mobile design will commence in 2007 on the existing station site and the completed station – Halley VI – will later be towed inland using bulldozers. The station will house 16 people during winter and 52 in summer.

Architect, Hugh Broughton, said the design consists of a series of interconnected, lightweight, steel modules on two platforms.

One platform provides the main living and sleeping areas and some plant and operational equipment, the other platform houses scientific and plant equipment. The two are separated by a walkway, in case of fire or other emergencies. Extra modules can be added as needed and each module is supported by jackable steel legs on skis. The legs enable the station to be raised above the surface in areas of very high snow accumulation, while the skis allow the whole structure to be moved inland as necessary.

A range of environmentally sensitive design and engineering options have also been added, including solar panels to augment hot water heating during summer, and infrastructure for the addition of photovoltaics and wind turbines.

'The steel frames of each module will be shipped to Antarctica and offloaded onto the sea ice as one complete unit, with legs and skis attached. These will be towed onto the ice shelf and skied to the construction site,' Mr Broughton told delegates at the symposium of the Standing Committee on Antarctic Logistics and Operations.

'The completed modules will weigh around 80 tonnes – light enough to be towed to a new site during their projected 20 year life time – making Halley VI a visitor to, rather than a resident of, Antarctica.'

More information:
http://www.hbarchitects.co.uk
http://www.fabermaunsell.com

CHRIS CURTIS WWW.7-T.CO.UK

The large living module (left) of the Halley VI Antarctic Research Station contains a dining room, recreational area for games, arts and crafts, library, office space, hydroponics and other modern conveniences. Standard modules in blue (above) house science, plant, operations and bedrooms.

RECONNECTING SCIENCE AND AR

ThreatenedTreasuredepictsasea-butterflywhoseshell is made of calcium carbonate.

The disciplines of art and science are often considered disparate and even hostile to each other. Yet during the Renaissance period the two disciplines worked together, resulting in significant scientific discoveries and inspiring art — such as the works of Leonardo da Vinci and Galileo Galilei. During the last century the two disciplines diverged, largely due to the specialisation of our education systems. However, science still uses the artistic medium of literature to disseminate its results in scientific papers and through popular science.

Science and art have much in common. At the broad level both pursue truth, knowledge, and work for the betterment of society — and both relate to and are inspired by the natural world. Both solve and reveal problems, experiment with ideas, arrive at and interpret a result, and publish or exhibit the work for critical review.

They differ, however, in their techniques, the way in which they communicate, and their outcomes. Science observes and interprets our world, whereas art expresses and provides experience of our world. During the last century these differences led to misunderstanding between the two disciplines and dismissal by each of the other's value. However, these differences can complement each other, leading to increased social and political influence.

Artists and scientists can engage each other in three main ways. Firstly, art can document and describe science – often for public relations purposes. Secondly, artists can use scientific methods, materials and concepts to pursue their own agenda. And thirdly scientists and artists can share a common ideology and actively collaborate, combining concepts and methods from each discipline to further their own practise.

In the Antarctic, several nations provide berths for artists to travel to Antarctica to facilitate wider education about the Antarctic continent and their nation's activities. The Australian Antarctic programme's vision is that Antarctica be 'valued, protected and understood'. It could be argued that science provides the factual understanding, art promotes social understanding and valuation, and both can lead to protection.

Surveying Sector 58

One of the most comprehensive marine ecosystem research projects undertaken by the Australian Government Antarctic Division concluded on the 28th February 2006, 10 years after it began.

The Baseline Research on Oceanography, Krill and the Environment-West (BROKE-West) voyage, aboard the Aurora Australis, surveyed 1.5 million km^2 of ocean between 30° and 80° east, in a region designated by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) as Division 58.4.2 (see map). The survey aimed to describe the marine ecosystem of the region and determine krill distribution and abundance – to help calculate precautionary catch limits for the krill fishery in the region.

BROKE-West followed in the footsteps of BROKE which, in 1996, conducted a similar survey of the adjacent 4.7 million km^2 CCAMLR Division 58.4.1. Together, the two surveys stretch around one third of the Antarctic coastline, adjacent to the Australian Antarctic Territory (Australian Antarctic Magazine 8:12).

The BROKE-West survey involved using a vast array of sensors whilst the ship was moving, together with information from satellites and samples obtained from Conductivity Temperature and Depth (CTD) probes and from nets. The CTD probes were deployed at 118 sampling stations and instrumented nets were lowered into the water 125 times. This concerted sampling strategy aimed to squeeze the maximum amount of information out of the ocean in the limited time available, and to use this information to build up a picture of the marine environment in this little-studied area. So what did we achieve?

Somewhat surprisingly we surveyed 50% more area than we thought we were attempting. We now have oceanographic and ecological information for this large region, which is compatible with information from BROKE and from a survey in the South West Atlantic – where four ships surveyed 2 million km^2 in 2000. We are now in a position to piece together the ways in which Antarctic marine ecosystems function in summer.

The vast amount of data collected will take years to analyse. So far though, some of the results have been presented to international meetings: the International Whaling Commission, the Scientific Committee on Antarctic Research and CCAMLR. The results of the krill biomass survey were presented to CCAMLR's Working Group on Ecosystem Monitoring and Management in July and the group recommended that the biomass estimate (15.9 million tonnes) should be used to calculate a precautionary catch limit on the krill fishery in this area.

STEVE NICOL
Programme Leader, Southern Ocean Ecosystems, AGAD

T IN AN AGE OF GLOBAL CHANGE

Through my artwork I aim to expose the beauty and diversity of microscopic marine life in an effort to educate people about these organisms and their role in our environment. I use microscopic patterns and forms in my wearable artworks to promote comment and conversation, and I use language to arouse curiosity and to make people stop, think and question their current knowledge and perception about our natural world. For example, my work Threatened Treasure begs the question, what is the treasure and why is it threatened? The accompanying description to the work explains that it depicts a sea-butterfly whose shell is made of calcium carbonate. These shells are being eroded by ocean acidification, caused by increasing amounts of dissolved carbon dioxide. The survival of these creatures is threatened, with unknown consequences for life in our oceans.

This series of work is most literal in its depiction of organisms, to directly engage with and educate the audience. However, the message in other artworks may not always be immediately obvious, and is often dismissed through a lack of understanding or effort to identify with the work. One needs to be taught to read an artwork in the same way one reads a book or scientific paper – you can't fully appreciate what it is saying by just looking at the cover. Artworks dealing in abstraction and distortion can often be more powerful than literal art, but also more challenging for both the artist and the audience, as the interpretation is influenced by the viewer's personal perceptions.

My next project is to create compositions, building on works such as Climate Change in our Backyard. This work explores our perception of scale in both a physical sense (bringing an iceberg down to a size that can fit on a finger) and a social sense (highlighting the scale of climate change). I aim to combine jewellery, sculpture, digital photography and other mixed media to create art that invokes a personal awareness of environmental processes, allowing people to connect and find meaning within the science that is, by its nature, objective and devoid of emotion.

My work will be exhibited at the Bay Discovery Centre in Glenelg, South Australia, in June-July 2007 to coincide with World Environment Day and the International Polar Year (IPY). The IPY brings together a variety of disciplines to understand the effects of climate change on the polar regions. Australia's involvement in the IPY via the Census of Antarctic Marine Life provides a prime opportunity for Australia to be innovative in publicising its science by collaborating with artists to interpret and portray the value of Australia's scientific research on a global scale, but also at an emotional level.

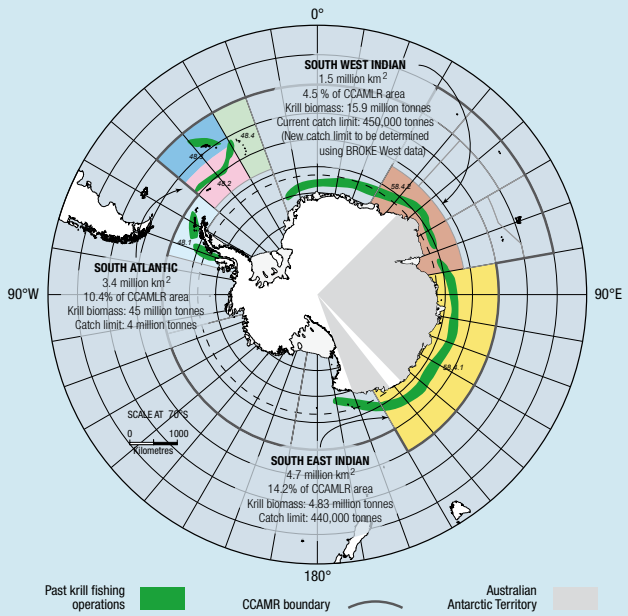
KARIN BEAUMONT
Karin is a former scientist of the Australian Government Antarctic Division, and has completed a PhD on microzooplankton. She now holds an honourary research position with the School of Zoology at the University of Tasmania, and runs her own jewellery business, Oceanides.

CHRISTIAN GALLAGHER

Karin sampling plankton in Antarctica.

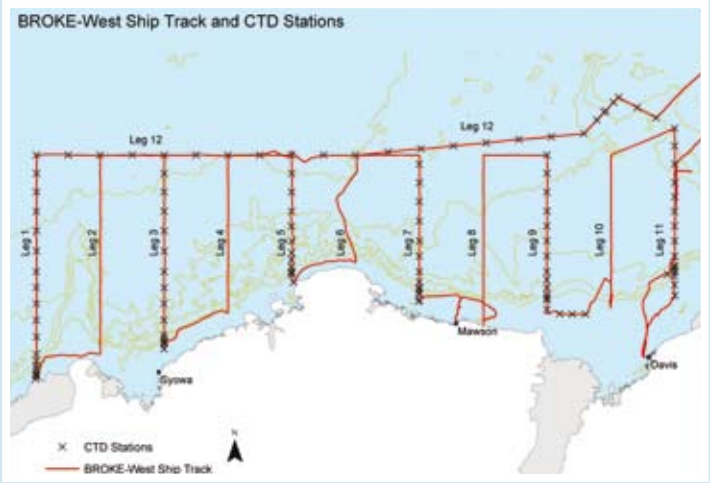
KARIN BEAUMONT

Climate Change in our Backyard explores perceptions of scale, physically and socially. The artwork includes a haiku poem which reads, 'tip of the iceberg, melting signals global change, it's in our backyard'.



In 1996 the BROKE survey estimated krill biomass in CCAMLR Division 58.4.1 and in 2006, BROKE-West surveyed Division 58.4.2. Krill biomass estimates are used by CCAMLR to set precautionary catch limits on the krill fishery for each region.

PETER BOYER, STEVE NICOL



The ship's track from the BROKE-West survey showing the 11 meridional transects and the CTD sampling sites.

BEC GORTON, AADC

IN BRIEF

Director's Awards

This year's recipients of the Australian Government Antarctic Division's Director's Awards were:

CLAIRE WOOLRIDGE

Mike Woolridge, the Antarctic Division's Station Support Coordinator, was commended for his enthusiasm, initiative and drive in supporting the preparation for and conduct of the 2005-06 summer programmes conducted in and around Davis station. He was especially congratulated for his quick thinking during the departure of the Aurora Australis from Hobart in 2005, when he rescued a young girl who fell into the water between the ship and the wharf.

The Davis station leadership team, consisting of John Rich, Graham Denyer, Ray Morris, Chris Tickner, and Janine Lea, were awarded for their actions following the unfortunate death of Peter Orbansen at Davis last summer. Individually and collectively each staff member worked professionally and with dignity and compassion, while participating in the formal investigation process following Peter's death. At the same time they provided high quality leadership and direction to maintain their community and the well being of many of their team significantly affected by the event.

Two lay 'surgical assistant' teams destined for Mawson and Davis, were awarded for their assistance in the care of a patient requiring an emergency appendicectomy aboard the Aurora Australis in October 2005. The team of chefs, carpenters, meteorologists and communication technical officers, assisted the Antarctic medical practitioners in preparing for the emergency surgery, during the operation, and in providing post operative care for the patient.

ANDREW JACKSON

Environmental policy officer Ewan McIvor was recognised for the outstanding and innovative support he provided to the Chair of the Committee for Environmental Protection (CEP) between 2003 and 2006. Ewan developed the Chariman's electronic brief – an archive of Antarctic Treaty and environment related documents. He also helped enhance the CEP's website to improve communications between Treaty Parties.

The Media Production Manager in Multimedia Services, Jessica Fitzpatrick, was recognised for her exemplary customer and results focused work, and for her efforts in support of the combined meetings of the Scientific Committee on Antarctic Research and the Council of Managers of National Antarctic Programs.

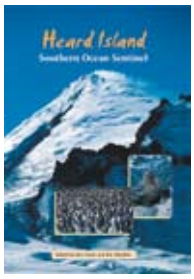
Australian Antarctic Medal

This year's Australian Antarctic Medal was awarded to Mr Per Larson for outstanding service in support of Australian Antarctic expeditions. Mr Larsen was Chief Integrated Rating (Bo'sun) on the RSV Aurora Australis and since 1994 has undertaken 26 voyages in support of the Australian Antarctic programme. His service includes more than 1000 days sea duty, including about 580 days below 60 degrees south.

DAN WEAVELL

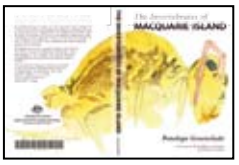
Minister's Achievement Awards

A Minister's Achievement Award for outstanding work to support the International Scientific Committee on Antarctic Research Open Science Conference, the Council of Managers of National Antarctic Programs, and associated meetings, was presented to Antarctic Division scientists Kate Kiefer (Project Manager for the meetings) and Ian Allison (Chair, local organising committee).



Story of a sentinel

A new book on Heard Island, edited by Ken Green and Eric Woehler brings together a wealth of information on the island, including its history, biology, geology, glaciology and climatology, gathered from sealers' logbooks, scientific papers, climbing journals and geographical magazines. Several of the 15 chapters of Heard Island: Southern Ocean Sentinel were written by staff of the Antarctic Division, which has conducted numerous scientific expeditions to the island. The book is available from Surrey Beatty & Sons: (02) 9602 3888, surreybeatty@iform.com.au



AGAD

Invertebrates of Macquarie Island

Invertebrates of Macquarie Island describes the taxonomy, biology and ecology of over 300 invertebrate taxa from subantarctic Macquarie Island. The book summarises the major diagnostic features of all taxa with 12 keys to species of beetles, flies, springtails and other abundant groups of invertebrates, providing an invaluable identification guide for those interested in subantarctic ecology. Written by Penelope Greenslade and edited by Dana Bergstrom, the book is available from the Antarctic Division for $80. Contact judy.whelan@aad.gov.au.

This jade berg, taken by scientist, Steve Nicol, formed part of the Parliament House exhibition.

Parliament House exhibition

The Antarctic exhibition at Parliament House in Canberra, in September, entitled Aurora – extraordinary visions of Antarctica, featured photographs showing that Antarctica is not just icebergs and penguins, but an amazing world of colour and creatures. The photographs were taken by scientists and support staff of the Antarctic Division and can be viewed at http://www.aad.gov.au/default.asp?casid=24039. The exhibition will again be on display at Central Park in Perth in February and the Cullity Gallery, University of Western Australia, in March.

Antarctic Station Leaders 2006-07

Mawson – Gary Dowes is an epidemiologist and public health physician whose early career focused on emerging 'western' diseases, including asthma, obesity, diabetes and cardiovascular disease, in developing countries of the Asia-Pacific region. During this period he coordinated field-based epidemiological studies in Papua New Guinea, Samoa, Nauru, Fiji and Mauritius, and advised governments of these and other countries on prevention and control of non-communicable diseases.

Gary has worked in the Western Australia Department of Health since 1995, initially with responsibility for public heath programmes in the Midwest region, and more recently within its Communicable Disease Control Directorate, where he has coordinated surveillance, investigation and response to outbreaks of infectious disease, and managed broader communicable disease prevention and control programmes across the state. Gary's outside interests include bush-walking, running, bike riding and collecting antiquarian books, maps and prints. This will be his first season in Antarctica.

Davis – Graham Cook returns to Antarctica after spending 2005 as the Mawson Station Leader. Prior to that he spent three years in a dual role as Operations Manager with Federal Hotels' Strahan Village Resort, and Manager of Gordon River Cruises on Tasmania's west coast. Between 1991 and 2001 he was responsible for the operation of a number of remote Aboriginal community stores and Aboriginal enterprise developments in Arnhem Land in the Northern Territory, the Kimberley in Western Australia, the Tanami and Great Sandy Desert areas, and the northern Gold Fields of Western Australia. Graham has travelled extensively throughout South East Asia. He is a keen mountaineer, skier and bushwalker.

Casey – Denis Rich. For the past 27 years Denis has been employed with the Melbourne Metropolitan Fire Brigade (MFB) where, as a Commander, he gained broad experience in emergency response, training and management. In recognition of his role in leading the development and implementation of the MFB's Emergency Medical Services First Responder programme – a first for fire services within Australia – Denis was awarded the Australia Fire Service Medal in the Queen's Birthday Honours in 2000.

In a parallel career, Denis has also achieved sporting success (or at least notoriety) as a VFL/AFL umpire, with over 250 games and three Grand Finals. Now a keen golfer, he enjoys travelling, outdoor activities, swimming, reading and morning walks. He lives by the sea in picturesque Williamstown and is married with two adult children and a dog – named Casey!

GEOFF NEWTON

Vale: Ken Assender (17.11.1937 – 10.09.2006)

Ken Assender went south on the Thala Dan as a young Pilot Officer with the RAAF Antarctic Flight in 1959-60. Stationed at Mawson as Third Pilot for the year, he participated in wide-ranging exploration programmes in the DC3/Dakota aircraft. As a co-pilot, he made extensive forays into the Prince Charles Mountains and Enderby Land to undertake topographical and geological surveys. Ken also flew between Mawson and Davis stations. Ken's skill as a navigator was later employed in the Sydney to Hobart Yacht Race.

Ken's strong interest in Australia's Antarctic programme led him to work part-time in the Antarctic Division's Multimedia Unit during the 1990s. Ken was also the mainstay, for many years, of the Tasmanian Branch of the ANARE Club, of which he became President in 1998.

Totally Wild in Antarctica

One of the priorities of the upcoming International Polar Year (2007-08) is education and outreach, in order to inspire a new generation of scientists and encourage young people into science. With this in mind, the Australian Government Antarctic Division selected this year's Antarctic Arts Fellows for their potential to reach a large, young audience.

Wesley Denning from Network Ten will film some 28 episodes of Totally Wild – a broadly based environment programme aimed at the 8-14 age group. The stories will be aired over 12 months and will promote nature, science, environment and adventure. Totally Wild attracts an audience of 1.4 million a week in Australia and, through the ABC Asia network, has young viewers in 41 countries. Wesley will also obtain footage for Network Ten's kids science programme SCOPE.

Wesley will be accompanied by cameraman Stephen Harris and producer Marie Davies.

DAVID McCLENAGHAN

Tanya Patrick from CSIRO education will collect material for the Kids Antarctic Awareness Project – a series of film, audio and written interviews with scientists. This will include segments for Network Ten's SCOPE and Totally Wild television programmes, magazine feature articles, an Antarctica hands-on activity kit, a diary in email newsletter Science by Email, pod casts, and an interactive website hosted by CSIRO Education www.csiro.au/helix. Tanya is editor of Scientriffic, CSIRO's science magazine for 7-10 year olds.

Correction

The photograph on page 15 of Australian Antarctic Magazine, Issue 10, of a crew member avoiding a wave on the Nella Dan, was taken by John Shearer.

A YEAR OF DISCOVERY AWAITS

A new era in our understanding of the polar regions and their impact on the Earth's climate, ecosystems and societies will awaken when the International Polar Year (IPY) gets underway in March 2007.

IPY 2007-2008, co-sponsored by the International Council for Science and the World Meteorological Organization, will lay the foundation for major scientific advances in the Arctic and Antarctic, while leaving a legacy of observing sites, facilities and systems to support ongoing research and monitoring. The official observing period will run from 1 March 2007 until 1 March 2009, to enable summer-based projects to be conducted over a full year.

International, collaborative research will be conducted under six broad themes:

- the environmental status of the polar regions;
- understanding past change and predicting future change;
- links between polar and global processes;
- bringing science frontiers to polar regions;
- observing the Earth and space from the poles;
- the sustainability of circumpolar societies.

The IPY follows on from three previous events. The First International Polar Year (1882-1883) was the inspiration of the Austrian explorer and naval officer Lieutenant Karl Weyprecht. Research during the year addressed fundamental problems of meteorology and geophysics and set a precedent for international scientific cooperation.

The Second International Polar Year (1932–1933), proposed by the International Meteorological Organization, investigated the global implications of the newly discovered jet stream and saw advances in meteorology, magnetism and atmospheric science. Both the first and second polar years placed the focus on the Arctic region.

The International Geophysical Year or IGY (1957-1958) emphasised the Antarctic, and included studies of meteorology, geophysics, the structure of the ionosphere, cosmic rays, solar activity, glaciology, oceanography, seismology and the Earth's gravitational field. The year saw the theory of continental drift confirmed, the discovery of the Van Allen Radiation Belt, the launch of the world's first satellites, and informed estimates of Antarctica's ice mass. Australia's second permanent Antarctic station, Davis, was established in January 1957, in preparation for the IGY, following on from Mawson which had been established in 1954.

IGY had been organised by the International Council of Scientific Unions (ICSU) through its Special Committee on Antarctic Research. The success of Antarctic research during IGY led to the establishment in 1958 of a permanent ICSU group to foster Antarctic research — the Scientific Committee on Antarctic Research (SCAR). Importantly, IGY led directly to the negotiation and adoption of the Antarctic Treaty in 1959, which included the objective of facilitating further scientific cooperation in Antarctica.

The unprecedented level of cooperation, exploration and discovery achieved during these three years, but especially during IGY (which involved some 80 000 scientists from 67 countries), has raised the bar for 2007-08. At a time of global change and with significant advances in scientific knowledge and technology since the IGY, the stage is set for new insights and breakthroughs.

Australia will play a key role in the IPY – the Australian Government Antarctic Division will lead four of eight scientific projects being hosted by Australia, while Australian scientists will be involved in some 50 other international projects. The Australian coordinated projects are described below.

Census of Antarctic Marine Life

The five-year Census of Antarctic Marine Life (CAML), led by Antarctic Division Chief Scientist Dr Michael Stoddart and Project Manager Victoria Wadley, will determine species biodiversity, abundance and distribution around Antarctica – on the sea floor, continental slope, in deep waters, under collapsed ice shelves and in upper

SEAN WICKS

sunlit waters. As knowledge of Antarctica's marine biodiversity is patchy, CAML will establish the state of these communities and provide a baseline against which future change – as a result of climate change – can be measured. More information: http://www.caml.aq/.

Taking the Antarctic Arctic Polar Pulse

A key component of this project will be the development of a snapshot database of health events occurring in the Antarctic during the IPY. Research will include investigations into the impacts of living in the total darkness of winter, the effects of isolated and confined conditions on the human immune system, metabolism, stress and social behaviour, and the viability of using internet-based telemedicine techniques to diagnose and treat disorders over exceptionally long distances. The project will be led by Antarctic Division Chief Medical Officer, Dr Jeff Ayton.

Solar variability linkages to atmospheric processes

Led by Antarctic Division atmospheric scientist, Dr Gary Burns, this project will investigate whether solar variability affects the Earth's weather and climate. Scientists will measure the global electric circuit – an electric current that flows around the world between the ground and the lower reaches of the ionosphere (about 70 km up) – to determine whether changes in the sun have an effect on the Earth's weather system. Such changes could alter the global electric circuit and the conditions under which clouds develop, potentially providing a link between solar activity and climate. Accurate measurements of the current could also enable scientists to monitor changes in global thunderstorm activity as the world warms. Instruments to measure the global electric circuit will be deployed on the Antarctic plateau and the Greenland ice plateau.

Aliens in Antarctica

The Aliens in Antarctica project, led by Dr Dana Bergstrom of the Antarctic Division, will assess the extent to which people unintentionally carry propagules (seeds, spores, eggs) of alien (non-native) species into the Antarctic region during the 2007-08 summer. People travelling to the Antarctic and subantarctic islands, by ship and aircraft, will have their clothing and equipment inspected for propagules. The project will provide an understanding of the threat that alien propagules pose, enabling appropriate mitigation methods to be established to combat this threat.

International Research Expedition

The Royal Society of Victoria will lead 'RSV-INTREPID' – two 40-day summer voyages of scientific investigation involving 50 year 12 students and 60 scientists. Students will participate in intensive ship-board and shore-based investigative and experimental projects designed to complement other IPY projects, and will prepare an investigative report for publication in the Society's Proceedings. The project will support one of the IPY's key objectives of education, outreach and communication through its continuing promotion and advancement of science and technology and by encouraging young people to pursue a career in science.

Astronomy from the Polar Plateau

The polar plateaus provide the best sites on the Earth's surface to conduct a wide range of astronomical observations, due to the extremely cold, dry and stable air found there. Led by Associate Professor Michael Burton of the University of New South Wales, the project aims to quantify these conditions at four sites – Summit in Greenland, Ellesmere Island in Canada, and Domes A and C on the Antarctic plateau – and begin the process of turning these sites into front line observatories. The project will build upon a decade of site testing experience, at both the South Pole and at Dome C, including the development of autonomous observatories that can gather data over winter. Currently, the research team is working on delivering an automated observatory to Dome A through a Chinese-led traverse planned for the region.

International Antarctic Institute

The International Antarctic Institute (IAI) will serve as an educational centre for Antarctic programmes, facilitating cross accreditation of courses from partner institutes. The IAI currently involves 12 countries with programmes in Antarctic education and/or Antarctic research. While its headquarters will be based at the University of Tasmania, the IAI will be a multi-campus, multi-disciplinary institution that will offer jointly accredited degrees from undergraduate level to Masters. Establishment of the institute is being led by Professor Andrew McMinn of the Institute for Antarctic and Southern Ocean Studies at the University of Tasmania.

The aurora australis or Southern Lights are produced as a result of charged particles from the sun (solar wind) colliding with gases in the upper atmosphere. The interaction of the solar wind and the Earth's magnetic field, the same process that leads to the aurora, influences the global electric circuit in the Polar Regions.

Climate of Antarctica and the Southern Ocean

Led by Dr Steve Rintoul of the Antarctic Climate and Ecosystems Cooperative Research Centre and CSIRO, this project will obtain a broad, circumpolar snapshot of the physical environment of the Southern Ocean. Collaboration with other IPY activities will extend the snapshot to include biogeochemistry, ecology, and biodiversity. The work aims to enhance understanding of the role of the Southern Ocean in past, present and future climate.

A key element of the project will be the establishment of a Southern Ocean Observing System to routinely monitor the behaviour of the ocean. Information from this system will be used in models for ocean and climate forecasts. The system will involve measurements of temperature, salinity and ocean currents using ships, free floating instrumentation, satellite trackers attached to marine mammals and seabirds, current meters and tide gauges.

More information about IPY projects is available at: http://www.ipy.org/.

Dr Ian Allison of the AustralianGovernment Antarctic Division and the Antarctic Climate and Ecosystems Cooperative Research Centre, is Co-Chair of the Joint Committee for the IPY. Dr Allison has studied the Antarctic for over 35 years, participated in more than 25 research expeditions to the Antarctic, and published more than 100 papers on Antarctic science. His current research interests include the interaction of sea ice with the atmosphere and ocean; the dynamics and mass budget of the East Antarctic ice sheet; melt, freezing and ocean circulation beneath floating ice shelves; and Antarctic weather and climate. Dr Allison was active in the planning and co-ordination of a number of international programmes within the Scientific Committee on Antarctic Research and the World Climate Research Programme before his present involvement in the IPY 2007-2008.

NEW DIETARY FACTS FROM FAECES

NICK GALES

DNA analysis of the faeces of lactating Antarctic fur seals showed that they ate squid more frequently than conventional faecal analysis suggested, and that mackerel ice fish – a target of commercial fisheries – were also an important part of their diet.

"Statistics show that of those who contract the habit of eating, very few survive."

George Bernard Shaw

All animals must eat to exist, and knowledge of a species' diet is fundamental to understanding its biology and role in an ecosystem. In the marine environment, we need to better understand complex food webs in order to evaluate such things as the indirect impacts of fisheries and the effectiveness of marine protected areas. Since it is rarely possible to observe marine animals feeding, determining what they are eating is a challenge.

One way to get dietary information is to see what is in an animal's stomach. For some marine species, such as fish that are caught by commercial fisheries, this type of analysis is feasible. However, it is not so easy (nor always ethically acceptable) to obtain stomach samples from top-level predators such as seabirds, seals and whales. Consequently, several alternative methods of dietary analysis have been developed.

Some methods rely on chemical signatures from prey that are incorporated into a predator's tissue. By carrying out chemical analysis on small tissue samples collected from predators (such as blubber biopsies, whiskers and/or feathers) it is possible to get broad information about their diet.

In seals, more detailed dietary information is often obtained by sorting through their faeces to identify the origin of bones and other hard parts that survive digestion – and you thought studying marine mammals was glamorous! Unfortunately, fragile bones of some prey species do not survive digestion and some hard parts, such as large squid beaks, are regurgitated. This means conventional faecal analysis provides a biased view of what animals are actually eating. Another problem is that many animals, such as penguins and whales, leave almost no visually identifiable remains in their faeces because they digest their food so thoroughly. In response to these problems the Applied Marine Mammal Ecology group at the Australian Government Antarctic Division has been researching the potential for using DNA in animal faeces to study animal diet.

DNA is probably the most famous biological molecule. It is well known as a natural information store and has been studied in detail in humans through the Human Genome Project. The information in DNA, and the ability to recover DNA from trace

Promising results from analysis of prey DNA in macaroni penguin samples indicate the need for invasive stomach flushing could be reduced in future penguin diet studies.

amounts of tissue, has made it indispensable in police forensic investigations. These same features give it the potential to be used to identify the food of animals – even after digestion.

We began our research in 2001 at a time when very little work had been done in the area and there were many unsolved technical difficulties involved in reliably isolating and identifying prey DNA from faeces. The challenges arise largely because DNA is broken into very small pieces during digestion and the prey DNA found in animal faeces is also mixed in with DNA from gut bacteria and parasites, and DNA from the gut cells of the predator. We looked at many laboratory techniques for separating out the DNA of prey species and eventually succeeded in isolating and identifying prey DNA in the faeces of a few different marine predators.

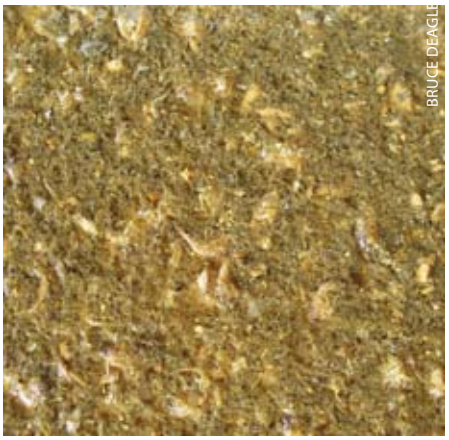
The next step was to determine if the prey DNA we isolated was representative of what an animal was eating. We decided to study animals in captivity, as the exact diet of the animals was known and their faeces could be collected and tested. Studies were undertaken on Steller sea lions housed at the Vancouver Aquarium in Canada (with colleagues from the University of British Columbia), and on fur seals at Sea World on the Gold Coast, Australia. In each case, the captive animals were fed a daily diet of several different prey species.

Back in Tasmania, the faecal samples were analysed in the laboratory using 'group-specific PCR' (a technique that allows detection of miniscule amounts of prey DNA). Both studies showed that prey DNA could be reliably recovered. In the Steller sea lion study, even prey that was eaten in small amounts (for example, squid fed as 5% of the diet) could be dependably detected. The proportions of prey DNA in the faeces were also roughly proportional to relative amounts of the different prey items consumed. The Sea World study compared DNA detection with recovery of prey hard parts. The results showed that even fish with robust hard parts were more likely to be identified by their DNA in faeces, than by their bony remains.

The next step was to field test the technique's capacity to address ecological questions. A perfect opportunity arose with the AGAD's Heard Island Predator-Prey Investigation and Ecosystem Study (Australian Antarctic Magazine 7:6-7). This food-web study involved determining the diet of some key predators using conventional methods (identifying remains of prey in fur seals' faecal samples and in the stomach contents of macaroni penguins), and trialling the new genetic approach.

Tests for prey DNA provided a new perspective on the diet of female Antarctic fur seals that were nursing pups. DNA analysis showed that they consumed a more diverse fish diet, and that squid was eaten more frequently than conventional faecal analysis indicated. A major component of the diet was mackerel icefish, which is also a target species for commercial fisheries in the region. The potential for competition between lactating Antarctic fur seals on Heard Island and these fisheries is currently being assessed.

For the macaroni penguins, analysis of samples collected through stomach flushing showed that the diet changed from primarily krill in the early part of chick rearing, to primarily fish at later stages. The species of krill being eaten also changed during the course of the study. Both of these dietary trends were mirrored in the data obtained through DNA testing of penguin faeces. This comforting congruence indicates that non-invasive faecal analysis could reduce the need for stomach flushing in future penguin diet studies. The penguin DNA faecal analysis also allowed for improved taxonomic identification of some prey species. For example, two species of krill, difficult to distinguish in digested stomach samples, were easily identified by genetic differences.



Species in dietary samples can be very difficult to identify. This photo shows the digested remains of krill and fish recovered from a penguin stomach.

Example of fish bones recovered from sea lion faeces (from top right, clockwise – herring, sandlance, pollock and salmon). Diet estimation based on recovery of bones can be biased since fish with fragile bones are poorly represented and some soft-bodied prey are not represented at all.

The studies have shown that DNA-based methods are useful for gleaning valuable dietary information from predators' faeces. However, several hurdles remain before the technique can be routinely applied. For example, we are currently working on more effective ways of removing the large amounts of predator DNA from faeces.

In addition, DNA-based faecal analysis does not provide some information obtainable with traditional diet analysis, such as the size of prey species being eaten. However, the technique has obvious uses: in seals and sea lions it will allow detection of fish with fragile bones and soft bodied prey, such as squid; and in penguins it provides a new, less intrusive method for studying diet.

In the future the methodology may be semi-automated, allowing analysis of large numbers of samples collected in population level surveys. While the technique will not overcome all the complications of dietary analysis, it is another tool that will bring ecologists closer to understanding the important question of who's eating whom in the ocean.

BRUCE DEAGLE, RUTH CASPER and SIMON JARMAN
Southern Ocean Ecosystems Programme, AGAD

Working towards seabird-safe longlining in pelagic tuna and billfish fisheries

Eighteen threatened seabird species breed in Australia and its Antarctic territories. A further 16 threatened species visit Australia's oceans in search of prey.

Unfortunately, these birds face the very real threat of becoming incidental bycatch in longline fisheries. The Australian Government helps to conserve these species through its contributions to the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), the Agreement on the Conservation of Albatrosses and Petrels (ACAP), and its own Recovery Plan for Albatrosses and Giant Petrels.

The Seabird Bycatch and Ecology group of the Southern Ocean Ecosystems programme at the Australian Government Antarctic Division works with industry to develop seabird-safe fishing methods. The group also provides scientific advice to enable the government to meet its responsibilities under CCAMLR and ACAP. The group undertakes:

- research on seabird population status and trends;
- fisheries interactions studies to determine where threatened species are likely to be caught;
- bycatch mitigation work with industry to develop seabird-safe fishing methods; and
- engagement in the policy process to improve uptake of seabird-friendly practices in southern hemisphere fisheries.

There has been considerable success so far. Both the Australian Government and CCAMLR introduced a suite of mitigation measures that have reduced seabird bycatch to sustainable levels within their regulated subantarctic fisheries.


GRAHAM ROBERTSON

Longline vessels attract hundreds of seabirds such as petrels and albatrosses intent on an easy meal.


BARBARA WIENECKE

Sink rate recorders were attached to hooks to assess the effect of different lead weight characteristics, bait types and other factors on hook sinking.


KIERAN LAWTON

Lines were set using different bait types – in this case squid – to assess its effects on hook sink rate. Experiments were also conducted in conjunction with bird scaring lines (red streamers pictured).

For Australia these are the Heard and McDonald Islands fishery and the Macquarie Island fishery (Australian Antarctic Magazine 8:18-19). These fisheries have, in some areas, achieved very low levels of incidental seabird bycatch through the implementation of mitigation measures.

Despite these successes there is more work to do. Seabirds, such as albatrosses and petrels, range around the world in search of prey. They are true world travellers; an albatross from Heard Island may spend part of the winter feeding in the Great Australian Bight. Other albatrosses are known to circumnavigate the world between breeding seasons. To conserve southern hemisphere seabirds effectively we must work in fisheries throughout their foraging ranges, even if the fisheries surrounding the birds' breeding islands are seabird-safe.

Because many subantarctic seabirds forage further north during the winter, attention has turned to the pelagic longline tuna and billfish fisheries that operate at those latitudes. Tuna and swordfish vessels set on average 1000 hooks a day on longlines extending over 90 km. Even if only a tiny fraction of these hooks is taken by seabirds, the resulting bycatch can be alarming. Birdlife International estimates that there are several tens of thousands of seabirds killed annually on longlines. These estimates apply to the open ocean (unregulated) fishery. Regulated fisheries that operate within national exclusive economic zones, such as Australia's Eastern Tuna and Billfish Fishery, are a good starting point for mitigation research. Practical and effective mitigation strategies that are developed in regulated fisheries may ultimately be adopted by similar types of fisheries operating on the high seas.

With this in mind, and to reduce the number of seabirds caught in the Eastern Tuna and Billfish Fishery, the Australian Government Antarctic Division and the Australian Fisheries Management Authority chartered the fishing boat, Assassin, to conduct an experiment aimed at increasing the sink rate of baited hooks. Understanding the factors that affect the sink rate of baited hooks is important because most seabird mortality occurs at or near the water's surface as the fishing gear is sinking. Measures that increase sink rates and limit the time baits are exposed should reduce the catch rate of seabirds.

We measured the effect of three different lead weighted swivels on hook sink rates. We also measured the effect of placing these weights at four different distances from the hook, and the effect of bait type (squid, saury and mackerel) and whether the bait was alive or dead.

The experiment resulted in a recommended line weighting regime (swivel weight and distance from the hook) that is currently being trialled in the fishery. Time will tell if these measures prove effective in reducing seabird bycatch to levels that are deemed to be safe to seabirds.

In the mean time, work on other mitigation measures continues. The development of a practical and effective bird scaring streamer line, to use in conjunction with the line weighting regime, is being pursued. Streamer lines are currently required in the East Coast Tuna and Billfish Fishery, but a lack of established performance criteria has resulted in a range of styles and constructions being used by fishers. Streamer lines are highly variable across the fleet and highly variable in their effectiveness.

Mitigation measures that prove effective in the Eastern Tuna and Billfish Fishery are likely to be effective in the large, unregulated open ocean fisheries. A significant future hurdle will be finding the means by which these measures might be adopted by these fisheries. However, a precedent for wide-spread uptake exists. Fast sinking longlines developed for demersal (bottom) fishing have proved an effective seabird deterrent (Australian Antarctic Magazine 5:14-15). These lines have been widely adopted in the Patagonian toothfish fisheries in the Southern Ocean because of CCAMLR's adoption of minimum sink rate standards (creating the incentive for uptake), and because the lines are practical for fishers to use. If similar incentives can be developed for tuna fisheries, both in national economic zones and on the high seas, the results of our research could yield significant seabird conservation dividends worldwide.

KIERAN LAWTON, GRAHAM ROBERTSON
and BARBARA WIENECKE
Southern Ocean Ecosystems Programme, AGAD

A NEW SCIENCE PROGRAMME

The Australian Government Antarctic Division Science Branch recently amalgamated two former science programmes – Impacts of Human Activities in Antarctica and Adaptations to Environmental Change – to form the new Environmental Protection and Change (EP&C) programme.

The programme aims to understand how the biodiversity of Antarctica responds to human-induced environmental change and to develop new techniques to remediate past environmental impacts. Scientists in the program will work across five priority themes:

Antarctic biodiversity – life in a highly fragmented environment

This theme aims to contribute to better protection of the natural heritage of the Antarctic, through the understanding of its biodiversity at all levels – from DNA to ecosystem interactions. Antarctic animals, plants and micro-organisms have evolved in an environment quite different from other regions of the world and have many unusual features which may influence their ability to tolerate environmental change. In addition, the landscape of Antarctica is unusual in having many distinct 'islands' of biodiversity that are separated by enormous distances; such as the pockets of ice-free land, lakes, and the shallow near-shore sea bed. For many species there are few opportunities for natural dispersal and spreading between individual islands of biodiversity. This has the potential to create genetically distinct sub-populations around the margin of Antarctica, with implications for the protection of this biodiversity.

Global climate change – biological responses in the Antarctic and Southern Ocean

This theme will investigate and monitor the effects of global climate change on the biota of the Antarctic and the Southern Ocean. Some of the first effects of climate change on the biosphere are appearing in polar regions because of the close interactions between temperature-dependent physiological processes in the biota and physical processes such as melting, freeze/thaw cycles, increasing exposure to ultraviolet-B radiation, de-glaciation on subantarctic islands, and the changing extent of sea ice. Plankton, coastal marine organisms and terrestrial biota are the focus of research, as they may serve as early warning indicators of detrimental or accelerated change in global climate.

On some subantarctic islands such as Heard Island, coastal and terrestrial organisms may serve as early warning indicators of detrimental or accelerated change in global climate.

Acidification of the Southern Ocean – biological impacts and feedback mechanisms

Scientists have only recently recognised ocean acidification, caused by increased concentrations of dissolved carbon dioxide (CO_2), as a serious threat to the Earth's ocean ecosystems (Australian Antarctic Magazine 10: 26-27). Acidification can reduce the ability of plants and animals to form calcium carbonate shells and may reduce photosynthetic efficiency in calcifying algae. Higher CO_2 concentrations may also make it harder for gill-breathing animals to obtain sufficient oxygen. The impacts of acidification to individual organisms are in addition to those caused by global warming and are likely to make marine ecosystems less robust and more vulnerable to other stresses. The impacts of acidification are predicted to be most severe on coral reefs and the Southern Ocean. Scientists within the Australian Antarctic programme are uniquely positioned to make a significant contribution to understanding

DENNIS CRAWFORD

The Antarctic landscape has many distinct 'islands' of biodiversity that are separated by enormous distances, such as these lakes in the Vestfold Hills, near Davis.

MARCUS SCHORTEMEYER

KIERAN LAWTON

the problem of ocean acidification, because of their regular voyages through the Southern Ocean, their expertise in broad-scale ocean sampling and their ability to conduct experiments under controlled conditions.

Environmental guidelines for Antarctica

Research in this theme will provide the scientific basis for environmental standards that are appropriate to Antarctic conditions and to the sensitivities of the species that live there. Environmental standards for contaminants in the environment are commonly based on dose-response data from temperate latitudes. Virtually no toxicology data is available from polar regions and it is not yet possible to say whether standards based on data from other regions are appropriate for Antarctica. Clean-up of contaminated sites cannot possibly remove every trace of environmental contamination, but how clean is clean enough for Antarctica?

Zero-discharge stations and contaminated sites remediation

Australia led the world to establish very high standards of environmental stewardship for Antarctica in the early 1990s when the Madrid Protocol was signed. However, there are still some

How clean is clean enough for Antarctica?

1-10 million cubic metres of contaminated material in Antarctica and stations continue to discharge waste into the environment – most of it concentrated on the narrow coastal ice-free fringe which makes up only 0.05 percent of Antarctica. If the principles of the Madrid Protocol are to be met, it is important that we continue to improve our operational practices, by developing new and affordable technologies for discharge reduction and site remediation that work under Antarctic conditions.

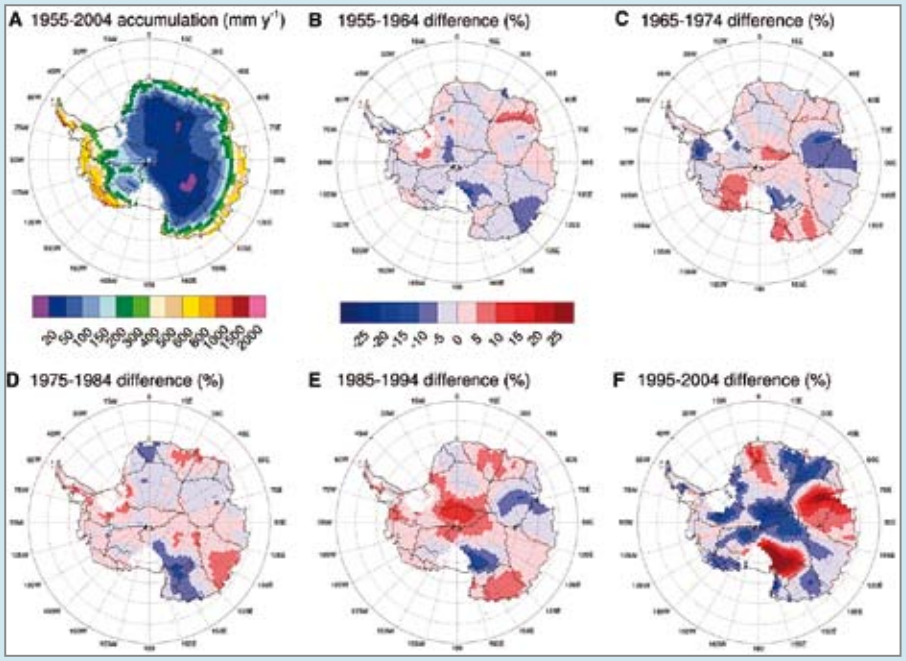
With environmental change happening at many scales and for a variety of reasons, the challenges for science are: to separate the meaningful signals of change from the background of natural variability, identify interactions of multiple drivers of change that may accelerate the detrimental effects and, as a priority, identify in advance the threshold conditions that could trigger irreversible phase shifts in the Antarctic and Southern Ocean ecosystem.

The merger of the Human Impacts and Adaptations to Environmental Change programmes provides new opportunities to understand the interacting effects of global and local processes; for example, how might stress caused by global warming exacerbate the effects of pollutants or create new opportunities for invasive alien species? Importantly, it also increases our opportunities to develop preventive measures and remediation techniques in response to a greater range of environmental pressures.

MARTIN RIDDLE
Programme Leader, Environmental Protection and Change, AGAD

SEA LEVELS RISE AS ANTARCTICSNOWFALLSSHORT

Global climate models have predicted that Antarctic snowfall should increase in a warming climate – as warmer air can hold more moisture – partially offsetting sea level rise caused by the melting and calving of ice along the coast. However, new research published in Science, shows that snowfall in Antarctica has changed little in the past 50 years, despite changes in climate.



The mean annual snowfall accumulation over the 1955-2004 year period, expressed as mm of water equivalent (A); and the percentage difference from this pattern in 10-year snapshots (B-F). The scale shown in 'B' applies from B to F. From Andrew J Monaghan et al., Science 313:827-831 (11 August 2006). Reprinted with permission from AAAS.

The research, conducted by an international team of 16 scientists including Tas van Ommen and Vin Morgan of the Australian Government Antarctic Division and the Antarctic Climate and Ecosystems Cooperative Research Centre, reconstructed the past 50 years of snowfall accumulation over Antarctica, using model simulations, satellite and meteorological data and ice cores.

The results showed that although snowfall is highly variable across Antarctica, and through time, there has been little overall change since the 1950s.

'We found that snowfall was quite variable, with yearly fluctuations equivalent to ±20 mm of water averaged across the continent, which could easily mask underlying trends in the short term,' Dr van Ommen said.

'So we extended the snowfall record back to the International Geophysical Year (1957-58), using snow and ice accumulation data, mainly from ice cores.'

The extended record was reconstructed at 16 sites across the continent, providing a map of regional snowfall variations for the last 50 years. This allowed the researchers to assess trends over a longer term, compare snowfall with the temperature record over the same period, and develop a 50-year benchmark for evaluating global climate models.

The study looked at both the West Antarctic Ice Sheet, which has been thinning over the past decade and contributing to global sea level rise by 0.13 to 0.16 mm per year, and the East Antarctic Ice Sheet, whose thickness is reported to be increasing.

'We found regions of both positive and negative change in all five decades, but no continental-scale changes in either direction dominated any period,' Dr van Ommen said.

'In contrast, satellite measurements showed that the ice sheet is growing in places and thinning in others, but such results give only a short-term snapshot of a much longer, slower drama.

'Ongoing ice core studies by many national programmes, including Australia, as well as radar studies that track ice layers beneath the surface, will provide more complete coverage and longer records that can be used to extend this work beyond 50 years.'

The absence of increased snowfall in the last 50 years, despite atmospheric warming, means that sea level rise has not been mitigated by increasing precipitation. For future projections of sea level it is important to understand why this is so and if this pattern will continue.

More information

A. Monaghan, D. Bromwich, R. Fogt et al (2006). Insignificant change in Antarctic snowfall since the International Geophysical Year. Science Vol 313, no. 5788 pp 827-831.

WENDY PYPER
Information Services, AGAD

The future of Antarctic environmental protection

Environmental challenges facing Antarctica in the future were the focus of a workshop at this year's Committee for Environmental Protection meeting in Edinburgh, chaired by Australian Government Antarctic Division Director, Tony Press.

Not surprisingly, climate change featured prominently. While the attending experts in environmental science and policy agreed that human activities in the Antarctic do not generate significant quantities of atmospheric pollutants, research and monitoring of change at the 'southern front' was considered vital for understanding and addressing global implications. This is important for a range of reasons, including:

- warming temperatures might cause populations of cold-loving Antarctic species to shift further south, with implications for site-specific approaches to area and species management;
- under a warming scenario the Antarctic could become more hospitable for unwelcome introduced species, making the implementation of rigorous quarantine measures critical; and
- increased melting of snow and ice at locations where rubbish and other waste was dumped many years ago could result in the exposure and release of harmful contaminants.

With continuing – and in some areas increasing – scientific research, support operations, fishing and commercial tourism, effective management of future human activities within the Antarctic region was not overlooked. Greater collaboration in science and logistic support was discussed as a potential way of minimising the overall footprint. Other goals included: improving energy management and increasing the use of renewable sources; focussing conservation efforts on vulnerable areas through a better understanding of the Antarctic environment; and working more closely with other Antarctic Treaty bodies and non-Antarctic bodies to develop environmental protection measures.

The next task is to formulate a prioritised five-year work plan, so the Committee for Environmental Protection can start putting these good ideas into practice.

EWAN McIVOR
Environmental Policy and Protection, AGAD

AUSTRALIA HANDS ON A LEGACY OF ENVIRONMENTAL PROTECTION IN ANTARCTICA

The Director of the Australian Government Antarctic Division, Dr Tony Press, completed his second and final term as Chair of the Committee for Environmental Protection (CEP) this year.

Since his election as Chair in 2002, Dr Press has overseen the Committee's work to provide advice to the Antarctic Treaty parties on measures to protect the Antarctic environment. Some of the highlights of his tenure include improving the environmental impacts assessment of activities in Antarctica; assessment of some 50 management plans for Antarctic protected areas; and improving the methods for storage and handling of fuel in Antarctica. The CEP has also become increasingly active in looking at ways to manage tourism so that environmental impacts are minimised.

At the conclusion of the ninth CEP meeting in Edinburgh in June Dr Press was congratulated on his leadership of the CEP. The meeting welcomed newly elected Chair, Dr Neil Gilbert, of New Zealand. Australia also handed over the role of providing the Committee's secretariat to the recently established Secretariat of the Antarctic Treaty in Argentina.

Outgoing CEP Chair, Tony Press (right), incoming CEP Chair, Neil Gilbert (centre) and the first CEP Chair Olav Orheim (left) of Norway.

Mercy dash for Australian patrol ship

The Australian Customs and Fisheries patrol ship Oceanic Viking made a 1800 nautical mile mercy dash from the remote Southern Ocean to the Indian Ocean, in October, to help save the lives of two critically ill men.

An Australian Government Antarctic Division doctor on board the ship performed emergency surgery on one of the men, with the assistance of Customs Officers specially trained as lay surgical assistants. Both men were eventually transferred in a stable condition to a hospital on the island of La Reunion, east of Madagascar, for ongoing assessment and medical care.

The Minister for Justice and Customs, Senator Chris Ellison, said the Oceanic Viking was diverted from a planned patrol of Australian waters around Heard Island and McDonald Islands (HIMI) on October 11. He said the patrol ship diverted to the French-owned Kerguelen Islands to pick up a seriously ill 43-year-old man; a fisherman from a licensed fishing vessel.

'The man had suffered a heart attack a few days prior and needed urgent transfer to more comprehensive medical facilities in La Reunion,' Senator Ellison said.

En route to La Reunion the Oceanic Viking then responded to an emergency request for assistance from a bulk carrier, the MV Dynasty, travelling between Brazil and China. The ship reported that it had a 35-year-old crewman in critical condition with a burst appendix.

'Thanks to a treaty between France and Australia on illegal foreign fishing, our interests were always protected while the Oceanic Viking was undertaking this important medical mission. The safety of life at sea is the prime concern of any mariner and the Australian Government supports this important international convention. The Oceanic Viking will always respond to distress calls while carrying out its patrol duties,' Senator Ellison said.

The Antarctic Division Polar Medicine Unit has been providing medical support to Australian Customs Fisheries patrols in the HIMI region since 2003. The Oceanic Viking previously undertook a medical evacuation of a seriously ill fisherman in the Southern Ocean in 2004 (Australian Antarctic Magazine 8: 26).

Australian Customs officers transfer the sick crewman off the bulk carrier MV Dynasty, in the Southern Ocean.

Site guidelines for popular tourist destinations in Antarctica, such as Cuverville Island off the Antarctic Peninsula, are the latest step in the effort to manage Antarctic tourism to the highest possible standards.

STEPHEN POWELL

TREADING LIGHTLY ON THE ICE

Once a year Antarctic Treaty delegates meet to share information, update the rules governing the frozen continent, and recommend actions their governments should take to uphold the principles of the Antarctic Treaty. Australia sends a sizeable delegation, including the Antarctic Division's Director, Chief Scientist, and senior policy advisers.

The latest (29th) Antarctic Treaty Consultative Meeting was hosted by the United Kingdom in Edinburgh, in June 2006. One clear theme emerged; when people gather to talk about the state and future of Antarctica, the conversation turns to how we can tread lightly on the frozen wilderness.

Aliens in Antarctica

One devastating footprint that Antarctic visitors – scientists and tourists alike – need to avoid leaving behind is the accidental introduction of alien species. Non-native animals, plants or diseases can all travel south as unwelcome stowaways on ships, aircraft, clothing and equipment.

Australia brought the alarming potential consequences of introduced species to the attention of fellow Treaty Parties in 2005. This sparked a special workshop on the 'quarantine' or 'biosecurity' question.

The June 2006 meeting adopted practical guidelines to prevent the transport in ships' ballast water of invasive marine organisms, either to the Antarctic, or between biologically distinct regions within the Antarctic. Ships are urged not to discharge ballast water in Antarctic waters at all, or to flush out and refill their ballast tanks en route, to minimise the risks.

Better guidelines for tourists

At home, hikers and campers aim to take nothing but photographs and leave nothing but footprints. Antarctic tourists are exhorted not even to leave footprints (at least in vegetation), to avoid damaging the wilderness that attracted them to Antarctica in the first place.

The Antarctic Treaty meeting made tourist visits to the most popular Antarctic sites subject to comprehensive site-specific guidelines. Australia sponsored and helped design the new guidelines, in line with the Government's policy that Antarctic tourism should be both ecologically sustainable and socially responsible. The new guidelines – for 12 sites in the South Shetland Islands and the Gerlache Strait region – are the latest step in the effort to manage Antarctic tourism to the highest possible standards.

Over 25 000 tourists set foot on Antarctica in 2005-06, but most of their landings took place at just a handful of sites. The new guidelines set high standards of behaviour and sensible controls on the number of visits, to help visitors tread lightly on these sites.

The International Polar Year

Looking ahead, the meeting reviewed plans for a major focus on polar research activities from 2007 to 2009, during the International Polar Year. Treaty Parties issued an Edinburgh Antarctic Declaration on the International Polar Year, to reaffirm their political, logistical and financial commitment to the year and to ongoing cooperation in Antarctica.

There was a sense among delegates that the IPY, which includes studies of human impacts on the Antarctic environment, should endeavour not to extend the human footprint through its own activities. In other words, delegates envisaged the IPY's legacy as knowledge, which will enable the world to understand and value the Antarctic environment, rather than a series of construction projects for new Antarctic facilities.

India will host the next Antarctic Treaty Consultative Meeting in New Delhi, April-May 2007.

STEPHEN POWELL
Antarctic and International Policy, AGAD

HAWKER ISLAND – PROTECTED FOR PETRELS

Hawker Island is now a protected breeding area for southern giant petrels, such as this pair on Heard Island.

A small rocky island below the Antarctic Circle might not be the favoured 'location, location, loction' for most couples, but for southern giant petrels looking to raise a family, it's prime real estate worth protecting.

Hawker Island lies just off the coast of the Vestfold Hills, a rare Antarctic ice-free oasis where Australia's Davis station has operated since 1957. Observations made since the early 1960s have shown that the breeding population of southern giant petrels on the island has decreased – this is consistent with downward trends observed at many breeding colonies elsewhere in the world. Even though Antarctic colonies represent less than 1% of the worldwide breeding population, Antarctic breeding sites are very important for the southern giant petrel, which is considered vulnerable to extinction on a global basis.

Australia has strictly managed access to Hawker Island from Davis station for many years to prevent disturbance, particularly during the breeding season. At the 29th Antarctic Treaty Consultative Meeting in June, Treaty parties agreed with Australia's proposal to formalise these protective arrangements by declaring the island an Antarctic Specially Protected Area.

The designation of Hawker Island as an Antarctic Specially Protected Area completes a suite of protected areas that safeguard the four known southern giant petrel breeding locations in East Antarctica. The management plan for the island provides for long-term protection of this important southern giant petrel nursery, while allowing periodic monitoring that will contribute to the development of conservation strategies for the species, and provide information for comparisons with populations elsewhere.

The next Antarctic Treaty Consultative Meeting in 2007 will discuss the need for greater action to protect these birds throughout the whole Antarctic Treaty area.

EWAN McIVOR
Environmental Policy and Protection, AGAD

New marine mammal research centre for Hobart

A new Australian Centre for Applied Marine Mammal Science will be established at the Australian Government Antarctic Division, to improve the management and conservation of Australia's 40 species of whales and dolphins, 10 species of seals, and the dugong.

The Centre will receive funding of $2.5 million over four years through the Australian Government's $100 million Commonwealth Environment Research Facility (CERF) programme, established in 2004. The Centre will also seek direct funding from marine industry groups such as oil and gas.

The Minister for the Environment and Heritage, Senator Ian Campbell, said the initiative would provide a high profile, internationally competitive research centre that would build on existing research and address gaps in the knowledge relating to marine mammal management and conservation.

'The Centre will also help improve links between the Australian marine mammal research community, the development of strong industry partnerships, and the integration of research and policy,' he said.

'The Centre's work will be especially important as we continue our efforts to convince pro-whaling nations of the benefits of non-lethal scientific research on whales.'

Research will be conducted under six themes, including the effects of noise on marine mammals, methods to estimate population structure and numbers, human-marine mammal interactions and the development of non-lethal study techniques.

The research will be led by Dr Nick Gales and will inform the development and implementation of public management and policy through an improved ability to assess and manage threats, and ensure sustainability of marine mammal populations.

'This will result in an improved capacity to conserve and protect marine mammals, while facilitating science-based processes for the management of activities such as whale watching and trawling,' Dr Gales said.

More information about ACAMMS:
http://www.aad.gov.au/acamms

More information about CERF:
http://www.deh.gov.au/programs/cerf/index.html

The Australian Centre for Applied Marine Mammal Science aims to improve the management and conservation of whales, dolphins, seals and dugongs.

KIERAN LAWTON

LOOKING TO AUSTRALIA'S ANTARCTIC FUTURE

The Antarctic Futures Project will define Australia's role in Antarctica to 2020.

How will Australia be involved in Antarctica in the future? The Australian Government Antarctic Division has embarked on a project to find out.

The Australian Antarctic programme is nearing its 60th year — one of the longest sustained programmes in Antarctica of any nation. The Australian Government Antarctic Division is almost as old. In that time we have seen some momentous changes, both within our organisation (Australian Antarctic Magazine 10), and our external operating environment – including adoption of the Antarctic Treaty and the Madrid Protocol.

2007 heralds an exciting new era for the Australian Antarctic programme. Australia's new intercontinental air link will radically change the way we do business in Antarctica and require us to adapt to new ways of working. The role of Antarctic science in understanding and monitoring global climate change is an increasing focus of our programme. At the same time, a global escalation in the price of oil is raising concerns about whether Antarctic programmes can be sustained at their current levels. In the long history of Australia in the Antarctic, these are landmark events. But what happens next?

To find out, the Australian Government Antarctic Division has embarked on an Antarctic Futures Project that will articulate top level objectives for Australia's engagement in Antarctica to 2020. The project will look beyond the Division's current scientific and operational planning; beyond the introduction and consolidation of the air transport system; beyond the life of the Antarctic Climate and Ecosystems Cooperative Research Centre; and beyond the point at which some pundits say that 'peak oil' will have materialised.

But how can we plan ahead when there are so many uncertainties? While we will aim to define a preferred Australian Antarctic future, we have to recognise and account for the many factors beyond our control.

We can start with what we do know. For example, we know that the air link will increase our flexibility in planning and allow more people to participate in the Antarctic programme; interest in marine science research and climate change science will continue to grow; and there is increasing interest in and growing opportunities for international collaboration. We also know, in many cases, what people want to do in Antarctica – there is no shortage of proposals for more research projects on land, at sea and in the atmosphere.

The Australian Government Antarctic Division project team is consulting with current and potential future participants in the Antarctic programme. We are seeking the views of a wide range of federal and state government agencies that have an interest in Australia's place in Antarctica, or that may have a future interest – from a policy, science or operational perspective. And we are using previous reviews and analyses, such as the Antarctic Science Advisory Committee's Foresight Report and the 'bold new vision' being developed by Antarctic Division scientists.

When people and organisations provide their 'wish lists' of things to do in Antarctica, a fundamental question we will be asking is, 'why will we want to do this?' The answer will enable us to identify, understand and justify what future activities we should spend our money and effort on.

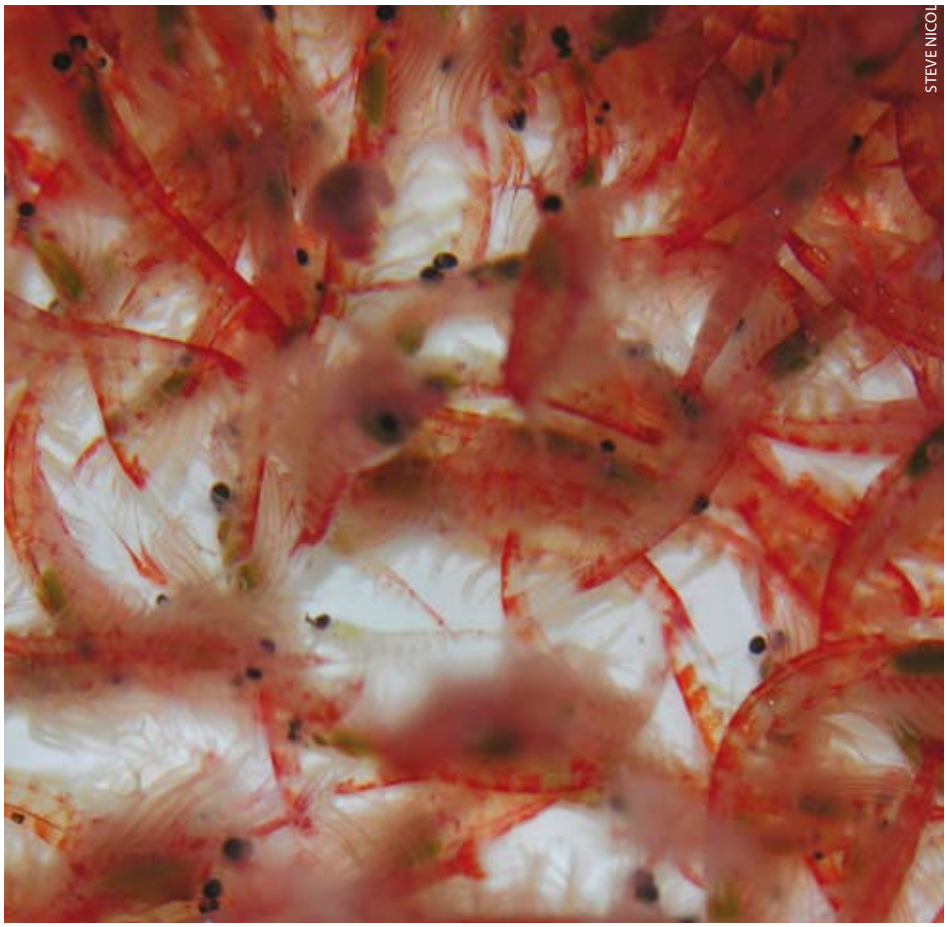
Given that the Australian Government Antarctic Division is the lead agency for advancing Australia's policy, science, environmental and operational interests in Antarctica, the outcomes of the project will also inform the future directions for the organisation. However, this is not an internal Division review. We are looking at Antarctica in terms of the range of national interests to be served. We will embrace the broad Government and Antarctic community aspirations, while accounting for the Division's current responsibility for pursuing the Australian Government's goals in Antarctica and the Southern Ocean.

The project will present an agreed '2020 vision' of Australia's engagement with Antarctica – providing context for short, medium and long term decision-making about Australia's approach to the Antarctic. This will allow for more confident strategic and operational planning within the Australian Antarctic programme and within the Antarctic Division, optimum use of Government resources, and an improved understanding of how our involvement in Antarctica matches with expectations.

Importantly, the project outcomes will help to protect future options – ensuring that the options for future generations will not be constrained by the decisions we make now.

ANDREW JACKSON
Antarctic Futures Project Manager

Twenty-five years of conservation


STEVE NICOL

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) celebrated its 25th annual meeting this year at the Commission's headquarters in Hobart. The Commission was established in 1982 pursuant to the Convention on the Conservation of Antarctic Marine Living Resources. The founding of the Commission represented a seminal move by the Antarctic Treaty System to adopt a conservation and resource management approach to ensure the health of the Southern Ocean ecosystem. The Commission now enjoys an international reputation as a leading regional conservation and fisheries management organisation.

The Convention arose out of increasing concern amongst Antarctic Treaty Parties over the expanding krill fishery. The negotiating Parties were concerned about the effect that krill harvesting might have on an ecosystem reliant on this marine resource and thought that early management intervention might avoid overexploitation.

CCAMLR represents a unique approach to the conservation of Antarctic marine living resources, where conservation includes harvesting, providing it constitutes 'rational use'. It was the first ecosystem-based approach to marine resource conservation and is internationally recognised as a progressive model for fisheries management.

The first phase of CCAMLR involved reactive management, where the Commission responded to the over-exploitation of stocks from earlier unregulated fishing. Over time CCAMLR has adopted a precautionary approach to new fisheries and developed methods for implementing an ecosystem-based approach to managing fishing, including monitoring and assessments. Decisions based on sound scientific research and modelling remains a fundamental tenet of the Commission.

CCAMLR has been a world leader in the development of some significant tools for international conservation and fisheries management, such as the catch documentation scheme for Patagonian toothfish (Dissostichus spp.) and the centralised vessel monitoring system (Australian Antarctic Magazine 7: 32). CCAMLR has been active in reducing the incidental mortality of seabirds, including endangered albatrosses, and also led the way with observation and inspection regimes.

Australia has been a major participant in initiatives developed by CCAMLR to combat illegal, unreported and unregulated (IUU) fishing, particularly in the development of conservation measures, notably the catch documentation scheme, and reducing seabird mortality. The surveillance and enforcement presence in the Southern Ocean has been increasing over recent years. Australia and other nations, such as France, New Zealand, the UK and South Africa, have all increased their monitoring and surveillance efforts, including through bilateral cooperation, in response to the continued threat of IUU fishing in the convention area. Despite the significant advances that CCAMLR has made in reducing IUU fishing, it remains a serious threat.

To maintain its position as a world leader in the conservation and management of marine resources, CCAMLR needs to address the threat posed by non-Party vessels fishing in the convention area, to increase international cooperation for the conservation of high seas marine living resources, and to continue its implementation of sustainable fishing practices.

SUSAN INGRAM
Antarctic and International Policy, AGAD

Australia was influential at the meeting of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) in November, and was successful in getting the Commission's agreement on a number of proposals including:

- stronger measures to combat illegal, unregulated and unreported (IUU) fishing, including to prevent port access by vessels listed by the Commission as having engaged in IUU fishing and to control Convention Parties' nationals from engaging in IUU fishing;
- an interim prohibition on deep sea gillnetting in the CCAMLR Area;
- an improved capacity building programme to encourage non-Contracting Parties to participate in measures to deter IUU activity, including participation in the CCAMLR Catch Documentation Scheme; and
- an intersessional review, led by Australia, of the System of Inspection to see what further improvements might be needed. The system governs the boarding and inspection of Parties' vessels to ensure they are complying with conservation measures.

Another notable achievement for Australian Government Antarctic Division scientists was the acceptance of the results of a major marine survey that assessed krill biomass in the waters off the western section of the Australian Antarctic Territory (page 18).

Other significant decisions by the Commission included:

- the adoption of a conservation measure placing an interim prohibition on fishing for sharks for purposes other than science; and
- general agreement to undertake an assessment of impacts arising from destructive fishing practices prior to the commencement of fishing activities.

LIHINI WERAGODA
Antarctic and International Policy, AGAD

THE INAUGURATION OF LAW-RACOVITA STATION

In the spirit of the Antarctic Treaty, Australia has opened the doors of Law Base – in the Larsemann Hills – to Romania. Along with delegates from China, Russia and Romania, Australian Government Antarctic Division Chief Scientist, Michael Stoddart, helped celebrate the first day of joint occupancy of 'Law-Racovita' station, on 20th February 2006.

Davis Station Leader, John Rich (left), hands the ceremonial key to Law-Racovita station to Romanian colleague Teodor Negoita.

The Australian delegation – Davis Station Leader John Rich, Deputy Station Leader Chris Tickner, physicist Ray Morris, pilot Dave Pullinger, and I – arrived at the Chinese station, Zhongshan, at 10 am local time, to be greeted by Mr Wei Wen Liang, head of Chinese Antarctic logistics and a very senior figure in China's Antarctic programme, and a number of his colleagues.

Joining them was Mr Vladimir Bondarchyk, the Station Leader at Progress II (Russia), and of course Dr Teodor Negoita, our colleague from Romania, resplendent in the largest hat made of wolf fur and wearing the largest grin. Teodor knew the day belonged to him and was unable to hide his joy that Australia had come to visit him and Romania, in his beloved Larsemann Hills.

We started the ceremonies with an official reception by Mr Wei, who commended Australia for helping Romania by making Law Base available for use by their Antarctic programme – an act strongly applauded by all parties at the Antarctic Treaty Consultative Meeting in 2005.

Next we toured Zhongshan with Dr Yang Huigen, head of science at the Chinese Polar Institute. His pride in the Chinese scientific programme swelled as he spoke of the significant infrastructure work that was about to overtake Zhongshan.

Lunch was a magnificent banquet, accompanied by moltai (53% alcohol by volume, aptly described as 'rocket fuel') served, thankfully, in thimbles. Dark Shanghai beer, Australian Coolabah cask red and soft drinks were served in more orthodox vessels.

After lunch we moved to Law by helicopter, Kässbohrer and Lada, to welcome Law-Racovita into the world. The flags of Romania, Australia, China and Russia flew high on the staves to greet us for the first of many photographs. Inside, a table had been set with traditional Romanian fare; smoked sprats, homemade cheeses, lamb and pork salamis and other meats, preserved figs, tomatoes and olives. Two bottles of Chinese red and a bottle of Smirnoff completed the necessities for a successful inauguration.

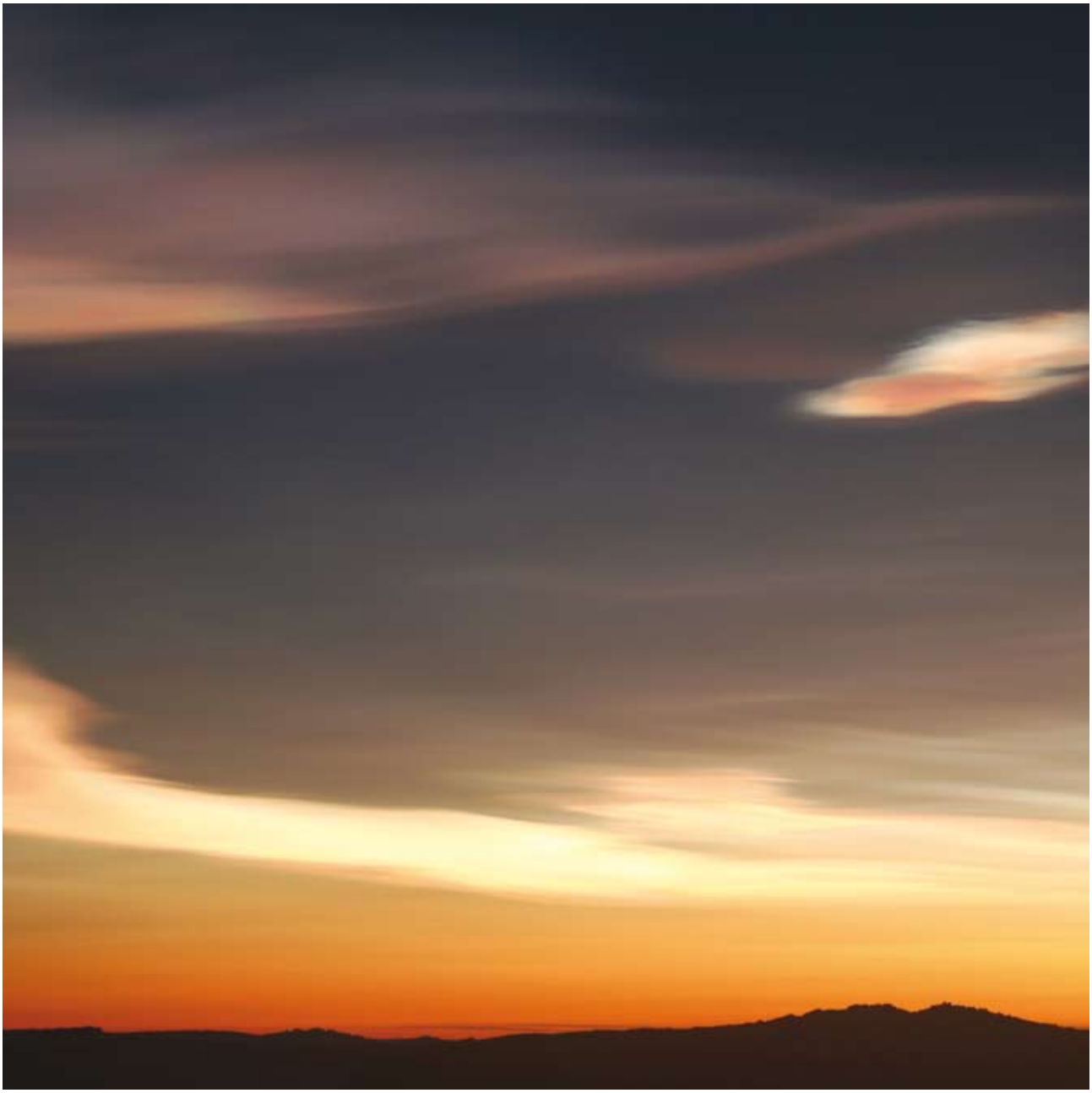
John Rich spoke eloquently on behalf of Australian Government Antarctic Division Director, Tony Press, welcoming Romania to Law-Racovita and wishing them every success for their future scientific endeavours in the Larsemann Hills. Taking from his bag a huge brass key, beautifully crafted in the workshop at Davis by Wayne Scandrett, he presented Teodor with the means for joint occupancy of the station. Amid rousing applause and salutations in four languages ('Nerok!', 'Zazdoraviya!', 'Campei!', 'Cheers!'), Teodor was rendered speechless – a sight to behold.

At some point in the proceedings Vladimir invited us to visit Progress I. Encountering a Chinese traverse party on the iceway at Progress I, Vladimir briskly veered the balloon-tyred Lada off to the left and promptly put the offside wheels into a crack. When the list got to 45 degrees it was clear we were not going to get out other than through the rear door, which Chris and I did with some alacrity. A friendly Chinese Kässbohrer was press-ganged into assistance and in a few minutes we were on our way. The experience failed to inhibit Vladimir's flamboyance at the wheel and when he cheerfully explained that just in front of us there had opened up a four-metre-deep crack, which had recently been filled, more than one heart missed a beat! Turning around at the airstrip a kilometre further on, we returned in the same jocular manner – though avoiding further mishap.

Our arrival back at Law-Racovita triggered another round of toasts and photographs before our procession could depart for Progress II. Here the fare was Russian, with caviar, cheese, sausages, olives and redcurrant jam. To support the jam was bread made from Russian flour and Australian yeast. And another bottle of the best Smirnoff. Again there were toasts to friendship and collaboration between nations in Antarctica, and enthusiastic welcomes to Romania as a new neighbour in the Larsemanns.

By 9pm our stalwart helicopter pilot's flying day was edging towards its close and we had to go our various ways. The day was one to lift the spirits, bringing our diverse community together in a common purpose and in friendship. As Dave started the Squirrel's engine for the run home, we thought of the many toasts he had drunk during the day with only water, tea and coffee to fend off the cold…a true professional. The glaciers and bergs along the way scintillated with mellowing tints of carmine, alizarin, tangerine, amber, heliotrope, lilac and ochre as the sun slid towards the horizon, bringing to an end a rare day which none of us will forget.

MICHAEL STODDART
Chief Scientist, AGAD



These rarely seen nacreous clouds, photographed some 20 km up in the stratosphere over Mawson, only occur at high polar latitudes in winter, at temperatures less than -80°C. The beautiful Mother-of-Pearl-coloured clouds promote chemical changes in the atmosphere that destroy ozone. But the clouds were a special and welcome sight as the end of winter neared, and the sun returned to Antarctic skies.

FREEZE FRAME

Renae Baker is a weather observer for the Australian Bureau of Meteorology. Her most memorable experiences on her first visit to Antarctica include seeing killer whales, emperor penguins, watching the aurora australis light up the sky, and experiencing the subtle, day-to-day changes in the environment.

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