ANTARCTICA, PLANET EARTH LOOKING AFTER THE ANTARCTIC ENVIRONMENT

Australian ANTARCTIC MAGAZINE

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3 AUTUMN 2002

A message from the Parliamentary Secretary

Antarctica is a special place, and so are its surrounding seas. The region's 'other-world' qualities – astounding ice formations, dangerous winds and numbing cold, vast fields of sea-ice, auroral spectaculars and stormy ocean waters – along with the unique and abundant wildlife of the Southern Ocean would be enough to justify this special status.

When we also consider the enormous contribution of the Antarctic to our knowledge of global processes, and its capacity to influence these processes, we have to acknowledge that understanding and protecting the Antarctic is a real imperative for Australia and the world.

I feel honoured to have been asked to take responsibility for Australia's work in the Antarctic. The Australian program in Antarctica, long known for its enterprise, innovation and high-quality science, is now focusing attention on how we protect Antarctica's natural qualities. This, in turn, can provide pointers to managing our global environment.

In addressing such weighty issues, we are finding that our answers come from small things. The signals we get from electronic probes into the atmosphere and ocean, from ice, soil and seawater sampling, from assessing penguin movements and contents of trawl nets, from close study of plant communities under sea ice or on subantarctic outposts, from what happens to our waste in Antarctica - all these and more are the sources of our steadily growing understanding of why Antarctica is so important to us.

To turn our back on the Antarctic is to turn our back on our own future. It's as simple as that.

Sharman Stone

Dr Sharman Stone MP, Parliamentary Secretary responsible for the Antarctic

→ *New Environment Minister p 47*

Protecting Antarctica

JAMES DRAGISIC

Back in 1933, when Australia took responsibility for a territorial claim on some 42 percent of the Antarctic continent, protecting the environment was low on the political agenda and not seen as an important issue by the general public. As the environment assumed a higher social and political profile over the decades, Australia has developed its own agenda for protecting its slice of Antarctica.

Antarctica is not isolated from the rest of the world, and environmental problems that result from activities thousands of kilometres from Antarctica can be felt or measured in Antarctica and its surrounding oceans.

We know that Antarctica plays an enormous role in the global climate system: we are understanding, and now beginning to predict, what natural and human induces changes to global climate will do to Antarctica and consequently, the globe.

The illegal toothfish fishery is a significant human pressure on Antarctic ecosystems and new and emerging fisheries in the Southern Ocean will require the use of the precautionary approach to fisheries management to ensure ecological sustainability. Australia has taken a strong and active role in efforts by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) to combat illegal, unregulated and unreported fishing (IUU).

Activities on the Antarctic continent itself can also become the source of environmental impact. The Australian Antarctic Division is implementing sound environmental practices in all its areas of operations and its human impacts research program focuses scientific effort on the impacts of human activities in Antarctica and on what needs to be done to repair any past damage. For example, we have stopped or changed bad environmental practices of the past, and are using advanced research and technology to clean up disused waste sites.

This edition of *Australian Antarctic Magazine* concentrates on the role Australia plays in managing the environment in Antarctica. No-one wants future generations to find Antarctica ravaged and despoiled. Our presence in Antarctica over many decades, our custodianship of the Australian Antarctic Territory and our role as an active partner in the Antarctic Treaty System provides us with an overwhelming obligation to understand, value and protect Antarctica. To this end, Australia has a well established regulatory framework for all its Antarctic operations and scientific or operational activity must be subject to an environmental impact assessment before it can proceed.

Gill Slocum and Lyn Goldsworthy show us that Australia played a leading role in the creation of the environmental annex to the Antarctic Treaty (the 'Madrid Protocol') which defines the obligations of Antarctic Treaty parties to protect the Antarctic environment. The AAD's Environmental Manager, Tom Maggs, covers the work of the Committee for Environmental Protection (CEP), the Antarctic Treaty forum at which environmental matters are discussed. Tom and Kim Pitt discuss implementation of an environmental policy for Australia's Antarctic program, the cornerstone of an Environmental Management System that will come on line this year and will track all the elements of our EIA and operational compliance. The AAD's legal adviser, Wendy Fletcher, has provided an overview of the legal regime affecting Antarctica and how this is translated into Australian law.

In earlier times one of the methods of dealing with Antarctic waste was to bulldoze it on to sea ice so that it would sink into the sea when the ice melted; spills weren't seen to be important when fuel-oil was being transferred to storage tanks or into vehicles. Today, environmentally sound waste management, prevention of marine pollution and environmentally-safe fuel handling are high on our agenda. We seek to reduce impacts by continuing to improve processes for the job in hand, for managing accidents when they occur, and revising contingency plans – even acting out real-time scenarios for environmental and other emergencies.

Articles by Bruce Hull and Peter Boyer discuss Australia's increasing awareness of Antarctic and subantarctic heritage and the steps we are taking to protect it. Places such as sea bird breeding sites and moss stands, specially protected for their environmental features, are subject to management plans drawn up in consultation with stakeholders, as Ewan McIvor explains. In 2002, for the first time, the Australian Antarctic Territory was included in the Australian State of the Environment report. Lee Belbin provides information about the evaluation process, and how what we might do to provide information for the next five-yearly report.

Much has been achieved in recent years, but we know the task is ongoing. We are working with our providers to reduce the amount of packaging materials that must accompany us to Antarctica. Projects in hand on waste water treatment and wind-powered electricity generation will help shrink our footprint in Antarctica. Our helicopter contractors are working with us to define flight paths to minimise disruption to bird and seal colonies. To eliminate any possible disturbance to elephant seal breeding at Macquarie Island we have changed the time of the 2002 resupply and changeover to March - well after the pupping season.

While the 'Antarctic factor', as usual, had a part in the 2001-2002 field season, we have achieved much in the Australian Antarctic program. Elsewhere in the *Australian Antarctic Magazine* you will find out about the scientific achievements of the season and about the besetment of the *Polar Bird*. The spirit of team-work has overcome adversity, leaving Australia's Antarctic Program in good heart, rugged health and ready for the future!

Dr Tony Press, Director, AAD

GRAHAM ROBERTSON

Antarctic ice and the global climate system

Planet Earth is a natural greenhouse. Some naturally occurring atmospheric trace gases, called greenhouse gases, permit incoming solar radiation to reach the Earth's surface but restrict the outward flow of infrared radiation. Carbon dioxide and water vapour absorb this outgoing infrared energy and re-radiate some of it back to ground level. This greenhouse effect is essential to most life on Earth. Without it the average temperature of the surface would be a frigid minus 18°C, rather than about 14°C as it is today.

But the concentration of greenhouse gases in the atmosphere, especially carbon dioxide, has been increased by human combustion of fossil fuels, exacerbated by deforestation. Since the Industrial Revolution began, carbon dioxide levels have risen from 280 parts per million by volume (ppmv) to 370 ppmv, and are reliably predicted to reach double pre-industrial levels in the second half of this century. Humans have also added other greenhouse gases such as methane, CFCs, and nitrous oxide to the atmosphere. The combined effect of these additional gases will be a rise in global temperatures, predicted by climate models to be 1°C to 4°C, by the end of the 21st century.

Global warming will not be uniform over the earth because of the complex interactions within and between oceans, atmosphere, land surface, clouds, biological systems and ice and snow. Some of the largest changes are predicted to occur at high latitudes. Exposed ocean or bare earth caused by the loss of ice and snow cover through melting will result in increased absorption of solar energy, which in turn will further reduce ice and snow cover leading to an amplified effect – a positive feedback. Against this, however, is an increase in heat fluxes from the ocean to the atmosphere – a negative feedback – caused by a decrease in sea ice.

A central objective of Australia's Antarctic program is to understand the role of Antarctica in the global climate system. This requires us to study Antarctic processes contributing to the climate system, determine the response of the Antarctic to climate change and seek evidence of past and present change in the region. Many important Antarctic climate-related processes involve ice. Ice and snow (the 'cryosphere') are important components of climate, with snow in particular limiting absorption of solar energy at the surface through its high reflectivity ('albedo'). Freezing of water and melting of ice involve latent heat exchange, and snow and ice on land or sea inhibit heat transfer. The water volume stored in ice sheets and glaciers is a major factor in considering sea level change. Ice and snow also provide evidence of past change from the ice core climate record and visual evidence of ongoing change due to melt.

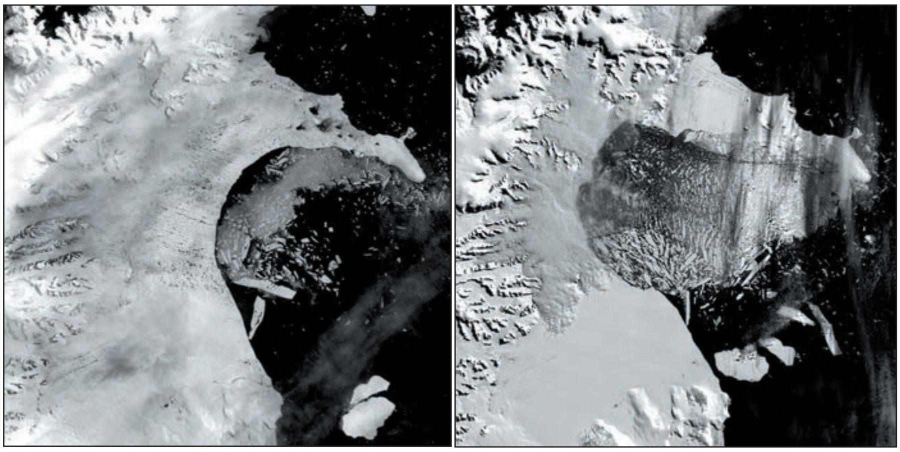
IAN ALLISON

The Battye glacier in the Prince Charles Mountains

All these factors make it important to understand the role of ice and snow in the climate system, a need recognised in the recent establishment of a new international research initiative, Climate and Cryosphere within the World Climate Research Programme. The Australian Antarctic glaciology program contributes to this program with cryosphere studies taking in Antarctic sea ice, the continental ice sheet including ice core climate records, subantarctic glaciers and abrupt change.

Sea ice

The extent of Southern Hemisphere sea ice (frozen sea) varies seasonally by a factor of five, from a minimum of 3-4 million km^2 in February to a maximum of 17-20 million km^2 in September. When the ice forms it ejects salt to the ocean, destabilising the water column and deepening the surface mixed layer. It can also influence formation of the global oceans' deep and bottom water and help drive overturning ocean circulation. Sea ice moved by wind and currents, as it melts, deposits freshwater onto the ocean surface to stabilise the water column. Sea ice has a dramatic effect on the physical characteristics of the ocean surface, modifying surface radiation balance due to its high albedo and influencing the exchange of momentum, heat, and matter between atmosphere and ocean. Through these effects, sea ice plays a key role in the global heat balance. A retreat of sea ice associated with climate warming could have global consequences through various feedback processes.



Imagery from the MODIS (Moderate Resolution Imaging Spectroradiometer) instrument on the NASA Terra satellite show the rapid disintegration of the Larsen B ice shelf early in 2002. The ice shelf had started to break-up by February 17 (left), and by March 5 (right) was completely fractured. Images prepared by Dr Ted Scambos, National Snow and Ice Data Center, Boulder, Colorado.

The Antarctic ice sheet

Antarctica's ice sheet covers 12.4 million km^2. It comprises 25.7 million km^3 of ice or 70 percent of the world's freshwater, which if melted would raise the sea level by nearly 65 m. Mass is continually added to the ice sheet from snowfall, and removed via melt and iceberg calving, particularly from ice shelves. Any change in the ice sheet's 'mass budget' caused by imbalance between these mass input and output terms affects sea level. However, with present Antarctic data a 20 percent imbalance, corresponding to about 10 cm of sea-level change per century, cannot be detected with confidence. The ice sheet is not a single dynamic entity, but comprises different drainage systems with both surface mass balance and dynamics responding differently to changing conditions. We need to be able to estimate the sensitivity of the mass budget to climate change before we can estimate Antarctica's future contribution to sea level change.

Most of the ice lost from the ice sheet comes from fast-flowing, wet-based outlet glaciers and ice streams, much of which passes through floating ice shelves. Up to 40 percent of the Antarctic coastline is composed of either large ice shelves in coastal embayments such as Filchner-Ronne, Ross and Amery or fringing shelves on the periphery of the ice sheet such as the West, Shackleton and Larsen shelves. Since ice shelves are floating on ocean waters at the freezing point, even a small change in ocean temperature (induced perhaps by changed ocean currents) can significantly affect the shelves' basal melt rate and cause them to thin much more quickly than rising air temperature. Ice shelves are already floating, which means their disintegration will by itself have no measurable impact on global sea level, but their depletion may lead to increased drainage of grounded ice 'buttressed' by the shelves which may cause sea-level rises.

Ice core records of past climate

Antarctica's ice sheet stores the Earth's longest and most representative record of atmospheric composition and temperature in times past. The ice sheet's layers of ice and snow, accumulated over tens or even hundreds of thousands of years, form a natural archive of global environmental information, accessible by drilling into the ice to sample past surface deposits. Analyses of the ice and the material trapped in it allow records to be made of both natural and man-made environmental variations over the time period during which the ice sheet has accumulated. Deep ice cores have yielded evidence of major interrelated climate and cryosphere fluctuations in glacial-interglacial cycles. Accurate information on local, regional and global climate change and potential changes in ice sheet surface elevation are available from ice cores.

Subantarctic glaciers

Like mountain glaciers in most parts of the world, subantarctic glaciers have been noticeably retreating over the past 50 years or more. Retreat of non-polar glaciers has contributed to sea level rise over the past century while also providing clear evidence of a changing climate. On Heard Island, for example, the Brown Glacier has decreased in area by 33 percent and in volume by 38 percent over the past 50 years.

Abrupt change

Palaeoclimate records from ice and ocean sediment cores show evidence of abrupt and widespread past climate changes – particularly, it seems, during periods of transition from one climate regime to another over glacial-interglacial cycles. While the causes and mechanisms of such rapid changes are by no means clear, a variety of roles have been suggested for ice sheets, glaciers and sea ice. These include effects of rapid glacial discharge and decomposition with a rise to melting point of basal ice temperature, massive iceberg discharge into the ocean delivering freshwater capable of modifying the overturning circulation of the global ocean, and changing sea ice formation causing change in brine release to the ocean. Greenhouse warming and other human alterations of the climate system may increase the possibility of large and abrupt regional or global climatic events.

A startling illustration of how abrupt some processes are is the recent rapid collapse of the Larsen B Ice Shelf on the eastern side of the Antarctic Peninsula in February and March 2002, when 3250 km^2 of ice 200 m thick disintegrated over a few weeks (see satellite image). The break-up of this shelf into thousands of small icebergs is totally different from the normal episodic calving of giant icebergs from the front of ice shelves. Temperatures around the Antarctic Peninsula have risen by 2.5°C over the past 50 years. It is hypothesised that water from large surface melt ponds that formed on the ice shelf as a result of this warming forced open cracks and crevasses to completely fracture the shelf. The ice of the shelf was already floating, so the collapse has no measurable effect on sea level, and direct impacts are believed to be mostly local. However, a similar collapse of some other shelves could bring a significant increase in glacial discharge from the ice sheet.

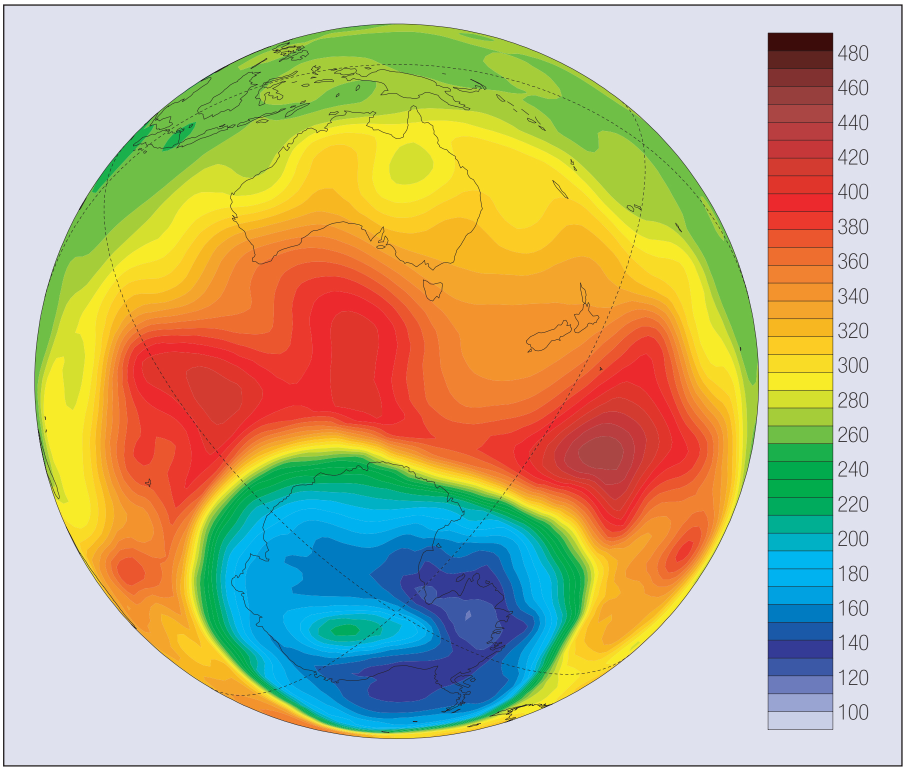
Ian Allison, Glaciology Program Leader, AAD

What happened to our ozone?

Most atmospheric ozone occurs in the lower stratosphere, between 15 and 30 km above Earth's surface, where it absorbs harmful ultraviolet radiation from the sun. The loss of two-thirds of the ozone above Antarctica is mainly a result of human-made gases being released into the atmosphere, including chlorofluorocarbons or CFCs (containing chlorine) and halons (containing bromine). These gases are chemically inert and don't dissolve in water, which means they resist removal in the lower atmosphere and can eventually migrate to the stratosphere.

During winter above Antarctica, a polar vortex forms in the stratosphere in which temperatures drop as low as minus 85°C. Ice clouds forming in this vortex provide an environment for these human-made gases to convert to compounds able to destroy ozone. The destruction begins and rapidly accelerates with returning sunlight in spring, reaching a maximum in early October and slowly declining as the ice clouds disappear, returning to normal by the end of December.

First detected in the early 1980s by British Antarctic scientists, depletion of stratospheric ozone has been happening for at least two decades. Globally averaged losses have been about five percent since the mid-1960s, with cumulative losses of about 10 percent in the austral winter and spring and five percent in the summer and autumn over locations such as Europe, North America, and Australia. Since the early 1990s Antarctic ozone holes have covered about 25 million square kilometers – about three times Australia's area.



The Antarctic ozone hole in early spring can be seen here as the predominantly blue area over Antarctica. The scale on the right shows the amount of total column ozone in Dobson Units. Information interpolated by Bureau of Meteorology (Australia) from NOAA/NESDIS data.

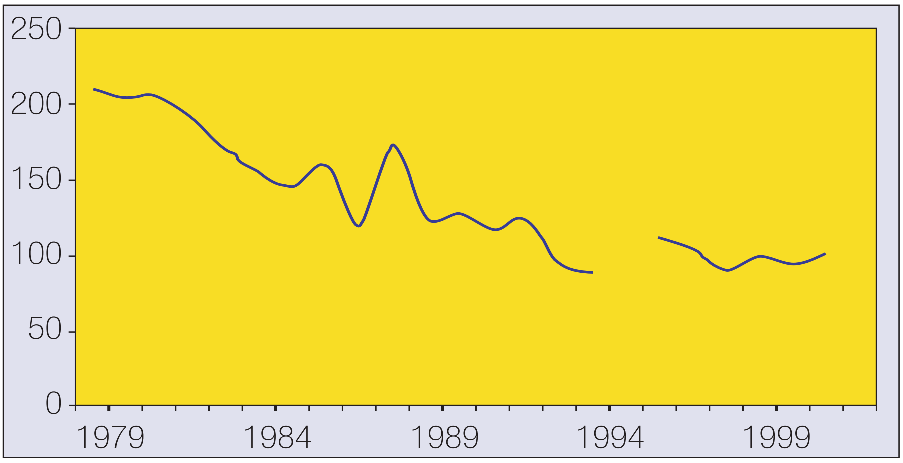
The Antarctic ozone hole has no direct northern hemisphere counterpart. The Arctic is warmer than the Antarctic because it is essentially oceanic, lacking the cold, stable continental conditions in which a circumpolar vortex can develop. With fewer ice clouds forming, ozone depletion is much less than in the Antarctic.

About two percent of sunlight is high-energy ultraviolet radiation, some of which (ultraviolet B) causes damage to living things, including sunburn, skin cancer, and eye damage. When skies are clear, decreased atmospheric ozone will mean higher ground-level ultraviolet radiation. Large increases in ultraviolet B have been observed in Antarctica during spring.

Stratospheric ozone losses have caused cooling of the lower stratosphere around the globe, resulting in less infrared radiation reaching the surface and lower atmosphere. Extrapolations based on observed ozone trends indicate that stratospheric ozone losses since 1980 may have offset about 30 percent of atmospheric warming due to greenhouse gases.

Future global ozone depletion would probably have been much greater without reduced human emissions of ozone-depleting gases. Worldwide compliance with current international agreements is rapidly reducing the yearly emissions of these compounds. The total amount of ozone-depleting compounds in the lower atmosphere peaked about 1994 and is now slowly declining. This trend will allow the ozone layer to recover, but the process will take decades because of the long times required for CFCs to be removed from the atmosphere.

Art Downey, Australian Bureau of Meteorology



The minimum values of total ozone recorded over the Antarctic since the early 1990s have been around 100 Dobson Units (DU), of which about half is in the upper stratosphere. This graph shows values observed by satellite each year since 1979.

Resource exploitation in the Antarctic region

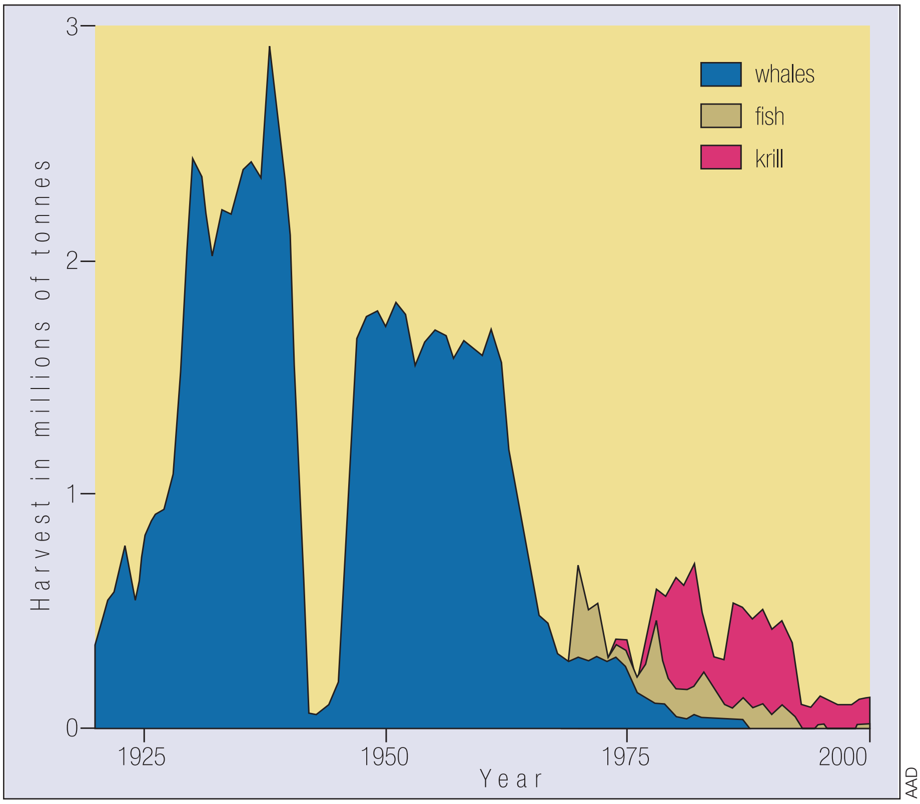
Virtually as soon as ships entered far southern waters, humans have been seeking to exploit the region's food resources. Exploitation has at times been so heavy that it may have irreversibly changed whole elements of the region's ecosystems.

During the heyday of seal hunting from 1791 to 1822, whole island populations of fur and elephant seals were eradicated. The removal of such large numbers of these higher order predators of fish, squid and krill must have had a substantial effect on the marine ecosystem, but the extent of this can only be guessed at because of the lack of any systematic studies of the region before and after the period of exploitation.

Between 1904 and 1986, commercial whaling occurred on an even larger scale, resulting in further significant modification to Southern Ocean marine ecosystems. Attempts were made to study the effects of whaling on the Southern Ocean, most notably by the British *Discovery* expeditions, but a definitive appraisal has proved elusive. Before the large baleen whales became the chief targets of Antarctic whaling, they consumed an estimated 190 million tonnes of krill each summer. The loss of 1.5 million great whales from the Southern Ocean is estimated to have reduced the species' krill consumption to 40 million tonnes. The difference between these figures, 150 million tonnes, became known as the 'krill surplus' and fuelled one of the next waves of exploitation.

Krill fishing began in the 1970s. Catches reached 0.5 million tonnes a year in the mid 1980s, but the demise of the largest fishing nation, the USSR, along with marketing and processing problems, led to a subsequent decline. The annual catch has recently stabilised at around 100,000 tonnes a year, but there is still much discussion about the fishery's potential to reach its theoretically sustainable level of around five million tonnes a year.

Fish, too, have not escaped exploitation. Stock levels of icefish and Antarctic cod have never recovered from heavy fishing in the 1970s and 1980s. Current Southern Ocean fish catch levels are a comparatively low 20,000 tonnes or less a year. High value species such as Patagonian toothfish, however, attract illegal fishing vessels which are thought to have depleted stocks around some subantarctic islands. Their incidental longline bycatch has also had a devastating effect on the region's seabirds.



Harvesting of Antarctic marine living resources in the 20th century. What will be the next wave of exploitation?

Exploitation of the Southern Ocean's marine-based species has thus had a major effect on ecosystems through the reduction in size of the populations of the targeted species, the indirect effects of harvesting such as bycatch, and the removal of so many predators from the ecosystems. Commercial harvesting has been the greatest documented human effect on the Antarctic, but this also serves as one of the few regionally-based controls on ecological change.

Southern Ocean fisheries are managed by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) which sets catch limits on target species. Unlike most fisheries management bodies, CCAMLR has adopted an ecosystem approach to managing the resources of the region. Catch limits are set in a precautionary framework that takes into account not only the long term yield of the harvested population but also the needs of dependent and related species. CCAMLR has taken 20 years coming to grips with this complex process (see *Australian Antarctic Magazine* #1, p. 57).

Management of an ecosystem or a series of interrelated ecosystems has to take account natural changes as well as human induced processes such as climate change and local changes such as harvesting. It also has to acknowledge that the ability to manage the system on a regional scale is limited largely to the harvesting controls that can be applied at various trophic levels.

When the CCAMLR agreement was negotiated, in the aftermath of overexploitation of the great whales, a particular concern was that the harvesting of krill should not impede the recovery of whale numbers. With current changes in the Southern Ocean, it may not be sufficient merely to place controls on krill harvesting. Simplistic solutions to problems developed in isolation may exacerbate existing problems.

The uncontrolled harvesting of the last 200 years indicate that caution is required when intervening in ecosystem processes. Comprehensive Southern Ocean ecosystem management will require a far deeper knowledge of ecological links and the consequences of management actions at different levels in the food chain. CCAMLR is progressing towards the construction of predictive ecosystem models which will allow the simulation of perturbations and such an approach will eventually replace the hit and miss management procedures of the past.

Stephen Nicol, Antarctic Marine Living Resources Program Leader, AAD

Whaling: unfinished business

JAMES SHEVLIN

The Basques of Spain were hunting whales 1000 years ago, but as recently as a century ago the Southern Ocean's great whales were relatively undisturbed. Until then, the slower right, humpback and sperm whales sustained the industry. Herman Melville, creator of Moby Dick, wrote in the mid-1800s that 'there is no means to catch the fin whale, or its fast cousins' – the fin, blue, sei and Brydes whales outpaced their slow pursuers. Modern shipping changed everything. Now the largest and fastest of the whales could be hunted, and with the advent of factory ships in the mid-1920s, whales could be slaughtered and processed in vast numbers. In the space of a few short decades whale populations were seriously depleted.

Whaling activities were suspended during the Second World War but this short period was not enough to allow whale populations to recover to sustainable levels. In order to promote the establishment of a system of international regulation for whaling to ensure the proper and effective conservation and development of whale stocks, a new convention was developed to succeed the International Agreement for the Regulation of Whaling (1937) – namely the International Convention for the Regulation of Whaling (1946).

This convention established the International Whaling Commission (IWC) which had as one of its main tasks the regulation of the number of whales taken and of setting annual quotas for a sustainable level of exploitation. The system failed, barely reducing the numbers of whales killed from prewar years. An alarming drop in whale catches by the 1960s caused the IWC to begin to take relatively drastic conservation measures by establishing full protection for the blue whale and reduced quotas for fin and sei.

The current era of whale protection reached its heights in 1986 when the IWC, to allow whale stocks to recover, set a zero catch quota for both pelagic and coastal whaling while it developed a better quota-setting method for when stocks had recovered sufficiently for hunting to resume. This became known as the 'moratorium' on commercial whaling. A small number of countries lodged objections to the moratorium, (Japan, Norway and the Soviet Union), but Japan later removed its objection. Norway continued commercial whaling and after a short period Japan turned its whaling efforts to so-called 'scientific' whaling.

In 1994, the IWC's scientific committee developed a revised management procedure (RMP) which uses a computer model to set allowable commercial catches. This model has not been implemented as the IWC decided that it alone would not be sufficient to regulate whaling and agreed to develop a 'Revised Management Scheme' to put in place management arrangements such as international observer schemes and DNA registers. While the moratorium on whaling remains in place to this day, since 1994 Norway, which formally objected to the moratorium, has been implementing the RMP model to set its own quotas for a commercial take of minke whales in the North Atlantic. Japan has continued to conduct 'scientific' whaling, and takes up to 400 minke whales each year from the Southern Ocean, as well as minke, Brydes and sperm whales from the North Pacific. These whales are sold for domestic consumption in Japan and yield about $80 million in revenue, which, along with Japanese government support, is used to fund their whaling operations.

The Australian Government has a strong policy that there should be a permanent and global end to whaling and in this context, argues that the life history of whales can effectively be studied without killing them.

Humpbacks and southern right whales are starting to recover from their exploitation and are now common visitors to Australian coastal waters during their northern migrations. A rapidly-expanding new industry involves an estimated nine million people in 87 countries spending more than $2 billion for the privilege of watching these animals. The blue whale, the largest creature that ever lived, remains highly endangered, and only time will tell if there were sufficient left after whaling for their numbers to recover. The debate about commercial whaling continues in the IWC.

Nick Gales, Antarctic Marine Living Resources Program, AAD

More than just having a good idea

Science programs have been integral to the Australian Antarctic program throughout its long history: we are in Antarctica and the subantarctic to do science. We do this within the structure provided by the Australian Government's goals of maintaining the Antarctic Treaty System and enhancing Australia's influence within it, protecting the Antarctic environment, understanding the role of Antarctica in the global climate system, and undertaking work of practical, economic and national significance.

Each area of Australian Antarctic research – Antarctic marine living resources, atmospheric and space research, astronomy, biology, geosciences, glaciology, human biology and medicine, human impacts, and oceanography – has a strategic plan with clearly defined milestones toward achieving the Government goals. All proponents of an Antarctic research project must show how their objectives contribute to achieving strategic milestones and give evidence of the project's scientific merit, institutional support, and investigator's capacity to undertake the work. The proposals are first reviewed by international specialists in the field concerned. They are then assessed by the Antarctic Research Assessment Committee, composed of eminent scientists not directly involved in Antarctic work, the Antarctic program leaders and the AAD Chief Scientist, and chaired by an independent scientist.

Approved programs involving fieldwork are then tested against environmental standards.

- All activities conducted south of 60°S require an environmental impact assessment and must comply with Australian legislation, notably the Antarctic Treaty (Environment Protection) Act (ATEP) and the Environment Protection and Biodiversity Conservation Act (EPBC). Under ATEP any flora and fauna collecting or disturbance of animals may only be done under a permit. Any research on seals south of 60°S also requires a permit.
- Entry into and activities in places designated as specially-protected or specially-managed areas require a permit under ATEP.
- A permit is needed for all harvesting and research on any marine organisms, even including bacteria and other microbes, in the area covered by the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), which takes in the Southern Ocean south of the Polar Front – including Heard Island but not Macquarie Island which is north of the Front.
- A permit is required to enter and undertake any scientific activity within the Territory of Heard and McDonald Islands, which includes the 12 nautical mile territorial sea.
- Macquarie Island, part of the State of Tasmania, is a State Reserve under the Tasmanian National Parks and Wildlife Act, requiring a Tasmanian permit for entry, undertaking research, collecting samples and other activities on the Island.
- Projects involving work on fish, birds or mammals must satisfy national guidelines for ethical experimentation on animals. All such projects must be approved by the Antarctic Animal Ethics Committee, an independent group appointed by the Minister for the Environment and Heritage. Following the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes, the group comprises a person with substantial recent experience in animal experimentation, a veterinarian, a person with experience in animal welfare, an independent member of the wider community, the Chief Scientist, and a Tasmanian Government representative. The Tasmanian Government has recently required that Macquarie Island wildlife research proposals be subjected to public comment as part of the State's approval process.

All research undertaken in Antarctica is of high quality and done for a purpose, but it must also be rigorously tested against environmental and ethical standards, as befits all human activities in such a special part of the planet.

Harvey Marchant, Biology Program Leader, AAD

Building knowledge to reduce human impacts

Australia's commitment to Antarctic environmental protection was illustrated by its leading role in securing international agreement that the Antarctic environment was worthy of comprehensive protection. A basic principle of the Madrid Protocol is that Antarctic activities should be planned on the basis of '…*information sufficient to allow prior assessments of, and informed judgements about, their possible impacts on the Antarctic environment***…'**

Antarctica's physical environment is very different from that of Australia, precluding the use there of unmodified Australian environmental guidelines and management procedures. AAD human impacts research seeks to build up enough information about Antarctic conditions for sound environmental decision-making using appropriate procedures.


JAMES DRAGISIC

Obvious human impacts on the Antarctic environment include the unsightly waste disposal dumps created during an earlier era when environmental protection was not a priority, and the Human Impacts Program is helping to develop the right procedures for clean-up, remediation and monitoring of these sites. Other less obvious impacts could have serious consequences. For example, increasing numbers of people – both with national programs and in private groups – are wanting to experience the unique wildlife close up. Can disturbance by visitors be harmful, and how close is close enough? The human impacts program is studying the response of wildlife to visitors as the basis for guidelines on approach distances.

Elsewhere in the world people have carried alien species and disease from place to place. Such biological impacts are particularly menacing because of the ability of organisms to reproduce themselves, spreading from small beginnings to the point where they cannot be controlled. The potential consequences of such introductions to Antarctica have ensured that further study of the dangers has a high priority in the human impacts research program.

Martin Riddle, Human Impacts Research Program Leader, AAD

Stop press: Aliens invade Antarctica!

The word 'alien' conjures up images of little green figures in spaceships, but it is also applicable to animals, plants and microbes that have been introduced by humans to a place where they don't belong. Wherever humans have travelled they have not travelled alone.

Invasion biology in Antarctic regions including subantarctic islands has historically focused on the direct impacts of the bigger aliens, such as cats, rabbits and rats on Macquarie Island. However, recent research of less obvious introductions of plants and invertebrates has shown that these organisms too can expand rapidly and considerably alter population and ecosystem processes. For example, a European grass, *Agrostis stolonifera*, has dramatically invaded drainage ecosystems on Marion Island over 50 years, excluding native plants and significantly decreasing biodiversity at invaded sites. On South Georgia an alien carnivorous beetle has indirectly caused a change in adult body size in populations of its major prey species, another beetle. Beetles that weren't eaten suddenly found that there was a lot more food around and grew larger.

The isolation and harsh environment of Antarctica and the subantarctic islands have resulted in limited floral and faunal environments in which many niches are unfilled. Here, many plant and animal groups found on warmer continents are missing, such as flowering plants in continental Antarctica, ferns and sedges on Heard Island and weevils on Macquarie Island. Species from groups not present in these ecosystems are the greatest invasive threat, as they can fill in the gaps. Antarctica's harsh climate and ice cover protect against alien colonisation, but on milder subantarctic islands – getting warmer in recent decades – there are increasingly favourable conditions for alien species to colonise and spread.

Recently, South Africa's Professor Steven Chown and colleagues provided statistical evidence for the strong relationship between the number of alien species on subantarctic islands and the number of human visitors over the last 200 years or so. Increasing world travel, including the recent development of Antarctic ecotourism, has dramatically increased the invasion threat to both subantarctic islands and Antarctica itself. For instance, Antarctic visitors have often recently travelled to the Arctic, whose animals, plants and microbes are biologically adapted to cold climates and could successfully establish in Antarctic environments, which previously would have been beyond their reach. Antarctic travellers are now potential carriers of propagules, such as seeds, egg cases and spores of these species, to Antarctic ecosystems.

Dana Bergstrom AAD, and Jennie Whinam, Tasmanian Department of Primary Industries, Water and Environment

Collecting the data

Theoretically identifying potential threats to Antarctica is one thing, but hard data is what's needed. We aim to identify the main threats of alien invasions to the Antarctic regions. We have been climbing over cargo, crawling through stores and wharves and combing and vacuuming expeditioners' clothing and personal effects. We also asked embarking tourists and Australian expedition members where they had travelled in the previous six months before travelling south. The long list included Iceland, Greenland, Norway, Spitzbergen, Sweden, and South American mountains.

Last year we found live spiders, snails and European wasps, seeds, fruits, eucalyptus leaves and a piece of blackberry stem in Macquarie Island cargo. Peoples' clothing and effects contained grass seeds in equipment boxes and tool kits, and plant and soil debris in packs, pockets and a flute case! We found a sprig of moss on an expeditioner's favourite beanie.


DANA BERGSTROM

Removing spiders from cargo, March 2002.

Stopping the aliens: what are we doing about it?

The Australian Antarctic Division has implemented two major changes in the way cargo is processed. Firstly the cargo store has been moved from the AAD's headquarters in rural Kingston to Macquarie Wharves in Hobart, where cargo is loaded on to southbound ships. This is a far more sterile environment than the Kingston store, where nearby flora includes 16 species we see as having a high potential to invade Macquarie Island and Heard Island.

Secondly, AAD store staff have adopted strategies to minimise contamination when handling cargo, including trials of a new food treatment process in which fresh fruit and vegetables are enclosed in a container with an 'ozone generator'. Results are very promising for both quarantine measures and food quality. Food including strawberries, cucumbers and lettuces – all difficult to store conventionally – was in excellent condition after 21 days. The absence of 'bad' patches on fruit and vegetables limits the potential for larvae or eggs to develop, and removal of oxygen from the container means that any insects that may have been accidentally packed are unlikely to survive.

These changes have had a substantial positive effect on reducing the risk of alien introductions to our Antarctic locations through ANARE cargo operations.


PATRICIA SELKIRK

Boots are scrubbed to remove plant material and soil before going ashore on Macquarie Island

10 years on – why is the Protocol important?

JAMES DRAGISIC

It is just over 10 years since the Antarctic Treaty parties signed the Protocol on Environmental Protection to the Antarctic Treaty in Madrid. At the time it was heralded as historic – a remarkable about-turn in thinking to establish comprehensive, legally binding measures to protect the Antarctic environment. Every new activity in Antarctica became subject to prior impact assessment. Strict rules were put in place to look after plants and wildlife. Australia undertook to better manage its wastes and to protect the sea from pollution.

The political significance of the change was encapsulated in Article 7 which prohibited mining. No-one was looking to exploit Antarctic minerals at the time, but this was a statement about attitudes to the Antarctic, that mining would not be part of its future. Thus was resolved a critical, long-standing Antarctic resource issue.

The Protocol was also a sign of a shift from a resource view of Antarctica to an environmental view. Antarctica got a new label – a natural reserve devoted to peace and science – a symbolic and effective link between key principles of the Treaty and the new direction for the continent. Globally, the Protocol was a landmark agreement – the first to cover an entire continent. On the ground in Antarctica it has had a remarkable effect. It remains an inspiration to those planning Antarctic activities.

The new environmental emphasis radically increased the amount of new Treaty business, leading to a doubling of the frequency of meetings and enlarged agendas, thanks largely to the new Committee for Environmental Protection (established 1998). There is also a higher degree of external accountability for actions in Antarctica and adherence to decisions made in the meetings. Environment related measures are still being developed under the framework of the Protocol, a demonstration that Parties remain committed to its environmental principles.

The Protocol didn't just prohibit mining. In designating the Antarctic as a natural reserve, it established environmental principles governing the conduct

When can we go mining in Antarctica?

We often hear that mining has been banned in Antarctica for 50 years. This is not true. The Protocol's prohibition on minerals resource activities is not limited in time. Further, there are strict rules for modifying the mining prohibition. Simply put, it cannot be modified before the passage of 50 years with anything less than consensus of all the Treaty's consultative parties. After that time a review conference could be called, and it could decide to lift the mining prohibition. But two conditions would have to be satisfied — at least ¾ of the consultative parties must agree (including all of the consultative parties when the Protocol was adopted) *and* a binding legal regime on mining would have to be in force. As there is no obligation to call a review conference it could be a very very long time until mining can be contemplated in Antarctica!

of all activities, subjected all activities to prior environmental impact assessment and then to regular and effective monitoring, provided for the Committee for Environmental Protection, required national programs to develop contingency plans for environmental emergencies, and provided for rules governing liability for environmental damage.

Under the Protocol, the intrinsic value of the Antarctic and the protection of its environment and ecosystems must be fundamental considerations in planning and conducting all activities in Antarctica. All such activities must limit adverse impacts on the Antarctic environment. They must avoid adverse effects on climate, air or water quality, or on the distribution or abundance of wildlife; they must not jeopardise endangered or threatened species; and they must avoid substantial risk to areas of biological, scientific, historic, aesthetic or wilderness significance. And they must give priority to preserving the value of Antarctica for scientific research.

The Protocol's Annexes detail specific measures. *Annex I* deals with one of the Protocol's most important requirements – for prior impact assessment of all new or significantly changed activities. People planning work in Antarctica must now think about how it can be done in the most environmentally friendly manner. For major activities, a Comprehensive Environmental Evaluation must be prepared and opportunity provided for the Committee for Environmental Protection and Consultative Parties to comment on the proposal.

Annex II provides measures for the conservation of Antarctic flora and fauna, including measures to deal with non-indigenous organisms.

Measures for managing and disposing of waste are provided for in *Annex III*, which prescribes disposal practices for each type of waste generated in Antarctica. It requires people to think about how they are going to minimise and store waste, along with development and circulation of waste management plans for all stations, field sites and ships. It specifies the wastes that must be removed from Antarctica, such as radioactive material and electrical batteries, and requires the cleanup of past waste disposal sites and abandoned facilities, where removal does not increase the impact.

An important aspect of *Annex IV* on preventing marine pollution is the need for marine pollution contingency plans for each ship and station. The Annex regulates discharge of substances from ships, including oily mixtures, garbage and ship-generated sewage. Disposal at sea of any plastics is prohibited. The Annex's prescriptions are broadly consistent with related provisions under the International Convention for the Prevention of Pollution from Ships (MARPOL).

Annex V on area protection and management establishes a scheme for protecting and managing sites of special value. Previous categories of protected areas are integrated into Antarctic Specially Protected Areas (entry to which requires a permit) and Antarctic Specially Managed Areas. Management plans apply to both categories. The protected area system also provides for the designation of historic sites and monuments, which must not be damaged or removed.

The Protocol has been the stimulus for a highly-productive CEP. It continues to form a large component of the agenda for Antarctic Treaty Consultative Meetings, and has become a fundamental component of Treaty inspections of national activities. Most importantly, it has ensured that when they make decisions about their activities, national programs put protection of the Antarctic environment at the top of their priority list.

Gill Slocum, Antarctic Treaty & Government, AAD

Madrid Protocol: what do the critics say?

As a non-government observer on the Australian delegation negotiating the Madrid Protocol, I went through a nail biting six months in 1991, including three trips to Madrid, leading up to its signing on 4 October 1991. It was worth it. The negotiation of an agreement specifically prohibiting minerals activities was a fantastic achievement.

Environmental groups welcomed it after a decade of opposition to the previously-proposed Minerals Convention, but even at the height of our euphoria we were realistic about what had been agreed. Protocol compliance looked a problem without a more developed inspection system (which we still don't have) or a Secretariat (which we hope we will have soon). Critically, the Protocol did not include the liability regime which we and others saw as the necessary 'teeth' for the new creation. And of course, we were aware that adoption was a long way from ratification.

While welcoming the achievement of Treaty states, particularly of Australia and France which led the drive for a new agreement, the Antarctic and Southern Ocean Coalition knew the Protocol still had to be 'bolted-down', a process which took until 1998. We have also seen the long drawn-out and so far inconclusive process of establishing a liability regime. While we never thought that such a regime would readily follow the commitment to developing it, we have found the slow progress depressing.

More encouraging has been the development of the Committee for Environmental Protection (CEP). It is clearly not been without problems, but the CEP has been blessed with a remarkably able first Chair in Olaf Orheim.

I have been involved in campaigning for protection of our last great continental wilderness for over two decades now. 1991 was a very special year for me, but the vigilance must continue – and it will!

Lyn Goldsworthy, Antarctic and Southern Ocean Coalition

The CEP

Protecting the Antarctic environment is the specific business of the Committee for Environmental Protection (CEP), established by Article 11 of the Madrid Protocol and meeting first in 1998. The CEP advises the Antarctic Treaty Consultative Meeting (ATCM) about matters concerning the Protocol's development and implementation. It is composed of representatives of the Parties which are signatories to the Protocol and includes observers from the Scientific Committee on Antarctic Research (SCAR), the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and other scientific, technical and environmental organisations.

The agenda for annual CEP meetings, generally in the first week of an ATCM, is based on the Protocol structure, with proceedings interpreted in the four Treaty languages (English, Spanish, Russian and French). A significant amount of its specific-issue work is undertaken between meetings by email or at annual meeting workshops.

Antarctic protected areas: layer upon layer

The protection provided to the Antarctic environment by isolation, a harsh climate and the absence of permanent inhabitants is no longer sufficient. Recognising this, the Antarctic Treaty parties have established formal protective arrangements including banning of nuclear, military and mining activity, requirements for environmental impact assessment of all activities and for minimising production and disposal of waste, and protection of all wildlife.

Under such comprehensive protection measures, the entire Antarctic region could be considered a protected area, but Treaty parties have deemed that some areas warrant additional protection due to the values they contain, or the risks of human impacts on these values. Since the early days of the Antarctic Treaty System there has been some form of Antarctic protected area system.

The 1964 *Agreed Measures for the Conservation of Antarctic Flora and Fauna* provided special protection to areas with unique natural ecological systems. These Specially Protected Areas (SPAs) were only to be entered under permit for compelling scientific purposes. Australia manages three SPAs, approved at the fourth Antarctic Treaty Consultative Meeting in 1966 (see box below).

In 1972, Treaty parties agreed to a new category, Sites of Special Scientific Interest (SSSI), to cover any characteristics of exceptional scientific interest. Entry to these sites also requires a permit and compliance with an accompanying management plan. Australia manages three SSSI (see box below).

Annex V to the Madrid Protocol, details a new Antarctic protected area framework intended to combine and strengthen previous arrangements. Antarctic Specially Protected Areas (ASPAs) are to replace SPAs and SSSI, while Antarctic Specially Managed Areas (ASMAs) are designated to facilitate cooperation between nations or to minimise environmental impacts. Places recognised for their cultural heritage value may be designated as ASPAs or ASMAs, or listed as historic sites and monuments as appropriate. Annex V is expected to enter into force soon, and the Treaty parties have agreed to implement its measures in the interim.

ATS-recognised protected areas managed by Australia

Specially Protected Areas (SPAs)


GRAHAM ROBERTSON

SPA 1: Taylor Rookery, Mac.Robertson Land (~0.4 km²) – The Taylor Rookery emperor penguin colony is among the few, and probably the largest, of the known colonies of this species located entirely on land.


WAYNE PAPPS

SPA 2: Rookery Islands, Holme Bay, Mac.Robertson Land (~30 km ²) – The 75 small islands of the Rookery group exhibit an unusual association of all six bird species resident in the Mawson station area. Of these, the southern giant petrel and the cape petrel occur nowhere else in the region.


ERIC WOEHLER

SPA 3: Ardery Island and Odbert Island, Budd Coast (~1.9 km²) – These two islands are an example of the habitat of several breeding species of petrel, two of which, the Antarctic petrel and Antarctic fulmar, are of particular scientific interest.

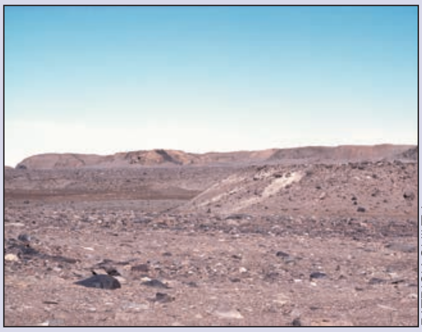
Sites of Special Scientific Interest (SSSI)


JANE WASLEY

SSSI 16: North-eastern Bailey Peninsula, Budd Coast, Wilkes Land (~0.5 km²) – Bailey Peninsula, an irregular area of rock exposed during summer, contains contrasting habitats and water bodies with rich lichen and moss communities and an important stand of liverwort. Proximity to nearby Casey station increases potential for disturbance of study areas.


ERIC WOEHLER

SSSI 17: Clark Peninsula, Budd Coast, Wilkes Land (~12.1 km²) – Clark Peninsula supports moss and lichen communities and penguin colonies used as control sites to monitor the environmental impact of Casey station.


PATRICK QUILTY

SSSI 25: Marine Plain, Mule Peninsula, Vestfold Hills, Princess Elizabeth Land (~23.4 km²) – The vertebrate fossil fauna of Marine Plain includes a new species, genus, and probably family of fossil dolphin. Burton Lake, within the site, represents a unique stage in the biological and physio-chemical evolution of a terrestrial water body from the marine environment.

The Committee for Environmental Protection has developed guidelines to help national operators assess the protection needs of special areas, and to ensure that consistent and effective management plans are developed. These guidelines are available at the CEP website at <http://www.npolar.no/cep>. Draft management plans are tabled at CEP meetings for discussion and possible modification prior to being passed to the full Antarctic Treaty Consultative Meeting for adoption. Areas currently being considered by Australia for proposal as new protected areas include Cape Denison at Commonwealth Bay, where Douglas Mawson established a base in 1911, and the Frazier Islands near Casey, home to an important colony of southern giant petrels. Australia is also cooperating with China and Russia to develop an ASMA in the Larsemann Hills, an ice-free area that supports facilities of the three nations.

The Australian Antarctic Division also administers the World Heritage listed Territory of Heard Island and McDonald Islands, in accordance with the Heard Island Wilderness Reserve Management Plan.

Managing, restricting or prohibiting human access to places in the Antarctic and subantarctic are in some cases the only means of ensuring sufficient environmental protection. While this could be considered 'protected area double-dipping', particularly in the case of Antarctica with its comprehensive environmental regime, the end result is protection of the values that make these areas special. And who wouldn't rather have two scoops than one, given the opportunity?

ERIC WOEHLER

The Frazier Islands near Casey – one of several areas in the AAT currently being considered for protected area status

Ewan McIvor, Environmental Management and Audit Unit, AAD

Study to identify places important for birds

A cooperative study between the Scientific Committee for Antarctic Research (SCAR) Bird Biology Subcommittee and BirdLife International is presently underway to compile an Inventory of Important Bird Areas (IBAs) for Antarctica. The IBA concept was initiated by BirdLife International in Europe in 1985 and to date has gained protection for 65,000 km^2 of key habitat around the world. IBAs have been identified in the Americas, Europe and Africa. The sites identified as IBAs are localities of international importance for threatened species, restricted range species, species confined to specific habitats and those that congregate in high numbers to breed. The inventory will be a major advance for conservation efforts in the Antarctic.

The inventory will draw upon compilations of the breeding distributions of Antarctic seabirds produced by the Bird Biology Subcommittee over the last decade. Detailed data are available for the five species of penguins that breed in Antarctica, including the Antarctic Peninsula: emperor *Aptenodytes forsteri*, Adélie *Pygoscelis adeliae*, gentoo *P. papua*, chinstrap *P. antarctica* and macaroni *Eudyptes chrysolophus* penguins. Other data on southern giant petrels *Macronectes giganteus*, a globally threatened species, snow petrels *Pagodroma nivea* and Antarctic petrels *Thalassoica antarctica*, will be used to assess localities against the IBA criteria.

The inventory will make use of criteria employed internationally, providing uniformity in application and results for the conservation assessment of breeding seabird colonies around the world. Several criteria are likely to be used in the selection of Antarctic IBAs. One criterion stipulates that a site holds one percent or more of the breeding population of a species. Use of this criterion would identify the emperor penguin colony at Auster (67°23'S 64°02'E) as an IBA, as the breeding population there is approximately 11,150 pairs of a worldwide total of approximately 200,000 pairs. Similarly, Scullin Monolith (67°50'S, 66° 50'E), with its massive Antarctic petrel colony (157,000 pairs of a minimum total of half a million pairs) and more than 50,000 pairs of Adélie penguins (of 2.2 million pairs in total) would also be identified as an IBA through the use of a site by two or more species. A third criterion will cover those sites used for breeding by species with an elevated conservation status. The three breeding localities of southern giant petrels in the AAT (Giganteus Island near Mawson, Hawker Island near Davis and the Frazier Islands offshore from Casey) would also qualify for IBA status.

ERIC WOEHLER

Scullin Monolith, Mac.Robertson Land, AAT: a candidate Important Bird Area due to the large Antarctic petrel and Adélie penguin colonies present.

Eric Woehler, AAD, John Cooper, University of Cape Town & Lee Belbin, AAD

Cairns and cans, plaques and plates

ANDY CIANCHI

Walkabout Rocks, Antarctic Treaty historic site No. 6

Explorers, wherever they have travelled, have usually felt impelled to leave a mark of their visit. Antarctica is no different – there too they have left their cairns and cans, plaques and plates. The Antarctic Treaty parties have acknowledged the efforts of early explorers by formally recognising historic sites and monuments and passing measures to protect them. Australia has six listed historic sites and monuments.

Australia's Antarctic connections go back beyond European settlement to the voyages of James Cook. They were later reinforced by numerous Antarctic expedition visits to Australian ports, culminating in Australia's own national expedition: Douglas Mawson's 1911–1914 Australasian Antarctic Expedition, based at Cape Denison south of Tasmania. Ninety years later the buildings still resist one of Antarctica's harshest environments. Mawson's main hut is listed as a historic site under the Antarctic Treaty (Historic Sites and Monuments No. 13) and is listed on the Register of the National Estate. On a hill 300 m southwest of the main hut, a cross and plaque erected by Mawson to commemorate Lieutenant Belgrave Ninnis and Dr Xavier Mertz, both of whom died during a sledging journey with Mawson, is listed as Historic Sites and Monuments No. 12.

In 1929-31, Mawson led two summer voyages of the British, Australian and New Zealand Antarctic Research Expedition (BANZARE) in the *Discovery*. Extensive BANZARE voyages along the Antarctic coast resulted in British territorial claims which a few years later were transferred to Australia. Mawson erected a rock cairn and plaque on Proclamation Island, Enderby Land on 13 January 1930, and installed another plaque at Cape Bruce, MacRobertson Land on 18 February 1930 marking BANZARE visits and asserting sovereignty. Both places are now listed as historic sites under the Antarctic Treaty (Nos. 3 and 5).

On 20 February 1935 Klarius Mikkelsen, captain of the Norwegian vessel *Thorshavn,* sighted the Vestfold Hills (named after a Norwegian province which he thought it resembled). A lifeboat containing Mikkelsen and his Danish-born wife Karoline landed on the coast and buried a provision depot under a cairn. This site of the first landing of a woman in Antarctica was relocated in December 1995 and is now an Antarctic Treaty historic site (No. 72).

Sir Hubert Wilkins, pioneering Australian polar aviator and explorer, was manager of Lincoln Ellsworth's private US expedition which departed Cape Town late in 1938 aboard *Wyatt Earp*. After departure, Ellsworth informed Wilkins of his intention to claim for the United States any land that he might visit in Antarctica despite a pre-departure joint statement declaring no intention to claim any land in Antarctica. Wilkins resolved to reassert Australian sovereignty over the areas claimed by Mawson. On 8 January 1939 he and fellow pilot J. H. Lymburner landed on the northernmost of the Rauer Islands, flew the Australian flag and deposited it near a rock cairn with a record of the visit in a small aluminium container. He repeated this exercise on the following day at the southwestern end of the Vestfold Hills, and again on 11 January at what is now known as Walkabout Rocks, because of the copy of the Australian magazine *Walkabout* which he deposited with the Australian flag and record of visit. The latter, the only one of these three Wilkins sites subsequently located, is listed as an Antarctic Treaty historic site (No. 6).

Bruce Hull, Environmental Management and Audit Group, AAD

DAVE KILLICK

Mawson's hut, Antarctic Treaty historic site no. 13.

DAVE KILLICK

Cross and plaque erected by Mawson to commemorate Ninnis and Mertz (site no. 12).

FRANK HURLEY

WAYNE PAPPS

Above: Mawson's BANZARE party at Proclamation Island (site no. 3).

Right: Plaque at Cape Bruce (site no. 5).

COURTESY SANDEFJORDMUSEENE

Karoline Mikkelsen, first woman ashore in Antarctica, with husband Klarius in 1935 on Tryne Island (now site no. 72).

Australia's subantarctic World Heritage

As late as 1997, the world's subantarctic islands were unrepresented among World Heritage properties. The nearest the UNESCO World Heritage Committee had come to acknowledging the importance of these oceanic outposts was the inscription of Gough Island (UK) in 1995, in cool temperate latitudes of the Atlantic Ocean. Australia's successful nomination of Macquarie Island and Heard and McDonald Islands in 1997 was followed by inscription of New Zealand's five subantarctic island groups in 1998.

In the early 1990s Australia determined that Macquarie Island deserved a place on the World Heritage List. Its initial nomination, mainly on the basis of its biological qualities, notably its exceptional animal life, was unsuccessful. In 1996, the Australian Environment Minister, Senator Robert Hill, determined that both Macquarie Island (part of the state of Tasmania) and the remote Australian territory of Heard Island and McDonald Islands deserved to be listed.

A two-month project to prepare separate nominations for each island groups involved input from Australian Antarctic Division staff (including scientists) and an array of other authorities on the islands' physical and biological properties from universities and other research institutions around Australia and overseas. The resulting nomination, supported by photographs and film, was presented to the World Heritage Committee in June 1996.

CHRISTO BAARS

The rocky coast of Macquarie Island: a unique example of exposed ocean crust which was the basis of its World Heritage listing

At its 1996 meeting in Mexico, the Committee deferred a decision on both nominations, requesting further comparative information on each. At its next meeting in Naples in December 1997, the Committee agreed that both properties warranted inscription on the World Heritage List.

The criteria for inscription vary. The

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What's happening on Heard and McDonald Islands

The Territory of Heard Island and McDonald Islands (HIMI) was listed on the Register of the National Estate in 1983 and inscribed on the World Heritage list in 1997. *The Heard Island Wilderness Reserve Management Plan* (1996), made under the Territory's *Environment Protection and Management Ordinance 1987*, is the primary instrument for guiding activities in the Territory.

The management plan addresses human pressures on the environment, which arise from government-run research expeditions and non-governmental visits to Heard Island and the surrounding waters. Of greatest concern is the potential introduction of non-native species, which would compromise HIMI's unique introduction-free status.

In early 2001 a proposal was made to declare a Commonwealth Reserve in the HIMI region, under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (see 'Marine Reserve proposed for Heard Island', *Australian Antarctic Magazine #2, p 39*). The proposed reserve will significantly extend the marine component beyond the current 12 nautical mile boundary, and is intended to provide increased protection of the marine environment and HIMI ecosystems overall.

KARL ROLLINS

Coastal vegetation on the slopes of Red Island with an erupting Big Ben in background

After significant stakeholder consultation over the past 12 months a revised proposal for the new reserve is expected to be available for public comment in the coming months prior to the reserve's declaration.

A management plan for the new reserve will be developed following the reserve's declaration.

The required new management plan would provide an opportunity to address changes since the current plan, such as HIMI's World Heritage listing, new research findings, and management requirements arising from EPBC Act.

Ewan McIvor, Environmental Management and Audit Unit, AAD

What's happening on Macquarie Island

JAMES DRAGISIC

Elephant seals feature prominently among the rich fauna of Macquarie Island

Macquarie Island, first declared a Wildlife Sanctuary in 1933, was declared a UNESCO International Biosphere Reserve in 1977 and became a Tasmanian Nature Reserve in 1978 (extended in 2000 to include surrounding inshore marine waters). It was listed on the National Estate register in 1980 and in 1997 became a World Heritage property. Nomination as a Ramsar Wetland of International Significance is currently in preparation. The 16.2 million hectare Commonwealth Marine Park around the island, declared in 1999, is the largest marine protected area in the world.

The Parks and Wildlife Service of the Tasmanian Department of Primary Industries, Water and Environment manages Macquarie Island Nature Reserve and World Heritage Area, while Macquarie Island Marine Park is managed by the Australian Federal Government.

Past, present and potential human activities on the island and its surrounding marine environment are the primary sources of pressure on the conservation values of the reserve. These include research and research support, tourism, fishing and shipping. Introduced pests, both vertebrate (cats, rabbits, rats, mice) and invertebrate, have had a significant impact on the ecological values of the reserve through their own activities and through the human efforts to control or eradicate them.

Main issues for a new management plan to replace that of 1991, to cover the entire Macquarie Island Nature Reserve and World Heritage Area, include cooperative management regimes for the ANARE research station and the marine protected areas, threatened species conservation, and management of human impact and tourism. The future of the ANARE research station and ongoing Australian Antarctic Division support of research and management activities is a major factor affecting long-term programs in data gathering and pest management. Your input is invited: contact the author at 13 St Johns Avenue, New Town, Tasmania 7008 or email <Leslie.Frost@dpiwe.tas.gov.au>.

Leslie Frost, Tasmanian Parks & Wildlife Service

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three World Heritage criteria addressed by the nominations were…

- *Criterion 1:* Outstanding examples of major stages of the earth's biological or geological history;
- *Criterion 2:* Outstanding examples of significant continuing processes in the evolution of ecosystems and communities of plants and animals; and
- *Criterion 3:* Contain superlative natural phenomena or areas of exceptional natural beauty.

Heard and McDonald Islands were accepted on the basis of Criterion 1, mainly derived from the islands' volcanic origins and the fact that they contain the only currently active subantarctic volcanos, and Criterion 2, mainly because they remain free of human-introduced species.

In the case of Macquarie Island, the nomination was accepted because the island is an outstanding example of exposed ocean crust (against Criterion 1) and because of its exceptional natural beauty (Criterion 3).

The two island groups remain the only subantarctic lands on the World Heritage list.

Peter Boyer, Information Services Manager, AAD

Boil, or just SIMR?

SIMR (the System for Indicator Monitoring and Reporting) is a new paradigm in State of the Environment Reporting. Instead of ramping up major resources for the production of a 'glossy' state of the environment report five years, SIMR is an efficient infrastructure for continuous monitoring and reporting based on environmental indicators.

Australia, like most other countries, is committed through legislation to producing a national state of the environment report every five years. In 1996 and 2001 we had to commit considerable resources to collating information and writing and publishing the report. Experts in the field agree that environmental indicators represent the most accurate and efficient method of environmental reporting, but to our knowledge SIMR, which automates collecting, managing and reporting on environmental indicators, is the first time this concept has been taken to its natural conclusion.

Like most 'systems', the quality of the output depends on the quality of the input. SIMR depends on the quality of the procedures associated with the selection of the environmental indicators and the associated data.

SIMR has two components, a database system and code that generates dynamic web forms, reports and emails. Along with the data, the database stores details about the indicators such as 'who is the custodian?', 'why choose this indicator?', 'how and when is this indicator measured?', 'when should indicator data be evaluated and reported on?', 'what are the research implications?'.

Instrumentation being linked to SIMR will allow it to directly acquire indicator data. In the case of most indicators, SIMR automatically prompts indicator custodians when new data or an evaluation is required and collects both via the web. Reporting on indicator status, data, custodians or any aspect of the system can be done at any time via the web.

So rather than boil very five years, we just SIMR away!

More information on the State of the Environment Report can be found at <http://www-aadc.aad.gov.au/soe/>. We will be reporting fully on developments in the next issue of *Australian Antarctic Magazine*.

Lee Belbin, Australian Antarctic Data Centre Manager, AAD

The laws of the Australian Antarctic Territory

The Australian Antarctic Territory has only transient inhabitants, and few of them. It has none of the legal infrastructure of an inhabited state, such as police or courts, but its legal regime is still relatively complex and contains a significant body of law, particularly environmental law.

The *Australian Antarctic Territory Act 1954* is the basis for Territory law. It provides for Commonwealth laws expected to extend to the Territory, for Territory ordinances, for application of Australian Capital Territory laws (except criminal laws) and for application of Jervis Bay Territory criminal laws.

Commonwealth laws made expressly for the territory focus largely on the protection of the environment. Many flow from international obligations arising from Australia's participation in the Antarctic Treaty system, so Commonwealth laws enacted specifically for the territory are generally to enable Australia to ratify the international agreements. Examples of such laws are the *Antarctic Treaty (Environment Protection) Act 1980* (amended in 1992 to implement the Madrid Protocol) and the *Antarctic Marine Living Resources Conservation Act 1981* (which implements the Convention on the Conservation of Antarctic Marine Living Resources). In Australia international agreements cannot be enforced against individuals until they become law.

Ordinances made under the Australian Antarctic Territory Act are specific to the territory and apply to everyone there. These 'State' type laws include the Criminal Procedure Ordinance 1993 (enabling enforcement of the other laws such as the environmental laws) and the Weapons Ordinance 2001 (implementing the National Firearms Agreement), allowing weapons to be used only for scientific research in very limited circumstances). Ordinances apply only to the territory, whereas laws enacted to fulfil Australia's obligations under the Antarctic Treaty system have a wider application and apply to Australians anywhere in the Treaty area.

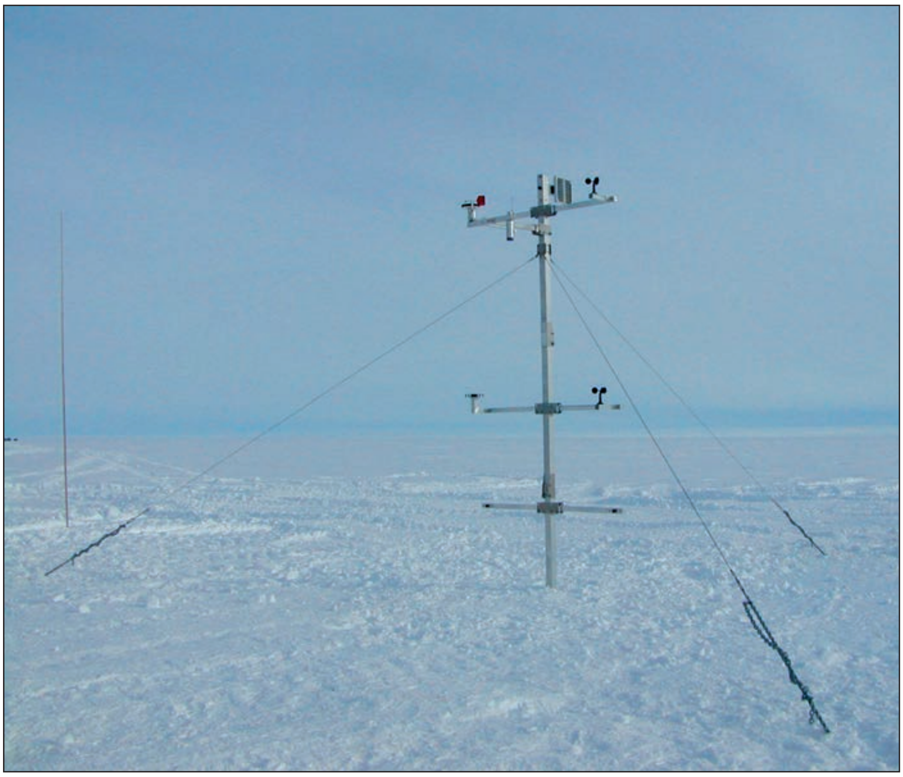
Finally, Australian Capital Territory non-criminal laws and the Jervis Bay Territory criminal laws are applied to fill any voids insofar as there are no specific laws. Such applied laws operate in the same way that Ordinances do in that they do not apply outside the territory.

The Madrid Protocol, signed in 1991, could only enter into force following ratification by all Parties. Australia's legal system requires that implementing legislation be passed by the Parliament. As Australia had been instrumental in developing the Madrid Protocol, the Government gave a high priority to implementation. The *Antarctic (Environment Protection) Legislation Amendment Act* was passed in 1992 and by 1994 all necessary regulations had been made. As a consequence, Australia was the first country to ratify the Protocol on the basis of new legislation.

Wendy Fletcher, Legal Adviser, AAD

Assessing the impact of Australian activities

Under the Madrid Protocol, protection of the Antarctic environment is a 'fundamental consideration in the planning and conduct of all activities in the Antarctic Treaty area.' Proponents of activities must consider the environmental aspects of their activity and seek environmental advice at the earliest planning stages.



LINCOLN MAINSBRIDGE

All activities require an environmental impact assessment, even an automatic weather station on a featureless ice plateau.

Environmental impact assessment of Australian activities in Antarctica may be required under two Commonwealth laws. The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) applies throughout the Australian jurisdiction, including the Australian Antarctic Territory, and to Australian citizens and residents, Australian corporations, the Commonwealth and Commonwealth agencies, and Australian aircraft and vessels and their crews, anywhere in the world. EPBC requires that actions which are likely to have a significant impact on specific matters of national environmental significance are subject to a rigorous assessment and approval process. These matters include: Commonwealth marine areas, listed threatened species and ecological communities, listed migratory species and World Heritage properties. The EPBC assessment and approval process also applies to actions on Commonwealth land which are likely to have a significant impact on the environment, actions outside Commonwealth land which are likely to have a significant impact on the environment on Commonwealth land, and actions by the Commonwealth which are likely to have a significant impact on the environment anywhere in the world.

The *Antarctic Treaty (Environment Protection) Act* (ATEP) implements Australia's obligations under the Madrid Protocol. Under this act, an assessment is required for any activity proposed to be undertaken in the AAT or by an Australian in Antarctica. For activities in the Territory of Heard Island and McDonald Islands, Australia is following the Antarctic assessment model.

The ATEP assessment process is three-tiered. A preliminary assessment is required for all activities: the activity will be authorised if its likely impacts are determined to be less than minor or transitory. If the preliminary assessment determines that the activity is likely to have a minor or transitory impact, an initial environmental evaluation (IEE) will be necessary, considering in more detail the elements of an activity, likely environmental impacts and possible alternative activities. There is a public consultation phase, and IEEs are made available to other Antarctic Treaty Parties on request. The IEE process may take three months.

If it is determined that the impact of an activity will be more than minor or transitory, a comprehensive evaluation will be required. This demands a thorough examination of the activity, the receiving environment and alternatives. The process is subject to wide public consultation and drafts are circulated to other Antarctic Treaty Parties and tabled at a meeting of the Committee for Environment Protection. The process may take up to two years to complete.

The AAD's Environmental Management and Audit Unit (EMAU) was established so that environmental issues could be managed at arm's length from proponents of activities, found mainly in research and operational areas. Unit staff provide advice on compliance and best practice during planning of activities, and on receiving an environmental impact assessment advise the Minister's delegate on matters to be considered before approval is given.

Guidelines for assessing activities in the Antarctic, produced by the Committee for Environmental Protection, have been adapted by the AAD for Australian legislation and regulations. The legislation and guidelines, with proforma for preliminary assessments, are available on the AAD's 'Environment' web page at <http://www.aad.gov.au/environment/eia/default.asp>.

Tom Maggs, Environmental Management and Audit Unit Manager, AAD

Permits: essential environmental safeguards

WAYNE PAPPS

All Australian biological field work in Antarctica requires a permit, including this long-running Béchervaise Island Adélie penguin monitoring program

The Madrid Protocol imposes on all Antarctic Treaty nations, including Australia, the obligation to impose limits on what people may do in the Antarctic, whether participating in a national program or visiting in a private capacity. The Protocol is given effect for Australian activities by a 1994 amendment to the *Antarctic Treaty (Environment Protection) Act 1980*.

Under this legislation no Australian may remove or interfere with any Antarctic animal or plant without a permit, unless the action was for the establishment, supply or operation of a station, in the case of an emergency or to protect the environment.

Permits allow collecting of animal and plant specimens for scientific, educational or cultural purposes only. The permit-holder may take no more animals than can be replaced by the next breeding season and must ensure that habitats, species variety and ecosystem balance for the area are maintained.

Native animals and plants may be given added protection by being designated under the Madrid Protocol specially protected species. All species of fur seal and the Ross seal are currently on this list.

The legislation makes it an offence to disturb animals with a helicopter, a vehicle, a vessel or on foot without a specific permit. Over the past few seasons Australian scientists and environmental officers have determined minimum approach distances to minimise disturbance. These distances are set out in the Australian Guidelines: *Flight paths for helicopter operations in Australian Antarctic Territory* and *Environmental Code of Conduct*, both of which are available on the Australian Antarctic Division website at <http://www.aad.gov.au>.

Protected areas established under the 1964 Agreed Measures for the Conservation of Fauna and Flora to preserve unique natural systems or scientific values are covered by the Act. A permit to enter a protected area will only be granted if the activity is authorised by the area's management plan. The permit may have conditions.

Before a permit is granted for an activity, the potential environmental impact of the activity must be assessed. Permits are generally issued yearly for multi-year projects to ensure that they reflect approved annual work programs and that they are consistent with all relevant approvals, including Antarctic Animal Ethics Committee conditions. About 30 permits are granted by Australia annually under the Act for activities in Antarctica.

The Australian Antarctic Division is presently seeking to integrate the processes for permit approvals, authorisations under EIA legislation and other approval requirements for people proposing activities in Antarctica.

More information on activities requiring permits is available at <http://www.aad.gov.au/environment/permits/activities_rqring_permits.asp>

Maxine Wolf, Permits Officer, AAD

Putting environmental policy into action

In his overview of this edition, the Director has drawn attention to the environmental impact of the activities of the Australian Antarctic program. Expeditioners might argue that effective operational implementation of environmental policy is the ultimate demonstration of the AAD's commitment to meet its obligations to protect the environment.

The variety of environmental policy documents, the Madrid Protocol, the AT(EP) Act and the many sources of related advice and guidelines all assist in determining what it is that can and cannot be done when conducting operations in support of science. The recently released AAD Environmental Policy is especially important in this regard. These 'rules' and the system in place to develop them – to review their appropriateness, report on them and ensure that AAD environmental management procedures are robust – make up the all-important policy framework. However, implementing environmental policy in Antarctica requires practical knowledge to be applied to the 'rules' before they translate into safe, environmentally-sound and cost-effective operational practice.

ROB EASTHER

At Davis (above) and Australia's other Antarctic and subantarctic stations, environmental issues including energy generation, energy conservation and waste management are always high on the agenda.

The AAD's Operations Branch is responsible for the way that many things are done in Antarctica, including coordinating and delivering sound environmental outcomes in the delivery of the three objectives that make up operational support to science:

- preparation and implementation of Antarctic and subantarctic operational programs;
- delivery of emergency response; and
- planning future Antarctic and subantarctic support infrastructure.

Expeditioners and Operations Branch staff form the group that leads, manages, implements and reports on the conduct of operational support, and consequently have significant environmental responsibilities. 'We make it happen' is our branch motto; making it happen in the most pristine environment on earth demands total commitment and involvement from everyone involved. We are developing processes to ensure highest-level environmental standards are met, and these are evolving to keep pace with a growing awareness of the fragility of the Antarctic environment and ever-improving policy and regulatory frameworks. In doing this, we take special account of:

- the importance of individuals understanding what is expected of them in the environmental context, and then accepting responsibility and accountability for their actions in this regard; and
- the significance of managers and staff incorporating good environmental practice into mainstream activities, and accepting environmental accountability for their actions.

The first of these requires quality training and education programs. Expeditioners are selected because of specialist skills, knowledge and personal attributes. It is the role of the Operations Branch to ensure that these highly motivated people are helped to understand their part in protecting the environment, and to give them the skills necessary to meet expectations.

Incorporating good environmental practice into line management processes, besides being good corporate governance, will align operational processes with the requirements of the AAD environmental management system now being developed. Much has been done already and improved environmental performance in all operational activities forms one part of a triumvirate of factors that must be properly managed in all that happens in Antarctica – safety, environment and cost effectiveness.

Photomontage impression of proposed wind turbines to be installed at Mawson. Wind power should save up to 75% of fuel usage and greenhouse gas emissions

Clearly, the Operations Branch has a major role in implementing environmental policies. It is also an important repository of expert knowledge on operational activities, providing valuable feedback and support to the policy makers. Those who implement the policy form a significant and important part of the overall environment management system. The Operations Branch has introduced many changes to ensure that it is well positioned to help achieve successful certification to the Environmental Management System international standard ISO14001.

That said, whether –

- leading in international forums such as the Council of Managers of National Antarctic Programs (COMNAP) and the Standing Committee of Antarctic Logistic operators (SCALOP);
- finding new ways of reducing environmental impact in such operations as waste treatment, clean-up projects, reduced energy consumption, new operating cycles that limit interaction with animals, improved quarantine procedures and handling of processes for field projects;
- improving the response to emergencies and unplanned events so that environmental issues are properly considered, such as new oil spill plans, contingency planning, responding to risks of introduced species;
- planning for the future through such projects as wind turbines, building management and control systems, new transport systems, designing infrastructure that matches future rather than contemporary expectations; or
- working to ensure easy certification to ISO14001;

the members of the Operations Branch unashamedly continue to boast that, when it comes to operational support… *We make it happen!*

Kim F Pitt, General Manager Operations, AAD

ROB EASTHER

Stringent fuel handling procedures minimise the risk of a spill during the transfer of fuel from resupply ships to the fuel farms on the stations.

New policy raises bar for environmental practices

EWAN McIVOR

The AAD environmental management system addresses the significant environmental aspects of all AAD activities in Australia and the Antarctic, including those at field locations such as Brookes Hut (above) in the Vestfold Hills.

As part of its strong commitment to protecting the environment, the AAD is bringing together and strengthening its numerous environmental management processes under an environmental management system (EMS) which will be certified under the Australian-New Zealand Standard 14001.

The EMS addresses all of the environmentally significant issues arising from the AAD's activities, wherever they may occur: in continental Australia, the Australian Antarctic Territory, the subantarctic region (Heard Island and Macquarie Island) and the Southern Ocean.

The first step towards a comprehensive EMS was an AAD environmental policy, which since its completion in December 2001 has been posted throughout the AAD's Tasmanian sites, on its ships and in the Antarctic stations. It is also being provided to suppliers and contractors to help to ensure that they understand and comply with the AAD's requirements. The policy can be found on the AAD's website at <http://www.aad.gov.au/environment/policy>. Questions and comments should be directed to <ems@aad.gov.au>.

The policy is a commitment by the AAD to:

- comply with all applicable environmental laws, regulations and agreements, and require compliance by participants in Australia's Antarctic program, by other Australian visitors to the Antarctic, and by our contractors and suppliers;
- encourage compliance with the environmental principles and agreements of the Antarctic Treaty System by other national operators, organisations and individuals in the Antarctic;
- develop and implement measures and technology to prevent or minimise pollution, waste and other human impacts on the Antarctic environment;
- develop and deliver environmental education, training and guidance for participants in the Australian Antarctic program, other visitors to the Antarctic, and the public;
- undertake and support research that further contributes to understanding the Antarctic environment and the effects of human activities upon it;
- systematically manage our activities to achieve and promote continual improvement, by setting environmental objectives and targets and assessing our achievements;
- annually review and update the policy and communicate it to all internal and interested external parties.

Tom Maggs, Environmental Management and Audit Unit Manager, AAD

Protecting Antarctica from intruders

The Tasmanian Quarantine Service and the Australian Antarctic Division (AAD) have recently joined forces to enhance the quarantine integrity of Australian Antarctic Territory, Macquarie Island, and the Territory of Heard and McDonald Islands. Quarantine measures previously applied have focussed on addressing the protection of the main island of Tasmania and mainland Australia from any exotics travelling north rather than protecting our southern interests from intruders.

Efforts by the AAD to reduce the risks posed by the accidental transfer of introduced species to the continent and islands as a direct result of our activities there have been recorded since the early 1980s. The memorandum of understanding (MOU) that has been developed by the AAD and the Tasmanian Quarantine Service is however the first rigorous and documented 'reverse quarantine' program conducted on an operational level. In particular the MOU establishes procedures for both parties to follow in jointly tackling quarantine issues that are an inevitable part of the movement of personnel and cargo.

One aspect of the MOU is the conduct of inspections of AAD-chartered ships prior to every voyage. These involve an examination of the accommodation, storerooms, food preparation and waste management areas, and cargo and machinery spaces for conditions that may constitute a quarantine risk. At the same time, specific checks for indicators of rat presence (droppings, nests, cargo damage and paw prints) are undertaken. Despite this high level of surveillance and the vessels having consistently received 'clean ship' status, *Aurora Australis* and *Polar Bird* are rat-baited as a further precaution.

The AAD's new cargo packing facility at Macquarie 4 Wharf is accredited as 'Quarantine Approved Premises – Class One Sea and Air Freight Depot', requiring it to comply with specified security, hygiene, isolation, and administration standards. Over and above inspections associated with maintaining this status, visual inspections of cargo, including of containers prior to packing with southbound cargo, are now regularly and randomly performed. A program of insect trapping in a 500 m grid pattern around the wharf loading area is expected to provide information to assist in the risk assessment process.

That there are many agencies involved in the packing and transport of goods and equipment south presents additional challenges. Some items are requested to be treated before they leave suppliers' premises. Gas bottles, and the tracks and wheels of vehicles and movable equipment are among cargo steam-cleaned before dispatch. While the cargo facility is fogged on a monthly basis, the fumigation of cargo is not routinely performed – dunnage and the cargo supporting last season's Heard Island expedition being significant exceptions. The usefulness of treatment with methyl bromide must be balanced against the fumigant's known depletion of stratospheric ozone. There are too, significant practical issues attached to processing a station resupply of three or four thousand cubic metres of cargo. One of these is preventing the cargo's post-treatment contamination prior to loading.

DANA BERGSTROM

Quarantine Tasmania officer with AAD storeman inspects southbound cargo in Macquarie 4 Wharf Shed.

In an effort to minimise the volume of likely high risk items potentially eluding inspection, expeditioners are restricted to carrying 30 kg of gear on board the ships as cabin luggage, the remainder of their personal effects and work equipment being consigned through Macquarie 4 Cargo Facility. Cabin luggage is subject to inspection by quarantine officers, and passive quarantine detection dogs that are trained to react to a wide range of organic scents have become a familiar site at voyage departures. The dogs also play an important educational role in heightening expeditioners' and the wider public's awareness of quarantine issues. The same 'sniffers' inspect all mail destined for the stations.

Supplies of fresh fruit and vegetables are required to meet Quarantine Tasmania standards prior to final packing. The sample rate is based on an internationally recognised 600 unit or 2 percent sample of each consignment with a focus on commodities likely to fall into the higher risk categories. The Standards address quality and contamination issues, requiring that fruit and vegetables are intact, clean, free from abnormal external moisture, free from foreign smell or taste, substantially free from disease, and free from insect infestation and foreign matter.

The procedures identified in the MOU are to be regularly reviewed as ongoing research contributes to our knowledge of quarantine issues in the Antarctic context.

Sandra Potter, Logistics Section, AAD

Reducing packaging for cleaning and household goods

The AAD has made a concerted effort over the past two years to reduce the packaging on a range of cleaning and household goods supplied to stations.

Soaps and shampoos, previously supplied to stations in numerous one-litre packs, have been replaced by a range of bulk products called Dermasoft. Fixed dispensers at washbasins and in showers, replenished from bulk supplies, have brought real progress in reduction of product types (deletion of six lines) and the amount of packaging. These products are being phased in as dispensers are installed.

A patented cleaning system, called Zep, uses a dispenser with four bulk products dispensed through a pre-set measuring mechanism. One product, Supermix, is for kitchen and living area applications, and Aquamix is for bathroom and shower applications. The products, in three-litre plastic bottles, effectively replace 14 associated cleaning products and their retail packaging.

John Brooks, AAD

Managing human waste in the Antarctic

Human waste has the potential to affect wilderness and aesthetic values, to introduce diseases into wildlife and to alter ecosystem balances by raising nutrient levels.

We've been treating sewage at Australia's Antarctic stations since their establishment. In early years human urine was tipped into the sea while solid waste was burnt using wood, briquettes or gas, or treated with caustic soda. These stations now have flush toilets and secondary sewage treatment plants. There is concern that effluent from the plants, which is released into the sea, may contain organisms capable of infecting wildlife; sterilisation of this effluent is now being trialled. Sludge from the treatment plants, formerly disposed of on the sea ice, is now returned to Australia.


JOHN RICH

JOHN RICH

JOHN RICH

Top: A plastic bag of waste is removed from the toilet at Jack's Donga, north of Casey station. Right: Grey water and urine drums ready to take into the field. Left: Staying on top of waste management in Antarctica.

We return human waste from Antarctic field sites wherever possible, as required under the Madrid Protocol and Australia's Environmental code of conduct for Australian field activities in Antarctica. Solid human waste is collected in plastic bags and returned to the station for incineration. Urine is collected in drums and disposed of in stations' sewage systems, although direct disposal in tide cracks is allowed at coastal sites. Facilities in the field range from purpose-built structures or adaptations – such as the toilet at Jack's donga made from an old bulldozer cabin (photo above) – to drums in the open; but they all have one feature in common – spectacular views.

Under the Madrid Protocol waste produced at inland camps may be disposed of in ice pits, provided certain conditions are met, and after consideration of the potential environmental impacts of disposal on site compared with alternatives. Considerations include the impacts of providing and burning gas if gas toilets are used, of transporting and treating waste on stations or transporting and shipping it to Australia. These issues are now being considered in planning for a major research program in the southern Prince Charles Mountains next summer.

Sewage on subantarctic Macquarie Island is only macerated before being released into the sea. This is considered an acceptable practice because of the rapid mixing and dilution which occurs in the surrounding ocean. At coastal sites away from the station, waste can be disposed of directly into the ocean. However, faeces must be removed from all inland sites for disposal in the ocean, to protect alpine vegetation on the central plateau.

Elizabeth Kerry, Operations Environment Officer, AAD

Collex provides containers for waste cleanup

The Australian Antarctic Division has joined forces with a leading international waste management company in a multi-year effort to fulfill a long-standing commitment by Australia to clean up abandoned waste sites in Antarctica. Under the agreement between the AAD and Collex/Onyx Australia - a subsidiary of French-based Vivendi Environment - Collex will provide 240 purpose-built containers to transport waste collected from Antarctic sites. After their initial use at Australia's Casey station, the containers will be made available for future work by Australia and other Antarctic nations.

The Collex-provided containers will initially be used to return rubbish from a site near Casey station, called Thala Valley, which for over 20 years through the 1970s and 1980s was the station's main waste dump. The clean-up follows a two-year study of the site by AAD scientists to determine how best to remove waste from the area without creating further environmental impacts. The study will continue into the clean-up process, monitoring the work and obtaining data for future work at other sites.

The agreement provides for AAD crews at Casey to sort waste and load the containers at the tip site under monitoring by human impacts scientists. The waste will be transported back to Australia for appropriate treatment and disposal by Collex.

Managing oil to cut pollution risks

Antarctic operations, both national and private, still rely on fossil fuels for power and heating. Wherever these are transported or stored there is a risk of spillage: oil spills are the most common environmental emergency incident reported by national Antarctic operators. These can be sudden, highly visible, regionally disastrous and very expensive, or small and undetected, which over time may turn out equally devastating.

Antarctic operators must ensure their fuel oil storage facilities minimise the risk of spillage and develop contingency plans for each operation which provide for immediate and decisive responses to oil spills. The AAD Operations Branch is extensively revising its oil spill response contingency plans. Site inspections in the past two summer seasons produced detailed spill risk assessments at each station. Enhanced response strategies specifying resources needed to address these risks will be the core of standardised oil spill response contingency plans. The new plans will meet international standards while providing local site information for on-site response teams.

A tiered response approach guides station leaders and response teams through defined spill levels which can be raised to higher levels should the need arise. Response equipment is housed in prominent locations across the stations to cater for both marine- and land-based spills. Brief decision flow-charts give site-specific directions for the station leader on notification, containment, recovery and disposal options. Specific equipment configurations and operational instructions are provided in a corresponding set of colour-coded pocket instruction cards attached to the plans and provided inside response equipment containers.

CAMILLE BOXALL

CAMILLE BOXALL

Top: Polar Bird *refuelling over fast ice at Davis this year. This 3.5 kilometre-long fuel line was inspected during refuelling. Above: Mawson's bulk fuel farm and drum storage areas are close to the open marine environment*

Efficient spill response operations must be planned and practised regularly. Station personnel are given emergency response training in combating spills before leaving for Antarctica and on arrival. This reinforces the importance of protecting the Antarctic environment in all operations.

Camille Boxall, Project Officer, Oil Spill Response Project, AAD

Learning to tread lightly

Each person working with the Australian Antarctic Program must take personal responsibility for protecting the environment and operating within national and international rules and regulations. To achieve the best outcome we run training programs covering these issues. This is particularly important for non-staff expeditioners, who experience only a short training period before each group takes on managing their station environment.

All expeditioners have one major training session and several shorter sessions between induction and arrival in Antarctica, supported by information on the AAD website training videos and publications. In the main training session, groups from each station build on expertise within their group by working through exercises and scenarios covering the Madrid Protocol, Australian laws and AAD requirements. Issues include environmental impact assessment, permits, wildlife protection, waste management, preventing marine pollution, special area protection, fuel management and energy conservation.

Additional courses are tailored according to need. For example, station leaders have training on legal and procedural requirements for their role as Antarctic Treaty inspectors and because of their ultimate responsibility for their stations' environmental management.

The AAD's training needs are being reviewed in preparation for certification of the Division's environmental management system to ISO 14001 (see 'New policy raises bar for environmental practices', p 20). This seeks to ensure universal awareness of environmental responsibilities and appropriate training. Likely developments include using accreditation to assess competency, and web-based training to complement and build on initial face-to-face sessions. Further reviews will be conducted periodically.

Elizabeth Kerry, Operations Environment Officer, AAD

A season of notable successes despite obstacles

WAYNE PAPPS

Aurora Australis returns to Hobart to complete Voyage 7, 2001-02

The 36-day besetment of *Polar Bird* had minimal effect on Australia's 2001–02 Antarctic field season, involving successful projects in oceanography, glaciology, marine biology, penguin studies and atmospheric science.

An early highlight was the successful completion of a complex marine science voyage involving 70 scientists from 11 nations. *Aurora Australis* travelled due south from Hobart to the ice edge to monitor changes in oceanic circulation patterns and the consequences of these changes on marine life. Upper ocean temperature data gathered by the French resupply vessel *l'Astrolabe* in recent years combined with 5-yearly repeats of *Aurora*'s transect and some satellite observations to effectively monitor the Antarctic Circumpolar Current. This work has produced evidence of a slowing of the so-called 'overturning circulation' – the movement of water that brings nutrient-rich deep ocean water into surface layers, where phytoplankton converts it into the raw material to fuel the marine food web.

Research into the effects of substances leaching from Casey's Thala Valley tip site was hindered by poor diving conditions early in the season, but very hard work during a few brief windows of good weather brought satisfactory progress. The project produced valuable information on environmental variation in the under-ice marine areas offshore from Thala Valley.

A comparison of reproductive success of Adélie penguins on Shirley Island, a site regularly visited by humans, and the no-go Witney Point area found that human visitation was not the cause of the lower reproductive rates on the island.

Geoscience work in the Beaver-Radok Lake areas extracted a core of glacial and lake floor sediments. The 5 m core from Lake Terrasovoje represents the fullest record since deglaciation, and should show how climate has varied over that time. The GPS units in the Prince Charles Mountains have been visited and serviced, and a Chinese team has successfully deployed an Australian automatic weather station, producing data for both countries.

The Lidar equipment installed at Davis last year has been used for extensive observations of stratospheric temperatures and other properties of the climate of this region high above the earth. The VHF radar array at Davis can be installed next season after a good start was made on footings. When fully functional the array will allow observations of atmospheric winds up to 90 km high, concentrating on winds above 10 km. Data on these phenomena have not been available before to climate modellers.

Out on the Amery Ice Shelf a team of glaciologists successfully drilled – and instrumented – a 30 cm diameter hole 479 m to the open water underneath. The work is designed to provide an understanding of how the ice melts and water refreezes to the underside of the shelf, central processes in the transference of energy from ice to atmosphere. In a surprising discovery they encountered a thick slurry of ice chips beneath the ice, forcing some new thoughts about these complex processes. Nine submerged moorings, which held a year's worth of hydrological data concerning the ocean's flow across the face of the ice shelf, were successfully retrieved by Voyage 7 under very tricky ice conditions.

Mawson programs felt the effects of *Polar Bird*'s besetment near Samson Island. The besetment prevented a full survey of the extent of a mass mortality event of Adélies, although a number of specimens were returned to Australia for autopsies (see 'Penguin deaths under investigation', p 39). One penguin researcher had overwintered at Mawson and was able to do much of the early season work while her colleagues were enjoying an enforced rest aboard the ship.

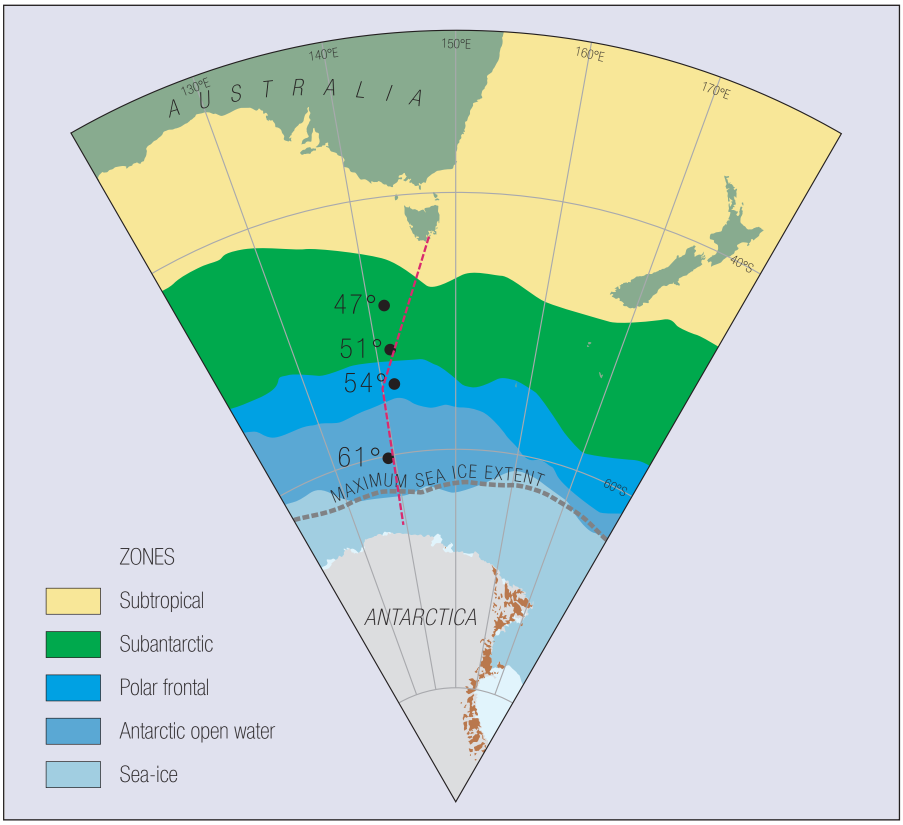
Professor Michael Stoddart, Chief Scientist, AAD

CLIVAR gathers evidence for global climate studies

The largest marine science cruise ever conducted by the Australian Antarctic program, over 45 days from late October to mid December 2001, involved a team of 70 researchers and technicians from 11 countries. The 'CLIVAR' cruise aboard the icebreaker *Aurora Australis* investigated how the Southern Ocean influences the Earth's climate and the global carbon cycle.

The Climate Variability and Predictability Program (CLIVAR) is a 15 year program initiated in 1995 by the World Climate Research Program (WCRP) to describe and better understand processes responsible for climate variability on seasonal to centennial time scales.

The cruise was one of a series in the Southern Ocean between Tasmania and Antarctica to investigate changes in oceanic circulation patterns and the consequences of these changes on marine life and the ability of the Southern Ocean to exchange heat and gases with the atmosphere. Three other, Japanese, research cruises in this area in early 2002 will provide a picture of the seasonal dynamics of the oceanic and biological processes in this part of the Southern Ocean.



S BRAY & C CURRAN, ANTARCTIC CRC

The CLIVAR track between Tasmania and the Antarctic coast. Also shown are the major zones of the Southern Ocean and the location of sediment trap arrays

The Southern Ocean is one of the primary regions where carbon dioxide is taken up and stored in the deep ocean. To be able to predict future atmospheric carbon dioxide concentration - and hence future climate – we need to determine how the ocean takes up carbon, and whether the amount of carbon taken up by the ocean is likely to change. Computer models suggest that the changes may be large in the Southern Ocean, but such predictions need to be tested by the sort of observations made on this cruise.


HARVEY MARCHANT

Instruments called sediment traps are used to determine what and how much of the biological production in surface waters is transported to the deep ocean. Here a sediment trap, one of an array of three, is about to be deployed. The array is anchored to the seafloor with the concrete weight (top left) and held upright in the water with floats – the yellow spheres (bottom right). This array will be recovered after collecting sedimenting material on a monthly basis for a year.

Phytoplankton (microscopic marine plants at the base of oceanic food webs) require carbon, nutrients and light to grow. Why the phytoplankton are not able to use all the nutrients available in surface waters of the Southern Ocean, as happens in most other parts of the global ocean, is still a mystery. A hypothesis is that it is because they lack iron – a necessary trace element – was explored on the voyage by adding iron to sea water. This confirmed that phytoplankton growth was limited by iron and that different groups of phytoplankton responded differently to iron addition – important from a carbon uptake and sinking perspective.

Formation of Antarctic bottom water – very dense water which sinks and carries oxygen and other gases to the deepest layers of the ocean – is a major process driving the vertical mixing of the oceans which, computer models suggest, will decrease with global warming with deleterious effects on ocean life. A special study was undertaken to investigate why a region of the Antarctic coast near Mertz Glacier is one of the few places around Antarctica where conditions are right to produce Antarctic bottom water.

Several experiments were conducted on board the ship to investigate biological responses to different light and the role of grazing of phytoplankton on biological production. Other investigations on the cruise included community structure of sea ice organisms, sea ice thickness and consistency and the distribution of planktonic animals and squid.

Harvey Marchant, Biology Program Leader, AAD

Amery Ice Shelf: home of the Troglodytes

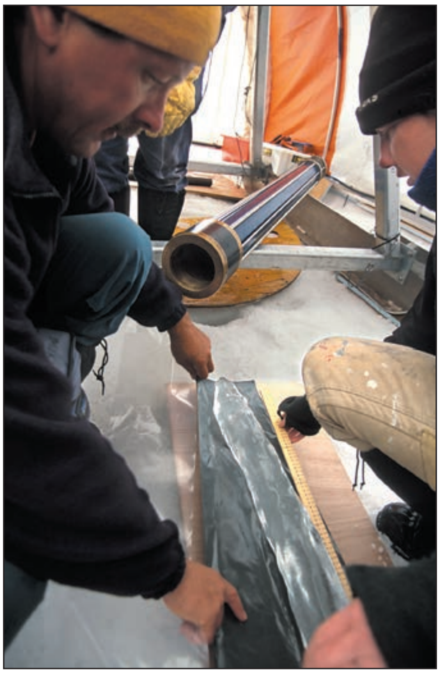
DOUG THOST

The Amery Ice Shelf – Ocean Research (AMISOR) project recently completed its third field season. This summer the project team drilled the ice shelf at the same geographic location as had the 1968 four man wintering party of Max Corry, Neville Collins, Alan Nichols, and Julian Sansom. These four have come to be known as the *Troglodytes* as they had to establish an underground tunnel system to connect various parts of the camp after heavy autumn snowfalls buried their fibreglass caravans.

The objective of this year's activity is to investigate melt and refreezing processes at the base of the ice shelf, processes which affect both the Antarctic ice sheet and the surrounding ocean. The 2001-2002 drill site is in a region of basal freezing, first identified in samples obtained to a depth of 315 m by the 1968 party, and subsequently confirmed from field and remote sensing studies.

Accumulating marine ice at the base of the shelf presented new challenges for the hot water drilling team. Deployment was delayed by inclement weather in December, when Davis had record levels of cloud cover and snowfall days, but after that, lessons learned from previous seasons resulted in a routine and smooth operation in generally fine conditions.

A 400-500 mm diameter borehole was melted through the ice shelf – at this position some 479 m thick – in less than 48 hours. There was some confusion when the drill head came into contact with seawater only 376 m down, rendering the water level sensor in the subsurface reservoir useless as an indicator of actual breakthrough. Drilling continued until only the last few wraps of hose remained on the winch, by which time it was believed that the drill head (at 490 m depth) was in the ocean cavity beneath the shelf. A borehole caliper tool then confirmed the actual depth of the base of the shelf at 479 m.



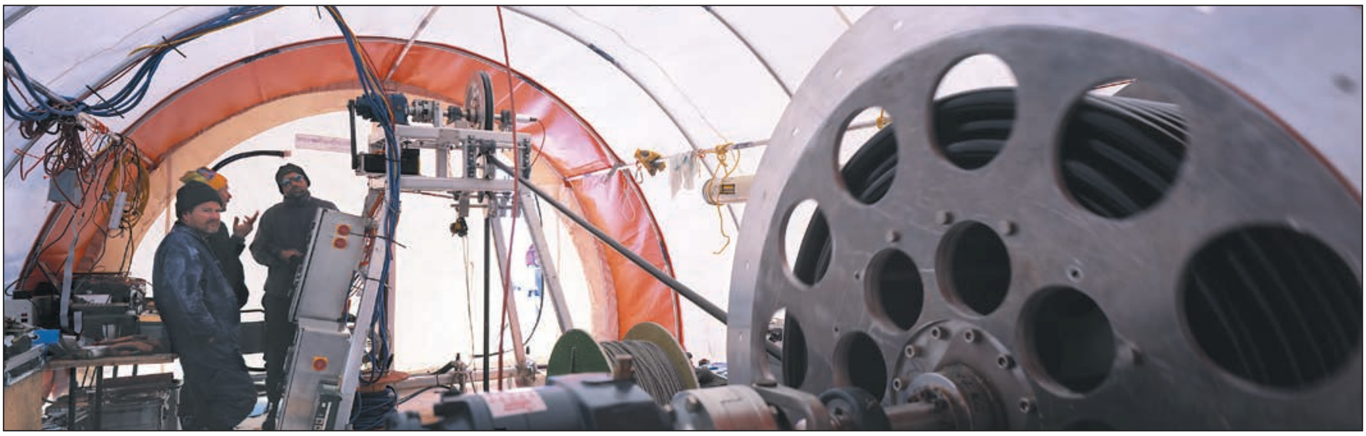
DOUG THOST

Top; Neatly organised field camp, almost ready for drilling. Above: Drilling proceeds smoothly as the team discuss the unexpected hydraulic connection at a depth of only 376m. Below: First ice core sample from 240m, with coring head in background

Repeat measurements of parameters including ocean salinity, temperature and current velocity were made in the cavity, and seawater samples taken. A new hot water coring head was employed to obtain small samples of the ice at four depths: at 240 m in the body of continental ice, at 290 m near the top of the refrozen marine layer, at 360 m immediately above where the hydraulic connection was achieved, and at 390 m. Ice at 390 m showed evidence of brine channels within, offering a likely explanation for the seawater connection at 376 m and prompting the label *honeycomb ice*. Detailed analysis of all core samples at the Antarctic CRC will enable a better picture of the fabric of the ice at different depths.

The AMISOR project, and in particular the 2001-02 field team of Russell Brand, Alan Elcheikh, Adam Drinkell, Shavawn Donoghue, Doug Thost and Mike Craven, owe a great deal to the willing assistance received from many AAD and Antarctic CRC people, as well as ANARE expeditioners (especially aircrews) and ships' crew. The current program is heavily indebted to all who have gone before, particularly the four intrepid *Troglodytes*. We gained but a mere inkling of what conditions during that 1968 winter must have been like for them.

Mike Craven, Glaciology Program, AAD



DOUG THOST

Why are we so interested in the Amery Ice Shelf?

Each year about 2000 million tonnes of snow falls on Antarctica, a precipitation balanced by an outflow of glaciers. The Lambert Glacier, draining 16 percent of the East Antarctic ice area, feeds the Amery Ice Shelf, the largest in East Antarctica. Ocean water penetrates over 550 km under the Amery, which thins as it flows towards Prydz Bay, and loses mass by calving of icebergs at its face. It is also diminished by melting where it meets ocean water underneath, an interaction with potential implications for the flow of the glaciers.

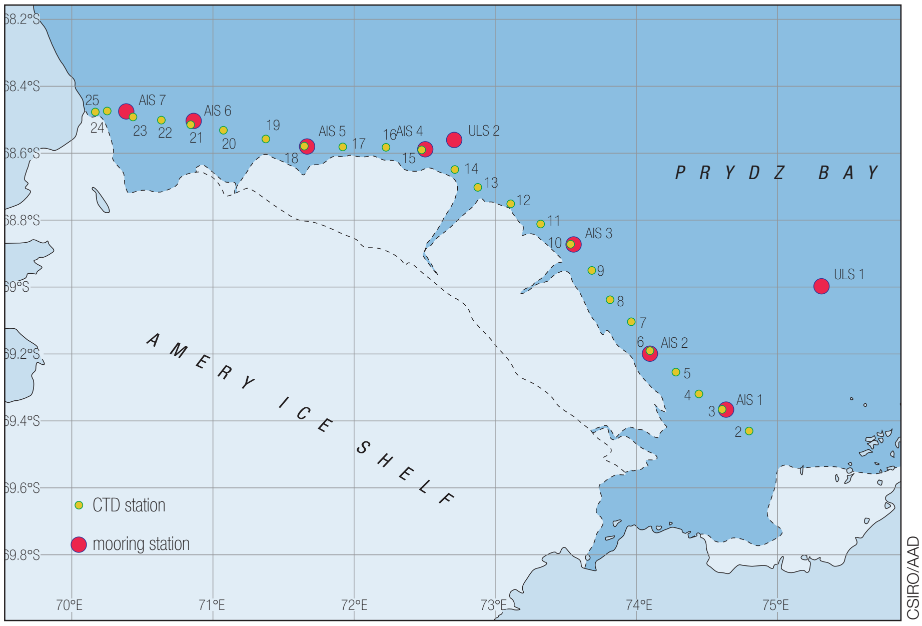
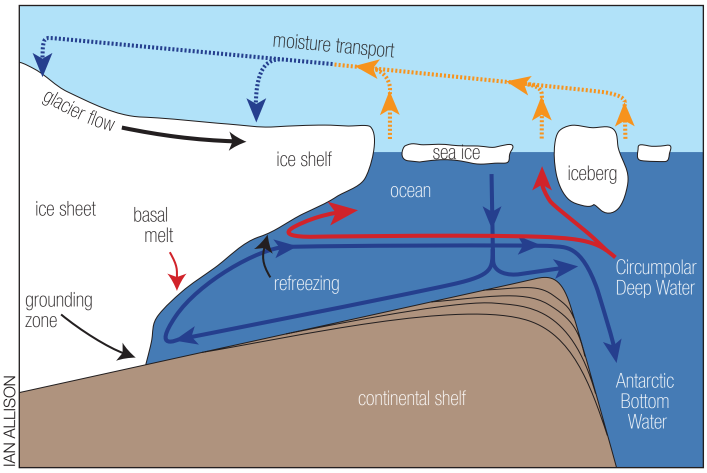
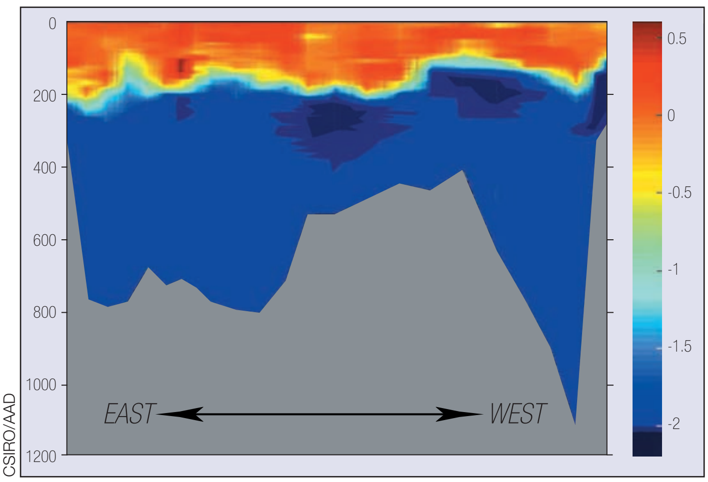


Figure 2. Location of the CTD locations and the moorings deployed in the 2000-2001 season.

In Prydz Bay, near-freezing water at the ocean surface sinks to the bottom and then flows under the ice shelf (Figure 1). At the Lambert Glacier grounding point, almost 2500 m below sea level, high pressure causes a lowering of the local freezing point, making incoming seawater warmer than the ice above, which it melts. This melting makes the seawater colder, fresher and less dense, so it rises along the base of the ice shelf until it reaches a point where it is colder than the local freezing point. Here ice crystals form and adhere to the underside of the ice shelf. This 'marine ice' is what gives some icebergs their distinctive green colour.





Top: Figure 1. Schematic diagram of circulation under the Amery Ice Shelf (source: Ian Allison, 'Peephole through the ice: the AMISOR project' in Australian Antarctic Magazine *#1 p 20.)*

Above: Figure 3. Temperature section (°C) at the front of the Amery Ice Shelf. The outflow of cold water below 2°C occurs at depths of 200 to 400m.

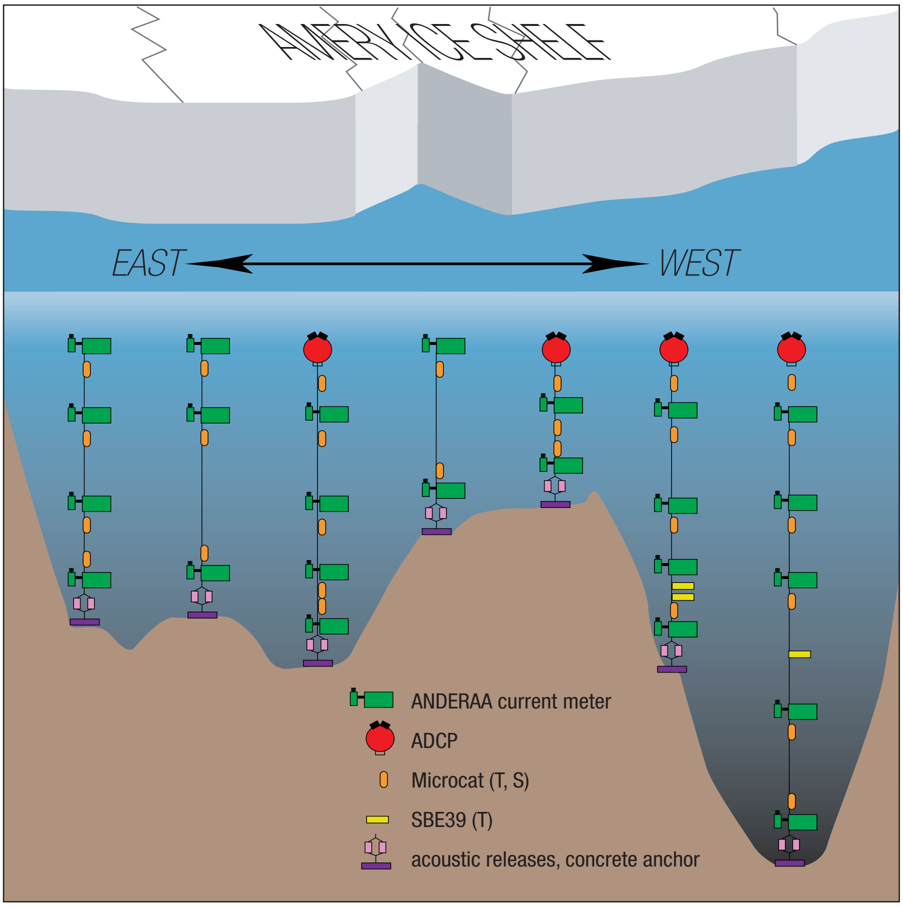
Some of this supercooled water flows out from under the ice shelf into Prydz Bay, where its interactions with ocean water and ice influences Prydz Bay circulation and thus the local ecosystem. It also contributes to formation of dense 'Antarctic Bottom Water' which ventilates the deep ocean.

Models of climate change project a warming of the water flowing under the ice shelf. This could significantly increase the rate of melting near the grounding line of the ice shelf, but implications for the Lambert's flow, the formation of Antarctic water masses and Prydz Bay circulation are uncertain.

The Amery Ice Shelf Oceanographic Research (AMISOR) project aims to quantify the processes occurring under the Amery – in particular the heat and freshwater exchanges between the ocean and the ice shelf – allowing us to make robust models for both present and future conditions. For this we need observations of the Amery's flow and thickness, the conditions underneath it by means of holes drilled through the ice shelf (see *Amery Ice Shelf: home of the Troglodytes* on the previous page) and the nature of the ocean at the front of the ice shelf.

The oceanographic program began in the 2000-01 summer, when top-to-bottom data on ocean temperature, salinity, oxygen, and nutrients at 24 locations along the face of the ice shelf were obtained and analysed on board *Aurora Australis* (Figure 2). Samples were also collected for US collaborators who will measure properties indicating the presence of helium gas, tritium and an isotope of oxygen ($\delta^{18}O$) in the ice shelf water.

The temperature observations (Figure 3) and ocean currents measured aboard *Aurora Australis* showed super-cooled water flowing out from under the Amery Ice Shelf at depths of 200 to 400 m. Measurements of temperature, salinity, oxygen and nutrient



concentrations were repeated several days after initial observations to help estimate the extent of short-term variability.

To understand the seasonal evolution of the ocean properties and the circulation, seven moorings (Figures 2 and 4) recording ocean currents, temperature and salinity every hour were deployed along the front of the ice shelf. All were recovered late in the summer of 2001-02, when we repeated the temperature, salinity, oxygen and nutrient measurements and collected more samples for our US collaborators.

John Church, Antarctic CRC and CSIRO Marine Research; Nathan Bindoff, Antarctic CRC; John Hunter, Antarctic CRC; Mark Rosenberg, Antarctic CRC

Figure 4. Schematic diagram of the mooring array deployed in February 2001.

The AMISOR mooring hunt

On 26 January 2002, when *Aurora Australis* set out from Hobart on the seventh voyage of the summer season, the major oceanic research objective around which the voyage schedule was planned – recovery of nine moorings with attached instruments – looked a lost cause. Sea-ice covered the region in front of the Amery Ice Shelf where the supply ship *Polar Bird* had been beset only weeks before.

The instrument moorings had been deployed a year earlier to complement 24 current, depth and conductivity casts. The invaluable data they had gathered was the main incentive to make an extra effort to retrieve them.

The use of satellite information was critical to the success of the voyage, allowing plans for the movement of the ship to be highly effective in combating the unseasonal conditions. Daily satellite images of weather and ice conditions provided the information needed to make the best of the changing conditions. Patience was rewarded when satellite images revealed a small area of open water at the eastern end of the Amery and the ship was able to enter, allowing the work to begin.

Over the following two weeks, *Aurora Australis* crisscrossed the face of the ice shelf several times to make the best of opportunities when the ice drifted away from mooring and instrument sites. This meant many hours of waiting, using the ship's propellers to clear ice. It also meant returning to some sites several times to get the right conditions – releasing a mooring prematurely could mean losing the data and the equipment under the ice. One site was visited five times before its mooring was successfully retrieved.

Rob Easther (Voyage Leader), AAD

Above: Where is it? Scanning the horizon for the buoys as they rise from the depths following release. Right: A mooring buoy retrieved onto the trawl deck where the instruments are removed.

Hunkering down: albatross research on the edge

GRAHAM ROBERTSON

One of the interesting things about Ildefonso was the flukey nature of the wind. This picture looks south with the west coast of Ildefonso, a rock stack in subantarctic Chile, to the right. Along most of the stack the wind is blowing from the west, boiling the sea and sending sea spray right over the top. But in the foreground, which shows albatrosses hunkering down for dear life, the wind is blowing with equal force in completely the opposite direction! On very windy days on Ildefonso it was sometimes hard to stand up because you never knew which way to lean.

The articles in this magazine describe Australia's involvement in Antarctica and the Southern Ocean. Quite rightly, the emphasis is on science because science sustains the Antarctic 'economy' – it creates international credibility and political sway, the sense of responsibility that stems from the acquisition of knowledge, and much-needed insights for the protection of the Antarctic environments and Southern Ocean.

But there is more to science than the outputs suggested by the economy analogy. Sometimes the logistical operations that underpin the science are more complicated than the science itself. In this article I describe research aimed at reducing the mortality of Southern Ocean seabirds in longline fisheries. The research involved a field program in subantarctic Chile that required teams of people on three islands simultaneously and a transport system dedicated to them.

Albatrosses and petrels die in longline fisheries when they seize baited hooks intended for fish (see *Australian Antarctic Magazine,* Autumn 2001). For some populations current death rates are unsustainable. For example, at the Falkland Islands, in the south-west Atlantic, about 17,000 black-browed albatrosses are lost each year, most likely to longlines in some other nation's fisheries. That's about two birds for every hour of every day! Seabirds in the Australian sector of the Southern Ocean are also killed in other nation's fisheries, particularly South Africa, South America and fisheries in the Indian Ocean. Mortality in these fisheries is central to the Antarctic Division's Antarctic Marine Living Resources Program's efforts to reduce fisheries-related mortality of Southern Ocean seabirds. The recently ratified Agreement on the Conservation of Albatrosses and Petrels also aims to reduce the take of seabirds. The Agreement recognises that parochial efforts alone will not be enough and that to protect seabirds throughout migratory ranges nations must work together.

In September-November 2001 Australia and Chile put the Agreement to work. Chile is a hot spot for the Agreement because seabirds from breeding sites throughout the Southern Ocean flock to its coast. Chile also has its own albatross populations – at Diego de Almagro, Ildefonso and Diego Ramirez islands – which are under threat in local and distant water longline fisheries.

Our study involved four Australians – Barbara Wienecke, Roger Kirkwood, Kieran Lawton and myself – and four Chileans – Jose Valencia from the Chilean Antarctic Institute, and Javier Arata, Marcos Munoz and Marcelo Flores from the University of Southern Chile. Our main task was to determine, by satellite telemetry, if albatrosses from each island fed in the same areas of the ocean and, therefore, faced the same threats from longline fisheries. We also collected blood samples to determine if populations differed genetically (this has implications for conservation). And we counted the birds to assess population status.

Diego de Almagro lies at 51°S on the western side of the Chilean channels. It is a big island, 40 km long and with peaks over 1200 m high, uninhabited and inhospitable, wet, windy and, as we were to discover, infested with rats. Ildefonso and Diego Ramirez lie in the Drake Passage 100 km south-west of Cape Horn and are the southern-most albatross colonies in the world (they're 450 km south of Almagro). Diego Ramirez is a collection of small tussock covered islands and islets and is permanently inhabited by a detachment from the Armada de Chile which runs the light house and monitors the weather. Ildefonso is a tiny archipelago of nine rock stacks rising 112 m from the sea. The largest stack is 1 km long and 200 m wide – the eastern side is near-vertical and the western side ramps down at a 45° angle to the sea. Both Diego Ramirez and Ildefonso are covered with albatrosses and penguins, whereas Almagro holds six albatross colonies – all on vertical cliffs or offshore stacks – on its rugged west coast.

When planning work on islands in the Southern Ocean it is essential to do your homework properly to know what's feasible, but with Ildefonso the information needed to inspire confidence didn't exist. We knew we'd have to swim on to the rock but didn't know if the conditions would allow it, or if we could live and work there. But the work was important enough to try, and what we ended up doing was a feasibility study and science program at the same time. To ease the uncertainty, and leave only the vagaries of the weather to deal with, we chartered the *Tooluka*, a 14.5 m steel yacht owned by Roger Wallis of Victoria. Dedicated to the program, *Tooluka* taxied people as required and acted as safety back-up. And she made a logistically difficult program possible.

GRAHAM ROBERTSON

Landing on Ildefonso was by swimming and climbing. An umbilical of climbing rope connects a dry suit-clad Kieran Lawton to a fuel drum in the zodiac while Roger Wallis (in zodiac) ties off and Tooluka *stands by waiting to despatch the next load of gear. In the far distance is the southern end of the Chilean Andes. Cape Horn is out of sight to the right of the picture.*

We reached Almagro on 26 September in mill-pond conditions. A local at nearby Puerto Natales referred to the weather as 'three weeks of milk', unseen in 16 years living there. We made use of the conditions and sailed around the uncharted west coast of Almagro, took *Tooluka* within 100 m of the cliffs and in one day completed photographic censuses of all six albatross colonies. We then deployed Roger Kirkwood, Barbara and Marcelo on the east coast where they camped for five weeks, making the ten-hour trek to and from the albatrosses on the west coast every second day to complete the tracking study. After deploying the Almagro party *Tooluka* sailed south through the Straits of Magellan to Ushuaia, Argentina, to collect other team members then to Puerto Williams, an Armada outpost on the island of Navarino in Chilean Tierra del Fuego. At Puerto Williams we received a special permit, called a 'zarpi', to cross sensitive military zones to Ildefonso. With permit in hand we back-tracked westward through the Beagle Channel to a protected cove north of Ildefonso and waited for the weather.

GRAHAM ROBERTSON

The wind at Ildefonso was so strong that sometimes albatrosses could barely hold onto their nests. If global warming leads to stronger storms – as the pundits predict – it makes you wonder how albatrosses will manage to stay on their eggs long enough to complete incubation. When the wind exceeded about 70 knots there was a real chance birds in the most exposed sites would be blown away.

The sea around Ildefonso in October is rough, heaped up by regular of 60-70 knot storms. We were prepared to wait up to three weeks for the right conditions, but needed only five days. The Ildefonso archipelago is broken into two groups – eight tightly grouped stacks to the north and a single big stack two km to the south. The big southern stack comprises about two-thirds of the land area of the archipelago. We sailed down the lee side of the first eight stacks scanning the cliffs for a landing place and found none. We were running out of options until reaching the very end of the southernmost stack: the rock face was steep but not impossibly so and the rise and fall of the sea was only two to three metres. Wearing dry suits against the cold Kieran and I jumped into the sea, swam onto the rock face and climbed, using the kelp as a ladder, to a ledge ten metres above the sea. We then hauled ashore 150 kg of food and camping gear (in dry bags and plastic barrels) and 200 kg of drinking water. The *Tooluka* then departed for

GRAHAM ROBERTSON

Tangible evidence of an interaction between albatrosses and longline fishing vessels. Here, Kieran pulls on a monofilament trace attached to a hook – intended for Patagonian toothfish – embedded in the bird's elbow. We later cut the hook free. Scenes like this are tough for the bird but they're very effective in efforts to win the support needed to change fisheries management regulations to include seabird conservation.

the 60 km voyage to Diego Ramirez to deploy the third party before nightfall.

The eastern face of Ildefonso lies about ten degrees off the vertical but it's tussock covered and the grass provided a way up. We found a ledge 45 m above the sea, hauled our gear up and made camp. To reach the albatrosses – 35 m above the ledge – we bolted two pitches of climbing rope to the rock face, wore climbing harnesses and 'roped up' whenever ascending to the birds.

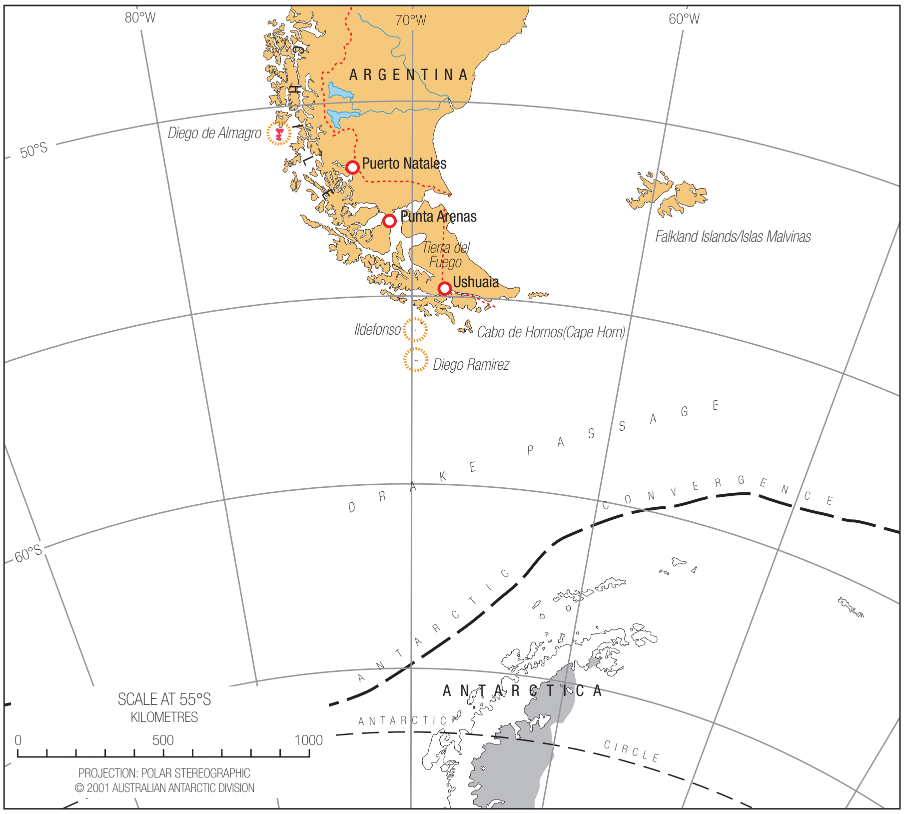
We spent five weeks on Ildefonso doing our research. The most time consuming part of the work was the satellite tracking. Although it takes less than two minutes to attach a transmitter to an albatross it can take hours to get your hands on the right one. During October and November albatross colonies are full of incubating birds sitting on mud nests. Incubation duties are shared by both sexes and sitting birds are relieved about every two weeks by their partners returning from feeding at sea. Inbound birds arrive in the early morning and late afternoon, find their mate and indulge in post nuptial behaviour that might take two hours to complete. Post nuptials are lovey-dovey stuff – birds groom one another around the head and face with tenderness and care - and are essential in maintaining a strong bond between couples (albatrosses shouldn't be disturbed until this bonding ritual is over). Eventually the birds switch roles – the outbound bird climbs off the egg and the inbound bird climbs on. The outbound bird then grooms its partner and renovates the nest in case it falls to bits from being constantly sat on. It does this by stealing mud or grass from the nests of neighbouring birds that aren't paying attention. At some point the behaviour of the outbound bird changes from incubation mode to flying mode, and that's when you've got to catch it.

Once a bird was caught everything moved quickly to minimise stress to the bird and anxiety to the people. We placed a black hood over the bird's head to eliminate light and subdue it. We then attached a 50-gram transmitter to the back feathers using cloth-backed sticky tape and a thin smear of Loctite glue. Birds were then released to forage at sea. For the next two weeks the albatrosses' whereabouts were traced via a constellation of satellites, to wherever in the world they chose to fly.

When the albatrosses returned to their nests one to two weeks later we'd retrieve the transmitters. If they looked relaxed and secure on the egg we'd remove the transmitter in daylight, but if they looked nervous we'd work at night. Working at night saved eggs. Nervy birds might step off the nest, leaving the egg vulnerable to attack by striated caracaras, which are raptors that live on the eggs and chicks of albatrosses and penguins. Bold and fearless, they're adept at flying in gale force winds and making dive-bomb descents, using an arsenal of talons in their undercarriage to catch and kill prey. But they're neutralised by the night, which gave us freedom to retrieve transmitters from nervous albatrosses without fear of egg loss.

The rewards for working at night weren't limited to the easy retrieval of satellite transmitters. After retrieving a transmitter I'd sit on a tussock and scrape residues of glue and feather off the device with my pen knife. I'd do this for longer than needed, to drag out the pleasure of having another $3,000 transmitter back in hand from a bird still faithful to the egg. One night while sitting there scraping, the

The three locations of the 2001 study are indicated by the orange circles.



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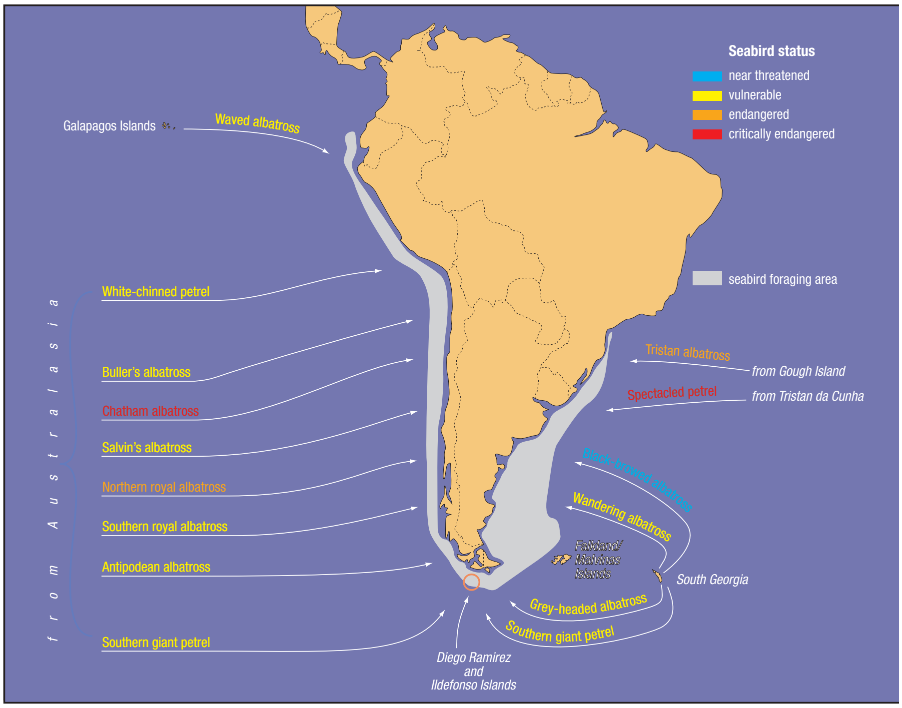


AAD

Seabirds fly enormous distances over the Pacific and Atlantic oceans to feed in the rich foraging area around the South American coast (in grey).

wind subsided and the clouds parted enough to reveal the Southern Cross. Then the night birds started arriving – blue petrels, sooty shearwaters and Patagonian diving petrels – circling around calling to burrow-dwelling mates. I was half-way down the ropes towards bed before deciding that the conditions deserved more time, so I climbed back up and sat on the tussock again to make the most of it.

Experiences like that remind me why I work on albatrosses. The immediacy of the conservation issue is compelling, but there is another side to the attraction. Years ago when I first saw an albatross colony I was overwhelmed by the remoteness and wildness of their breeding places, their powers of flight, courtship rituals and jam-packed breeding style. But mostly it was their impeccable beauty that got me in – the ice-cream cone heads, sharp eyes, delicate feather structure and perfect proportions created the impression they'd been sculptured from marshmallow. Back then I couldn't conceive how growth and differentiation could produce thousands of individuals that looked identical, all equally stunning. I still have trouble with that.

Our study yielded the tracks of 40 albatrosses from Ildefonso, 20 from Almagro and 15 from Diego Ramirez. Though there are some site-specific differences, early indications are that albatrosses from the three islands overlap to a large extent at sea. Interestingly, one bird from Ildefonso flew east around Cape Horn and north over the Argentine Patagonian shelf to southern Uruguay. Managing fisheries-induced effects on albatrosses with this flight path requires the co-operation of at least three nations, highlighting the importance of the Agreement mentioned above. Blood samples taken from the three islands will be analysed at the Australian National University to assess the genetic diversity of the populations. As analytical techniques improve, the samples might one day enable the breeding sites of albatrosses caught by longline fishing vessels to be identified and risks to populations more finely assessed.

After a few weeks camping on Ildefonso we became a bit drag-arsed. It takes energy just staying alive, you tire of being wet and cold, hit by bullets of wind and walking on rocks that are angular, wet and slippery. Inevitably lassitude sets in, simple things take twice as long. For pleasure we watched albatrosses battle wind and sea, learnt Spanish, thought about things the hustle and bustle of normal life rarely allows time for, looked forward to the next fine day. When the weather was screaming we paced up and down camp ledge, boiled the billy and 'talked the talk', as blokes inevitably do. An inspiring environment, meaningful work, regular physical activity and a simple, uncluttered agenda. Hard to beat.

Finally, a word about Ildefonso itself. I remember it as being hard, raw, rugged, punished and vulnerable, the latter description deserved because the west coast is constantly punished by big seas and it's obvious from the fissures that traverse its breadth that one day the sea will have its way and the big southern stack will be cut into free standing stacks, like the others in the archipelago. As a breeding site for albatrosses Ildefonso's aesthetic qualities are remarkable. The sea and its spray are hostile and in the birds' faces always, the wind is strong and persistent and the tussock that creates the veneer of organic material for nest construction and subsequent renewal of life must cope with slopes that are almost too sheer to hold onto and a water table that is high and loaded with salt. Due to the force and relentlessness of the sea and the strength of the wind it is easy to gain a temporary feeling about Ildefonso. It would be difficult to imagine another area in the albatross world where birds, wind, rock, tussock and sea interact with one another in such a raw and intimate way.

Graham Robertson, Antarctic Marine Living Resources Program, AAD


KIERAN LAWTON

Camp ledge on Ildefonso showing two mildly depauperate blokes. The odd thing about this scene is the tussock of grass in the middle of the cave floor. Tussock doesn't grow in places like that. When we arrived at Ildefonso I shovelled it there to see if any visitors to the island could pick it. They didn't. Come to think of it we never had any visitors.

GPS system: remote data breakthrough

In 1998 a group of scientists at the Australian National University's Research School of Earth Sciences (RSES) began a program in the Lambert Glacier region to use global positioning system (GPS) measurements to monitor any changes in the elevation of the Earth's crust, or isostatic adjustments, resulting from a changing glacial mass. This has involved installing and operating equipment in places hundreds of kilometres from the nearest permanently-staffed Antarctic stations. The solar-powered installations have transmitted recorded data automatically via satellite phone since December 2000.

The project aims to estimate absolute vertical and horizontal movements of the sites and, coupled with other geophysical data, to discriminate between several different ice models for the Antarctic continent. Three permanent GPS sites have been established on the coast at Landing Bluff, at Beaver Lake behind Amery Ice Shelf, and Dalton Corner 450 km inland. A fourth installation is planned at Komsomolskiy Peak in the 2002–03 season.

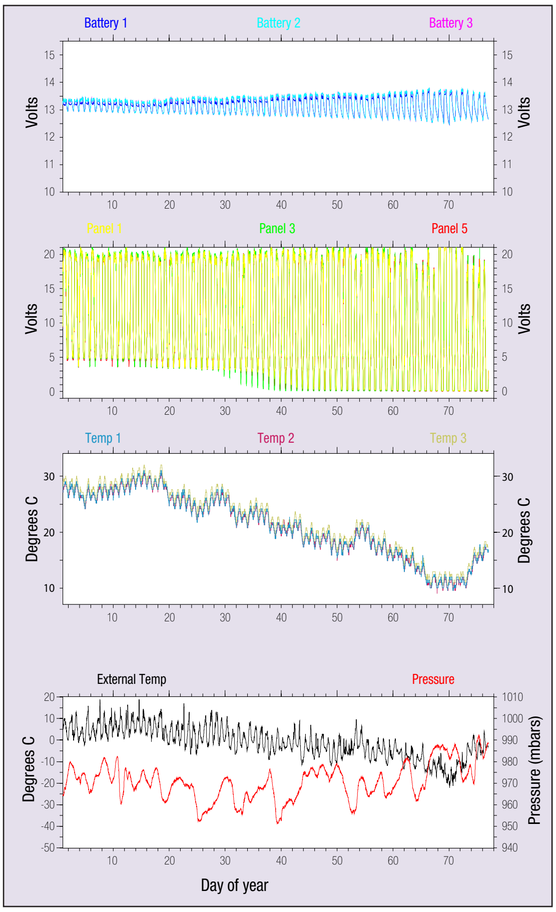
RICHARD STANAWAY

Equipment at Landing Bluff. The solar panels provide power to three 73 Ah batteries (inside the silver box) which are kept warm by the heat dissipated from the GPS receiver, satellite phone and solar panel regulators. The white radome contains the satellite phone antenna.

Solar-powered equipment at Landing Bluff and Beaver Lake consists of an Ashtech Z-12 GPS receiver, a PC-104 computer, a Satcom-B satellite phone and an in-house designed and built power controlling system (PCON). Careful integration of power dissipation and insulation has resulted in a system that sustains itself while solar power is available. Internal operating temperatures are typically between 10 and 30 degrees.

When solar power is inadequate for operating the GPS receiver, the PCON reverts the system to a 'hibernation' mode in which the power supply to the receiver is cut and the computer is prevented from making phone calls. Diagnostic data is still recorded by the PCON and transferred to the computer during winter while the system is hibernating. When solar power is again available in the spring the PCON wakes the system from hibernation and the GPS receiver starts recording again.

The PCON (consuming 0.7 W) runs continuously. Every 20 minutes it logs data on the battery voltages, internal and external temperatures and atmospheric pressure, providing valuable feedback to scientists on the performance of the system. If sufficient power is available, it provides power to the GPS receiver (12.5 W) which records satellite GPS data every 30 seconds.



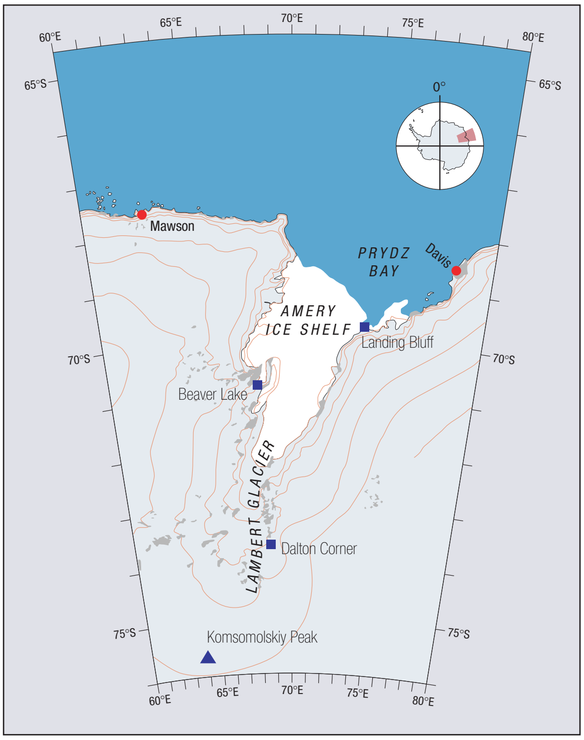
Battery voltages, solar panel voltages, internal box temperatures and external temperature and air pressure from the Landing Bluff system in 2002. Data shown commences 1 January (day of year 001) and ends 18 March 2002 (day of year 077).

Every 24 hours the PCON powers up the computer which downloads the data from the GPS receiver and the system diagnostic data from the PCON, stores it locally on a 'flashdisk' and then, if sufficient power is available, turns on the satellite phone and transmits the data back to Canberra. It takes about 5 minutes to transmit the 300 Kb of GPS data and 8 Kb diagnostic data.

Data transmission worked successfully at Landing Bluff from December 2000 until May 2001 when the system hibernated. A minor design glitch (now rectified) prevented the system from restarting in the spring of 2001 but it was quickly put to work in December 2001 when our field party visited the site. A failure of the satellite phone at the Beaver Lake installation caused communication problems through 2000 and 2001, but in January 2002 one of our group, Richard Stanaway (a geodesist from RSES), was able to fix the problem.

Both sites have been regularly transmitting the GPS and diagnostic data. The communications system is designed so that scientists in Canberra can gain control of the remote computer in Antarctica and perform certain tasks including installing new software, replacing GPS receiver firmware and changing system control parameters. On learning of the behaviour of the systems in 2001 we modified our controlling program and successfully uploaded new software to both sites.

Satellite phone communications have been



Location of GPS sites in the Prince Charles Mountains. The sites at Mawson and Davis are operated by the Geodesy division of Geoscience Australia.

sporadic during 2002. Several times both sites failed to make successful connection, which we believe is due to atmospheric disturbances – we have noticed correlations between failed communications and rapid changes in temperature and pressure indicating blizzard conditions. However, with a simple command we can retrieve the missed data during the next successful data transmission.

Remote instruments such as automated meteorological stations have been operating unattended in Antarctica for many years, but the power requirements of the GPS instruments are several orders of magnitude greater, precluding use of solar-powered systems over winter. The success of our remote systems represents a considerable breakthrough in the operation of relatively high-powered remote equipment. Furthermore, we have been able to retrieve and provide GPS data from our two sites to support the research of other scientists working in the area, thereby permitting their analysis to be performed in 2002 rather than having to wait until the next summer season for our data to be retrieved. The GPS data are of high quality and we expect that, after the next summer season, we will have accurate velocity estimates at our GPS sites, enabling the scientific goals of the experiment to be met.

Further information about the project can be found at <http://rses.anu.edu.au/geodynamics/gps/antarctic/index.html>. Paul Tregoning can be contacted at pault@rses.anu.edu.au

Acknowledgements: The electronics group at the Research School of Earth Sciences for developing the electronics for these installations; also station leaders, field personnel, voyage leaders, helicopter pilots and AAD staff for logistic support.

Paul Tregoning, Richard Stanaway and Herb McQueen, Research School of Earth Sciences, The Australian National University

The 'A' factor hits summer logistics

Logistics planners in Antarctica know they must never lose sight of the A (for Antarctic) factor. Right around Antarctica this past summer, heavy ice conditions in key localities affected the shipping activities of a number of countries. Australian shipping was affected by the besetment of *Polar Bird* for five weeks in Prydz Bay (see following story), but the US and Great Britain also had their trials.

Up to last summer, the record sea ice extent to the north of McMurdo Station was 74 km; in November 2001 it persisted to almost 120 km from the base, forcing the use of a second icebreaker to help cut the required channel through to the base to allow resupply ships to enter, at an estimated cost of A$6 million dollars. Difficult weather conditions also hampered activities at Amundsen-Scott, South Pole, where mainly poor visibility prevented 50 scheduled flights from arriving. Temperatures below minus 20°C following early spring temperatures below minus 80°C also hampered work on construction of a replacement Amundsen-Scott station.

Heavy ice restricted UK activities in the Weddell Sea, east of the Antarctic Peninsula. In December, the resupply ship *RRS Ernest Shackleton* was unable to reach Halley station, delaying resupply by two months. The following month the ship eventually made landfall at Drescher Inlet, 200 nm north-east of the station, from where personnel and essential and priority cargo had to be flown in.

ROB EASTHER

Aurora Australis *rides up and over a 16-metre wave in a Force 12 storm en route to Antarctica in January 2002.*

Southern Ocean crossings were a mixed bag. Barbara Wienecke of the AAD, travelling between New Zealand and the Ross Sea between early December and mid-January, reported 'mill pond conditions', while on 31 January south of Australia *Aurora Australis* encountered the effects of an intense low. The ship's captain, Les Morrow, reported a 24-hour storm with 50-knot winds and short 10 m swells that created an uneasy, pitching ship motion and caused water to be shipped over the bow and even over the mezzanine level above the stern trawl deck. Winds at one stage reached 60 knots with wave heights peaking at 16 m, and the ship was forced to heave to for a long period.

On land, the 'A factor' also affected members of the Prince Charles Mountain geology expedition. Field leader, Andy Cianchi, reported a blizzard cycle of four days around Beaver Lake and Lake Terasavoja – clouding over for a day, then blowing a two-day blizzard, then clearing and starting again, allowing only one working day in four and one flying day every two weeks.

In contrast, Macquarie Island experienced very dry conditions, particularly in January, helping a terrestrial ecologist, ornithologists and geologists to complete extensive fieldwork. Station leader Robb Clifton boasted about not wearing his waterproof jacket for 10 days straight – something of a record in predominantly cool, wet windy Macquarie Island, affectionately called the green sponge.

Dana Bergstrom, Eric Woehler, Rob Easther and Annie Rushton, AAD

RICHARD STANAWAY

Raging katabatic wind drift off the Prince Charles Mountains, January 2002

Abnormal low pressure system brings extreme weather to Australian stations

Spring and early summer at Australian Antarctic stations saw some unusual weather patterns. December 2001 at Davis was the station's third windiest month on record. Included in its extreme weather was the station's first recorded December blizzard (gale-force wind, horizontal visibility less than 100 m). December also saw records broken in numbers of gales (12), days of snowfall (18) and days of blowing snow (6).

Mawson had nearly three times the normal number of blizzards in November and December, and half again as many gales (31) as usual. Casey, by contrast, had much less boisterous weather – strong winds and gales were well down on normal – and days of snowfall in December 2001 were about half the long-term average.

Atmospheric pressures at Mawson and Davis provide some insight into the unusual weather: surface atmospheric pressures in December 2001 at Mawson were 10hPa below normal and at Davis 4hPa below average with a very strong northerly wind anomaly at Davis and over Prydz Bay. Throughout the three months of October to December, depressions were south of their normal paths.

Hugh Hutchinson, Bureau of Meteorology, Hobart

Christmas in the Prydz Bay pack ice

An important task for Voyage 4 last summer for the Norwegian-owned ice-strengthened supply ship *Polar Bird* was restocking of the Sansom Island Fuel Depot and positioning scientific parties at shore locations. *Polar Bird* left Davis on 4 December 2001, but an unseasonal gale and heavy seas slowed its progress to Sansom Island.

Helicopter operations to transport fuel and other supplies to Sansom Island began on 7 December over 60 nautical miles, double the distance of a normal fly-off. A large band of pack ice prevented a closer approach. An attempt during a blizzard two days later to move the ship towards open water was stalled by failing visibility.

On 10 December clearing weather allowed two days of flying, in which field parties with all food, stores and equipment were put ashore. But the ship was now surrounded by dense, rafted pack ice consolidated over the next two weeks by northeasterly weather. Two unsuccessful attempts to move confirmed that *Polar Bird* was beset. A reconnaissance flight on 28 December revealed 47 nautical miles of heavy pack ice between the ship and open water.

During the besetment, all remaining fuel was delivered to Sansom Island and the ship was maintained in readiness for an eventual move. While *Aurora Australis* travelled west from Casey to assist, taking on expeditioners by helicopter and transporting them to Mawson, ice reconnaissance flights were maintained from *Polar Bird*. Mawson-bound expeditioners aboard *Polar Bird* continued field training, conducted their own version of the Olympic Games, played a variety of competitive sports, organised quiz nights and theme nights, and celebrated both Christmas and the New Year.

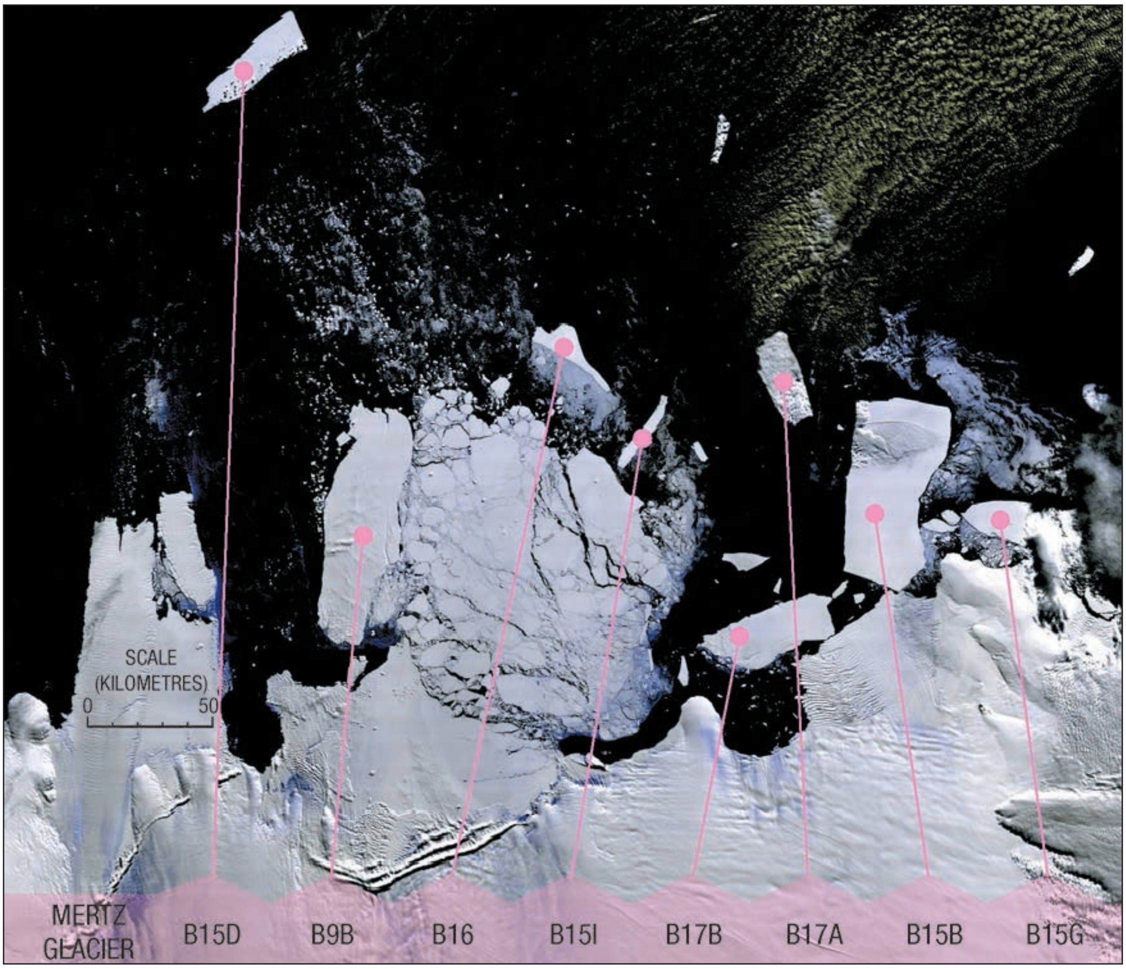
RIC PIACENZA

Aurora Australis *(left) manoeuvres toward the stationary* Polar Bird *on 13 January 2002 at the start of a 24-hour operation to free the ship after more than a month beset in heavy pack ice in Prydz Bay.*

On 11 January cracks around the vessel enabled it to move under its own power some 21 miles to the north, where it was met by *Aurora Australis*. At this point the weather changed again, preventing both vessels from moving for another 24 hours. *Aurora Australis*, with its greater engine power, was able to manoeuvre around *Polar Bird* and break it free from the ice before clearing a way to the open sea. The complex operation ran from the early morning of 13 January until the following day, when both ships entered clear water and could proceed to Australia.

Joe Johnson, Voyage Leader, Voyage 4 2001–02

More of those big bergs: where are they now?



This image showing the icebergs along the coast of George V Land was acquired by the MODIS instrument on NASA's Terra satellite on 9 March 2002. The Mertz Glacier Tongue is on the left (west), as well as iceberg B9B, and others that have calved from the Ninnis Glacier over recent decades. Sections of the icebergs B15, B16, and B17 that calved from the Ross Ice Shelf have drifted into the region immediately to the east, except for B15D which has already drifted past Mertz Glacier on a path that is likely to take it around the continent and eventually through the Weddell Sea.

Data provided by NASA/GSFC/DAAC.

A massive iceberg of about 5000 km^2, designated B22, broke away from the Thwaites Glacier in West Antarctica in March 2002. In the previous November, iceberg B21, about 700 km^2, calved from the neighbouring Pine Island Glacier. Such events are part of the natural process of extension of the glacier tongues and their reduction through iceberg calving, but they have left the tongues at the shortest extent observed for these glaciers.

In another part of West Antarctica, along the east coast of the Antarctic Peninsula, more than 3000 km^2 of the Larsen 'B' Ice Shelf disintegrated over a few weeks in February and March 2002, producing several large icebergs and thousands of smaller fragments. Unlike the calving of B21 and B22, this event is clearly associated with climatic warming in the Peninsula region (see 'Antarctic ice and the global climate system', p 3). The flotilla of icebergs has joined the group of massive icebergs that calved from the Ronne Ice Shelf two years ago, and which are still moving slowly north along the Peninsula (see *Australian Antarctic Magazine #2,* p 5).

In East Antarctica, the massive icebergs that calved from the Ross Ice Shelf in early 2000 (*Australian Antarctic Magazine #1,* p 24) continue their slow progress around the coast. The largest remaining section of B15 (B15A) and iceberg B16, still next to Ross Island, have caused major changes in the movement and breakup of sea ice in that region, reduced biological productivity of surface waters and wrought havoc on local penguin colonies (see story below), as well as seriously affecting shipping to and from McMurdo station. Other Ross Ice Shelf icebergs have now drifted together close to the coast near Mertz and Ninnis Glaciers, where many could run aground, joining others accumulating over the past 20 years. One large section, B15D, has passed the Mertz Glacier Tongue and continues moving around the coast to the west.

Neal Young, Antarctic CRC and AAD

Hard times for Ross Sea penguins

In March 2000 a huge piece of the Ross Ice Shelf, south of New Zealand, broke off and drifted westward to Ross Island. The iceberg, known as B15A, has remained grounded there since July 2001. Its presence changed the lives of the region's emperor penguins. Some 1200 emperor pairs gather at Cape Crozier at the eastern end of Ross Island in April and May to breed.

Some time last winter, B15A shifted slightly south just far enough to crunch up the icy breeding platform of the emperor penguins. In December 2001, American scientists found ice ridges up to 30 feet high with penguin eggs on top. They collected carcasses of about a dozen male emperors that had starved to death. Ice ridges had probably prevented them from getting out of the colony area and made it impossible for females to return. It's not known whether any penguins managed to leave the colony before disaster struck, whether any of them moved to another site or how many adults died, but it is known that not a single chick survived. If most males were trapped by the ice, the colony's survival would be in serious doubt.

In a season of very heavy ice conditions, B15A may also have prevented sea ice in the region from breaking out. In spring 2001, Adélie penguins trying to return to their Ross Island breeding grounds were faced with a prolonged journey across sea ice and walls of jumbled ice. By November only a fraction of the 136 000 pairs usually breeding at Cape Crozier had reached the colony.

Winds of over 100 knots on 14 December 2001 blew out some 20 miles of fast ice, allowing many penguins to reach the colony. But it was two months too late. If these birds lay their eggs after 20 November, there is not enough time to rear their chicks over summer. The storm blew about 500 adult penguins and their eggs off their nests, killing the birds. Others were buried under as much as 4 m of snow, from which most never emerged. After the storm only two percent of the penguins in this colony had chicks.

Other Ross Island Adélie colonies suffered similar fates. Penguins eventually returned but too late to breed successfully. In one of the Cape Royds sub-colonies, where in a good year up to 150 chicks are reared, there were only nine youngsters this season.

BARBARA WIENECKE

Top: Adélie penguin colony at Cape Royds. After a record winter sea-ice year the ice broke out too late for the penguins. Open water encouraged the birds to return but only in December rather than October. Above: A sparse Adélie penguin colony at Cape Royds in early January 2002, at a time when chicks should be thick on the ground. Adélie penguins are engaged in courtship displays and nest building activities...but they are two months too late to be successful in their breeding attempts.

Mother Nature has performed an exclusion experiment that no ethics committee would ever approve, but it has provided invaluable data on the resilience of these penguins. One year of near total breeding failure tends to increase the rate of adult survival: potential parents do not have to invest energy into chick rearing activities and are exempted from the crucial decision as to when to stop feeding their chicks and start fattening up for their moult. But a continuation of the Ross Sea ice situation bringing several years of poor breeding success would threaten the survival of the world's southernmost Adélie penguin colonies.

The good news is that the Ross Sea colonies on Franklin Island and farther north appear to have had a successful year with many Adélie penguin parents feeding two chicks.

Barbara Wienecke, seabird ecologist, AAD

Sydney company chosen to progress Antarctic air link

Australian Antarctic scientists are now a step closer to having air access to the ice. Following assessment of several industry proposals, a Sydney-based company, SkyTraders has been selected as the preferred supplier. Further work with the Australian Antarctic Division will now be undertaken to see how the service can best be provided and funded before final approval from the Australian Government is sought.

An airlink would give Australia's Antarctic research program much more flexibility. Parliamentary Secretary responsible for the Antarctic, Dr Sharman Stone commented: 'This is an important development which will significantly reduce travelling times for scientists and improve Australia's capacity to support research in remote areas'.

The SkyTraders proposal is for a 16-passenger jet operating between Hobart and a hard glacier ice runway near Casey station. The Falcon jet can fly non-stop from Hobart to Casey and return. This avoids the need for refuelling in Antarctica, minimising the risk of fuel spills and the need to transport and store aircraft fuel in Antarctica.

This air service would also increase safety for passengers, with only a six-hour weather window for each flight. If there is any significant weather change during flight, the aircraft could return to Australia.

Subject to adequate financing and environmental approvals and a decision to proceed, airfield construction for the air service could start next summer, with the first flights beginning in the 2003-2004 summer. The Falcon intercontinental service would aim to provide 25 flights to Casey during each summer season. Personnel bound for other Antarctic destinations would change at Casey, to a ski-equipped, CASA 212 aircraft for flights to Davis, Mawson or remote field locations.

The next stage of the air service project development will also involve identification of other potential users of the service.

WAYNE PAPPS

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The Director of the Australian Antarctic Division, Dr Tony Press (above), discusses the air transport proposal involving use of a jet-powered Falcon aircraft (below) for intercontinental travel.

Making sure clean-ups don't add to problems

Human impacts research at Casey this year focused on developing procedures for monitoring the planned clean-up of Thala Valley tip and other decades-old Antarctic waste dumps. Australia is committed to cleaning up such past sites, but only if it can be done without causing more environmental disturbance. We are monitoring the Thala Valley site so we can detect any environmental changes that may be caused by the clean-up. Because most Antarctic waste tips are near the seashore monitoring will focus on marine impacts.

The proposed monitoring has three main components that will provide information at different time scales. *Short-term monitoring* will provide information as the clean-up operation progresses. New field techniques and tools for measuring run-off contaminants and for on-site chemical analysis will enable excavation and removal work to be modified if necessary. To cover for the chance of such 'snapshot' chemical monitoring missing peak periods of contaminant spread, small amphipod crustaceans in tanks fed with tip run-off water will serve as biological sentinels, observed for behavioural changes compared to amphipods in 'clean' control tanks.

In the clean-up's final assessment and audit, *medium-term monitoring* will confirm whether or not the work added to environmental impacts. This year sediment traps deployed in Brown Bay and elsewhere measured contamination carried into the sea during the normal summer melt. Traps deployed during the clean-up will show any changes in contaminant mobilisation during and after the work, while sentinel amphipods will be analysed for contaminants in body tissues. Other experiments will determine whether clean-up work causes changes in recruitment of nearby sediment-living animals, whose larval stages are particularly vulnerable to pollution.

Long-term monitoring will determine whether the effort invested in the clean-up creates significant and lasting environmental improvements. Our research indicates that Brown Bay marine life, adjacent to Thala Valley, is very different from that at other locations near Casey and that human activity is the most probable cause of these differences. However, we do not know whether removing the tip will change the biological communities and if they do, how long it will take. We will look for increases in the diversity of animals and plants living on the sea-bed near Thala Valley as an indicator that the community is recovering.

IAN SNAPE

A cautious approach to the clean-up of Antarctic waste dumps ensures that the clean-up itself does not cause a greater environmental impact than leaving the site untouched.

The three monitoring time scales are needed not just for practical information to guide the Thala Valley clean-up, but also for more general insights into human impacts in Antarctica. Antarctic environmental impacts are assessed against whether they are likely to be *less than minor and transitory*, but the meaning of this is not easily defined. The three levels of monitoring will allow assessment of how serious the impacts are (whether they are minor) and how long they last (whether they are transitory).

Martin Riddle, Human Impacts Program Leader, AAD

Contaminants in freezing ground meeting

Hobart was the venue for the Third International Contaminants in Freezing Ground conference, held in April 2002. The first two such meetings at the Scott Polar Research Institute in Cambridge (UK) focused mainly on the Arctic. In the Hobart conference we aimed to widen the audience to encompass people involved in Antarctic contaminated sites issues.

In both the Arctic and Antarctic, we need to know how best to manage a legacy of contaminated sites, abandoned facilities and waste disposal sites in freezing ground. We often lack the technical capability to remediate these sites because of environmental challenges unique to cold regions. This was the focus of the Hobart meeting, where we promoted exchange of information between Antarctic Treaty nations and learnt from Arctic experiences.

The meeting focussed on fundamental properties of contaminated soils (physical, chemical and biological), processes of contaminant transport and dispersal (especially hydrology), contaminated sites assessment procedures, legal, policy and compliance issues, environmental impacts (especially the impact of contaminants on biota), application of remote sensing in assessment, monitoring and remediation of contaminated sites, and new strategies and techniques for contaminated site management and remediation.

Participants had a scientific or practical interest in contaminants in cold climates, including scientists, engineers, remote sensing specialists, hydrologists and environmental managers. Organisations represented included universities, corporations, government, military and the environmental consulting industry.

Conference papers are now available by email from <publications@aad.gov.au>.

Ian Snape,
Human Impacts Program, AAD

A soaking Mawson's hut gets some loving care

'Hello, this is Ian at Cape Denison. It's 7 degrees C and raining. And it's been completely calm since we arrived three days ago.' Sir Douglas Mawson would have loved Dr Ian Godfrey's call on an Iridium mobile phone from Mawson's historic hut in January 2002. Mawson would have liked the lack of wind, an event he experienced very rarely between 1911 and 1914, but also he loved technology. His Australasian Antarctic Expedition established the first radio contact between Antarctica and Australia via Macquarie Island and operated the first aircraft in Antarctica (though as a 'tractor' since it could not be flown after a pre-departure accident).

IAN GODFREY

Artefacts and melt stream outside Mawson's Hut

Ian reported that an unusually high level of melt at the historic site had revealed artefacts not previously seen, including a box of finnesko (reindeer) boots and a small boat and paddle. Consistent with the site's management plan, the artefacts were recorded but left alone as they were not under immediate threat. Ian's main task was to assess the site following the work of the 2001 AAP Mawson's Huts Foundation expedition and to install corrosion meters to monitor the likely impacts on artefacts in the hut. He also collected data from previously installed temperature and humidity monitors.

Ian's observations on return to Australia have re-affirmed the need to complete the conservation works program on the huts. The AAD is planning an expedition to the site in 2002-03. The Conservation Management Plan for the site and details of the 2002-03 expedition can be viewed on the AAD's website at <http://www.aad.gov.au/goingsouth/expeditioner/projects/mawsonshuts.asp>.

Rob Easther, Mawson's Huts Project Manager, AAD

Penguin deaths under investigation

The AAD's Béchervaise Island penguin research program, now into its 13th year, involves long term monitoring of Adélie penguins at Béchervaise Island, just off the Mawson coast, as part of Australia's contribution to the regulatory work of the Commission for the Conservation of Antarctic Marine Living Resources. There are over 80,000 Adélies spread over about 40 islands in the Mawson region.

LYN IRVINE

Dead Adélie penguin at Welch Island.

During routine fieldwork this summer a total of 160 dead adult penguins were found on four coastal islands between 23 November 2001 and 15 January 2002. Over half of these birds were found at Welch Island. The dead penguins were on the sea ice close to the islands at the seaward side of colonies and within the colony on Welch Island.

Amongst a population of over 80,000, 160 dead penguins is not a lot of birds, but usually we find only one or two dead adults each breeding season. We suspect many deaths occur at sea and so remain undetected. The only other instance of penguin deaths on such a scale occurred in the Mawson region in 1972.

The penguins all appeared outwardly healthy on their return to the breeding grounds after their winter feed. There were more birds than we've ever seen before along this coast – 10 percent higher than our previous high in 1997-98 – and more chicks than we've ever had in the 12 years of the monitoring program.

The majority of dead penguins were found between 23 November and 11 December 2001. These deaths coincided with egg laying and early incubation.

Preliminary investigations suggested disease as a cause, but this will be known only when the analysis of tissue samples is completed in Australia. Location of the dead birds is evidence for a naturally occurring cause: three of the four islands are rarely visited by humans. In addition, stringent measures were implemented to minimise the possibility that infectious material is transferred between penguin colonies by humans. These measures included the washing of boots on arrival at and departure from the penguin colonies.

These penguin deaths are not linked to the major penguin breeding difficulties at Ross Island. The sea ice extent at Mawson in 2001–02 was fairly typical although poor weather prevailed throughout November and December.

STOP PRESS: Evidence from the post mortem examination of birds returned to Australia from Welch Island suggests that the majority of birds died from injury probably sustained among the broken ice at the island's edge. No evidence to implicate disease as a cause of death has been found.

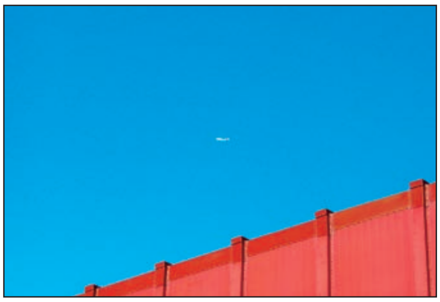
Lyn Irvine, Antarctic Marine Living Resources Program, AAD

Tourism trends: larger ships, more air transport

It is now nearly 50 years since the first commercial tourism activity in the Antarctic. Recent shifts in world tourism, partly resulting from the 11 September terrorist attacks in the United States, provide an incentive to take stock of the Antarctic tourism industry and look at likely future directions.

EWAN McIVOR

Above: Tourists on a QANTAS Antarctic overflight, January 2002
Right: QANTAS aircraft flies over the Casey living quarters on 10 February 2002



MAX PATERSON

Commercial Antarctic tourism probably started in the mid-1950s when a Chilean national airline carried 66 passengers aboard a Douglas DC6-B on an Antarctic overflight. In the late 1950s commercial ship tours from Chile and Argentina took passengers to the South Shetland Islands and the northwestern Antarctic Peninsula. Dedicated Antarctic ship-cruising began in the late-1960s when Lars-Eric Lindblad operated his purpose-designed *Lindblad Explorer* for nature-based, including Antarctic, cruising.

The number of tourists overflying and visiting the Antarctic and associated islands is very small compared with most other tourist destinations and activities, but these numbers and the range of activities are slowly growing – roughly doubling over the past decade. This is largely a result of ice-class vessels from the former Soviet Union becoming available for charter during the 1990s for tourist cruises.

Information from the International Association of Antarctica Tour Operators (IAATO) indicates the total number of tourists visiting and overflying Antarctica in the 2000–01 Antarctic summer season was about 2000 fewer than in the previous season. This is thought to be due to the unusually high number of tourism activities throughout the world during the millennium year and to the unavailability last summer of three cruise vessels that had operated in the 1999–2000 season. IAATO estimated at the 2001 Antarctic Treaty Consultative meeting that numbers for 2001–02 would be over 20,000, including 14,500 from cruise ships and land-based activities (some air-supported), 2,400 on large cruise vessels that did not involve landings, and 3,585 undertaking overflights or landing briefly.

Before the 11 September attacks, tourist numbers were predicted to rise to over 34,000 by 2005–06, much of that coming from non-landing passengers on large tourist vessels. Final data on tourist numbers for the 2001–02 season will not be available until later this year, but comments from a number of Antarctic tourist operators indicate that total visitor numbers may be unchanged, or even slightly higher than, those of 2000–01. There may be fewer US nationals travelling and reduced early-season numbers.

The predicted increase in Antarctic tourist numbers may well eventuate, with three tour companies proposing to operate four large passenger vessels in the Peninsula area in the coming season. Operators of large passenger vessels have previously been excluded from IAATO membership, but at its 2001 meeting the Association agreed to create a new membership category for companies with vessels able to carry more than 500 passengers, subject to those vessels not landing passengers in Antarctica.

The overwhelming majority of Antarctic tourism is in the Antarctic Peninsula area, south of South America, and associated subantarctic islands, and most tours operate out of either Ushuaia (Argentina), Punta Arenas (Chile), or Stanley (Falkland Islands). Landings in the Ross Sea area, southeast of Australia, currently comprise only about three percent of all tourist landings in Antarctica.

Australia's involvement in commercial Antarctic tourism is multi-faceted, involving cruise operations out of Hobart to the Ross Sea region, Commonwealth Bay and the Australian and New Zealand subantarctic islands; Antarctic overflights; and Australian companies (currently five) operating cruise and adventure tours in the Antarctic Peninsula area. In 2002–03, Albany in Western Australia will be the finishing point for a proposed tourist cruise to subantarctic islands in the southern Indian Ocean, including Kerguelen and Heard Islands.

Between November to February each summer, over 2,000 passengers experience Antarctica via overflights from Sydney or Melbourne, or occasionally Adelaide or Perth. Chartering Qantas 747-400 aircraft, the Melbourne company Croydon Travel organises around six flights a season, each lasting around 12 hours. A highlight in past sea-

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2002-2003 Antarctic research grants announced

Global and regional climate change and managing the Southern Ocean ecosystem are the main study themes among the 54 Antarctic research projects granted Australian Government funding totalling $670,000 for 2002–03. Announcing the Australian Antarctic Science (AAS) grants, Dr Sharman Stone, Parliamentary Secretary responsible for the Antarctic, said the scheme illustrated the Government's commitment to supporting long-term Antarctic research, both for understanding regional and global processes and for helping to preserve the region's natural qualities.

'Australia leads the world in research into managing Southern Ocean fisheries, covering development of a sustainable fishery and the conservation of animals – notably seabirds – endangered by that activity. It is important that we sustain this level of research if we are to continue to have an influence in the international forums that regulate the fishing industries,' Dr Stone said.

The Australian Antarctic Division's Chief Scientist, Prof. Michael Stoddart, said that with the Australian research program's five-year science plan now three years old, a more complete picture of fundamental processes and changes in the region was beginning to emerge.

Among projects supported this season are:

- an intensive Australian-German study of the physical and climatic history of Antarctica's remote southern Prince Charles Mountains, seeking to fill major gaps in knowledge of a period when Australia and Antarctica were one continent;
- a study of the production and movement of extremely cold, dense 'Antarctic Bottom Water' to improve climate forecasting models and understanding of their influence on Southern Ocean ecosystems;
- analysis of contaminated sites in Antarctica to guide work to manage the contaminants and rehabilitate the sites producing new technology with application to similar sites elsewhere in the world;
- studies of fur seals on Australia's sub-antarctic islands which have indicated rapidly rising numbers with implications for Southern Ocean fisheries;
- investigations of the upper atmosphere above Antarctica and near-Earth space to develop our understanding of the role and influence of this coldest part of the Earth's atmosphere on weather and climate throughout the world; and
- use of robot technology to investigate growth patterns of microscopic plants that grow on the under-side of sea ice off the coast of Antarctica.

The 54 projects awarded an AAS grant this year – among 130 research projects being conducted next summer – involve universities and government research agencies throughout Australia and other countries.

Institution : total funding (with GST)	Chief investigator	Project title	Grant (with GST)
Australian National University [ACT] : $60 904	Skotnicki, Dr Mary	Conservation of plant biodiversity in Antarctica - a genetic approach	$20 460
	Skotnicki, Dr Mary	Investigation of virus biodiversity in Antarctic terrestrial plants	$8 256
	Tregoning, Dr Paul	Crustal rebound in the Lambert Glacier area	$17 698
	Reading, Dr Anya	The deep structure of East Antarctica from broad-band seismic data	$14 490
Curtin University [WA] : $20 900	Rosman, Prof Kevin	Climatic and sea-level changes during the glacial/Holocene transition inferred from isotope ratios of trace metals in Law Dome ice cores	$20 900
Edith Cowan University [WA] : $10 241	Moro, Dr Dorian	Prevalence and intensity of enzootic pathogens in populations of the black rat (Rattus rattus) on Macquarie Island	$10 241
Flinders University [SA] : $29 700	Kaempf, Dr Jochen	Cross-shelf exchange created by dense water cascading in the presence of submarine channels: physical-biological implications	$14 850
	Tomczak, Prof Matt	Evolution of water mass properties in the Circumpolar Current during 1991-1996	$14 850
Griffith University [QLD] : $18 801	Gabric, Dr Al	Investigating the relation between aerosol optical depth, dimethylsulphide production and phytoplankton dynamics in the Antarctic Southern Ocean	$18 801
La Trobe University [VIC] : $89 442	Essex, Dr Elizabeth	Mapping the GPS total electron content and scintillation activity at southern higher latitudes during high sunspot numbers	$19 800
	Dyson, Professor Peter	Upper atmosphere dynamics and thermodynamics	$17 287
	Dyson, Professor Peter	Investigations of space weather and the mesosphere using the TIGER radar	$20 900
	Goldsworthy, Dr Simon	The conservation of fur seals in the Antarctic marine ecosystem	$31 455
Macquarie University [NSW] : $31 815	Gore, Dr Damian	Palaeoenvironments of the Antarctic coast, from 50°E to 120°E	$16 777
	Gore, Dr Damian	Glacial history of the Framnes Mountains, East Antarctica	$15 038
Southern Cross University [NSW] : $20 900	Jones, Prof Graham	Factors affecting DMS in the seasonal ice zone	$20 900
Tasmanian Parks & Wildlife Service [TAS] : $22 000	Gales, Dr Rosemary	Status and conservation of albatrosses on Macquarie Island	$22 000
University of Adelaide [SA] : $14 553	Vincent, Dr Bob	Dynamical coupling in the Antarctic middle atmosphere	$14 553
University of Melbourne [VIC] : $110 840	Simmonds, Assoc Prof Ian	The influence of the El Nino-Southern Oscillation on Antarctic and subantarctic climate	$21 451
	Simmonds, Assoc Prof Ian	The nature of the Antarctic Circumpolar Wave and its connections with Australian rainfall variability	$22 000

	Bye, Dr John	Effects of the modulation of the surface shear stress by the wave field in a model of the Southern Ocean	$12 719
	Stevens, Prof Geoff	Development and application of technologies for the removal of heavy-metal contaminants from run-off associated with abandoned waste disposal sites	$17 192
	Wilson, Assoc Prof Chris	Prince Charles Mountains Expedition of Germany-Australia (PCMEGA)	$22 000
	Wilson, Assoc Prof Chris	Structure and dynamics of the Sorsdal Glacier	$14 355
	Bishop, Assoc Prof Ian	Development of a GIS of wilderness and aesthetic values for the AAT	$1 123
University of Newcastle [NSW] : $36 297	Fraser, Prof Brian	Observations of ULF space plasma waves in Antarctica	$16 170
	Fraser, Prof Brian	A Southern Hemisphere imaging riometer experiment (SHIRE)	$20 127
University of New England [NSW] : $3 212	Smith, Dr Steve	Spatial and temporal variation in the recruitment of benthic macroinvertebrates to artificial substrata	$3 212
University of New South Wales [NSW] : $10 346	Burton, Dr Michael	The automated astrophysical site testing observatory	$10 346
University of Queensland [QLD] : $11 254	Gasparon, Dr Massimo	Baseline metals in Antarctic environments: Casey area and Bunger Hills	$11 254
University of Sydney [NSW] : $17 800	Codd, Dr Rachel	Metallated Proteins expressed by Psychrophilic bacteria	$10 870
	Pile, Dr Adele	Cascading effects of global climate change on near shore benthic communities in the Antarctic	$6 930
University of Tasmania [TAS] : $178 874	Bowie, Dr Andy	Iron content of Southern Ocean phytoplankton: implications for carbon transfer to the deep sea	$8 338
	Bowman, Dr John	Bacterial hydrocarbon degradation and impacts of hydrocarbon pollutants on microbial communities within Antarctic coastal sediments	$8 910
	Coleman, Prof Richard	Ridging and calving on the Amery Ice Shelf	$12 162
	Coleman, Prof Richard	GLAS validation on the Amery Ice Shelf	$22 000
	Davidson, Dr Garry	Tectonic, magmatic and hydrothermal evolution of ocean floor spreading at Macquarie Island	$7 115
	Hindell, Dr Mark	The effect of spatial and temporal variation in marine productivity on energy acquisition in southern elephant seals, Mirounga leonina	$20 900
	Kiernan, Dr Kevin	Geomorphological evolution of Heard Island	$14 509
	Kirkpatrick, Prof Jamie	Long term changes in vegetation and soil stability, Macquarie Island	$11 545
	McMinn, Assoc Prof Andrew	Sea ice primary production off eastern Antarctica	$22 000
	McMinn, Assoc Prof Andrew	Role of micronutrients in the sea ice microbial ecosystem	$10 626
	McMinn, Assoc Prof Andrew	The effect of global climate change on Antarctic marine diatoms	$1 228
	McMinn, Assoc Prof Andrew	Antarctic glacial history: Cenozoic geology of the Prince Charles Mountains	$4 389
	Michael, Dr Kelvin	Ocean colour measurements in the East Antarctic sea ice zone	$1 228
	Nunez, Dr Manuel	UV climate over the Southern Ocean south of Australia, and its biological impact	$10 450
	Quilty, Prof Pat	Palynology of Pliocene sediments, Prince Charles mountains	$2 451
	Roberts, Dr Donna	High resolution palaeoclimate analysis of lacustrine systems in the Vestfold Hills	$6 215
	Swadling, Dr Kerry	The fate of primary production in Antarctic sea ice: the role of metazoan grazers	$13 867
	Williams, Dr Ray	Near-coastal distributions of icebergs, derived from SAR and Landsat MSS data using semi-automated image analysis techniques	$941
University of Western Australia [WA] : $18 876	Shellam, Prof Geoff	South polar skuas as vectors of disease	$9 306
	Waite, Dr Anya	The role of large diatoms' sedimentation dynamics in the biogeochemistry and global climatic impact of the Southern Ocean	$9 570
University of Wollongong [NSW] : $30 263	Davis, Dr Andy	Effects of UV radiation on community establishment: a global perspective	$16 335
	Robinson, Dr Sharon	Assessing UV-B induced DNA damage in Antarctic plants: is desiccation a compounding factor?	$13 928

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sons has been a New Year's Eve flight travelling over the continent at midnight, the dramatic Antarctic geography being still visible during the long daylight hours of the Antarctic summer.

The area covered by the flights depends on the point of departure and local weather conditions. Flights from Sydney and Melbourne usually take in the area from Terra Nova Bay in the Ross Sea to Adélie Land while those from Adelaide and Perth overfly Wilkes Land and Wilhelm II Land further west. The AAD provides observer guides on each flight and organises radio link-ups with Australian stations and research vessels to give passengers a chance to ask questions of expeditioners 'on the ground'.

Like all tourists, visitors to Antarctica are constantly seeking new experiences, reflected in the changing range of tour activities and destinations. Mountain climbing, snowboarding and kayaking are regular highlights on some tours, but recent and proposed activities include half and full marathons run at the South Pole, a circumnavigation of Antarctica, a North Pole–South Pole overflight, and an overflight tracking progress of a total solar eclipse over Dronning Maud and Queen Mary Lands in November 2003.

The future also may see a push for greater involvement of aircraft to transport tourists to Antarctica. Over the past decade, US-based Adventure Network International has provided air transport and ground support for trekking, climbing and other adventure activities on the continent, mainly from ANI's summer base camp in the Patriot Hills, Ellsworth Land. Flights to the continent are also provided by Chilean companies, and 2001–02 saw the establishment of a company offering tourist flights from Cape Town to Dronning Maud Land, although no tourists were actually carried this season.

David Moser, Senior Policy Officer, AAD

Cooking up a voyage schedule

JAMES DRAGISIC

Antarctic weather and ice conditions – the 'A' Factor – create numerous scheduling problems for AAD logistics staff. Following is their recipe for planning Antarctic voyages.

Gather the ingredients: For high-quality research we need time to prepare and a plan (voyage schedule) to follow. Scientists' assessment of the relative priority of research projects, and the major programs for the season, determine the timing and route of particular voyages.

Take those programs, add station resupplies as permitted by ice and weather, when the resupply activity is least likely to impact on the native environment, and you have the basic recipe for an annual voyage schedule.

Prepare mixing bowl: However we draft the schedule, ingredients must fit the budgetary mixing bowl, of which shipping costs are a major component. Select activities to match budget, rejecting activities which cannot be accommodated. The shape of the mixing bowl is also restricted by the time limits to our charter agreements and ships' capabilities (range, speed, cargo and passenger capacity, ice capability). *Polar Bird*'s ice classification restricts its effective operation to relatively light ice conditions, while *Aurora Australis* can operate earlier when ice is more prevalent. Stagger their use so that we can extend the summer ice window to its practical margins.

Stir ingredients: Mix in the demands to deliver summer scientists to continental stations before the penguins and other wildlife arrive and bring them out after the last penguin leaves. Blend delivery of summer trades teams to support science or environmental projects. Ensure ships arrive at stations in the right order so that essential resources are delivered where and when they are needed. Carefully add the preference to deliver wintering station personnel soon after completion of training. Add helicopters and the occasional fixed wing aircraft to taste. Minimise transit times, maximise time for marine science. Ensure that voyages use the most economical route and remember environmental implications for voyages calling at Heard or Macquarie Islands. Blend in changeovers and resupply activities to allow enough familiarisation time for incoming personnel and for safe cargo removal. At times the stirring requires a large wooden spoon when demands exceed practical possibilities.

Place in hot oven: The secret to an acceptable schedule is to open the oven door at least twenty times, each time allowing the schedule to be revised to meet changing program needs. The variation might be by only a day or two but small changes can have dramatic impacts on other programs and as many as 40 versions of schedule drafts may be needed for consideration by interested groups, each version accompanied by an esti-

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Australian Antarctic shipping program 2002-03

The following shipping schedule for the 2002-03 season was correct as at 9 April 2002. However, published voyage timings are subject to change without notice and may be brought forward or delayed.. The most current information is available on the AAD's website at <http://www.aad.gov.au/goingsouth/schedules/0203_ship_sked.asp>.

Voyage 1 — Aurora Australis: Macquarie Island deployment and Marine science
Departing Hobart 13 October 2002, returning Hobart 19 November 2002

Voyage 1.1 — Kapitan Khlebnikov: Mawson, Davis and Casey deployment
Departing Cape Town 20 September 2002, returning Hobart 2 November 2002

Voyage 2 — Aurora Australis: Davis and Mawson changeover
Departing Hobart 22 November 2002, returning Hobart 31 December 2002

Voyage 3 — Polar Bird: Casey resupply and changeover
Departing Hobart 17 December 2002, returning Hobart 10 January 2003

Voyage 4 — Aurora Australis: Marine science, Mawson retrieval
Departing Hobart 3 January 2003, returning Hobart 15 March 2003

Voyage 5 — Polar Bird: Mawson resupply, Davis retrieval
Departing Hobart 13 January 2003, returning Hobart 19 February 2003

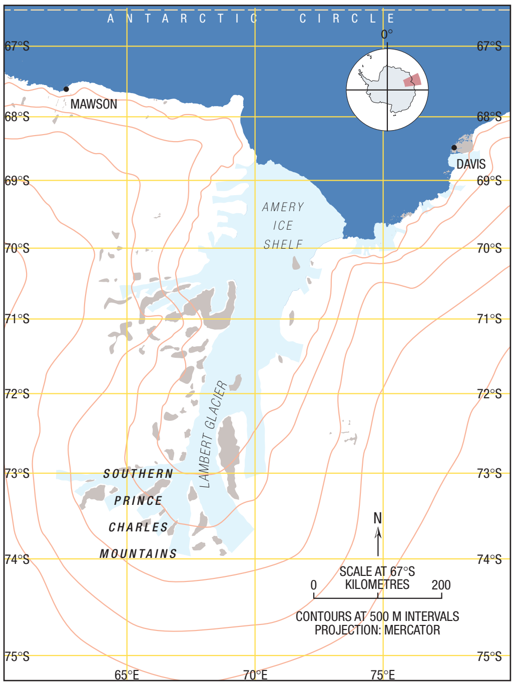
Voyage 6 — Aurora Australis: Macquarie Island resupply
Departing Hobart 17 March 2003, returning Hobart 28 March 2003

Voyage 7 — Polar Bird: Casey retrieval
Departing Hobart 20 February 2003, returning Hobart 13 March 2003

German and Australian scientists collaborate in the Prince Charles Mountains 2002-03


ROB EASTHER

Traverse vehicles south of Mawson in February 2002 depot the first of the 450 drums of fuel for the PCMEGA program.



AAD

A combined German Australian expedition will work in the rarely visited southern Prince Charles Mountains region, 500 km south of Mawson, during the austral summer of 2002-3. In the field for 10 weeks, the group of 34 comprises geophysicists, geologists, helicopter and fixed wing aircraft pilots and engineers, field guides, medical doctor, communications officer, mechanic and a field leader.

Known as the PCMEGA (Prince Charles Mountains Expedition Germany-Australia) the project's Principal Investigator is Professor Chris Wilson of Melbourne University, School of Earth Sciences. He shares the coordination of the scientific program with Dr Norbert Roland of the Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) in Hannover.

Planning for PCMEGA is being coordinated by an Operations Branch Project Team at the Australian Antarctic Division and includes specialists in safety, air, field and tractor traverse operations, environmental impact assessment, medical services and financial management and logistics. AAD operational support for the program includes a traverse by tractors towing sleds of fuel and equipment from Mawson to Mt Cresswell, a return journey of over 1000 km, arriving to coincide with deployment of the field team in November 2002. This group of Mawson winterers will measure snow deposition on a section of the Lambert Traverse route last travelled in 1994.

The field leader will shortly be selected and the environmental impact assessment for the scientific and operational support programs finalised before the expedition departs on Voyage 2 later this year. The field parties will be deployed by Twin Otter fixed-wing aircraft and Aerospatiale AS350B (Squirrel) helicopters through Sandfjord Bay, southwest of Davis.

A major component of the program will be the conduct of an airborne geophysical survey with equipment fitted into the Twin Otter, delivered from Canada for the operation. Groups of geologists and surveyors will camp in the field using four wheel drive bikes (quads) and snowmobiles, assisted by experienced field guides and supported by helicopters.

The Expedition will return to Australia on Voyage 5 in March 2003. Progress on planning the Expedition can be viewed at <http://www.aad.gov.au/goingsouth/expeditioner/projects/pcmega.asp>

Rob Easther, PCMEGA Program Manager, AAD

STOP PRESS: After almost five weeks away from Mawson, the six-member traverse team led by Jim Dragisic returned triumphantly to Mawson on Thursday 2 May in high spirits. They are to be congratulated on a magnificent effort, depoting fuel 300 kms south of Mawson in preparation for a second traverse in October 2002 which will deliver supplies, equipment and fuel to support the PCMEGA field season. Well done to all involved! – *Dr Tony Press, AAD Director*

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mate of charter hire, fuel, victualling, helicopter and other related costs.

Keep in refrigerator: Preparing a schedule two years in advance requires a calculated risk. Even though historical ice data is referenced in drafting schedules, it is almost inevitable that a ship will find ice conditions (like those off Casey and Davis in recent years) waiting to frustrate our efforts.

Serve with side-salad: Don't forget that ships deliver fresh fruit and vegetable supplies to stations, so plan the schedule to minimise the delivery time. They have to still be fresh on arrival.

Add condiments to taste: Publication of draft schedules brings a generous sprinkling of add-on programs to support. Proponents of those programs are happy to accept that they will only be supported if an opportunity presents itself during the voyage, but they still require preparation and planning if the most of those opportunities are to be made. Proponents never lose expectation that they will get the support they need. Select and brief voyage leaders on the range of programs they need to support, share the frustrations of those waiting at a station for the ship to battle its way through the ice to retrieve them, placate those waiting at home, listen to the plaintive and often complaining messages left on the shipping message service (1800 030 744). Be prepared to cut the cake into smaller slices when ice or weather causes delays that can't be made up.

Geoff Dannock, Logistics Manager, AAD

Illegal fishing dominates 20th CCAMLR

A major agenda item for the 20th meeting of the Commission for the Conservation of Antarctic Marine Living Resources (Hobart, 22 October to 2 November 2001) was illegal, unreported and unregulated (IUU) fishing for Patagonian toothfish. Several delegations reported sightings, arrests and prosecutions for IUU activities in the Southern Ocean. While difficult to estimate, IUU fishing in the CCAMLR area has increased significantly over the last year and remains at unacceptably high levels.

The meeting agreed to compulsory use of vessel monitoring systems to verify the area fished by a vessel, which if adopted should significantly reduce fraudulent reporting of Patagonian toothfish catch origins. This was a key goal for the Australian delegation.

The meeting also saw useful advancements in management of exploratory fisheries, including acknowledgment of the need for improved arrangements to minimise bycatch and commitment to further research. A program was endorsed to improve monitoring and assessment of fisheries' impact on Antarctic ecosystems.

Illegal fishers brought to account

Two Russian-flagged fishing vessels have been taken into custody by Australian defence and fisheries officers following their apprehension in Australian waters off the Territory of Heard and McDonald Islands, about 4000 km from the Australian mainland. The vessels apprehended, *Lena* (apprehended on 6 February) and *Volga* (7 February) are suspected of fishing illegally for Patagonian toothfish inside Australia's Exclusive Economic Zone around the territory. The *Lena* had previously been sighted in the Heard Island region late last year.

The vessels were brought to Fremantle, where three *Lena* officers pleaded guilty to charges under the *Fisheries Management Act 1991* related to using a foreign vessel equipped to fish inside the Australian fishing zone. No pleas had been made at time of writing by officers from the *Volga*.

ROYAL AUSTRALIAN NAVY

The apprehension of the *Lena* and the *Volga* are part of a much broader campaign by Australia and other members of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) to stamp out illegal, unreported and unregulated fishing, which undermines international efforts to manage the toothfish resource sustainably.

All 24 CCAMLR members were represented, including Namibia at its first meeting since joining the commission. Other delegates represented Convention parties, states with an interest in Patagonian toothfish issues, intergovernmental organisations, regional fisheries management organisations and conservation organisations.

The Commission meets again in Hobart from 21 October to 1 November 2002.

Gill Slocum, Antarctic Treaty and Government, AAD

Environmentally-friendly Swedish station minimises impact on Antarctica

Australian participation in the 2001–02 Swedish expedition to Dronning Maud Land provided an opportunity to see one of Antarctica's most innovative low-impact station designs, Wasa station on Basen Nunatuk, 120 km inland. The visit aimed to facilitate information exchange between the two Antarctic programs with emphasis on environmental management practices.

WARREN PAPWORTH

Wasa station on Basen Nunatuk, Dronning Maud Land. From left: portable laboratory, main station building, blue generator modules, workshop and storage area, blue and yellow portable laboratories, and red storage containers.

The 2001–02 Dronning Maud Land expedition was termed 'light-weight'. It was deployed via aircraft with minimal cargo and used skidoos as the main form of transport in the field. The group of 11 – expedition leader, doctor, three scientists, logistics expert, technician, glacier safety expert, environmental chemist, photographer and myself, as the Australian representative – was flown on an Illyushin 76 from Cape Town to Novolazarevskaya and from there to the Swedish station, Wasa, on a Basler DC3 aircraft.

Wasa, completed in 1989 and designed to accommodate 16 people, combines good design with use of appropriate technology and operating procedures to minimise impact on the Antarctic environment. Operation of the station over the two months of occupation in 2001-02 used about 300 kg of LPG and 28 litres of petrol.

Wasa's solar-gain design uses well-placed triple-glazed windows that can be opened in a variety of positions to ventilate and regulate heat within the building. Other Wasa design features include solar electricity panels, well insulated walls, floor and ceiling, a heat exchanger to circulate air within the building, and a 'dry' toilet for human waste.

Adoption of these measures has resulted in an Antarctic station that is not only environmentally friendly, but also highly efficient, effective and comfortable.

Warren Papworth, Antarctic Treaty and Government, AAD

Australian Antarctic weather records: Casey


WAYNE PAPPS

This issue's Australian Antarctic station weather information moves from Mawson and Davis to Casey, where the Met team was led by Gary Malpass.

Month by month overview of 2001

Jan., Feb. & March 2001: Average conditions
April & May 2001: Higher than average wind strength and snowfall
June 2001: Average conditions
July 2001: Above average wind strength and temperature
Aug. 2001: -32.9°C on 24 Aug, lowest August temperature since records began in 1989 at current Casey site
Sept. 2001: Slightly above average precipitation
Oct. 2001: Highest October mean daily sunshine since 1989: 5.9 hours of sunshine per day, exceeding old record by 0.7 hour.
Nov. and Dec. 2001: Average conditions.

2001 weather extremes

Lowest air pressure: 949.7 hPa on 2 and 29 June
Highest air pressure: 1008.0 hPa on 24 May
Lowest daily minimum temperature: minus 32.9°C on 24 August
Highest daily minimum temperature: 0.0°C on 17 January
Lowest daily maximum temperature: minus 26.7°C on 24 August
Highest daily maximum temperature: 5.0°C on 31 December
Highest daily maximum wind gust: Easterly, 195 km/h (105 knots) on 11 September

Weather phenomena

	No. of Days	*% of the year*
Wind above 22 knots	178	49
Wind above 34 knots	127	35
Blizzard*	61	17
Snow fall	175	48

*A blizzard is defined as a period of more than one hour when snow reduces visibility below 100 m, the temperature is below freezing point and the wind speed is above 33 knots.

Steve Pendlebury
Bureau of Meteorology, Hobart

International visitors check out Antarctica

Malaysian and Indonesian scientists visited Antarctica last summer as guests of the Australian Government. Dr Siti Alias and En. Omar Pozan from Malaysia visited Casey on Voyage 5, and Dr Agus Supangat and Ir. Muhammad Lukman from Indonesia visited Davis on Voyage 7.

The Academy of Sciences Malaysia has been developing an Antarctic life-science project with the AAD for the past two years. The University of Malaya in Kuala Lumpur, Putra University and the University of Science, Penang, are all contributing to a study of the biodiversity and biology of marine algae, fungi and bacteria. Malaysia's growing Antarctic program includes upper-atmosphere research and a glaciology project with New Zealand at Scott Base as well as their nascent program with Australia. Next season Malaysian scientists will for the first time conduct their own project within the Australian Antarctic program.

Agus and Luky are not the first Indonesians to travel with the Australians; in 1996 two marine scientists, Ir. Fadli Syamsudin and Ir. Muh. Evri, undertook a marine science voyage and visited Macquarie Island. This year's scientists visited Davis, where they presented a plaque commemorating the Indonesian Antarctic Expedition 2002, signed by President Megawati Soekarnoputri, to the Australian Antarctic program. Luky collected water samples for a study of aquatic organisms at Hasanuddin University, Sulawesi. Agus will be investigating oceanographic data upon his return.

The AAD has greatly enjoyed the company of our four visitors this season and looks forward to future cooperative work with Malaysian and Indonesian scientists on research questions of common interest.

Michael Stoddart,
Chief Scientist, AAD


ROB EASTHER


HAU LING

Above: Indonesian scientists Dr Agus Supangat and Ir. Muhammad Lukman at Davis. Below: Malaysian scientists En. Omar Pozan (at Casey) and Dr Siti Alias (at Mawson).

In the news

Two new faces in charge of Antarctic Program

WAYNE PAPPS

Dr Sharman Stone, Parliamentary Secretary responsible for Australia's Antarctic program, pictured above with the Minister for the Environment and Heritage, Dr David Kemp, during a joint visit to Australian Antarctic Division headquarters at Kingston, Tasmania in April 2002. Dr Kemp and Dr Stone took up their new positions following the re-election of the Howard Government in November 2001.

Dr Stone, MP for the Victorian rural seat of Murray, is Parliamentary Secretary with responsibility for the Antarctic and the Bureau of Meteorology. Dr Kemp replaced Senator Robert Hill, who has been transferred to the Defence portfolio.

WAYNE PAPPS

New Kingston facilities to enhance Antarctic research capability

$6.2 million of building projects which began at the AAD's Kingston headquarters in February will involve construction of a new building by the site's owners and refurbishment of existing laboratories. The work is scheduled to be completed in October 2002. The new facilities will include upgraded laboratories to bring biological, ecological and atmospheric science research facilities up to world standard, a dedicated krill aquarium to enable long-term studies of this central component of the Antarctic food chain, and a new building linking existing structures, to house office, planning and research facilities. The redevelopment will add 2160m² of accommodation to the complex and will be followed by the refurbishment of the existing Display, Administration and Science buildings. Work will also be completed in the Workshop and Stores building.

The project follows agreement on the sale of the AAD complex to a private consortium, financed and sponsored by ABN AMRO, which is leasing the facilities back to the AAD. The building contractors are the Hobart-based company, Hansen Yuncken Pty Ltd.

KEN BARRETT

Mobile crane breaks records

A 50-metre mobile crane was delivered to Mawson station over summer to make an early start next season on building the station's new wind turbines. The Grove All-Terrain GMR 5100 was selected for its height and ability to lift wind turbine components, weighing up to 10 tonnes, to a height of about 40 metres. With all its counterweights attached, the crane has a total lifting capacity of 100 tonnes, and weighs about 80 tonnes. The crane will later be shipped to Casey and Davis for similar installations there.

KEN BARRETT

Fuel-saving Mawson water tank

A new 600,000 litre water tank being built at Mawson will allow the station to make the most of the annual melt while considerably reducing the fuel needed to melt ice – both an energy and labour intensive task. The tank will capture summer melt water for consumption over the winter, while providing a thermal energy storage system when the station's new wind turbines are commissioned. It will also allow greater flexibility in deploying winter staff.

WAYNE PAPPS

Classroom Antarctica launched

A comprehensive Web-based Antarctic educational resource set developed by the Australian Antarctic Division was launched on 15 February by Dr Sharman Stone, Parliamentary Secretary responsible for the Antarctic.

Classroom Antarctica is an online teaching resource providing teachers with a practical, lavishly-illustrated manual of Antarctic information and ideas for class activities within Australia's National Curriculum Profile framework. It seeks to channel students' curiosity about the Antarctic into effective learning about the region and its place in the world.

Classroom Antarctica showed that the Australian Antarctic Division took this commitment seriously, taking educational services to new levels of excellence, Dr Stone said.

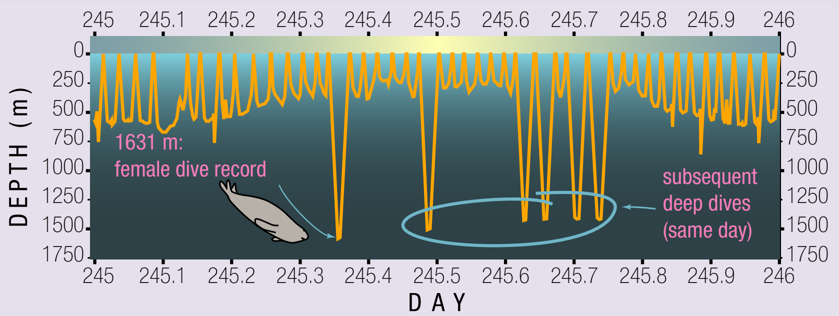
Classroom Antarctica's eight inter-disciplinary units have been designed to enable teachers to engage students in virtually any teaching situation. They may be used for single lessons or as a basis for a whole year's planned learning activities. The resources include a series of profiles of Antarctic expedition members, providing a personal insight in a pattern of questions and responses.

Classroom Antarctica is also a resource centre for Antarctic information elsewhere, providing thousands of links to relevant websites throughout the world. *Classroom Antarctica* can be viewed at <http://www.classroomantarctica.aad.gov.au>.

Tasmania celebrates midwinter

Antarctica's midwinter will come to Tasmania in 2002 with a week-long program of activities for young and old. The 'Antarctic Tasmania Midwinter Festival', supported by the Tasmanian Government, the Australian Antarctic Division and numerous Antarctic-related institutions in Hobart, will include a polar film festival, art exhibitions, lectures including the inaugural Phillip Law Lecture, a barbecue, and a traditional midwinter hosted by Antarctic author Tim Bowden.

Deep-diving record sealed



The deepest dives by a mammal ever recorded have been achieved by elephant seals carrying Australian Antarctic Program data-loggers. Dives by a male elephant seal to 1926 m and by a much smaller female to 1631 m have been reported by scientists studying seals hauling out at Macquarie Island. Harry Burton and John van den Hoff of the Australian Antarctic Division reported the male's dive, and Corey Bradshaw and Mark Hindell at the University of Tasmania's Antarctic Wildlife Research Unit announced the deepest dive recorded for a female. Both seals had been equipped with data-logging devices which measure dive depth, temperature and light levels every 30 seconds during the seals' eight-month winter foraging trips that can take them as far afield as Antarctica and South America.

Southern elephant seals (*Mirounga leonina*), the world's largest seals, are known to dive regularly over 1000 m (1 km). The five-year-old male elephant seal, numbered C026, dived nearly double that depth to where pressures are about 200 times those on the surface. C699, an eight-year old female among 18 eight-year old females to which were attached data-loggers, was the largest female weighed on the island this season, coming in at a hefty 691 kg (1523 lbs). Dr Bradshaw believes that above-average size was the main reason for the feat, allowing the seal to hold her breath for longer, carry more oxygen and maintain a relatively low metabolic rate. However, scientists have little idea how the seals deal with the great pressure encountered at such depths.

Mark Hindell and Corey Bradshaw, University of Tasmania, with contribution from John van den Hoff, AAD

Electrical fault leads to Casey building damage

MICKY LOEDEMAN

An electrical fault at Casey on 12 November 2001 triggered a chain of events that led to damage to two electricity substations and the station's satellite communications control room, as well as minor damage to components within the buildings.

The fault caused automatic fire extinguisher systems to be activated. Rapid response pyrogen extinguishers were then discharged, causing a build-up of pressure within buildings that led to the structural damage, mainly to roofing. Normal satellite communications with Australia were cut by the incident, which was reported to Australia via an emergency communication link.

Confronted with what appeared to be three separate fires at the same time, the fire response team dealt with the emergency skilfully and calmly. The AAD Director, Dr Tony Press, commented that what might have been a major setback, with lost power and communications, had quickly been set right because of the professionalism and skill of station leader Paul Cullen and his team.

For a period following the incident the station was without electricity and building damage took several weeks to repair. The diligence and skill of the building crews resulted in minimal impact on the science programs – and no weather-induced damage during the lengthy period of repair.

Award to AMISOR Ice Team

WAYNE PAPPS

Members of the AMISOR Ice Team have been awarded an Australia Day Achievement Medallion. The citation for the award reads:

'*In order to obtain data on climatically linked processes that occur beneath the floating Amery Ice Shelf in East Antarctica, the Amery Ice Shelf Oceanographic Research (AMISOR) Project Team has spent three Antarctic summers developing and using a new hot-water ice drill. The drill is enabling oceanographic measurements to be made in the cavity beneath the shelf, a location otherwise inaccessible.*

After field-testing the equipment in 1999-2000, and subsequent refinement, the Project Team drilled a near-perfect 370-m deep, 400-mm diameter hole during the 2000-01 field season. The six-person party worked around the clock under severe conditions in a remote field camp to drill the hole and to successfully collect the necessary research data.

Returning to the Amery Ice Shelf in the 2001-02 field season, the Team has completed a second hole, 479-m deep. The dedication of the Project Team, their design and engineering skills, and their enthusiasm for the task is recognised by the award of an Australia Day Achievement Medallion."

Exercise Blue Ice gets thumbs up

An exercise at AAD headquarters in December 2001 to test new crisis management and recovery procedures and response groups' ability to deal with different emergencies also provided an opportunity to consider issues associated with a future air transport system. 'Exercise Blue Ice' simulated an incident in which people were injured and an aircraft damaged on landing near Casey station. Over two days, staff were confronted with realistic demands from media, family and friends, politicians, other government departments, other stations, commercial colleagues, state authorities, fellow international Antarctic agencies and our parent department.

Specialists from Campbell Crisis Management and Recovery Pty Ltd, which managed the exercise, reported that the AAD response teams performed well and the exercise was a great success. Further such exercises are planned.