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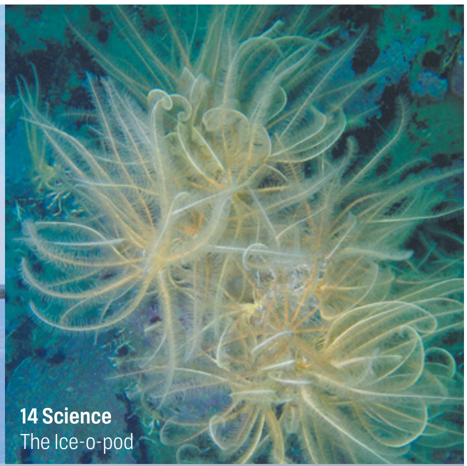
Traverse capability at core of ice research



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Australia's new icebreaker, RSV *Nuyina*, alongside the wharf at Damen Shipyards, Galati, Romania, in April 2020. While the ship is now 98 per cent complete, final harbour acceptance trials and sea trials have been delayed due to travel restrictions arising from the COVID-19 pandemic. (Image: Damen)

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

Australia's Antarctic national interests are to:

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

We're living through a world of change. Most of us are experiencing disruption to our lives and livelihoods due to the COVID-19 pandemic and the Australian Antarctic Program is no exception.

The COVID-19 pandemic has meant substantial changes to our Antarctic and Southern Ocean operations, this year and into the next. This includes a limit on the movement of people south on ships and planes, a reduced ability to recruit and train new teams for next summer, disruptions to our supply chains, and delays to work on major projects.

In spite of these limits, the Australian Antarctic Program continues with a transformational change in how it operates in Antarctica, with a new icebreaker, upgrades to station infrastructure, a reinvigorated traverse capability, and the Davis Aerodrome Project.

Our teams have responded quickly to the change, bringing resilience, adaptability and good humour to the challenge of managing the risks to delayed projects, adapting our program and continuing to deliver on our scientific and operational commitments.

In March we bade farewell to our much-loved icebreaker, *Aurora Australis*. This was an important milestone for the Australian Antarctic Program after 30 years of Antarctic service, however the pandemic scuppered our plans for a series of farewell events. The *Aurora* will live on in the hearts and minds of those who sailed on her, and now in the digital world too – with our 2019-20 Arts Fellows, Wild System, creating a virtual version of the ship and their voyage for an interactive exhibition (page 28).

While final harbour acceptance and sea acceptance trials for our replacement icebreaker, RSV *Nuyina*, have been delayed, we have sought an interim shipping solution. The Ice Class Multi Purpose Vessel (MPV) Everest will resupply our stations and change over expedition teams (see In Brief). Despite delays to testing, the *Nuyina* is more than 98 per cent complete and is looking spectacular. I hope you enjoy the special poster insert we've included in this issue, showcasing many of her scientific and logistic capabilities.

Like so many aspects of our business, the *Australian Antarctic Magazine* has also been undergoing a review. Since its inception in 2001, the magazine has been published twice a year, and made available online. We're excited to announce that with an imminent upgrade to our website (www.antarctica.gov.au), we will bring you an enhanced digital version of the magazine, with more interactive content. We will also move to one annual print issue – you can look forward to the next one in June 2021.

Before the pandemic hit, I was fortunate to spend two months conducting the most extensive international inspection program Australia has ever undertaken in Antarctica – in accordance with the Antarctic Treaty and its Protocol on Environmental Protection. My colleagues and I, from the Australian Antarctic Division and the Department of Foreign Affairs and Trade, inspected six Antarctic stations from the Republic of Korea, Germany, China, Russia and Belarus. We also visited six other stations operated by the United States, New Zealand, Italy, China, India and Russia (page 27).

We were warmly welcomed at all the facilities we visited, reflecting the spirit of international cooperation that is fundamental to all Antarctic endeavours. Our inspections found a high level of compliance with the environmental and non-militarisation principles of the Antarctic Treaty system. We were also very pleased to see examples of the scientific research being undertaken, and the operational practices of other Antarctic nations. Our inspection report will be available following consideration by the Antarctic Treaty Consultative Parties.

Unfortunately the pandemic has caused the cancellation of what would have been a significant international gathering of Antarctic scientists and operators in Hobart in July – the combined Scientific Committee on Antarctic Research Open Science Conference, and the Council of Managers of National Antarctic Programs Annual General Meeting.

While there have been disappointments this year, the good news is that Australia's Antarctic and sub-Antarctic stations remain virus-free. Thanks to the hard work and planning of our doctors and other dedicated teams across the Division, Antarctica is now the safest place to be.

I hope you and your families are safe and healthy, and I look forward to reporting on positive developments in the Australian Antarctic Program in the next issue of the *Australian Antarctic Magazine*, a year from now.

Kim Ellis
Director

Kim Ellis at China's Taishan station during Antarctic Treaty inspections. (Image: AAD)

The new icebreaker RSV *Nuyina* will see a scale change in the amount of marine data that can be collected by the Australian Antarctic Program. (Image: Rob Bryson)

Big data science gets Kool

With a name like Dr Kool it seems destined Johnathan Kool should end up as Manager of the Australian Antarctic Data Centre. Of course his enthusiasm for working with large amounts of data helped too.

After completing his PhD at the University of Miami, simulating the movement of fish populations and genes in coral reefs, Dr Kool's ability to distil large amounts of data into meaningful information for decision-makers had already set him on the 'big data' path.

"I feel like I was a big data scientist before big data was even a thing. I had to work with trillions of larval fish, trying to understand where they came from and where they went, to inform marine habitat conservation," he said.

His expertise eventually saw him working with Geoscience Australia, where he managed large collections of marine data; even contributing to the search for missing Malaysian Airlines flight MH370.

His skills are now sought after to manage the Australian Antarctic Division's large collection of marine and terrestrial information.

"The Antarctic Division is at the cusp of huge changes in the amount of data it will be able to collect, with a new ship, proposed aerodrome at Davis station, new traverse capability and modernising stations all coming online.

"When the new icebreaker RSV *Nuyina* arrives, there will be a scale change in the amount of marine data available," Dr Kool said.

"There will be an incredible number of sensors on the ship and potentially hundreds of terabytes of information coming in, which will be repeated voyage after voyage, year after year.

"Similarly, the proposed aerodrome at Davis, and inland stations set up by traverse, could act as hubs for drones or autonomous vehicles that can collect large amounts of information.

"So we have to think about how to scale things up, while maintaining the same level of accessibility and transparency."

To do this Dr Kool has a few guiding principles. The first is honing in on the message and tuning out the white noise.

"My role is to help curate and deliver information in a focused way, ensuring that the work of researchers is available to policy-makers. Better information leads to better decisions, which leads to better outcomes," he said.

Better information also means having 'metadata' – or data about the data.

"It's not just about numbers but also the science of where, what, who and how. Where the data was collected, what is it, who collected it and how it was collected?

"Metadata is incredibly important because it helps to make data FAIR – 'findable', 'accessible', 'interoperable' and 'reusable' by others."

As Chair of the Standing Committee on Antarctic Data Management, which is part of the Scientific Committee for Antarctic Research, Dr Kool is working with representatives from other national Antarctic programs to enhance the interoperable and reusable aspects of FAIR data.

The committee aims to develop common standards and approaches to data collection that means the data can be used by anyone in any country. Representatives then work within the relevant organisations in their countries to ensure the approach is adopted.

To improve data 'FAIRness', Dr Kool is also working towards delivering data as services. Rather than individuals downloading files that reside on a single computer and that might end up out of date, the data sits on a master computer or in the cloud and is delivered through an interface on request, similar to how technology companies deliver satellite and map collections online.

"This has been a recent transformation for us, to move from data collections being locked away in our file systems to opening them up so they're available online and for processing at scale," Dr Kool said.

"Our biodiversity database, our underway data and our weather system service, for example, are now being made available through online applications and services.

"The point is to make sure all the data is accessible in a consistent way, and this promotes interoperability and reusability as well.

"My vision is that we can open up our Australian Antarctic data collection for big data research, so people can incorporate our data into weather models, global biodiversity models or whole of Antarctica studies."

The service-oriented model will also allow the Australian Antarctic Data Centre to get a better understanding of how the data is being used, which will help the team to deliver products that people want.

With this in mind, Dr Kool and his team have a range of collaborations afoot, including with AusSeabed – a coordinated effort to map Australia's undersea environments. This will feed into the global Nippon Foundation-GEBCO Seabed 2030 project, which aims to map the world's oceans by 2030.

"The seabed information we collect on the *Nuyina* will be made available to the Australian Hydrographic Office, Geoscience Australia, and to programs like the Seabed 2030 Project, which will be able to generate their own products based on it," he said.

Dr Kool is excited by the opportunities new technologies and automation will bring to exploring and mapping Antarctica and the Southern Ocean, including remote sensing from ships, aircraft and satellites, autonomous under-ice rovers and other submersibles, remotely operated cameras, and drones.

But he is quick to highlight that there will always be a role for people in Antarctica, to maintain, fix and fact check machines. And most importantly, to bring context and method to data collection.

"I want people to be excited by the possibilities of automation, without being overwhelmed," he said.

"To do this we always need to bring it back to the story we want to tell, because there are so many stories we are able to tell."

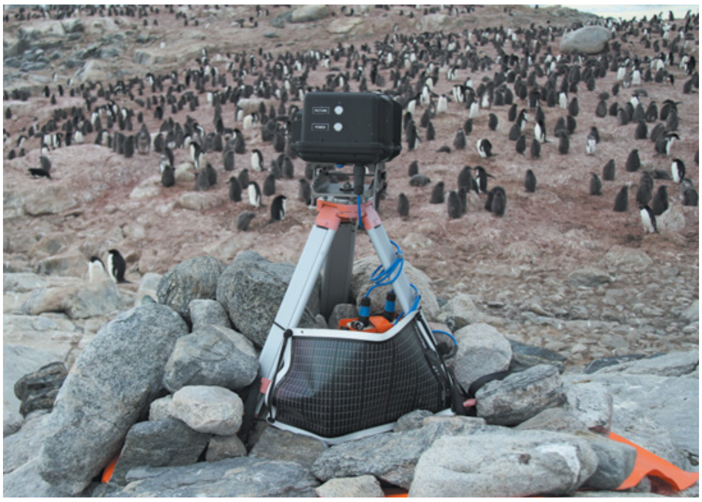
Wendy Pyper
Australian Antarctic Division

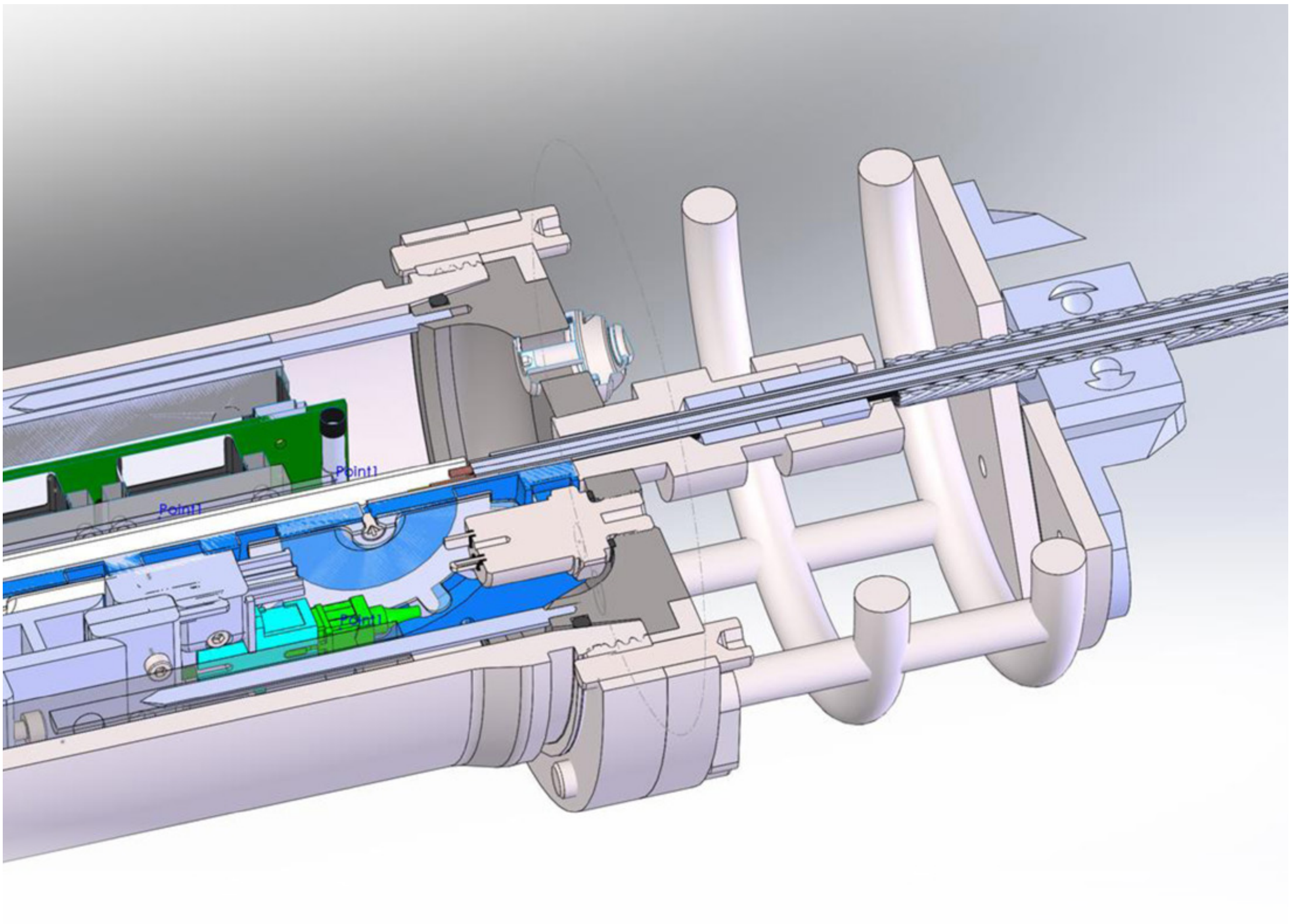
"Metadata is incredibly important because it helps to make data FAIR – 'findable', 'accessible', 'interoperable' and 'reusable' by others."

TOP LEFT Data collected by remotely operated cameras (pictured) and other automated technologies still need humans to provide maintenance, fact checking, context and metadata. (Image: Nisha Harris)

BOTTOM LEFT Australian Antarctic Data Centre Manager Dr Johnathan Kool is focused on data 'FAIRness'. (Image: Simon Payne)

RIGHT Inland stations set up by traverse could act as a hub for autonomous vehicles that provide large amounts of information. (Image: Tas van Ommen)





Southern Ocean science at the speed of light

Deep ocean systems on board Australia's new icebreaker, RSV *Nuyina*, will be enhanced with data transfer speeds up to 120 times faster than current fibre to the premises technology, thanks to four new fibre optic tow and instrument cables installed on the ship.

Boasting speeds of at least 12 Gigabits per second, the fibre optics will provide scientists with real-time data and high resolution video of the Southern Ocean sea floor and water column, down to 6000 metres.

The four cables also include copper wires to deliver power to cameras, lights, submersible vehicles, acoustic net releases and other marine instrumentation. An external armour of galvanised steel provides mechanical strength to each cable, enabling the use of various payloads.

Australian Antarctic Division Electronics Lead Engineer, Kym Newbery, said two 7600 metre cables will be used to deploy the Conductivity Temperature Depth (CTD) rosette and other oceanographic instrumentation from the starboard side of the ship and through the moon pool.

The other 4900 metre and 8100 metre cables will be spooled from winches at the stern of the ship.

"Our strongest cable can support 5000 kilograms of equipment at 1000 metres depth," Mr Newbery said.

"The cables are similar to the deep sea cables criss-crossing the oceans, used to deliver power and communications around the world."

While the cables themselves are an impressive example of engineering design, it is at their termination point, connecting to the electronics at the bottom of the ocean, where the real design challenge occurs.

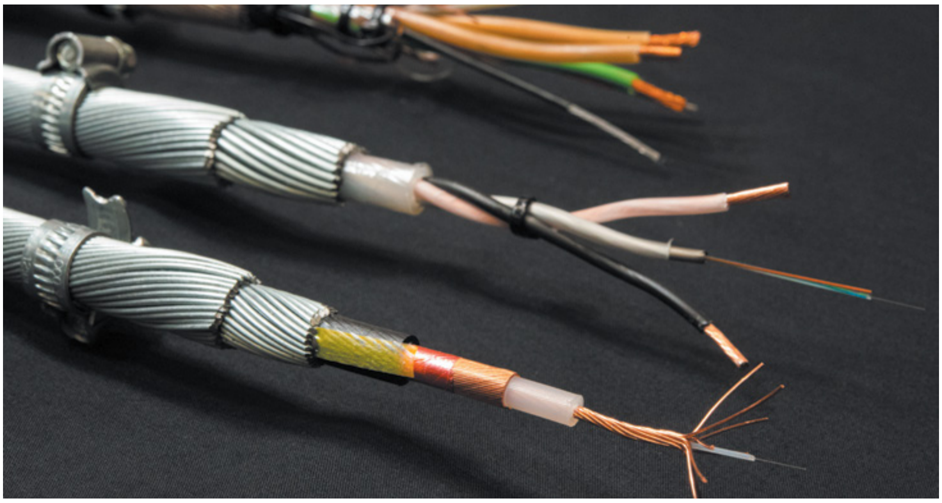
In fact, it's so important Mr Newbery's team has coined its own acronym for the project – the *Nuyina* Underwater Towed Termination System, or NUTTS.

"The cables will pass through a 'penetrator assembly' attached to end caps that will then screw on to a cylindrical pressure housing made of titanium, containing our electronics," Mr Newbery said.

"The pressure housing, endcap and penetrator need to withstand up to 700 bar of pressure – 700 kilograms per square centimetre – otherwise seawater will leak in, atomise and destroy the electronics. It can also make its way back up the cable.

"We've spent hundreds of thousands of dollars on these cables and winches so the stakes are incredibly high. We can't afford to test the pressure housings for the first time at depth, on the ship, in the middle of the ocean; we need to test and validate them in a separate facility and be able to tweak the design if it doesn't work."

To do this the team has commissioned deep-sea systems experts, Ron Allum Deep Sea Services, to design and test the method of connecting the cables to the pressure housings.



"The cables are similar to the deep sea cables criss-crossing the oceans, used to deliver power and communications around the world."

The Sydney-based company designs, builds and pressure-tests specialised underwater systems for science and Defence. The company's founder co-designed and built Director James Cameron's submarine *Deepsea Challenger*, which took him to the ocean's deepest point, 10,907 metres into the Mariana Trench.

"Ron Allum has hydrostatic testing facilities – a large vertical steel pressure chamber – that can test to 14,000 metres depth," Mr Newbery said.

"So they'll be able to test the end-cap design, tweak it if something goes wrong, and retest it.

"Once we know the caps work, they will be permanently attached to the cables and we'll only need to swap the electronics."

NUTTS; it sounds pretty sensible.

Wendy Pyper
Australian Antarctic Division

LEFT This model shows the electrical-optical-mechanical cable running through a penetrator into the end cap and terminating in a titanium pressure housing. The housing contains electronics that will be attached to different underwater instruments. The penetration on the end cap is a critical part of the cable package that will prevent the ingress of seawater into the pressure housing. (Image: Kym Newbery)

TOP RIGHT The three types of electrical-optical-mechanical cables to be used on the RSV *Nuyina*. The lower, front cable shows an optical fibre in the centre of copper wires that will deliver power. Two of these cables will be used in the CTD room. The middle and rear cables have 6 and 3 optical fibres respectively and will be installed on specialised winches at the stern of the ship. (Image: Simon Payne)

BOTTOM RIGHT One of the cables being spooled on to its custom-designed winch drum. The whole package will be installed on the RSV *Nuyina* science deck. The drum has a 'Lebus Shell' with grooves the same size as the cable to assist spooling. (Image: Damen)

Shining a light on deep sea cables

A deep-water laser for testing the new 'Electrical-Optical-Mechanical' cables on the RSV *Nuyina* (see main story) has been designed and built by the Australian Antarctic Division's Technology and Innovation team.

Electronics Design Engineer, Mark Milnes, said the device would be used on the ship during sea trials in the northern hemisphere, to test the new cables' fibre optic and electrical capabilities.

"This device will attach to dummy payloads lowered on the cables, and will connect to their fibre optic and electrical inputs, to ensure everything is working properly," he said.

A laser will provide a stable wavelength of light to the fibre optics, allowing engineers to look for any variation in the signal as the cable is released and winched back in, which could interrupt data transmission. The electrical connection will look for any loss of power in the cable.

The deep-water "torch" is housed inside a titanium shell to protect it from the immense pressures of the ocean, while the wiring, circuitry and batteries are held together with plastic components manufactured on the Australian Antarctic Division's 3D printer.

Wendy Pyper
Australian Antarctic Division

Mark Milnes with the test device for Nuyina's fibre optic and electrical cables. A laser transmits light through six fibre optic connections (gold dials on the end-cap), while electrical resistance is tested through the red connection. The titanium pressure housing will also be used to protect electronics attached to payloads once the ship is commissioned (see main story). (Image: Wendy Pyper)

Nuyina's new Antarctic anchorage

Four hundred kilograms of steel and several tonnes of concrete is set to secure Australia's new multi-million dollar icebreaker, RSV *Nuyina*, to a finger of rock off Mawson research station.

A 125-tonne-rated bollard will sit, statue-like, on a concrete plinth on West Arm, outside Horseshoe Harbour, allowing the 160.3 metre-long ship to tie up when resupplying the station.

However finding a suitable location for the kidney-shaped bollard, designing its supporting infrastructure, and working through the logistics of installation, has been a complex task.

Icebreaker Project Officer and former ships' Captain, Mike Jackson, said hydrographic surveys by the Royal Australian Navy showed that the ship had to be tethered to West Arm, as glacial scouring of the ocean floor made it too smooth for an anchor to hold.

A mooring simulation by a private contractor, and subsequent terrestrial surveys by Australian Antarctic Division personnel, Geoscience Australia and icebreaker Captain, Scott Laughlin, identified a location within 20 metres of the water line, with suitable rock to anchor the bollard, and room for the ship to safely swing on its mooring lines in up to 30 knot winds.

"The mooring simulation showed the ship could be tethered with its normal berthing lines, provided the bollard was installed no more than five metres above sea level," Mr Jackson said.

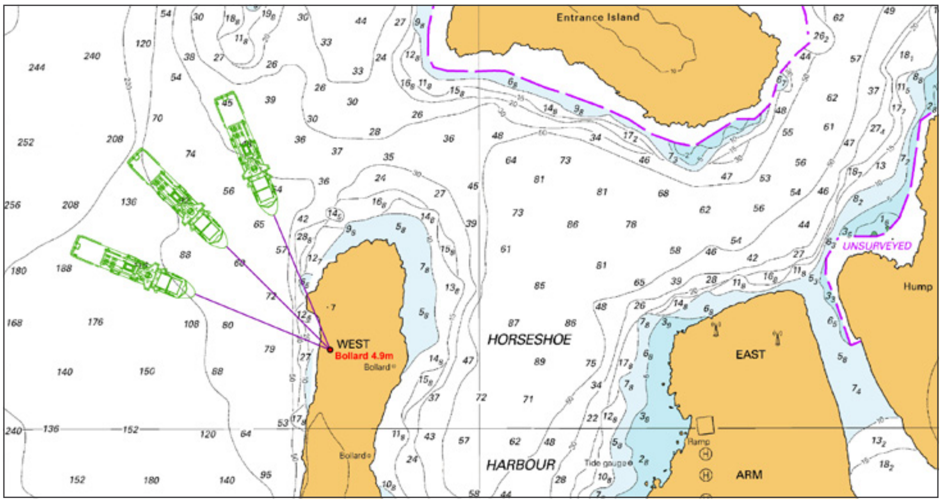
"This height will ensure the correct distribution of load between the bollard and the ship's line winches, when the ship is fully loaded at low tide."

Mr Jackson sourced the bollard from Swedish engineering company Trelleborg. While it is rated to 125 tonnes, it's unlikely to experience that amount of force.

"Thirty knots of wind generates about 70 tonnes of force, and the ship will propel astern with about six tonnes of force to keep the lines straight; so the bollard is over-specced," he said.

"If conditions don't allow the ship to tie up, it can turn around and wait out the weather in Kista Strait."

Picturesque Mawson research station, an ice-covered Horseshoe Harbour, and West Arm. Photo: James Bumak



With a suitable bollard location identified, Australian Antarctic Division Capital Project Officer and engineer, Ron Wilson, commissioned a Tasmanian engineering firm to design the bollard's installation.

"The bollard comes with seven one-metre-long steel bolts, which will be held in place on a reinforced concrete plinth," Mr Wilson said.

"You could describe the plinth as having three sections, but it will be poured as one solid piece of concrete."

The first 1.1 x 1.1 x 0.3 metre section of plinth will be set down 30 centimetres into a diamond cut section of rock.

A larger, 2.4 x 2.4 x 0.5 metre mid-section of concrete will straddle this, with two 5.3 metre-long rock anchors at either end, to transfer load deep into the rock.

An upper section of concrete, the same size as the lower section, will then sit on top.

"Connecting the three sections will be a 1.5 tonne pre-fabricated reinforcement cage, and the seven bollard bolts, set within the concrete," Mr Wilson said.

To cope with the Antarctic conditions the plinth will be made from 'Antarctic blend concrete', which has additives that allow it to cure faster in cold temperatures. Special grout was imported from Canada to ensure the rock anchors remain secure at temperatures as low as -40°C.

With the design details sorted, the final challenge is the logistics of getting equipment and materials out to site to install the plinth and bollard.

In February a range of equipment was transported to Mawson research station to allow drilling work over winter.

Currently, an eight tonne excavator with a drill rig attachment and tungsten carbide drill bits, is grinding out the 90 millimetre holes for the rock anchors, while a ring saw is cutting through the rock to accommodate the lower section of the plinth.

Come summer, helicopters will be used to fly batches of concrete the short distance from the station to West Arm.

"We'll have the dry concrete lined up, the water heated to 60°C and the kibbles ready to load," Mr Wilson said.

"Once the process starts it will be very quick. As one helicopter takes off with its load we'll be filling the second kibble for the next helicopter.

"The concrete will cure over about a month and then we'll lower the bollard on to its anchors and bolt it on."

All going well, a shiny new ship will be swinging from its kidney-shaped stake in 2021.

Wendy Pyper
Australian Antarctic Division

CLOCKWISE FROM LEFT The 400 kg cast-steel bollard. (Image: Wendy Pyper)

1.5 tonnes of steel reinforcing for the concrete plinth. (Image: Ron Wilson)

Tests on the excavator and drill rig prior to its transfer to Mawson research station. The bag catches drill dust. (Image: Ron Wilson)

The location of the bollard on West Arm and the position of the ship in different degrees of swing. (Image: AADC/Mike Jackson)

Traverse capability at core of ice research

In 2021*, the first major Australian Antarctic traverse in decades will depart Casey todeliver a mobile inland station to one of the coldest places on Earth.

Five bespoke tractors, three snow groomers, 28 sleds, fuel, food and the infrastructure to support 16 people drilling for an ice core dating back more than one million years, will traverse 1100 kilometres to Little Dome C in East Antarctica.

Traverse Systems Lead Project Officer, Anthony Hull, said the expedition would take about two weeks, travelling 90 kilometres per day.

"Each tractor can tow 80 tonnes and we'll haul between 320 and 400 tonnes per traverse," Mr Hull said.

"There are six sleds per tractor but we may need to run different tractor-sled configurations depending on the snow conditions, terrain and weight."

Five 12.5 metre sleds and 23 7.5 metre sleds are currently being constructed by Tasmanian-based company Elphinstone Engineering. The Australian traverse will use two types of sleds – a flat deck sled, and a skeleton sled consisting of a frame with skis and chassis.

"The skeleton sleds will carry fixed infrastructure that will stay on the sled, such as the accommodation vans, while the flat deck sleds will allow us to take things on and off and reconfigure the loads," Mr Hull said.

During the traverse, the team of up to 10 people will travel from Casey up to Law Dome, at an elevation of 1500 metres. They will then drop down towards the Totten Glacier, before ascending to Little Dome C, more than 3200 metres above sea level.

Along the way, the team will be able to use ground penetrating radar on a snow groomer to assess the traverse route.

"It's very unlikely we'll encounter crevasses," Mr Hull said.

"The start of the traverse is a proven historical route used between Casey and Law Dome in the 1970s and 80s, with old reports indicating the route is crevasse-free.

"We've also assessed the second part of the route for crevasses, between Law Dome and Little Dome C, using optical and radar satellite imagery and aerial surveys, and we have a series of maps and contour profiles based on that."

Once at Little Dome C the traverse team will set up the mobile inland station, to support Australia's Million Year Ice Core project. This station will operate for eight to nine weeks each summer, for at least five years, allowing scientists to drill more than 3000 metres into the ice sheet (see *Drilling Deep*, page 10).

To accommodate the scientists the mobile inland station includes four, four-bed sleeping vans, a kitchen, dining, operations and ablutions van, generator vans to provide power, a medical facility, and a water services van to melt snow for fresh water and manage grey water (see diagram).

The first drilling season is expected to commence in the 2021-22* Antarctic summer.

Wendy Pyper
Australian Antarctic Division

*Due to the COVID-19 pandemic, this time-frame may change.

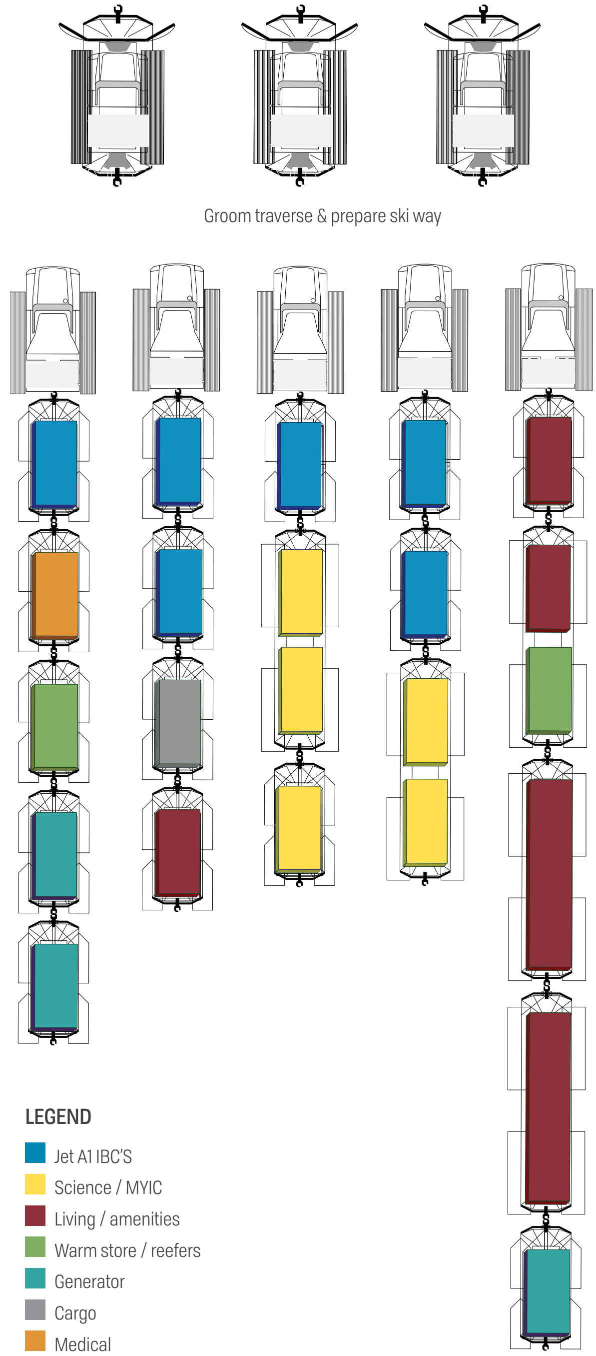
"The start of the traverse is a proven historical route used between Casey and Law Dome in the 1970s and 80s, with old reports indicating the route is crevasse-free."

BELOW Each traverse tractor will be able to tow up to 80 tonnes. (Image: Casey Balmers)

TOP RIGHT A possible traverse layout, carrying infrastructure, equipment, food and fuel for the million year ice core project, as well as facilities for the traverse team. (Image: AAD)

BOTTOM RIGHT A 7.5 metre flat-deck sled under construction in Tasmania. (Image: AAD)

OVERLAND TRAVERSE DIAGRAMMATIC LAYOUT / TRAVERSE SUSTAIN & ANNUAL RESUPPLY



Drilling deep

The first task of Australia's new traverse fleet is to support an ambitious project to drill the Earth's longest continuous ice core record.

This million year ice core will be a window into a time when a major shift in the Earth's climate system took place, and when the regular pacing ice ages gradually slowed. Scientists want to understand what caused this shift, to better understand present day climate change (*Australian Antarctic Magazine* 33: 6, 2017).

To collect such an ice core scientists need a drill capable of working in temperatures as low as -55°C, and so precisely made that it is within millimetres of being perfectly straight and perfectly round.

Australian Antarctic Division engineers and instrument technicians, led by Million Year Ice Core Project Lead, Tim Lyons, are building the cutting head of the drill using drawings provided by American colleagues, based on a Danish design.

"The main part of the drill is the drill sonde, which consists of the spinning drill head that cuts into the ice, a three metre core barrel to collect the cores, a motor, and an anti-torque section that stops everything from spinning," Mr Lyons said.

"Our instrument workshop has machined a lot of parts for the drill head, with many difficult geometries, but we're sourcing the core barrel from a specialist company in the United States because it needs to be almost perfectly straight and round.

"If the parts are out of tolerance, the drill won't perform as it should and it may not drill straight."

To detect any diversion away from plumb while drilling, electronics engineers are building a sensor pack that will sit inside the drill to relay azimuth and inclination to the drill operator in real time.

"Our focus is to do what we can to engineer the drill to make it as easy as possible for the drillers to extract the ice core, while keeping the hole as straight as possible," Mr Lyons said.

The team expects to have the parts of the drill sonde assembled by October. They will then work to interface the sonde with a winch, cable and drill tower – which moves the drill from horizontal to vertical.

"We need to make sure these three components talk to each other, so we can fully test and evaluate the system before we send it to Little Dome C," Mr Lyons said.

The team is also drawing on information from other countries that have used the drill design, to tweak components and provide alternative options in the event things go wrong. This includes providing two different options for clearing ice chips from the drill hole, and changing the type of power and communications cable that will power the drill and feed critical information back to the drill operator.

"We've been working to pre-empt the challenges scientist might have, and 'de-risk' them, by providing a choice of systems that have worked for others," Mr Lyons said.

"We've also simplified our electronics which we think will take a lot of the risk out of drilling operations."

Both the Little Dome C traverse and Million Year Ice Core project are requiring Antarctic Division personnel to dig deep in order to drill deep.

"We've never had an inland station or a traverse as big as this. We've never operated at Dome C, and we've never tried to drill 3000 metres into a glacier. So in terms of the challenges, they're all there," Mr Lyons said.

Wendy Pyper
Australian Antarctic Division

LEFT Senior Technical Officer Chris Richards (left) and Instrument Workshop Manager Steve Whiteside have helped engineer a variety of parts with complex geometries for the ice core drill head. (Image: Jessica Fitzpatrick)

RIGHT A drilling system similar to this will be set up in a drill tent at Little Dome C, and including a heated cabin for the drill operator. (Image: Mana Inoue)

Artful tractors reflect Australian spirit

The designs of iconic Australian artist Ken Done are adorning a new fleet of Antarctic tractors, that form part of Australia's new traverse capability

Director of the Australian Antarctic Division, Kim Ellis, said Ken Done's colourful art works on the side of the five tractor bonnets, embody the Australian spirit.

"The vibrant designs capture iconic Australian scenes such as the beach, reef, gum trees and outback," Mr Ellis said.

"This imagery will provide a much needed sensory stimulus and slice of home to the Australian expeditioners, as they travel through a stark, white landscape."

Artist Ken Done, who donated the designs, said he's thrilled to be involved in the project.

"Never in your wildest imagination would you think that some of your paintings would end up on Australian Antarctic Program tractors – how amazing!" Mr Done said.

Hobart-based business, William Adams, spent six months modifying the Caterpillar Challenger tractors for Antarctica. This included the installation of double-glazed windows, heaters on the engines to cope with the expected -50°C temperatures, and bonnets designed to keep the snow out (*Australian Antarctic Magazine* 36: 11, 2019)

Nisha Harris
Australian Antarctic Division

The first of five tractors deployed in Antarctica, with a vivid Ken Done design – 'Sailing Saturday'. (Image: Chris Burns)

Seal biologist Andrew Irvine (left) and diesel mechanic Dane Eden conduct seal counts. (Image: Mark Horstman)

Surveys to set environmental baselines for proposed Davis aerodrome

Scientists have successfully completed an ambitious field season in the Vestfold Hills, undertaking detailed ecological surveys as part of a project to investigate the feasibility of a year-round runway near Davis research station (see *Australian Antarctic Magazine* 37: 2-5, 2019).

The field season focused on gathering data for environmental baselines to inform the proposed aerodrome's environmental assessment, with a focus on lake ecology, the sea floor (benthic) environment, vegetation surveys, and seal and seabird surveys.

The surveys focused on areas that could be impacted by construction of the proposed runway and associated infrastructure, or that were under potential flight paths, but also included the broader Vestfold Hills.

Principal Research Scientist with the Australian Antarctic Division, Dr Aleks Terauds, oversaw the ecological surveys and said they represent the most intensive and extensive surveys ever conducted in the region.

"It was an ambitious program that not only required a dedicated and experienced team but also a significant amount of operational support. Fortunately we had both," he said.

Ecotoxicologist Dr Catherine King spent four months sampling more than 50 lakes across the Vestfold Hills, with colleague Dr Kathryn Brown.

She said the region is biologically unique because of its freshwater and hyper-saline (very salty) lakes, which support diverse microbial life and microscopic invertebrates.

"There are more than 300 lakes and tarns of varying salinity and size, from small ponds to lakes stretching over several kilometres," Dr King said.

"The region has one of the largest concentrations of 'meromictic' (stratified or layered) lakes in the world, with around 35 permanently stratified water bodies."

Within these water bodies salinity can range from four to 235 parts per trillion, with temperatures between -14 and 24°C, and depths between one and 110 metres. Surface levels range from 30 metres below sea level to 29 metres above.

While most of the soil and lake bottom samples were collected from the lakes' edge, Dr King and Dr Brown used an inflatable dinghy, transported to site in a helicopter sling, to access nine priority lakes.

The pair collected samples in the centre of each priority lake using a set sampling regime.

The pair walked more than 500 kilometres over the summer, and used a purpose built mobile app to record detailed vegetation and environmental data at over 300 sites

"We used a hand-held instrument to measure salinity, conductivity, temperature, pH, dissolved oxygen and other physico-chemical parameters continuously through the water profile, from the bottom of each lake to its surface," Dr King said.

"A sampling bottle was then lowered through the water profile and snapped shut at particular depths.

"This technique allowed us to sample the different layers, which is especially important in the stratified lakes, where different layers have different characteristics and biological communities.

"We also took sediment grabs from the bottom of lakes to sample the benthic communities, and vertical and horizontal tows to collect phytoplankton and zooplankton for identification and genomics testing."

Dr King said detailed analysis, now underway, will show whether the lakes are biologically unique and likely to be impacted by the construction of an aerodrome.

For Dr Dana Bergstrom and Associate Professor Patti Virtue, the summer was spent primarily on foot – albeit with a helicopter for their daily commute to and from the Vestfold Hills, where they headed each day to conduct vegetation surveys and collect samples.

The pair walked more than 500 kilometres over the summer, and used a purpose built mobile app to record detailed vegetation and environmental data at over 300 sites – documenting the species present and recording elevation, slope, water availability and other environmental features.

Most Vestfold Hills vegetation communities are 'sub-lithic' and 'endo lithic' – living beneath rocks or within rock cracks, respectively, especially in areas subjected to salt-laden winds.

Dr Bergstrom said the vegetation patterns seen in their surveys are consistent with previous vegetation studies in the 1970s and 80s.

"The patterns documented in those earlier surveys remain today, but we've been able to add to the story," she said.

The area surrounding Davis station is also home to both penguin and petrel breeding colonies and Dr Louise Emmerson and Dr Colin Southwell had a busy six weeks installing remotely operating cameras, conducting population counts, observing penguin traverse routes across the sea ice, and deploying satellite trackers.

"We want to understand more about the foraging routes of the large population of Adélie penguins in the Vestfold Islands, which has breeding colonies some three kilometres from the site of the proposed runway, and close to the planned flight path," Dr Emmerson said.

"We deployed 12 trackers on penguins at a breeding site north of the runway, to see the direction they crossed the sea ice to get to the open water for foraging. Our observations of the birds also showed that they don't always take the shortest route to their foraging grounds. We were reminded that energy efficiency is thrown out the window when it comes to penguins!"

CLOCKWISE FROM LEFT Patti Virtue conducting vegetation surveys in the Vestfold Hills. (Image: Dana Bergstrom)

Dr Catherine King sampling water depth in one of the Vestfold Hills lakes. (Image: Kathryn Brown)

Remote operating cameras similar to this one were set up to monitor Adélie penguin colonies close to the proposed aerodrome site at Davis. (Image: Anthony Fleming)

The pair also counted cape petrels in the region.

"We were able to finalise our design of a monitoring strategy and will use our count and data from remote monitoring cameras to assess whether the cape petrel population has changed since the early 1970s," Dr Southwell said.

"If the aerodrome is approved to proceed, we can use this data to assess whether they experience any impacts from the construction and operation of the runway."

Another long-term monitoring program at Davis station is the annual seal count, conducted periodically since the 1960s.

Led by environmental scientist Andrew Irvine, expeditioners at Davis counted the Weddell seals, elephant seals and leopard seals.

The team undertook weekly surveys from the arrival of the seals in October, conducting counts on foot, from a helicopter, and using quad bikes and hägglunds to access sites across the sea ice. Small boats were used to access historically popular sites for seal populations when sea ice travel was no longer possible.

Mr Irvine and Assoc. Prof. Virtue also conducted site surveys for nests of snow petrels and the tiny Wilson storm petrels. These nests are under carefully selected boulders that allow for quick entry and exits, to avoid predatory skuas.

While most survey teams were busy above the sea ice, a purpose-built remotely operated vehicle was exploring beneath it.

Dr Jonny Stark and Dr Glenn Johnstone drilled 40 centimetre holes in the sea ice to deploy a mini submarine, revealing never-before-seen habitats surrounding Davis station (see next story).

Since the conclusion of the field season in March 2020, data processing, laboratory work and analysis has commenced. The data will be included in the aerodrome's Comprehensive Environmental Evaluation, which will be released for public comment in Australia, and internationally through the Antarctic Treaty system.

Science will continue to support the Davis Aerodrome Project through the environmental assessment process and the establishment of environmental monitoring work that will provide important baselines from which to measure change.

The Antarctic Division's environmental manager, Andy Sharman, said the Division's efforts to build a comprehensive environmental baseline within the proposed operational area, heralds an improved approach to understanding and managing human impacts in Antarctica.

"What we have done at Davis will inform future environmental monitoring and management for the whole of the Australian Antarctic Program," Mr Sharman said.

Eliza Grey
Davis Aerodrome Project

"If the aerodrome is approved to proceed, we can use this data to assess whether they experience any impacts from the construction and operation of the runway."

CLOCKWISE FROM LEFT A small inflatable rubber boat allowed the lake sampling team to access the centre of nine priority lakes for sample collection. (Image: Catherine King)

Glenn Johnstone with the mini-submersible used for under-ice studies.(Image: Mark Horstman)

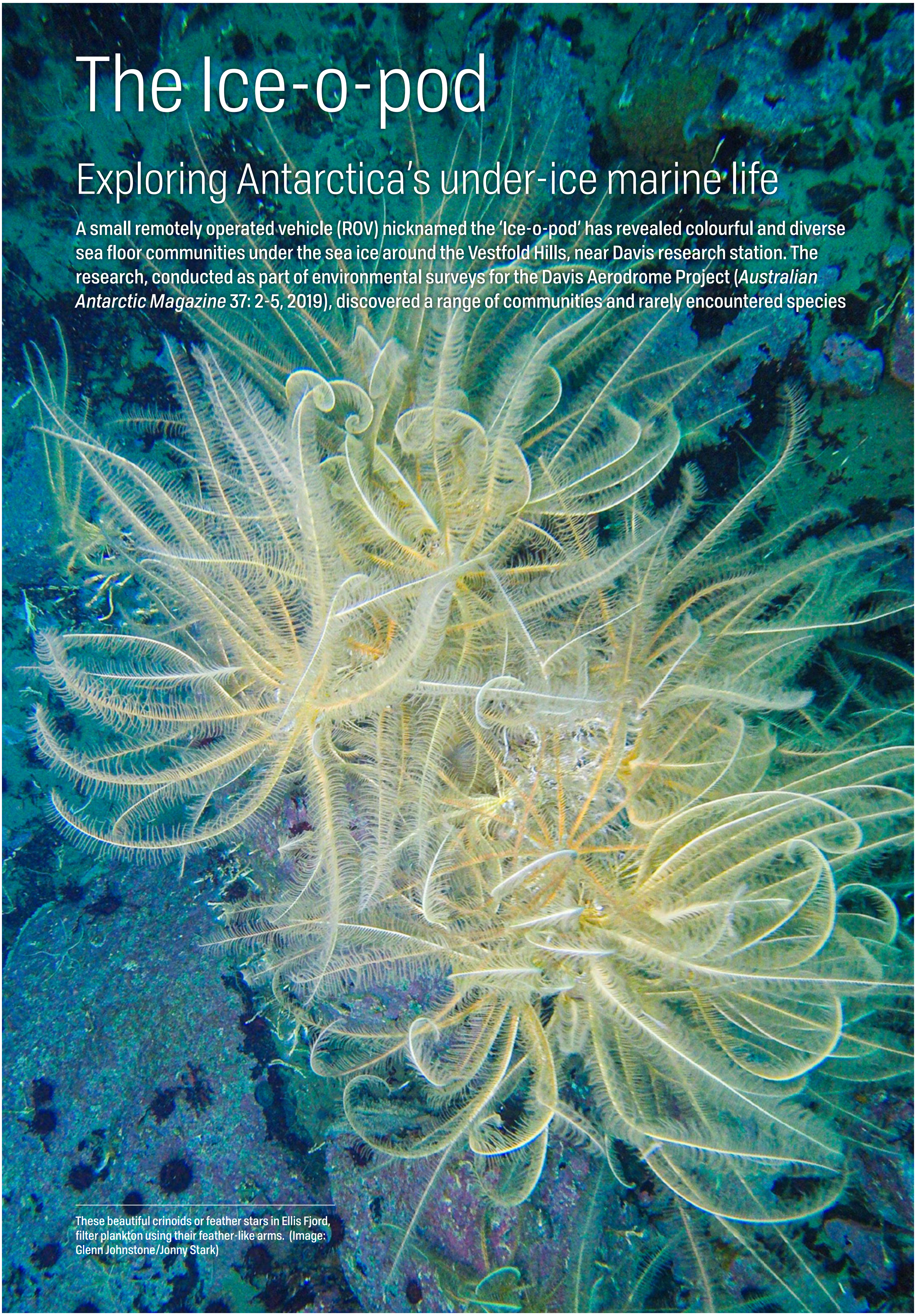
Patti Virtue examines algae under a rock with a digital microscope, while Dana Bergstrom records data with the app (Image: Mark Horstman)

Snow petrel nests are under carefully selected boulders that allow for quick entry and exits, to avoid predatory skuas. (Image: Wendy Pyper)

The Ice-o-pod

Exploring Antarctica's under-ice marine life

A small remotely operated vehicle (ROV) nicknamed the 'Ice-o-pod' has revealed colourful and diverse sea floor communities under the sea ice around the Vestfold Hills, near Davis research station. The research, conducted as part of environmental surveys for the Davis Aerodrome Project (*Australian Antarctic Magazine* 37: 2-5, 2019), discovered a range of communities and rarely encountered species



These beautiful crinoids or feather stars in Ellis Fjord, filter plankton using their feather-like arms. (Image: Glenn Johnstone/Jonny Stark)

The Ice-o-pod proved to be a logistically efficient way of exploring under-ice habitats and conducting quantitative photographic surveys of sea floor communities in the Davis region. Most sites we visited during the 2019–20 summer have never been explored, and much of what we saw was unexpected, including extensive polychaete reefs.

The ROV surveys were undertaken to inform a Comprehensive Environmental Evaluation for the Davis Aerodrome Project, and were part of broader survey and sampling work of lakes, vegetation, seals and seabirds (see previous story).

The benthic marine program visited 28 sites and collected macroinvertebrates from the sea floor, sediment profiles for chemical analysis, and seawater and sediment samples for environmental DNA (eDNA). We conducted ROV surveys at 10 of these sites, which ranged from Hawker Island and Ellis Fjord in the south, to Bandits Hut in the far north of the Vestfold Hills.

All our sites were covered by between 1.6 and 1.9 metres of sea ice, presenting one of the key challenges for Antarctic coastal marine fieldwork; getting to the water in the first place. The 35 centimetre-wide Ice-o-pod was specifically designed to fit down a 40 centimetre-wide access hole, drilled through the sea ice using an easily transported posthole drill. But it was hard work, particularly after the first metre, when a second metre-long auger section had to be added. The torque generated by over 1.5 metres of auger in a sea ice hole filled with ground-up ice and slush was unbelievable. It was backbreaking work and our record of eight holes in one day isn't one we'll try to beat in the future.

After almost an hour of ROV setup and pre-dive checks, the Ice-o-pod was attached to a 300 metre-long tether and to our control centre – a laptop and X-box game controller. These were housed on a portable table with a custom built vinyl cover to block out the high ambient light. The back of a hägglunds made an excellent shelter from which to operate the ROV, providing protection from the freezing wind blasting across the sea ice. The Ice-o-pod was easily manoeuvred down the access hole and, after a series of in-water checks, went to work surveying the sea floor.

Photoquadrat surveys were conducted by driving the ROV in a series of transects, either down-slope (between approximately three and 45 metres depth) or across-slope, between specific depth intervals of four to six metres, 12 to 15 metres and 20 to 25 metres.

Transects were driven at approximately one metre above the sea floor using an on-board altimeter, while two downward facing GoPro cameras captured video and photos. The sea floor was illuminated by four 1500 lumen lights, while a laser scaler projected points 100 millimetres apart onto the sea floor within the area imaged by the front GoPro. Maintaining a steady height above the sea floor was tricky as many of the sites had complex topographies, particularly on steep boulder-covered slopes.

The Ice-o-pod performed superbly, allowing us to capture photoquadrats of known area, thanks to the laser scaler, within which we can identify

The Ice-o-pod performed superbly, allowing us to capture photoquadrats of known area, thanks to the laser scaler, within which we can identify and count the organisms living on the sea floor.

CLOCKWISE FROM LEFT These dense colonies of the tube building polychaete worm, *Serpula narconensis*, form reefs that extend for kilometres around Ellis Fjord, generally on slopes between depths of five to 35 metres. (Image: Glenn Johnstone/Jonny Stark)

The 35 centimetre-wide ROV was designed to fit down a 40 centimetre-wide hole. (Image:Jonny Stark)

Drilling a hole through up to 1.9 metres of sea ice was back breaking work. (Image: Glenn Johnstone)

Another surprise was the presence of three species of crinoids (feather stars) that we haven't seen around Davis before. These strangely beautiful echinoderms move around the sea floor filtering plankton from the water column with their feather-like arms.

CLOCKWISE FROM LEFT A dense cover of epifauna on a boulder in Shirokaya Bay, including various species of sponges, ascidians, feather worms and bryozoans. (Image: Glenn Johnstone/Jonny Stark)

Vast numbers of holothurians, or sea cucumbers, were found in Ellis Fjord. (Image: Glenn Johnstone/Jonny Stark)

Dr Jonny Stark with the ROV and its control centre, in the back of a hägglunds. (Image: Glenn Johnstone)

and count the organisms living on the sea floor. Importantly, quantifying diversity and abundance in this way allows us to compare the composition of these communities spatially, between sites, and to monitor how they change over time.

The images we captured revealed colourful, diverse and complex communities, with every site providing new and unexpected surprises. The polychaete reefs in Ellis Fjord were a particular highlight. These dense colonies of the tube building polychaete worm *Serpula narconensis* form reefs that extend for kilometres around the fjord and generally occur on slopes between depths of five to 35 metres. Like reefs anywhere, they provide a complex habitat for a diversity of other organisms, including sponges, ascidians, sea cucumbers and large numbers of the common red urchin *Sterechinus neumayeri*.

Polychaete reefs were also found in Long Fjord, although not in as large congregations, and we found small colonies of S. *narconensis* far to the north, in the steep rocky bays near Bandits Hut.

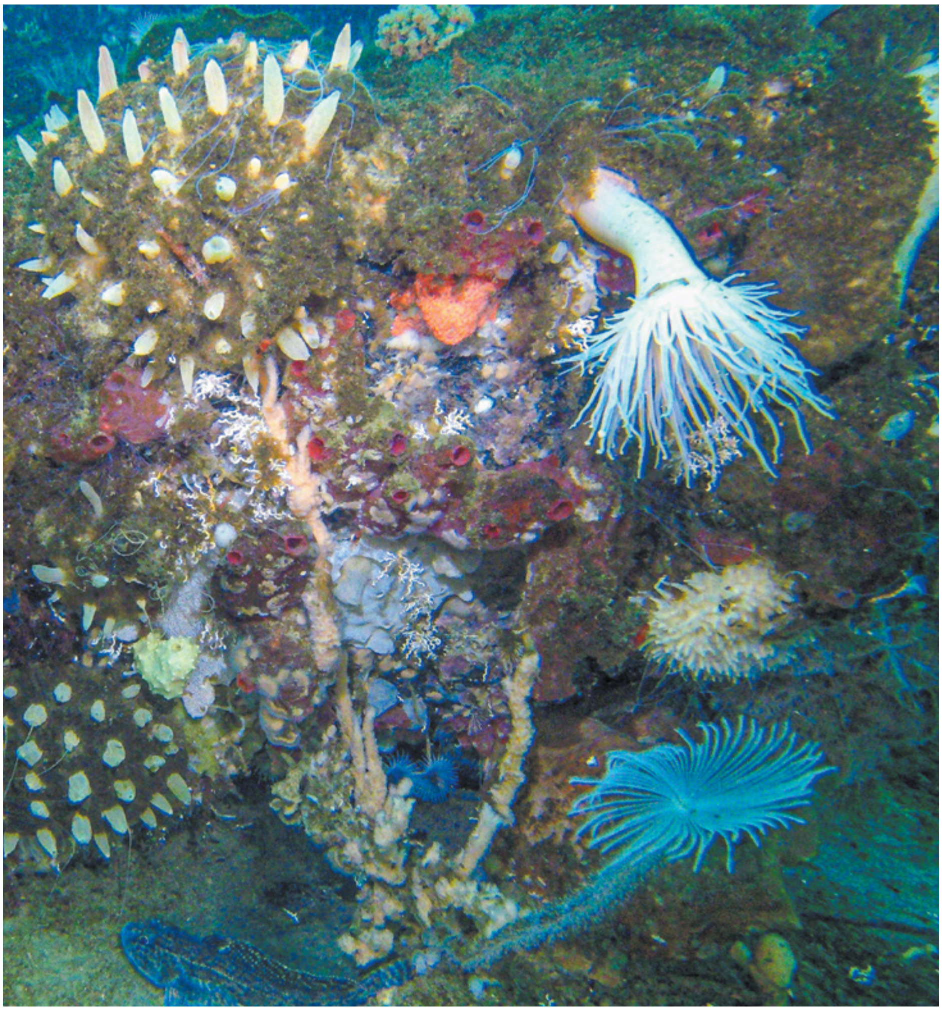
Another surprise was the presence of three species of crinoids (feather stars) that we haven't seen around Davis before. These strangely beautiful echinoderms move around the sea floor filtering plankton from the water column with their feather-like arms.

It wasn't all plain-sailing however, as the Ice-o-pod had a few teething problems that only Antarctic conditions can induce. Sealant used in some of the cable housings cracked or shrank in the very cold Antarctic water (-1.85°C), bringing our first dive to an abrupt end after only 10 minutes. These very hard to find leaks almost derailed the season but with some relentless detective work in the lab and the application of lots of Sikaflex we fixed the problem and operations resumed.

This first summer of work proved that the Ice-o-pod is a superb tool for exploring under-ice habitats with a small team and relatively simple logistics. Importantly, it also captured high quality imagery that will allow us to determine how Antarctic marine communities may change over time – vital for future monitoring efforts.

The Ice-o-pod is also a highly adaptable research platform that can be modified to provide upgraded or new capabilities. ROV control and data collection software is rapidly evolving and a range of potentially useful sensors are becoming smaller and easier to attach. In the coming year we'll use this flexibility, along with the lessons learned this summer, to improve the Ice-o-pod's capability and performance as an exploration and survey tool and to meet emerging research needs.

Glenn Johnstone and Jonny Stark
Australian Antarctic Division



Understanding the winter habits of krill

New video camera moorings deployed on the Southern Ocean sea floor for up to a year, could help solve the mystery of where Antarctic krill go during winter, and how they use their deep ocean habitat.

Australian Antarctic Division krill biologist, Rob King, said three 'Krill Observational Moorings for Benthic Investigation', or KOMBIs, would be deployed at depths of between 300 and 1500 metres for 12 months, to see if and when the crustaceans visit the sea floor.

"We don't know where the krill go during winter when the sea-ice freezes over, and the shield of sea ice cover makes it difficult for us to study and understand their movements," Mr King said.

"In the summer, we know krill feed on phytoplankton at the ocean surface, but they may also raid the sea floor for sunken particles.

"This will be the first study to quantify how krill use the sea floor and the seasonal sea ice area across space and time, and it will allow year-round monitoring of krill in some of the main foraging grounds for whales, seals and penguins off East Antarctica."

The moorings have a sideways looking video camera that films the sea floor for three to five minutes, every five hours. They also carry instruments to measure ocean properties and currents, and an upward looking 'echosounder' that will detect krill swimming down to the sea floor, returning to the surface or just passing by.

"The video will allow us to identify the krill species and the time of day or year they appear, while the echosounder will provide an estimate of krill biomass, their distribution and the speed with which they descend and ascend to and from the surface," Mr King said.

"This work will provide information to improve management strategies for the expanding krill fishery, and our understanding of how foraging grounds for krill predators are formed."

The moorings will be deployed off Mawson research station between January and March 2021, using the RV *Investigator*, in areas known to contain krill.

The video cameras will begin recording in darkness, to capture any bioluminescent activity, before the 1000 lumen white LED lights switch on to attract the krill.

"Previous work with deep sea cameras has shown that krill often arrive within two minutes of the lights switching on," Mr King said.

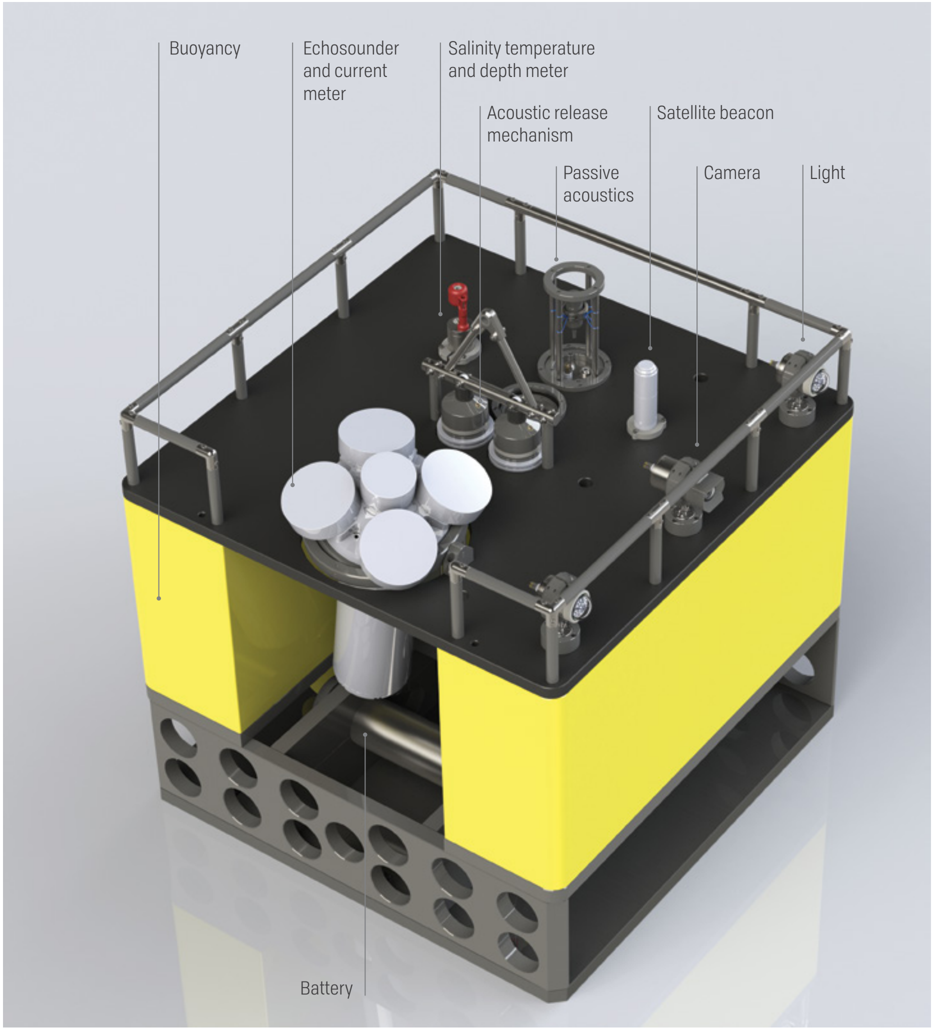
The lights will then switch off and the camera will have time to record any escape response signalling by krill.

About 87 hours of vision will be recorded over the year and stored within the camera until the mooring is retrieved.

To retrieve the mooring an acoustic signal from the ship will release the instrumentation from weights anchoring it to the sea floor. Once at the surface, a satellite beacon will send the mooring's location to the ship.

The design, build and testing of the KOMBIs is being done by Tasmanian company, Metocean Services International, with input from Mr King and the Antarctic Division's Technology and Innovation team.

Wendy Pyper
Australian Antarctic Division



A preliminary render of the deep sea video moorings, which are currently under development, and which will be deployed up to 1500 metres below the ocean surface. The moorings will be the size of an Australian shipping pallet (1.165 x 1.165 m), and will weigh a few hundred kilograms each. The moorings contain a biological echosounder and current meter that detect krill and currents in the water column. Passive acoustic instruments record marine mammal sounds. There are also a camera and lights, temperature and salinity sensor, a mooring release system, and a satellite beacon to aid recovery of the mooring once it returns to the surface. (Image: develogic)

Building capacity for marine conservation

For the first time, an Australian scientist has been elected Chair of the Scientific Committee of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR).

Australian Antarctic Division Fisheries researcher, Dr Dirk Welsford, took on the leadership role at the conservation body's annual meeting late last year, and will serve up to two, two-year terms.

"I'm really honoured to be playing a key role within this scientific group, where I'll be working closely with scientists from all around the world to help conserve and manage Southern Ocean ecosystems," Dr Welsford said.

The Scientific Committee provides scientific data and guidance to CCAMLR to assist their decision-making processes on fisheries and ecosystem management.

As Chair of the Scientific Committee, Dr Welsford will run meetings of the scientific representatives of the 26 member countries of CCAMLR, review research from national programs active in Southern Ocean waters adjacent to Antarctica, and oversee the preparation of a scientific report for presentation to the Commission.

"During the Scientific Committee meetings we look at issues such as sustainable harvest levels for krill and toothfish, seabird bycatch, seafloor diversity, Marine Protected Areas, and the implications of climate change," he said.

In the 14 years Dr Welsford has been attending CCAMLR – four as Chair of the Working Group on Fish Stock Assessment – he's seen the complexity of decision-making ratchet up. This has turned his focus to building capacity and diversity within CCAMLR.

"CCAMLR can be daunting for the new, younger people coming through, with its lengthy and unusual format, so I'd like to develop an induction package to help people make their contribution more effectively and get through the learning curve quickly," he said.

"I'd also like to implement a mentoring program, with more experienced people helping new people navigate the process.

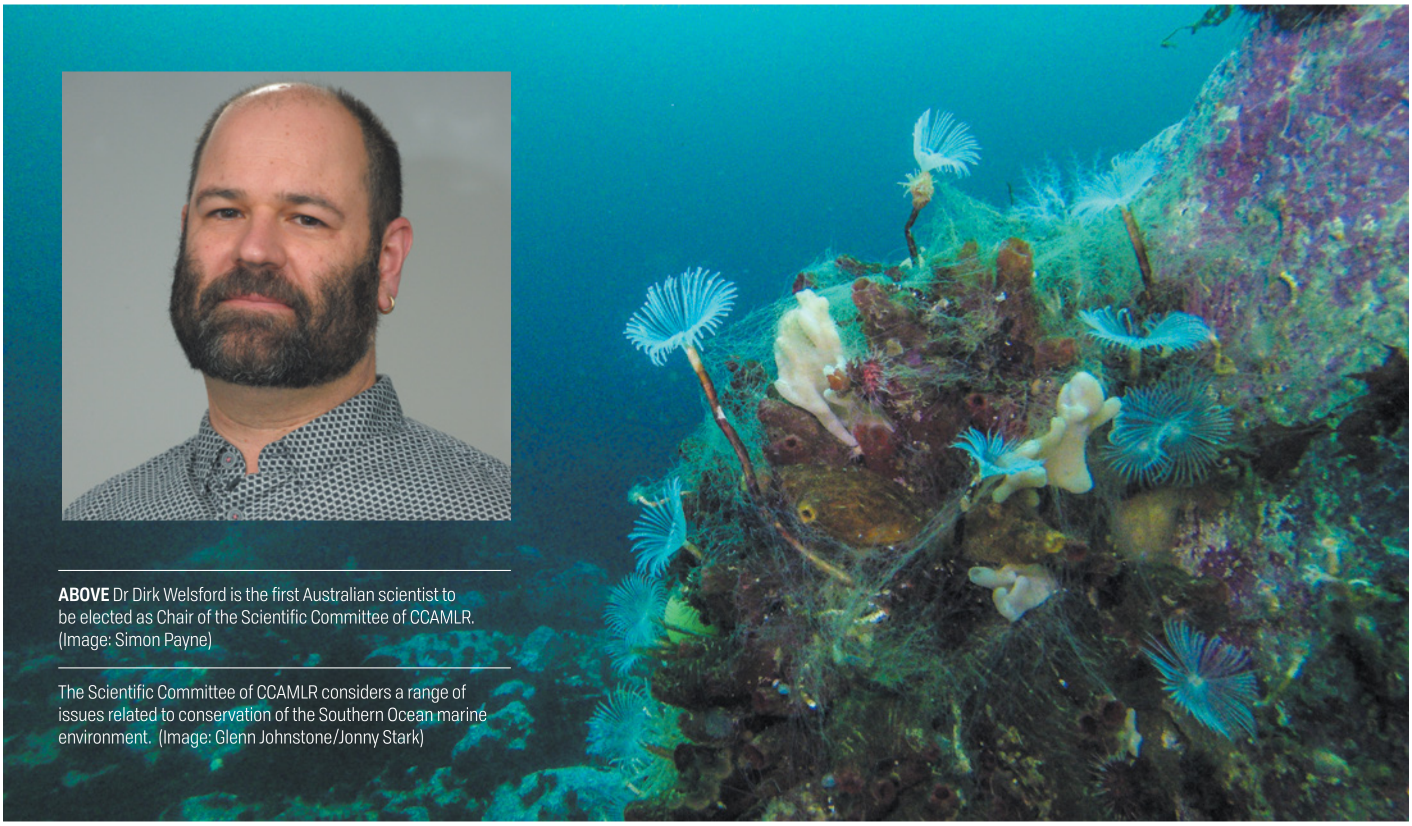
"I hope this will increase diversity in the organisation and encourage women and people from non-English speaking backgrounds to take up leadership positions.

"The more diversity of voices we have at the table, the better ideas we'll have, and the more robust our decision-making will be."

This year Dr Welsford is excited to be working towards the first major revision in 20 years of how the krill fishery is managed, and research and monitoring plans for Marine Protected Areas.

"During my term I'd like to see CCAMLR successfully transition to a new and diverse generation of people working to keep doing the good things the Commission does, including revising the procedures for krill fishery management, so that it continues to lead marine conservation – after all, that's why CCAMLR was established 39 years ago."

Wendy Pyper
Australian Antarctic Division



ABOVE Dr Dirk Welsford is the first Australian scientist to be elected as Chair of the Scientific Committee of CCAMLR. (Image: Simon Payne)

The Scientific Committee of CCAMLR considers a range of issues related to conservation of the Southern Ocean marine environment. (Image: Glenn Johnstone/Jonny Stark)

Dr Tessa Vance and other Australian Antarctic Program scientists have shown that ice cores from Law Dome contain climate signals that are linked to rainfall patterns in eastern Australia. The cores reveal that there have been much longer droughts in the past 1023 years than the three droughts covered by instrumental records over the past 120 years. (Image: Jill Brown)

Ice core climate insights assist drought management

Ice cores from East Antarctica could be used to improve water security decisions and drought planning and management, for agriculture and other sectors in eastern Australia, according to research involving Australian Antarctic Program scientists.

The research focused on water catchments in south-east Queensland (SEQ), and found that modelling based on instrumental rainfall records (rain gauges), spanning the past 60-120 years, may underestimate the probability of drought.

However, Antarctic climate scientist Dr Tessa Vance, from the Institute for Marine and Antarctic Studies, said palaeoclimate data in ice cores could provide a better understanding of drought frequency and duration extending back centuries or millennia.

"The short-term instrumental rainfall records in Australia do not encompass enough climate variability to get a reliable understanding of the risks of multi-year droughts or major flood events," Dr Vance said.

"However palaeoclimate data, such as that found in ice cores, tree rings, or corals, can extend hydroclimatic records by thousands of years, providing greater insight into what is possible in terms of drought frequency and duration.

"This will improve estimates of current and future water supply, and enable Australian water supply agencies to better plan for rare but high impact droughts."

The research team, led by Dr Anthony Kiem from the Centre for Water, Climate and Land at the University of Newcastle, analysed climate signals in ice cores from Law Dome dating back to the year 1000.

Dr Vance has previously shown a relationship between yearly summer sea salt concentrations in the ice cores and rainfall variability in SEQ, making them a useful proxy for broader hydroclimate studies in eastern Australia.

The team used the ice core records to reconstruct pre-instrumental rainfall in the study location, between 1000 and 2012, and compared this to drought statistics calculated using instrumental records from 1900 to 2012.

"The results suggest that the instrumental record underestimates or at least misrepresents the full range of rainfall variability that has occurred and is possible in SEQ," Dr Kiem said.

The instrumental record contains three major droughts – the Federation (~1895-1902), World War II (~1937-1945), and the Millennium drought (~1997-2010).

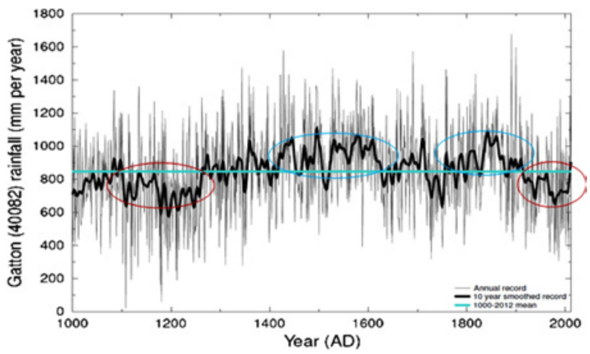
The ice core records show that the lengths of these three major droughts were matched or exceeded several times prior to 1900, including from 1100 to 1250. Some centuries were drier than others, but there were also long wet periods, from 1400–1650 and 1750–1900.

"Our results indicate that current drought risk estimates based on the instrumental record are misleading and probably convey a false sense of security that is not justified given the insights from palaeoclimate data," Dr Kiem said.

"Further research is needed to collect, develop and compare different palaeoclimate records, and to refine the accuracy of these records, to maximise their usefulness for drought planning, agriculture, water management and water security decision making."

The research was funded by the Queensland Department of Environment and Science, Seqwater, and the Australian Research Council. It was published in the *Journal of Hydrology – Regional Studies* in April 2020.

Wendy Pyper
Australian Antarctic Division



This graphic shows rainfall in south-east Queensland (Gatton) reconstructed using Law Dome ice cores. Multi-decadal dry periods (red circles) and wet periods (blue circles) are highlighted. The horizontal blue line is annual average rainfall from 1000 to 2012, with anything below the line considered dry. (Image: Journal of Hydrology: Regional Studies https//doi.org/10.1016/j.ejrh.2020.100686)

First Antarctic heatwave recorded at Casey research station

Australian Antarctic Program scientists recorded the first reported heatwave event at Casey research station in East Antarctica, during the 2019–2020 summer.

Writing in *Global Change Biology* in March, University of Wollongong biologist Dr Sharon Robinson said that between 23 and 26 January this year, Casey recorded its highest ever minimum and maximum temperatures.

"Heatwaves are classified as three consecutive days with both extreme maximum and minimum temperatures," Dr Robinson said.

"In those three days in January, Casey experienced minimum temperatures above zero and maximum temperatures above 7.5°C, with its highest maximum temperature ever, 9.2°C on 24 January, followed by its highest minimum of 2.5°C the following morning."

"In the 31 year record for Casey, this maximum is 6.9°C higher than the mean maximum temperature for the station, while the minimum is 0.2°C higher."

Temperature records were also broken at research bases on the Antarctic Peninsula in February, with the average daily temperatures for the month exceeding the long-term means by between 2°C and 2.4°C.

Australian Antarctic Division applied Antarctic ecologist, Dr Dana Bergstrom, said the warm summer would most likely lead to long-term disruption to local populations, communities, and the broader ecosystem. This disruption could be both positive and negative.

"Most life exists in small ice-free oases in Antarctica, and largely depends on melting snow and ice for their water supply," Dr Bergstrom said.

"Melt water flooding can provide additional water to these desert ecosystems, leading to increased growth and reproduction of mosses, lichens, microbes and invertebrates.

"However excessive flooding can dislodge plants and alter the composition of communities of invertebrates and microbial mats.

"If the ice melts completely, early in the season, then ecosystems will suffer drought for the rest of the season.

She said higher temperatures could also cause heat stress in some organisms.

Australian Antarctic Division atmospheric scientist, Dr Andrew Klekociuk, said the warmer temperatures were linked to above average temperatures across parts of Antarctica, and other meteorological patterns in the Southern Hemisphere that occurred during the spring and summer of 2019.

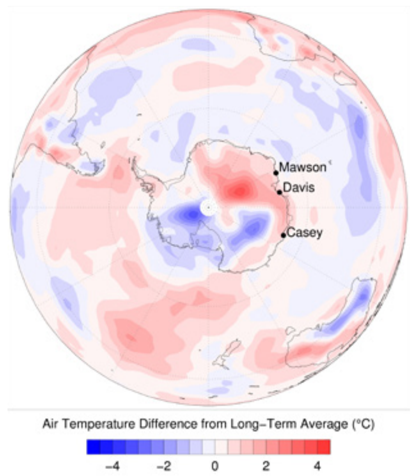
These patterns were influenced in part by the early breakup of the ozone hole in late 2019, due to rapid warming in the stratosphere – the atmospheric region above 12 km altitude.

"The upper levels of the atmosphere at the edge of Antarctica were strongly disturbed in the spring of 2019, and effects of this likely further influenced the lower atmosphere over Antarctica during the summer," Dr Klekociuk said.

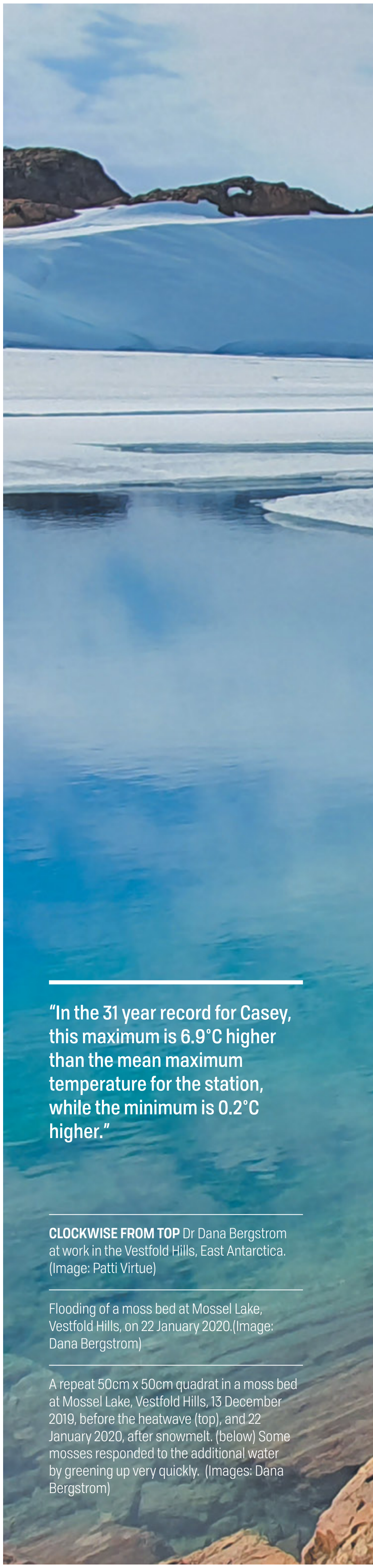
He said the international controls that are working to ensure long-term recovery of stratospheric ozone, and the eventual closing of the ozone hole, are an important part of helping to reduce regional shifts in the climate system.

The exact biological impacts of the heatwave should be revealed in coming years, as scientists continue to monitor local communities.

Wendy Pyper
Australian Antarctic Division



Map of surface air temperature differences between the January 2020 average and the 1979-2019 mean for the Southern Hemisphere. Above average temperatures are coloured red. Most of East Antarctica, including the Australian stations of Mawson, Davis and Casey show above average temperatures. The data used are from the United States National Centres for Environmental Prediction meteorological analysis. (Image: Andrew Klekociuk based on NCEP-NCAR Reanalysis 1 data, *Global Change Biology* DOI 10.1111/gcb.15083)



"In the 31 year record for Casey, this maximum is 6.9°C higher than the mean maximum temperature for the station, while the minimum is 0.2°C higher."

CLOCKWISE FROM TOP Dr Dana Bergstrom at work in the Vestfold Hills, East Antarctica. (Image: Patti Virtue)

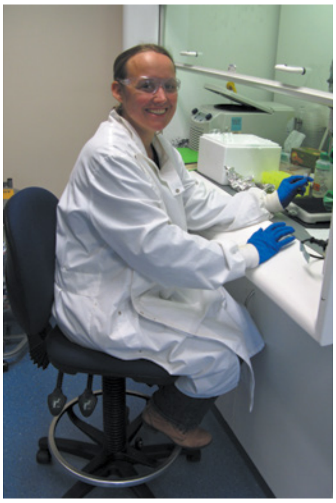
Flooding of a moss bed at Mossel Lake, Vestfold Hills, on 22 January 2020.(Image: Dana Bergstrom)

A repeat 50cm x 50cm quadrat in a moss bed at Mossel Lake, Vestfold Hills, 13 December 2019, before the heatwave (top), and 22 January 2020, after snowmelt. (below) Some mosses responded to the additional water by greening up very quickly. (Images: Dana Bergstrom)

"On a recent voyage, we found one krill swarm contained only seven per cent females, while another was made up of 82 per cent females."

Battle of the sexes

A new molecular test will allow scientists to identify the sex of juvenile and sexually 'regressed' Antarctic krill, for the first time.



ABOVE Dr Leonie Suter has developed a new molecular test for krill that allows scientists to identify the sex of all but the larval phases of krill, for the first time. (Image: Bruce Deagle)

LEFT Adult and sub-adult male krill can be identified can be identified under the microscope by the presence of a 'petasma'. (Image: Leonie Suter)

RIGHT Adult and sub-adult female krill can be identified under the microscope by the presence of a 'thelycum'. (Image: Leonie Suter)

The test, developed by Dr Leonie Suter and her colleagues at the Australian Antarctic Division and the University of Padova in Italy, will provide insights into some of the unusual features of krill reproductive biology.

It will also help researchers identify the gender distribution within swarms.

"The ratio between males and females in krill swarms is often very uneven," Dr Suter said.

"On a recent voyage, we found one krill swarm contained only seven per cent females, while another was made up of 82 per cent females.

"This gender bias could affect the reproductive capacity of the swarm, or the behaviour of the swarm, as males surrounded by males might act differently to when they're surrounded by females, and vice versa.

"We don't know how widespread this biased sex ratio is or what causes it, and determining whether there is a pattern to the distribution of these swarms could improve conservation measures and fisheries models."

But there's a catch. To identify the sex of krill, tell-tale physical characteristics have to be examined under the microscope, but these are only present in sub-adult and adult krill.

Larval and juvenile krill lack these characteristics, and over winter when food is limited, adult krill can shrink in size and revert or 'regress' to a form without external sexual structures.

While finding a gene responsible for male or femaleness would be ideal, the krill genome is complex and 15 times larger than the human genome, so only a small amount of the DNA has been sequenced.

However the presence of genes related to sexual development can be identified using RNA (ribonucleic acid), which is produced from DNA when genes are actively expressed.

So Dr Suter examined the RNA in krill testes and ovaries to identify genes expressed in these tissues.

"There were extensive gene expression differences between ovary and testis tissue, meaning that although the same genes are present in males and females, many are activated or expressed in a sex-specific way in their gonads," she said.

She then looked to see which of these differentially expressed genes were present in either whole female or whole male krill.

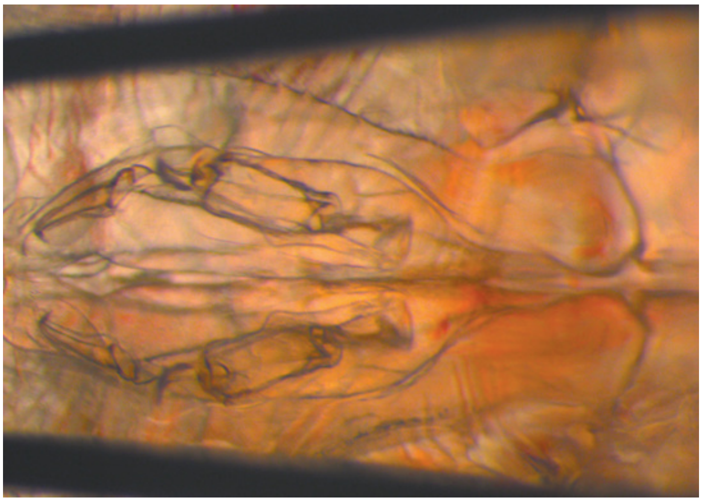
"We found three genes that were only expressed in females and that these could reliably determine the sex of juvenile, sub-adult, adult and sexually regressed krill, but not larval krill," she said.

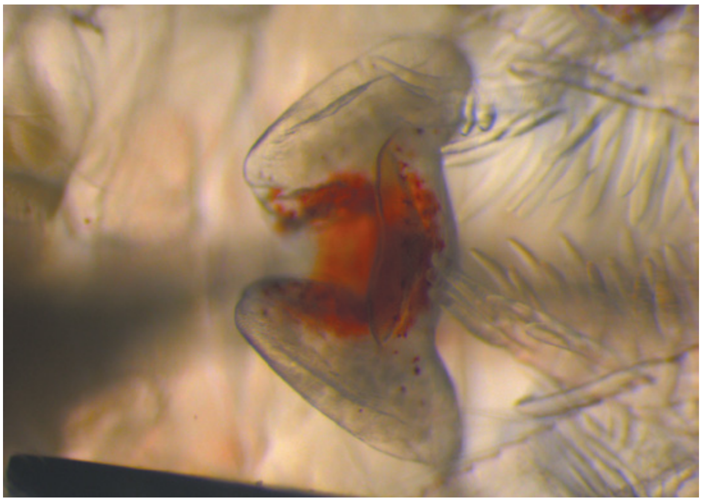
"Using these genes we've been able to develop a molecular test for unambiguous sex determination of krill lacking external sexual characteristics, for the first time.

"This will contribute to our understanding of krill population dynamics, genetic diversity and reproductive behaviour."

When it comes to sex, even amongst krill, it's complicated.

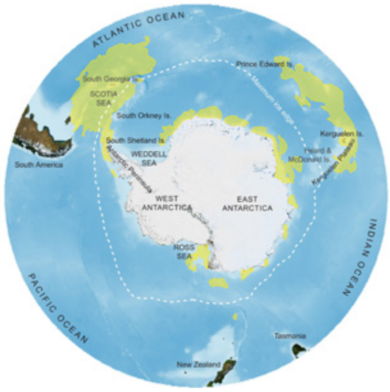
Wendy Pyper
Australian Antarctic division





Areas of Ecological Significance

New ecologically important areas around Antarctica have been identified based on tracking data from more than 4000 Antarctic marine predators, according to research published recently in *Nature*.



The location of Areas of Ecological Significance (yellow) identified by tracking 17 species of Antarctic and sub-Antarctic marine predators to their prey. (RAATD team & NASA's Earth Observatory).

The 'Areas of Ecological Significance' are located on the Antarctic continental shelf, in the Scotia Sea and surrounding waters, and around the sub-Antarctic islands in the Indian sector of the Southern Ocean.

The research, led by Professor Mark Hindell, from the Institute for Marine and Antarctic Studies, and Australian Antarctic Division computational ecologist, Adjunct Professor Ben Raymond, suggests the areas need greater protection from human activities and the impacts of climate change.

"These areas are ecologically significant because of their high biodiversity, biological productivity, or their importance for particular stages in the life cycle of species," Professor Raymond said.

"We found that these areas are subject to stressors including climate change and direct human activity, and that continued climate change over the next century is predicted to impose further pressure on them."

To identify these important ecological regions the research team, drawn from 12 different national Antarctic programs, combined 26 years of tracking data from 12 seabird species and five marine mammal species, with habitat models.

"The principle is simple," Professor Hindell said.

"Identifying areas of the Southern Ocean where predators most commonly go, tells us where their prey can be found. If multiple species of predators and their diverse prey are consistently found in the same place, then this area has both high diversity and an abundance of species, indicating that it is of high ecological significance."

The team found that the location of Areas of Ecological Significance (AES) correspond with the availability of suitable breeding or resting habitat, and regional oceanography and sea ice dynamics that affect how biologically productive the waters are.

The AES in the Scotia Sea, for example, corresponds to an area of elevated krill biomass, while the AES around the sub-Antarctic islands are in a region dominated by small pelagic fish.

The team found that 29 per cent of AES are within formally protected areas known as Marine Protected Areas (MPAs), set by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) or other national authorities. The adoption of new MPAs currently being considered by CCAMLR would raise this coverage of AES to 39 per cent.

However, Professor Hindell said climate model projections indicate that areas of important habitat may change by 2100. This means that continued monitoring of species and an on-going assessment of the effectiveness of MPAs and other management actions will be important.

"Dynamic management of Marine Protected Areas, updated over time in response to ongoing change, is needed to ensure continued protection of Southern Ocean ecosystems and their resources in the face of climate change and growing resource demand," he said.

"Our study highlights where future science-informed policy efforts might be best directed, including both adaptive spatial protection and improved fisheries management."

The research was conducted by the Scientific Committee for Antarctic Research, with support from the Centre de Synthèse et d'Analyse sur la Biodiversité, France, and the WWF-UK.

Wendy Pyper
Australian Antarctic Division

Areas of Ecological Significance are important because of their high biodiversity, biological productivity, or because of their importance for particular stages in the life cycle of species, such as this Weddell seal with an icefish in East Antarctica. (Image: Helena Baird)

Going gaga over Googies

The Googie hut, designed and built by Australian Antarctic Division engineer Attila Vrana in the mid-1980s, has provided a robust and versatile field hut in the Australian Antarctic Territory for almost 30 years.

The elliptical 'googie' was given its name from the Australian slang for egg. Shaped not unlike a UFO, it was designed to prevent snowdrift build up and withstand high winds. The Googies were usually painted 'international orange', a vivid colour chosen for high-visibility in whiteout conditions.

Designed to prevent snowdrift build up and withstand high winds, the Googies were made from moulded fibreglass cast in two halves and mounted on a steel frame cradle, supported by three anchored legs. Light-weight and portable, at 600 kilograms without fitout, they were transported via ship and sling-loaded by helicopter to a field-work location.

With an integrated fibreglass shell spanning five metres in diameter at bench height, the three-person hut maximised usable interior space with storage in its under-floor cabinets for food and other items. Under-floor heating and heat exchangers were installed around the walls, with a standard fit-out that included up to three couches doubling as a beds, a work bench, showers and toilet. The prefabricated huts could be configured to serve as accommodation, laboratory, mess area or medical surgery. A metal stairway provided access. Large windows provided a light-filled experience, but often made sleeping difficult in summer.

The Googies were more spacious than other huts designed at the time, and their insulation and weather-proofing provided comparatively better protection than predecessors from extreme Antarctic elements.

Only five prototype Googies were made. They were deployed in February 1992 – the first at Béchervaise Island near Mawson station to support the Adélie penguin monitoring program, and the other four huts at Spit Bay, on Heard Island. Overwintering on Heard Island in 1992, Mr Vrana experimented with using a wind turbine to power the huts – the first Australian foray into using renewable energy. The wind turbine successfully provided most of the field camp's power needs on a regular basis.

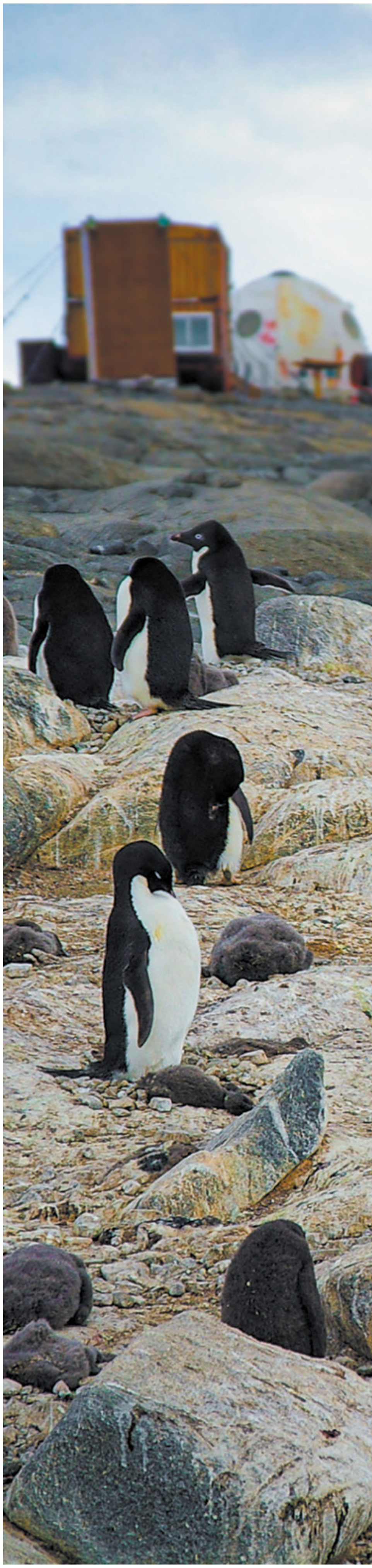
In February 1993 the four huts at Heard Island were dismantled and subsequently distributed to other locations. One was sited at Hop Island in the Rauer Group near Davis station to support seabird research, while another was sent to Béchervaise Island to expand the field camp, by providing a companion hut to the original Googie. The third Googie was sent to Waterfall Bay at Macquarie Island to replace an ageing hut at Lusitania Bay. The last Googie was re-sited at Brothers Point on Macquarie Island in 1996, to replace the hut at Sandy Bay.

The Australian Antarctic Division's Macquarie Island Modernisation Project team are currently undertaking an assessment of existing field huts to determine whether each meets the structural, functional and environmental criteria for future needs (*Australian Antarctic Magazine* 36: 2-3, 2019). As part of a broader modernisation plan for Macquarie Island's infrastructure, the assessment will recommend which huts should be refurbished or replaced, and where new huts might be sited.

Despite some issues in the field, the Googies remain a sentimental favourite for many expeditioners. Though the Googie designs and moulds haven't survived, their iconic look has inspired inquiries from enthusiasts all over the world, cementing its unique place in Antarctic architectural history.

Tess Egan
Australian Antarctic Division, Library Services

Special thanks to Attila Vrana for his assistance in writing this article.



RIGHT Googie huts have been used on Béchervaise Island since 1992 to support a long-term Adélie penguin monitoring program. (Image: Matt Low)

BELOW The interior of a Googie. (Image: Karen Andrew)

The stamps reflect the ship's Norwegian origin, being designed by the celebrated Norwegian engraver Martin Mörck using traditional intaglio techniques and offset printing

Stamps commemorate the 1948 Wyatt Earp Expedition

Australia Post released the long awaited HMAS *Wyatt Earp* Australian Antarctic Territory (AAT) stamps in March, correcting the omission of the ship from their earlier 1979–82 AAT definitive' Ships of the Antarctic' series.

The HMAS *Wyatt Earp* holds the proud distinction of being the first Royal Australian Navy (RAN) commissioned ship to have sailed to Antarctica, and the only RAN ship that has ever ventured to the continent.

The three-stamp issue depicts, among other things, the *Wyatt Earp* with her orange painted superstructure and black hull, the ship moored in the sea ice in the vicinity of Commonwealth Bay, and the gold coloured Vought-Kingfisher float plane that was carried on board, in flight over ice strewn seas, piloted by RAAF Squadron Leader Gray with Observer, Jones.

The stamps reflect the ship's Norwegian origin, being designed by the celebrated Norwegian engraver Martin Mörck using traditional intaglio techniques and offset printing – this was undertaken by the French specialty stamp printing company, Cantor.

The 1948 Antarctic voyage of the HMAS *Wyatt Earp* was the result of geopolitical tensions and national interests in the Antarctic and sub-Antarctic, which emerged after the Second World War. It motivated the Australian Government of the time to establish a presence across the Australian Antarctic Territory, and stations on the sub-Antarctic Heard and Macquarie islands.

The *Wyatt Earp's* proposed voyage was to travel along the coastal length of the AAT, then arrive at the recently built station on Heard Island. It would then voyage to the Isles de Kerguelen for refuelling, before returning to Melbourne. The proposed voyage proved to be beyond the sailing capabilities of the ship, having left Australia in January 1948 – too late for such an enormous and hazardous sea ice voyage during the closing months of the Antarctic summer.

There is an interesting epilogue to the naming of the ship during her costly refit at the Birkenhead Naval dockyard in South Australia in 1947. After her launch in Norway as *MS Fanefjord* in 1919, the ship was subsequently purchased by American adventurer Lincoln Ellsworth, and renamed *Wyatt Earp* after the American Wild West gunslinger of the same name. After a series of successful voyages to West and East Antarctica, the ship was bought by the RAN and subsequently named HMAS *Wongala* and later, SSTS *Wongala* (see *Australian Antarctic Magazine* 26: 28-29, 2019).

With a new Antarctic voyage imminent, RAN Commander Karl Oom proposed to the Naval Board that the ship be re-named HMAS *Wyatt Earp*, given that she had achieved international fame and a reputation for Antarctic exploration under that name. The Naval Board agreed and announced the name at the ship's formal commissioning ceremony on 17 November 1947.

An old sailor's superstition suggests that if you change the name of a ship you change her luck. The *Wyatt Earp* had seven names during her 40 years of service. Her luck finally ran out after she became the *Natone* in 1956, with her wreck on the Queensland coast in January 1959.

David Dodd
ANARE

LEFT The 1948 Wyatt Earp Expedition First Day Cover. (Image: Australian Postal Corporation)

RIGHT Norwegian engraver Martin Mörck used traditional intaglio techniques and offset printing for this stamp issue of the 1948 Wyatt Earp Expedition, released on 31 March 2020. (Image: Australian Postal Corporation)

Australia conducts Antarctic Treaty inspections

In January 2020, Australian officials led by Australian Antarctic Division Director, Kim Ellis, completed Australia's most extensive program of Antarctic Treaty inspections to date, spanning much of East Antarctica. Australia regularly conducts inspections in Antarctica, in support of the Antarctic Treaty and its Environmental Protocol, and to confirm compliance with key requirements including non-militarisation and environmental protection.

The team from the Australian Antarctic Division and the Department of Foreign Affairs and Trade flew via Christchurch to McMurdo Station (USA), and made an official visit to New Zealand's Scott Base to compare experiences on station modernisation plans, Antarctic science, and operational support. The team moved on to Terra Nova Bay, where Italy kindly provided support at Mario Zuchelli Station. The team conducted the first inspection of Korea's year-round Jang Bogo Station, established in 2014, and the first inspection of China's temporary station on Inexpressible Island, where China plans to build a year-round facility. Germany's Gondwana Station was inspected as a follow-up to an Australian inspection in 2011, and the team also reviewed Italy's gravel runway construction project.

The team then flew some 2000 kilometres from Browning Pass skiway in spectacular mountain scenery, to Casey research station, before continuing to Davis research station. This served as the base for the team's next inspection, of China's Taishan Station, high on the inland plateau. Taishan Station had not previously been inspected.

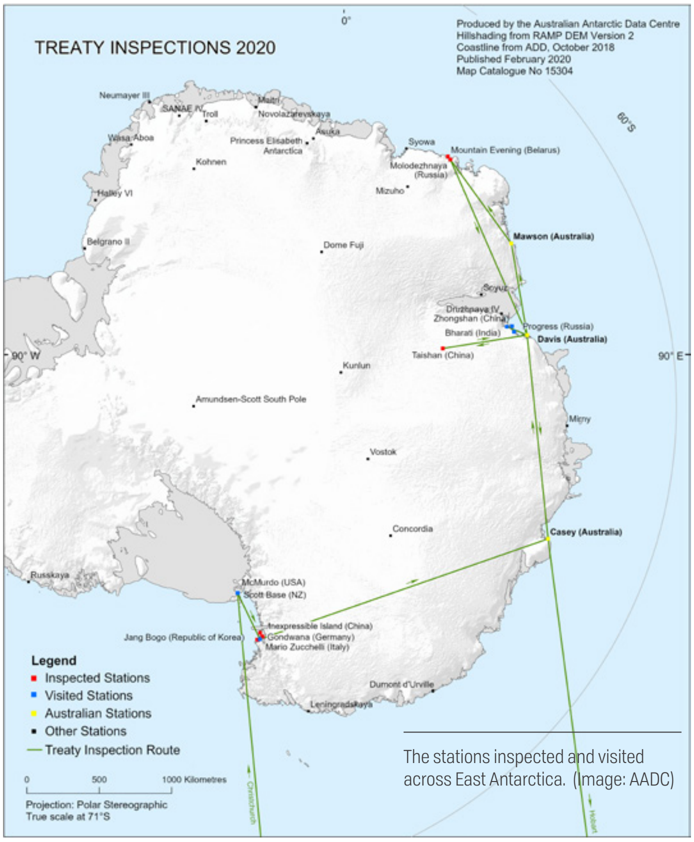
While at Davis Mr Ellis led official visits to stations in the Larsemann Hills, where Australia, Russia, China and India cooperate in a management coordination arrangement under the Environmental Protocol (Larsemann Hills Antarctic Specially Managed Area No.6). Valuable discussions on cooperation in the area were held with personnel at India's Bharati Station, China's Zhongshan Station, and Russia's Progress Station.

The team then visited Mawson research station, before flying to Russia's Molodezhnaya Station, around 700 kilometres further west, where they were hosted by the Russian Antarctic program. Molodezhnaya is currently operated as a seasonal facility, but was formerly the USSR's largest Antarctic station, and much of it is now unused. This was the first on-ground inspection of Molodezhnaya since 1983, and followed an Australian aerial inspection in 2010. The final inspection was Mountain Evening Station, a new facility under development by Belarus, located about 20 kilometres to the east of Molodezhnaya. Currently a seasonal station, Belarus plans to operate Mountain Evening year-round in the near future.

The Australian team was warmly welcomed at all of the facilities visited, and found a high level of compliance with the provisions of the Treaty and Protocol. These inspections provided important oversight of these stations, and an opportunity to observe scientific research being undertaken, and the operational practices of other Antarctic nations.

The reports of the inspections will be considered by the Antarctic Treaty Parties and then made publicly available.

Phil Tracey
Senior Policy Advisor, Australian Antarctic Division



The stations inspected and visited across East Antarctica. (Image: AADC)

Why inspect?

Antarctica is internationally managed through the agreements of the Antarctic Treaty system. The Treaty and its Protocol on Environmental Protection include mechanisms to support transparency and ensure that the countries active in Antarctica are abiding by the agreed rules and standards. Any country that has signed up to the Treaty can operate and conduct science anywhere in Antarctica. Australia is one of 29 nations with decision-making rights under the Antarctic Treaty, known as Consultative Parties. These Parties can appoint inspectors who then have free access to stations and installations anywhere in Antarctica. Inspection reports are considered by the Antarctic Treaty Consultative Meeting, and subsequently made public (see www.ats.aq).

The Australian Antarctic Division inspection team at Russia's Molodezhnaya Station (L-R): Phil Tracey, Chris Gallagher, Kim Ellis and Justin Whyatt. (Image: AAD)

Icebreaker's last voyage becomes digital artwork

Arts Fellows John McCormick and Adam Nash spent six weeks digitally documenting the final voyage of the *Aurora Australis* for an interactive audiovisual exhibition.

As 'Wild System' we have been making digital art together for about 15 years. With a professional background in performance (dance and music), we usually use digital technologies like motion capture, virtual reality and data visualisation, to create performative, interactive audiovisual works in gallery and festival spaces.

For many years we had discussed the possibility of applying for the Australian Antarctic Arts Fellowship; we were fascinated by the thought of Antarctica and held a romantic notion of wanting to go there. But the annual call for submissions always seemed too broad for us to apply.

The call in 2019 was different; it specifically asked submissions to address the theme of 'the final voyage of the *Aurora Australis*' – the icebreaker that has been sailing its legendary Antarctic route for 30 years.

"Here's something we can set our talents to," we thought.

There would be so much data generated and collected by the ship and its scientists and crew. We workshopped the idea over a couple of hours and decided to make a virtual version of not just the ship, but the whole voyage.

"It will be an artistic impression of the voyage, rather than any attempt to portray it realistically," we told each other.

"It'll be like a giant, artistic data visualisation, projected onto the walls and ceiling of a large gallery, to create a totally immersive environment for people to enter.

"It can't hurt to put in a submission; it's a great idea and we know how to do it."

Drawing on our experience and reputation, we sought support from the Australian Centre of the Moving Image in Melbourne, and the Salamanca Arts Centre in Hobart, who were keen to have us involved in the bi-annual Antarctic Festival that would be held three months after the end of the voyage.

We knew we would need to source a LIDAR scanner, which is a laser scanner that can scan physical spaces and turn them into digital 3D models. We also needed an ambisonic recording setup – a spatialised 3D audio recording technology. And we needed drones to capture high resolution imagery of the outside of the ship, to use in photogrammetry

"It'll be like a giant, artistic data visualisation, projected onto the walls and ceiling of a large gallery, to create a totally immersive environment for people to enter."

– another way of capturing physical spaces or objects as digital 3D models.

When our submission was accepted, we started to worry – will we be able to handle the harsh conditions, will we get seasick, will the crew and scientists think we're crazy, or worse, annoying? Well, we probably were annoying in the end, and a little crazy, but happily everyone else was crazy too, in the best possible sense.

We left Melbourne in the smoke haze of devastating bushfires and landed in Hobart amid the unfolding of a global coronavirus pandemic. We arrived a week prior to departure for training and inductions. Boarding the ship in Hobart for the first time was quite the experience; us in our immaculately 'new out of the box' Australian Antarctic Division issued high-viz gear and hard hats, looking every bit the new arrivals. This was also our first inkling of the enormity of the quest we had embarked upon. The ship, though dwarfed by the new *Nuyina* research vessel, was huge, with very intricate small spaces. Scanning was going to take an order of magnitude longer than planned.

We cast off from Hobart with a six week round-trip ahead of us. It was two weeks before anyone set foot on land again, at Davis research station. Just enough time to quarantine the ship and expeditioners, with the potential risk of COVID-19 infection to Antarctic expeditioners and wildlife on everyone's minds.

The voyage was, of course, amazing. The expeditioners, Captain, crew and voyage leaders, were incredibly supportive of the project. Every day on the ship was full to the brim with interesting challenges: collecting data, helping with experiments, interviewing people on board, scanning the ship, scanning people, recording Glacial TV footage, 360 video, ambisonic audio recordings, motion capturing individuals, and flying drones around the ship and stations, photographing so much beauty.

Every day offered up incredible experiences. The seething Southern Ocean, towering Iceberg Alley, majestic Sørsdal Glacier, the mirror glass waters of the polynya approaching Mawson research station, the ice plain above the station, incredible wildlife, and an aurora australis dancing above the ship on the way home.

We envisaged collecting as much data as possible for the exhibitions. Along with the underway voyage data from the ship, we accessed data from a whale mooring (year-long whale song recordings), a plankton recorder, the Bureau of Meteorology (weather), a sunshine recorder, ARGO buoys (sea temperature and salinity), cosmic ray records, and more.

We now have a huge amount of data that will form the basis of a number of exhibitions. The first was to be part of the Antarctic Festival in late July. The festival is postponed due to COVID-19, but we are continuing to work on it. This may become an online virtual exhibition, instead of, or as well as, the physical exhibition at Salamanca Arts Centre. Things are changing daily in the current world.

Which brings us to the point of going to Antarctica. We wanted to track the voyage of the *Aurora Australis* and gather as much data as possible on the ship, people and science as we could. This will allow us to create a snapshot of the interaction between the people, ship, technology and the Antarctic environment – to try to envision how things connect through an artistic lens. The fragility of these connections are increasingly apparent in these challenging times.

John McCormick and Adam Nash
Wild System

CLOCKWISE FROM LEFT Wild System digital artists Dr John McCormick (left) and Dr Adam Nash, gather sound and vision on the *Aurora Australis*. (Image: Martin Passingham)

John McCormick does a body scan of Chief Mate, Nick Smith, to create a 3D digital model. (Image: Wild System)

2019-20 Arts Fellows Dr John McCormick and Dr Adam Nash, seen here at Mawson Station, are creating a virtual version of icebreaker, *Aurora Australis*, and their voyage. (Image: Wild System)

Wild System captured drone footage of the outside of the ship to use in photogrammetry. (Image: Wild System)

Interim icebreaker

The MPV *Everest* will resupply Australia's Antarctic and Macquarie Island stations next summer.

The Ice-Class Multi-Purpose Vessel is operated by Dutch company Maritime Construction Services, and can navigate in ice up to one metre thick.

Australian Antarctic Division General Manager of Operations and Safety, Charlton Clark, said the end of the *Aurora Australis*' contract and the delayed arrival of Australia's new icebreaker RSV *Nuyina* (due to the COVID-19 pandemic) meant an alternative ship had to be contracted.

The 140 metre-long *Everest* was built in 2017 and will be used for a minimum of 90 days next summer. The vessel can accommodate up to 100 expeditioners, has large fuel storage tanks, and space for up to 96 20-foot cargo containers on its decks. It also has a helipad above the bridge, which will be used for ship-to-shore resupply operations.

Read more about the MPV *Everest* at https://mcs.nl/assets-and-facilities/fleet-and-facilities/mpv-everest/

Corporate Communications
Australian Antarctic Division

The MPV *Everest* will resupply Australia's Antarctic and sub-Antarctic stations in the 2020–21 Antarctic season. (Image: Maritime Construction Services)

Icebreaker's propeller turns for the first time

The propulsion system of Australia's icebreaker, RSV *Nuyina*, heaved to life with the turning of the starboard propeller for the first time in January.

The rotation of the 43.5 tonne propeller and another 80 tonnes of shaft line marked another major milestone in the ship's construction.

General Manager of the Australian Antarctic Division's Assets and Infrastructure Group, Rob Bryson, said it was exciting to watch the ship come to life.

"The Damen shipyard commissioning team activated the advanced electric drive, which is connected to the shaft line, and used the ship's diesel generators to power that drive and rotate the propeller," he said.

"It made four revolutions over two minutes, which doesn't sound like much, but it was turning about 120 tonnes of high tensile steel."

The shipyard team subsequently started the main engine and commissioned the port propeller.

While the ship is now 98 per cent complete, final harbour acceptance trials and sea trials have been delayed due to travel restrictions arising from the COVID-19 pandemic. The delay is not expected to have any impact on the cost of the long-term contract.

Wendy Pyper
Australian Antarctic Division

The starboard propeller of the RSV *Nuyina* turned for the first time in January. (Image: Damen)

Sealers' ships immortalised on remote Heard Island

Ships carrying 19th Century sealers to the remote Australian Territory of Heard Island and McDonald Islands (the Territory), have lent their names to some of the islands' beaches, lagoons and tarns.

The ships, named *Josephine*, *Bertha*, *Eliza*, *Marcia*, *Lydia*, *Zoe* and *Cornelia*, transported people, mainly from the United States and Cape Verde islands off West Africa, to the region between 1855 and 1882.

For nearly 30 years the sealers hunted and processed Heard Island's southern elephant seals for oil, enduring extreme isolation, freezing temperatures and incessant winds.

Naming geographic features is a key part of the Australian Antarctic Division's role in administering the Territory. It helps to keep maps of the region current, which is especially important given the current extent of glacial retreat and volcanic activity in the Territory.

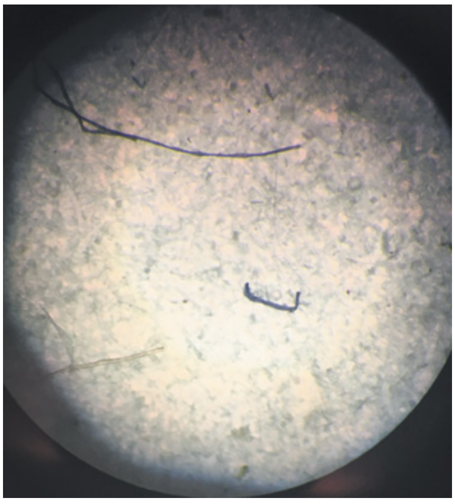
Among other new feature names on the island is Quilty Cone, commemorating eminent Australian scientist Professor Patrick Quilty, AM, who died in August 2018. Professor Quilty possessed unique knowledge of the Heard Island and McDonald Islands' geology and authored key geological research papers.

Search for names in the Australian Antarctic Gazetteer http://data.aad.gov.au/aadc/gaz/

Sally Chambers
Australian Antarctic Division

Rusting trypots, used to render elephant seal blubber, are a reminder of the sealing industry on Heard Island in the mid-19th century. (Image: Eric Woehler)

Microplastics found in Antarctic sea ice



Microplastics have been identified in Antarctic sea ice for the first time.

The research, published in *Marine Pollution Bulletin* by scientists from the Institute for Marine and Antarctic Studies and the Australian Antarctic Division, analysed an ice core collected in East Antarctica in 2009. The team identified 96 microplastic particles from 14 different types of polymer.

Lead author, Anna Kelly, said plastic pollution has previously been recorded in Antarctic surface waters and sediments, as well as in Arctic sea ice, but this is thought to be the first time plastic has been found in Antarctic sea ice.

"The ice core we analysed was from coastal land-fast sea ice and averaged almost 12-particles of microplastic per litre," Ms Kelly said.

"While this concentration is lower than that found in some Arctic sea-ice samples, the 14 different polymer types we identified is only slightly less than the 17 found in Arctic studies."

The microplastic polymers in the Antarctic ice core were larger than those found in Arctic cores, indicating a local pollution source, as the plastic has less time to break down into smaller fibres. Such sources could include clothing and equipment used by tourists and researchers, but varnish and plastics commonly used in the fishing industry were also found.

Ms Kelly said the study's findings indicate sea ice has the potential to be a significant reservoir for microplastic pollution in the Southern Ocean. Rather than sinking to the deep ocean, the entrapment of microplastics in Antarctic sea ice allows them to persist for longer near the sea surface.

"This would make them more available for consumption by marine organisms such as krill, a keystone species in Southern Ocean ecosystems, and consequently marine predators higher up the food chain," she said.

Andrew Rhodes
Institute for Marine and Antarctic Studies

Microplastics in an Antarctic ice core, visible under the microscope. (Image: Anna Kelly)

New Antarctic science strategic plan

Climate research using million-year old ice, and studies into Antarctic krill, will be key features of Antarctic science over the next decade, according to a new Australian Antarctic Science Strategic Plan release in April.

The plan was developed by the Australian Antarctic Science Council, in consultation with the Antarctic science research sector, Commonwealth agencies, Tasmanian government, universities and industry stakeholders.

It highlights the global importance of the Antarctic and sub-Antarctic region and Australia's leadership in the sector.

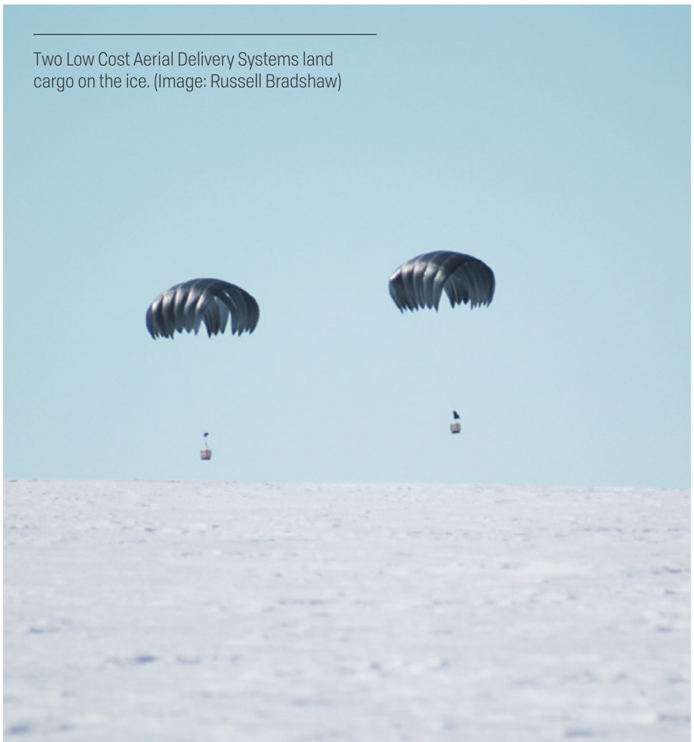
The plan sets out three key research areas:

- Environmental Protection and Management;
- Ice, Ocean, Atmosphere and Earth Systems; and
- Human Presence and Activities in Antarctica.

It also highlights the importance of digital integration, with data collection and analysis underpinning scientific outputs. Read the plan at http://www.antarctica.gov.au/__data/assets/pdf_file/0008/236519/Australian-Antarctic-Science-Strategic-Plan.pdf

Australian Antarctic Division

The new Australian Antarctic Science Strategic Plan will oversee the delivery of research outcomes including obtaining and analysing a million-year-old ice core. (Image: Tas van Ommen)



Two Low Cost Aerial Delivery Systems land cargo on the ice. (Image: Russell Bradshaw)

Precision parachute drop

Two new parachute systems were successfully used to resupply Casey research station with dried food and forklift parts, in January.

Three 'low-cost' and two 'precision-guided' parachutes were deployed near Casey by a Royal Australian Air Force (RAAF) C-17A Globemaster III.

The Low Cost Aerial Delivery System (LCADS) provides a cost-effective means of delivering airdrop cargo to Antarctica, and can be packed down into a smaller package than traditional parachutes, on recovery.

The Joint Precision Aerial Delivery System (JPADS) is a GPS-guided system which steers the parachute and provides airdrop delivery from higher altitudes and with high accuracy. It could be used to resupply remote deep-field camps, tractor trains on inland traverses, or vessels stranded in sea-ice.

Remarkably, the precision-guided parachute dropped from 10,000 feet at a speed of 270 kilometres per hour and landed its cargo of foodstuffs within 30 metres of the target.

The airdrop trial was also used to train Australian Antarctic Division ground crews in the methods and equipment required for using aerial delivery systems in Antarctica.

Mark Horstman[1] and Eamon Hamilton[2]
[1]Australian Antarctic Division, [2]Royal Australian Air Force

PHOTO: JESSICA FITZPATRICK

Freeze Frame Simon Payne

This image of the *Aurora Australis* entering the sea ice was taken by drone pilots Simon Payne (Australian Antarctic Division) and Angus Hardwick (Helicopter Resources), during one of the ship's last voyages to Antarctica. When perfect flying weather presented itself, the pair quickly organised the required paperwork. While occupied in the task, and unbeknown to them, the ship's Third Mate saw the ice edge approaching. She put the ship through a donut manoeuvre, giving the pair time to launch the drone and capture the moment it crashed through the ice pack.

Simon Payne is a camera operator, drone pilot and videographer in the Australian Antarctic Division's Corporate Communications team. He travelled to Antarctica in late 2019 to capture vision and stills that support the outreach work of the Division.

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