The Royal Society of Victoria
Promoting science since 1854

SCIENCE VICTORIA

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

THE OFFICIAL NEWSLETTER OF RSV

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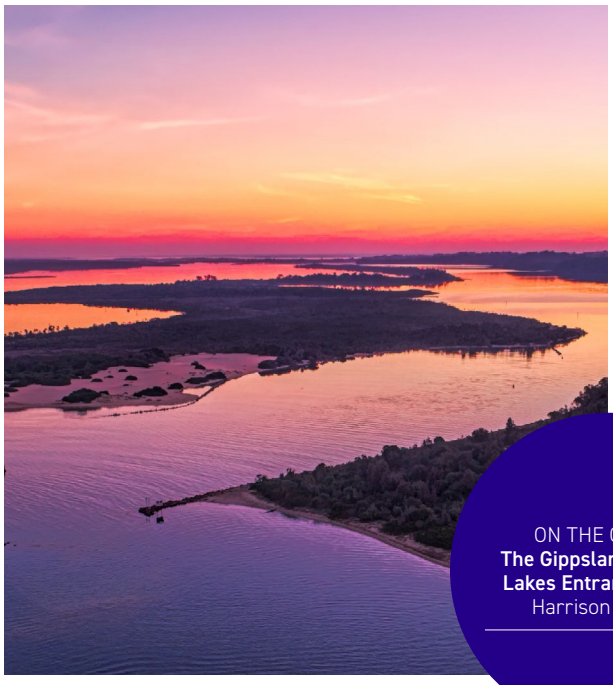
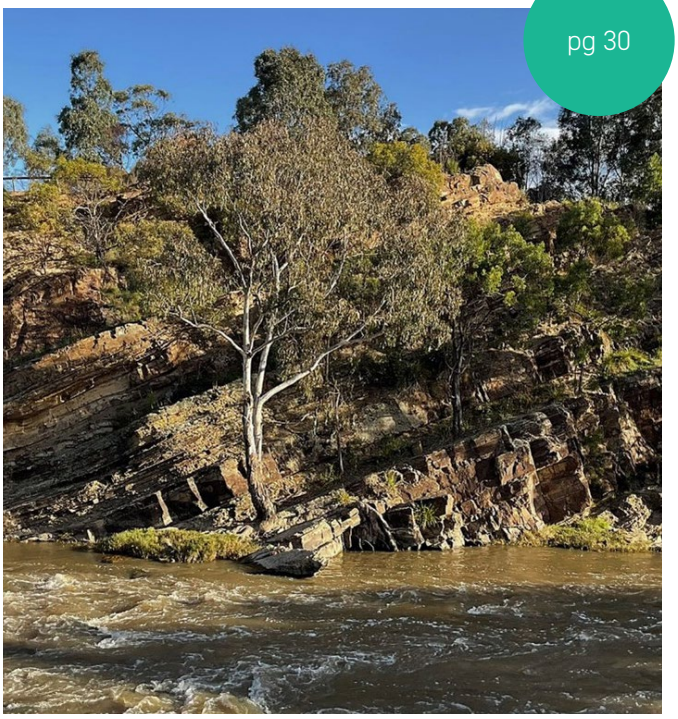


ON THE COVER: **The Gippsland Lakes at Lakes Entrance**. Photo: Harrison Fullard



INTERESTED IN SCIENCE? ENJOY WRITING? WE WELCOME LETTERS, ARTICLES AND IDEAS.

The submission deadline for content to be included in the September 2022 edition of Science Victoria is **5pm Friday August 26th 2022**. Email **ceo@rsv.org.au**.

FROM THE CEO

A Winter Festival of Science Engagement

Yes, it's really August. Happily, that means National Science Week is here with hundreds of events across the State of Victoria to get your brain cells out of cold storage and back into action. Thanks to everyone who has contributed their time, efforts and resources to keeping this long-standing national celebration of knowledge and scientific endeavour alive and kicking.

In terms of major events, we've got the fabulous **RARE** program to interest you, along with an exciting selection of events from our major public institutions, community networks, public libraries and more. We explore some of these in this month's edition of Science Victoria, but if nothing else, please get along to the main National Science Week site at **https://www.scienceweek.net.au/** to check out what's coming up near you (or online) this month and get involved. It's a brilliant national effort so far, so all that remains is for our audiences to engage and participate! Over to you.

Among many items, this month we feature a call to action on the enduring and deepening plight of the Gippsland Lakes from the science community, and we're seeking your participation in September's symposium on **Next-Generation Biocontrol of Invasive Vertebrate Pests**. We have an updated position on Climate Change to consider thanks to the work of our friends at the Australian Meteorological and Oceanographic Society, an Entrepreneur in Residence to welcome, and new **Superstars of STEM** to recruit, along with our feature articles. My thanks to all contributors, and especially to the freshly indoctrinated Dr Catriona Nguyen-Robertson (congrats)!

Spring is coming, I promise! Stay safe, stay warm, stay dry, stay positive, and have a great National Science Week.

Mike Flattley
CEO

SCIENCE VICTORIA, VOLUME 2, NUMBER 7, AUGUST 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 welcomes all First Peoples and seeks to support and celebrate their continued contributions to scientific knowledge.

FROM THE PRESIDENT

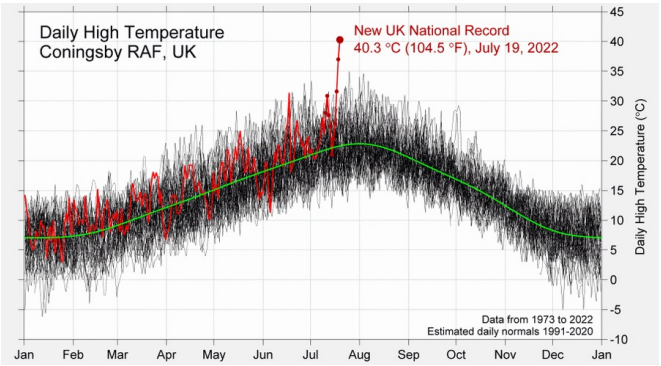
Science is All Around Us

When our patron the Hon. Linda Dessau AC, Governor of Victoria, presented to our Fellows at Government House in May 2021, she remarked that as a lawyer who studied in the humanities she had never really been engaged in scientific matters.

She also made the point that through her engagements with the research sector and the Royal Society of Victoria, she had become much more aware of science and technology and that it is everywhere around us.

Indeed it is, and in recent weeks we have been starkly reminded of the two existential crises we face and the importance of science, scientific data, scientific analysis and scientific reporting.

THE EUROPEAN HEATWAVE



Daily High Temperature (°C) Records, Coningsby RAF Base, UK (1973-2022)

On 19th July air temperatures in excess of 40°C were recorded in the United Kingdom: 40.2°C at Heathrow in London then 40.3 (104.5 °F) at Coningsby Royal Air Force Base in Lincolnshire. The previous record high temperature in the UK was 38.7°C (101.7°F).

A report from **Berkeley Earth**, a high quality, open source, independent, non-government, environmental science, data, and analysis organisation has provided a valuable analysis of the recent European heatwave in the context of a world at +1.3°C.

The World Weather Attribution (**WWA**) initiative identifies changing risks of extreme weather through Extreme Event Attribution and found that found that global warming made the devastating March heatwave in India and Pakistan 30 times more likely, while also concluding that the 2021 Pacific Northwest heatwave would have been virtually impossible without climate change.

Carbon Brief provides a useful 'fact check' on the proposition that global warning has paused in the last eight years - it hasn't! See: **Factcheck: No, global warming has not 'paused' over the past eight years**

Subscribe to Berkeley Earth's newsletter here: **http://berkeleyearth.org/whats-new/**

STATE OF THE ENVIRONMENT 2021

Australia State of the Environment 2021

The long awaited and overdue fourth **Australia State of the Environment Report 2021** was released on the same day as the UK heatwave and provided another wake-up call to Australians.

More than two hundred plants and animals have been added to the threatened species list and nineteen ecosystems are at risk of collapse, a result of the combined impacts of land clearing, invasive species, pollution, mining and climate change.

Environment Minister Senator Robert Hill released the first SoE in May 1996. Ian Lowe as Chair of the State of the Environment Advisory Council that produced the report made the point in his overall message that 'in

many cases national information is lacking, or scientific knowledge is not advanced enough, to do more than lay a foundation for future reports to build upon'.

Minister Hill's Media Release on 25th September 1996 said:

> ***"A key finding of the report is the loss of Australia's wealth of biodiversity is perhaps our most serious environmental problem.***
>
> ***Australia is home to more than one million species, but for many groups there have been significant losses, 23 percent of our marsupials, nine percent of our birdlife and nine percent of native freshwater fish are extinct or currently endangered.***
>
> ***... the time for talk is over. We need action now ... "***

Clearly there has been little improvement in the last twenty-six years. We do have better data available now and the picture is not good:

- the number of listed threatened species rose 8% since 2016 and more extinctions are expected in the next decades.
- the number of plant and animal species listed as threatened in June 2021 was 1,918, up from 1,774 in 2016
- nearshore reefs are in overall **poor condition** due to poor water quality, invasive species and marine heatwaves.
- land clearing of native vegetation is a major cause of habitat loss and fragmentation particularly in New South Wales and Queensland; 7.7 million hectares of land habitat was cleared between 2000 and 2017
- environmental destruction costs our economy billions of dollars
- We need better and entirely new approaches to environmental management.
- ... and everything is exacerbated by climate change and its impacts.

The Chief Authors of the report Professor Emma Johnston AO FTSE FRSN, Deputy Vice-Chancellor (Research), University of Sydney, Dr Ian Cresswell, Adjunct professor, UNSW Sydney and Dr Terri Janke, Honorary Associate Professor, UNSW Sydney have presented the report's key findings in *The Conversation*: **This is Australia's most important report on the environment's deteriorating health. We present its grim findings**.

Another very valuable commentary is available in an interview of Professor Sarah Bekessy, Professor of Sustainability at RMIT University on the 23rd July edition of '**This Week**' on Radio National.

These are critical scientific issues facing our country and the Royal Society of Victoria is stepping up to give science a louder voice in decision-making. We welcome your thoughts and ideas on how members can become more involved in this effort. Please write to me at **president@rsv.org.au** to continue this dialogue; 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

LETTERS

More on Masson

By Professor Ian Rae, The University of Melbourne

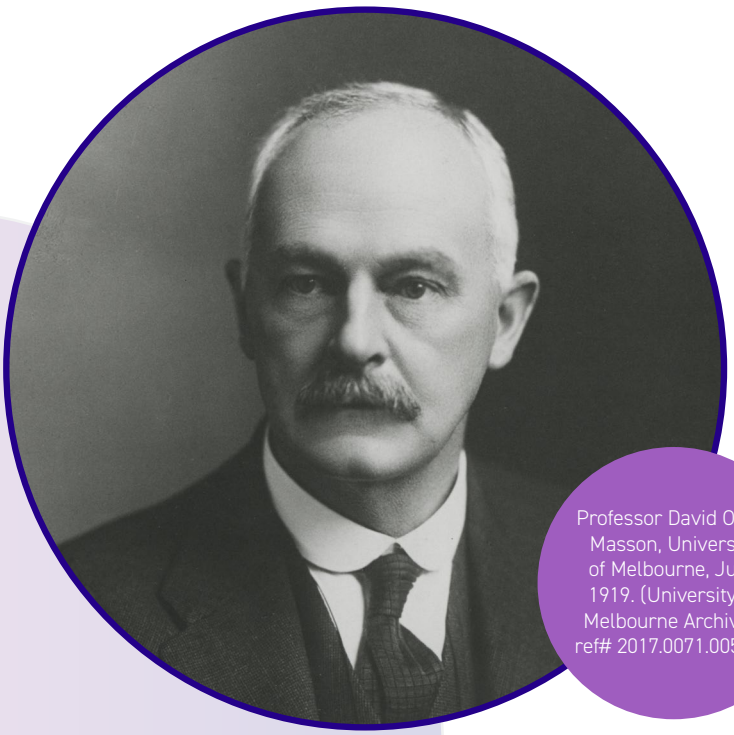
I was interested to see the article about David Orme Masson in the latest (July 2022) issue of Science Victoria. Your readers might be interested to know that as well as the old references cited, there has been more recent scholarship about Masson and his work.

I have had a couple of papers published in Historical Records of Australian Science... The one about the 'flap' model of the periodic table is hiding behind a paywall (**https://doi.org/10.1071/HR12018**), but I can provide copies to anyone who's interested and cares to contact me at **idrae@unimelb.edu.au**. The more recent one, about organomagnesium chemistry, is accessible under CSIRO's 'read and publish' system (**https://doi.org/10.1071/HR22001**) that allows open access when the author is a member of a participating institution.

Regarding 1920, I gave a talk about that work a couple of years ago to the Melbourne University Chemical Society and I'm currently writing it up for publication. The crux of the matter was that Masson suggested a new name for the hydrogen nuclei that are released in atomic collisions but was beaten to it by Rutherford who coined the name 'proton'.

Kind regards,

Professor Ian Rae
The University of Melbourne

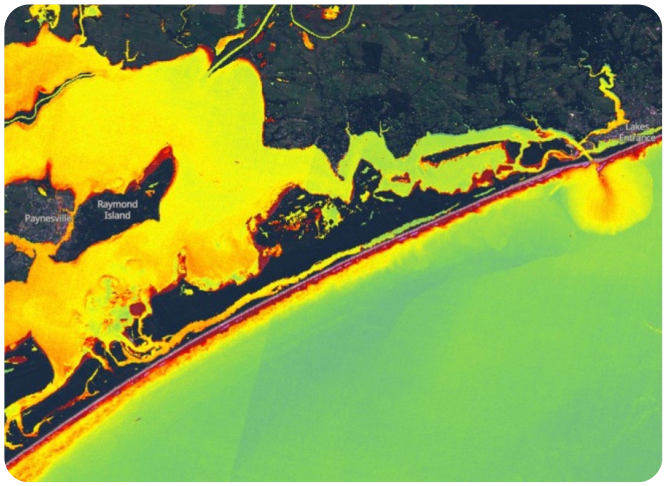


Professor David Orme Masson, University of Melbourne, June 1919. (University of Melbourne Archives, ref# 2017.0071.00586).

Time for Real Action on the Gippsland Lakes

Professor Bruce Thom AM, FTSE

Australia is blessed with a great array of estuary types. From tropical high-tidal to those in southern regions where we encounter coastal lakes, it is apparent that threats exist to the health of estuary waters and ecological assets.



A satellite image providing a visual representation of the chlorophyll levels in the Gippsland Lakes on 25 May 2022, caused by a widespread, toxic blue green algae bloom. The red areas indicate where the algae bloom is most concentrated, the green indicating more diluted areas. Note a clear release of the bloom into the ocean at Lakes Entrance.

While this species of algae cannot survive in the ocean and is actively breaking down due to the saltwater, prawns caught from the Gippsland Lakes and up to 5 nautical miles off the Gippsland coast between McLoughlin's Beach and the NSW border may have travelled from bloom affected water and were not suitable for human consumption. Ingesting these toxins by consuming affected seafood can lead to serious illness.

Source: **DELWP Gippsland**

These threats are not new. There are some like the Ord in Western Australia that have experienced fish kill from input of pesticides used in farming. Others like the Lower Lakes and Coorong in South Australia are subject to reduced freshwater flows due to over-extraction by irrigation. Sydney Harbour suffers from the legacy of industrial pollution that has long prevented commercial fishing.

The list goes on and on as we struggle to balance various public and private interests. But the threats will multiply as climate change impacts take effect, placing those estuaries such as the Gippsland Lakes in danger as those different interests seek to gain advantage of changing environmental conditions.

Gippsland Lakes represent a range of environmental conditions along a salinity gradient that can and has been disturbed. Eric Bird back in the 1960s made this very clear in documenting impacts of the artificial entrance at Lakes Entrance. What was a system with limited marine input was expanded and this process continues as dredging continues to even greater depths. Meanwhile more freshwater inputs are not just being diverted for agriculture, there are also threats of farm (and perhaps mine) products being added to flows to pollute lake waters. Climate change in the form of drier periods and sea level rise will contribute further to all that threaten the future of Gippsland Lakes.

A way forward is for major stakeholders in consultation with local communities to first recognise that the current degrading trajectory must stop. Then there should be a collective recognition for the establishment of a process that will formulate pathways to recovery and sustainability. No such process exists for this to happen here at the moment. Elsewhere in Australia different levels of coordinated management of threats to estuary health are being explored. It is time now to start the journey for a sustainable and healthy future for these precious estuary areas of Victoria.

Completely Eggless

**Gordon Noble MRSV, Research Director,
UTS Institute for Sustainable Futures**

My colleagues and friends in Melbourne may have noticed supermarkets currently have empty shelves where the eggs used to be. This is an indicator that a sustainability transition is taking place.

War in Ukraine causing energy prices to spike? Supply chain disruptions in China due to Covid lockdowns? Nope.

Turns out the reason there are no eggs is that free-range eggs now make up over 50% of consumption and free-range chickens don't like to lay eggs when it is cold. A free-range chicken has to be out of the barn for 8 hours a day. And it has been a very cold Melbourne winter. Just ask the crowds at the 'G.

Who knew this would happen? Well, the chickens did. Environmental Social Governance metrics, not so much.

But this is an indicator of progress. As sustainability is baked into everyday life there will be changes. That is not a bad thing. It will mean we will become better aligned with nature's seasons. Mangoes and watermelons in a Melbourne winter? They will cost more. But the market will provide healthy alternatives.

For financial systems, it will mean getting better at foresight and understanding the adaptive nature of transitions.

RSV NEWS AND NOTICES

New RSV Members

Ms Lisa Gervasoni
Policy Advisor, Victorian Farmers Federation

Mr Rafael Gracioso Martins
Head of Technology, State Library Victoria

Mr Sean Wilson
PhD Candidate, Murdoch Children's Research Institute

Mr Yongqiang Wang
PhD Candidate, The University of Melbourne

Mr Aakash Chhabra
PhD Candidate, Monash University

Mr Yang Fu
PhD Candidate, Swinburne University of Technology

Miss Priscilla Cardoso
PhD Candidate, RMIT University

Ms Ilariya Tarasova
PhD Candidate, The University of Melbourne

Mr Patrick Taylor
PhD Candidate, RMIT University

Mr Reinhold Willcox
PhD Candidate, Monash University

Ms Sachinthani Karunaratne
PhD Candidate, The University of Melbourne

Ms Sanjana Naveen Prasad
PhD Candidate, RMIT University

Ms Mahshid Sadeghpour
PhD Candidate, RMIT University

Mr Zicheng Zhuang
PhD Candidate, RMIT University

Miss Jennaya Christensen
PhD Candidate, Monash University

Mr Yunzhen He
PhD Candidate, RMIT University

Mr William Melbourne
PhD Candidate, The University of Melbourne

Mr Yik Lee, PhD Candidate
RMIT University

Miss Shanika Achini
PhD Candidate, Monash University

Mr Adilson Fonseca Teixeira
PhD Candidate, The University of Melbourne

Mr Sina Mansour Lakouraj
PhD Candidate, The University of Melbourne

Ms Azelle Hawdon
PhD Candidate, Monash University

Mr Julian O'Shea
PhD Candidate, Monash University

Mr Kevion Darmawan
PhD Candidate, RMIT University

Dr Sharman Pei Yi Tan Tanny
PhD Candidate, The University of Melbourne

Ms Nasrin Sohrabi
PhD Candidate, RMIT University

Miss Rebecca Cooper
PhD Candidate, The University of Melbourne

Unless Members request a ballot, these will be considered by Council and, if elected, will be confirmed at the next Ordinary Meeting of the Royal Society of Victoria.

Notice of Intention to Endorse: AMOS Position Statement on Climate Change

Notice is here given to Members that the June 2022 meeting of the Council of the Royal Society of Victoria has resolved to endorse the official Statement on Climate Change published by the Australian Meteorological and Oceanographic Society (AMOS) on 2 November, 2021.

Subject to due consideration of any feedback received from Members of the Royal Society of Victoria before the end of August 2022, the Council will move to formally endorse the AMOS Statement in September 2022 in observance of the Society's Rules and By-Laws.

This will supersede the RSV's **earlier position**, which was formulated in 2019 before the release of the IPCC 6th Assessment Report in 2021; as a general science society that does not specialise in the various fields of climate science, we have resolved to take our lead from the rigorous review of the latest IPCC Report undertaken by atmospheric and oceanographic scientists to inform the official AMOS Position Statement, which is reproduced below for context.

AMOS STATEMENT ON CLIMATE CHANGE – 2 NOVEMBER 2021

This statement provides a brief summary of climate change and the role of human action in causing this change, with a particular focus on Australia.[1] *It has been compiled by atmospheric and oceanographic scientists, reviewed by members of the Australian Meteorological and Oceanographic Society (AMOS), and approved by the AMOS Council as an official AMOS Position Statement. The statement will expire 5 years from its approval, or earlier as determined by AMOS Council.*

Key points:

- Global climate is changing rapidly due to human activities, with global mean temperatures having increased by about 1.1°C since the second half of the 19th century. For Australia specifically, temperatures have warmed by more than 1.4°C since national records began in 1910.
- Warming is already leading to dramatic changes in the global and Australian climate, with impacts on ecosystems and most aspects of human health, economic activity and wellbeing. These impacts will intensify with future warming.
- Australia is highly vulnerable to the impacts of climate change, with many regions expected to experience intensified droughts or floods, increased heatwaves and extended bushfire seasons as well as increased coastal erosion and inundation due to sea level rise. Ocean warming and acidification will threaten coral reefs and other marine ecosystems.

1 Climate change here refers to 'modern' climate change, i.e., since the Industrial Revolution.

- Climate projections indicate that significant, urgent and sustained reductions in greenhouse gas emissions and fossil fuel production are required to limit global warming to the Paris Climate Agreement targets of well below 2°C above pre-industrial temperatures with efforts to limit the temperature increase to 1.5°C.
- Delays in reducing emissions will increase the practical and economic costs of avoiding dangerous climate change and place a greater burden on future generations to adapt to higher levels of warming.

CLIMATE SCIENCE PROVIDES RIGOROUS EVIDENCE

Climate science is based on the scientific method, using rigorous and thorough comparison of observations and theory underpinned by the independent peer review process. There is an ongoing effort of refinement as new data are collected and technologies developed. Australian climate scientists, including AMOS members, conduct research and assessments as part of global efforts to improve and refine understanding of how the climate system operates, including interactions between the atmosphere, ocean, land and cryosphere (frozen water on Earth's surface). The availability of high-quality climate data, the methodologies employed in data analysis and climate assessments, and climate models have improved over the past 50 years, such that we now have a high degree of confidence in the findings from climate science. While some uncertainties persist in the climate system response to human influence, there is high confidence in most of the information summarised in this statement. Quantifying remaining uncertainties will help further inform decision making.

Global climate has changed substantially since 1850

Global warming due to human-induced greenhouse gas increases is real and observable and the rate of warming has been the largest in recent decades. Each of the last four decades has been successively warmer than any previous decade since 1850, with the global mean surface temperature of the Earth for 2011-2020 1.1°C above the 1850–1900 average (which is generally used to represent the preindustrial period). The years 2020 and 2016 were the equal warmest years on record, while the six years from 2015 to 2020 were the warmest six years on record.

A summary of major observed climate changes include:

- Since the mid-20th century, increasing temperatures have been observed throughout the Earth system, including over land and in the oceans, in rural areas and cities, at the surface and in the lower atmosphere.
- Increases in the frequency of warm temperature extremes and heatwave events and decreases in the frequency of cool temperature extremes have accompanied the rise in mean temperatures over most areas.
- There has also been a decrease in the number of frosts, a rapid contraction of almost all alpine glaciers, significant mass loss of the Greenland and West Antarctic ice sheets and a reduction in Arctic sea ice and global snow cover.
- The absorption of carbon dioxide by the oceans has reduced near-surface pH by approximately 0.1 units compared to pre-industrial levels – a process known as ocean acidification.
- In the centuries prior to 1850, the rate of sea level change was only a few tenths of a mm per year. Since then, sea level rise has accelerated to reach a rate of 3.7 ± 0.5 mm per year over the period 2006-2018, with a net rise in global average sea level of 20 cm from 1901 to 2018.[2]

AUSTRALIA'S CLIMATE IS CHANGING

Temperatures

Since the introduction of robust instrumental surface temperature measurements in the early 20th century, the mean surface temperature of Australia has increased by about 1.4°C, larger than the global average increase. The warming has been concentrated in the post-1950 period with over 1°C of warming since 1960. Warming is observed in all months with both day and night-time temperatures increasing.

Based on records to 2020, Australia's warmest year on record was 2019, and the eight years from 2013 to 2020 all rank in the ten warmest years since at least 1910.

The warming over Australia has been accompanied by marked changes in the frequency of extreme temperatures at a variety of timescales, with warm extremes generally becoming more frequent and cold extremes less

2 The sea level rise is caused by melting of alpine glaciers, loss of mass of the Greenland and West Antarctic ice sheets, and expansion of the warming ocean.

frequent. There have been an increased numbers of individual hot days and extreme warm months and decreased numbers of cool nights and extreme cool months. There has also been an increase in the frequency, intensity and duration of heatwaves in many parts of the country.

Ocean

Sea surface temperatures in the Australian region have increased by more than 1°C since 1900. Since 1993, sea level has risen by 2–4 mm per year over much of the southern coastline of Australia, in line with the global average. Northern coastlines of Australia experienced sea-level rise more than twice the global average since 1993, though much of this enhanced rise may be related to natural variability. Sea level extremes that result in episodic coastal flooding have increased in frequency on the east and west coasts of Australia.

Rainfall

Rainfall in Australia is highly variable from year to year, and from region to region. Nevertheless, long term trends are evident in Australia's regional rainfall.

In the southwest and southeast there has been a trend towards drier conditions since the 1970s, especially for the cool season (April to October). In 17 of the last 20 years, rainfall in southern Australia in these months has been below average. The trend is particularly strong for the period from May to July over southwest Western Australia, with rainfall since 1970 around 20 per cent less than the 1900-1969 average. For the southeast of the continent, April to October rainfall for the period 2000 to 2019 has decreased by around 12 per cent when compared to 1900–1999. The reduction in cool season rainfall in the southwest and southeast of Australia has led to an increase in droughts in these regions.

In contrast with southern Australia, average northern Australian rainfall has exhibited an increasing trend since the 1970s across all seasons, especially in the northwest during the northern wet season (October to April). However, year-to-year rainfall variability remains high, with, for example, below average rainfall totals in northern Australia during both the 2018–19 and 2019–20 wet seasons.

Observations indicate that short-duration (hourly) rainfall events have become around 10 per cent more intense in some regions in recent decades, with larger increases seen in the north of the country.

Tropical cyclones

Tropical cyclone activity in Australia's cyclone region varies substantially from year to year. This is partially due to the influence of oceanic conditions and large-scale climate drivers; the number of cyclones in our region generally declines during El Niño events and increases during La Niña events. There has been a downward trend in the number of tropical cyclones observed in the Australian region since 1982. The historical trend in tropical cyclone intensity is harder to quantify due to large natural variability and limited observations.

Human influence has increased greenhouse gases leading to global warming

The physical role of greenhouse gases in the atmosphere has been understood for more than a century. Shortwave radiation from the Sun passes through the atmosphere and is absorbed by the Earth's surface which thereby warms. The surface emits infrared radiation. In the absence of greenhouse gases, this radiation is emitted direct to space, and approximately balances the solar radiation reaching the Earth from the Sun. But the greenhouse gases (water vapour, carbon dioxide, methane and other gases present in small amounts in the atmosphere) absorb some of the infrared radiation emitted from the surface. These greenhouse gases also emit infrared radiation in all directions, including back to the Earth's surface thereby increasing the warming of the surface. The warm surface causes the overlying atmosphere to warm, through convection, conduction, and radiation. The surface temperature, and the temperature of the lower atmosphere, increases as the atmospheric concentration of the greenhouse gases increases, because of these processes.

Human activities have increased the concentration of greenhouse gases in the atmosphere since 1750, and it is now certain that this human influence has warmed the atmosphere, ocean and land.

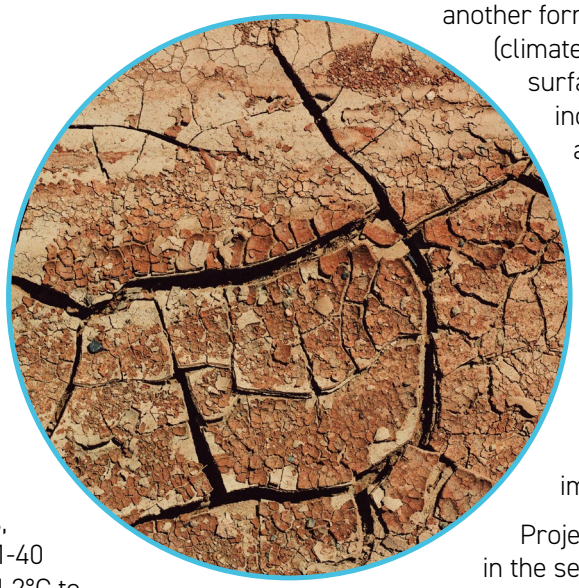
The warming associated with increases in greenhouse gases originating from human activity is called the enhanced greenhouse effect. The average atmospheric concentration of carbon dioxide exceeded 410 ppm in 2019, higher than at any time in at least the last 2 million years. Atmospheric concentrations of methane and nitrous oxide (other major greenhouse gases) are higher than at any time in at least 800,000 years.

The increase in atmospheric carbon dioxide is a direct result of burning fossil fuels, large-scale deforestation and other human activities. Concentrations of a range of other greenhouse gases, such as methane, nitrous

oxide and CFCs, have also contributed to the observed warming.[3] Some other by-products of human activity, most notably industrial aerosols, have had a net cooling effect on the atmosphere, offsetting some of the warming from the enhanced greenhouse effect.[4]

Increased greenhouse gas concentrations due to human activities have led to warming of each of the inhabited continents, including Australia. As well as a direct link between increases in greenhouse gases and mean temperatures, evidence increasingly suggests that human activities have also substantially increased the risk of very hot years and seasons at the continental scale, for example the Australian record hot year of 2019. Human influence on ocean warming and sea level rise is also clear.

FUTURE CHANGES TO GLOBAL CLIMATE DEPEND ON AMOUNT OF GREENHOUSE GAS EMISSIONS



While some future increase in global temperature is unavoidable due to past and current greenhouse gas emissions, the magnitude and rate of this warming is highly dependent on our greenhouse gas emissions over coming decades. On shorter time scales, global average warming by 2021-40 is very likely to be in the range 1.2°C to 1.9°C relative to 1850-1900. Uncertainty on this time scale is dominated by natural climate variability and model uncertainty.

Under the Paris Climate Agreement, international efforts aim to keep warming to below 1.5°C, or at least well below 2°C relative to pre-industrial levels. As global warming has already exceeded 1°C, the remaining carbon budget (total amount of carbon dioxide that can be emitted) available to avoid exceeding these thresholds is limited. At current rates of greenhouse gas emissions and temperature rise, there is a high risk of exceeding 1.5°C during the 2030s and 2°C by 2040-2060.

Future greenhouse gas emission trajectories can be summarised by a range of low, medium and high emission "scenarios", described in detail in the IPCC Assessment Reports. Low emission scenarios represent the best opportunity to meet the Paris Agreement targets. To achieve the reductions in greenhouse gas emissions consistent with a low emission future pathway, a rapid transition to ending the production and burning of all fossil fuels is required globally and in Australia. A wide range of technological solutions already exist to facilitate this rapid transition from fossil fuels to renewable energy.

Some low and very low emission pathways that provide a high probability of meeting the Paris Agreement temperature targets assume negative emissions from the middle of this century, with more CO2 being drawn out of the atmosphere than is emitted. Negative emissions technologies, including methods to increase carbon storage in natural reservoirs (land or ocean) as well as to capture and store carbon from fossil fuel burning, are not proven to be practically or economically viable at the scale required. Beyond carbon removal, another form of proposed "geoengineering" (climate intervention) is to directly reduce surface temperatures by blocking incoming solar radiation, e.g., through adding reflective particles such as aerosols to the upper atmosphere. Caution is required as the risks of such approaches may outweigh the benefits. Further research is urgently needed to evaluate the full range of carbon removal and geoengineering technologies to fully examine their possible climatic, ecological and geopolitical impacts.

Projected warming and sea-level rise in the second half of the 21st century depend on the emission scenario, with additional uncertainty due to the range of climate model projections for a given scenario. By 2081-2100 under very low or low emission scenarios, best estimates are warming ranging from 1.0–2.4°C (relative to 1850-1900) and sea-level rise ranging from 0.43–0.78 m (relative to 1900). Under high and very high emission scenarios, the projected likely ranges of global warming and sea-level rise by end of century are 2.8–5.7°C (relative to 1850-1900) and 0.79–1.20 m (relative to 1900). It is also important to note that warming and sea level rise will continue beyond 2100 for hundreds of years as the climate system reaches a new equilibrium. Uncertainty about ice sheet processes means that sea level rise of 2 m by 2100, and many metres more over coming centuries, cannot be excluded. When human greenhouse gas emissions reach zero (or net-zero, taking into account carbon removal technologies), the excess carbon dioxide in the atmosphere will gradually be taken up by the land and ocean over hundreds to thousands of years.

3 CFCs (chlorofluorocarbons), the gases responsible for the ozone hole, are also greenhouse gases.
4 Aerosols are tiny solid or liquid particles suspended in the atmosphere.

Projections indicate larger rates of warming over land than over ocean, and greater warming at high latitudes than in the mid-latitudes and tropics. For rainfall change, there is more uncertainty. Most models agree on an average increased rainfall in the tropics and mid-latitudes (generally wet regions in the current climate), with decreased rainfall in the subtropics (generally arid or semi-arid regions in the current climate). However, rainfall changes at a regional and local scale are driven by changes in atmospheric circulation as well as a warmer atmosphere, resulting in complex patterns of change with higher levels of uncertainty.

There are a number of sources of uncertainty in global climate projections. The largest source of uncertainty beyond the next few decades is the trajectory of greenhouse gas emissions, which is due to the range of future economic, demographic and technological pathways that society may choose. There is also uncertainty due to natural variability of the climate system, which can cause global temperature variability on decadal time scales. This natural variability is overwhelmed by the larger human-induced warming trend when longer time scales are considered. Finally, there is uncertainty in the way climate models represent some components of the climate system (e.g., due to the limited spatial resolution of the model grid, constrained by computer resources). This model uncertainty results in a range of different representations of regional temperature and rainfall and a range of sensitivity to increased greenhouse gases. Note that other lines of evidence apart from climate models are used in producing projections which adds confidence. These sources of uncertainty are included in projections of future climate change and discussed in detail in the IPCC Assessment Reports.

AUSTRALIA IS HIGHLY VULNERABLE TO THE IMPACTS OF CLIMATE CHANGE

The average Australian surface temperature is likely to increase by between 0.6 and 1.3°C by 2030 above the climate of the recent past (1986-2005) under all emission scenarios. Warming over Australia beyond the next few decades depends strongly on the emission scenario followed. Continued high emissions are likely to produce an increase in Australian average temperatures of 2.8°C –5.1°C by 2090. A rapid reduction in emissions (low emission scenario) is likely to result in temperature increases that are limited to between 0.6°C and 1.7°C by 2090.

Climate models suggest that the warming in inland Australia will be larger than coastal areas, with the least warming (on an annual mean basis) expected in southern Australia. The number of days classified as extremely hot, including multi-day heatwaves, is projected to increase, and the temperatures on the hottest days will typically be hotter than at present. In contrast, there will generally be a reduction in frost events. Many areas where frost typically occurs only a few times a year are likely to be nearly frost-free on average by 2030. The projected changes in extremes will be especially important as many of the most significant impacts of climate change are manifested through the occurrence of extreme events.

Rainfall in Australia will continue to vary from year to year and decade to decade due to natural variability, including large-scale circulation features such as El Niño-Southern Oscillation. In addition, there are significant rainfall trends projected for some regions. These include a decrease in cool season rainfall across much of the south and east, with more time spent in drought. Drying combined with warmer temperatures in the south and east will lead to a longer fire season with more dangerous fire weather days. There are likely to be more intense short-duration heavy rainfall events throughout the country. There are also likely to be fewer tropical cyclones, but a greater proportion are projected to be of high intensity, with ongoing year to year variability.

In the oceans, projections indicate more frequent, extensive, intense and longer-lasting marine heatwaves leading to increased risk of more frequent and severe bleaching events for coral reefs, including the Great Barrier Reef and Ningaloo Reef. There will be continued warming and acidification of their surrounding oceans. Higher sea levels will result in more frequent extreme sea level events, leading to more frequent occurrences of coastal flooding. For most of the Australian coast, extreme sea levels that had a probability of occurring once in a hundred years are projected to become an annual event by the end of this century under low emissions, and by mid-century under high emissions.

Analysis of the impacts of extreme weather and climate events has shown how risks associated with those events increase disproportionately as the temperature increases. These disproportionate risks can arise from extreme heat, floods, droughts, fire weather, strong winds and coastal oceanic events, all of which have the potential to adversely affect communities and ecosystems. Altered risk of extreme events also changes the probability of compound events (e.g., concurrent severe drought, heatwaves and fire weather, as occurred in 2019). While the magnitude of climate change expected in the next decade is similar under all plausible global emission scenarios, by the mid-21st century, higher emissions of greenhouse gases will lead to greater warming and associated impacts, while reducing emissions will lead to less warming and fewer impacts.

URGENT ACTION IS NEEDED TO AVOID DANGEROUS CLIMATE CHANGE

In summary, climate science provides overwhelming evidence that significant, urgent and sustained reduction in greenhouse gas emissions, reaching greenhouse gas neutrality by 2050, is required to limit global warming to the Paris Agreement targets of well below 2°C, and preferably below 1.5°C, above pre-industrial temperatures. A target of 50% reduction relative to 2005 levels by 2030 for Australia would be consistent with the required rate of emissions reductions to meet the Paris Agreement targets.

Warming will lead to more extreme climate impacts on Australia, including increases in extreme heat, fire weather, floods, droughts and coastal erosion and inundation. We will have to adapt to that part of climate change we can no longer avoid. The 2021 IPCC 6th Assessment Report concluded recently "Every tonne of CO2 emissions adds to global warming." Any delay in reducing emissions will increase the practical and economic costs of avoiding dangerous climate change and place a greater burden on future generations to adapt to higher levels of warming.

SOURCES OF INFORMATION AND FURTHER READING:

IPCC 6th Assessment Report: **https://www.ipcc.ch/assessment-report/ar6/**

IPCC Special Report on Global Warming of 1.5°C: **https://www.ipcc.ch/sr15/**

IPCC Special Report on the Ocean and Cryosphere in a Changing Climate: **https://www.ipcc.ch/srocc/**

State of the Climate 2020: **http://www.bom.gov.au/state-of-the-climate/index.shtml**

WMO State of the Global Climate 2020 Report: **https://public.wmo.int/en/ourmandate/climate/wmo-statement-state-of-global-climate** (recent version browsers only)

Climate Change in Australia: **http://www.climatechangeinaustralia.gov.au**

The Risks to Australia of a 3°C Warmer World – Australian Academy of Science Report (March2021): **https://www.science.org.au/files/userfiles/support/reports-and-plans/2021/risks-australia-three-deg-warmer-world-report.pdf** (recent version browsers only)

Calling All Australian Teachers!

Are your students between the ages of 11–18? Do you teach Science? Geography? History? Media? Sustainability? Interested in a fun, creative, surprising and insightful film that will teach your students the story of carbon (and everything we stand to lose if we can't learn to live with carbon)?

THIS FILM IS FOR YOU!

ABOUT THE FILM

With Carbon in the news every day, you might think you know everything about her. But you'd be wrong. This spectacular and surprisingly unorthodox documentary reveals the paradoxical story of the element that builds all life, and yet may end it all. Narrated in first person by Sarah Snook (Succession), Carbon tells of her birth in the violent core of an exploding star and of turbulent sagas through the fabric of our evolving Earth. Accompanied by celebrated scientists, unique animations and a stunning orchestral score, Carbon reminds us of our humble participation in the most extraordinary story in the universe.

SCREENING INFORMATION

Carbon – The Unauthorised Biography is on ABC TV + iView from 8.30pm, Tuesday July 12, 2022. Streaming on all major Education platforms from July 20th including ClickView, Enhance TV, Beama Film, ATOM and Kanopy.

STUDY GUIDES

Here are the study guides that accompany the film – you will find links to the curriculum, plus suggested lesson plans and activities with links to relevant sections of the film. The study guides have been created by **ATOM**.

FILM TRAILER

Share this trailer far and wide! Get your community of teachers and your students excited to see the film by sharing the trailer.

STILLS

These are a selection of stills from the film and behind the scenes – you can use these to supplement your teaching materials.

EXTRA VIDEOS

We have a range of extra videos available for you to use in your lessons, should you wish to use these to get your students excited for the film, or should you wish to show standalone snippets individually. Please email **marta@genepoolproductions.com.au** for more info.

Website: **https://www.thecarbonmovie.com**
Facebook: **https://www.facebook.com/thecarbonmovie**
Twitter: **https://twitter.com/thecarbonmovie**
Instagram: **https://www.instagram.com/thecarbonmovie/**

Join the conversation using the hashtag **#thecarbonmovie**

Introducing our Entrepreneur in Residence

We're delighted to welcome Rafael Gracioso Martins as the Royal Society of Victoria's first Entrepreneur in Residence.

Rafael's substantive role is as Head of Technology at **State Library Victoria**. He has a deep interest in the intersection of science, technology, and entrepreneurship.

Rafael will be contributing his skills and experience in building ventures, launching startups and translating research into applications to building a new STEM entrepreneurship program for a curated community based at the Royal Society of Victoria. This will provide resources, events and a support network for current and aspiring entrepreneurs interested in the advancement and application of scientific work. The program is currently under development, so stay tuned for details!

INSPIRING VICTORIA

RARE @ National Science Week

This National Science Week we're exploring RARE (or maybe not so rare!) phenomena across astronomy, palaeontology, botany, ecology, technology, and more. We've curated a special series of experiences featuring scientists from Victoria's major public scientific and cultural institutions. Many events are streamed online so you can access them from the comfort of your home.

Here are our top picks!

Caring for the RARE

Date: Sunday 23 August 2022
Time: 3pm–4.30pm

Audience: Best for 12+
Location: **Online** via Facebook Live

Take a deep dive into caring for our natural world with scientists who manage Victoria's botanical and zoological collections.

Scientists at the Royal Botanic Gardens maintain the Seed Bank at the National Herbarium and activate the amazing network of community botanic gardens across metropolitan and regional Victoria. Museums Victoria maintains tissue and DNA samples cryogenically stored in a BioBank to safeguard the genetic diversity of threatened species. Biologists and ecologists Zoos Victoria leads captive breeding programs for species on the brink of extinction and diligently nurtures population back to health.

Join us for this RARE panel conversation, streamed live from Parliament House, to learn from the botanists, zoologists and collection managers leading this important work. Find out some of the ways they are planning to help

our plants and animals adapt and persist through the multiple challenges in our immediate future.

Presented in partnership with the Royal Society of Victoria, Parliament of Victoria, and Victorian Parliamentarians for STEM for National Science Week 2022.

Planetarium Nights - *Ticket to the Universe* and *Particle/Wave*

Date: Friday 5, 12, 19 and 26 August
Time: Ticket to the Universe at 7:30pm–8:30pm
Particle/Wave at 9pm–10pm

Audience: Adults
Location: Melbourne Planetarium

What about Science date night at the Melbourne Planetarium? During National Science Week we're taking an astronomical view of what RARE means on a universal scale.

Museums Victoria astronomer Dr Tanya Hill has carefully curated a special selection of rare (or maybe not-so-rare) astronomical events for the 7:30pm show *Ticket to the Universe*. Or go on a poetic journey into the rarely detected phenomena of gravitational waves with the full-dome feature *Particle/Wave* at 9pm.

See **here** for more information.

Science on Show

Date: Saturday 13 and Sunday 21 August
Time: 11am–2pm

Audience: All ages
Location: Melbourne Museum

Bring the whole family to Melbourne Museum for a special day showcasing some of the rarest and most fascinating species displayed at Melbourne Museum. Museums Victoria scientists will share insightful stories linked to the unique collections including experts in the fields of palaeontology, marine biology, herpetology, birds and mammals, entomology, live exhibits and mineralogy.

Make and create some amazing creatures with our family activities inspired by *Tyama: A deeper sense of knowing*, an interactive experience immersing you in 360-degree responsive projections, breathtaking effects, and exquisite soundscapes. And don't forget to visit the Museum's newest resident: the most complete and finely preserved Triceratops fossil in the world!

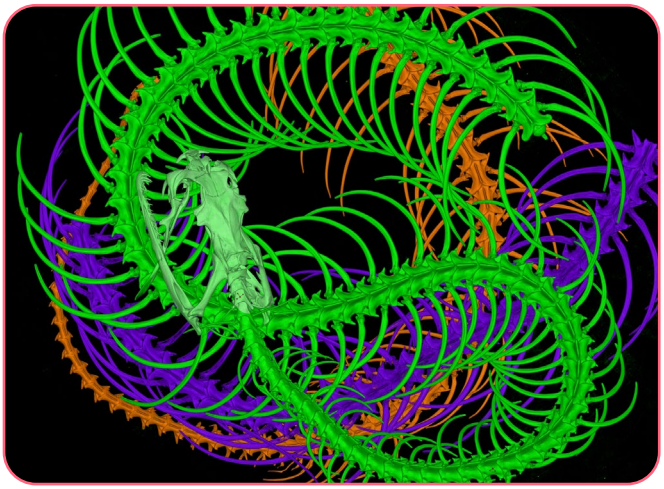
MV Lecture: Snap, Scan, Model, Predict!

Date: Wednesday 17 August
Time: 6pm–7:15pm

Audience: Best for 12+
Location: Melbourne Museum and Online

Join Museums Victoria scientists to hear what innovative new technology reveals about rare reptiles and frogs. These technologies will map Australian reptiles and amphibians in space and time giving a powerful picture of the herpetological fauna in the landscape. We will be able to use this for predicting and mitigating the impacts of climate change on reptile and frog species.

Hear from the scientists on this bold new project combining the fields of palaeontology, macro-ecology, computed tomography (CT scanning), taxonomy and genetics. They will illustrate how museum-based work with large, data-rich collections and new non-invasive techniques can reveal more than ever before and built an interactive, online space for collection access.



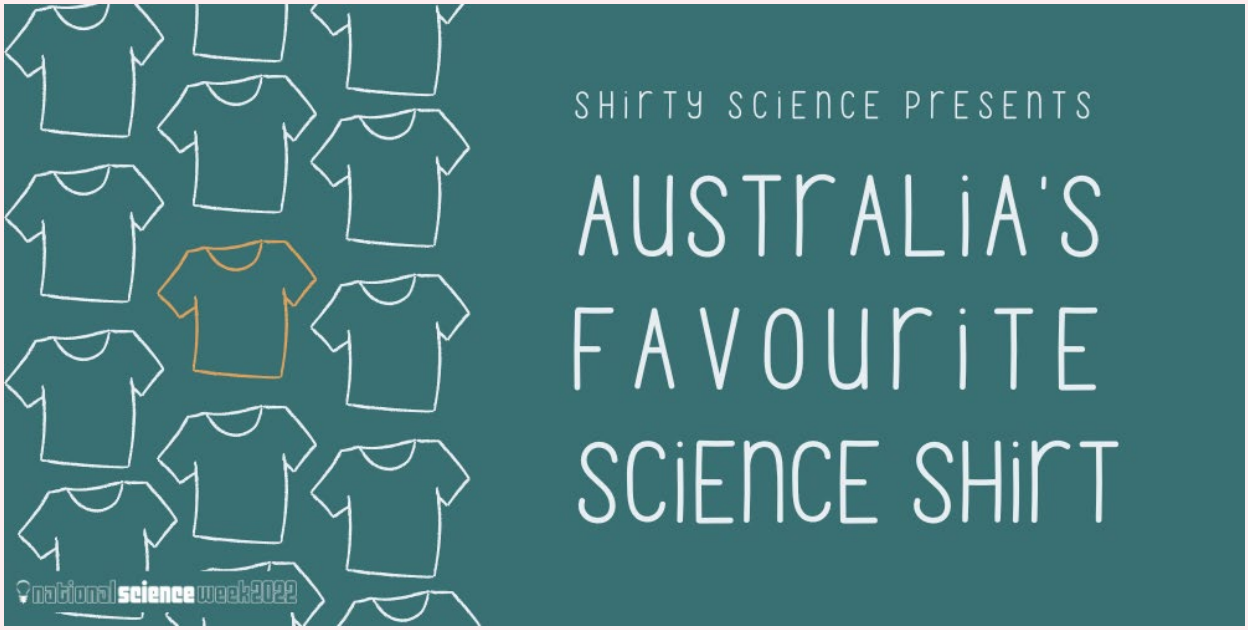
For **#RARE** program updates and details on making bookings, please visit **https://inspiringvictoria.org.au/programs/national-science-week-victoria/rare/**.

Science Week in Victoria: Highlights

Shirty Science

Madison Hartill-Law

17 August



Who will go home with the title of Australia's Favourite Science Shirt in 2022?

16 awesome scientists and artists from across the country currently creating 8 super cool science shirt designs for #ScienceWeek. Now it is time to determine Australia's Favourite Science Shirt.

Hosted by Nate Byrne, ABC Breakfast Weather Presenter, our scientist and artist pairs will have 60 seconds to pitch their shirt design to a panel of esteemed judges and YOU at home.

The National Quantum and Dark Matter Road Trip

ARC Centre of Excellence for Engineered Quantum Systems and the ARC Centre of Excellence for Dark Matter Particle Physics

16–27 August

The National Quantum & Dark Matter Road Trip is a travelling science show, bringing all things quantum and dark matter to a town near you.

Scientists from the ARC Centre of Excellence for Engineered Quantum Systems and the ARC Centre of Excellence for Dark Matter Particle Physics will highlight the importance of fundamental scientific research taking place in Australia, with engaging and accessible talks, hands-on activities such as dark matter pom-poms, mystery boxes, 3-D virtual lab tours and art workshops using the science of light.

Victorians can catch the tour in **Bendigo**, **Crawley**, and Stawell.

Help us solve spider crab mysteries

Remember the Wild

13-21 August

Every winter, in the heart of Port Phillip Bay and parts of the Great Southern Reef, a truly amazing natural phenomenon unravels: the gathering of thousands and thousands of great spider crabs. Those crabs come to the shallows together to seek safety in numbers and they are on a mission.

We know very little about spider crab biology and ecology? Dr Elodie Camprasse and her team at Deakin University are here to change that and they need your help!

So, calling all ocean lovers: you're all invited to come on a science-packed journey to help scientists solve spider crab mysteries. Scientists have deployed timelapse cameras to sneak up on spider crabs and other marine life at various sites around Port Phillip Bay during the last few months. Now, they need YOU to jump onboard and help scan through photographs and identify and count spider crabs and a range of other sea creatures to understand when and where spider crabs gathered this year and what other creatures are around at that time of year.

THINK SCIENCE! At Old Gippstown

Gippstown Reserve Committee of Management

13 August

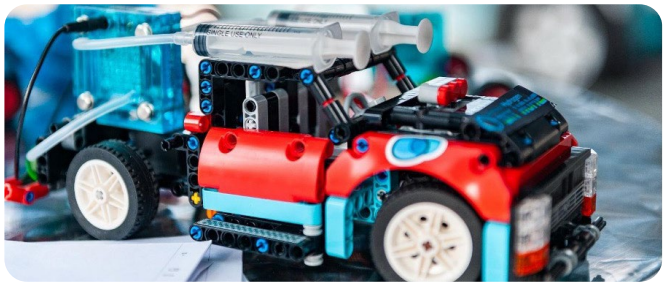
Come see the wonders of science at Old Gippstown's THINK SCIENCE! event. We will have a large range of engaging activities and stalls for both children and adults alike. Our heritage park, where we are hosting the event, has 8 acres of space to hold stalls and activities and we are filling it up quickly.

From a live butterfly house, to a native animal petting zoo, to smoothie bikes, to glass blowing demonstrations, this event has a little bit of everything to celebrate science. We have a Science Discovery Dome, an Amazing Anatomy show and a Dinosaur Dig. We look forward to helping our community learn about all different aspects of science and to providing a great day out.

Hycel - Hydrogen Power and Clean Energy

Warrnambool Library

17 August



Warrnambool Library is partnering with Hycel Technology Hub to run interactive and informative sessions for upper primary and lower secondary students.

Participants will make hydrogen with a tabletop electrolyse and experiment with toy hydrogen cars. This is a hands-on experience that puts science in the hands of our community.

iNaturalist: Be a Local Nature Hero

Eastern Regional Library, Croydon Library

21 August

Join Your Library Ecologist and Entomologist Luis Mata for a walk in the park where we learn how to use the iNaturalist app to contribute to conservation and ecology research. Explore the Tarralla Wetlands and Eastfield Park to discover what creepy crawlies, fungi, and plants are making these environments their home.

Participants' photo observations on iNaturalist will get identified, categorised and added to global databases of ecological observations which scientists depend on for their research. The skills learned in this session will help turn an everyday walk into an opportunity to get involved with global conservation efforts.

A Garden in a Jar

Ballarat Libraries

20–21 August

Ballarat Library will collaborate with local community organisation Food is Free Inc. to host all-ages "Create a Terrarium" workshops. There will be two sessions, held over the weekend of 20-21 August at two library branch locations.

Use recycled glass containers to create a take-home terrarium, planted with herbs or ferns, in support of the 2022 National Science Week theme "glass." There will be information on the science of glass production and a practical demonstration of reducing waste by reusing common household products. There will be lessons on minimising food waste through composting and worm farming. Participants will receive a take-home bag with seeds, ecopots and relevant community information on the Food is Free and City of Ballarat Libraries programs.

Science from the Shed

Ocean Grove & District Men's Shed

12–13 August

A series of 55-minute sessions across two days including a 15-minute science show. Interactive workstations will be set up in and around the shed where a problem will await participants, who will work together to predict what will happen or develop a solution, then let the scenario play out to observe outcomes. They will then attempt to explain what happened and why it happened with guidance from volunteers, written instructions at each station and booklets of further activities to do at home provided.

National Science Week: From Past to Present

Islamic Museum of Australia (Thornbury)

13 August

An intercultural event on-site at the Islamic Museum of Australia in Thornbury, tracing the collaborative and multicultural contributions of historic and modern worlds to STEM fields. This youth-orientated program presented in partnership with the Hellenic Museum and STEM activity provider Robofun will feature two 1-hour robotics and coding classes for primary-aged students, a herbal workshop for all ages inspired by the herbs and plants championed in traditional Greek and Islamic medicine, and a pigment mixing session to give participants insight to the science behind some of the world's oldest artworks from Ancient Greece and Late Antiquity, and the types of pigments and inks used in Islamic manuscripts.

The evening will proceed to an outdoor stargazing session. Binoculars will be provided for participants

to take turns in spotting constellations in the sky. This will accompany a "Build Your Own Astrolabe" print-out activity, illuminating how the astrolabe was developed by Hellenic astronomers and later improved and refined by Islamic scholars. The program will conclude with a family-friendly evening screening of the "Night at the Museum" (2006) film in the Museum's function room. Light refreshments, as well as freshly popped popcorn, will be provided.

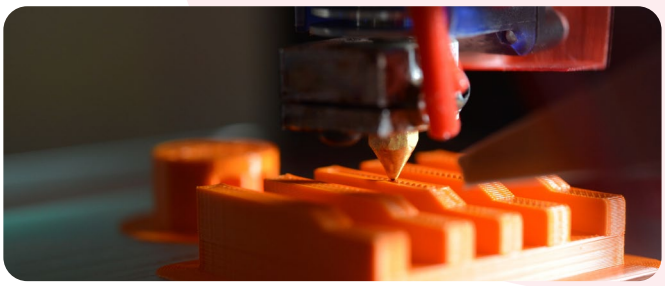
STEMician Workshop

Bacchus Marsh Library

13 August

An inclusive, day-long program designed to help students from Foundation to Grade 4 grow interest and build confidence in the world of STEM, with a range of interactive and fun projects in an inclusive and safe environment.

Participants will work with robots and write codes to instruct them, create CAD models and transform them into real objects using 3D printers, making effective use of digital technologies to design energy efficient and sustainable houses. Scientists, researchers, academics



and industry experts will inspire and guide the students through interactive projects to show what the future holds for them in the exciting world of STEM.

STEM Zone: Experiments with Glass

My Community Library, West Gippsland

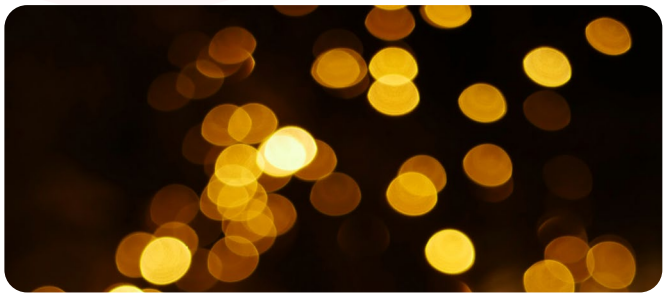
15–19 August

A series of 3 events held at **Drouin Library**, **Trafalgar Hall** (run by the mobile library) and **Warragul Library**. Participants will learn about how glass is made and how its properties determine its many uses. Activities will include looking at the use of mirrors and creating optical illusions, they will explore the effects of tools like lenses, and they will have an opportunity to showcase their creativity.

Light and Sound

Greater Hamilton Library

18 August



In this sensory-based 90-minute incursion, early primary years students use their sight and hearing to learn more about the properties of light and sound. From making their own box guitar, to creating shadows, this incursion is packed full of activities that are perfect for younger year levels. The library's passionate science educators will carefully guide students through each step, prompting students to predict, observe and reflect on each activity.

Scope it Out - Under the Microscope

Brimbank Libraries

13-19 August

Brimbank libraries are running a special schedule of optics-related events. Across a week of science workshops, activities and storytimes, young people in Brimbank will explore the science of optics, magnification and light exploring the vastness of space, the microscopic world of bacteria and making their own periscopes to look around corners. Two *Under the Microscope* events will run at **Sunshine Library** and **Sydenham Library**, with a total of 13 events across all Brimbank Libraries.

Science Festival

The University of Melbourne

13 - 21 August

A week-long celebration of scientific knowledge, innovation and progress with a series of free events and activities for both students and the public. From public lectures, expert-led masterclasses, panel discussions, games and activities, the festival has something for everyone. This year's theme will spotlight discovery – what has science discovered so far and what will it uncover next. Find out how these scientific discoveries have changed our world and what the future of scientific exploration could look like.

Neighbourhood Houses Victoria
Showcase Science

The future is for everyone to create, and science is helping to build the future. Supported by Inspiring Victoria grants, 18 Neighbourhood Houses across the state are delivering events that encourage their communities to share in the love of science and help shape our bright, collective future.

The activities and workshops aim to help young children grow an interest and build confidence in STEM. Scientists from different scientific fields will visit communities to inspire young people. These events also invite whole communities to participate in hands-on activities to consider how science can be used to solve global challenges.

A sustainable future begins with all of us. The 'Green Earth Kids' workshop series hosted by Creswick Neighbourhood Centre aims to build a more sustainable community. With explorative conversation, games and recycled craft activities, it will show off our amazing planet and highlight how we can use Earth's resources responsibly to more effectively look after it.

One important resource is soil, playing an important role to support all life on the planet. Healesville Living and Learning Centre and Reynard Street Neighbourhood House are exploring the science of soil. People are invited to experiment with soil properties and discover what lives in soil, while adults can also dabble in worm farming and composting practices. For some ideas for what to grow with that compost, Chelsea Heights Community Centre is holding a Science Expo featuring interactive science activities, ways to protect the land and ocean, and their Community Garden's volunteers will provide some gardening tips.

An ecologist is visiting Kyneton Community House and bringing out creepy crawlies. They will invite children to discover the mini world right under their noses in the garden. All things in the environment are equally important regardless of their size. Long Gully Neighbourhood Centre are also playing with garden "minibeasts" to learn about compost, soil, and pollinators. Children are encouraged to build pollinator hotels and even do a little taste-test of edible bugs.

Perhaps, for something sweeter, Mount Eliza Neighbourhood House will explore family recipes that use honey. A local beekeeper will bring an interactive beehive for children to see bees at work, share recipes, and guide people through making beeswax wraps and candles. The Mad Food Science Experience at Balla Balla Community Centre will also be pretty sweet: investigating the amount of sugar in popular drinks and how gut bacteria feed on different sugars in the gut. They have many experiments lined up to highlight key health messages for children.

Cutting-edge technology is coming to Sea Lake Neighbourhood House with a virtual reality (VR) incursion. The ClassVR is a fun, hands-on and interactive platform that will provide Sea Lake members with the opportunity to visit all sorts of places – inside a cell or the surface of the Moon. They will especially be working with schools to highlight how VR can be used in a classroom.

Simpson & District Community Centre and Waverly Community Learning Centre are using a different type of technology with introductory sessions to programming and robotics. Using problem-solving computer games and robots, they will run workshops to encourage children to adopt critical thinking skills as they break down tasks. They are bringing all aspects of STEM together, exploring architecture, engineering, technology, and coding fundamentals. Quantin Binnah Community Centre will not only have locals coding robots, but also using digital technologies, creating 3D-printed objects, and building energy efficient and sustainable model houses.

Away from the bright lights of cities, Charlton Neighbourhood House are setting up a large telescope to view the night sky. All those attending will have the opportunity to view stars and planets, especially given that Saturn will hit the opposite part of the sky to the Sun during Science Week (on the 14th of August) and its rings will become brighter and brighter in the lead up.

Kyabram Community and Learning Centre are collaborating with Aldara Yenara (Aboriginal Co-op), Kyabram Fauna Park, Cool Kids First Aid to teach science through storytelling. Through yarns about animals and people, families can learn from knowledge passed down for tens of thousands of years.

> *One place of Indigenous cultural significance is Stony Creek. Walk along the mangroves of Stony Creek with Yarraville Community Centre, and learn to identify vegetation, birds, frogs and fish, and the ecological role they play. The embankments and wetlands were once used as a meeting place and for gathering food, and you can discover which animals still live within the habitat.*

With a focus on sustainability, Oakgrove Community Centre will host an Art session for migrant families using natural resources. They will host an information session on protecting our environment, caring for nature, sustainable resources and appreciate agriculture & farming. **Riddells Creek Neighbourhood House** is advocating for greater sustainability within their community, especially through reduced use of soft plastics and more recycling. They will run activities that explore the chemistry behind plastics and discuss innovations in both the reuse and development of plastic that degrades more efficiently.

As those communities are helping to clean up the planet, Jika Jika Community Centre is teaching people how to make soap. Homemade soaps are more environmentally friendly and there are many scientific processes and chemical reactions behind soap-making that people will learn as they go.

With the variety of fun, informative and interactive National Science Week activities held by Neighbourhood Houses, there is something for everyone. Because science is for everyone. They encourage you to explore the ways that STEM impact the world around you and nurture curious thinking in everyday life.

EVENTS

Studley Park – Go Bush in Inner Melbourne!

Saturday, 13th August (10:00am–3:00pm)

A field trip organised by Geography Victoria and the Royal Society of Victoria for National Science Week.

It's time to lace up the walking boots/shoes and head to "the bush!"

Right on our doorstep here in inner Melbourne, Studley Park is a mecca for cycling, walking and canoeing. Whether you've been to Studley Park on many occasions or not at all, this guided fieldtrip will provide a new insight into this unique location – the largest area of natural remnant vegetation in inner Melbourne.

Our expert, Dr James Driscoll from Monash University (geologist), will be accompanied by the President of the Royal Society of Victoria and Patron of the Geography Teachers' Association of Victoria, Mr Rob Gell AM FRGS (geomorphologist) who will see if he can remember anything from field trips to Studley Park that he attended both as a student and as an educator. Together, they will unravel the area's 420 million years of geological and geomorphological history and provide insights to the Yarra River that flows through the park.

Please note: Places are limited – suitable for ages 12 and up. There will be approximately 4 km of walking involved with some inclines. Morning tea provided – BYO lunch.

Registrations: **https://rsv.org.au/events/studley-park/**

Organised by Geography Victoria in collaboration with the Royal Society of Victoria.

national science week
13 - 21 AUGUST 2022 - AUSTRALIA WIDE

A part of National Science Week in 2022.

RSV Symposium: Next-Generation Biocontrol of Invasive Vertebrate Pests

PRESENTING PARTNERS

Convened in partnership with the Invasive Species Council and the Victorian Department of Environment, Land, Water & Planning, Zoos Victoria, Rabbit-Free Australia, the Centre for Invasive Species Solutions and the Victorian National Parks Association.

Friday, 16th September (8:30am–3:30pm)

A one-day symposium to canvass the impact of invasive vertebrate species on ecosystems and agricultural activities throughout Australia, explore new and emerging biological control strategies for invasive vertebrates, and consider the ethical, social, technological, and decision-making challenges posed by these technologies for governments, industries, and land managers.

WHO SHOULD ATTEND?

We welcome all audiences, including researchers, land managers, First Peoples, government policy leads, industry groups, conservation groups and any other parties with a stake in the challenges posed by invasive vertebrate species and an interest in emerging research that can offer new and effective tools for biocontrol in the years to come.

BENEFITS OF PARTICIPATION

The symposium presents an opportunity to share insights and access expertise in identifying and responding to some of the most pressing challenges facing the Australian continent's ecological health from the impacts of invasive vertebrate species.

FEATURED TOPICS:

Session 1: The Problem

- The broad-scale ecological impacts of invasive species
- The economic costs of invasive vertebrate species management
- The agricultural impacts of invasive species in Australia
- Indigenous land management and the impacts of invasive vertebrate species on Country
- Priorities for management of invasive species from a threatened species perspective

Session 2: The Technologies

- Rodent genetic biocontrol
- Gene drives for foxes, rabbits, pigs etc
- Genetic biocontrol of invasive fish species
- Herpesvirus biocontrol for the management of carp
- Immuno-contraceptives for feral cat management
- Viral biological control strategies for rabbit population control
- Convened in partnership with the Invasive Species Council and the Victoria State Government's Department of Environment, Land, Water and Planning.

Session 3: The Caveats

- Attitudes in New Zealand towards gene editing for invasive species management
- The problems and perils of biotechnology
- Social challenges of invasive vertebrate management
- First Nations perspectives on invasive species management
- Animal welfare considerations for new invasive species management tools
- Modelling genetic biocontrol

Tickets are available from to either attend in person or participate in the webinar via Zoom. RSV Members are prompted to enter their "promo code" to access a member's ticket. Please register online at **https://rsv.org.au/events/invasive-pests-biocontrol**.

AWARDS, PRIZES AND FELLOWSHIPS

Superstars of STEM

Do you think you might be one of our next Superstars of STEM?

The Superstars of STEM program advances gender equity in science, technology, engineering, and maths. Superstars receive advanced communications training to build a strong media and public profile, be a role model for the next generations, and supercharge their career. A strong desire to build a media profile is key – the program exists to create a growing cohort of highly visible diverse role models in the media of people who are experts and leaders in STEM. The program is open to women and non-binary people in STEM.

The program runs for two calendar years with 60 participants in each group of Superstars, identified in a comprehensive competitive selection process. As well as receiving training, the participants are paired with a high-profile mentor, supported to use their new skills to raise their public profile, and visit schools to inspire the next generation.

The current program concludes in December 2022. The next program will run from January 2023-December 2024.

Key dates:

- First round applications open: Wednesday 20 July 2022
- **Applications Close: Sunday 14 August 2022**
- New cohort announced in December 2022

Current Superstars of STEM are offering three Q&A sessions by Zoom during the application period. If you have questions about the application process or what it's like to be in the Superstars of STEM program, join on one of the following dates to get some answers from those who've been there!

Thursday August 4 (3:30-4:30pm AEST)
Tuesday August 9 (12:30-1:30pm AEST)
Wednesday August 10 (12-1pm AEST)

To get a Zoom link email superstars@sta.org.au or DM @StephGGardner on Twitter.

Science & Technology AUSTRALIA

Further information and applications: **https://scienceandtechnologyaustralia.org.au/what-we-do/superstars-of-stem/applicant-info/**

New Award for Outstanding Writing on Social Change

The AUD$10,000 Bruce Piasecki and Andrea Masters Award on Business and Society Writing seeks to inspire future generations to become catalysts for a better, more just society. The winner of the award will be announced in September 2022 with an award ceremony to follow.

Applicants must be between 18 and 45 years old and have published at least one work prior to the 31 August application deadline. Submissions can include essays, research papers, books and articles. Topics must be thematically consistent with positive social impact and business. Themes include, but are not limited to, climate change, racial/gender equality, sustainability, innovation, and new approaches to lessen war and social stresses.

To apply, send your published pieces (link or PDF) and a brief (1 to 2-page) working plan addressing your future writing endeavours and career plans for the next five to 10 years to AWARDS@ahcgroup.com (also cc: rsa@scienceaustralia.org.au). Please contact rsa@scienceaustralia.org.au with any questions you may have.

The award is being offered in collaboration with the Royal Societies of Australia and the Royal Society of New Zealand Te Apārangi.

The award is financed by the Creative Force Foundation started by Bruce Piasecki, the founder of the AHC Group Inc. He is the author of A New Way to Wealth, 2040: A Fable, Doing More with Less, World Inc. and Missing Persons.

The Royal Societies of Australia
Supporting a National Culture of Creativity and Knowledge

TRANSACTIONS

FEATURES AND ARTICLES

Jenolan Caves, spectacular limestone caves in NSW

The Secrets of Australian Caves and Karst

by Catriona Nguyen-Robertson MRSV

This article follows the ***2022 Howitt Lecture****, presented to the Royal Society of Victoria and the Geological Society of Australia (Victoria Division) on 23rd June 2022, delivered by* ***Professor John Webb*** *(La Trobe University).*

People think of Australia being an old, boring continent... but it is definitely not'. As geomorphologist Professor John Webb points out, while the continent is not well-endowed with caves on a global scale, those we do have are notable for their diversity.

As you walk across the Australian landscape, perhaps unbeknown to you, there may be caves beneath your feet. Australia is endowed with a variety of caves of different sizes, scattered across the country.

The caves contain fossils that are records of animals and the environment for at least the last 25 million years and hold the memory of past climates. They also house many living creatures, including bat colonies that consume hundreds of kilograms of insects every night.

Along the Nullarbor Plain, time has stood still for millions of years. It is a former shallow seabed, as indicated by the presence of calcareous skeletons of sea invertebrates that make up the limestone. The limestone is layered as the sea retreated before coming back and stacking on more. There are also low, undulating ridges that are remnants of the sand dunes that once lined the Nullarbor, marking the previous wind directions that deposited these dunes.

- Below the ground, accessible via surface collapses, are many caves. Entering one is like taking a step back in time. John has explored many of them. The largest caves are close to the coast – simple long tunnels that stretch on, perhaps with branching here and there. Even the most delicate of stalagmites, like thin straws, have survived, seemingly untouched. The area drifted into an arid climate some 2.5 million years ago, preventing the geological processes that may have otherwise obliterated these structures.

Collection of water in a cave along the Nullarbor Plain

The Nullarbor caves are covered in sand dunes from the degraded limestone that became grain, blown about by the wind. In some chambers, beautiful, clear, blue-green water collected over time to form lakes. The lakes can stretch to depths of 100 metres and being extremely salty (as John can attest to), they hold a large amount of rock salt (halite), interesting microbes and a variety of fossilised bones.

Further inland, the caves are smaller and rounder. Rather than forming by collapses, they were made by the water from stream valleys that carved its way through the limestone. John believes that they formed across a previous shoreline, where a mix of fresh and salt water dissolved the caves.

A more secret third area of Nullarbor caves exists, only explored by divers. Lying close to sea level, the caves are completely flooded with green water. Although too salty for vegetation, when it rains, a thin layer of fresh water lies on top where tree roots can grow to form seemingly floating plants.

Two cave divers exploring completely submerged caves below the Nullarbor

Another Australian area underlined by limestone is the region stretching west from Portland to Mt Gambier, with caves even extending underneath houses in the towns. Collapsed chambers and sinkholes, called cenotes, formed as carbon dioxide from volcanic activity rose through fractures in the earth and acidified groundwater that then dissolved the limestone. John has snorkelled in the water-filled caves south of Mt Gambier and awed at the completely clear water that allowed him to follow a wall of limestone for as long as he could hold his breath.

These caves hold the history of the land.

Within the caves are 80,000-year-old stromatolites, stony structures in ancient rock that were carved by colonies of microscopic cyanobacteria. Further north in the Naracoorte caves are chambers that have acted as pitfall traps for wandering animals over hundreds of thousands of years. They now store the fossilised remains of thousands of ancient animals that roamed the area.

A dinosaur skeleton reconstructed from bones found within the caves at Mt Gambier

A flat-roofed chamber of the Buchan Caves

On the other side of our state, in East Gippsland, the Buchan Caves formed 400 million years ago. The tourist caves are a honeycomb of crystallised calcium carbonate stalagmites and stalactites, derived from the skeletons of shellfish and coral that were deposited when the sea still covered southern Gippsland. Subterranean chambers and passages were carved out by rainwater that trickled in, and some chambers even now hold large springs.

While the tourist caves are more famous, slightly north is an unusually large collection of vertical caves in The Potholes Area. So named because of their small entrances, the Potholes are a denser collection of caves compared to anywhere else in Australia. The stepping roofs of the caves suggest that they formed along the ancestral flow of the Snowy River. Where limestone met mud of the riverbank, groundwater was forced to flow up and out, carving a path as it did. While the river now flows to the east, it made its mark: as water filled the stone, the caves began to form. Then, after a major tectonic uplift 2.6 million years ago (similar to the uplifts that created the Snowy Mountains), the caves drained.

The landscape has changed beyond all recognition in the last ten million years,' says John. As the sea and land shifted, it dissolved the bedrock to create karst: sinkholes, sinking streams, caves, springs – spectacular mazes that now support unique ecosystems.

Karst landforms, formed over millions of years, need our protection. Karst features are not only pieces of history, but they also house complex ecosystems that plants, animals, and micro-organisms which, in many cases, cannot survive elsewhere. Mining and littering have been quite damaging to biodiversity in the past. But now, the biggest threat is overuse for tourism – which John is in two minds about as tourism helps publicise caves but also requires cleaning and paths to be built.

Caves provide critical habitat for a variety of plant and roosting animal communities. They are also nature's time capsules. Exploring Australian caves is a journey to a hidden underworld that, as John Webb has seen first-hand, holds many wonders.

Rob Gell AM, Professor Bronwyn Fox, Dr Amanda Caples

Building a New Manufacturing Sector in Victoria

Catriona Nguyen-Robertson MRSV

*This article follows a presentation to the Royal Society of Victoria and Australian Academy of Technology & Engineering (Victoria Division) on 7th July 2022 delivered by **Professor Bronwyn Fox** (CSIRO) titled* ***'Creating a World Leading Manufacturing Sector in Victoria'****.*

How do we create a world-leading manufacturing sector in Victoria? Building on a long tradition in automotive, aerospace, defence, metal, food, chemical and general manufacturing, Victoria continues to be the epicentre of Australian manufacturing. Combined with a highly skilled workforce, infrastructure, education, and research, we can be a global hub for science infrastructure and R&D.

Chief Scientist at CSIRO, Professor Bronwyn Fox, is no stranger to scientific innovation. She sees herself – to use an engineering term – as a systems integrator. She has a long history of bringing together researchers from multiple institutions and different scientific disciplines, leveraging digital science, and translating brilliant research ideas into real world solutions.

Bronwyn started out at CSIRO in the 1990s as a fresh graduate. Throughout her studies and career as a researcher, she partnered with CSIRO on various projects. She wants all universities to be set up so that others can do what she did and reap the same benefits. But not many PhD students in academia have the opportunity to partner with industry.

Now, she has returned as Chief Scientist, she is guiding CSIRO to solve great challenges with innovative science and technology with the goal of helping the community.

'We're not in the science business at CSIRO,' she says. 'We're in the people business.'

One of the megatrends that Bronwyn sees as shaping the future of the manufacturing sector is the Internet of Things (IoT). It has great potential to transform enterprise and industry, and even the way we interact with each other.

The IoT allowed for the emergence of digital twins that simulate manufacturing and mining processes. This now means that people can use data from multiple sources to virtually test machines and accurately predict what

maintenance needs to be done. In addition, test products can be commercialised in the digital space before people invest in physical resources.

There has also been a shift in mindset within the sector due to IoT. Data is becoming more decentralised and more widely shared so that manufacturing processes can be replicated around the world. Furthermore, sustainability has become a large focus in supply chains. Larger companies have started deciding partners based on real-time data of which companies are working sustainably. Bronwyn is concerned that Australia is at risk of being cut out of supply chains if we cannot provide evidence of reducing carbon emissions.

Bronwyn is interested in leveraging the successes of the mining sector's use of digitisation, automation, and control in manufacturing. CSIRO's mining division aims to create a suite of technologies that change the way we think about time and space. As Bronwyn puts it, 'it all sounds very "Doctor Who"'.

Measuring the concentration of valuable material in rocks is difficult and time consuming. As this is a major impediment to efficient mining, researchers rose to the challenge of developing new sensing technologies. Using magnetic resonance to analyse the atomic properties of materials, the NextOre sensor can measure ore grade in large volumes. A CSIRO spin-out company, Chrysos, also developed a PhotonAssay to measure gold in rocks. By hitting samples with high-energy X-rays, it can analyse gold, silver, copper and other elements quickly and accurately. 'It is the new gold standard for the gold standard,' says Bronwyn.

CSIRO also developed artificial intelligence to help drones navigate mines and VoxelNET, a technology that can generate a virtual mine to simulate its operation.

Together, these technologies make the mining process more streamlined and sustainable.

CSIRO's Manufacturing Business Unit develops innovative products and processes for Australian manufacturers to also be globally competitive. **CSIRO's Data61** is an example of a hub of state-of-the-art labs and facilities. Bronwyn herself also drove the establishment of the **Swinburne/CSIRO Industry 4.0 Testlab** for Composite Additive Manufacturing. The centrepiece of the lab is an industrial scale, multilayer 3D printer that builds carbon fibre composite products with improved production quality and reduced waste in the process.

The manufacturing sector is evolving, and we are producing world-class infrastructure here in Victoria, but do we have a workforce that can keep up with its evolution? With all the elements that we mine and use in products, the most important element of all is the people.

Bronwyn discussed with Dr Amanda Caples and Mr Rob Gell about nurturing the next generation of leaders in STEM. Amanda is concerned at the dive in numbers of secondary and tertiary students taking advanced mathematics and science subjects, when the skills gained in those subjects are highly valuable – whether students become pure mathematicians or scientists or not. Rob and Amanda are both involved in outreach activities that engage young people in STEM, but point out that we need multiple points of intervention as people diverge from the path of STEM throughout school and their careers.

Not only do we need more young people pursuing STEM, but we also need to create a supportive environment for those who do. While things are improving, there remains relatively little culture of crosstalk between academia and industry. Amanda made an analogy to biochemistry: R&D needs to be more of a dynamic equilibrium of industry and academia, with ideas and support going both ways.

CSIRO's On innovation programs are one such example of ways to connect research organisations with commercialisation pathways. They help Australia's publicly funded researchers and small and medium enterprises develop the skills needed to fast-track their technology and ideas into the market.

With people like Bronwyn at the forefront of industry research, Victoria is in good hands. Amanda, Bronwyn, and Rob all advocate for bringing multidisciplinary scientific and engineering capabilities together. Our state is home to many success stories in advanced manufacturing, and it will only grow from here.

The Aurora Australis

By Priya Mohandoss MRSV

If you have the opportunity to travel to southern parts of Tasmania, the South Island of New Zealand, the Falkland Islands in the South Atlantic or to the Antarctic during the southern hemisphere's winter, when nights in darkness are longer, this is the optimum time and place to witness the spectacle of the Aurora Australis, otherwise known as the Southern Lights.

While this phenomenon naturally happens every day of the year, we can generally observe the Aurora Australis from March to September as a subtle display of coloured, ribbon-like waves that traverse the sky during the night.

It is caused as a result of activity from our Sun, including geomagnetic storms and coronal mass ejection. The Sun's magnetic field is volatile and often powerful enough to tug at the Earth's magnetic field, pulling it further into space, then releasing it like a rubber band. The recoil causes powerful electromagnetic ripples, known as Alfvén waves, to travel between the Sun and the Earth. The prevailing theory is that electrons ejected from the Sun are swept up and accelerated in these Alfvén waves, travelling to Earth to collide at high speeds with the nitrogen and oxygen molecules in our upper atmosphere (the ionosphere), causing a reaction that releases light as an aurora.

An aurora tends to slowly increase in strength and brightness as the night proceeds. Therefore, it is initially silvery in appearance yet later projects into a stream of colours that glide across the sky in sheet-like form, with oxygen atoms releasing green and red while nitrogen atoms produce green and blue.

Since aurora formation happens in the upper atmosphere, the most suitable conditions are a clear and dark night, when the Moon has 25% or less light, and in an area where a minimal amount of light and air pollution is present.

In terms of Indigenous astronomy, this stunning glow is culturally associated with fire, death and omens. While it is collectively seen as the 'fire of the cosmos', each particular Aboriginal group has their own insight to this representation. Sometimes noises can be heard similar to the sound of rustling grass or radio static. In 1851, Aboriginal people in Hobart compared it to the sound of "people snapping their fingers."

Here in Australia, we are fortunate enough to have the Aurora Australis on our doorstep, so it is well worth the effort to catch a glimpse of one of nature's wonders at its best.

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FROM THE ARCHIVES

Compiled by Scott Reddiex MRSV

1972

Gippsland Lakes Entrance in 1863, by Mr. Rawlinson

GIPPSLAND LAKES AND THE CHANGING COASTLINE

In 1972, J. J. Fryer published a piece in the Proceedings of the RSV as part of the Bass Strait Symposium, titled '*Development of the Gippsland Lakes Entrance Since 1851*'.

The Gippsland Lakes are Australia's largest inland waterway system, however the impacts of European settlement - such as the development of a permanent entrance to the lakes from Bass Strait - have had lasting effects on the ecosystem.

Prior to the establishment of a railway link between Melbourne and East Gippsland, and with horse and cart the only other form of land-based transport, settlers in the area instead needed "*to ship their goods to Melbourne through the extensive river and lake systems of Gippsland and out into Bass Strait*".

Before the arrival of Europeans, the waters of the Gippsland Lakes and the currents of Bass Strait had existed in a cyclical relationship: these opposing forces would gradually deposit sand to build a barrier beach between the two bodies of water, which would then break at one or more points to form channels. Following a breach, the cycle would begin anew, and the openings would again be filled with sand. This made the establishment of a permanent entrance to the lakes by Europeans difficult, with one attempt in 1889 quickly resulting in the formation of an offshore sand bar that restricted its use and "*also modified conditions within the lakes and caused erosion and accretion along the Ninety Mile Beach*".

With the creation of a more permanent entrance, it reduced the periodic flooding of the township of Lakes Entrance that had previously occurred whenever a natural entrance was closed up, and by around 1925 the offshore sand bar had established "*a quasi-equilibrium condition*". Fryer notes that while a railway connection with the area reduced the shipping traffic, "*the discoveries of oil and natural gas offshore have attracted further interest in the port, since there are few natural harbours along this portion of the Victorian coast*".

For more on the history and impact of Europeans on the Gippsland Lakes, *Environmental History and the Hydrological Cycle in Colonial Gippsland, Australia, 1838–1900* by Dr. Kylie Carman-Brown (ANU Press, ISBN: 9781760462857) is available to read for free online by ANU Press at **https://press.anu.edu.au/publications/following-water**

1922

TABLE I.

Observer.	Type of apparatus.	g cm. sec.-2	Weight.	Diff. from weighted mean
Baracchi-Love	Kater	979·977	0:5	– ·010
v. Elblein	v. Sterneck	·991	1·	+ ·004
Guberth	,,	·997	1·	+ ·010
Hecker	Potsdam	·985	2·	– ·002
Alessio	,,	·985	1·5	– ·002
		Weighted mean: 979·987		
		Mean error: ±·0027		

Table I: The data for the evaluation of g for the Melbourne observatory.

THE WEIGHT (MASS X G) OF THE WORLD

On the 13th of July 1922, the paper 'Gravity Determinations in Australia' by Dr. Ernest Frederick John Love was read to the RSV.

Following the work of Galileo, Newton and others on gravity in the 15th and 16th centuries, in 1671 the French scientist Jean Ricer observed that the strength of gravity varied between different locations on earth. This finding prompted similar scientific expeditions to other parts of the world over the proceeding centuries.

E.F.J. Love (1861-1929) was a physicist, who had moved to Melbourne from the UK in 1888 to become an assistant lecturer at the University of Melbourne. The following year, he became a member of the Royal Society of Victoria, and on the 10th of October 1889 read the paper, "On a Proposed Gravity Survey of Australia". This had been received favourably by the society, with the then President Prof. Kernot noting, "If the work were done in the way proposed, a substantial and valuable addition to our knowledge on this subject would be gained. Certainly, if it could be done at anything like the cost suggested by Mr. Love, then nothing should be allowed to hinder its being done." A sub-committee was formed, and over the coming years progress was made in completing the survey at sites around Australia, with regular reports published in the Proceedings.

Love revisited the subject of gravity surveys in 1922, after the National Research Council had appointed a committee to report on the matter. His paper addressed the slightly different approaches and measurement tools (either Kater, von Sterneck or Potsdam pendulums) that had been utilised by the different groups around Australia over the past 30 years, and their resulting observations. From this, he calculated the values:

Melbourne Observatory:

g = 979.987 (± 002) cm.s^{-2} = 9.799 87 (± 0.000 02) m.s^{-2}

Sydney Observatory:

g = 979.680 (± 001) cm.s^{-2} = 9.796 80 (± 0.000 01) m.s^{-2}

Difference:

g(Melb.) - g(Syd.) = 0.307 (± 0.003) cm.s^{-2} = 0.003 07 (± 0.00003) m.s^{-2}

For comparison, the 'standard' acceleration due to gravity on earth (g_n) was defined in 1901 as 9.806 65 m.s^{-2}

While these values have since been updated very slightly thanks to more precise measurements, the trend between the two cities has held firm, meaning that you will weigh slightly more in Melbourne than you do in Sydney – although this may also be influenced by the quality of Melbourne's restaurants.

SOLAR ECLIPSE OF 1871

"On November 22 [1871], it will be remembered, the Australian Eclipse Expedition started from Melbourne. Our next meeting was a special one held on January 22 [1872], and was devoted to matters connected with the Eclipse Expedition."

The expedition to Cape York, QLD, was to observe the total solar eclipse that occurred on the 12th of December 1871. This was to be the first total solar eclipse visible from the continent since 1857, and the first since the 'remarkable' total solar eclipse observed from India in 1869 with a newly developed spectroscope.

In his 1870 Presidential Address, RSV President R. J. Ellery (an astronomer) writes with palpable excitement about this eclipse seen from India: "*The eclipse was successfully observed, the results were extremely satisfactory, and the mystery of those wonderful red or rose - coloured prominences which during the moments of totality have been seen to jet out from or hover over the sun's edge, and which had hitherto puzzled astronomers and physicists, was to a great extent unravelled.*

The spectroscope revealed in their light the well known lines of hydrogen. Every observer told the same story - hydrogen lines, the light of incandescent hydrogen. These beautiful rose-coloured prominences, therefore, appear to be jets and clouds of red-hot hydrogen of enormous dimensions, some of which are sometimes projected nearly 100,000 miles into space."

1872

Royal Society of Victoria Solar Eclipse Expedition, Cape York, Queensland, 1871

Photographer: Edward John White

Source: **Museums Victoria**

With this, the stage was set, and Ellery led a group from Melbourne Observatory to Cape York via Sydney, for a better view than could be obtained in Melbourne.

Unfortunately, the weather was to be their undoing. In Ellery's eloquent words from his 1872 Presidential Address, "*Up till the 11th December the weather had been on the whole fine, and promising of clear skies; but on that day the wind fell, and heavy thunderstorms came on during the afternoon and evening, which continued all night. Next day broke gloomy, overcast and raining. Now and then came a slight break, and a peep of the sun for a moment to tantalise us. Every instrument was set and ready, every observer at his post, and prepared - hoping against hope - till our time-keeper called out that the eclipse had commenced, warning us from time to time of the approach of totality and its progress, but impenetrable clouds hid all from us. Once for a moment a break showed us the last thin crescent just before totality - and that is all the Australian Eclipse Expedition saw of the total eclipse of December 12, 1871.*"

While they were unsuccessful in observing this total eclipse, the party returned to Melbourne at least with botanical specimens and meteorological observations to show for their trip.

R. J. Ellery's Presidential Addresses for 1870-1872 can be read in the Transactions and Proceedings of the Royal Society of Victoria, Volume X, 1874 (viewable at **https://www.biodiversitylibrary.org/item/105585**)

PROCEEDINGS

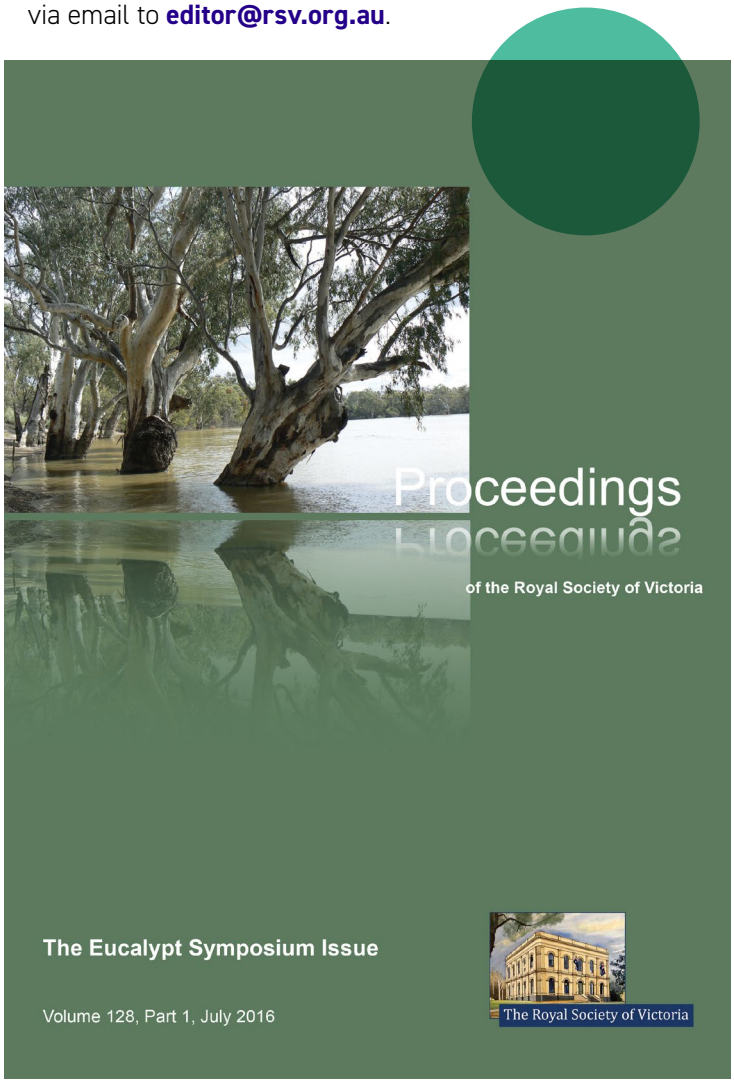
Call for Papers

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

Draft Declared Mine Regulations 2022 and RIS for public consultation

Have your say on draft regulations that will deliver a clearer approach to the rehabilitation of land where our biggest mines operate

Consultation closes 17 August.
https://engage.vic.gov.au/draft-declared-mine-regulations-ris

Victorian Transmission Investment Framework Preliminary Design

Have your say on the proposed approach to developing Victoria's Renewable Energy Zones and contribute to Victoria's energy future.

Consultation closes 15 August.
https://engage.vic.gov.au/victorian-transmission-investment-framework

Planning for Environment Protection

Do you deal with land which is potentially contaminated in your role as developer, consultant or planner? Then we'd like to hear from you.

Consultation extended to 12 August.
https://engage.vic.gov.au/planning-for-environment-protection

Proposed Metropolitan and Regional Parks Regulations

Have your say on how metropolitan and regional parks are managed to help ensure the protection

Consultation closes 22 August.
https://engage.vic.gov.au/MRP_Regulations

Willatook Wind Farm Project Inquiry

The Inquiry seeks submissions to advise the Minister for Planning on the EES for the proposed Willatook Wind Farm Project.

Consultation closes 12 August.
https://engage.vic.gov.au/victorian-transmission-investment-framework

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 managemen**t, 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.

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.

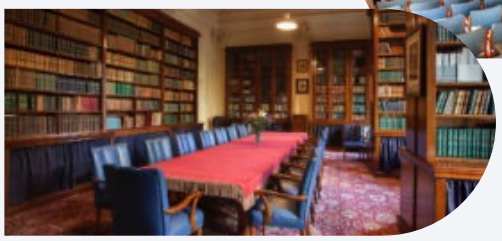
For more information and bookings please contact our Business Manager at **james@rsv.org.au** or on +61 3 9663 5259

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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I enclose my cheque or money order made out to **The Royal Society of Victoria**.

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I have transferred my donation to the Royal Society of Victoria as follows:

BSB: 083-019
Account No: 51-515-2492
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