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ANTARCTICA
valued, protected
and understood

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Australian Antarctic Division

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OPERATIONS
5 A taste for shipping

SCIENCE
19 'Whale cams' reveal secret life of ocean giants

SCIENCE
22 The Bureau of Meteorology in Antarctica

IN BRIEF
32 Chance discovery triples critically endangered plant population

CONTENTS

ABOUT THE COVER

This image by Canadian photographer Dave Brosha was taken during a whale research voyage to the Antarctic Peninsula in February 2017. In the photo, Australian Antarctic Division marine mammal scientist, Dr Mike Double, prepares to deploy a LIMPET satellite tag on a minke whale, as part of a broader program of satellite and video tagging of minke and humpback whales. Read the full story on page 16.

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

Australia's Antarctic national interests are to:

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

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From the Director

As this magazine went to press, entries for the "Name our Icebreaker" competition were flooding in from schools around Australia. The competition is a unique and exciting opportunity for Australian students in grades 5 to 8 to play a role in Australia's Antarctic history and to learn more about the Australian Antarctic Program through associated classroom materials aligned with the curriculum.

These students are our future Antarctic scientists, station leaders, or the huge range of occupations that are key to supporting our program. Twelve students from the winning classes in the primary and secondary school sectors will be privileged to a flight down to Wilkins Aerodrome to experience Antarctica first hand. This extraordinary prize is sure to drive a huge amount of interest in our new state-of-the-art icebreaker.

In my view, spreading the word about our Antarctic activities is as important as the work itself

The Australian Antarctic Program is also looking to the future through the development of a heavy-lift aviation capability, in association with the Royal Australian Air Force (RAAF). This past season the RAAF C17-A Globemaster made seven flights in support of the program, including an airdrop of fuel to support deep field science (page 31). Traditionally, fuel has been flown into the field using helicopters or ski-equipped aircraft. However, it takes an extended weather window and numerous flights to move the same amount of fuel as delivered by the C17-A in a single mission. Proving this concept is a major capability step for science. A major project to scope out the feasibility of year-round aviation access to Antarctica is also underway, and more details will follow in a future issue of this magazine.

Keeping all our ships and aircraft in motion and ensuring the safety of our Antarctic operations is the job of a team of highly talented people at Head Office and in Antarctica. In this issue we profile some of the people behind these important roles (pages 2-10).

On the scientific front, this Antarctic season saw a range of investigations conducted on the Totten and Sørsdal glaciers to better understand ice shelf processes, including the role of surface meltwater in ice-shelf thinning. Glaciologists are now planning next season's work – and we'll bring you an update in a future issue.

Whale research was also a feature of the season, with work tagging humpback and minke whales off the Antarctic Peninsula (page 19), and acoustic tracking of blue whales as part of the multi-disciplinary Antarctic Circumnavigation Expedition (page 18). Both research activities will provide important information to the International Whaling Commission in support of whale science and conservation. In this issue we also look at the success of the International Whaling Commission's Southern Ocean Research Partnership, which for the past eight years has driven innovative, non-lethal approaches to studying whales (page 16).

Photo: Adam Roberts

International collaboration is an inherent part of our work in Antarctica and enshrined in the Antarctic Treaty System. As part of Australia's obligation under the Comprehensive Nuclear-Test-Ban Treaty, Davis research station will become the site of a monitoring facility for nuclear explosions in the atmosphere. The site will form part of an International Monitoring System, but it will also provide useful data for much broader research applications (page 14).

In my view, spreading the word about our Antarctic activities is as important as the work itself. This season we were fortunate to have a prolific and talented wordsmith visit Casey research station as part of the Australian Antarctic Arts Fellowship (page 26). Speculative fiction author Sean Williams collected insights and inspiration for a novel about Antarctica and wrote a blog about his adventure. His book, merging alien fiction with the Heroic Age of exploration, will bring Antarctica to a whole new audience, and no doubt collect some new fans along the way.

Finally it is with sadness that we mark the 100th anniversary of the sinking of the Australasian Antarctic Expedition's ship, the SY *Aurora*, and the loss of her crew, off the coast of New South Wales (page 30). The ship was key to Mawson's expedition and, as a result, Australia's reach and influence in Antarctica. One hundred years on we are building a very different ship, to support a new era of Antarctic research and exploration.

Dr NICK GALES
Director, Australian Antarctic Division

Navigating the ‘A’ factor

With the 2016-17 Antarctic summer season in full swing, Australian Antarctic Division Operations Manager, Robb Clifton, convenes the weekly Season Operation Coordination Group meeting. In the room are the Division’s experts on shipping, aviation, station and field operations, science planning, engineering and polar medicine. On the phone are the station leaders from Australia’s three Antarctic stations and Macquarie Island, and representatives from the Bureau of Meteorology and Department of Defence.

The meeting is short, sharp and to the point, as participants summarise the key activities of the past week, what’s coming up, and any potential issues with delivering the season’s operational and scientific priorities.

It’s just one of many meetings Robb facilitates each week, with a calm competence and friendly manner that belies a heavy responsibility – keeping up to 60 science and infrastructure projects, multiple aircraft, four stations, field camps, and one or two ships, operating as planned.

But the former Australian Army Special Forces Officer, mountaineer, and Antarctic station, field and voyage leader, has plenty of experience and training to draw on.

“Applying a rigid military model to this role may not work so well, but there are useful skills that translate very well, including leading by example, being flexible, dealing with change and understanding people,” he says.

“The challenge for us at Head Office is to maintain a connection with the on-ground field operations and not forget what it’s like at the other end.”

As Operations Manager, Robb leads and works with an operations team of up to 20 people in Hobart, and coordinates and collaborates with many more in Hobart, Antarctica and around the world. The team is responsible for planning and delivering the Australian Antarctic Program’s operations in the Antarctic, sub-Antarctic and Southern Ocean.

“We spend a lot of time in discussion with groups of people, to establish a broad season plan and detailed concept of operations for individual projects, which outline the season’s priorities and how they’ll be achieved,” Robb says.

“We try and plan as much as we can before the season starts, but we always need to make running adjustments, as we’re impacted by the ‘A’ factor – adverse Antarctic weather or events. So weekly and even daily meetings are required to tweak the plan and try to maintain the original objectives and outcomes.”

While Robb’s team undertake much of the tactical work, he still wakes every morning with little or no certainty around how his day will unfold.

“In this job, if you need to control or know everything, you won’t sleep at night,” he says.

“You need to be fairly comfortable with uncertainty and be able to delegate and accept risks that you don’t fully control. You just have to put good systems in place and trust in your team.”

Testing times

Over the years the team has been tested. In October 2015, for example, the first voyage of the season was just hours away from departure when an expeditioner on Macquarie Island fell ill, requiring repatriation to Australia. While expeditioners bound for Davis cooled their heels in Hobart for six days, the operations team, alongside polar medicine, supply services and others at the Division’s headquarters and on station, swung into ‘Crisis Management and Recovery’ mode, to get the sick expeditioner safely home and the season back on track.

Later that season, in February 2016, the *Aurora Australis* broke free of its mooring lines at Mawson during a blizzard and ran aground in Horseshoe Harbour. While marine scientists and other personnel on the ship and at Mawson research station were immediately affected, the incident had a domino effect on expeditioners at Davis research station, who were waiting to return home on the ship. Among the complex logistics required to recover the season was assistance from the United States to fly Davis expeditioners to McMurdo on their LC 130 aircraft. From there they were flown home on the Antarctic Division’s Airbus (A319).

Meanwhile, personnel stranded on the ship were transferred to Mawson research station by barge, and then to Casey two weeks later by the Japanese ship, *Shirase*, for an onward journey to Wilkins Aerodrome. Helicopters were returned to Australia from Wilkins by the Australian Defence Force’s C17 aircraft, and remaining people and cargo were collected by the Chinese ship *Xue Long* from Davis and returned to Australia.

While the big puzzle pieces were falling into place, a range of behind-the-scenes support plans were being implemented, covering such things as marine pollution, wildlife impacts, medical needs and station food supplies. Multiple contingency plans for different assets were developed and discarded as the situation evolved. Last, but not least, the *Aurora Australis* was assessed for damage and deemed safe to return home with a skeleton crew.

Robb says standard operating procedures, crisis management plans, strong relationships with external stakeholders, clear goals, and a flexible approach to achieving those goals, allows the team to deliver a good season in most years, and recover a bad one.

“We have a clear structure where we all know our roles,” he says.

“Even during a crisis, a lot of our work is about coordination of the different parts – helicopters, fixed-wing aircraft, ships, personnel – to get the job done and devise solutions. How do we keep achieving our goals with less resources? It’s a bit like our business-as-usual model, but it’s faster and more intense.”

Cooperative spirit

Cooperation with international Antarctic partners plays a key role in the team’s success too. Australia works closely with French, Italian, American, Japanese, Chinese, Indian and New Zealand programs, sharing resources, such as whole aircraft or ships, seats on planes, traverse capabilities and medical expertise.

“Most seasons we utilise the French ship *L’Astrolabe* to resupply Macquarie Island, and in return we’ll fly French expeditioners to Concordia,” Robb says

“We provide our A319 to the United States for flights between Christchurch and McMurdo. We fly Chinese expeditioners on the Airbus to Wilkins and then across to Zhongshan Station by Chinese or Australian Basler. We’ve even provided A319 flights to the Norwegian program from Cape Town to their runway at Troll. And this year we sub-chartered our Basler to the New Zealand program.”

It’s all part of the spirit of cooperation enshrined in the Antarctic Treaty, which is critical in an emergency, but it also has financial and operational advantages, reducing the cost of operating in Antarctica and allowing countries to do more with less.

Changing capabilities

Australia’s operational capabilities in Antarctica have increased significantly over the past 10 years, since the introduction of intercontinental flights (via the A319) between Hobart and Wilkins Aerodrome in 2007, and increasing use of Twin Otter and Basler aircraft between stations. The A319 allows more people and cargo to flow between Australia and Antarctica, with connections to ships or smaller aircraft once in Antarctica. More recently, the Antarctic Division has partnered with the Royal Australian Air Force to use their heavy-lift C17-A Globemaster to deliver and retrieve heavy vehicles and outsize cargo that’s too big to fit in the A319 (*Australian Antarctic Magazine* 30: 24-25, 2016). In late 2016, the C17-A was used to airdrop supplies into deep field.

“Aviation has caused a paradigm shift in the way we operate in Antarctica,” Robb says.

“Previously, operations were essentially quarantined to individual stations and run by the station leaders. Now we’re dispatching aircraft from our headquarters at Kingston, and all the stations are heavily connected to each other. So our operations are now more integrated, flexible and busy.”

1. *Australian Antarctic Division Operations Manager, Robb Clifton, manages a team that plans and delivers the Australian Antarctic Program’s operations. (AAD)*

2. *Robb has a wealth of experience in Antarctica, including as a Field Leader for the Prince Charles Mountains Expedition of Germany and Australia in 2003, which involved some 20 scientists spending three months in the field. This photo shows the beginning of a traverse into the mountains, from Mawson. (Gary Kuehn)*

3. *The grounding of the* Aurora Australis *during a blizzard at Mawson in early 2016, threw the season plan into chaos and put the skills of the Crisis Management and Recovery team to the test. (Brett Free)*

4. *Part of Robb’s role involves addressing the media in a crisis. (Jessica Fitzpatrick)*

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Things are set to become a whole lot busier with the integration of the new icebreaker into the operations model in 2021 (*Australian Antarctic Magazine* 31: 2-6, 2016). Robb is also keen to see the Antarctic Division's traverse capabilities return, and a scoping project is currently underway to determine what an Australian traverse capability might look like.

"Getting a traverse capability back will enable us to support deep field projects such as our ambition to drill a million-year old ice core," Robb says.

"I think a combined aviation-traverse model, such as the one used during our Aurora Basin ice coring project in 2014, would be very powerful. The traverse allows you to get heavy equipment into a remote field site, while people, lighter equipment, and scientific samples can be moved quickly in and out by air."

It's an exciting time for the Australian Antarctic Program, with new cooperative arrangements, operational capabilities and technologies coming on-board in rapid succession. It all makes for busier and more complex seasons, which means more pressure points. But Robb says the Antarctic Division team has these covered.

"The last thing I want is for me or anyone else to be the single point of failure. So we've put good systems in place to ensure that other people can come in and do my job or other's. That's vital for my own health and for the organisation. Technology lets you do an interesting and exciting job wherever you are, but it's critical that at times you can shut it all down."

WENDY PYPER
Australian Antarctic Division

5. *Aviation has revolutionised Australia's Antarctic operations. The A319 (background) allows more people and cargo to flow between Australia and Antarctica, with connections to ships or smaller aircraft (such as the Basler, foreground) once in Antarctica. (Tony Fleming)*

6. *As part of cooperative arrangements between Australia and France, the Australian Antarctic Division charters the French Antarctic resupply ship* L'Astrolabe, *to resupply Macquarie Island each year. In return, Australia flies some French Antarctic expeditioners to the French-Italian station, Concordia. (George Bettingham-Moore)*

A taste for shipping

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For someone who was once resigned to working in taxation, Leanne Millhouse has had an enviable career in Antarctic shipping.

After almost 35 years with the Australian Antarctic Division, Leanne is now the second-longest serving staff member and a good example of how a career can unfold, even in the absence of a plan.

"I had no idea about Antarctica when I started. I came in on a 17 week training scheme in the records section and then I kept applying for temporary jobs as they came up," she says.

With no firm employment commitment, however, Leanne sat the Public Service merit selection exams and was offered a job with the Australian Taxation Office. Just before she left, a permanent position in the Division's records section opened up, and the rest is history.

"I ended up here permanently and then I just fell into things from there. I never had a definite plan or career path."

What Leanne did have was a willingness to try anything and work hard at it. This included working in various Head Office positions in finance, property and reception, as an Expeditioner Liaison Officer, an Operations Coordinator at Casey, and in various voyage management roles.

In 2009 she was asked to join the shipping group for six months. She hasn't looked back since.

"It's hard work and you're thinking on your feet all the time. But it's a very supportive environment, and I enjoy being part of a team where everyone has a contribution and every contribution is different," she says.

Leanne is now a Shipping Officer, helping to manage access and activities on the ship when it is in port. She also takes care of the voyage management team, ensuring they have everything they need to do their job on the ship, and assisting with their training and briefings.

While Leanne is a seasoned hand now, she recalls her first experience on the job as a "baptism of fire". On her first time on-call, a 10 foot refuelling container and hose reel got left behind in Hobart, as the ship headed south.

"The ship was on its way to Casey and was scheduled to stop at Macquarie Island on the way back to refuel the station," Leanne says.

"Two days after the ship left I got a call from the Voyage Leader saying the refuelling equipment was missing. My boss was in Europe at the time, so I spent a lot of time on email working through the problem. Ultimately, we had to organise a separate voyage to Macquarie Island to refuel.

"You hear the term 'flexible' bandied about, but it does apply to this job. You might start on plan A but you'll end up on plan D. You really have to adjust to the circumstances thrown at you."

Leanne's first experience as a Voyage Leader in December 2013 was similarly memorable...the year a tourist and scientific expedition became trapped in sea ice near Commonwealth Bay, onboard the Russian vessel MV *Akademik Shokalskiy*.

Leanne was onboard the *Aurora Australis* overseeing resupply operations at Casey research station when the call to assist the stricken vessel came through.

"We were in the middle of refuelling so we had to stop and work out who needed to be on or off the ship, how we'd get everything on to the ship that we needed, and what equipment we'd leave at the station. And we didn't know whether we'd be able to come back to Casey," she says.

1. *Leanne Millhouse has had a rewarding Antarctic career after passing up a job in taxation. (Jessica Fitzpatrick)*

2. *Leanne's first trip as a Voyage Leader involved the rescue of 52 passengers from the* Akademik Shokalskiy *when it became stuck in sea ice near Commonwealth Bay. Here, experienced field training officers guide passengers across the sea ice to a waiting rescue craft. (Jessica Fitzpatrick)*

3. *Leanne has seen many changes in shipping since she first went south in 1985, including tighter security around the wharf area and strict safety protocols. In the past, a festive atmosphere prevailed when ships, such as the* Nella Dan *(pictured), departed Hobart. (Robert Reeves)*

The rescue operation was run by the Master of the *Aurora Australis*, with assistance from Leanne and fellow expeditioners with skills in glaciology, search and rescue, sea ice travel and watercraft operations, as well as the ship's crew and a team at Head Office.

Once they reached the scene they worked with a Chinese helicopter team from the MV *Xue Long* to fly the 52 passengers from the *Shokalskiy* to an ice floe. From there the Australian team guided the passengers across the ice and used a fast rescue craft as a lift to transfer them to the *Aurora Australis*.

"There were about 40 people on the *Aurora* and they all had a job – greeting the passengers on the deck, guiding them down to the mess for something to eat, sitting with them and trying to provide a level of comfort," Leanne says.

"From a people-management perspective it was exhausting. A lot of people just needed to talk and most afternoons the Deputy Voyage Leader and I would have people up to our office for a chat. We were proud of the fact that when they left our office they were laughing."

Leanne has worked in voyage management on 13 voyages: three times as a Voyage Leader, twice as a trainee and the rest as a Deputy Voyage Leader. Despite her years of experience Leanne says her knowledge of Antarctic operations and logistics is still only "up to my ankles". As Voyage Leader, Leanne is the decision-maker on voyage management issues, but she relies on a raft of experts.

"I don't know everything and I'm happy for people to provide advice. We're all working as a team to achieve an objective, whether that be resupply or responding to an emergency.

"As a Deputy Voyage Leader I work more closely with the crew. You tell them what you need done, but not how to do it.

"The key is managing relationships to ensure everyone has the information they need to do their jobs."

Since her first voyage in 1985 on the *Ice Bird*, Leanne has seen many changes in Antarctic shipping operations.

"I remember when there were no fences and you could just turn up when a ship came in. There were streamers, bands playing and champagne corks popping," she says.

"Security has tightened up since then. It's a reflection of how the entire world has changed. We have more processes around safety and duty of care and they're all documented in standard operating procedures. Safety is our number one priority."

Leanne will miss the "small family business" she joined all those years ago when she retires in a few years' time. But she plans to continue her regular catch-ups over coffee with the shipping and operations teams and she hasn't ruled out a shot at voyage management when the new ship arrives in 2020-21.

WENDY PYPER

Corporate Communications

4. Leanne's first trip south in 1985 was aboard the Ice Bird *(now the* Polar Bird*). Since then she has sailed on the French ship* L'Astrolabe*, the* Aurora Australis *and the Russian ship* Kapitan Khlebnikov*. (Wayne Papps)*

5. Leanne conducts a muster drill on the deck of the Aurora Australis *during a voyage. Regular musters are a critical part of the safety culture of Australia's Antarctic operations. (Jessica Fitzpatrick)*

Safety first

Keeping people safe in Antarctica is a big responsibility. But with experience in the State Emergency Service and as an outdoor leader in the rugged Scottish highlands, Martin Boyle is well prepared.

As the Australian Antarctic Division's Field Support and Emergency Management Coordinator, Martin recruits and manages field training officers, runs the Division's field and emergency response training system, and coordinates the Division's Crisis Management and Recovery (CMR) training.

Underpinning these activities is a raft of standard operating procedures, field manuals and training systems, and the four pillars of emergency management – prevention, preparedness, response and recovery.

"We've bedded down a good system over the past 10 years that's working well for us," Martin said.

"We've put in place a lot of policies and procedures that are international best practice in emergency response and we have a range of manuals for field operations, which we review annually or in the interim, as needed."

The Antarctic field training officers (FTOs) are a critical cog in the safety wheel. These highly skilled outdoors-people come to the Division with a "standard bag of tricks" and other skills relevant to their various pursuits, such as mountaineering or climbing. However, some may need supplemental skills training, relevant to the Antarctic Program, and it's Martin's role to provide this.

"We give our FTOs contextual training, as some have never been to Antarctica. So we need them to understand the operational environment, training frameworks, and how the Antarctic Program works. This then allows them to provide consistent training to Antarctic expeditioners across the Program," he said.

"We also provide FTOs with pre-departure training in land search and rescue techniques, technical rope rescue, and field travel using quads, Hägglunds and small boats."

Once they get to Antarctica the FTOs are responsible for running the field and emergency response training (see page 9). The FTOs also guide parties conducting field research over summer, and may facilitate recreational travel off station.

Martin spent his first season with the Australian Antarctic Program as an FTO, but his skills in emergency management soon saw him drawn into a desk job at Head Office. However, over the past nine years he has had stints as a Voyage Leader, watercraft operator, and Operations Coordinator at Casey research station, and he tries to go south when opportunities arise.

"It's important to go south to refresh your skills and your understanding of the context of your work. Now with the Airlink, it's easier to go to Antarctica as part of my normal day job, and reconnect with the people on the ground," he said.

> *The Antarctic field training officers are a critical cog in the safety wheel*

Maintaining close relationships with the FTOs and other expeditioners he works with is one of the high points of Martin's role, but it can be a double-edged sword in a crisis, when his emergency management skills are called on.

"The Australian Antarctic Program is like a family, and it's a fact that when people you know are involved in an incident, it is more challenging to do the job," he said.

1. Martin Boyle is the Field Support and Emergency Management Coordinator at the Australian Antarctic Division. (Martin Boyle)

2. Expeditioners learn search and rescue and technical rope rescue techniques from a field training officer in Antarctica. (Todor Iolovski)

3. *One of Martin's pre-season exercises for the Crisis Management and Recovery team involved the ship grounding at Casey station. Later in the season the ship grounded at Mawson (pictured) when its mooring lines broke in a blizzard. (Brett Free)*

4. *Expeditioners undertake small boat training in Tasmania. (Barry Becker)*

Martin relies on process, experience, and strong relationships with colleagues in crisis management events. During a CMR – such as when the *Aurora Australis* ran aground at Mawson research station in early 2016 – Martin's role is to coordinate the operational response developed by a range of sub-teams and feed that back into the broader CMR process.

"When the ship ran aground we had teams in shipping, aviation, fuel spill, cargo and supply services, developing response and recovery plans. My role was to work through the options with these different groups and report back to the CMR team, so everyone had situational awareness of the overall operation. The CMR team then decided on a way forward, and briefed the Executive with a plan for them to approve."

The CMR team has been called together a number of times over the years, including through annual pre-season training exercises, developed by Martin, some of which have come eerily to fruition.

"I generally pick a scenario that would be representative of a project we're undertaking or an environment we're working in during the season, and we bring together all the stakeholders, such as Helicopter Resources, P&O Maritime, Bureau of Meteorology, Australian Maritime Safety Authority and Defence, to workshop the problem," he said.

"Before the ship ran aground at Mawson our pre-season exercise was a grounding at Casey. We've also workshopped an earthquake scenario at Macquarie Island, a day before one actually occurred."

Despite the stresses, Martin enjoys the challenge of thinking through problems and coming up with solutions.

"The first plan you develop generally isn't the one that's used. You need a few plans ready to pull out of your back pocket. We work in a complex environment and the situation can rapidly change, which keeps you on your toes."

WENDY PYPER
Australian Antarctic Division

Emergency response in Antarctica

Crisis management and emergency response in Antarctica can be exceptionally challenging.

There are 30 national programs with stations, bases and depots across the continent, each with their own emergency management framework. The Council of Managers of National Antarctic Programs (COMNAP) brings these nations together to facilitate and provide opportunities to build relationships, develop systems, and exchange information. In 2004, COMNAP members developed the 'Framework and Guidelines for Emergency Response and Contingency Planning in Antarctica' which was a major step forward in multi-national cooperation and interoperability.

Mutual aid from other national programs across the continent can be essential during any emergency response. The Australian, French, Italian, Chinese, Japanese, Russian and Indian national programs have created the East Antarctic Emergency Coordination Group, to share information on logistics and emergency coordination. It is a long-standing principle that all Antarctic nations assist each other in times of need, where practicable. The Antarctic community is relatively small, despite the number of nations involved, and assistance from other programs can be crucial for emergency response and evacuation across large geographical distances in such an extreme environment.

It is the remoteness of the Antarctic that makes search and rescue (SAR) a difficult proposition. The Australian SAR region covers an area nearly one-tenth of the world's surface. This includes the majority of the six million square kilometres of the Australian Antarctic Territory. The Australian Maritime Safety Authority (AMSA) Rescue Coordination Centre (RCC) is responsible for any aviation response as far south as the South Pole, and maritime response to the coast of Antarctica. The RCC is also the national monitoring centre for the COSPAS-SARSAT satellite distress beacon system.

The Australian Antarctic Division has a memorandum of understanding with AMSA which outlines the cooperation arrangements for response to major environmental incidents and search and rescue support. The Antarctic Division is responsible for coordinating SAR for its own activities in the Antarctic, and where

practicable, responding to land-based SAR incidents reported by AMSA, including distress beacons from a land-based source in the Australian Antarctic Territory. Given the huge area to cover, lack of resources and extreme weather, the reality is that any rescue could take a long time and would most likely be a multinational effort.

This was the case on Christmas day 2013, when a distress call was received from the MV *Akademik Shokalskiy* near Mawson's Huts at Commonwealth Bay. The resupply at Casey station was well underway and refuelling had commenced, when the RSV *Aurora Australis* was tasked by the RCC to assist the vessel, along with other national Antarctic program ships, MV *Xue Long*, MV *L'Astrolabe* and USCGC *Polar Star*.

The *Shokalskiy* was unable to make its way out of the pack ice and was being threatened by icebergs, with the possibility of having to abandon ship. It took five days for the *Aurora Australis* to arrive on scene, but it was unable to penetrate the thick sea ice to assist in breaking the ship out. Seven days after getting stuck, 52 passengers were transferred from the *Shokalskiy* to the *Aurora Australis* using a Chinese KA32 helicopter, after a sea ice landing pad was created close to the ship. This was a truly multi-national response with the national programs of Australia, China, France and the United States sending assets to assist the vessel.

The Australian Antarctic Program works on a strategic (tactical) operational model, with coordination at the level appropriate to the size of the incident. During incidents that require logistical coordination, family liaison and media management, the Crisis Management and Recovery (CMR) team at Head Office in Kingston, Tasmania is activated. The CMR team not only manages overarching strategic response to the incident but also the logistical implications and season recovery for the Antarctic Program. On station and voyages, an

1. *The* Aurora Australis' fast *rescue craft lifts passengers from the stricken Russian vessel* Akademik Shokalskiy, *which became trapped in thick sea ice in 2013, from a sea ice floe on to the Australian ship. (Jessica Fitzpatrick)*

2. *Expeditioners undertake search and rescue (SAR) training using quad bikes and Hägglunds at Casey. (Martin Boyle)*

3. *The Mawson research station fire team. Prior to deploying to Antarctica, wintering expeditioners receive two weeks of emergency response training in incident management, fire, and search and rescue. They receive further training once in Antarctica and continue their training through regular drills. (Shane Ness)*

4. *The Australian Antarctic Division conducts collaborative emergency response exercises, such as this Antarctic medical evacuation exercise with the Royal Australian Air Force Aero-Medical Evacuation Squadron, on board a C17-A aircraft bound for Wilkins Aerodrome. (David Said/RAAF)*

Incident Management Team is stood up using the Australasian Inter-service Incident Management System. Each station has a multi-disciplinary Emergency Response Team that responds to fire, SAR, fuel spill and medical incidents. Rostered teams of six expeditioners, led by a Team Leader, are on-call for a period of usually two weeks. A Fire Chief and SAR Leader are also chosen from the wintering team and are responsible for continuation training, maintaining equipment and team rostering.

Prior to deploying to Antarctica, wintering expeditioners receive two weeks of emergency response training in incident management, fire, and SAR. Some expeditioners may have developed prior skills sets with fire and emergency services, or on previous deployments, however most will be new to emergency response. When they arrive in Antarctica, in addition to survival and field travel training, they get a further seven days of land search and technical rescue, conducted by professional Field Training Officers. The technical SAR training is based on techniques taught by the Search and Rescue Institute of New Zealand. In 2007 the Australian Antarctic Division, Antarctica New Zealand and the United States Antarctic Program developed a joint Antarctic Search and Rescue Training Manual, which supports interoperability in technical search and rescue across the programs.

The Emergency Response Team continue their training throughout the winter with a series of drills and exercises across the various disciplines. Practicing a station muster is critical to the safety of all expeditioners. When the fire or SAR alarm is activated, all expeditioners make their way to a central point and await instructions. Each person has a tag on the muster board that is colour coded. White for on and red for off station. As they assemble, each person takes their white tag and those left on the board should all be red. In the event that an expeditioner is missing, a station search will be conducted, methodically searching each building and outlying area until they are found. Meanwhile the Emergency Response Team does an initial investigation in the case of a fire, or starts planning for a field SAR. Depending on the nature of the SAR a hasty team may deploy using quad bikes, while the rest of the team follow up in a Hägglunds over-snow vehicle. During the winter these vehicles are kept in a temperature controlled emergency vehicle shelter. This means vehicles can be deployed immediately, without the need to warm or deblizz them. Helicopters, fixed-wing aircraft and inflatable rubber boats may also be used to support operations if conditions and availability permits.

Over the history of the Australian Antarctic Program the skills and attributes of these emergency response teams have been tested during many difficult missions. Incidents such as finding people lost in blizzards, responding to quad bike accidents, aircraft crashes, and vessel groundings in extreme conditions have provided challenges that are difficult for the uninitiated to comprehend. It is a testament to the courage and professionalism of Australian Antarctic expeditioners that they are able to respond to the demands of the Antarctic environment and assist those in need when called upon.

MARTIN BOYLE

Field Support and Emergency Management Coordinator, Australian Antarctic Division

Feeding the troops

When the closest supermarket is more than 4000 kilometres away, and resupply is just once a year, getting the shopping list right for Australia's Antarctic and sub-Antarctic stations is crucial.

From Christmas feasts to the traditional mid-winter dinner, the man charged with ensuring everything is on the table is Australian Antarctic Division Chefs' Adviser, Noel Tennant.

"Life on station pretty much revolves around food," Noel said. "Meals bring variety and excitement to the expeditioners' lives, particularly during the long dark winter months when it can become a bit like ground-hog day.

"Food is also the first layer of defence, to warm the body against the cold, so getting the right amount and type of food is essential."

The Division has an annual catering budget of $1.3 million for 12 months. This means today's expeditioners can enjoy greater variety and more appetising fare than the "hoosh" (stewed pemmican and sledging biscuits) relied on by early Antarctic explorers.

"I work out the average amount of food a person would eat over a year, then I round up," Noel explained.

"We have to have some 'fat' in our stores, because we could end up with more people on station at any time, if the ship is late or people get stuck because of bad weather."

The station shopping list includes about 52 000 kg of frozen and fresh fruit and vegetables. Any fresh produce has to have a long shelf life.

"We send a lot of potatoes, carrots, apples and citrus south. We tend to steer away from soft fruit and vegetables that spoil easily," Noel said.

Annual shopping list for all stations (2016–17)	
Total frozen and +4°C food (no dry goods)	51 976 kg
Bacon	1310 kg
Beef eye fillet	457 kg
Chicken	2961 kg
Frozen peas	864 kg
Ice cream	1980 litres
Coffee beans	546 kg
Potatoes	4800 kg
Fresh eggs (oiled)	34 560
Chocolate	864 kg
Cheese	2262 kg
Toilet paper	1920 rolls

"Fresh eggs are oiled with paraffin before they are sent south, which essentially seals the shell and stops the egg from going off.

"In the dairy department, all the milk is powdered and the yoghurt is made from freeze-dried cultures. We mainly use hard and semi-hard cheeses that are more likely to last 12 months."

The food is generally not plate ready and most things have to be made from scratch.

"We provide a lot of base ingredients that take time to prepare; for example the chefs have to make bread and pastry daily, but this also gives them more scope to produce different dishes."

The journey by ship across the notoriously rough Southern Ocean can take a toll on the condition the food arrives in, so Noel and his team have developed a range of methods to ensure the supplies arrive in top condition.

"We pack everything very carefully in refrigerated containers and use ozone generators in transit, to keep bacteria and fungi at bay," he said.

"We also put 'ethyl stoppers' in the containers of fresh fruit and vegetables, to slow the ripening process. Ethylene is produced by fresh food, such as bananas, when it ripens, which accelerates the ripening of everything else around it."

The kitchen at all the stations is a focal point and social hub for expeditioners, so getting the right chef is central to the happiness of the team.

1. *Antarctic chefs need to be solid all-rounders, producing 'home-style' food as well as being able to pull out all stops for special occasions. (Jessica Fitzpatrick)*

2. *Casey Chef Eddie Dawson plating up pork belly, saffron pommes fondant and red cabbage for a mid-winter lunch. (Peter Hargreaves)*

While they don't have to be Michelin starred chefs, they do need to be solid all-rounders, producing more 'home-style' food. They also need to be able to step it up when there are big social occasions, such as the traditional mid-winter feast, Christmas or birthday celebrations.

Each station has one winter chef, while there are two extra chefs at Davis and Casey over the busy summer period, when the kitchen can be catering for up to 100 hungry expeditioners.

The kitchens provides four meals a day, including morning tea. Casey serves nearly 56 000 meals each year, while Davis plates up about 47 000, Mawson 22 000 and Macquarie Island around 27 000.

"Our chefs generally work five and a half days a week and are rostered off on Sundays. On the rest day the 'slushy' usually steps in to fill the void, or it will be a 'catch and kill' affair, with expeditioners fending for themselves," Noel said.

Most importantly, chefs must manage their supplies carefully so that they don't use up all their ingredients within the first month.

"If you run out of an ingredient you can't just ring up a supplier, you have to be innovative and resourceful in what you can produce from a finite Antarctic pantry."

NISHA HARRIS

Corporate Communications

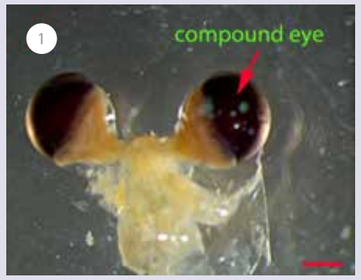
3. Meals bring variety and excitement to expeditioners' lives, particularly during the long dark winter months. Here Macquarie Island expeditioners enjoy a mid-winter banquet. (AAD)

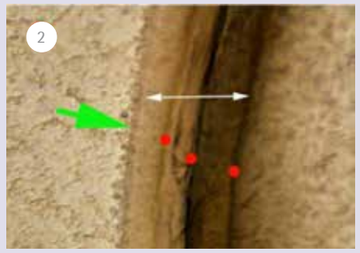
4. Bacon is one of the most popular foods on the Antarctic menu. (Stuart Shaw)

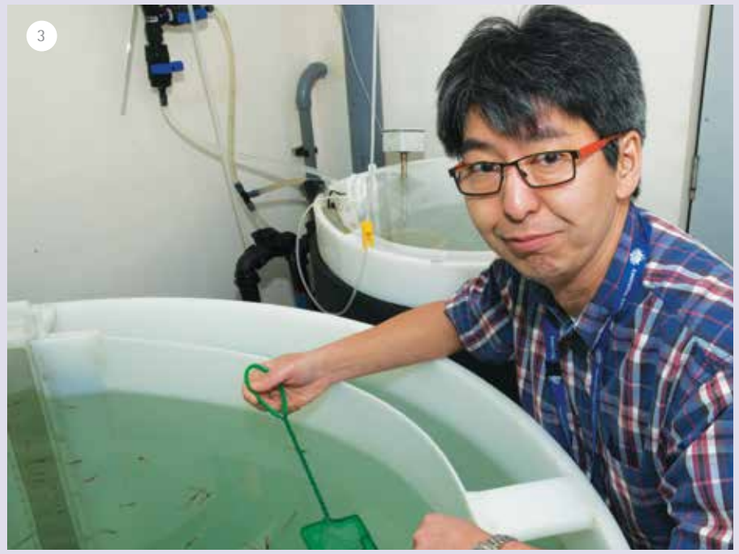
5. Noel Tennant, Adviser to Antarctic and sub-Antarctic chefs. (Jessica Fitzpatrick)

Eye test for krill age

For the first time scientists have been able to determine the age of Antarctic krill by counting the growth bands in their eyestalks.







The research, published *PLOS ONE* in February, found krill grow annual bands in their eyestalks, much like growth rings in trees, and these correlate directly with their age.

Australian Antarctic Division krill biologist, Dr So Kawaguchi, said it's a remarkable finding.

"Despite more than 50 years of research, until now it's been impossible to accurately assess the longevity of krill and the age structure of their populations," he said.

"Krill don't have any hard parts, such as ear bones, shells or scales, so we can't determine age using these calcified structures. Additionally, there's almost no size difference in krill beyond two years of age, and their regular moult means they can actually shrink in size, depending on the time of year and food availability."

The new method, pioneered on larger crustaceans such as lobsters and crabs, involves looking at the eyestalks under a microscope.

"We look at a longitudinal section of the eyestalk to identify the light and dark growth bands and count exactly how many years the specimen has been alive."

The ageing technique has also been successfully used on formalin-preserved samples, which means scientists can accurately determine the age of preserved krill from the early 1900s.

"The ability to retrospectively age krill allows us to compare length-at-age over time and across environments, to examine changes in the Southern Ocean ecosystem," Dr Kawaguchi said.

The scientists studied both wild and known-age captive krill, bred in the Australian Antarctic Division krill aquarium and the Japanese Port of Nagoya Public Aquarium.

The age-based assessment methods will provide information on stock structure to assist with catch limits and management options for the krill fishery through the Commission for the Conservation of Antarctic Marine Living Resources.

"Krill are a keystone species in the Southern Ocean, predated by penguins, seals, flying seabirds and whales, so any fishery needs to be carefully managed," Dr Kawaguchi said.

"The Southern Ocean is also undergoing major changes in the sea-ice zone, in primary production and through ocean acidification, so a better understanding of how long they live will help us more accurately predict the potential impacts of climate change on krill."

The research is a joint project* of the Australian Antarctic Division, the National Ocean and Atmospheric Administration (USA), University of New Brunswick (Canada), Port of Nagoya Public Aquarium and the National Research Institute of Far Seas Fisheries (Japan). It was partly funded through a grant from the Antarctic Wildlife Research Fund (*Australian Antarctic Magazine* 29: 5, 2015).

NISHA HARRIS

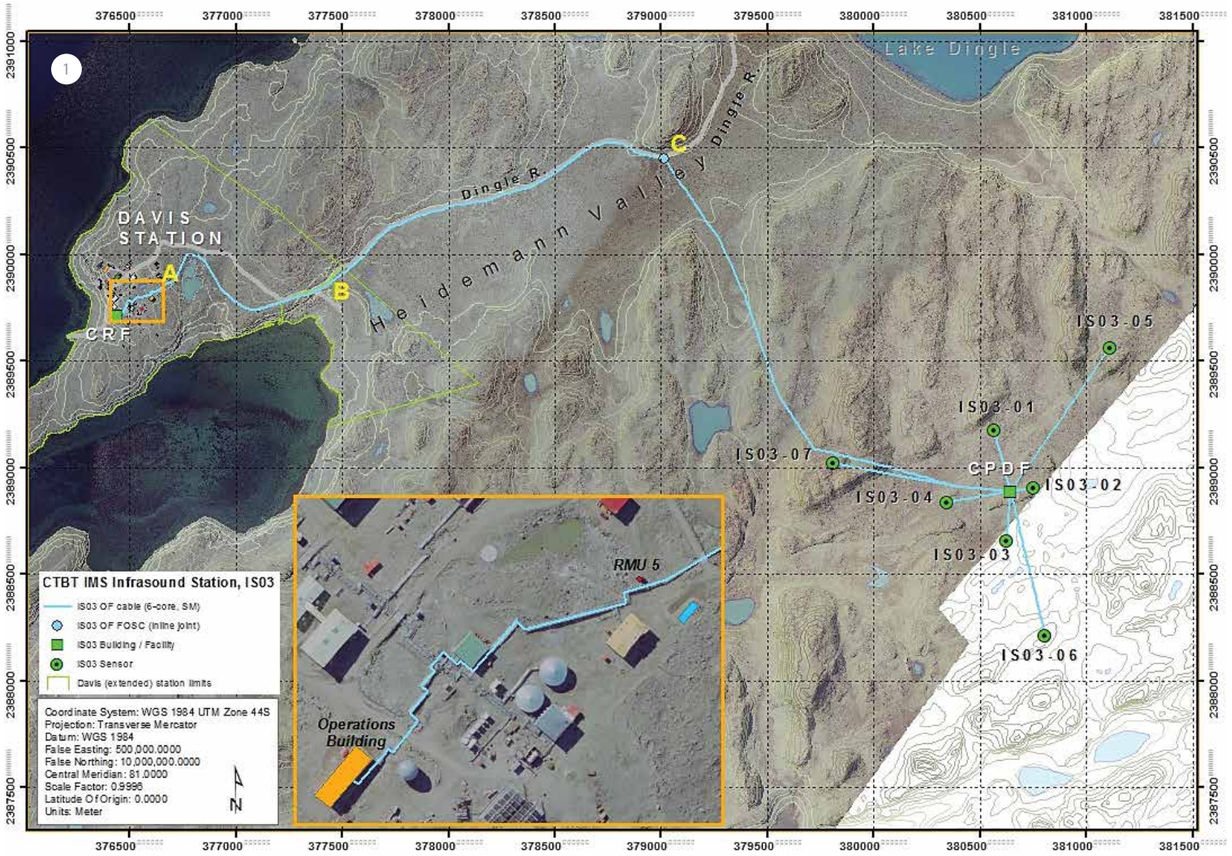
Australian Antarctic Division

**Australian Antarctic Science Project 4037*

1. A new technique allows scientists to age krill by counting the annual growth bands in their eyestalks. The compound eye is removed and the remaining eyestalk is cut longitudinally to reveal the bands. Scale bar indicates 200 µm. (R. Kilada, University of New Brunswick)

2. Annual growth bands indicated by dots in this eyestalk show the krill was three years old. Scale bar indicates 20 µm. (R. Kilada, University of New Brunswick)

3. Dr So Kawaguchi in the krill aquarium at the Australian Antarctic Division. (Glenn Jacobson)



Infrasound monitoring in the Vestfold Hills

The first stage of a facility to monitor nuclear explosions in the atmosphere was constructed in the Vestfold Hills, some five kilometres from Davis, this Antarctic summer.

1. *Figure 1. Location of the IS03 site (array of green circles around the square) and the cable runs (blue lines) back to Davis. (Geoscience Australia & Australian Antarctic Division)*

The 'infrasound monitoring facility' (IS03) is being installed by the Australian Antarctic Division in conjunction with Geoscience Australia, to meet Australia's obligations under the Comprehensive Nuclear-Test-Ban Treaty (CTBT). The facility will form part of an International Monitoring System (IMS) of 337 facilities around the world, to verify compliance to the Treaty. Twenty one facilities will be in Australia, including the Australian Antarctic Territory.

International Monitoring System

The IMS network has been designed for detection threshold capability of approximately 1kt TNT-equivalent. To fulfil the global detection capability objective of the Treaty, infrasound facility IS03 has been specifically located near Davis to contribute to coverage of the eastern Antarctic, Southern Ocean and southern Indian Ocean regions.

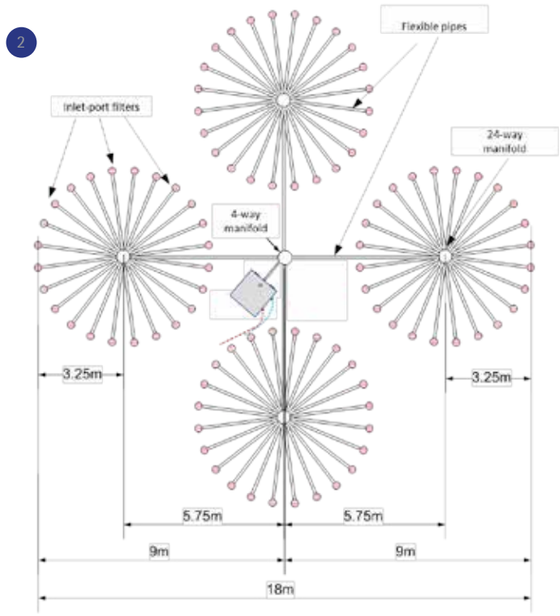
As part of the IMS, Australia also has radionuclide detection facilities at Mawson (*Australian Antarctic Magazine* 31: 23, 2016) and Macquarie Island, and a CTBT seismic facility at Mawson, all supported by the Antarctic Division's Engineering Branch.

Infrasound monitoring is an important technology for detecting and locating nuclear explosions in the atmosphere. The attenuation of sound waves in the atmosphere is frequency dependent and infrasound signals (0.001-20 Hz) can propagate over large distances, reaching altitudes in the atmosphere of more than 100 km.

The usefulness of infrasound data is also much broader than the study of explosive sources for CTBT verification. Infrasound data is also used in detecting and characterising a range of natural phenomena, including:

- atmospheric disturbances such as auroras, thunderstorms, tornadoes, bolides (very bright meteors), upper-atmospheric lightning and volcanic eruptions;
- earth-atmosphere coupled disturbances including earthquakes, volcanic activity, avalanches; and
- ocean-atmosphere coupled signals from phenomena including tsunamis, ocean swells, and iceberg calving.

Data from Australian IMS facilities is available to the broader research community.



Infrasound facility

The infrasound facility at Davis (Figure 1) will be a seven element monitoring array (typical array shown in Figure 2) designed to detect atmospheric disturbances at infrasound frequencies. The seven sensing nodes of the array will be situated in the Vestfold Hills and cover an area approximately 0.5 km². Three nodes will form an outer triangle with sides approximately one kilometre long, and four nodes will form a central quadrilateral with sides approximately 300 m long.

The sensing array will also require construction of supporting infrastructure by the Antarctic Division:

- a Central Power Distribution Facility (CPDF) – a small, pre-fabricated building located near the centre of the sensing-node array, containing the centralised uninterruptible power supply for the sensing nodes;
- a Central Recording Facility (a rack of electronic equipment housed in the Operations building at Davis);
- power infrastructure (3.3 kV to 415 V AC) connecting the CPDF to the Davis station power supply; and
- communication (optic fibre) infrastructure connecting the CPDF to the Davis communications system.

Progress so far

Main facility

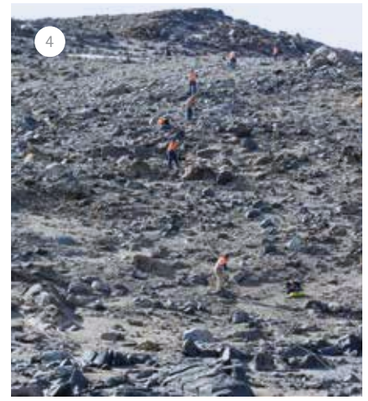
The Central Power Distribution (CPDF) building was initially constructed at Kingston during the 2015 winter and then flat-packed for shipment to Davis later that summer. Works began in earnest this summer with six pad-footings for the building installed.

A 925 kg mini excavator was slung to site by helicopter, as the site is well away from any access roads or tracks. Placement of the six footings and the steel frame was also undertaken by heli-sling loading. The building was up and clad by the end of December. However, before the cladding could be completed the four control and uninterruptible power supply cabinets needed to be installed – each weighing more than 250 kg.

Over January and February the building internal electrical systems and heating and cooling systems were installed. The building is now being monitored for power demand and internal temperature.

Cable haul

To deliver power to the CPDF building, electrical transformers were installed at the site and station, and high voltage power cables run back to the Davis power supply. To minimise any future maintenance issues the power cables were hauled out in a continuous 6000 m run. With no road access some 2800 m had to be hauled by hand.



The three high voltage power cables and an armoured fibre optic communications cable were installed by early February and power and communications to the infrasound site became operational.

Array element

Another goal was to install at least one of the array sensing node vaults so that the internal temperature and battery health within the insulated stainless steel vaults could be monitored during the 2017 winter. Four of the seven vaults have been installed, partially buried at their specific sites. Only array site two has been connected to monitor the system performance, but none of the array sites have their 'rosettes' (sound detection tubes) installed as yet.

Next steps

The stability of the internal environment at the CPDF building and the array site two vault will be monitored over the 2017 winter. During the 2017–18 summer the remaining vaults will be installed, along with the rosettes, and all array sites connected back to the CPDF building. Once this work is complete a certification process will be undertaken and a six-month-long commissioning phase can commence. By late 2018 the facility should be live for detection.

MARK PEKIN

Engineer, Australian Antarctic Division

2. *Figure 2. Schematic of a typical array site showing the vault (square box) and rosettes which detect the infrasound. (Geoscience Australia)*
3. *Array vault H2 installed on site. (Mark Pekin)*
4. *Hauling one of the power cables up a steep section of the Vestfold Hills. (Ash Pym)*

Partnership advances whale research

Over the past eight years the International Whaling Commission's Southern Ocean Research Partnership (IWC-SORP) has driven a range of innovative new whale research, resulting in significant advances in tracking, detecting, and ageing marine mammals. Following are some of the highlights.*

Tracking and movement instrumentation

IWC-SORP scientists have worked with manufacturers to develop, test and refine satellite tags that contain a suite of sophisticated sensors.

In 2012-13, long-term satellite tags deployed on minke, blue and humpback whales in Antarctica, were used to describe their broad-scale foraging movements and migratory behaviour. The satellite tags provided insights into how the whales move around their feeding grounds in search of prey, where they go when they leave the feeding grounds, and where they go for their winter breeding (*Australian Antarctic Magazine* 24: 4-5, 2013).

On the same voyage, scientists also deployed short-term, high resolution movement tags on minke, humpback and killer whales. The tags provided information on the whales' three-dimensional movements, such as dive depth, fluke strokes, acceleration, and the pitch and roll of their bodies. The scientific team was also able to observe the whales' movements and activity when they dived below the water to feed, while simultaneously assessing prey distribution.

Australian Antarctic Division scientists continued this research off the West Antarctic Peninsula in 2016 and early 2017 (see page 19), deploying additional long-term satellite tags on minke whales. The team also deployed suction-cup video tags on the backs of humpback whales, providing a remarkable 'whale's eye view' of where the whales went and what they were eating.

Altogether, information from this tag development and telemetry work is contributing to sophisticated statistical models that are used to derive estimates of whale abundance and foraging ecology. The work will ultimately help scientists determine which areas and prey types are important to the various whale species, for conservation purposes.

Passive acoustic detection and tracking

Before the advent of whaling there were over 200 000 blue whales in the Southern Ocean. Today there are less than 4000, making finding and counting the whales, to assess their recovery, difficult.

Now, novel passive acoustic tracking methods and software have been developed that use 'directional sonobuoys' (underwater listening devices) to detect vocalising blue whales up to 1000 km away. The technology allows Antarctic blue whales to be tracked over vast distances and is a huge improvement on previous detection methods that relied on getting close enough to sight whales visually – usually within a 10 km range.

The sonobuoys were used to locate hundreds of Antarctic blue whales, including large aggregations of up to 80 individuals, during the 2010 and 2013 Antarctic Blue Whale voyages (*Australian Antarctic Magazine* 24: 16-17, 2013) and the 2015 New Zealand-Australia Antarctic Ecosystems voyage.

As a result of this increased encounter rate, scientists were able to conduct the first ecological studies of these rare and endangered animals (*Australian Antarctic Magazine* 28: 4-5, 2015).

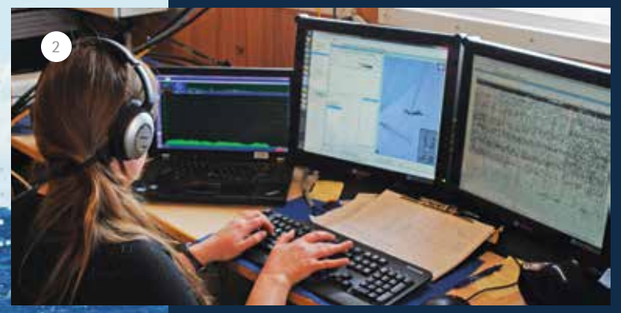
"By matching the sounds recorded by the sonobuoys, with movements recorded by a shipboard video camera, coupled to a GPS and gyro compass, we may be able to identify sounds associated with feeding or breeding," Australian Antarctic Division acoustician, Dr Brian Miller, said.

"On our 2015 voyage, we always found krill when we saw whales. We think that blue whale aggregations could be driven by foraging and that dense swarms of krill suit the whales, allowing them to feed quickly and efficiently."

1. IWC-SORP scientists were the first to apply non-lethal ageing methods to humpback whales, based on changes in the DNA methylation of genes involved in the ageing process. (Andrea Polanowski)

Photographic database

In just a few years, IWC-SORP voyages have contributed over a quarter of all photographs of individual Antarctic blue whales to the circumpolar Antarctic Blue Whale catalogue. The database originated in the early 1990s and is used to assess the total number and recovery of the species.



IWC-SORP voyages have also contributed images to photo-identification catalogues for humpback whales, and the Australian Antarctic Division's Australian Marine Mammal Centre (AMMC) has developed the Australasian Right Whale Photo-Identification Catalogue for southern right whales. The Australian Antarctic Division also hosts the online National Marine Mammal Data Portal, to which all sightings of cetaceans in Australian waters and the Southern Ocean can be added.

Head of the AMMC, Dr Mike Double, said the catalogues and databases are essential for archiving valuable images and metadata, and sharing them with the international scientific community to maximise the potential for cross-identification and matching of individual whales.

"Ultimately, photo-ID catalogues and databases can help us estimate population abundance, delineate stock structure between different populations of the same species, and piece together movement patterns for recovering whale populations," Dr Double said.

Underwater listening stations

In 2013, scientists involved in the 'IWC-SORP Acoustic Trends Project' commenced an exciting new long-term data collection effort called the Southern Ocean Hydrophone Network (SOHN). This network of 20 underwater listening stations, moored on the sea floor around Antarctica, passively monitors ocean noise for the sounds generated by blue and fin whales.

The SOHN is an international collaboration of scientists from France, Germany, Australia, South Africa, Chile, and the United States and United Kingdom. The underwater listening network will continue to expand as additional resources are made available and additional partners join the network.

The project partners are continuing to improve the recording devices and new loggers are sensitive to a broader spectrum of frequencies, allowing them to detect not only Antarctic whales, but dolphins and seals as well.

Non-lethal genetic ageing

IWC-SORP scientists were the first to apply non-lethal ageing methods to whales, based on changes in the 'DNA methylation' of genes involved in the ageing process (*Australian Antarctic Magazine* 26: 16-17, 2014).

DNA methylation is a biochemical process where a methyl group (CH_3) is added to specific DNA building-blocks, altering the expression of genes. DNA methylation is involved in processes like sex determination and the development of many cancers, but it has only recently been shown to be involved in the ageing process.

Estimating age is important for monitoring the recovery of whale populations following commercial whaling. When combined with genetic information about the relatedness of individuals in a population (parents, siblings, offspring), age data improves methods for estimating the size of whale populations and helps scientists understand how the biological characteristics of whales change with age.

Survey design and statistical analyses

IWC-SORP scientists have invested significant effort in determining the most appropriate and efficient survey methods that will provide a new circumpolar abundance estimate for Antarctic blue whales.

This in turn has driven the development of a novel survey approach called 'kin-based mark-recapture'. The method uses genetic identification of close relatives and can provide an assessment of population size, adult survival and even population trend. The method has since been applied in many commercial fish stocks assessments and has the potential to revolutionise the monitoring of previously intractable species in marine and other environments.

Why does it matter?

The research partnership has contributed valuable data to international bodies, such as the International Whaling Commission, to help conserve and manage whales. The methods and technologies developed and advanced by IWC-SORP scientists have demonstrated that whales do not need to be killed to be studied.

WENDY PYPER[1] and ELANOR BELL[2]

[1] *Corporate Communications, Australian Antarctic Division*

[2] *Australian Marine Mammal Centre, Australian Antarctic Division*

What is the IWC-SORP?

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

The partners – including Australia, Argentina, Belgium, Brazil, Chile, France, Germany, Italy, New Zealand, Norway, South Africa and the United States – aim to maximise conservation results through research into the status, health, dynamics and environmental linkages of whale populations and the threats they face. The main focus of the partnership is the large whale species managed by the IWC, including the humpback, blue, fin, Antarctic minke, sei, southern right and sperm whales. The partnership is coordinated through the Australian Marine Mammal Centre at the Australian Antarctic Division.

The work of IWC-SORP described in this article has been supported by the governments of its partnering nations, One Ocean Expeditions, WWF-Australia and the International Fund for Animal Welfare.

2. Novel passive acoustic tracking methods and software have been developed that use 'directional sonobuoys' to detect vocalising blue whales, up to 1000 km away. Here, Australian Antarctic Division acoustician, Dr Elanor Miller, monitors calls during the Antarctic Circumnavigation Expedition (page 18). (Brian Miller)

3. Dr Mike Double prepares to deploy a LIMPET satellite tag on a minke whale as part of a broader program of satellite and video tagging off the Antarctic Peninsula in early 2017. (©Dave Brosha)

Mapping Antarctic blue whale hotspots

Scientists have identified Antarctic blue whale hotspots north of the Ross Sea and in the Mertz Glacier region, during one of the longest survey tracks for the endangered animals.

Australian Antarctic Division acousticians, Dr Brian Miller and Dr Elanor Miller, used 'directional sonobuoys' (underwater listening devices) to detect more than 15 000 blue whale calls between Hobart and Punta Arenas, during the second southernmost leg of the Antarctic Circumnavigation Expedition* (ACE) voyage in February.

"We'd previously detected blue whales on other research voyages in 2013 and 2015, when we entered the western edge of the Ross Sea hotspot, but it turns out that was just the tip of the iceberg," Dr Brian Miller said.

"As we traversed north of the Ross Sea towards Punta Arenas, we continued to hear loud, intense calls and we passed more than a dozen groups within 300 km of our voyage track."

The pair conducted 'listening stations' every 30 miles, recording and monitoring whale song in 12 hour shifts. By conducting stations throughout the voyage they were able to triangulate the direction and distance of loud, low-frequency calls from blue and fin whales.

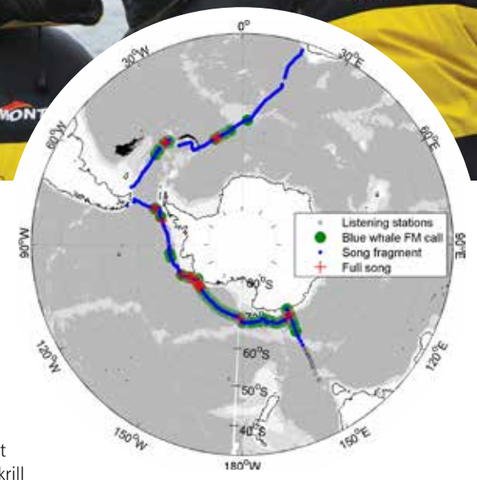
"We recorded 259 hours of underwater sounds and detected blue whales on 140 of the 159 listening stations," Dr Elanor Miller said.

"We also recorded calls from other marine mammal species including fin, sperm, killer, humpback and minke whales, as well as leopard and crabeater seals."

As the pair were part of a broader expedition onboard the RV *Akademic Treshnikov*, supported by the Swiss Polar Institute, they were unable to track and sight the blue whales, as they had on previous voyages (*Australian Antarctic Magazine* 28: 4-5, 2015).

"We were purely listening for Antarctic blue whales to better map their distribution around Antarctica, and we've been able to identify hotspots in the northern Ross Sea and Mertz Glacier region," Dr Brian Miller said.

1



2

"As we moved into the Amundsen and Bellinghausen seas, the density of calls from blue whales really thinned out."

The pair also mapped the distribution of calls from endangered fin whales and found it correlated with that of the blue whales.

"It may be that both whale species inhabit the same areas because that's where the krill is, but we'll need to investigate this further on future voyages," Dr Brian Miller said.

Two collaborating acousticians, Russell Leaper and Susannah Calderan, continued the acoustic survey on the third leg of the ACE voyage, from Punta Arenas to Cape Town. Altogether, the two teams surveyed whales on two-thirds of a circumpolar transit.

"We can use this data to compare the locations of the blue and fin whales on this voyage with historic whaling data, to see whether the mammals are inhabiting the same areas," Dr Miller said.

"We can also use remotely sensed data from satellites, such as sea ice distribution, sea surface temperatures and phytoplankton abundance, to see if there are any relationships between the whales' locations and environmental conditions."

The research is part of the Australian Government's ongoing commitment to the International Whaling Commission's Southern Ocean Research Partnership. The partnership aims to develop, test and implement non-lethal scientific methods to estimate the abundance and distribution of whales and describe their role in the Antarctic ecosystem (see previous story, page 16) .

WENDY PYPER

Corporate Communications

The project Acoustic mapping of endangered Southern Ocean whales *was made possible via funding from the Swiss Polar Institute and Australian Antarctic Division, with in-kind contributions from Australian and international collaborators.*

1. *Dr Elanor Miller and Dr Brian Miller spent 33 days aboard the* Akademic Treshnikov *mapping the distribution of Antarctic blue whales and fin whales through their calls, and recording and monitoring a range of other marine mammal calls. (Elanor Miller)*

2. *The map showing the location of listening stations conducted during two legs (Hobart to Punta Arenas and Punta Arenas to Cape Town) of the Antarctic Circumnavigation Expedition. The red crosses show where full song was recorded and indicate that individual Antarctic blue whales were in close proximity to the listening station. The green area indicates that calls from aggregations of blue whales were detected and located within 300 km of the listening station. The Mertz Glacier region is due south of Tasmania and the Ross Sea hotspot is identifiable by the large area of red crosses. (Brian & Elanor Miller)*

1

'Whale cams' reveal secret life of ocean giants

Electronic tags with 'whale cams' deployed on humpback whales in Antarctica have revealed the secret feeding habits of the ocean giants.

The small camera tags were placed on the backs of humpback whales by Australian and United States scientists working off the Antarctic Peninsula, in the Gerlache Strait.

Australian Antarctic Division whale researcher, Dr Mike Double, said the cameras reveal where and how the mammals are foraging over the summer months.

"The tags show the feeding methods used by the humpbacks in the region, including footage showing them lunge feeding into tight swarms of krill," Dr Double said.

The camera tags were attached by suction cups to the back of the whales for about 24 hours, before they detached for retrieval by the scientists.

"There's a camera on the front of the tag and three dimensional motion sensors, which record the movement of the whale as well as the time and depth of each dive," Dr Double said.

Lead collaborator on the study, Dr Ari Friedlaender from Oregon State University, said the suite of data collected allows scientists to reconstruct the underwater feeding behaviour of the whales in great detail.

"These non-lethal research methods allow us to determine how krill abundance affects the feeding success of whales and how any change in krill population, due to climate change, commercial fishing, or ocean acidification, may impact the mammals into the future," Dr Friedlander said.

During the voyage the researchers also deployed longer-term 'LIMPET tags' on Antarctic minke whales.

Whale research scientist, Dr Elanor Bell, said there is very little information on minke feeding behaviour.

"Minkes are faster and more elusive than humpback whales and often forage in areas with lots of sea ice. This makes it challenging to find and approach them to deploy tracking equipment," Dr Bell said.

"So it was really exciting to be able to attach some LIMPET tags on this voyage. These will transmit the location and dive depth data to satellites every time they surface for up to two months."

The study is part of a long-term ecological research to better understand the divergent impacts of climate change on the ice-dependent minke whales and more open-water humpback whales in this part of the Antarctic.

The research is being conducted through the International Whaling Commission's Southern Ocean Research Partnership (see story on page 16), supported by One Ocean Expeditions and WWF-Australia.

NISHA HARRIS

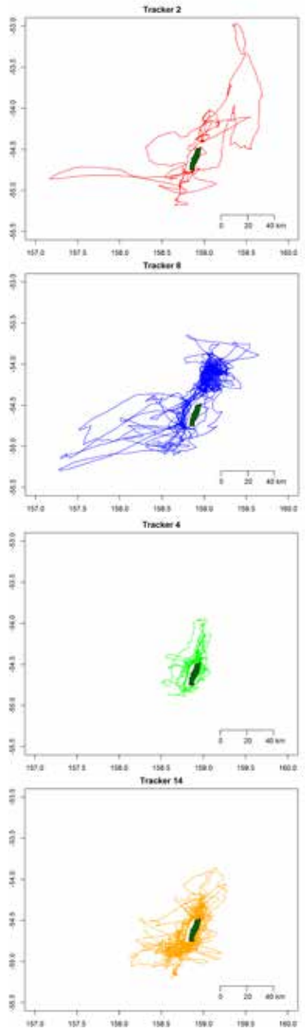
Corporate Communications

2

1. *A humpback whale with a camera tag. The tags were attached via a suction cup and fell off after 24 hours. (Elanor Bell)*

2. *A minke whale with a LIMPET tag which will transmit location and dive depth data to satellites, each time the whale surfaces, for up to two months. (©Dave Brosha)*

Logging the feeding habits of black-browed albatross



Scientists successfully deployed miniature GPS loggers on five threatened black-browed albatross on Macquarie Island this season, to find out more about the foraging habits of the birds.

Field biologists Kimberley Kliska and Penny Pascoe, successfully taped miniature GPS data loggers to the feathers on the backs of five birds. The data loggers remained on the birds for between five and 30 foraging trips.

The data was downloaded from the devices once they were retrieved, enabling the team to map the foraging locations of the birds.

"We found the birds forage locally, within 200 kilometres of Macquarie Island, during the egg incubation period, highlighting the importance of the marine protected area around Macquarie Island," Ms Kliska said

Approximately 40 pairs of black browed albatross breed on the steep slopes of the island and biologists regularly visit the colony to record the progress of the breeding season.

Chief Investigator* from the Tasmanian Department of Primary Industries, Parks, Water and the Environment, Marine Conservation branch, Dr Rachael Alderman, said the birds are threatened by fishing and climate change, on land and at sea.

"This is the first time such high resolution GPS tracking has been done on this population," Dr Alderman said.

"We will try and collect more data over the coming seasons to understand how foraging distribution and behaviour is varying over time, what the environmental drivers are and, importantly, how these populations may be affected by climate change."

The data from this and other long-term albatross studies is fed into the international Agreement on the Conservation of Albatrosses and Petrels, to inform conservation measures such as reducing seabird by-catch in fisheries. Australian sub-Antarctic fisheries are closed during summer, to avoid albatross when they are foraging close to shore to feed their chicks.

CORPORATE COMMUNICATIONS

Australian Antarctic Division

**Australian Antarctic Science Project 4112*

1. *Black-browed albatross chicks hatch throughout late December and January each year. Their parents leave them in search of food after a few weeks, but the chicks remain on the island until April. Most chicks will return to breed on Macquarie Island if they survive to seven or eight years old. (Kim Kliska)*
2. *The figure shows the foraging trips of four black-browed albatross from GPS trackers deployed at Macquarie Island during the egg incubation period (before chicks hatched). The red track, for example, shows five foraging trips ranging between 30 and 203 km from the colony. (Kim Kliska)*

Conservation counts on accurate penguin estimates

Scientists have their best estimate yet of how many Adélie penguins live in East Antarctica, numbering almost six million, 3.6 million more than previously estimated.

The new research*, published in *Global Ecology and Conservation* by a team of Australian, French and Japanese scientists, used aerial and ground surveys, tagging and resighting data, and automated camera images, over several breeding seasons.

The researchers focused on a 5000 km stretch of coastline in East Antarctica, estimating 5.9 million birds and extrapolating that out to a likely global estimate of 14–16 million birds.

Australian Antarctic Division seabird ecologist, Dr Louise Emmerson, said up until now, population estimates only took into account breeding pairs and did not include non-breeding birds.

"Non-breeding birds are harder to count because they are out foraging at sea, rather than nesting in colonies on land," Dr Emmerson said.

"However, our study in East Antarctica has shown that non-breeding Adélie penguins may be as, or more, abundant than the breeders.

"These birds are an important reservoir of future breeders and estimating their numbers ensures we better understand the entire population's foraging needs."

The research has implications for both terrestrial and marine conservation, with more birds potentially interacting with human activities on the continent and in the Southern Ocean than previously thought.

Lead author of the study, seabird ecologist Dr Colin Southwell, said rocky, ice-free areas along the East Antarctic coast are favoured by both Adélie penguins, for nesting sites, and research stations, due to their easy access for resupply.

"There are currently nine permanently occupied research stations in the ice-free areas of East Antarctica and we found over one million birds, or 29% of the population, breed within 10 km of a station, and 44% within 20 km of a station," Dr Southwell said.

"Of the 16 Antarctic Specially Protected Areas in the study region, eight contain breeding Adélie penguins, encompassing about 10% of the breeding age population.

"By identifying significant penguin breeding populations near stations we can better identify which areas may need enhanced protection into the future," Dr Southwell said.

The research also estimates the amount of prey (krill and fish) needed to support the Adélie penguin population.

"An estimated 193 500 tonnes of krill and 18 800 tonnes of fish are eaten during the breeding season by Adélie penguins breeding in East Antarctica," Dr Emmerson said.

This information will be used by the Commission for the Conservation of Antarctic Marine Living Resources to set sustainable krill fishery catch limits.

When it comes to conservation, every penguin counts.

NISHA HARRIS and WENDY PYPER

Corporate Communications

**Australian Antarctic Science Projects 2722, 4087 and 4088.*

1. *Including non-breeding birds in counts, along with those nesting in colonies (pictured), has provided the most accurate estimate yet of Adélie penguin numbers in East Antarctica. (Tony Fleming)*
2. *Adélie penguins share the rocky, ice-free habitat they need for nesting, with nine permanently occupied research stations in East Antarctica. (Noel Tennant)*

1

The Bureau of Meteorology in Antarctica

Weather preparedness is always a key consideration in Antarctica, whether you are flying a plane, fixing a roof, drilling ice cores or counting penguins.

2

The Australian Bureau of Meteorology has a long history of supporting the safe and efficient undertaking of the Australian Antarctic program. We've been present at each of Australia's Antarctic and sub-Antarctic stations since they were established. Bureau meteorologists were also part of some of the earlier heroic age expeditions, including Griffith Taylor, who represented the 'Weather Service' (as an ex-Bureau officer) on Scott's Terra Nova Expedition (1910–1913), and Bureau officer George Ainsworth, who led Douglas Mawson's team on Macquarie Island in 1911.

Safer and more efficient operations are not the only reason the Bureau partners with the Australian Antarctic Division. The Bureau also has the important Government mandate to monitor the Australian climate. The Bureau's continuous, quality managed and long-standing record of weather observations from the four stations, provides Australians and the global community with information to research and monitor Antarctica's weather and climate, and help understand Antarctica's role within the larger Earth system.

1. These 'Armageddon clouds' over O'Brien Bay near Casey research station are formally known as arcus shelf clouds. (Glenn Johnstone)

Because weather and climate do not recognise geopolitical boundaries, most nations have agreed to collaborate in the taking and sharing of weather observations for the benefit of the global community. These efforts are coordinated at the global level by the World Meteorological Organisation (WMO), which today comprises 185 member nations, and in which the Australian Bureau of Meteorology plays a proactive role. The Bureau's weather observation and climate monitoring program follows strict WMO standards, to manually and automatically record and distribute information on wind, atmospheric pressure, humidity, temperature, solar radiation and space weather.

As with most things Antarctic, we partner with other organisations. We benefit from the Australian Antarctic Division's remote Automatic Weather Station network and VHF wind-profiler for the provision of our aviation forecast services and for the initialisation of our global weather model, the Australian Community Climate and Earth System Simulator (ACCESS). We also partner with the CSIRO and the Australian Nuclear Science and Technology Organisation.

We support various national and international research campaigns. These include the current Macquarie Island Cloud and Radiation Experiment* (*Australian Antarctic Magazine* 30: 13, 2016), the upcoming Antarctic Cloud and Radiation Experiment, and two wider-ranging Southern Ocean cloud and radiation experiments that will use instruments on land, ships, aircraft and satellites. Other important research is being undertaken in Hobart to evaluate the skill of our seasonal sea-ice forecasts from ACCESS-S ('S' for sea ice) as well as evaluate the skill and optimise the polar physics of our shorter term ACCESS-G (global) forecasts in Antarctica.

> *The Australian Bureau of Meteorology has a long history of supporting the safe and efficient undertaking of the Australian Antarctic program*

In terms of direct service to the Antarctic Division, time has proven that meteorologists perform best after they have experienced the local environment first-hand, and that they communicate most effectively when embedded in the operation. This is particularly salient in the Australian context, where many forecasters have focussed their training and experience on phenomena like tropical cyclones, fire weather and flood forecasting, rather than the polar regions. Until they undertake their one month of pre-departure polar meteorological training in Hobart, most of our recruited Antarctic forecasters would have not considered the nuances of katabatic interactions with transient low pressure systems that can whip up 160 km/hr winds in minutes, or ocean-air-ice interactions that can see a ship disappear in its own localised fog patch.

Our forecasters are typically deployed to where aviation operations are focussed, such as at Casey and Davis over summer and at Macquarie Island during the station resupply. We have an annually recruited workforce of 11 over-wintering observing and technical staff, five summer weather forecasters (often including a Royal Australian Navy forecaster), and another officer or two on project work at any given time. Over the quieter winter season, forecast support is provided on a by-request basis from Hobart. In addition to marine and atmospheric weather, we also warn for tsunami, abnormally high tides, and space weather (which can have detrimental effects on satellite systems and communications).

The future

Increased computing power, more expansive and precise observational systems (particularly from space) and our ever-improving understanding of meteorological and ocean science, suggest that the current gap between seasonal and sub-seasonal modelling will be bridged. We might also expect that coupling of the ocean, ice and atmosphere in numerical weather prediction will be achieved with sufficient skill as to become operational over the coming decade (there's a bold forecast!). Ensemble forecasts (a set of forecasts) provide decision makers with a sophisticated means of assessing the risk of weather impacts on their operations. On this front the Bureau will improve its provision of training materials so users may best interpret the information provided.

The clear and growing interest in the Antarctic climate is recognised by the Bureau and WMO. Interested national weather services are starting to consider how to collaboratively build an Antarctic Regional Climate Centre, to provide authoritative, standardised and validated products that will better meet the Antarctic operational, research and policy community needs.

To best capitalise on our investment, the Bureau climate monitoring program is renewing its focus on its contribution to the big global initiatives, principally as defined by WMO and partners, such as Global Cryosphere Watch, Global Atmosphere Watch, Baseline Surface Radiation Network, space weather initiatives, and the Global Sea Level Observing System. Options to automate certain processes are also being considered, which may allow us to minimise our staff footprint on Antarctic stations.

Currently, national Antarctic programs collect their own weather, sea ice and climate information and there is considerable duplication of service effort in some areas. For example, near Australia's Davis station, Russian, Chinese, Indian and Australian national weather offices provide overlapping services for their respective national stations, situated within 100 km of each other.

The unique arrangements of the Antarctic Treaty System place the region in a framework of international collaboration that reflects the borderless nature of atmospheric and ocean processes, and the cooperative delivery of weather and ocean services. The Bureau is considering how connecting our services with other international providers could lift service levels for the wider operational community and reduce the cost of production.

In all we do, the Bureau works in close partnership with the Australian Antarctic Division to ensure that our future programs are mutually supporting and aligned with the government's wider strategy in Antarctica.

SCOTT CARPENTIER

Regional Manager Antarctic Meteorology, Bureau of Meteorology

**Australian Antarctic Science Project 4292*

2. Senior Antarctic Forecaster Michelle Hollister received first-hand experience of wind-blown drifting snow on a helicopter trip into Mawson research station. (Michelle Hollister)

Being a General Practitioner (GP) is pretty tough these days. But imagine looking after up to 100 people on the most inhospitable continent on earth, for a year at a time, separated from the nearest hospital, pathology lab or specialist by more than 5000 km of treacherous ocean.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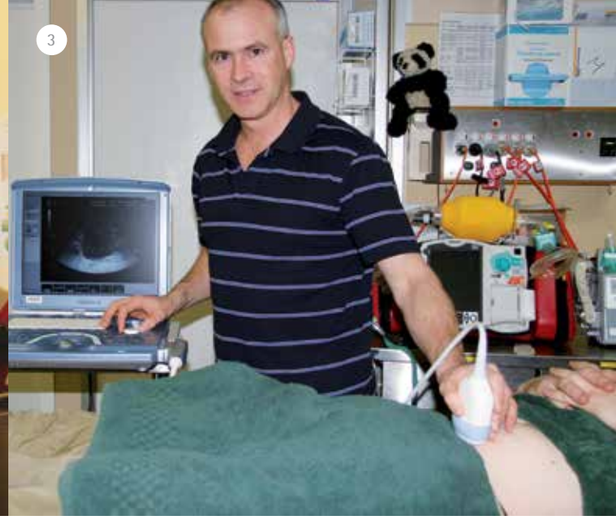
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Cold truths about the future of general practice and digital health

On a recent field trip to Tasmania, where I had managed to imbed myself with the Australian Digital Health Agency (ADHA), I found myself stuck in in the back seat of a smallish SUV, pinned between two senior ADHA minders.

Following a particularly robust public forum in the morning we, somewhat oddly, appeared to be heading out of town south of Hobart.

"Where to next," I enquired of my chaperones. "Australian Antarctic Division", came the reply.

Antarctica? My brain tried to make the connection but no obvious links came to mind. I figured we might be on a break. After all, who doesn't like penguins and lots of snow?

Our host at the Australian Antarctic Division was Dr Jeff Ayton, Chief Medical Officer of the Polar Medicine Unit.

Dr Ayton, a previous president of the Australian College of Rural and Remote Medicine, and a well-known extreme-medicine expert, opened with a story that made it immediately clear why'd we'd been brought here.

Doctors who practice in Antarctica are arguably the most extreme practitioners of generalised medicine in the world.

They are GPs who do much of their more difficult work via relatively tenuous communication links to the mainland. They don't have the luxury of a nearby hospital or pathology lab if things get hairy, or an easy call to a local specialist if something is particularly strange and potentially awkward.

In order to improve their chances of saving lives and managing complex cases, everything has, over many years of operation and planning, been optimised to extreme levels in this unit. This means telehealth systems, the storage and analysis of electronic health records, secure messaging, expert-decision support, medical wikis, patient-management software, communication protocols and so on.

This unit turns out to be a potential microcosm of the future of a national Australian "connected" healthcare system and, in some ways, the future of the "general" practice of medicine.

It's sort of an accident that it exists. It's been created by the necessity to have the most perfectly connected and serviced general practice in the world – because it's in Antarctica.

The insights that this unit provides into what is actually feasible, using the latest in innovative technology, clever co-ordination, and co-operation between normally disparate medical groups, are nothing short of amazing.

One GP (over winter), well resourced, connected to decent expert systems and with the right protocols and links to support services, can do a heck of a lot by themselves. Well, by themselves, but with very well-engineered telehealth support from experts when things go belly up.

Although it's clearly challenging work, it's also highly rewarding and wildly efficient. If any of this is in the future of being a GP, then there is cause for quite a bit of optimism for the profession.

As Dr Ayton casually ran us over the basics, it felt like I was watching *Towards 2000* when I was a kid. Nearly all of what he described I'd only heard about in plans and discussions from the likes of medical software entrepreneurs and senior visionary health bureaucrats.

But Dr Ayton has this all working today in his unit. Ayton and his technical crew have spent years quietly and diligently honing and refining the systems to make our Antarctic stations work medically at an incredibly efficient level. And connected technology is a big part of what they've managed to crack.

The unit started a fully networked electronic health record system in 2009 and they started collecting electronic health records as early as 1989. It's comprehensive. Although not actually cloud-based (that's too difficult with the data communication issues), it's seamless between the various Australian Antarctic stations and the mainland. It can talk to the My Health Record, directly to pathology labs and to various other important ancillary services.

The records are precise and longitudinal over many years and, as a result, the data is starting to provide the unit with valuable insights into the preparation, servicing and delivery of healthcare on the stations.

Each station staff member has full access to a full and well-organised electronic medical record via a web connection with all the associated privacy settings and permissions.

Today, thankfully, Antarctic Division Polar Medicine doctors use satellite links. But this is still tricky. Delays in audio of several seconds can occur. And if you're sending data back and forth, as you do when having to get a second opinion on a scan or X-ray, or the like, the maximum bandwidth speed is something akin to an AOL internet connection in the early 1990s. At 356 bps, it's nearly that slow.

> *The assistants on the mainland had to communicate multiple times via telex, including getting the station's plumber to make the various instruments that were required for the operation.*

Notwithstanding, the unit has managed to achieve some telehealth support for the stations which is highly efficient, and something which most GP practice owners would love to have as a part of their services.

When something really goes wrong, the surgery on the station in Antarctica goes online to the Division's headquarters back at Hobart, where the Antarctic doctors have tele-access to a range of sophisticated gear. This includes blood chemistry analysis, X-ray, ultrasound, and more.

The unit is currently looking at using robotic surgery remotely, where a trained surgeon on the mainland can perform the operation via telehealth. Currently, when things get this complex, the GP is being guided to do their work via audio from a surgeon in Hobart.

If that all sounds a bit scary, then spare a thought for the doctor on call at Casey station in the winter of 1961, when one of the station staff suffered a brain aneurysm.

To prepare for this surgery, which ended up saving the station member's life, the assistants on the mainland had to communicate multiple times via telex, including getting the station's plumber to make the various instruments that were required for the operation.

Recently, with the only doctor on one of the stations injured in a fall, and with tele-surgery support, a non-doctor was able to perform complex surgical procedures on the injured doctor, allowing that doctor to recover and resume duties at the station.

Other alarming Antarctic surgical stories include that of a Russian doctor who, facing acute appendicitis on the Russian Antarctic station in 1961, and with no-one capable of helping, operated on himself. During the operation he lost consciousness, but later awoke to complete the procedure and make a full recovery.

Not to be outdone by the Russians, Dr Jerri Lin Nielsen, an American doctor with a background in emergency medicine, famously self-treated her breast cancer while working at the Amundsen-Scott South Pole station in 1998.

There has been a doctor on Australia's Antarctic stations since the establishment of the first station there in 1947. Initial medical contact with the mainland for earlier expeditions was via morse code and later via HF radio, both of which were relayed via Macquarie Island and both of which were notoriously unreliable. A full medical unit was established in Australia to support the Australian Antarctic stations in 1963. At that time communication was via telex machine.

What the Polar Medicine Unit of the Australian Antarctic Division confirms for us is that everything that technology promises, is actually possible. It does work, it does create enormous efficiency, it can make a GP's job more interesting and less isolated. And it's not that expensive.

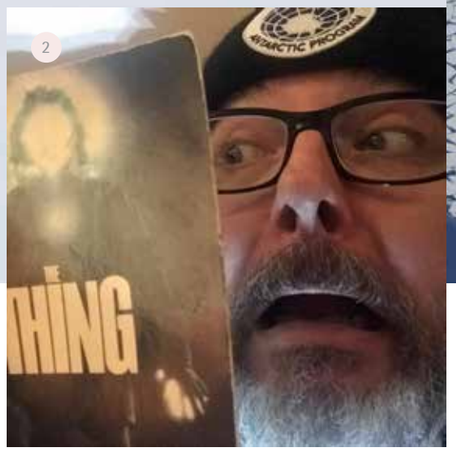
It's a matter of organisation, co-ordination focus and co-operation. That, of course, is no small problem across the Australian healthcare system. But at least we know we can do this stuff if we really want to.

JEREMY KNIBBS

The Medical Republic

This is an edited version of an article that first appeared in The Medical Republic *http://www.medicalrepublic.com.au/cold-hard-truth-future/ on 9 February 2017.*

1. *Dr Jeff Ayton and Dr Trudi Disney (Royal Hobart Hospital Specialist Anaesthetist) use telemedicine to demonstrate and remotely supervise a procedure conducted by a trained lay surgical assistant, being undertaken in real time at an Antarctic station some 4000 km away. The patient's vital signs are being monitored in real time via another screen on the right. (Eliza Grey)*
2. *The doctor and lay-person surgical assistants conduct a mock operation on a 'patient' in the Macquarie Island station surgery. (AAD)*
3. *The Australian Antarctic Division Polar Medicine Unit is a world leader in store and forward and real-time transmission of 3D/4D ultrasound images from Antarctica. This is a still image of this critical capability being demonstrated by Dr Glenn Browning, with a live telemedical link from Mawson research station to the International Space Medicine Symposium III in 2009. (Frederique Olivier)*



Mawson and the Martians: what if...?

Australian Antarctic Arts Fellow and speculative fiction author, Sean Williams, visited Antarctica in February to research his latest book idea of a meeting between protagonists of The War of the Worlds *and the Heroic Age of Antarctic exploration.*

Like a lot of people, I was inspired to visit Antarctica because of a book. In my case, it was a book by Alan Dean Foster that was in fact the novelisation of a film script by Bill Lancaster, which was in turn an adaptation of a 1938 novella called *Who Goes There?* by John W. Campbell writing under the name of Don A. Stuart.

Appropriately, given all this layering of adaptation and identity, the book in question was *The Thing*, a masterpiece of paranoia in the guise of science fiction horror that, quite apart from inspiring dreams of visiting "the worst desert on Earth", also had a huge influence on my desire to be an author.

I applied for the Australian Antarctic Arts Fellowship with the aspiration of writing a book that is just as much about Antarctica as it is about Scott, Shackleton and Mawson on an expedition that never happened in real life. In order to capture the character of this incredible place, I knew I would have to go there.

Quite a lot has already been written about Antarctica. The Australian Antarctic Division library holds something in the order of 20 000 books. If each of them contains 50 000 words, that amounts to one billion already devoted to the subject. Do we really need more?

I would argue that yes, we do. If every one of those billion words was a snowflake, Australian Antarctic Division's vast library would amount to little more than a bucketful of snow, a tiny pinch compared to the vast amount covering the great southern land.

This vast, changeable environment deserves to be preserved–in words as well as from reckless forces that would destroy it forever, such as commercialism or territorialism.

Examining these forces is one of the things that speculative fiction prides itself on being able to do better than any other genre: think the dystopias of Philip K Dick, the techno-mysticism of Arthur C Clarke, and the discomfiting hybrids of Octavia S Butler. By viewing the present through the lens of "what if", we can sometimes see our own reflections most clearly.

So, what if *The War of the Worlds* actually happened, and a Martian cylinder crash-landed a long way off-course, in Antarctica? How might a band of hardy explorers react to the discovery of this desperate survivor? More specifically, how would Douglas Mawson, citizen of new nation "Australia", feel about being caught between two crumbling empires, the Martian and the British? Whose side would he take?

This question lies at the heart of the novel I went to Antarctica to research. Called *Lone Soul Standing*, after a moment in Douglas Mawson's diaries when he vividly compares Antarctica to Mars, my book combines the core issues of H G Well's masterpiece with the Heroic Age and Australian Federation–something that, to the best of my knowledge, no one has attempted before.

At this early stage, novels are bold in conception but requiring great effort to design, scaffold, and construct before they can possibly stand on their own. Going to Antarctica allowed me to explore certain scenarios, and in the process inspired many more.

I fully expected to be challenged by the cold. Born and largely raised in South Australia, I didn't properly see snow until 2015, and even then only for a few hours. When I stepped off the plane at Wilkins aerodrome, I had no idea whether the environment I had dreamed of experiencing for thirty-five years would amaze or appal me.

It turned out that I was hot, dressed in full emergency gear and blasted by bright sunlight. Only later, when I doffed gloves and beanie and stepped out into a brisk wind to have my photo taken at the Antarctic Circle sign, did I begin to appreciate what true cold felt like.

Thus began a complex process of discovery, in which I learned that I loved the cold very much indeed, when cold was something I could chose to be.

I also loved the endless, white plain that was so much like my beloved outback and yet at the same time completely different.

I marvelled at the way my mind, lacking everyday referents such as trees, quickly lost track of distance and size, and equally quickly ascribed any straight-edged berg to the category "building" or "ship" or "city". I became used in a way I previously thought impossible to a near-absence of night.

I never stopped being amazed by the friendly openness of the people who worked at Casey research station, who more than tolerated my questions and went out of their way to supply the answers I desired. This generosity of spirit I recognised from Apsley Cherry-Garrard's *The Worst Journey in the World* and other pioneering accounts. I wondered if this kindness might extend to something not of this Earth.

My Antarctic adventure took me to the ruins of a previous station (Wilkes) and on foot around Casey. I marvelled at wildlife, geology, history, and science. Each time I stepped outside, I learned something new. A chance encounter with the aurora australis reminded me to look up as well as down.

It's no wonder that Antarctica has inspired dozens of stories about aliens, because it really is the closest place to an alien world that we can experience right here on Earth. I have returned inspired to write not just *Lone Soul Standing* but another novel that came to me in my first ride on a Hägglunds tracked vehicle. I suspect I'll be writing about this incredible experience for years to come.

"There are no words," I overheard one of my fellow expeditioners say.

Many have tried to find those words. I sincerely believe that there will never be enough.

SEAN WILLIAMS

Read more about Sean Williams experiences in Antarctica in his blog http://seanwilliams.com/tag/antarctica/

1. *Sean found he quickly ascribed any straight-edged berg to the category "building" or "ship" or "city". (Sean Williams)*

2. *The book that started it all. Speculative fiction author Sean Williams continues to be horrified and inspired by* The Thing. *(Sean Williams)*

3. *Sean describes his departure from Antarctica on the A319 as "like watching a world fall apart with every mile, white marble splitting and fracturing and crumbling into blue jade ocean". (Sean Williams)*

4. *There are a lot of sci-fi fans in Antarctica and Sean drew a full house to his talk about his book and his reasons for visiting Antarctica. (Zoë Loh)*

5. *Sean enjoyed an overnight visit to the abandoned Wilkes station. "Light pours across the landscape, reflecting from snow, cliffs, water, icebergs, my fellow humans." (Sean Williams)*

Davis research station turns 60

Davis research station marked the 60th anniversary of its establishment on 13 January 2017.

A team of expeditioners, led by former Director of the Australian Antarctic Division, Dr Phillip Law, established Davis station in the Vestfold Hills, East Antarctica, in January 1957.

The station consisted of seven buildings and was erected in just eight days, before a hardy team of five expeditioners was left at the site for the winter ahead – led by Officer In Charge Bob Dingle (*Australian Antarctic Magazine* 31: 24, 2016).

1. *The original buildings at Davis were small and functional, with limited or no privacy. (Phillip Law)*
2. *At 4pm on 13 January 1957, expeditioners gathered at the flagpole to officially recognise the establishment of Davis research station. (Phil Law Collection)*

The station was named after famous Antarctic navigator and ship Master, Captain John King Davis. Captain Davis was a central figure in the early exploration of Antarctica, as Master of the *Aurora* and the *Discovery* during several expeditions led by Sir Douglas Mawson and Sir Ernest Shackleton.

The research station has since become a hub for international engagement and a significant base for a range of scientific studies. As Davis is very close to the Chinese, Indian and Russian stations, Australia is developing collaborations on joint science and logistical projects with these countries.

Today's modern research station now supports up to 90 expeditioners in summer and 20 in winter, with research focussing on environmental protection, climate processes and change, conservation and management of Antarctica, and flora and fauna.

Davis is the second oldest of Australia's Antarctic stations. Mawson research station was established in February 1954 and construction of the current Casey research station started in 1964. The sub-Antarctic research station on Macquarie Island was established in March 1948 and has been operating continuously since.

CORPORATE COMMUNICATIONS
Australian Antarctic Division

3. *Today's modern kitchen at Davis caters for up to 100 people in summer. (Kerry Steinberner)*
4. *The kitchen of the newly built Davis station in 1957. (Bob Dingle)*
5. *The modern-day Davis research station looks more like a space colony. The award-winning designed buildings are spacious and comfortable and have plenty of privacy. There are also good satellite communication links with the outside world. (Noel Tennant)*

Davis research station: then and now

Engineer Mark Pekin and Station Leader, Kirsten Ie Mar, reflect on how life at Davis research station has changed over the past 60 years.

The common theme, irrespective of era, are the four main functions of the station to sustain life: water, food, power and heat.

In the early years, water was obtained in winter by using heat exhaust from the engines to melt ice, and in summer a solar still was used to desalinate seawater. Fresh water was a major concern and the chief engineer of the *Kista Dan* rigged up a distilling plant with two electric elements.

The solar still was one of many different methods adopted over the next 50 years to supply adequate fresh water at Davis. Today a reverse osmosis water treatment plant is now utilised at Davis to carry out the same basic task. However it produces 75 000 litres per day during January and stores 1.5 million litres to supply the station for the next 12 months. There is no ability to make water over the winter period.

With less than 10 people on station during the early years, the kitchen was very similar to that found in a home of that era. The crew also took turns to be the cook. Today, with up to 100 people needing to be fed over summer, there are three professional chefs during summer and one for winter.

The engine hut of the original Davis research station initially housed the two Lister 15 kVa generator plants, a small workshop and the bathroom. This was sufficient to supply all the power and heating needs for the 10 personnel on station. Today, Davis has a main powerhouse with four 125 kW Caterpillar 3306 diesel powered generators and an emergency powerhouse with two 125 kW generators. A main ring of power feeds all the buildings, as well as some of the more remote scientific facilities.

Heating in the original station was primarily from electrical heaters. Since the early 1980s Davis has been heated primarily by capturing the heat from the powerhouse engines and piping it all round station, similar to a number of northern hemisphere cities. In the colder months, this heating is augmented by diesel-fired boilers to ensure that sufficient heat is available for the numerous buildings.

Back in the 1950s the buildings were small and functional, and although efficient, had little privacy. Today the award-winning design buildings are made of state-of-the-art materials and provide functionality as well as an excellent quality of life. The buildings are warm and have places to play and rest, such as the climbing wall, library, cinema, gym, and games area. There are also private areas and we have good communication links with home.

Our clothing has evolved over the years. We now have clothes made of modern fibres that are warm, light and breathable. The job descriptions have also changed. Where generalists were once sought, we now have highly trained specialists in all fields.

All in all, modern day life in Antarctica is pretty good. We have the best of both worlds – the location with its beautiful icebergs, charismatic penguins, the adventure and experience of living and working in Antarctica, but in a much more comfortable and sustainable way. So while we admire those that have come before us, we don't envy their conditions. Instead we are grateful for the comforts of home in this extraordinary location.

The final voyage of SY Aurora

"Now a Coal Vessel" was the Northern Times *newspaper article that recorded the Aurora's arrival in the port of Newcastle: "...the* Aurora *arrived unexpectedly slipped through the Heads at Newcastle at 11.39 pm on Tuesday 10 April 1917 and berthed at Stockton, near the Mitchell Street Wharf".*

The article mentioned that the *Aurora's* Master, Captain R. J. (Jack) Reeves, had experienced a fairly rough voyage from Wellington, New Zealand, and went on to say that the *Aurora*, "...after many voyages to the Antarctic, had now entered the more prosaic role of an ordinary merchantman on charter and instead of carrying discoverers, will in the near future, at all events, carry coal". In Wellington, Shackleton had sold the *Aurora* to an American Company W. R. Grace and Co., with interests in Chile.

Such was the inglorious end to this faithful 41 year old polar ship, which had survived over 33 years of annual sea going voyages to the Newfoundland sealing and the Davis Strait/Greenland whaling grounds, in the ice strewn north Atlantic. Then followed a further eight years of sailing in the tempestuous Southern Ocean and Antarctic seas; firstly with Mawson's Australasian Antarctic Expedition (AAE 1911–1914) and finally with Sir Ernest Shackleton's Ross Sea Party – the East Antarctica component of his abortive attempt to be the first to cross the Antarctic continent during the Imperial Trans-Antarctic Expedition (ITAE 1914–1917).

Little did the crew of Australians, New Zealanders and UK merchant seamen realise that her impending voyage to the Chilean port of Iquique, and then on to Europe, with nitrates for the war effort, would write the final chapter of the "Heroic Age" of Antarctic exploration and discovery, with her subsequent loss with all hands off the coast of New South Wales.

The *Aurora* was opened for inspection and many people visited the ship. Such was the interest that the Newcastle Ferries Company was running a special quarter-hour service from the Market Wharf for those wishing to visit during the weekend. At the time of her departure from Newcastle on 18 April 1917, the *Northern Times* newspaper reported that £2113.1s.10d (in silver coin entry) had been collected for the Field Force Fund – a considerable sum for the times.

Three days into the voyage the *Aurora* was discovered to be leaking badly and returned to Sydney on 23 April. Her 500 tons of coal were off-loaded, and an inspection at Morts dockyard revealed substantial leaks behind the iron plates of her original icebreaker bow. Extensive and lengthy repairs were undertaken and finally in early June she returned to Newcastle to reload with coal.

The *Aurora* sailed again on 20 June 1917 and within days was hit by a southerly storm and disappeared with all hands. It was believed that the removal of the icebreaker plates and the dead weight of the coal had compromised the structural integrity of the ship. The only item found six months later was the *Aurora's* lifebuoy with the faded letters "A.A.E.", overwritten with the letters "I.T.A.E.", signifying her proud association with the Mawson and Shackleton expeditions.

The lifebuoy was recently presented to the nation on the 100th anniversary of the ship's loss by Mr John Hooke CBE, son of Mr Lionel Hooke (later Sir), the wireless operator onboard *Aurora* during part of Shackleton's ITAE expedition.

On 20 June 2017, the ANARE Club held a commemorative ceremony at the Newcastle Cathedral, during which a memorial plaque was unveiled in memory of the *Aurora* and the 21 members of her crew – lost at sea.

DAVID DODD
Secretary, ANARE Club

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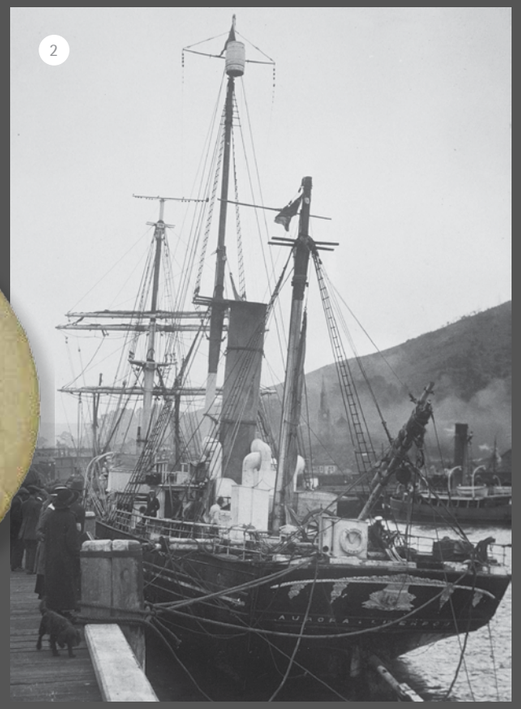


1. *The original* Aurora *lifebuoy was recently donated to the Australian National Maritime Museum by Mr John Hooke CBE. (Photo courtesy ANMM Collection)*
2. *The* Aurora *at Port Chalmers (Dunedin), New Zealand, after returning from the Ross Sea in April 1916 during Shackleton's Imperial Trans-Antarctic Expedition. The ship had been locked in sea ice for 312 days and this image shows the damaged rudder replaced by a jury rudder. (AAD)*

Medical diagnosis in extreme environments

Malaria is not a disease you'd expect Antarctic expeditioners to suffer from. But it makes sense when many expeditioners holiday in the warmer climes of South-East Asia before departing for Antarctica.

Despite rigorous screening of expeditioners to ensure they are fit for Antarctic duty, acute and chronic medical conditions can develop during their stay. Being able to diagnose and monitor conditions such as malaria, peptic ulcers, influenza, meningitis, gastrointestinal bleeding and pregnancy, is a critical part of the lone doctor's role at Australia's Antarctic and sub-Antarctic stations.

The Australian Antarctic Division Polar Medicine Unit has refined methods to help station doctors diagnose a range of diseases and conditions over the past 50 years. Being able to perform pathology tests on site and generating timely results that help in making clinical decisions ("point-of-care testing") are important factors in providing quality medical care in Antarctica. This expertise now provides an effective and efficient model for medical care in other remote and extreme environments, including space.

Polar Medicine Unit Deputy Chief Medical Officer, Roland Watzl, and Chief Medical Officer, Dr Jeff Ayton, recently described this model in *A Practical Guide to Global Point-of-Care Testing*, published by CSIRO Publishing late last year.

The book covers management of point-of-care testing services and their use in diagnosing different medical conditions and diseases, and in different settings (such as hospital, paramedic services and sports science).

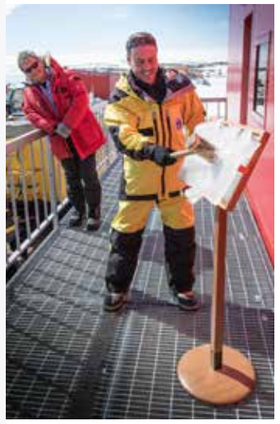
In their chapter, *Point-of-care testing and extreme environments – the Australian Antarctic Division*, Drs Ayton and Watzl consider how to design a point-of-care test system, given issues such as the effect of a harsh environment on medical equipment and supplies, limited technical support and restricted supply – constraints that exist in both space and third world countries. They also provide a list of robust tests that reduce diagnostic uncertainty when used alongside a customised diagnostic handbook, and examples of how these tests have been used.

"Our system provides capability on the ground at research stations, in the field, on ships and on aircraft," Dr Watzl said.

"Most importantly, a point-of-care result is never interpreted in isolation, but always used in clinical context, preferably over time to allow analysis of trend. The tests aim to support the clinical impression, but never to replace it."

See more at: http://www.publish.csiro.au/book/7500/#sthash.2ZEDcGnd.dpuf

Dr Roland Watzl (left) and Dr Jeff Ayton with a copy of A Practical Guide to Global Point-of-Care Testing. *Their chapter describes a model for point-of-care testing in the Antarctic environment, which can be applied to other remote and extreme envrionments, including space. (Wendy Pyper)*



Minister visits Casey

In December (2016) the Minister for the Environment and Energy, the Hon. Josh Frydenberg MP, visited Casey research station to open the new East Wing accommodation, and to meet with expeditioners and learn more about their work in Antarctica. The Minister flew from Hobart to Wilkins Aerodrome and was helicoptered across to Casey for a quick tour, before returning to Australia – the first time such a trip has been completed in one day.

Minister for the Environment and Energy, the Hon. Josh Frydenberg MP, opens the new East Wing at Casey research station. (Stuart Shaw)

Proof-of-concept deep-field air drop a success

A Royal Australian Air Force C17-A Globemaster undertook the first proof-of-concept deep-field airdrop of more than 8000 litres of aviation fuel, at the Bunger Hills, in support of science in December 2016.

The plane dropped 40 drums of fuel, each with their own parachute, at the remote location, 455 km west of Casey, for research investigating the contribution of the East Antarctic ice sheet to sea level rise.

Forty drums of aviation fuel were successfully deployed to the Bunger Hills in support of science. (Justin Hallock)

Traditionally fuel has been flown into the field using helicopters or ski-equipped aircraft. However it takes a suitable weather window and numerous flights over several days to move the same amount of fuel as delivered by the C17-A in a single mission.

"Supporting deep field science projects with fuel, equipment and rations is often our biggest challenge, so proving this concept is a major capability step for science supported by the Australian Antarctic Program," said Australian Antarctic Division Operations Manager Robb Clifton.

Governor-General visits Antarctica

The Governor-General, His Excellency General the Honourable Sir Peter Cosgrove AK MC (Retd), visited the Australian Antarctic Territory in November 2016, meeting expeditioners and scientists at Wilkins Aerodrome.

The Governor-General and Lady Cosgrove flew the 7000 km round trip from Hobart to Australia's ice runway on the Royal Australian Air Force Globemaster Boeing C17-A, which was supporting the Australian Antarctic Program.

His Excellency is the second Australian Governor-General to visit Australian Antarctic Territory.

The Governor-General (right) with Australian Antarctic Division Director, Dr Nick Gales, at Wilkins Aerodrome. (Sam Groves)

Unfrozen in Time

Huffington Post journalist Josh Butler and cameraman Tom Compagnoni visited Casey research station over summer as part of the Australian Antarctic Division's media program. The team compiled an online feature *Unfrozen in Time* on science and life in Antarctica. Watch video interviews and imagery and read more about Australia's work in Antarctica at http://stories.huffingtonpost.com.au/antarctica/?utm_hp_ref=au-homepage

The delicate 'terminal' white flowers and fleshy leaves of Galium antarcticum, *which grows amongst mosses and grasses on Macquarie Island. (Alex Fergus)*

Chance discovery triples critically endangered plant population

A new population of a critically endangered plant species has been discovered on sub-Antarctic Macquarie Island, tripling the previously known population to some 1500 plants.

The tiny, herbaceous *Galium antarcticum* ('sub-Antarctic bedstraw') was recently discovered by chance at Skua Lake, near the central west coast of the Island, by Monash University PhD student Cath Dickson.

Ms Dickson and fellow botanist, Dr Alex Fergus from the Department of Conservation New Zealand, surveyed the area and found 1000 healthy individuals within a 15 m radius, many in flower.

"*Galium antarcticum* is tiny, generally less than 50 mm long, and grows in association with moss beds, making it easy to overlook," Ms Dickson said.

The plant was first sighted on Macquarie Island in 1982. In 2013, following the dramatic reduction in rabbit numbers as part of the pest eradication program on the island, botanists rediscovered a population of about 500 plants at the original site on the north-west side of Skua Lake. The new plants were discovered in March (2017) on the southern side of the lake. The species only grows on a few sub-Antarctic islands and in Patagonia, South America.

"This is a very exciting and significant discovery. I look forward to checking on the health of the plants when I return next year and hope that the team can collect some seeds to further secure its survival," Ms Dickson said.

Australian Antarctic Division Director Nick Gales (right) and Dr Kang Joon Seog of the South Korean National Institute of Fisheries Science, signing the Memorandum of Understanding on non-lethal whale research. (Glenn Jacobson)

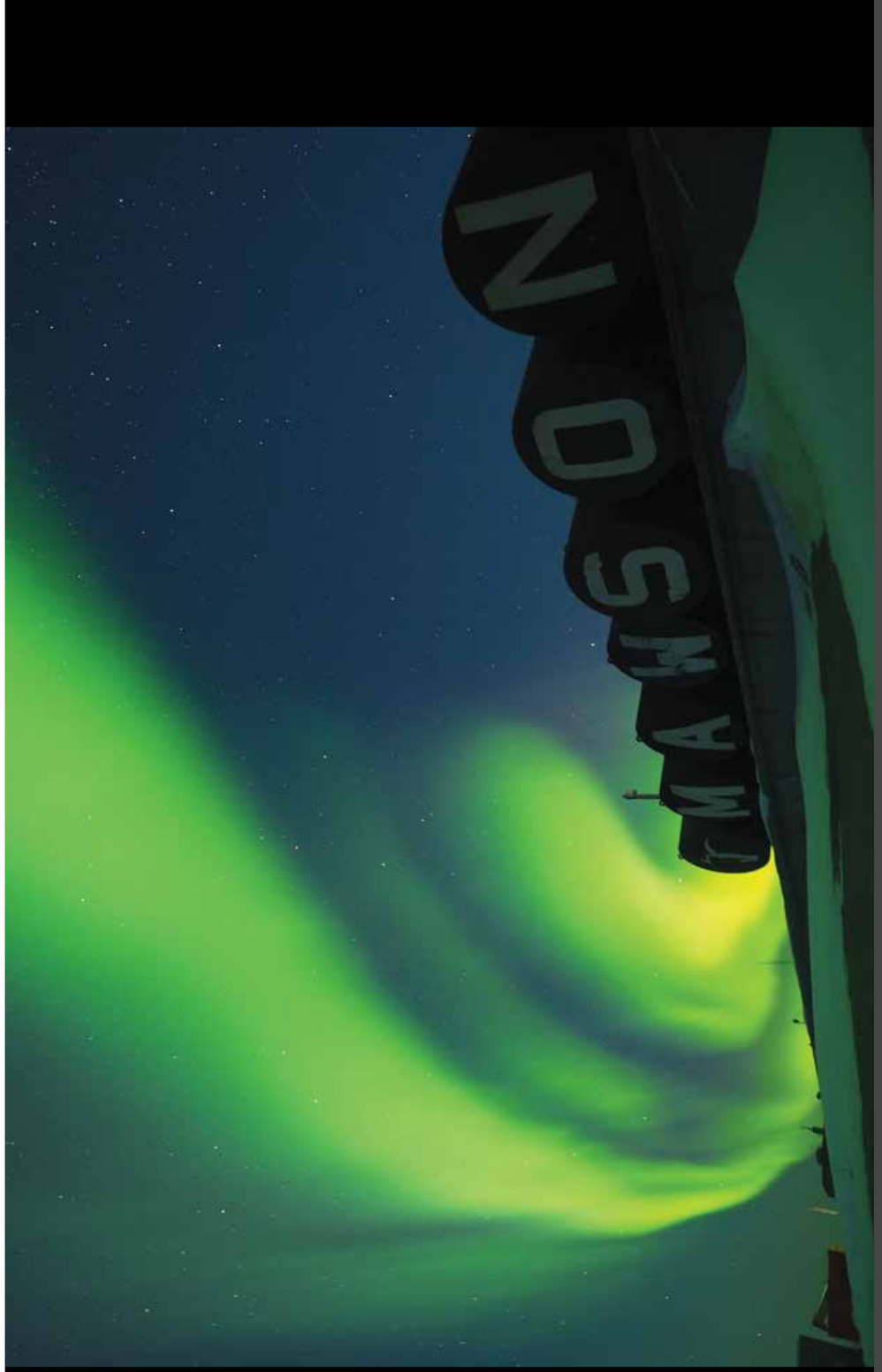
New agreement on non-lethal whale research

Australia and the Republic of Korea signed a new agreement to promote scientific collaboration on non-lethal whale research in March.

The agreement, signed in Hobart by the Australian Antarctic Division and Korea's National Institute of Fisheries Science, aims to promote non-lethal whale studies and improve methods to reduce the accidental capture of cetaceans by the fishing industry.

Leading research techniques, such as satellite tagging and genetic mark recapture, will improve estimates of abundance, trends, movements and dispersal patterns of marine mammals in Korean coastal waters.

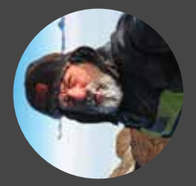
The new agreement will gather data on cetacean-fishery interactions, ecosystem modelling, sighting survey design and marine mammal tourism, which will be fed into the International Whaling Commission's Scientific and Conservation committees.



Freeze Frame

This photo was taken using an Olympus OMD E5 Mk II set at F2.8 with a 20 second exposure. It was about 8.30 pm at the end of March, when the aurora was quite active. This was one of a series of photos I took over two hours in temperatures hovering around -22°C, and my fingers were pretty frozen by the end of the evening. Photographing auroras can be frustrating as you just get your camera set up and the aurora moves or disappears. It is addictive though and I hope to get many more photos over the coming winter.

Brian Jury is the 2017 wintering Mechanical Supervisor at Mawson research station, responsible for the operation and maintenance of the power generation and plant. He has spent 35 years working in the mining and construction industry in Western Australia, as well as periods in Indonesia and Indo-China. He previously wintered as a diesel mechanic at Casey station in 1986.



BRIAN JURY