The Royal Society of Victoria
Promoting science since 1854

SCIENCE VICTORIA

NEWS FROM THE ROYAL SOCIETY OF VICTORIA RSV.ORG.AU OCTOBER 2022

THE OFFICIAL NEWSLETTER OF RSV

In this issue

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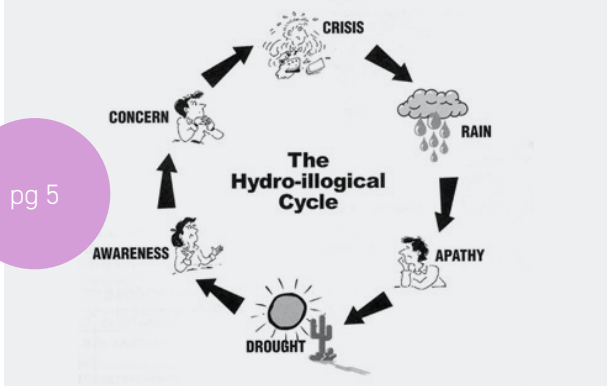

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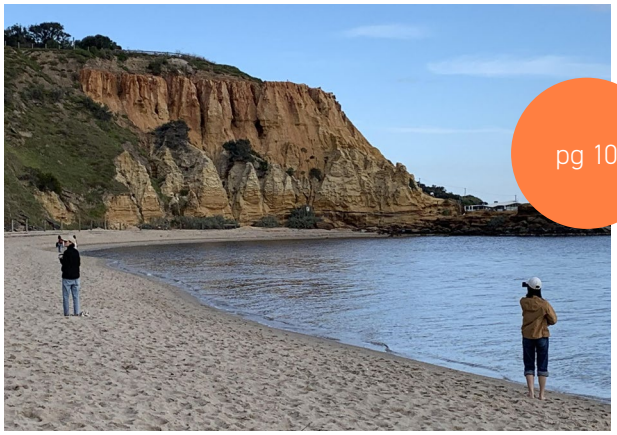

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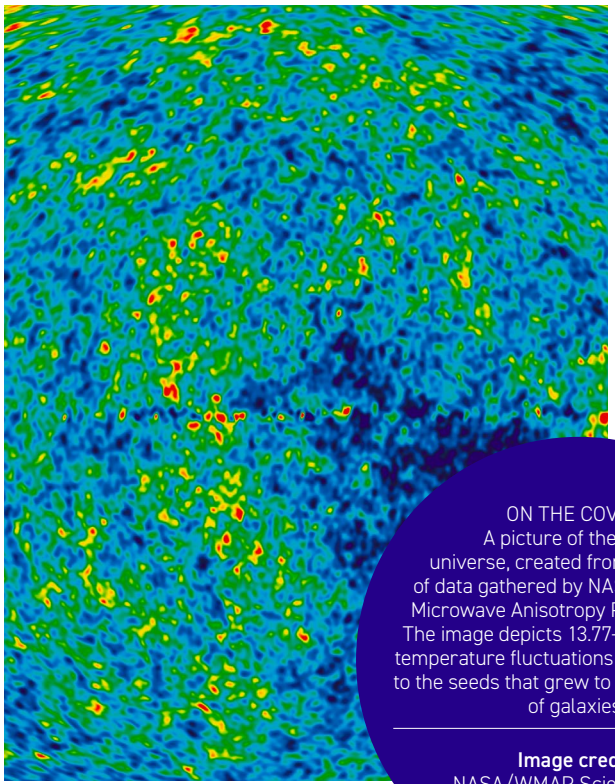
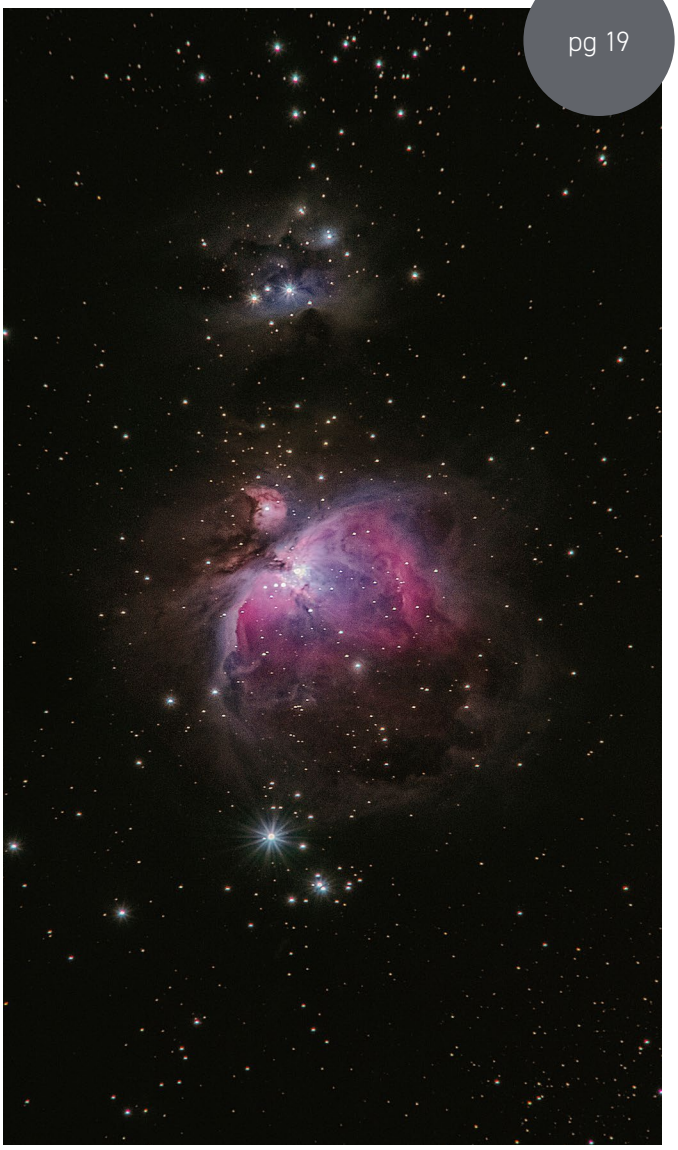


ON THE COVER:
A picture of the infant universe, created from nine years of data gathered by NASA's Wilkinson Microwave Anisotropy Probe (WMAP). The image depicts 13.77-billion-year-old temperature fluctuations that correspond to the seeds that grew to become clusters of galaxies.

Image credit:
NASA/WMAP Science Team
(Public Domain)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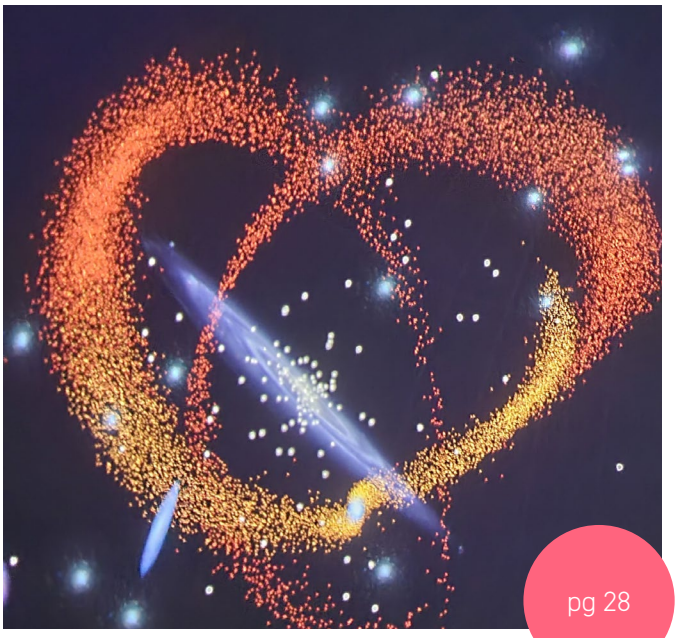
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INTERESTED IN SCIENCE? ENJOY WRITING? WE WELCOME LETTERS, ARTICLES AND IDEAS.

Please note that the submission deadline for content to be included in the November 2022 edition of Science Victoria is **5pm Friday 21st October 2022**
Email **editor@sciencevictoria.org.au**.

FROM THE CEO

Here Comes the Victorian Election

It's getting harder and harder for the public service to collaborate with us – it must be election time! We continue the year's run of public knowledge events concerned with conserving and restoring Victoria's ecological systems and values this month with a symposium on **Conservation of the Northern Victorian Floodplains**, convened to gather scientific and community intelligence on the appropriate management of rivers and streams representing the State of Victoria's contribution to the health of the Murray-Darling Basin; particularly the Goulburn River. Given the low-risk appetite of government while our representatives take to the campaign trail, we're holding this one in partnership with our colleagues from the Wentworth Group of Concerned Scientists. Join us if you can.

After a busy year of public engagement in decidedly cost-constrained circumstances, I'm afraid our science awards and prizes have backed up against the end-of-year close – so we'll be looking at a lively November and early December ahead, celebrating our Young Scientist Research Prizes finalists, our Phillip Law Postdoctoral Award winner and the 2022 Research Medallist. Our long-awaited paper on the current state of biodiversity conservation and recovery in Victoria will be released later this month and will feature in our November edition.

For now, we have articles based on recent events for National Science Week, the small question of life elsewhere in the universe, historical notes, government consultations that await your expert input, and more. My thanks to Scott Reddiex and Catriona Nguyen-Robertson for their excellent work this month.

See you in November!

Mike Flattley
CEO, The Royal Society of Victoria

SCIENCE VICTORIA, VOLUME 2, NUMBER 9, OCTOBER 2022

The Monthly Publication of the Royal Society of Victoria – established 1854 for the promotion and advancement of science.

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Acknowledgement of Country:

The Royal Society of Victoria acknowledges the many First Peoples of our continent, their vast history and connection to the lands and waters within and beyond the State of Victoria, and the valuable cultural and scientific knowledge held by Elders to care for Country.

We acknowledge our headquarters are located on Wurundjeri land, never ceded, and convey our respect to Elders past and present.

The RSV seeks to support and celebrate the continued contributions of First Nations people to scientific knowledge.

FROM THE PRESIDENT

What About Our Rivers?

In April this year, the former Victorian Minister for Water Lisa Neville announced a Consultative Committee to enable 'communities to play a key role in the proposed Victorian Constraints Measures Program'. The Minister's Media release of 27th April 2022 explained:

> ***"Across the Murray-Darling Basin, dam and weir construction has reduced natural flooding events resulting in river channels becoming disconnected from the floodplain.***
>
> ***While ecological benefits of re-instating environmental water to lower floodplains and wetland habitats could be significant, there are concerns about the impacts to public and private assets such as roads, bridges, fences, pumps and private land."***

As a geomorphologist I have had both an interest in and understanding of the issues involved since graduation. Coupled with a public position related to weather and climate matters I have on occasions had the opportunity to present at conferences on topics ranging from climate change and energy generation to flood management and river health.

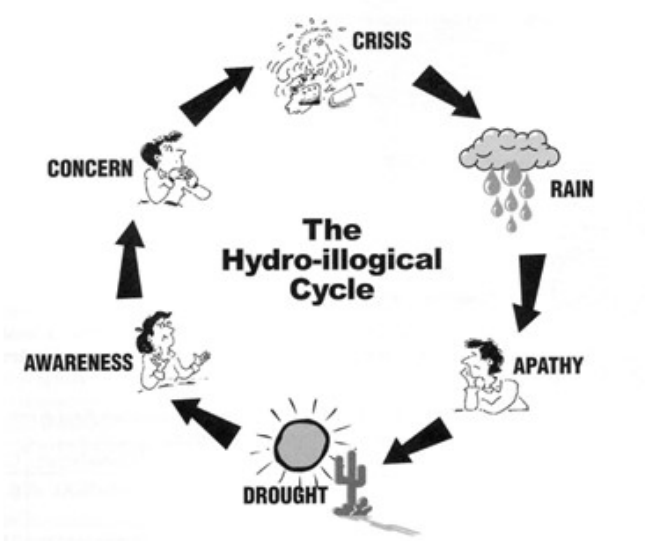
In 2010 I was asked as the National President of *Greening Australia*, an organisation which continues to be a pre-eminent landscape restoration non-profit organisation, to present to the 7th Victorian Flood Conference at the time that the Federal Government presented its Murray Darling Basin Plan.

Kerry O'Brien, reporting on the Federal Government's Murray Darling Basin Plan on the 7.30 Report in 2010

At the time, Kerry O'Brien was hosting 7:30 Report on ABC television and had this to say on the 4th of October 2010:

> ***"The long-awaited Murray Darling Basin Plan will be released this week and with it a renewed debate over the priorities of the nation's food bowl. The plan will identify how much water is needed to keep the rivers and wetlands of the entire Basin healthy and is likely to reduce the amount available for irrigation.***
>
> ***The Basin Plan comes at a time of high moral for farmers and environmentalists as heavy winter rain has ended almost a decade of drought. So strong have the flows been in Australia's greatest river that freshwater is likely to flow out of the Murray's mouth in South Australia this week, something that hasn't happened since 2002."***

A review of my presentation "*Climate Change Impacting River Health*", which included the above quote from Kerry O'Brien, serves as a reminder that the issues facing our rivers and streams have changed little in the last decade.



My points were about the high variability of Australia's climate, that in Australia 'average' conditions are ecologically meaningless, that the river channel is a function of its interaction with the floodplain, and there was a need to accommodate floods "in the national interest", not in the interests of a few. I enjoyed introducing Donald Wilhite's *Hydro-illogical Cycle*[1], in which he summarises the current approach to drought management.

It is still essential that we consider productive pastures as floodplains and that to achieve long term river health we need a better general understanding of the eco-hydrology of rivers & streams; understanding that our river systems currently exhibit all the anthropogenic equivalent chronic and communicable diseases, and that radical investment in both ecosystems viability and climate change mitigation opportunities is required.

Notwithstanding the fact that in our third La Niña event in succession delivering widespread flooding across south-eastern Australia, the management of the Murray-Darling Basin region, its waters, and broader ecosystems continues to be problematic.

When is the best time to discuss the link between climate change and bushfire? When is the best time to discuss the need to flood our river systems on a regular basis to maintain river health?

"No time like the present," say the Royal Society of Victoria and the Wentworth Group of Concerned Scientists, and we will hold an important full-day symposium, '*Conservation of Northern Victorian Floodplains*' on the 24th of October 2022. Register to attend online or in person here: **https://rsv.org.au/events/northern-floodplains/**

I have long held the view that the RSV can play an important role as a strong advocate for evidence-based decision making at levels in our community. Victoria needs a voice that our community can draw on to provide independent, scientific information, correction where required and strategic advice if consulted. Our partnership with the Wentworth Group of Concerned Scientists is a step in that direction.

Please write to me at **president@rsv.org.au** to discuss this matter and any other issues you wish to raise; we'd like to publish your letters and engage as many members as possible in future editions of Science Victoria.

Rob Gell AM MRSV
President, The Royal Society of Victoria

1 Breaking the Hydro-Illogical Cycle: Changing the Paradigm for Drought Management, Donald A. Wilhite, University of Nebraska – Lincoln: https://digitalcommons.unl.edu/droughtfacpub/53/

LETTERS

The Waterhouse Natural Science Art Prize

Dr Jane Canestra, MRSV

Fossilised stromatolites by Peter Syndicas

Banksia seritfolia by Anne Hayes

Sing by Debbie Symons

Surface beneath by Alexandra Hirst and Mirjana Dobson

The Waterhouse Natural Science Art prize brings art and science together. The annual competition encourages artists to reflect on scientific issues across many artistic disciplines and attracts participants from around the world. The prize is awarded in honour of the inaugural curator of the Museum of South Australia and this year celebrates 20 years since its inception.

The exhibition is currently displayed at the National Archives of Australia in Canberra until 13 November. If you have an opportunity, take the time to see this gem of an exhibition.

Amongst the works are reflections on the impact of climate change, loss of biodiversity, pollution, survival, and hope. As well as traditional artistic media such as paint, collage, sculpture and video, some works incorporate recycled and transformed materials. Above all is a sense of the beauty of the world around us, and a feeling of devastation at the impact of the Anthropocene.

I would encourage a visit to see these beautiful and thought-provoking visions. The impact on me was visceral, with both a reverence for the skill demonstrated and a yearning for the beauty of the natural world to be preserved.

Further information:

https://www.naa.gov.au/visit-us/events-and-exhibitions/waterhouse-natural-science-art-prize-0

https://www.samuseum.sa.gov.au/c/waterhouse

RSV NEWS AND NOTICES

New RSV Members

INDIVIDUAL MEMBERS

Dr Ian Powell,
Microbiologist & Food Technologist (retired), Swinburne University

Ms Judith Deland,
Land Covenantor & Biodiversity Photographer

Mr Dale Christensen,
Accelerator Operator, Monash University

Ms Fiona Sutton,
Ecologist (Botany), Jacobs

Mr Pronab Pal,
Senior Cloud Engineer, AURIN

Mr Saket Apte,
Lead AI Quantum Researcher, Tech Mahindra

Dr David Low,
Senior Policy Officer, Victorian Government

Mr Neeraj Das,
Managing Director, Ojas Group

ORGANISATIONAL MEMBERS

Eucalypt Australia,
Grant-Making Charitable Trust - **https://www.eucalyptaustralia.org.au/**
(Represented by Linda Baird)

Renu Energy,
Renewable & Clean Energy Technology Projects - **https://www.renuenergy.com.au/**
(Represented by Greg Watson)

EVENTS

Dr Shruti Nirantar, 2019 finalist

Young Scientist Research Prizes Competition: Presentations, Judging and Prize Ceremony

Thursday, 10th November 2022 (from 6:00pm)

To foster and recognise excellence in Victoria's early career scientists, the Royal Society of Victoria has established four prestigious competitive prizes open to Victorian students in their final year of doctoral candidature, in all areas of the Biomedical & Health Sciences, Biological Sciences (Non-human), Earth Sciences and Physical Sciences.

Following assessment of applications across the four categories, we will select **eight PhD finalists** to present their work to us during **National Science Week**. Join us to hear about the latest science from our emerging scientists, and to support and celebrate the achievements of Victoria's upcoming high achievers.

Registration is available from **https://rsv.org.au/events/ysrp-2022/** to join us for the competition and awards ceremony at the Royal Society of Victoria's historic Hall in the Melbourne CBD. Alternatively, you can watch along via our **YouTube channel** at the appointed time without needing to register.

Livestreamed as part of the Inspiring Victoria program in 2022.

Dr Emily Roycroft, 2019 finalist

Inspiring AUSTRALIA Victoria

Explore Melbourne's Dynamic Coastline

Saturday, 12th November 2022 (10:00am–3:00pm), Rickett's Point, Beaumaris

A field trip organised by Geography Victoria in collaboration with the **Association of Bayside Municipalities**.

Port Phillip is a wonderland of coastal geomorphology, right on Melbourne's doorstep!

Join RSV President and coastal geomorphologist Rob Gell AM, fellow coastal geomorphologist Professor David Kennedy (Office for Environmental Programs, University of Melbourne), marine scientist Dr Rebecca Morris (National Centre for Coasts and Climate, University of Melbourne) and geologist Dr James Driscoll (Assistant Lecturer, Monash University) to explore the dynamic nature of the coast and marine environment – looking at evidence of historical changes on the coast, the geological landscapes that shape our foreshores and the bay, the impacts of climate change, storms and sea level rise on the marine and coastal environment, and more...

Our presenters will share the emerging science and practices changing the way the Bay is monitored and managed. This includes the use of cutting-edge technology, engaging citizen science and the use of nature-based methods of coastal protection.

- There will be some walking (approximately 2 km).
- Street parking is available at Rickett's Point (fees apply).
- Lunch will be at the picnic tables at Rickett's Point – BYO or feel free to purchase from the Rickett's Point Beachside Café.
- The afternoon will be spent at the beach/cliffs opposite Edward St, Sandringham (street parking available).

Maps, specific information for the day and fieldtrip notes will be provided following registration. Places are strictly limited – suitable for ages 12 and up.

Registrations: **https://rsv.org.au/events/melbourne-coastline/**

2022 Australian Synchrotron Open Day

Sunday, 16th October 2022 — Multiple Times

The light created at the Australian Synchrotron is about a million times brighter than the sun. This brilliant light can be used to assemble tiny machines that would fit into the eye of a needle, improve cancer detection, and develop new drugs to fight malaria.

You will have a rare chance to go behind the scenes of this state-of-the-art facility and experience these scientific wonders first-hand.

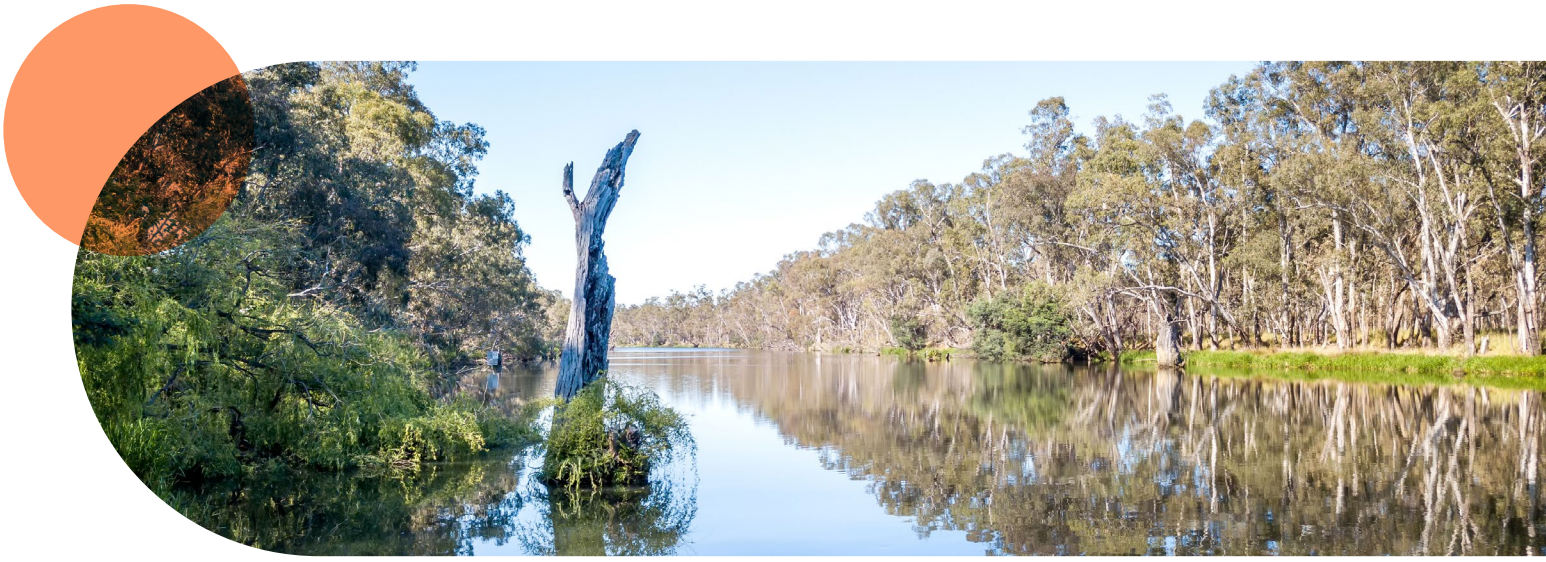
Please **book** into the introductory 30-minute presentation and allow one hour for the self-guided Synchrotron tour. In this time, you will have the chance to:

- Learn how the Synchrotron works and the amazing research it enables.
- Talk to our scientists stationed at each of the Synchrotron beamlines
- Unwind in our cafe and picnic areas, where you can listen to live interviews with ANSTO scientists while children enjoy one of our exciting science workshops and hands-on activities

There will be plenty of photo opportunities and regular giveaways too!

Bookings: **https://www.eventbrite.com.au/e/australian-synchrotron-open-day-2022-tickets-416444134617**

Enquiries: **education@ansto.gov.au**



Conservation of the Northern Victorian Floodplains

PRESENTING PARTNERS

The Royal Society OF VICTORIA Promoting science since 1854

WENTWORTH GROUP OF CONCERNED SCIENTISTS

Saturday, 24th October 2022 (10:00am–4:00pm) — Melbourne and Online

Presented by the **Royal Society of Victoria** and the **Wentworth Group of Concerned Scientists**.

An important opportunity has arisen in Victoria for the conservation of the Murray-Darling Basin (MDB)'s rivers and sustainable development for river communities. The Victorian Government has asked a Consultative Committee into the Victorian Constraints Measures Program to report by December 2022.

Further, changes to both the Victorian and Federal governments and an increasing focus on implementation of the **MDB 2013 Constraints Measures Strategy** ahead of a 2024 reconciliation (audit) provide impetus for positive change.

The Royal Society of Victoria and the Wentworth Group of Concerned Scientists are hosting this symposium to synthesise scientific knowledge on the costs and benefits of river floodplain restoration to inform the Victorian consultation process.

NORTHERN VICTORIAN FLOODPLAIN RESTORATION

Conservation of river ecosystems, such as Victoria's extensive redgum forests, depends on water releases from dams filling river channels and spilling out onto floodplain wetlands. Without regular watering, extensive areas of the redgum forests and other wetlands will be lost. State and federal governments agreed in 2013 to a "constraints management" strategy to purchase easements from farmers for temporary and occasional inundation of low-lying paddocks along the River Murray and its key tributaries.

However, implementation has stalled. Some landholders are concerned over the accuracy of inundation mapping or oppose watering all together. There is debate about the appropriate scale of the floodplain restoration in a changing climate and whether restoration may enable more water recovery for the environment.

THE PROBLEM

The governments have communicated floodplain restoration as an impost on local communities rather than offering many benefits, which include:

- flood risk reduction;
- pasture growth;
- groundwater recharge;
- fish breeding;

– and considerable local infrastructure investment, and all with little or no land use change.

Floodplain restoration is an important climate change adaptation for generating environmental and socio-economic benefits in a future that anticipates less reliable water.

Since 2008 the Federal Government has acquired environmental water at the cost of billions of dollars to implement the Murray-Darling Basin Plan. However, without agreements with farmers, the water acquired can't be used for broadacre wetlands conservation due to fears of damages claims.

THE OPPORTUNITY

Floodplain restoration along the Goulburn River would enable 12,000 of 13,000 hectares of wetlands to be directly conserved. In combination with NSW, along the River Murray 375,000 hectares could be watered plus more areas in South Australia. The incoming Federal Government has allocated funding and is committed to overcoming this impasse.

SYMPOSIUM AIMS

The science of the costs and benefits of Victorian floodplain conservation needs to be synthesised and communicated, to contribute to the Victorian consultation process. This one-day symposium will bring together leading biophysical and social scientists, Indigenous and other local knowledge holders, and government agency leadership to share knowledge on floodplain restoration.

We aim to provide a formal input to the Victorian Government's consultation process on the Victorian Constraints Measures Program from these proceedings.

THE PROGRAM

Program Chair: Professor Kate Auty
Professorial Fellow, The University of Melbourne
Chair, Environment Protection Authority Victoria

SESSION 1: CONTEXT

The Constraints Management Strategy (2013)

Andrew Reynolds
Executive Director, River Management, Murray-Darling Basin Authority

Traditional owners' perspectives of floodplain management

Yorta Yorta Nation Aboriginal Corporation (speaker TBC)

Interdisciplinary work across knowledge disciplines to enhance floodplain management practices

Professor Robyn Watts, Gulbali Institute for Agriculture, Water & Environment, Charles Sturt University

SESSION 2: FLOODPLAIN PROCESSES

The ecological needs of floodplain forests and other wetlands

Association Professor Matt Colloff, Fenner School of Environment & Society, Australian National University

The ecological needs of fish

Professor John Koehn, Gulbali Institute for Agriculture, Water & Environment, Charles Sturt University

The ecological needs of waterbirds

Professor Richard Loyn, School of Agriculture, Biomedicine and Environment, La Trobe University

Goulburn River flows and constraints

Mr John Pettigrew, President, Goulburn Valley Environment Group & Board Member, Murray Darling Wetland Working Group

SESSION 3: WATER

Trajectories of change and water quality on floodplains

Emeritus Professor Peter Gell, Institute of Innovation, Science & Sustainability, Federation University

Climate change challenges and opportunities

Dr Francis Chiew, Surface Water & Basin Outcomes, CSIRO

Hydrological constraints and opportunities

Dr Eytan Rocheta, The Water Research Centre, University of New South Wales and Wentworth Group of Concerned Scientists

Ecosystem service benefits from floodplain restoration

Professor Max Finlayson, Gulbali Institute for Agriculture, Water & Environment, Charles Sturt University

SESSION 4: GOVERNANCE

Legal implications and options for constraints relaxation

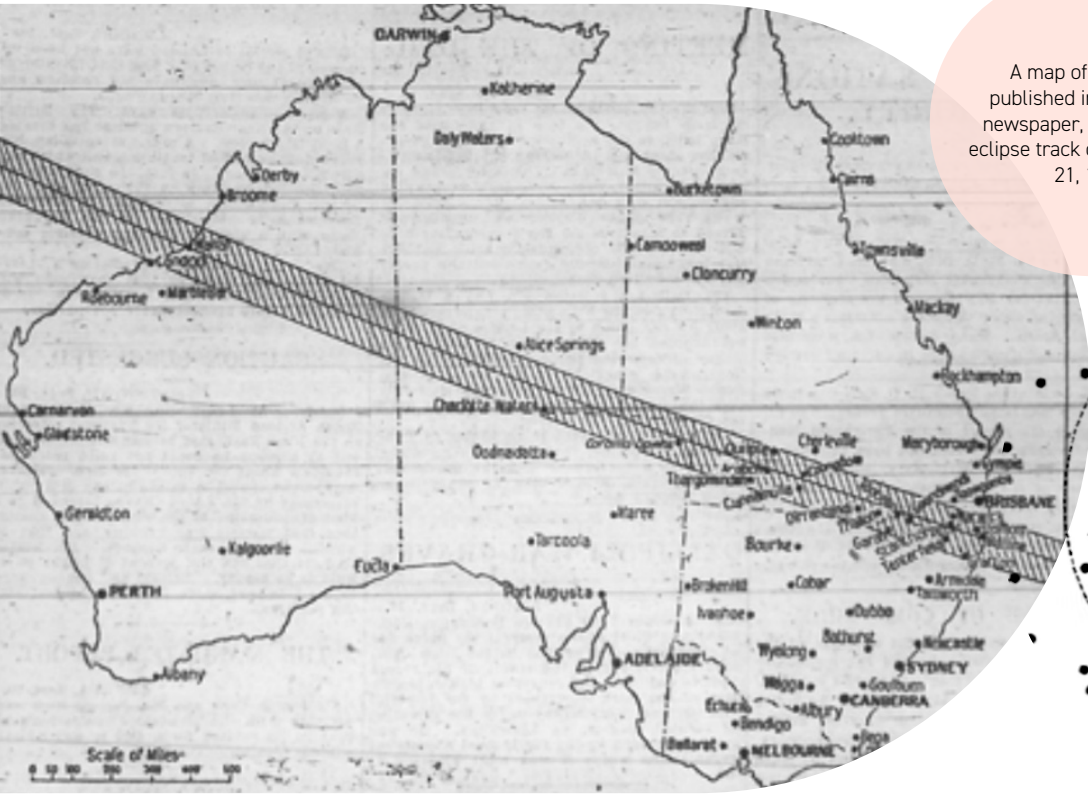
Dr Erin O'Donnell, Melbourne Law School, The University of Melbourne

Floodplain restoration policy options

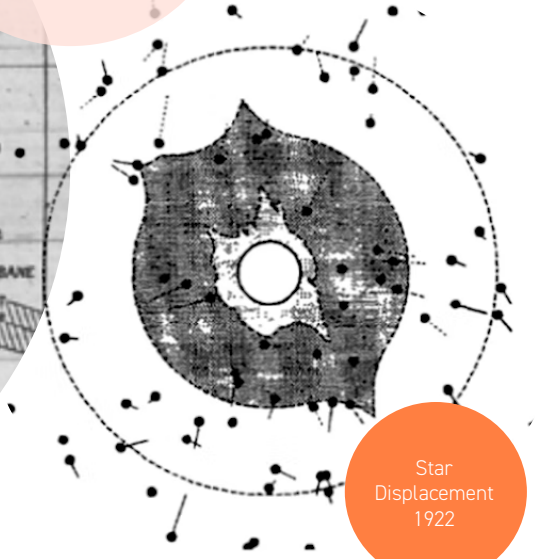
Professor Jamie Pittock, Fenner School of Environment & Society, Australian National University & Wentworth Group of Concerned Scientists

Rapporteur's summary and next steps.

SYMPOSIUM CLOSE & NETWORKING FUNCTION



A map of Australia published in The Argus newspaper, showing the eclipse track on September 21, 1922



Star Displacement 1922

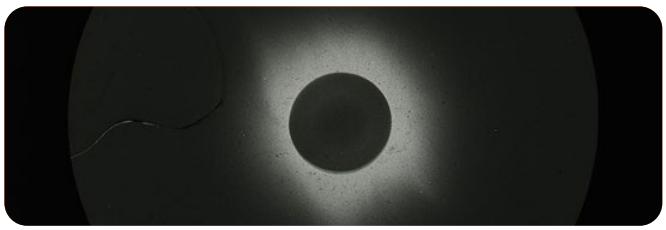
Validation of Einstein's General Relativity

Thursday, 17th November 2022 (5:30am–7:30pm) — Malaysian Theatre, Glyn Davis Building, The University of Melbourne

Celebrating the Centennial of an Australian Scientific Achievement

In 1922, the path of a total solar eclipse crossed the central part of Australia, presenting the first opportunity to validate Eddington's claims that Einstein's Theory of General Relativity was a 'representation of nature'. Expeditions were sent from different states in Australia to observe the eclipse, involving both Australian and international scientists. The scientific results were a resounding confirmation of Einstein's theory.

A distinguished panel will present details of the events surrounding the eclipse in 1922: the expeditions, the scientific data and the implications. Some of the most recent scientific results that directly reflect this new understanding of the nature of gravity will also be presented.



Solar Corona Australian Eclipse 1922

The panel will include Professors David Jamieson and Rachel Webster, and Emeritus Professor Brian Finlayson.

5.30PM refreshments at foyer outside B117 Glyn Davis Building (133 - Melbourne School of Design), followed by a panel presentation and discussion at 6PM.

Registrations: **https://rsv.org.au/events/1922-eclipse/**

TRANSACTIONS

FEATURES AND ARTICLES

Adapted from a presentation at the Bay Environment Forum, 5th of October 2022

What's in the Water?

By Rob Gell AM FRGS

Part 1

I've had an interest in water management for more than two decades. I'm not an engineer - I'm a geographer; a geomorphologist. Someone who is concerned about the morphology, the shape, of the landscape, how a landscape has evolved and changed over geological time and the influences that have caused the changes in morphology; geology - faulting and folding, rivers and streams, waves and currents, winds, weathering and erosion, climate.

I've also had a long-term interest in environmental issues since I read Rachel Carson's '*Silent Spring*' as an undergraduate science student in the early seventies, which described the harmful effects of pesticide use on our environment. The 27th of September 2022 marked the 60th anniversary of Rachel Carson's book.

Unfortunately, Australia still uses dozens of chemicals[1], like the ones Rachel Carson warned us of sixty years ago, that are banned in other countries including the UK and USA. These chemicals are banned because they're toxic to humans, animals or the myriad other plants and animals that inhabit our planet with us.

Chemicals like Atrazine, Paraquat, Malathion, Dichlorvos, and of course the neonicotinoids that are threatening bees globally. Paraquat has been linked to Parkinson's disease; Atrazine, which interferes with reproduction, may cause cancer.

Then there's the pharmaceuticals: pharmaceutical pollution of the world's rivers is far more extensive than previously thought – so much so that it now poses a global threat to environmental and human health. Add to that the drugs for human and veterinary use, including antibiotics, natural and synthetic hormones, detergents, plasticizers, insecticides, and fire retardants.

Consider your visit to the supermarket, and the thousands of litres of inorganic chemicals in white plastic bottles that we see lining 'cleaning' aisle. Where does all that stuff go? If you live in Sandringham, your sewage waste, and all the other stuff you use, ends up in the bay.

1 The dirty dozen: 12 pesticides that are banned elsewhere but still used in Australia

A lot of these chemicals end up in our sewer systems. They either go through our bodies into the toilet or off the kitchen bench and are washed down the sink or the shower or down the gutter into the stormwater system.

I should also mention the endocrine disrupters - hormone disrupting chemicals. The endocrine system is the network of glands that produce all the hormones used by our bodies. In addition to well-known sex hormones like testosterone and estrogen, the endocrine system also secretes important hormones like insulin and adrenaline.

Endocrine disruptors are chemicals that interfere with this system. They are also known as endocrine-disrupting chemicals or EDCs. These are things like PFAS, dioxins, things in plastics, things in soap, things in pesticides, fungicides, and herbicides. They all disrupt our endocrine system and they're all around us.

They accumulate in human fat tissue and can have effects on obesity, diabetes, reproduction, breast cancer, ovarian cancer, thyroid problems, and problems with the prostate. Endocrine disruptors may be associated with the development of learning disabilities, severe attention deficit disorder, cognitive and brain development problems, and deformations of the body.

SO, WHAT DOES THAT HAVE TO WITH A PORT PHILLIP BAY ENVIRONMENTAL FORUM?

The point is that all these things are used by humans, escape to the environment, or are flushed down our toilets and end up in our sewage treatment plants. The biggest in Victoria is Melbourne Water Corporations' Western Treatment Plant at Werribee that discharges to Port Phillip Bay.

It's difficult to find out the exact number, but the volume of treated sewage that is discharged to Port Phillip Bay each year is about 140 GL - that's 140 billion litres. This sewage has only undergone secondary treatment[2].

That's better than primary treatment, secondary treatment often uses biofiltration, aeration and oxidation ponds to allow for safer release into the local environment.

It's not tertiary treatment though, that is utilised elsewhere in the world to raise the quality of the water to domestic and industrial standards or to meet specific requirements around the safe discharge of water. Tertiary treatment involves the removal of pathogens ensuring that water is safe for **drinking purposes**. This is **not** what is done at Werribee.

The outfall water is full of nitrate and all the other stuff that other stuff I've mentioned that we don't even measure.

2 What Are the Three Stages of Wastewater Treatment?

In many ways the Western Treatment Plant at Werribee, and the other major treatment plant at Carrum that discharges at Boags Rocks into Bass Strait represent the 'ecological footprint' of Melbourne's human population.

The Port Phillip Bay Environmental Management Plan[3] (2017 to 2027) concluded that nutrients, sediment, and other pollutants flowing into the Bay are the main contributors to poor water quality.

The Victorian Environment Protection Authority Beach report is currently closed and will reopen on the 1st of December. Is Port Phillip Bay safe to swim in today? Should I surf at Boags Rocks?

The EPA website currently says there are **two** alerts affecting Port Phillip Bay and its associated water catchments[4].

The first was Issued on 6th September 2022 and updated on the 20th for 'maintenance dredging' at Werribee River entrance at the Werribee South jetty, it says:

> **Parks Victoria will soon commence maintenance dredging around the entrance of Werribee River, near Werribee South jetty. Dredging is expected to commence on the 15th of September and will continue for 3 to 6 weeks (weather dependent). Sand disposal will provide sand to adjacent beaches north of the river entrance. Dredging may cause discoloured or odorous water. Avoid use of the beach during this time.**

My question is: what are the levels of heavy metals, pesticides and hydrocarbons in the sediments being disturbed by Parks Victoria and put in the water column in the bay?

The second alert is a PFAS risk assessment on **fish** in Maribyrnong River that was issued on the 7th of May **2019** - it's still on the website, and it says:

> **EPA has conducted a risk assessment on levels of PFAS in fish caught from the Maribyrnong River. As a result, EPA recommends anglers don't consume fish caught from the Maribyrnong River upstream of Solomons Ford in Avondale Heights to Deep Creek at Bulla, and within all of Arundel Creek.**

I may be wrong, but I don't think I noticed this warning on any of our news services.

My question then is: where did the PFAS come from and how much is still in the Maribyrnong? If it's not still there, where has it gone - into the Yarra, its sediments or into the bay?

More on this next month! Your letters and responses welcome: **president@rsv.org.au**

3 Port Phillip Bay Environmental Management Plan (2017 - 2027), Department of Environment, Land, Water and Planning
4 EPAVic Water Quality Alerts

Is There Anybody Out There? The Fermi Paradox

by Scott Reddiex MRSV

Regardless of any surprises that tomorrow may hold, one thing is certain: life currently exists on Earth. In a universe ~13.77 billion years old, on a planet formed ~4.54 billion years ago, the first signs of something resembling life can be traced back ~4.1 billion years[1] – meaning that not only does life currently exist here, but it has done so for *quite* a while.

EARTH AS A MODEL PLANET

Earth is just one planet, orbiting a single star. In turn, our sun is one of 100-400 billion stars in the Milky Way Galaxy. With our galaxy being one of an estimated 2 trillion galaxies[2], this takes the total number of stars in the universe up to somewhere between 2-8 billion trillion (2-8 x 10^{21}).

We know that our solar system has eight planets (sorry Pluto!), with more than 200 moons shared between them, and many more (~1 million) minor planets (which includes asteroids and dwarf planets like Pluto). However, regardless of the many different objects orbiting our star, the only evidence of life we have comes from here on Earth. Using this as our starting point, we can define a range of potential locations in the universe that life could similarly emerge: a planet with all of Earth's characteristics, orbiting a star with all of the Sun's characteristics...while also acknowledging that life could also exist elsewhere.

To make some rough calculations, we can call a Sun-like star one that falls into the F, G, or K-class of stars, which makes up around 20% of stars in the galaxy[3]. Each of these stars is estimated to have 0.4-0.9 rocky planets in its habitable zone[3], bringing our range down to *only* 0.26-1.04 billion trillion 'Earth-like' planets in the universe. For comparison, this number (1.04x10^{21}) is greater than the number of *milliseconds* that have passed since the beginning of the universe (4.3x10^{20}).

THE DRAKE EQUATION

The task of combining the various mathematical factors into a logical formula was undertaken in 1961 by the astronomer/astrophysicist Dr Frank Drake. Focusing only on the Milky Way Galaxy, his work resulted in the eponymous **Drake Equation**: $N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$.

This equation states that:

N (the number of civilisations in our galaxy emitting a detectable electromagnetic signal)

= **R_*** (the average rate of star formation in our galaxy)
x f_p (the fraction of those stars that have planets)
x n_e (the number of planets per star that can support life)
x f_l (the fraction of planets on which life emerges)
x f_i (the fraction of planets on which intelligent life evolves)
x f_c (the fraction of civilisations that develop technology that produces a signal we can detect)
x **L** (the length of time that a civilisation produces the detectable signal).

The value of the Drake Equation lies less in producing a magic number, and more in the breakdown of the individual contributors to the chance of detecting life. As our technological ability to detect any signals advances, the value for f_c will increase, and it has done so over the past 150 years of human history. The value of f_l varies greatly depending on how the question is approached – Earth is our only 'model planet' for Earth-like conditions, and life definitely emerged here. Does this mean that abiogenesis (life originating from non-life) is something that is very likely to occur on an identical planet? Life seems to have emerged here only once (i.e., all life on Earth shares a common ancestor, and there has been no evidence of any extinct alternate lineages), however systems like the Miller–Urey experiment have shown that amino and nucleic acids will form under conditions similar to early Earth[4,5]. Should we ever discover evidence of life (either extinct or extant) on a planet like Mars or a moon like Titan, it would understandably increase the values of f_l, and n_e.

THE FERMI PARADOX

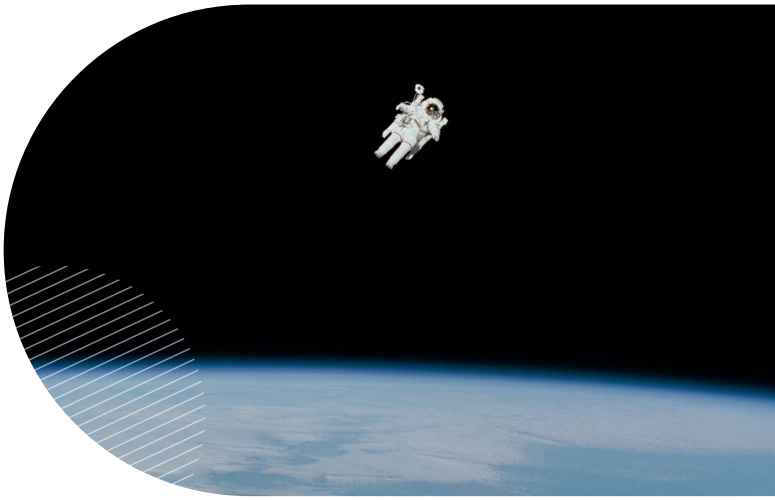
Now that we've established **1.** that there are a lot of places in the universe where life could possibly start like it did on Earth, and **2.** that life on Earth started ~440 million years after it was formed, this raises a question: *where is everybody*?

This particular question is called the **Fermi Paradox**. Named after physicist Prof Enrico Fermi, the story goes that he exclaimed it after discussing faster-than-light travel and reports of UFO sightings with fellow physicists. Put simply, the nature of the paradox is: if the chances of life starting somewhere are relatively high, then why haven't we seen any signs of anyone else in the universe?

By this point, you have probably had some ideas coming to mind as to why we haven't heard from any potential cosmic compatriots. We can make different groups from some of the many hypothetical reasons:

(Intelligent) Life is Rare

As we saw from the breakdown of the Drake Equation, it *seems* abiogenesis has a good chance of occurring on a planet like Earth, even though we only have Earth as our model for this. However, something that is significantly rarer than abiogenesis is the subsequent emergence of *intelligent* life. While it only took ~440 million years for life to get started on early Earth, it took another ~4.1 billion years for the only intelligent life form to emerge (and even then, we all have our slow days). There are many hypotheses for why this is the case, with one of them being the number of mass extinction events throughout the planet's history, culling the more complex forms of life and resulting in a delay in progression towards intelligent life. Although...



Evolutionary Pressure

...intelligent life isn't really 'progress' in an evolutionary sense. While humans did arise from non-intelligent ancestors, evolution by process of natural selection is about survival and advantage in a niche, and not about reaching any preordained target. This means that '*life*' + '*time*' isn't guaranteed to equal '*intelligent life that builds a spaceship*'. An example of this is the coelacanth: a fish that has remained relatively unchanged in its underwater niche for ~400 million years, and is very unlikely to build a spaceship anytime soon. Therefore, while there may well be life on other planets, there is no guarantee that there was any evolutionary pressure on it to become intelligent.

However, if intelligent life did emerge elsewhere, human history shows us that, despite surviving mass extinction events, there has always been a great threat from other members of the same species. The Doomsday Clock was devised in 1947, following the use of atomic bombs in World War II, as a representation of how close we are to human-made global catastrophe (signified by the clock hands reaching midnight). With present threats from nuclear war and climate change, the time on the Doomsday Clock is currently set to 100 seconds to midnight, however it is possible that other intelligent life in the universe has already been the cause of its own demise.

Finding Life is Too Hard for Us

As we worked out earlier, you could say that the universe is pretty big and has been around for a while. In contrast, humans have only been actively searching for signs of life elsewhere in the universe since the invention of the radio telescope – around 85 years. The vast scale of time and space in our universe means that intelligent life may have come and gone in multiple places, and might even be sending signals of their own, but nothing has yet reached us in the relatively short window of time we have been listening.

If we couple this with the evolutionary pressures discussed above, even if signals travelled close to the speed of light directly from an intelligent civilisation to Earth, by the time it reached us, their Doomsday Clock may have struck midnight tens of thousands of years ago.

Willingness to Communicate

A.k.a., we've been 'left on read'. As part of actively searching for extra-terrestrial life, humanity has been transmitting different messages (such as the *Arecibo Message* sent in 1974) intermittently into space for around 60 years. These messages typically provide basic information about the planet and humanity, with some (including Prof Stephen Hawking) criticising the practice, saying that it has the potential to put Earth at risk.

These messages from Earth may indeed be reaching intelligent life in our galaxy, informing them of our existence, but they might be reluctant to respond out of fear for their safety. Other reasons we haven't heard back could be that they might simply see no benefit to responding to us, they are indeed planning to attack us, or, like David Attenborough observing lions hunting gazelles, they have a 'no intervention' policy and have opted to leave us blissfully unaware of their existence.

WHAT'S NEXT?

For now, at least, all is quiet. Working through the different components of the Fermi Paradox and the Drake Equation, it does seem logical that life on many other planets would be quite common, and equally logical as to why might never detect signs of anyone else. Humanity is actively searching for any signs of life beyond Earth, supported by ever-advancing technological capabilities. NASA's *Perseverance* rover is currently exploring Mars for any indication that microbial life has ever existed on the Red Planet[6], and data gathered by NASA's *Cassini* spacecraft has this month revealed that the six elements required for all life on Earth (carbon, nitrogen, hydrogen, oxygen, sulphur, and phosphorus) are all present on Saturn's moon *Enceladus*, in addition to liquid water below its surface[7,8].

The only thing we do know with 100% certainty is that intelligent life exists here, now, for the only time in Earth's history. We must hope that the hands of humanity's Doomsday Clock retreat from midnight, so that we have the chance to continue exploring this amazing universe.

Do you have a particular theory about where everyone is hiding? Should we be sending a signal out into space advertising our location? Have you ever visited the Planetarium at Scienceworks, read up on abiogenesis and the Miller-Urey experiment, or seen a coelacanth build a spaceship?

We'd love to hear from you! Send your letters, news, and feature articles to editor@sciencevictoria.org.au for inclusion in future editions of Science Victoria.

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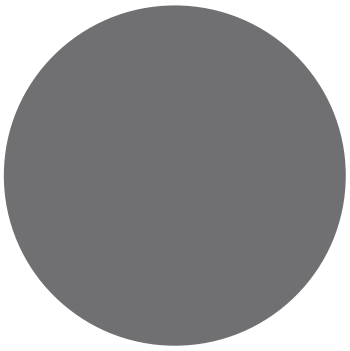
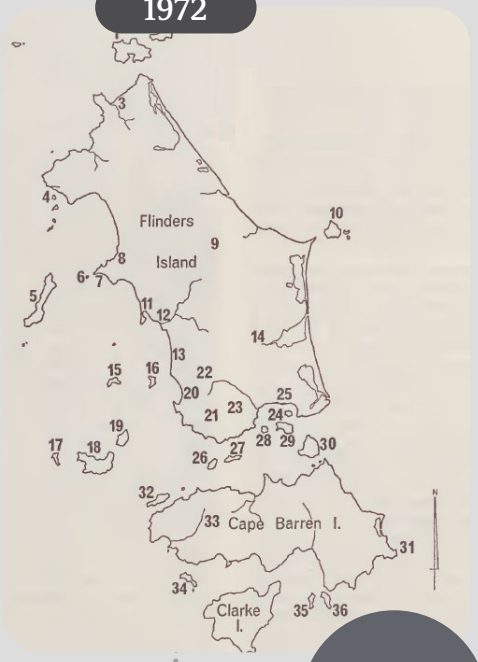


FROM THE ARCHIVES

Compiled by Scott Reddiex MRSV

1972



Islands of Eastern Bass Strait

Source: Proceedings of the Royal Society of Victoria, Volume 85 (1972/73)

BASS STRAIT MAMMALS

In 1972's *Proceedings of the Royal Society of Victoria*, the Australian National University's Dr. Jeanette H. Hope published an article entitled, "Mammals of the Bass Strait Islands".

During the last ice age, a land bridge between Victoria and Tasmania existed in what is now Bass Strait, allowing for the migration of both humans and terrestrial animals. As the planet warmed and sea levels rose, only the highest points of the land bridge remained above the waves, resulting in the formation of a number of small islands. The gradual flooding of the area not only prevented further migration of many species, but also isolated those who opted to remain in the areas that became the modern-day islands of Bass Strait.

J. H. Hope and his colleagues recovered a large number of fossils and subfossils (remains that are only partially fossilised due to a lack of time or sub-optimal conditions) from deposits on these islands, and compared the composition of extant and extinct species between the islands, Tasmania, and the Australian mainland. By referring to records and journals of early European explorers of the area, Hope was also able to determine which species only became extinct on the islands after 1800, such as the Tiger quoll (*Dasyurus maculatus*). Hope notes that "*Of the 31 native mammals found in Tasmania, 17 are known to be living on the islands of Bass Strait, and six introduced species have established feral populations there. Fossil deposits studied indicate that all but three of the present Tasmanian mammals (excluding the bats) were present on the islands in the past.*

1922

The Avoca River, near Logan, Victoria.

Source: Public Domain

THE HUMAN CHANGES TO THE AVOCA RIVER

On the 9th of November 1922, a paper entitled "*The Increasing Run-off from the Avoca River Basin (due apparently to Deforestation)*" by Edwin T. Quayle was read to the members of the RSV.

The paper discusses the human-driven changes to the river system and surrounding environment from around 1870 to 1922, and their impacts. Edwin Quayle was a meteorologist, born in the local town of Amphitheatre, who spent 14 years working for the Commonwealth Bureau of Meteorology.

Similar to the Moonee Ponds Creek before the arrival of Europeans, sections of the Avoca River had previously existed as a series of connected waterholes rather than a uniform channel. Quayle wrote of the impact of various human activities on the area: '*The destruction by stock of the reeds and coarse grasses lining the channel, and the removal of logs and growing trees, have permitted the beginning of erosion, and this has lately become rapid.*'

'The sand resulting from this erosion, especially in granite country, is carried downwards into the waterholes, and is obliterating one after the other. So that, whether the river flow is rapid or slow, the waterholes have to disappear—either by draining or silting. From the angler's point of view, this is particularly sad, as these water holes once provided line fishing.'

'Most of the basin has been in its present state for perhaps 20 or 30 years, but within the last decade much clearing has been done on the slopes of Mt. Lonarch and Ben More, as well as on the Sugarloaf itself. On Mt. Lonarch the clearing is most noticeable, especially within the last five years, and amounts to perhaps two or three thousand acres.'

'The deepening of the channels has had effects upon the extent of the flooding. According to Mr. Ennis, an Amphitheatre resident, the flats are now flooded less frequently and extensively than formerly. This is due in all probability to the increased channel capacity which also involves increased velocity.'

While preventing seasonal flooding better suits nearby roads and buildings, it has also completely changed the local ecosystem and fertility of the surrounding land along the length of the Avoca River.

1871

ART. XXXI.—*Abstract of a Paper on Aboriginal Art in Australasia, Polynesia, and Oceanica, and its Decay.* By MR. PAIN.

[Read 11th September, 1871.]

Source: Transactions and Proceedings of the Royal Society of Victoria, Volume X (1874)

STOLEN ARTWORKS AND GENERATIONAL TRAUMA

On the 11th of September 1871, the ominously named Mr. Pain read an abstract of a paper on "*Aboriginal Art in Australasia, Polynesia, and Oceania, and its Decay*" to the RSV.

As might be anticipated from the year of publication and the title, the article is an awful and jarring read. It reflects the thinking of many white academics at the time, who continually attempted to devise 'scientific' theories that justified their racism, and whose work would influence the eugenics movement of the late 19th and early 20th centuries.

The First Peoples of Australia, Fiji, New Zealand are described throughout the article as though they were animals, soon to become extinct, whose works should be collected for posterity.

The author unemotionally recognises the catastrophic impact of Europeans on the First Australians, and writes about the art pieces in a way that mentally separates them from both the artists and any cultural significance the pieces have. Anything resembling admiration for the pieces is undercut with constant reminders of the perceived inferiority of the artists: after describing Indigenous people as "*primitive*", "*indolent*", and "*lowest-intelligence*", he then states that "*With Nature as their guide and director, and their powers of design being restricted, they have acquired a skill, almost hereditary, enabling them to carry out these designs with a degree of precision and nicety of workmanship seldom surpassed in even the more civilized parts of the globe. Indeed, some of their works of a century past would, at the present day, bear favourable comparison with the finest specimens of European art.*"

During this time in Victoria, the *Aboriginal Protection Act 1869* had established the *Victorian Central Board for the Protection of Aborigines*, which existed to extensively control the lives of the Aboriginal population with respect to where they could live and work, who they could marry, and even who they could associate with. This particular Act stated that 'half-castes' (i.e., children with one Aboriginal parent and one non-Aboriginal parent) were to be recognised as 'Aboriginal', and consequently compelled to stay on one of the Aboriginal Reserves in the state. This was later reversed by the *Aboriginal Protection Act 1886*, which mandated that mixed-race children were to be forcibly removed from their parents – creating the Stolen Generations. The impacts of the legislation were not short-lived – some controls on the lives of Aboriginal people established by these Acts endured beyond the 1967 referendum and into the early 1970s, and the resulting trauma endures to this day.

You can engage with the artwork and culture of Aboriginal artists at the Bunjilaka Aboriginal Cultural Centre at Melbourne Museum, which is home to the Birrarung Gallery, Milari Garden and the Kalaya performance space.
https://museumsvictoria.com.au/bunjilaka/

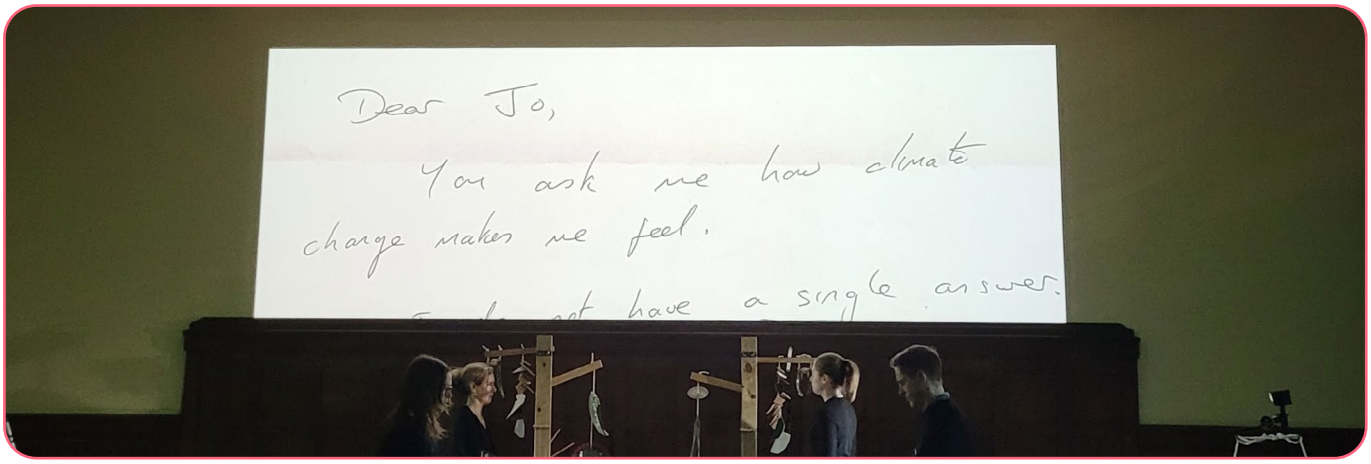
INSPIRING VICTORIA

Inspiring Australia Victoria

Climate Notes

Dr Catriona Nguyen-Robertson

The following article features Climate Notes, presented by Royal Botanic Gardens Victoria as part of Victoria Nature Festival. The exhibition was supported by the Inspiring Victoria Program and Monash University.



DEAR JOE,

How I feel about climate change is constantly changing. Sometimes I feel a great sense of frustration at the inaction and misinformation. I mourn for the animals that lost their lives in catastrophic bushfires and the extinct species that no longer are found on this planet. I dread what is coming with the predictions of sea level rise and warming average global temperatures. But other times, I feel a strong sense of hope, thinking about the people championing change, the communities trying to be more sustainable, and the scientists developing ways to reduce our footprint on the planet.

Many of these feelings may resonate with others, including the oscillating emotions. But I hope that the hope lingers – long enough for us to cling on to. The brilliant minds we have and technologies that we can develop will hopefully push climate change itself towards extinction.

Sincerely,
Catriona

Between 2014-2015, Joe Duggan approached the world's leading climate scientists and asked them to respond to one seemingly simple question: 'how does climate change make you feel?'

The powerful collection of letters he collected expresses both despair about lack of action and hope for effective solutions.

These ***Is This How You Feel*** letters were the inspiration for *Climate Notes*. Handwritten letters lined the walls of the National Herbarium of Victoria, embellished with native flora, and the installation grew as people added their own thoughts and feelings.

Climate Notes was an emotive, interactive exhibition and performance work that explores how we feel about climate change through music, letter writing and film. The project, developed by the Royal Botanic Gardens, commissioned six Australian composers from different cities to write works evoking feelings about climate change and responding to the letters: in essence, to compose a 'musical letter'.

In a performance to launch the installation, *Climate Notes* co-creators Anna McMichael and Louise Devenish performed music live accompanied by their past selves on video. The combination of live and recorded music and imagery allowed the musicians to reflect on the climate letters and explore the Royal Botanic Gardens' collections. They breathed musical life into pressed plant specimens, integrated field recordings of various natural biomes, and drew inspiration from the natural environment.

The first piece, *Red Garden* by Cathy Milliken, created a magnificent soundscape for Australia's Red Centre. Filmed in the Red Sand circles at Cranbourne Gardens, the piece gave the impression of a quiet vastness as the wind whistled across the landscape. Music played on a xylophone reverberated in the stillness, then the music swelled as raindrops and bird calls joined – mixed in with the live bird calls audible from outside the hall). The echo of Anna and Louise playing slightly out of sync with their past selves in the recording added to the sense of limitlessness in the red sands.

Other pieces took inspiration from nature for percussive elements to add to the atmospheric music. Daniel Blinkhorn's *Unequal Forms 1-3* used field recordings with the live rustling of eucalypt branches and crunching of dried leaves. Kate Moore's Infinity was played with porcelain tree rings, Dylan Crismani's *A Glimmer of Hope* with aluminium bell plates. The ringing of the bell plates was carried by the wind as they continued to sway after being struck. The pieces conjured imagery of being in the solitary yet beautiful outback, or being surrounded by bush.

Anna played a calm, haunting violin solo Bloodwood variations composed by Katy Moore that gradually sped up and became more urgent. Damian Barbeler's Pressed featured images from the plant archives of the State Botanical Collection. The piece was quite dissonant between the violin and vibraphone, yet simultaneously somewhat harmonious in the discord.

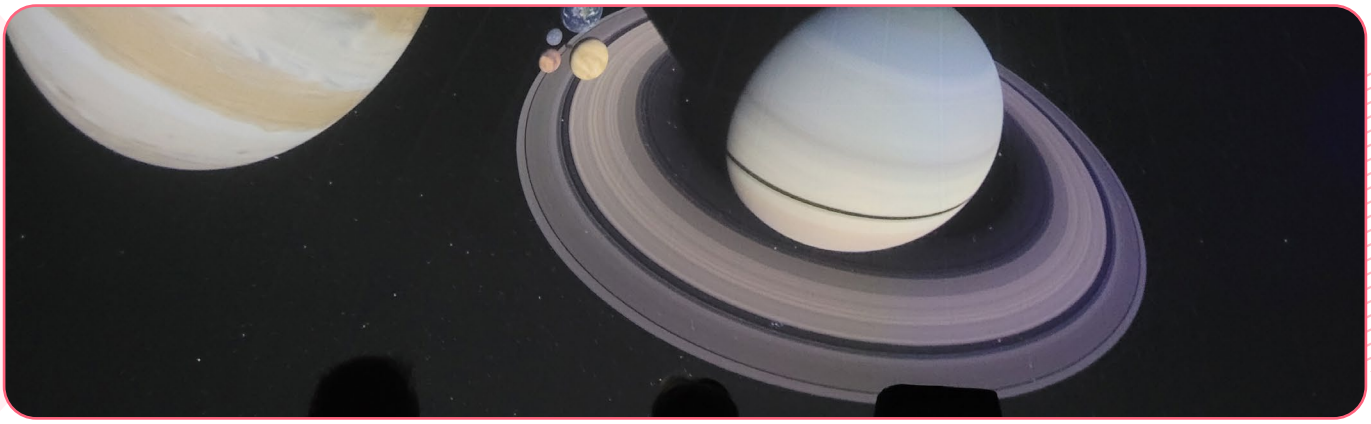
The centrepieces for the finale, *How We Fell* by Bree van Reyk, were two custom percussive/string 'Replica Tree' instruments. The piece was divided into multiple parts: 'a sufficient catastrophe', 'falling ice', 'an uncontrolled, risky experiment', 'tipping point, tipping cascade', and others. They travelled listeners to different places affected by climate change and built a sense of urgency. Perhaps the most striking section was 'inaction': Anna and Louise kept poising as if ready to begin playing but made no sound.

Understanding and withstanding a major challenge such as climate change calls for emotional not just intellectual effort: feelings as well as facts, stories as well as statistics. *Climate Notes* invites us to consider what it feels like to live through a time when climate change affects every aspect of our lives.

A RARE Ticket to the Universe

Dr Catriona Nguyen-Robertson

The following article follows a presentation of Ticket to the Universe by Museum Victoria's Senior Curator of Astronomy, Dr Tanya Hill, in Melbourne Planetarium. This event was part of Inspiring Victoria's RARE program for National Science Week.



After two years of celebrating virtually, the Victorian science engagement community was delighted to meet in-person again to mark the 25th birthday of National Science Week. Surrounded by mysterious, enthralling space in the comfort of Melbourne Planetarium, Rob Gell AM officially declared the beginning of Science Week in Victoria for 2022.

Rob noted that we have entered an era of great global and regional disruption, during which scientific literacy and skills have become more important than ever. It is therefore encouraging to see many people sharing the excitement, challenge, and utility of scientific work with Victorians across the state.

Those who attended the Science Week Launch were treated to a "quick trip" through the Universe guided by astronomer, Dr Tanya Hill. While it is a little tricky to take a brief tour of the observable Universe, given that its diameter is 93 billion light-years (8.8×10^{23} km) – and still expanding – Tanya managed to zip through faster than the speed of light, pointing out highlights of 'rare' phenomena along the way.

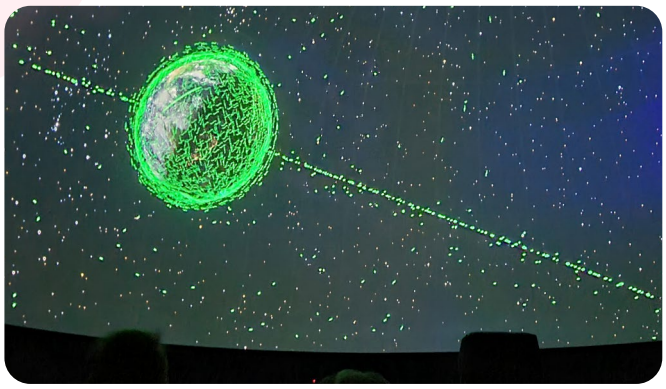
Astronomers have an interesting relationship with the idea of 'rare'. Things we seldom see on Earth may be commonplace at a universal scale. Conversely, things all around us that we take for granted may actually be quite rare phenomena. Heavy metals like iridium are more common in asteroids than on Earth's surface, whereas wood, oil and coal are scarcer in the whole Universe than diamonds.

As astronomer Carl Sagan wrote in his 1994 book, *Pale Blue Dot*, 'the Earth is a very small stage in a vast cosmic arena'.

While we are so familiar with our home planet, it may in fact be an example of something quite rare. Our exploration of space has been nothing short of astonishing in terms of the images and scientific data attained, and yet all the worlds we have seen beyond Earth appear to be completely void of any evidence of life.

We simply do not know how abundant life is in the Universe. Mathematically speaking, the chances that we are alone are low. But even if extra-terrestrial life exists, is it as simple (relatively speaking) as a bacterium, or is it complex like a multi-cellular organism? If there is intelligent life, how intelligent is it? The unique conditions on Earth that allowed complex life to flourish may be unlikely to occur throughout the Universe. To learn more, we need data we do not have...yet.

But if there is intelligent life out there, they could be collecting data on us. In this expansive Universe, are we the only planet broadcasting our activities into space? Launched in 1977, Voyager 1 is now 23.6 billion kilometres away with Voyager 2 around 3 billion km behind. Both carry metal plaques identifying the time and place of their origin as well as a golden record to communicate the sounds and story of Earth to extra-terrestrials. We also broadcast radio waves into deep space, with an ever-expanding bubble announcing the presence of humanity to anyone listening. For anyone listening, they could tune into the first Big Brother Australia series (2001) at 21 light years away, the beginning of Neighbours (1985) at 36 light years, or the first television broadcast (1927) at 95 light years. We are alive, and we are noisy.



We are noisy here on Earth. Depicted in green are artificial satellites that have sent out to orbit our planet

The Oort Cloud is the most distant part of the Solar System, thought to be made of remnants from when the Sun and other stars formed.

It may be the case that we owe our existence to the Moon: life only appeared on Earth some 700 million years after the Moon formed, and life as we know it would not exist without it. We may take our Moon for granted, but Earth is the only rocky planet in the Solar System that has a substantial Moon. Neither Mercury nor Venus has a moon, and while Mars has two moons – Phobos and Deimos – they are quite small. If Deimos hovered above Melbourne with one end at Scienceworks, the other end would only reach the CBD (13 km). Doing the same with Phobos, it would reach out to around Heidelberg (22 km). The size of our Moon means that it makes our planet more liveable by stabilising Earth's axial wobble to allow for a relatively stable climate. The Moon's pull also creates the oscillating ocean tides that allowed ancient marine microbes to thrive and eventually evolve.

Moving further away from Earth, we pass by different planets. Each a unique world. But we cannot discuss rarity in our solar system without mentioning poor Pluto. Since its discovery in 1930, it did not quite fit in. Literally – its erratic orbit does not align with the flat plane of other planetary orbits. Smaller than any other planet – even smaller than our Moon – and so far away, it has not completed a full orbit around the Sun since its discovery. Although, now it has found its place, or rather, we have found a place for it as a "dwarf planet". There are currently five official dwarf planets with up to a thousand other candidates. Perhaps Pluto is not so alone after all!

The Solar System extends far beyond Pluto and the Kuiper Belt, to the Oort Cloud, for possibly a full light year. When light leaves the Sun, it takes a little over eight minutes to reach us on Earth, and about 4.5 hours to reach Neptune. Add another three hours and the Sun's light passes beyond the edge of the Kuiper Belt, yet it does not reach the inner edge of the Oort Cloud for another 10 to 28 days. The Oort Cloud is thought to be a giant bubble around our solar system, comprised of icy, comet-like objects – and it really is giant. In fact, it may be perhaps as much as a year and a half before sunlight reaches the edge of it and the Solar System.

As you fly further away from home, you realise that the Sun is simply one of the billions of stars that form the Milky Way Galaxy. Beyond the Solar System are worlds that orbit other stars (with rogue planets that answer to no star, scattered in between). The Kepler Mission estimates that 40 billion rocky, Earth-like exoplanets orbit stars like our Sun or red dwarf stars in our region of the Milky Way Galaxy. Is Earth perhaps not so special?

You also realise that the stellar constellations we see in the night sky are rare: they can only be seen from Earth (or more accurately, from our solar system). We draw 2D pictures in the night sky by connecting stars together when each star is in fact quite far apart in space. The only thing that links stars in a constellation is our perception. The individual stars we see only comprise a small portion of the galaxy, and because are stuck inside the plane of the Milky Way Galaxy, we will never see a face-on view of its beautiful spiral. (Although, we do bob up and down in its plane, causing the Milky Way band across the sky to become thicker or thinner).

Stars located within the *stellar halo* would see something entirely different. A stellar halo is a spherical group of stars that surround most disk galaxies, and those stars in the Milky Way Galaxy halo are the galaxy's oldest stars. They orbit in the outskirts of the galaxy and are not bound inside the plane. If anyone lived on a planet orbiting a halo star, they would see the full face of the Milky Way Galaxy at some parts of the year...and at other times, they would see absolutely nothing in their night sky.

Stars have been pulled from the Sagittarius Dwarf Galaxy by our Milky Way Galaxy. The stars left behind surround our galaxy and litter the sky.

Part of the reason there are so many stars in the Milky Way Galaxy may be because of our little neighbour, the Sagittarius Dwarf Galaxy. On its looping, spiraling orbit, it has passed through our galaxy at least three times. Each time it has passed through it has left a trail of stars that were pulled out of it by our galaxy. As Dr Hill says, 'These stars are like breadcrumbs that litter the sky'. Not only were stars left behind each time the Sagittarius Dwarf Galaxy barged through the plane of the Milky Way Galaxy, but the events also sparked the formation of new stars. Its first passage five billion years ago coincides with the formation of the Sun and our solar system – perhaps we are only here because of this small galaxy.

For much of human history, it was thought that the Milky Way Galaxy was all that existed: it was the whole Universe. Yet even though nearly all of them are invisible to our eyes, the observable Universe, extending tens of billions of light years in all directions, contains a fantastically large number of galaxies within it. And no one knows just how big the Universe really is.

The furthest thing we can see is the cosmic microwave background, a glow that fills the entire Universe. This light is nearly 14 billion years old, leftover from the Big Bang. If you remember the days of the static between channels on an old analogue television, some of that static could be attributed to this ancient afterglow.

The cosmic microwave background - a glow that fills the entire Universe

Within our mind-bogglingly large Universe, with all the stars in all the galaxies, there are more stars than there are grains of sand on our entire planet. Although there is nothing particularly remarkable about our star, the Sun, our "pale blue dot" might be another story.

For now, there is nowhere else that we could live – at least in not our immediate surroundings. Nor have we found signs of other life in the Universe. There is a chance that we could be the rarest things of all.

PROCEEDINGS

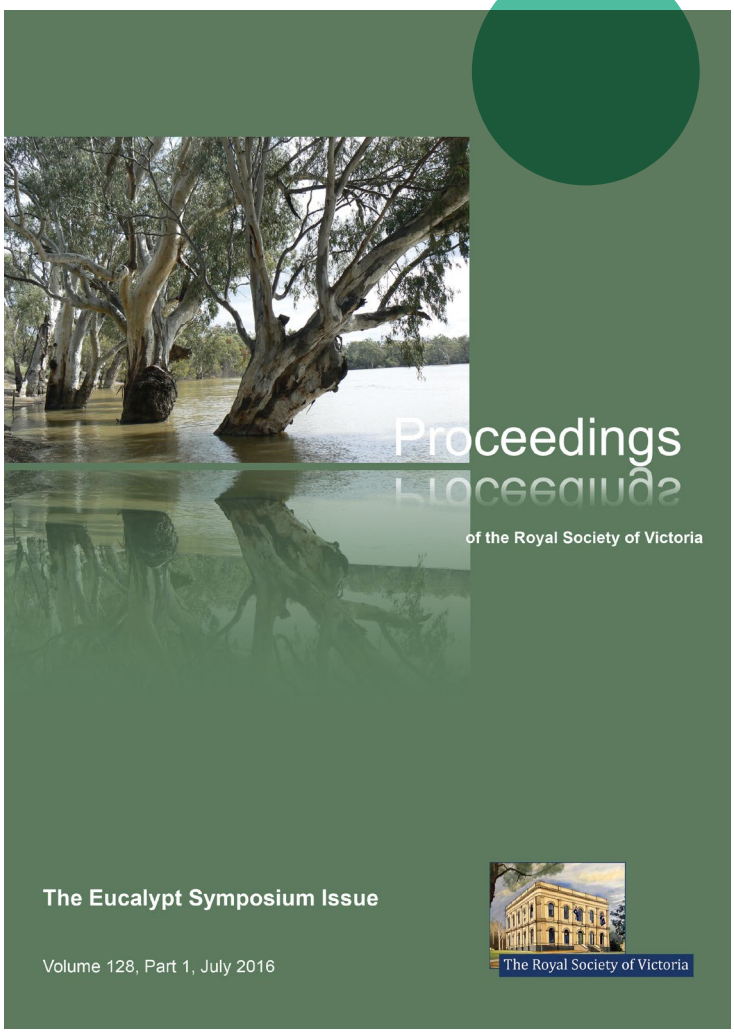
Call for Papers

The *Proceedings of the Royal Society of Victoria* is our refereed journal, published twice annually by CSIRO Publishing. Current and recent editions are available online in open access format from http://www.publish.csiro.au/rs.

The *Proceedings* is one of Australia's oldest and longest-running science journals, a terrific platform for establishing an individual research presence, grouping papers derived from symposia on specific subjects, or simply joining a distinguished tradition of science published in or about our region that stretches back to the 1850s. We are always interested in hearing from authors.

Papers, Reviews and Reports of experimental or descriptive research, submitted for publication by the Royal Society of Victoria, should not have been published hitherto, nor should they be under consideration for publication elsewhere. Published papers are typically concerned with natural history, encompassing the biological and earth sciences, in the Oceania region.

Those interested in submitting papers should review the **Instructions for Authors**. All enquiries and manuscript submissions should be forwarded via email to **editor@rsv.org.au**.



ENGAGE VICTORIA

Current Government Consultations of Interest to Victoria's Science Community

The Minister for Planning has appointed the Victorian Murray Floodplain Restoration Project Standing Inquiry and Advisory Committee (SIAC) to inquire into, and report on, each of the proposed nine Victorian Murray Floodplain Restoration Projects (VMFRP) and their potential environmental effects. The main page is at https://engage.vic.gov.au/VMFRP-SIAC.

The nine projects are being assessed in four 'assessment packages' to inform preparation of Environment Effects Statements (EES) or Environment Reports (ER). The first to open on consultations, concerning Hattah Lakes North and Belsar-Yungera, is below.

EES Central package - Hattah Lakes North and Belsar-Yungera

The Standing Inquiry and Advisory Committee seeks submissions to advise the Minister on the proposed Hattah Lakes North and Belsar-Yungera Floodplain Restoration Projects

Consultation closes 14 November.
https://engage.vic.gov.au/VMFRP-SIAC-EES-Central

Other Open Consultations:

The Victorian eating disorders strategy

Have your say and help us to develop the new Victorian eating disorders strategy.

Consultation extended to 13 November.
https://engage.vic.gov.au/the-victorian-eating-disorders-strategy

Reforming Victoria's animal care and protection laws

Have your say on the Plan for Victoria's new animal care and protection laws

Consultation closes 16 October.
https://engage.vic.gov.au/new-animal-welfare-act-victoria

Wellbeing in Victoria: A Plan to Promote Good Mental Health

Help shape Victoria's first ever Statewide Wellbeing Plan

Consultation closes 28 April 2023.
https://engage.vic.gov.au/wellbeing-in-victoria-a-plan-to-promote-good-mental-health

Royal Exhibition Building and Carlton Gardens Review

The World Heritage Management Plan for the Royal Exhibition Building and Carlton Gardens is being reviewed.

Consultation closes 20 November.
https://engage.vic.gov.au/rebcgreview

Setting the standard for better recycling at home

Have your say on the standard of waste and recycling services delivered to households across Victoria

Consultation closes 26 October.
https://engage.vic.gov.au/setting-the-standard-for-better-recycling-at-home

RSV Membership

Become a Member of The Royal Society of Victoria

OUR PURPOSE

The Royal Society of Victoria is the State's oldest scientific society, a part of Australia's intellectual life since 1854.

We bring together an independent community of science practitioners, educators, industrialists, and enthusiasts to promote an understanding and utilisation of scientific knowledge for the benefit of the state of Victoria.

OUR WORK

- Fostering, recognising, and rewarding excellent Victorian scientists across their career trajectory through awards and prizes
- Promoting understanding of science in the community
- Promoting science literacy and education so that people of all ages discover and understand the value of science
- Assisting and lobbying governments on issues relating to science and evidence-based decision making

MEMBERSHIP BENEFITS

- Learn about developments in a wide range of science disciplines through our lecture program and symposia, and how this knowledge can be applied to issues confronting Victoria
- Connect and share knowledge with like-minded people, bringing together expertise and learnings from all backgrounds and fields.
- Collaborate with colleagues to deliver the Society's various programs and projects, using (and developing) your professional skills and experience
- Support the translation of science into action through development of policy and science education initiatives
- Access discounts to RSV events and forums, and car parking in the Melbourne CBD

MEMBERSHIP OPTIONS

Full Membership

Open to all adults (18+) with an interest in science! **$120/year**

Student Membership

For students enrolled full-time at a recognised Victorian education and/or research institution (proof of current, full-time enrolment required for Student Membership commencement/renewal) **$40/year**

Organisational Membership

For organisations to claim membership of the Royal Society of Victoria. Provides a method for general sponsorship of the RSV's programs, along with discounted rates for access to RSV facilities throughout the year. **$1000/year**

Contact us with any questions about membership
Email: **james.mcarthur@rsv.org.au**
Phone: **+61 3 9663 5259**
Or visit us at 8 La Trobe St, Melbourne VIC

RSV Services and Facilities

The RSV engages communities with scientific knowledge through aligned partnerships, special events, festivals, conferences, and education programs. Email rsv@rsv.org.au to discuss your needs and ideas!

We provide services in **event management**, meeting **venues**, grants and awards **administration**, broadcasting and video **production**, social media c**ampaign management**, **recruitment** of scientific panels, and **convening** community engagement and deliberation processes where scientific work contributes to social, environmental, and economic impacts and benefits.

Social Traders CERTIFIED SOCIAL ENTERPRISE
Business for good

We are registered as a **Certified Social Trader** working for the benefit of Victorian communities, which makes our services eligible under the **Victorian Government's Social Procurement Framework**, as well as the social procurement guidelines of the governments of New South Wales and Queensland. Our certification also assures **industries** of our authenticity in building social procurement into services and supply chains.

For more information and bookings please contact our Business Manager at **james@rsv.org.au** or on +61 3 9663 5259

SERVICES AVAILABLE

The Burke and Wills Room
Multi-functional space with adjoining kitchen, suitable for: Workshops ‹*30 people; Dinners ‹60 people; Seminars, functions, catering, etc., ‹80 people.*

The Von Mueller Room
Seminar room for ‹*15 people.*

The Ellery Lecture Theatre
Raked seating for ‹*110 people.*

The Cudmore Library
Capacity for ‹*24 people*

FACILITIES FOR HIRE

The Royal Society of Victoria's facilities are available for hire to organisations, companies, or private groups. This heritage-listed building opposite the Carlton Gardens is suitable for a wide range of events, including conferences, seminars, meetings, and private functions.
Limited parking is available on-site and a commercial parking operator is adjacent on La Trobe Street.

The RSV has audio visual and seminar equipment available for use, including videoconferencing facilities. There is a commercial kitchen on the ground floor, suitable for your own use or by a caterer.

Support Victoria's Science Society

To support our programs with your donation, please fill out this form and return it to the Royal Society of Victoria, 8 La Trobe Street, Melbourne VIC 3000. You can also support our efforts through online donations and bequests at **https://rsv.org.au/support-the-rsv/**

RSV 2020 FUNDRAISING CAMPAIGN AMOUNT	*AMOUNT*
The Area of Greatest Need, as identified by the Society's Council	$
Inspiring Victoria – Community Science Engagement Program	$
Science Awards & Prizes	$
Science History & Heritage	$
Science for All - Citizen Science Programs	$
BioQuisitive Community Lab	$
The Phoenix School Program	$
The BrainSTEM Innovation Challenge	$
Australian Indigenous Astronomy	$
TOTAL	**$**

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