JULY 2024 — BUILDING SCIENTIFIC COMPETENCY

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The State Library of Victoria. Photograph: Geraldine Lewa via Unsplash.

In This Issue

BUILDING SCIENTIFIC COMPETENCY

A solid foundational understanding of science and the scientific method is an increasingly valuable tool. Whether it be adapting our communities and industries to the changing climate, pursuing a career in a STEMM field, or using critical thinking to review information, building the level of scientific competency in our state is essential for our future.

ON THE COVER

Inside the Learning and Teaching Building at Monash University, Clayton. Photograph: Nils Versemann via Shutterstock.

Upcoming Submission Deadlines

For all 2024 editions and deadlines, refer to page 45.

AUGUST 2024	DUE DATE
STEMM Throughout Victoria	*5pm, 19 July*
SEPTEMBER 2024	**DUE DATE**
Pollution in Victoria	*5pm, 16 August*

From the Editor

SCOTT REDDIEX
Editor-in-Chief — Science Victoria

In our May edition, I spoke about science being a toolkit, rather than a single subject, job, or task. Everyone uses this toolkit in every part of their life, whether it be cooking a meal, crossing a road, or hammering a nail. Science is for everyone.

This month, we look at how we can build scientific competency in our state. But what exactly does 'scientific competency' mean?

Revisiting the idea of a toolkit, we can give a simple definition: scientific competency is making sure that everyone knows what tools are available, and how to use them.

In practice, building scientific competency in our communities means that everyone has a solid, foundational understanding of the scientific method, and strong critical thinking skills. It means that everyone is able to look at a piece of information, and then question, analyse, interpret, evaluate, and develop a reasoned conclusion.

While there are clear benefits of this for a STEMM workforce, building this scientific competency in the community has far-reaching positive impacts. It supports people and communities to be less susceptible to mis- and dis-information. It helps people in all manner of jobs to better review and act on data available, which is increasingly important as industries respond to the changing climate. It also encourages curiosity and inquisitiveness in all ages, as we ask better questions to find better answers.

At a societal level, it would make a population more resilient to unscientific/pseudoscientific, and blatantly false claims made by politicians, policy-makers, individuals, and industries.

Where, then, do we start? Are there any 'quick wins' to be had? What are the longer-term projects?

Addressing the way that sciences are taught at all stages of the education journey is a big part of this, and something that pedagogical researchers Prof Amanda Berry and Prof Jan van Driel presented to the RSV last year (full presentation: **youtu.be/s94ZMWhdxIs**, 10-min summary: **youtu.be/JL6SiKT9jSI**).

Citizen science is a great example of how everyone can be involved and contribute to a non-trivial STEM project. In this edition, Dr Marissa Parrott, Estelle Van Hoeydonck, and Hannah Sly from Zoos Victoria discuss the Moth Tracker citizen science project, helping to identify and track the numbers of the Bogong Moth.

Elsewhere in this edition, Dr Catriona Nguyen-Robertson and Dr Giulia Iacono discuss improving scientific competency at a tertiary level, while Tessa Kum from the Royal Botanic Gardens Victoria looks at how botanic gardens are addressing climate change.

We hope you enjoy this edition of *Science Victoria*.

SCIENCE VICTORIA

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Erratum

The May 2024 edition of *Science Victoria* incorrectly attributed the article 'Beware Reef' to Ms Priya Mohandoss, instead of *Science Victoria* staff. This has been corrected in the digital edition.

Letters to the Editor

editor@sciencevictoria.org.au
Letters may be edited for length and clarity

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Acknowledgement of Country

The Royal Society of Victoria acknowledges 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.

Subscribe to receive *Science Victoria* online at **eepurl.com/bg-fjH**

Scientific Competence vs. Incompetence

ROB GELL
President, The Royal Society of Victoria

Robert Boyle (1627-1691) was one of the fathers of modern chemistry, and a founding Council member of The Royal Society of London for Improving Natural Knowledge.

In this edition of *Science Victoria*, we look at how to build scientific competency in our communities. What would Boyle think of our current task, in comparison to those of the Royal Society in the 17th century?

While our understanding and application of science has increased exponentially since then, the core principles established by the Scientific Revolution remain constant: empiricism, hypothesis testing, reproducibility, and peer review.

Who, what, when, where, why, how

There are questions that we should first consider. Why is there a need today to empower individuals and communities to understand the scientific method?

Who should be responsible for the training? Is it a matter of tweaking what is already in place in schools, or is something new needed? How best can science societies like the RSV support our communities in building scientific competency?

How do we best manage the 'selective incompetence' in the media? Have elements of the media landscape warped the idea of 'impartiality' as a way of avoiding responsibility for accurate reporting of scientific topics?

How much does 'tribalism' in the scientific community hinder the evolution of scientific practices, and meaningful public engagement with science?

Thinking about the answers to these and other questions is important, for understanding the need, deciding the method, and evaluating the outcomes.

Challenges in the 21st century

There are also a number of influences in the modern era that challenge science, the scientific method, and scientists.

Vested interests – for political, commercial, or religious purposes – regularly challenge the competency of researchers through traditional and social media channels.

The rise of social media has accelerated the spread of misinformation and disinformation, which has undermined efforts relating to vaccine safety and uptake, climate change, and public health issues by continually sharing retracted, debunked, or completely fictitious studies.

The extension of this is what is referred to as 'weaponised incompetence'; feigning ignorance or dismissing scientific evidence by claiming inability to understand it. This is distinct from a genuine lack of skill or understanding.

Lessons from the past

It often takes considerable time for established communities to accept good science. While Robert Boyle and his colleagues at the newly established Royal Society in London were promoting experimental methods, peer review, and communication of findings, the polymath Galileo Galilei was being persecuted by the Catholic Church for supporting 'heliocentrism' – the fact that the Earth orbits the sun, and not vice versa.

In 1663, Galileo was forced by the Catholic Church to recant his claims under the threat of torture. Galileo's comment from that time, "eppur si muove" ("and yet it moves"), is taken to mean "believe what you want, but it doesn't change the fact that Earth revolves around the Sun". We might make the same observation regarding climate science today.

Facts vs. "Alternative Facts"

Today we face a range of facts, truths, beliefs, opinions, and "alternative facts" that make the effort to build scientific competency more difficult, perhaps now more than ever. I recall speaking to graduating science students at the University of Melbourne in 2010 and making the comment that they were entering the workforce at a time when science hadn't been questioned as strongly since Charles Darwin took on the church! In Australia this was at the time that Kevin Rudd's Labor government, with the support of Ross Garnaut's Climate Change Reviews, was endeavouring to introduce a Carbon Pollution Reduction Scheme (CPRS), on the basis of accepted climate science from the Intergovernmental Panel on Climate Change (IPCC).

To combat science incompetence in the media, efforts are needed to improve scientific literacy, fact-checking, and the ability to identify misinformation or disinformation.

Of course, the Royal Society of Victoria does have a role to play in increasing science literacy by making science available to the wider community through *Science Victoria* and our regular lectures, but we also have a role to play in the promotion of evidence-based decision-making. To that end the RSV is available to provide information and to discuss and interpret science through our membership or referral to specialist scientists.

Inaugural Australian Research Council Board

SCIENCE & TECHNOLOGY AUSTRALIA

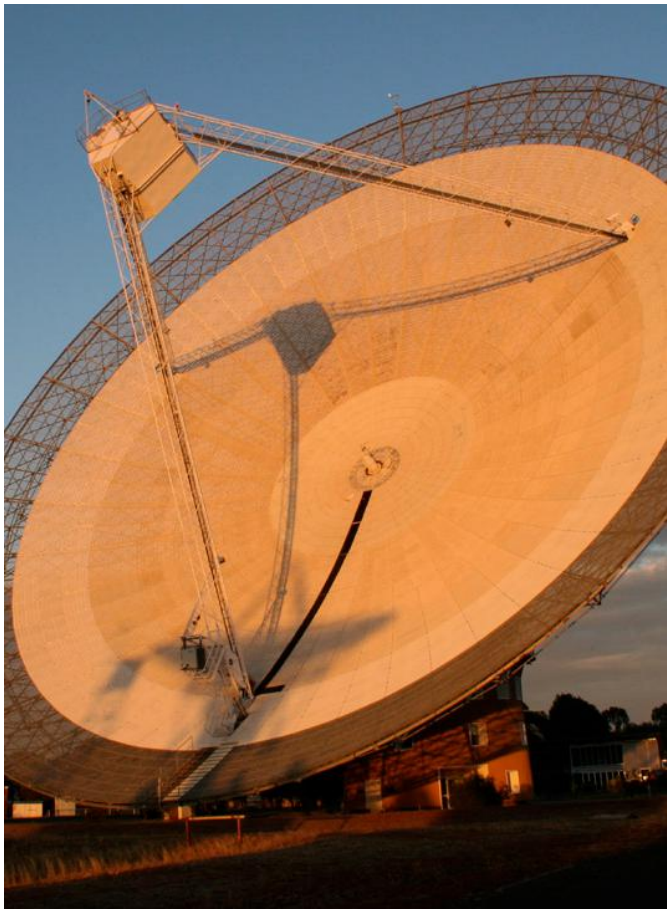
Australian research will be powerfully boosted, and researchers strongly supported by the appointment of the inaugural Board of the Australian Research Council, recently announced by the federal Minister for Education, Jason Clare MP.

The establishment of this Board is a great outcome, and one Science & Technology Australia (STA) strongly advocated for as part of the Review of the ARC Act 2001.

The new and highly experienced Board includes Professor Peter Shergold AC as Chair, and Professor Susan Dodds as Deputy Chair, with other Board members drawn from across the research sector: Mark Stickells AM, Distinguished Professor Maggie Walter, Professor Cindy Shannon AM, Professor Paul Wellings CBE, Emeritus Professor Margaret Harding, and Sally-Ann Williams.

The Board was created on the recommendation of the independent review of the Australian Research Council Act. That review – led by Professor Margaret Shiel, Professor Susan Dodds and former STA President Professor Mark Hutchinson – recommended 10 changes to the ARC's governance and independent decision-making processes.

The Board will be responsible for determining priorities, strategies and policies for the ARC and advising the Education Minister, and approving research grants for many ARC funding schemes.



Parkes Radio Telescope. Photograph: Shami Chatterjee via flickr (CC BY-NC 2.0).

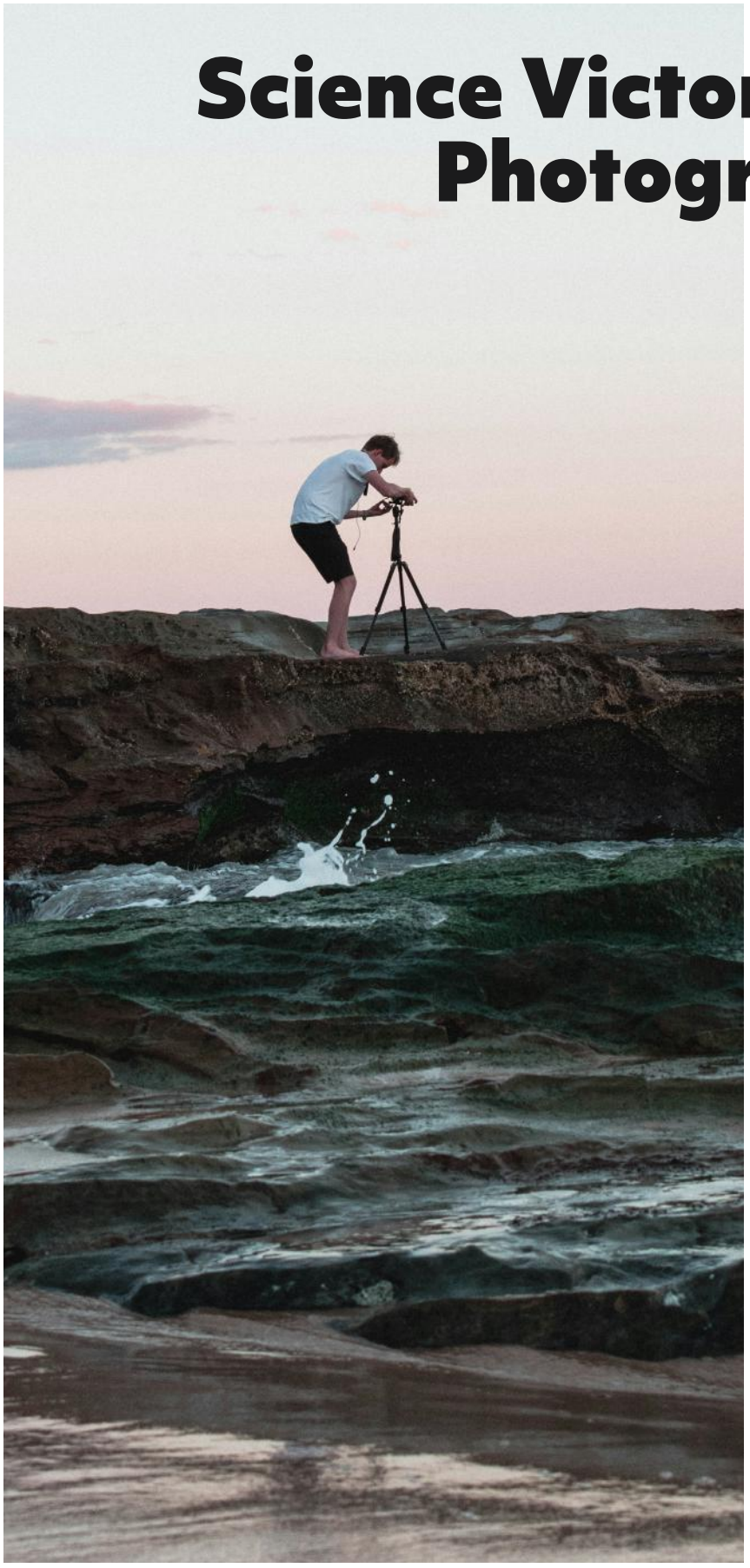
Photograph: CDC via Unsplash

About Science & Technology Australia

Science & Technology Australia (STA) is the nation's peak body representing more than 225,000 scientists and technologists. We're the leading policy voice on science and technology. Our flagship programs include Science Meets Parliament, Superstars of STEM, and STA STEM Ambassadors.

The Royal Society of Victoria is one of 140 member organisations of STA, along with universities, research institutes, and others.

► *This article is an excerpt from an article originally published 26 June 2024 at* ***scienceandtechnologyaustralia.org.au/welcome-arc-board***



Photograph: Karl Hedin via Unsplash

Science Victoria STEMM Photography Prize

Win $300 and celebrate the world of STEMM.

We are excited to announce the first annual *Science Victoria* Photography Prize!

In 2023, we introduced the 'Snapshots of STEMM' section to our magazine, as a way to connect the images of everyday science with a general audience.

This year, the images published each month will form a shortlist, from which a winner will be selected at the end of the year.

Applications for the 2024 round are open until 15 November (the deadline for the December edition), and a winner announced in the February 2025 edition of *Science Victoria*.

The winner will receive a $300 prize, and a certificate.

Images must be original photographs that capture your day-to-day work in STEMM. These are not stock photos or overly posed images. Instead, they show what working and studying in a STEMM field is actually like.

PRIZE:
$300 prize, and a certificate.

RESOLUTION:
All photographs must be of sufficient size and quality for printing – as a rough guide, aim for >1.3 MB in file size.

SUBMISSIONS:
Submissions can be made until 15 November 2024 by emailing **editor@ScienceVictoria.org.au.**

ENQUIRIES:
For any questions about submissions for the *Science Victoria* STEMM Photography Prize, please contact **editor@ScienceVictoria.org.au.**

Scienceworks Learning Facilitator, Zofia Witkowski-Blake, at working with a child to make a ball hover in the air using the Bernoulli principle. Photograph: Phoebe Powell/Museums Victoria.

Alice Terrill, a PhD candidate at Monash Institute of Pharmaceutical Science, discussing her work on optimising antibiotic treatment with members of the public. This was part of the Soapbox Science event in 2023, held at the State Library of Victoria. Photograph: STEM Sisters.

The Law Courts Building in Sydney CBD. Photo: Gary Yim, via Shutterstock

Science, Media and the Law: Lessons from the Kathleen Folbigg Case

Kathleen Megan Folbigg was arrested in 2001, accused of murdering her four infant children. She was convicted in 2003 and sentenced to 40 years imprisonment with a non-parole period of 25 years.

Scientific and medical research suggesting the daughters might have died of natural causes was rejected by a judicial inquiry in 2019. Subsequent research published in 2020 led ninety eminent Australian scientists and medical professionals (led by the Australian Academy of Science) to petition the NSW Governor to pardon Folbigg. The petition succinctly demonstrated that all four deaths could be explained as the effects of very rare genetic factors. In June 2023, Folbigg was unconditionally pardoned by NSW Governor Margaret Beazley and released from prison, having served 20 of her minimum 25 year sentence. Her convictions were overturned in a subsequent decision by the NSW court of criminal appeal in December 2023.

Join key members of "Team Folbigg" to understand the barriers they experienced to considering complex genetic science as robust legal evidence in an Australian judicial system, and hear the case for change.

About the Speakers

Mr Peter Yates AM FTSE FAICD operates across three sectors in society, Financial Stewardship, Science and Not-for-Profit. In May 2021 he was appointed Chair of AIA Australia. He is Chair of the Australian Science Media Centre, the Royal Institution of Australia, the Royal Childrens' Hospital Foundation, the Shared Value Project, the NHMRC Centre for Personalised Immunology and the ARC Centre of Excellence for Quantum Computation and Communication Technology.

Ms Anna-Maria Arabia is CEO at the Australian Academy of Science. Starting her career as a neuroscientist, Anna-Maria has worked internationally in scientific research, policy development and advocacy. Her leadership has led to significant reform at the science-policy interface. She has established novel mechanisms to facilitate evidence-informed decision making in parliaments and the justice system; spearheaded new approaches to science communication; and implemented global initiatives to make visible underrepresented scientists.

About the Panellists

Professor David Balding FAA is a statistical geneticist with a long history of giving expert evidence in the courts of Australia, UK and other countries. While his primary expertise is in the evaluation of DNA profile evidence, he has also advised on many other issues relating to statistics and probabilities in court. He was educated at Newcastle (NSW) and Oxford (UK), holds honorary appointments at the University of Melbourne and University College London and is a fellow of the Australian Academy of Science.

Ms Tracy Chapman is a lifelong friend of Ms Folbigg who became her leading personal advocate and, later, the face of the campaign through interactions with high-profile media commentators and journalists. Ms Chapman is completing a Masters in counselling and autism education, volunteers in wildlife rescue and runs animal therapy programs for people suffering from grief, trauma and chronic pain.

DATE/TIME:
Wednesday 14 August 2024, 6 - 7.15pm

PRICE:
$5 - $10

LOCATION:
The Royal Society of Victoria, Wurundjeri Country
8 La Trobe Street, Melbourne
(Simulcast on Zoom)

BOOKING LINK:
rsv.org.au/events/science-media-law

A joint presentation by the Royal Society of Victoria, the Australian Academy of Technology and Engineering, and the Australian Academy of Science, broadcast with the support of the Inspiring Victoria program.

Presented as a part of National Science Week in 2024.

The 2023 Soapbox Science team. Photograph: STEM Sisters.

Soapbox Science

Soapbox Science is a global initiative that promotes and showcases the work of women scientists to break down the barriers that prevent women from entering and progressing in science careers.

The format involves female scientists standing on a soapbox in a public area and giving short talks on their research to engage with the public in a fun and informative way. Soapbox Science events also provide an opportunity for female scientists to network and connect with others in their field, as well as gain experience in science communication.

Soapbox Science is also currently looking for speakers and volunteers. If you're a woman in STEM eager to share your research with the public, or wish to support a vibrant science outreach event as a volunteer, please get in touch!.

DATE/TIME:
Friday 16 August, 2 - 5pm

PRICE:
Free

LOCATION:
Forecourt, State Library Victoria
328 Swanston St, Melbourne

BOOKING LINK:
stemsisters.org.au/soapbox-science-melbourne

Linda Xu via Unsplash

National Youth STEM Summit

Are you 18-25 and ready to kickstart your career in science and technology?

- Gain insights from leaders in STEM from a diverse range of disciplines and career stages;
- Up-skill with workshops in communications and media, leadership, work-life balance & personal branding and interview skills;
- Connect with your peers and exchange ideas on the current trends in STEM fields;
- Network with business, government & senior representatives in the STEM sector;
- Celebrate NYSF's 40th anniversary at a Gala Dinner at the Australian Parliament House.

DATE/TIME:
17 - 19 August 2024

PRICE:
$295 - $625

LOCATION:
The Australian National University, Canberra

BOOKING LINK:
nysf.edu.au/programs/national-youth-stem-summit

RSV Events

The RSV hosts many STEMM-related events, public lectures, and meetings throughout the year. These are predominantly held at the RSV Building at 8 La Trobe St, Melbourne (unless otherwise indicated), and simulcast online via YouTube.

Our public lectures comprise the "Scientists in Focus" component of the Inspiring Victoria program in 2024.

Missed an RSV event?

You can catch-up on presentations from world-leading minds at **youtube.com/@RoyalSocietyVic**

Don't have time to watch a full presentation? Try one of the summary videos to catch the highlights.

youtu.be/JL6SiKT9jSI

Aiming Higher: Improving Science Education in Victorian Schools

youtu.be/_cWif2yGmH0

Space To The Rescue: Australia's Dependencies on Space Technology

youtu.be/CDE446enrt0

Holocene Climatic Fluctuations in the Australian Region

youtu.be/OdSsdcSUO0o

Reimagining Humanity in the Age of Generative AI

Awards & Prizes

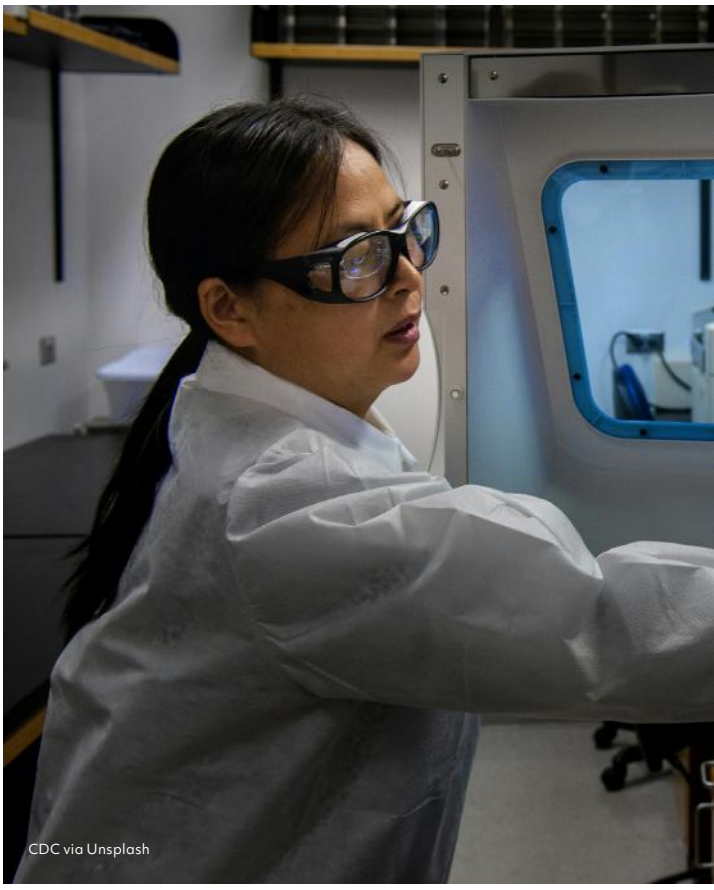
Postgraduate Mental Health Nurse Scholarship Program

APPLICATIONS CLOSE *15 July 2024*

The Department of Health funds 117 postgraduate mental health nursing scholarships per year. Each scholarship is up to $3,000.

Scholarship funds contribute towards the cost of undertaking postgraduate studies including:

- tuition fees, student contributions
- study loans (including HECS-HELP and FEE-HELP)
- books and equipment
- travel required to attend lectures and clinical placements
- childcare
- other related study costs.
- For more information, and to apply, **visit health.vic.gov.au/3000-postgraduate-mental-health-nurse-scholarship-program**



CDC via Unsplash

MRFF 2024 Early to Mid-Career Researchers Grant Opportunity

SUBMISSIONS CLOSE *24 July 2024*
MINIMUM DATA REQUIRED BY *26 June 2024*

The objective of this grant opportunity is to provide grants of financial assistance to support medical research and medical innovation projects that:

The objective of this grant opportunity is to provide grants of financial assistance to support medical research and medical innovation projects that:

Stream 1 (Incubator): conduct early stage, small scale research, led by early-career researchers, that seeks to assess the potential and feasibility of novel strategies to address a critical or intractable health issue in one or more Priority Populations.

Stream 2 (Accelerator): establish a large-scale interdisciplinary research program, led by mid-career researchers, that drives implementation of substantial improvements to health care and/or health system effectiveness for one or more Priority Populations.

Stream 3 (Targeted Call for Research): utilise co-funding between the MRFF, a sponsoring academic organisation and other organisation(s) to accelerate translation of research led by early to mid-career researchers.

- For more information, visit **grants.gov.au** and search **'GO6748'**.

Christin Hume via Unsplash

crcCARE High School Essay Competition

APPLICATIONS CLOSE *12pm, 31 July 2024*

The crcCARE High School Essay Competition aims to inspire students to recognise the importance of a clean environment to our wellbeing, and to understand how easily human activities can jeopardise environmental sustainability. crcCARE performs scientific research to help stop or clean up contamination of our soil, water and air. Your essay can help!

Who can enter and what can you win?

Entries are open to Australian school students in Years 7 to 12. The two best essays (one for each topic listed below) will be judged on writing quality, interest, newsworthiness, and scientific accuracy.

Winners will receive a cash prize and a trip to Adelaide for the CleanUp 2024 conference gala dinner on Tuesday 17 September 2024 (prize winners must be accompanied to the gala dinner by a parent/legal guardian, at their parent/guardian's expense).

How do I enter?

To enter, download the entry form and write an essay of 500 to 1000 words in either of two categories below:

The Dr Roneal Naidu Award - How can innovative technologies help clean up emerging contaminants, such as pharmaceuticals and micro-nano plastics, to protect human health and the environment? ($1000 prize)

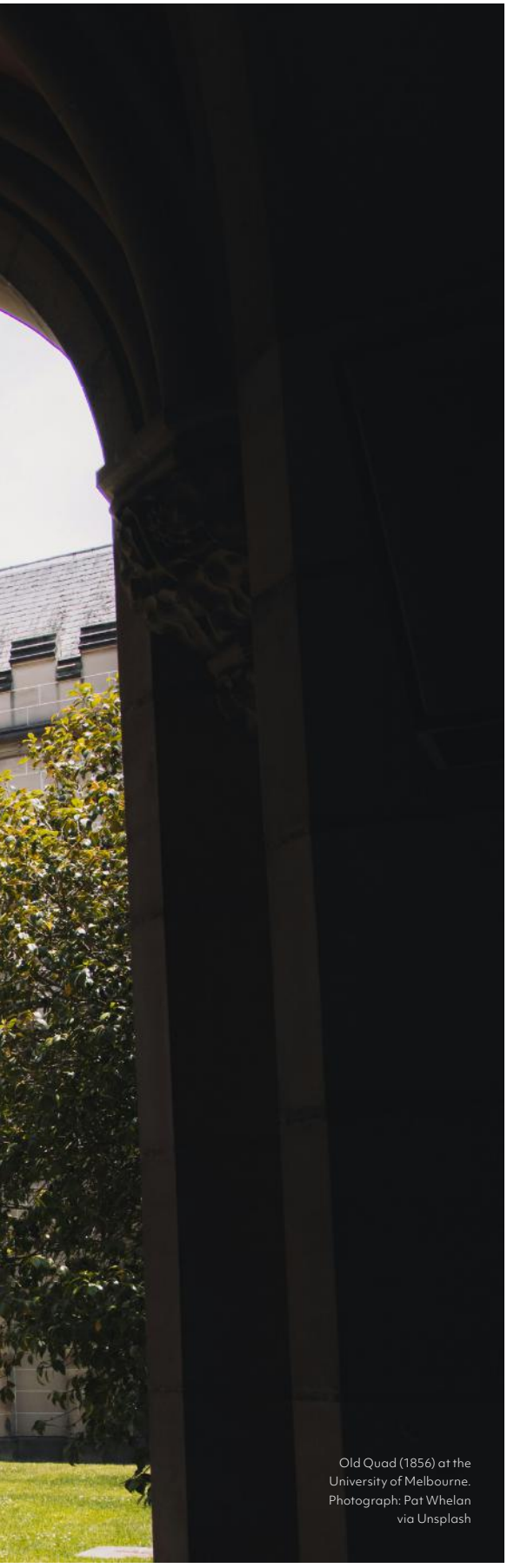
The crcCARE Award - How can packaging be redesigned to facilitate a circular economy, and can Indigenous knowledge help guide modern environmental practices? ($500 prize).

You are welcome to submit entries in both categories, but you are limited to only one (1) entry in each category.

Entries (comprising the completed entry form and the essay) should be emailed to Cintya Dharmayanti at Scientell (**cintya@scientell.com.au)** by 5pm on Wednesday, 31 July 2024.

- For more information, and to download the entry form, visit **adelaide2024cleanupconference.com/high-school-essay-competition**

> Graduates may have perfected the art of following assessment rubrics or rote-learning for exams, but are generally found lacking in communication, problem-solving, and critical thinking skills.



Old Quad (1856) at the University of Melbourne. Photograph: Pat Whelan via Unsplash

Building Scientific Competency in University Education

DR CATRIONA NGUYEN-ROBERTSON *and* **DR GIULIA IACONO**
Emerging Network Leaders in the Australian Academy of Technological Sciences and Engineering (ATSE) Education Forum

With an increasing number of global environmental and health challenges requiring innovative solutions to solve, Australia is going to need greater numbers of scientists, technologists, engineers, and mathematicians.

But Australia is in a STEM crisis. It has been for years.[1]

The low uptake of science and mathematics subjects by school students, and dwindling interest in STEM-related tertiary courses, has led to chronic shortages of skilled STEM professionals.[1]

It comes at a time when these subjects are playing greater roles in our lives, and economies. The Australian Universities Accord Report 2023 states that "Australia needs a more equitable and innovative higher education system" and that "significant changes are needed in Australian higher education" to equip Australians with the skills and knowledge needed to meet our current and emerging social, economic and environmental challenges.[2]

In light of the dire situation, what reforms are needed to build scientific competency at a tertiary level?

Fostering critical thinking

Completing a STEM-related university degree does not guarantee that graduates have all of the skills required to thrive in the workforce. There is increasing evidence suggesting that tertiary education does not provide students with the skills necessary to match the demand of current workplaces.[3] Graduates may have perfected the art of following assessment rubrics or rote-learning for exams, but are generally found lacking in communication, problem-solving, and critical thinking skills.[3]

Critical thinking is the systematic process of analysing and evaluating information, in order to form well-reasoned conclusions and decisions. It is a core part of effective problem-solving, and is assisted by creative thinking to generate unique or innovative solutions.

It doesn't help that students may not have solid foundational skills when they commence their tertiary studies. Unlike many other countries (including New Zealand, the USA, and China), Australia does not mandate the study of mathematics or science through to the end of secondary school. This means that fewer than 30% of Australian Year 12 students are currently studying intermediate or higher mathematics.[4] More students are entering university, but lacking a sufficient foundation in STEM, and experience utilising critical thinking skills.

To better match current requirements of STEM work practice, students need to be challenged with course content and assessments that will encourage them to develop critical thinking and analytical skills. As one example, this could be achieved by designing assignments based on real-

world scenarios and datasets, which hold all of the real-world complexities they will encounter in the workplace.

More emphasis needs to be placed on the value of critical thinking skills. The University of Queensland Critical Thinking Project, for example, assists teachers to embed critical and creative thinking within their classes.[5] While this project mostly targets primary and secondary school, the positive outcomes for students are clear: over 90% of students participating in the "Effective Thinking and Writing" subject express greater confidence in their thinking and writing skills, and greater preparedness for their future studies.[5] The University of Melbourne has also implemented "Discovery Subjects" across each undergraduate degree, which are not content-based, but instead encourage students to solve real-world problems and assess their process.

While STEM industry sectors certainly need to be more vocal about this skill shortage, it is the responsibility of universities to develop curricula in better alignment, and put more weight on merit and achievements that reflect the required skill sets (e.g., effective project management, leadership and collaboration, application of transferable skills across disciplines, and critical thinking to solve multifaceted problems). An example of this is the Graduate Research Industry Partnership (GRIP) program developed by Monash University, where PhD students undertake a government or industry-based research project aimed at solving current Victorian issues.[6]

Increase academic standards

Teaching academics can occasionally be caught between their role as educators, and their role as an employee of a money-making business. Lecturers and tutors are grappling with a tide of academic misconduct, and pressure from their superiors to award passing grades to poor-performing students, so that these fee-paying students continue to generate revenue for the university.

An investigation by ABC TV's Four Corners program in 2015 unearthed alarming evidence of a decline in academic standards at institutions around the country.[7] With universities depending on the income derived from international students, they tend to overlook the fact that many do not have the English proficiency needed to successfully undertake their studies.[7]

The question is: has anything changed since 2015?

With global university rankings being based primarily on research output and not on teaching quality, universities have less pressure to demonstrate educational outcomes. The Academic Ranking of World Universities – the first global ranking system – focuses its ranking on research excellence, favouring the natural sciences, research indicators, and emphasis on institutions that have been awarded Nobel Prizes, over teaching quality or graduate employability.[8] The Times Higher Education World University Rankings emerged in 2010 to factor the quality of teaching and the learning environment, but it still places a high importance on citations when assessing a university.[9]

More emphasis needs to be placed on the quality of teaching and learning among global university rankings. This would force universities to adapt, in order to ensure that they remain highly ranked.

ABOVE: Swinburne University, Hawthorn Campus. Photograph: Widhi Rachmanto via flickr (CC BY 2.0).
LEFT: RMIT University, City Campus. Photograph: Akshay Chauhan via Unsplash.

Moving away from "trial by fire"

Tertiary students are no strangers to psychological anxiety. A heavy workload, rising living costs (and therefore managing employment while studying), and familial separation all have an impact on emotional wellbeing. Many students find the jump between secondary and tertiary education both academically and emotionally challenging.

The rate of students completing their degree within six years hit a record low in 2022.[10] In addition, Australian Tertiary Admission Rank (ATAR) scores that students receive upon completion of secondary studies are predictive of tertiary attrition: students with ATARs below 60 are twice as likely to drop out of university compared to students with ATARs above 90.[10]

Unsurprisingly, meaningful support for students makes a big difference. Several studies have observed that support from family, teachers, and the institution itself, is often one of the reasons why students regain their motivation and continue their studies, even when they have academic difficulties.[11]

Graduate students (pursuing Honours, Masters, or a PhD), who have only experienced the confines of lectures and practical classes, tend to be quickly thrown into the deep-end of academia. They are suddenly expected to deeply understand and critique the current literature, excel in their science communication skills, and publish their research in high-impact academic journals.

For many, this can be overwhelming.

A survey of over 2,000 students worldwide revealed that more than 40% of Masters and PhD students experience moderate to severe anxiety and symptoms of depression.[12] If that wasn't enough, more than 60% of full-time Australian students have to juggle their studies with working a second job to supplement their income, resulting in 30% of university students taking over 8 years to complete their degree.[13]

It is a challenging transition from being an undergraduate student, where rote-learning and cramming information before exams is often enough to succeed, to becoming a graduate student, expected to adapt quickly to research-based learning and the pressures of academia.

It is therefore encouraging that there has never been more help available to students. Universities now provide a wide range of resources and support systems to help students overcome a potentially stressful and isolating period. For example, the Monash University introductory academic program provides international students with all the writing, reading, and research skills needed to undertake an academic degree at an Australian university.[14] For students already enrolled, the University of Melbourne has established the Honours Alumni Mentor Program, pairing Honours students within the Faculty of Medicine, Dentistry and Health Sciences with PhD candidates who have previously navigated the transition themselves.[15]

Connecting the disconnected teaching environment

Academics are generally required to divide their time between three main tasks: research, teaching, and community service. While teaching responsibilities depend on a person's position – e.g., associate lecturers and lecturers are generally expected to spend more time instructing students – many academics juggle teaching multiple units in parallel with undertaking research.

Many academics are therefore expected to provide students with an annual lecture despite having very little teaching experience. They may not be up to speed with current teaching practices, and their lecture might not be consistent with the other content of the unit. For subjects taught by multiple lecturers, the incongruity between content and teaching styles can make the subject matter more challenging to learn.

Teaching involves more than simply delivering classes. It also involves the preparation of classes, administering and marking assessment tasks, and providing students with academic support and guidance throughout their course. Generally, academics are also expected to support the reputation of their host university by engaging in research and publishing their findings in reputable journals.

Specific teaching academic roles in Australian universities have risen, allowing for better separation of teaching and research.[16,17] The rise of these teaching-only roles in Australia and other countries (including Canada, the UK, and the USA) is driven by the rapid growth of student numbers in higher education and research-focused university rankings. This is

Monash University, Clayton Campus.
Photograph: rushwright.com via flickr (CC BY 2.0).

considered a win-win: researchers don't have teaching commitments that take up their time, while teaching specialists can deliver streamlined courses and develop rapport with students across a semester.

STEM skills are crucial for Australia's changing future. We need more STEM professionals to transform our energy grid, to advance our manufacturing sector, to make our agriculture and transport more sustainable, and to drive new discoveries and innovations. Our education system needs to support this growing need. While the STEM crisis is by no means an issue to only tackle at a tertiary education level, we need to ensure that we create teaching and learning environments at universities that support students to study STEM.

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Aiming Higher

Improving science education in Victorian schools

DR CATRIONA NGUYEN-ROBERTSON
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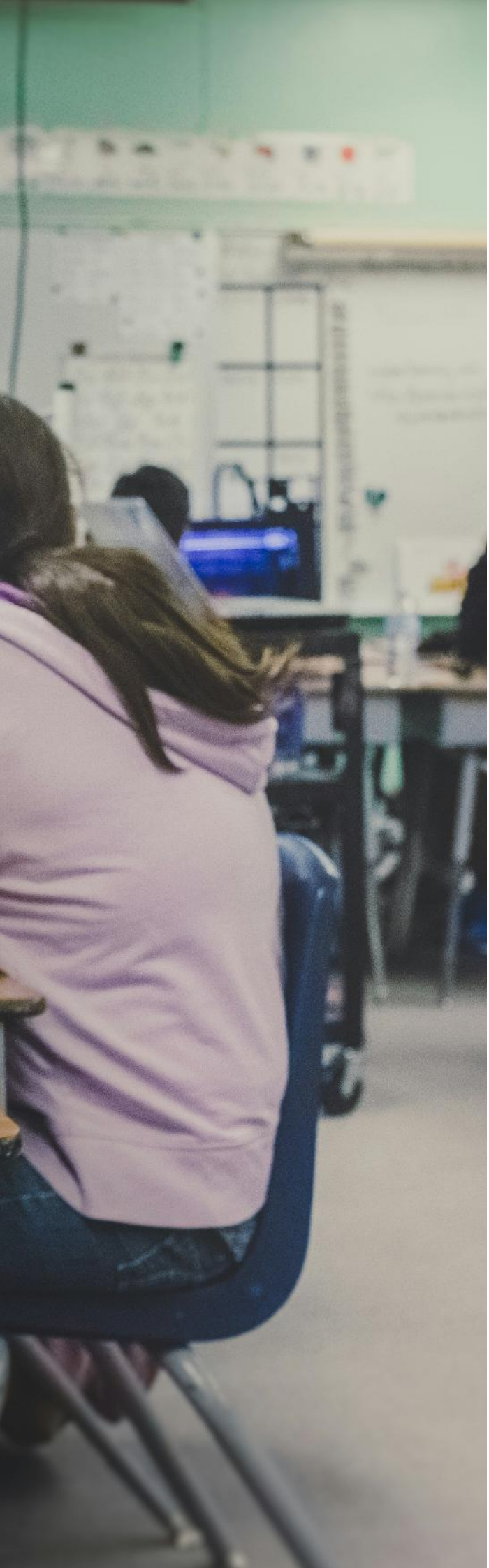
Photograph: Kenny Eliason via Unsplash.



The world is changing. Automation, technological advances, and globalisation are changing the way we define careers and even live our lives. Entire job sectors are emerging, changing, or disappearing. People will increasingly change professions during their career, and even have multiple professions simultaneously.

Similarly, we need to adapt our skill sets for the changing world and workforce. Future careers will rely heavily on '21st century skills': critical thinking, creativity, collaboration, and problem-solving.[1] STEM education lays the foundation for these skills, as well as the ability to understand and utilise data and information.

However, people often don't necessarily appreciate the importance of STEM and these vital skills until it's too late – when they already need to be confidently using them. Australian school students' participation in science and maths is declining or stagnating.[2] Year 12 enrolment in science and mathematics subjects dipped in 2019, and still hasn't returned to what it was.[3]

Multiple factors play a role in influencing participation in STEM education

Students are exposed to STEM and science identities (whether students can see themselves as "science people") differently at different stages in their schooling. In addition, parent or guardian attitudes towards science can influence their children's science achievement – and there are a number of factors connected with a parent's perceptions and attitudes towards STEM.

The 2022–23 STEM Influencer Survey showed that STEM engagement is higher among parents from metropolitan locations, compared to those from regional and remote locations. It is also higher amongst parents from higher socioeconomic (SES) areas compared to parents from lower SES areas.[4]

When students see people like themselves underrepresented in the STEM workforce, or feel unsupported or unsuccessful in the space, they may be less likely to aspire to STEM careers.

By age six, some students already will have lost interest.[5]

When looking at overall numbers, the gender divide paints a positive picture: the proportion of STEM subject enrolments from girls has increased over time. From 2013 to 2021, the proportion of STEM (including health) enrolments by girls increased from 48% to 51%.[3]

However, their enrolment in maths has remained stagnant at ~48%, and women remain under-represented in information technology (24% of enrolments in 2021), physics and astronomy (24%), and engineering and related technologies (23%, down from 26% in 2013).[3]

The gap in STEM achievement between First Nations and non-First Nations students has remained steady over the past 20 years. First Nations students have lower STEM engagement and tend to have poorer performance (e.g., 68% of First Nations students scored below the international maths

The FlushBack augmented reality (AR) adventure is used to teach science and history in the Spotswood Pumping Station. Photograph: Dr Catriona Nguyen-Robertson.

standard in Year 8, compared to 34% of non-First Nations students scoring below, with a similar gap seen in results for science).[5]

Students from a low socio-economic status (SES) background are also more likely to have negative perceptions of STEM, and are less likely to pursue STEM beyond high school. SES can affect access to quality education (e.g., affordable school options), resources (e.g., additional tutoring and technologies), and extracurricular opportunities. A typical 15-year-old Australian from a low SES background is three years behind in mathematics and science compared to their high SES peers.[5]

Remote, rural, and regional students are similarly falling behind in STEM education.

These factors often do not work in isolation, and they all impact interest and performance in STEM education. "Students' demographics shouldn't be predictors of their science participation to the extent that they are," says Professor of STEM education at RMIT University, Prof. Amanda Berry. "But the reality is that they are."

Teachers and schools also play a crucial role in shaping student participation and success in STEM education. By creating an inclusive and supportive learning environment, teachers can encourage students to actively engage in STEM, helping students overcome barriers to their participation.

But teaching STEM is no easy feat for teachers.

Although 98% of Australian educators (whether or not they teach STEM) believe that STEM skills and literacy are important, and 89% believe that they will provide future job security, fewer have confidence in teaching them.[6]

It does not help that there has been an overwhelming amount of scientific knowledge generated in recent times – it is simply impossible to cover everything.

"Topics that were included in the 1900 science curriculum were similar to my 1970's education – but with new topics added," says Prof. Jan van Driel, Professor of Science Education at the University of Melbourne. With even more content crammed in in the decades since, educators often have no choice but to decrease the amount of time they spend on each topic and only cover them superficially.

Textbooks also have a lack of a "hook" to draw students into topics and keep them interested. By moving away from textbooks, and instead connecting curriculum content with real-world concepts and applications, or providing more tailored resources, students may be more engaged.

Teachers are required to adhere to a curriculum that outlines individual subjects. While primary teachers can incorporate different learning areas in their lessons, secondary teachers find it difficult to implement a more integrated approach to STEM education at a secondary level.[7]

This kind of approach would help students to tackle problems more holistically, and better understand links between disciplines and the relevance of STEM beyond what is taught in the classroom.[7]

We can tackle the stagnating interest in STEM education from multiple angles

While teachers have finite time and resources to bring contemporary scientific content to the classroom, they could partner with experts through school-industry partnerships, public institutions (e.g., museums and zoos), or volunteer programs (e.g., BrainSTEM, In2Science, and Skype a Scientist).[8]

Additionally, when educators frame the students' learning around investigating problems, students can learn as they go rather than having the facts laid out for them. It could be anything from designing a greenhouse for the school garden, to designing a solution to a local council or industry problem. Victoria's Tech Schools, for example, provide free programs for local school students to use their facilities (e.g., 3D-printers, laser cutters, etc.) to design prototypes to solve real-world challenges mapped to the curriculum.[9]

Advances in technology provide additional tools that can be adopted in the classroom. Simulations, games, augmented reality (AR), and virtual reality (VR) can enhance the learning experience. Using AR tools or VR headsets, students could attend virtual excursions around the world, out in space or inside the human body, visit historical locations, and conduct experiments. These technologies apply "gamification" (adding elements found in games) to classical education, making the process more engaging and accessible.

Lastly, public perceptions of teachers and what it means to be a STEM educator need to change. Being a teacher is stressful – 76% of Australian teachers experience significant stress during the work week – and it also gets a bad rap.[10] An analysis of over 65,000 print media articles from 1996-2020 revealed that teachers are predominantly negatively portrayed.[11] "Teacher bashing" is unfortunately not uncommon, and people consider teaching a "cushy" profession.

It's no wonder so many teachers consider leaving the profession. COVID-19 exacerbated the problem, with the percentage of teachers planning to or considering leaving jumping from 58% in 2019 to over 72% in 2022.[12]

Unsurprisingly, the COVID-19 lockdowns did grow public appreciation of teachers: more than 40% of Australians have greater appreciation for the teaching profession after the transition to online learning.[13]

To aim higher for science education, we require a multifaceted approach that addresses the diverse needs of students, integrates relevant content, and provides robust support for teachers. STEM can too often be perceived as "too difficult" or not interesting by students throughout their education if they become disengaged or cannot see its relevance.

Recognising the impact of demographics on participation in education is crucial to create targeted strategies to ensure equitable access and engagement. Implementing more contemporary and integrated approaches can make science more accessible and exciting, bridging the gap between theoretical knowledge and real-world applications.

Furthermore, empowering teachers through resources and support systems is essential for fostering an environment where all students can thrive. By addressing these key areas, we can build a more inclusive, effective, and inspiring STEM education system now, and for future generations.

- *This article follows an event co-hosted by the Royal Society of Victoria, Australian Academy of Technological Sciences and Engineering, and Science Teachers' Association Victoria, supported by the Inspiring Victoria program. The event featured Prof Amanda Berry (Professor of STEM Education, RMIT University) and Prof Jan van Driel (Professor of Science Education, The University of Melbourne), with panellists Alexandra Abela (President, STAV) and Dr Brendan Rigby (Director, Tech Schools).*
- *Watch the full presentation online at **youtu.be/s94ZMWhdxIs**, or a 10-minute summary at **youtu.be/JL6SiKT9jSI***

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Systems Thinking

Weather change & weather resources will decide Australia's future in a warming world

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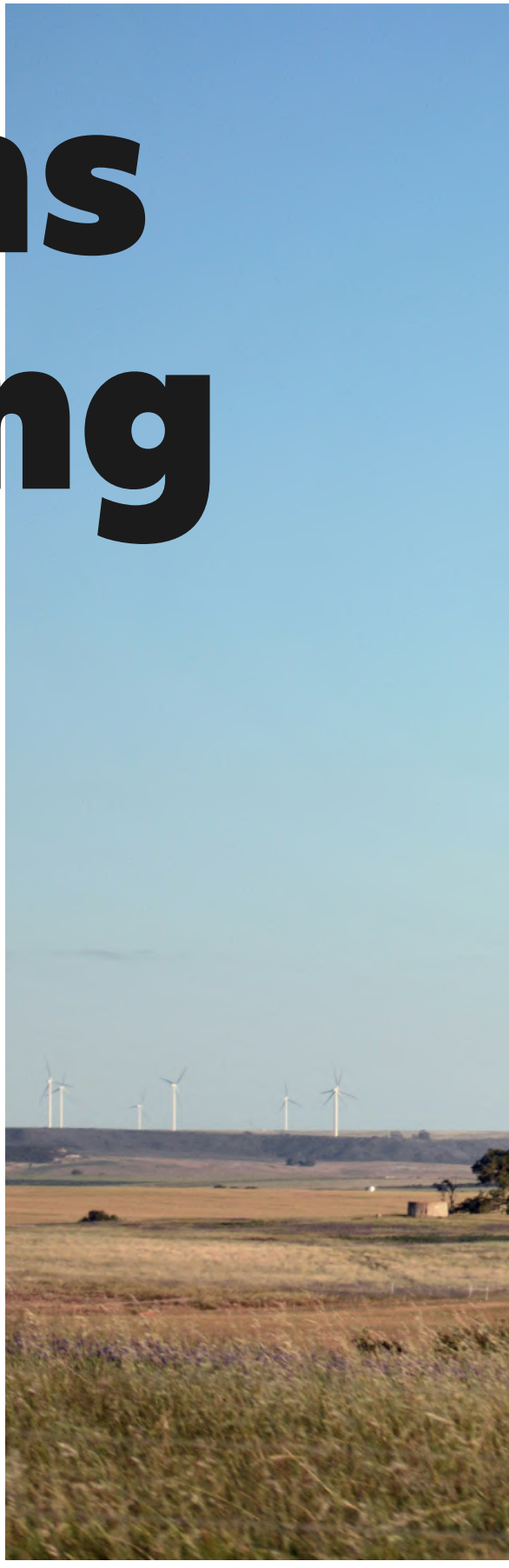

What will a typical Australian summer look like in 2060? How can we maximise the potential of our rapidly growing renewable energy infrastructure? And how will high-impact weather, like storms, floods, and droughts, change in a warming world?

While we know human-driven climate change is occurring, the picture of what *exactly* that will mean for Australia in the coming decades is unclear. Climate models created in the United States and Europe lack the local data and specificity to provide good insight into what we can expect here.[1]

What is clear, though, is that we're already experiencing climate change as a change in our weather. Shifting energy production from fossil fuels to clean, renewable sources of energy is an essential part of mitigating and adapting to the changing climate. The output of renewables like solar and wind are dependent on weather. As such, they constitute *weather resources*. How can we build new wind farms if we don't know where strong, consistent winds will be in the future? How can we make informed decisions about new water catchment and storage infrastructure without more accurate and precise data about future rainfall frequency and intensity?

Currently, it's hard to answer these questions, because translating 'climate change' into weather change remains a major challenge for Earth System sciences.[2]

Wind turbine, Geraldton, WA.
Photograph: Kshithij Chandrashekar via Unsplash.

Melbourne's Maribyrnong River flooded in October 2022, following unprecedented rainfall. The changing climate means increased chance of flooding, putting hundreds of homes and businesses at risk of inundation. Photograph: Ian Melton via Unsplash.

A new research initiative

The ARC Centre of Excellence for 21st Century Weather was established in 2024 as a consortium of 24 organisations, led by Monash University in partnership with the University of Melbourne, the University of New South Wales, the Australian National University, and the University of Tasmania. Its goal is to answer these questions, and equip Australian governments, businesses, and communities with the information they need to make informed, evidence-based decisions about climate change, high-impact weather and the future of our weather resources.[3]

The Centre has partnered with government and industry organisations, including the Bureau of Meteorology, CSIRO, the federal Department of Climate, Energy, the Environment and Water (DCCEEW), and the state Department of Energy, Environment and Climate Action (DEECA).[4] By co-designing our research with the end users, we will ensure that elected officials, policy-makers, civil servants, and businesses have the bespoke information and expertise they need to take meaningful action.

To enable Australia to navigate this century's climate and weather challenges with confidence, two major problems must be overcome: we need better understanding of atmospheric circulation change, and to develop more accurate, high-resolution climate modelling.

Atmospheric circulation change

The weather we experience near the Earth's surface – the wind, the heat, the rain – is created by the movement of air in our atmosphere. Clouds and rainfall occur in regions where air is laden with moisture, while clear skies are the result of calm, dry air.

Atmospheric circulation transports heat around the Earth's surface, and it is affected by incoming solar radiation, the Earth's rotation, and the distribution of continents. The atmosphere both shapes and is shaped by the circulation of the oceans.

Human-driven climate change is altering the way that atmospheric and oceanic circulations combine to create weather systems.

The traditional approach to climate science studies weather, climate variability, and global climate change separately. Yet it is the interactions between these parts that provide the greatest potential for scientific predictions of future weather change.

There are several gaps in our knowledge that must be closed to fully harness the advantages of a weather-systems approach to understanding the climate of Australia and how it is changing.

First, the weather systems of the 'mid-latitudes' – between the Antarctic Circle and the Tropic of Capricorn, and between the Arctic Circle and the Tropic of Cancer – are fundamentally different from those in tropics (around the equator). As the Australian continent covers both these climatic zones, we need new approaches to describe weather systems across them.

Second, existing algorithms to objectively detect and track weather systems are generally limited to a single weather feature, such as a heatwave or weather front, yet it is important to consider a more complete picture of the weather.[5,6,7]

Climate change brings greater risk of extreme weather events, like the flooding experienced in 2022. Photograph: Wes Warren via Unsplash.

To address these challenges, among many other new approaches, researchers will:

- Develop innovative algorithms to detect and track weather systems in the Australian region.
- Develop a comprehensive understanding of the physical and dynamic processes that determine weather system behaviour.
- Develop the first-ever definition of continent-wide Australian weather regimes through a unified tropical/extratropical circulation framework.

Ultra-high-resolution climate modelling

Climate models are a key tool to understand the Earth's climate and its future. These are computer programs that simulate climate or weather patterns over time, and can estimate the Earth's climate under different conditions by running simulations.

The climate system is made up of varying factors such as rain, wind, temperature, humidity, and solar radiation. Climate models are similar to weather prediction models, using mathematical equations to describe each component of the climate and how they interact, like the movement of the air in the atmosphere, or the exchange of moisture between the ocean, land and atmosphere.

Using advanced supercomputing facilities, climate model simulations enable us to understand how the different components of the earth's climate interact and are changing. They allow us to test ideas and measure how our actions or decisions will change the climate in the future. For example, what happens if we increase greenhouse gas emissions, or revegetate landscapes?[8]

The Australian Community Climate and Earth System Simulator (ACCESS) is one of the climate models used worldwide to collectively provide an understanding of weather change at continental and global scales, but improving the models we work with is fundamental to improving our ability to understand future weather change.[9] One particular issue with existing climate models is they cannot faithfully represent the key interactions between weather and climate that are so important to determining the future of our weather.

In response, 21st Century Weather and its partners are developing new, ultra-high-resolution climate models based on the ACCESS modelling framework. With a more accurate and precise modelling system, we will be able to represent physical processes in the atmosphere, on the land, and in the ocean at very fine scales, over a wide area. This will allow us to explore the links between climate variability (like the oscillation between El Niño and La Niña) and the weather (such as thunderstorms).

Albany Wind Farm, WA. Photograph: Harry Cunningham via Unsplash.

To develop the modelling systems that will underpin the Centre's research, scientists will need to better understand how the atmosphere, ocean, and land influence each other, as well as managing the computational and big data aspects of running such models. The size of the task is enormous. Australia's oceans and climate variability, for example, are modulated by the Pacific, Indian, and parts of the Southern Oceans. The modelling systems must therefore focus on small scales, while also considering the influence of important processes that occur over larger regions or the entire globe.

Building ultra-high-resolution models will require us to combine scientific discovery with the large-software systems that are climate models, as well as the most advanced high-performance computing and big-data handling capabilities, and advances in artificial intelligence.

Weather resources

We often think about 'bad' weather such as destructive storms or heatwaves, but what about 'good' or 'useful' weather?

The Centre will have a strong focus on weather resources, such as the wind and sun that are used to generate renewable electricity. For example, we know that certain parts of Australia have some of the 'best' wind energy resources in the world, but how do weather systems influence the wind that we can harness?[10] How will these weather systems change as our planet warms? Will there be more wind-droughts and/or cloudy days, and how might this affect our electricity production?

Scientists within the Centre will endeavour to understand how the wind resource varies in coastal areas, and the interplay between renewable resources and electricity demand.

Achieving future climate resilience requires us to transform our thinking of "climate change" to "weather change". Australia's adaptation to a changing climate needs to be informed by the highest quality data and models. How will our changing weather impact our economy and community? It is the day-to-day variations in local weather that constitute resources and hazards to our society.

Researchers at 21st Century Weather will help to protect the economy, to inform investment in effective adaptation and risk mitigation, and to establish a knowledge-based decision-making mechanism for a prosperous future.

High-impact weather

Floods and droughts are a challenging fact of life in Australia, but weather events don't have to be extreme to have a big impact on us. For example, unexpected absence of wind over a long period of time or prolonged cloud cover won't put lives at risk, but they will significantly impact Australia's renewable energy generation capacity.

We define high-impact weather as those events that pose either a large risk or provide a large benefit to communities, businesses and governments, or the natural environment.

As the Earth's climate is warming, high-impact weather events are undergoing fundamental changes at a time when our reliance on them is growing as we decarbonise our economy. Owing to the complexity of the climate system, weather changes do not relate to increases in global mean temperature in a straightforward way. Instead, they are the result of an intricate interplay of thermodynamic and dynamic changes in the climate system and are strongly coupled to circulation changes). Understanding the nature of high-impact weather events and how they change in a warmer world is a key focus of our research.

For example, warmer than usual sea surface temperatures to the north of the Australian landmass can lead to more moisture being carried through the air, contributing to flooding events on the east coast. However, the current models used to analyse these dynamics aren't advanced enough to include representations of some tropical processes, like warm air rising, which leads to thunderstorms.

More accurate climate models will help us identify and understand the high-impact weather that Australia is already seeing more of, and which is likely to escalate over time. By understanding the two-way interaction between local high-impact weather, with wider weather regimes and large-scale planetary circulation, we aim to get a better understanding of local and global weather systems.

Whether it's a lack of wind or an abundance of low cloud and fog that inhibits renewable energy sector expansion, or the torrents of rain that cause flash flooding and infrastructure damage, our research will help prepare Australians for the future of extreme weather.

Future forecasting

Knowing the future of our weather in a changing climate matters. It provides the resources for the weather-fuelled, net-zero economy that we need to build to combat the worst effects of climate change. The teams at the ARC Centre of Excellence for the Weather of the 21st Century are providing the insights needed to better prepare our economy and communities for the changing weather ahead.

► *This article was made possible with contributions from 21st Century Weather researchers Prof Christian Jakob, Prof Sarah Perkins-Kirkpatrick, Dr Andrew King, and Dr Claire Vincent.*

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Dem Bones

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Editor-in-Chief, Science Victoria

Fossils are nothing new. While our present ability to find, extract, and study the fossilised remains of animals and plants is better than ever, fossil discoveries have been recorded throughout human history.

The Ancient Greek author historian Herodotus (484-425 BCE) wrote of fossilised shells he observed in Egypt.[1]

Chinese polymath Shen Kuo (1031-1095 CE) discovered fossilised bamboo in a region that bamboo wasn't ever known to have grown, and hypothesised that the climate had changed over time.[2]

In the 1800s, the recovery and study of fossils accelerated, and became professional scientific pursuits. The word *palaeontology* was coined, and the fossil record formed part of the supporting evidence for the theory of evolution by natural selection.[3,4]

In Australia, the 19th and 20th centuries saw fossils unearthed in every corner of the continent, finding their way to museums, universities, institutes, and private collections around the world. While these fossils reveal much about the history of life in and geology of Australia, it can take many years from their discovery before they are studied in any detail.

Thinking big

The term megafauna typically refers to "big animals" that came after the dinosaurs, with living examples including elephants and hippopotamuses. While the most well-known extinct examples are the woolly mammoth, megalodon, and giant sloth, Australia's fossil record shows that it was once home to a unique collection of massive animals.

Diprotodon (*Diprotodon optatum*) was the largest marsupial known to have existed, looking like a 3-tonne wombat.[5] Hackett's giant echidna (*Murrayglossus hacketti*) was roughly the size of a large dog.[6] Australia also boasted several species of 'marsupial lion' (*Thylacoleo* spp.), with *Thylacoleo carnifex* being the largest carnivorous mammal to have ever existed on this continent.[7,8]

In the 1975 edition of the *Proceedings of the Royal Society of Victoria*, evolutionary biologist Max K. Hecht provided the detail for another unique Australian megafauna, in his article "The Morphology and Relationships of the Largest Known Terrestrial Lizard, *Megalania prisca* Owen, from the Pleistocene of Australia".[9]

Putting the pieces together

Megalania (*Varanus priscus*) was a relative of goannas (various *Varanus* spp.) and Komodo dragons (*Varanus komodoensis*). The first part of Hecht's study was to find and examine the scattered Megalania fossils.

"Material of Megalania is widely distributed in museum collections. The best was obtained during the late 19th century from the east Darling Downs [south-east Queensland] and sold by the local inhabitants to various museums."

"Megalania is now known from the collections of the Queensland Museum, Australian Museum, South Australian Museum, British Museum (Natural History), University of California Berkeley Museum of Vertebrate Paleontology, American Museum of National History (AMNH), Hunterian Museum of University of Glasgow, National Museum of Victoria, and Western Australian Museum."

From these collections, Hecht was able to then describe every part of the animal's skeleton. In turn, this allowed him to compare Megalania to other species, and also make some assumptions about the animal's dimensions, overall size, and even its ecological role.

"It was the largest terrestrial lizard, attaining a maximum body length of five m and two or three m tail length and an estimated maximum weight of about 600 kilograms."

"Megalania was probably the important predator of the large diprotodontid herbivores [i.e., Diprotodon] and giant ground birds of the Australian Pleistocene [11,700 – 2.6 million years ago] and became extinct along with this associated fauna."

If you want to get up close with Australia's largest lizard, a cast of a Megalania skeleton is on display at Melbourne Museum.

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OPPOSITE:
An artist's rendition of Megalania (*Varanus priscus)* hunting Bullockornis (*Dromornis planei),* a prehistoric bird that shares an ancestor with modern ducks and geese. Source: Peter Trusler/Monash University via flickr (CC BY-NC-ND 2.0).

Inspiring Victoria

inspiringvictoria.org.au

The Inspiring Australia strategy was developed by the Australian Government to increase general engagement and interest in the sciences by Australians. The *Inspiring Victoria* program is jointly funded by the Australian and Victorian governments with the Royal Society of Victoria (**rsv.org.au**).

Inspiring Victoria encourages involvement in STEM through initiatives (such as National Science Week Victoria - **scienceweek.net.au/your-state/vic**) that are governed and delivered by the RSV's program partners:

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stav.org.au

A photograph of a Bogong Moth, spotted in Bimberi, NSW. Uploaded to Moth Tracker by Moth Tracker Woo in 2022.

Moth Tracker

Citizen science to help the Bogong Moth and Mountain Pygmy-possum

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Senior Conservation Biologist, Zoos Victoria

ESTELLE VAN HOEYDONCK
Conservation Campaigner, Zoos Victoria

And **HANNAH SLY**
Senior Reporter, Healesville Sanctuary, Zoos Victoria

The Bogong Moth (*Agrotis infusa*) is an Australian icon. While it is small, around 25-35 mm long, and weighing an average of 0.33 g (less than a Tic Tac!), the species manages an epic annual migration.

The moths travel up to 1,000 km from their breeding grounds in southern Queensland, NSW, ACT, western Victoria, and South Australia, to the alpine zones of Victoria and New South Wales every spring.[1,2] They make an equally impressive migration back to their breeding grounds each autumn to lay their eggs, feasting on native flower nectar and pollinating plants along their route.

However, a collapse of the Bogong Moth population by an estimated 99.5% has placed them – and the alpine species which rely on them, like the Critically Endangered Mountain Pygmy-possum (*Burramys parvus*) – in peril.[3]

Prior to 2017, there were estimated to be around 4 billion moths migrating annually, with people recalling swarms of these little moths blocking out the stars and moon when they travelled overhead.[2] Bogong Moths spend their summers in cool boulder-fields, and dark caves, where they nestle over each other like tiles on a roof. There can be up to 17,000 moths per square metre lining cave walls.[4]

The moths use a combination of visual landmarks, light on the horizon, and Earth's magnetic field to navigate on their migration.[5] Previously, such nuanced navigation and sophisticated migratory abilities were thought to occur only in vertebrates, but a handful of invertebrates like the Bogong Moth, and internationally the Deaths-head Hawkmoth (*Acherontia atropos*), have proven invertebrates are just as remarkable.[6]

The annual arrival of the Bogong Moths brings the second biggest influx of nutrients into the alpine zone, beaten only by the sun.[1] The nutrition from these magnificent moths nourishes everything in the ecosystem, via their consumption by predators.[1] The arrival of the moths is also culturally important: for thousands of years, First Nations people travelled to the alpine zones to meet, celebrate and feast on the bountiful moths.[7]

What went wrong?

There has been a long-term decline in Bogong Moth numbers since around 1980, due to threats from agricultural practices including land clearing for crops, irrigation (a key issue as moth eggs and caterpillars live on/under-ground), and increased use of damaging insecticides. Further threats include increased light pollution that disrupts the moth's migration, direct poisoning of moths when they are drawn away from their migration by the bright lights (e.g., to buildings and city centres), destruction of habitat and flowering food plants on their migration routes, introduced predators, and a warming/drying climate.[2]

There was a catastrophic collapse of the Bogong Moth population in 2017 and 2018, which was likely due to the widespread and devastating drought across south-eastern Australia in their breeding grounds. In some regions, this was the worst drought in recorded history.

In December 2021, the Bogong Moth was added to the International Union for Conservation of Nature (IUCN) Endangered species list.[8]

The catastrophic decline of the Bogong Moth is not only devastating for the moth itself, but affects a wide range of species and ecosystems. One species whose survival is closely intertwined with the moth is the Mountain Pygmy-possum. There are likely fewer than 2,000 of these tiny possums left in the world.

Bogong Moths are a rich source of fats, protein, vitamins, and nutrients, and are a critical food that Mountain Pygmy-possums consume in spring after they wake from their annual winter hibernation, before breeding and raising their young.[9]

Work by members of the Mountain Pygmy-possum Victorian State Recovery Team showed that in the worst years, females were often underweight, and could not produce enough milk for their young. Over 50% of female Mountain Pygmy-possums in monitored Victorian populations lost their full litters, and in the largest and worst affected population, 95% of females lost all their young. Post-mortem analyses did not show any disease, illness or injury. They simply starved.[10]

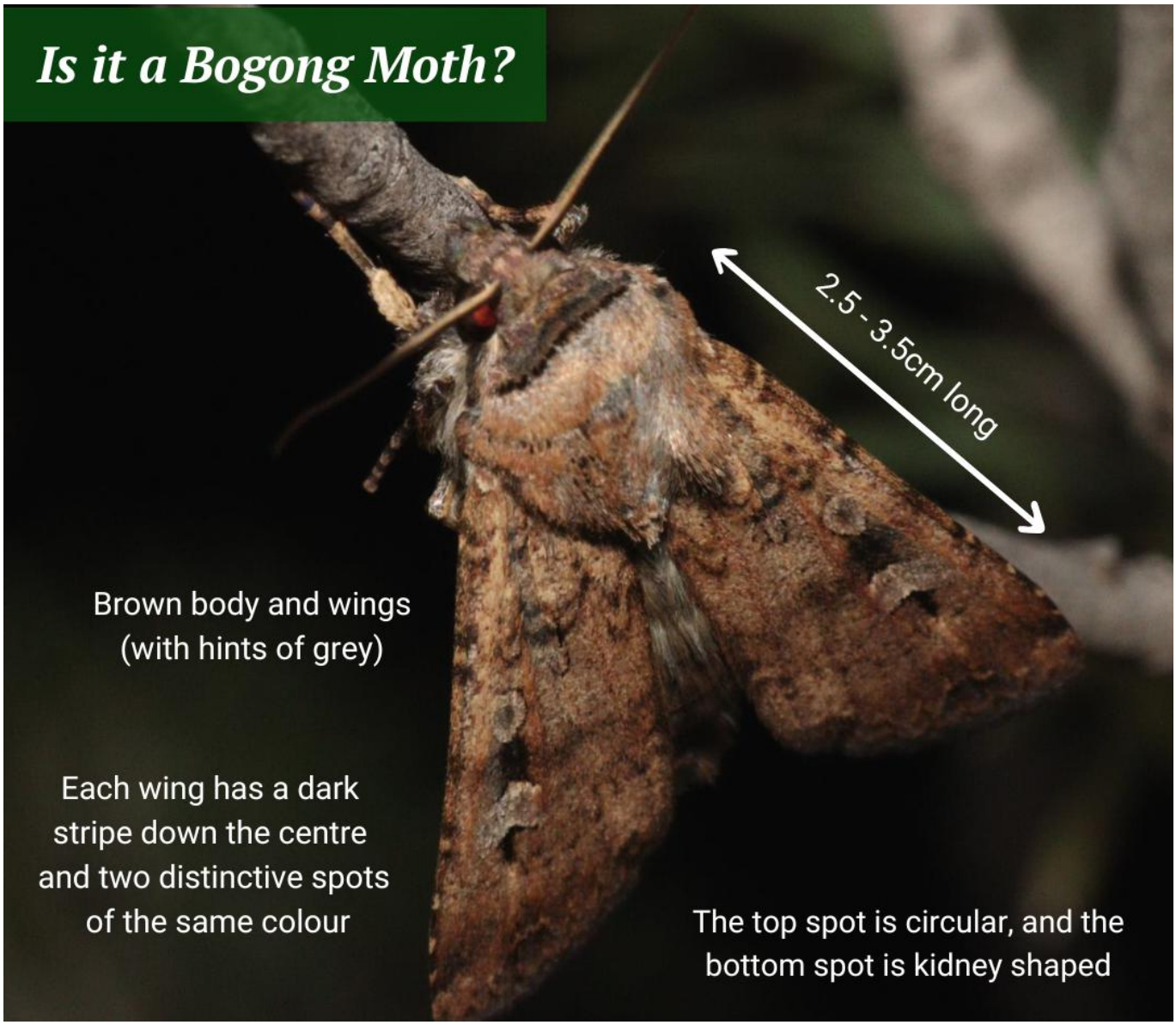


Image: Zoos Victoria.

A Mountain Pygmy-Possum with a Bogong Bikkie. Photograph: Zoos Victoria

New programs to protect and recover moths and possums

The Recovery Team and partners developed and expanded programs to investigate the issue and further protect the possums and moths.[10] At Zoos Victoria, we commenced a new program in 2019 to develop a supplementary food source from commercially available ingredients for use in emergencies: "Bogong Bikkies".[11] Using previous analyses of Bogong Moths, we worked with world experts in veterinary nutrition to develop the bikkies – nutritionally suitable baked biscuits for Mountain Pygmy-possums, and other species that live alongside them.[11]

We trialled the bikkies with the Mountain Pygmy-possums in our care at Healesville Sanctuary to show they were safe, palatable and effective. With partners, Parks Victoria, we then trialled the food with a wild population of Mountain Pygmy-possums to ensure the food, and appropriate ways to deliver the food, were all ready in case of emergencies such as food shortages or bushfires.

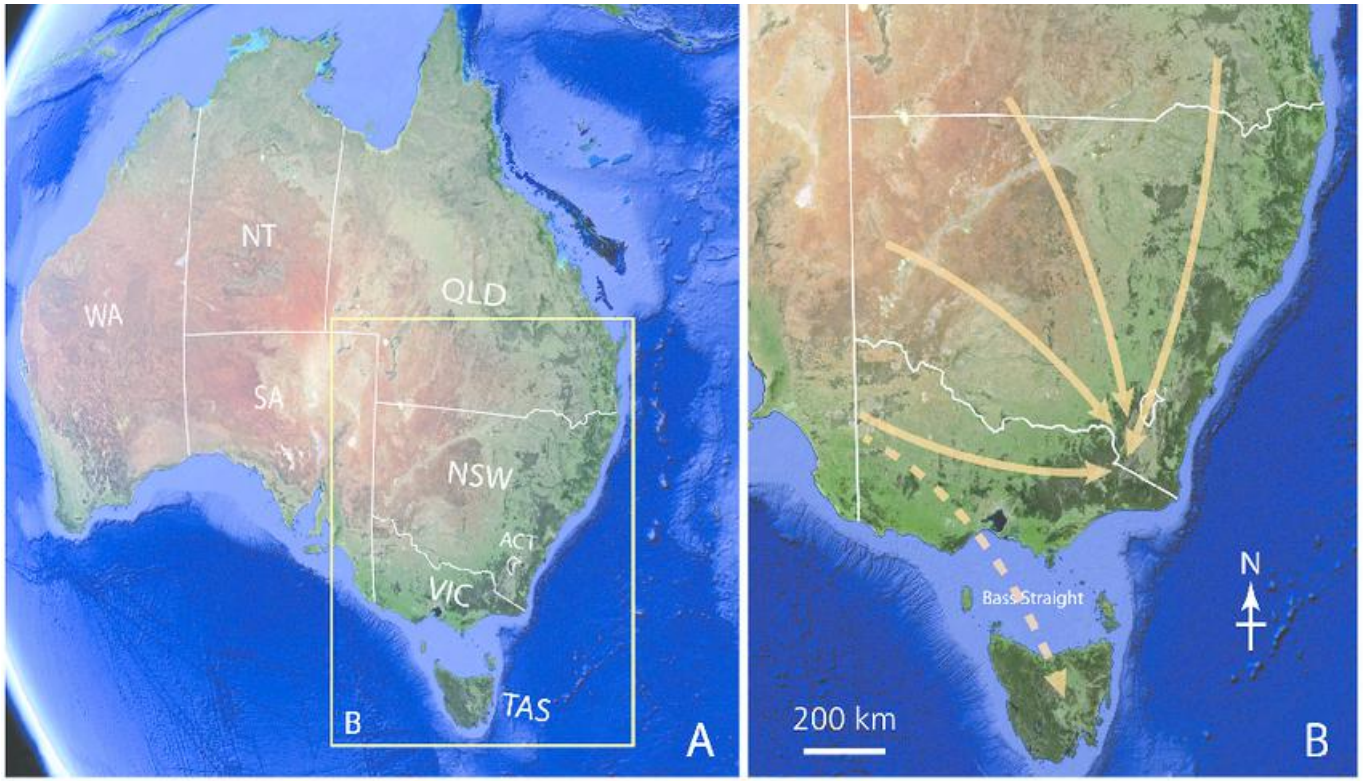
Thankfully, the food has not been needed yet in Victoria. However, we have been very proud to help our partners in the NSW Saving Our Species team, who used the bikkies to sustain wild possum populations in the Northern Kosciuszko National Park following the devastating 2019/20 Black Summer bushfires.[12] As a result, the possum populations successfully bred and raised their young.

But how do we learn more about Bogong Moths and how best to help them? There are still numerous questions about their breeding grounds, migration routes, areas of rest or foraging, and potential pitfalls and threats along their journey. Thus, in 2019, we developed a new citizen science program, Moth Tracker.[13]

The program aims are four-fold:

- to gain important knowledge on the migration, annual trends and numbers of Bogong Moths;
- to investigate key threats to the moths and determine where they may be drawn away from their migration;
- to provide early indications of moth numbers to aid planning to assist support of Mountain Pygmy-possums in times of food shortage; and
- to raise awareness of the plight of the Bogong Moth and Mountain Pygmy-possum and empower the community to help.

Zoos Victoria launched Moth Tracker as a free-to-use citizen science webpage, hosted on the State Wide Integrated Flora and Fauna Teams' (SWIFFT) website. If people see what they think is a Bogong Moth, they can take a photo, upload it to the Moth Tracker website (**zoo.org.au/mothtracker**) with the time, number, and location of the moth(s) and Zoos Victoria's moth team will confirm the species and add it to our live interactive map.[14] This species verification ensures the correct data and species is recorded. Members of the public can then check their sighting on the map after a couple of days to see if it was a verified Bogong Moth.



Bogong Moth migratory routes.[5] Copyright © 2016 Warrant, Frost, Green, Mouritsen, Dreyer, Adden, Brauburger and Heinze. Reproduced under CC BY 4.0.

How is Moth Tracker tracking?

With the Bogong Moth traversing such a wide area of Australia, using people power and citizen science can help fill the knowledge gaps on population trends and migration. Now completing its fifth year, Moth Tracker continues to grow, with the highest number of sightings submitted in spring 2023-autumn 2024. Over 1,000 sightings were submitted this season, with a total of 5,018 photos analysed across the life of the program from all Australian states and territories.

In consultation with Bogong Moth research partners, we have also engaged with communities in areas of interest and gathered new data from key breeding areas and states including Western Australia and Tasmania, where Bogong Moths occur, but less is known of their distribution.

While Bogong Moth numbers have increased since the collapse of 2017 and 2018, their numbers remain dangerously low, and the moths have failed to return to some long-term survey sites.[2] The number of verified Bogong Moths, and the number of swarms or groups of moths, also fluctuates widely between years, following the trends seen by our partners at long-term sites. It appears the La Niña weather pattern assisted numbers in 2022-2023,[15] but numbers in 2023-2024 were lower, and we hold grave concerns for future years under a changing climate.

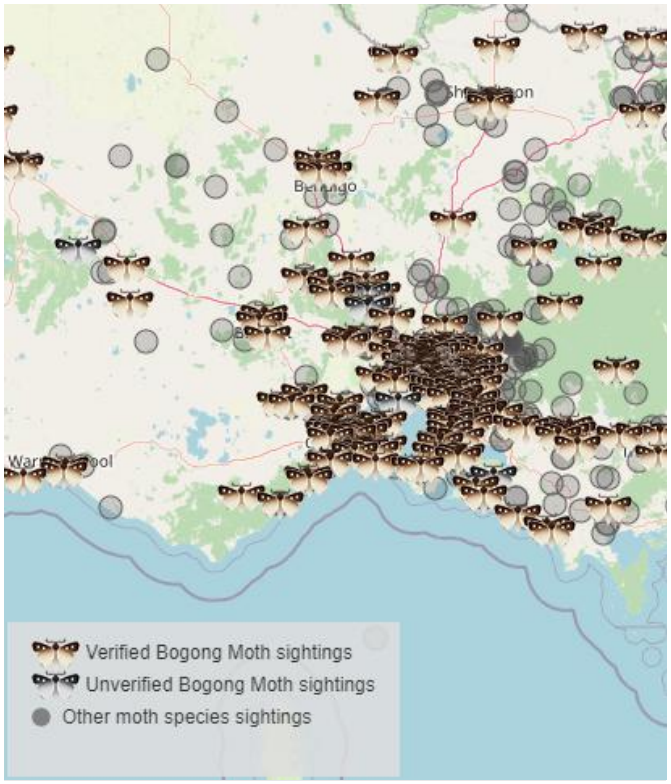
Early research of community recognition of Bogong Moths and Mountain Pygmy-possums showed a statistically significant increase in the correct identification of the species after Zoos Victoria's campaign.[13] However, many people struggle to identify the moths, and mistakenly believe that Bogong Moths are very large, even up to the size of a human hand. Therefore, we have focused on education about the size and appearance of Bogong Moths.

In the early years of Moth Tracker, around 30% of spring-time submissions were verified as Bogong Moths. The rest could not be verified from the photo provided, or were actually other species like the larger Emperor Gum (*Opodiphthera eucalypti*), Southern Old Lady (*Dasypodia selenophora*), and Rain Moth (*Abantiades atripalpis*). In the past two years, however, there has been an increase to 50% of spring-time submissions verified as Bogong Moths.

Media interest in the program and species has remained very high with annual media articles and stories calling for action. Over the past two years, Zoos Victoria has also provided asset packs to over 60 partner organisations to encourage participation in Moth Tracker. First Nations groups, environmental and government partners, community groups and more, have shared Moth Tracker posts, reaching millions of people.

Data from Moth Tracker has been added to Australia's Atlas of Living Australia,[16] significantly increasing the data available on the species, and has also been used by multiple university and other research programs. Moth Tracker is also a component of an exciting Bogong Moth Australian Research Council Industry Fellowship program at the University of Western Sydney, with partners including Lund University and Invertebrates Australia.[17]

Data has also been submitted as part of the current Australian Government's review into listing the species as Endangered in Australia. While the Bogong Moth met key criteria and was added to the IUCN's Endangered species listing in 2021, it is not yet listed nationally.[8] However, data from multiple scientists and programs have been submitted, which should also trigger an Endangered species listing and additional protection under Australia's *Environment Protection and Biodiversity Conservation Act*.



Moth Tracker map for the current season (2024-25), from **mothtracker.swifft.net.au.**

Bogong moths in Bimberi, NSW. Submitted by Moth Tracker Ben in 2023.

How can you help?

This spring, we invite you to join the search for the small but mighty Bogong Moths during their migration and add suspected sightings to the Moth Tracker website. People often spot them around their homes and gardens! To identify a Bogong Moth, look for the dark stripe on their wings, accompanied by a circular spot and a kidney-shaped spot on either end.

Additional ways to help Bogong Moths include simple measures such as planting native flowering plants in gardens, not using insecticides, and turning off unnecessary outdoor lights at night.[18]

The ability to help and track species like the Bogong Moth reminds all of us how truly amazing our moths and other insects are. When we learn about these species, we care about them. When we care about them, we act to protect them for the future. Will you join us?

► Visit: **zoo.org.au/mothtracker**

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Climate Change Alliance of Botanic Gardens

Global collaboration for plant survival in a warming world

TESSA KUM
Landscape Succession Officer, Royal Botanic Gardens Victoria

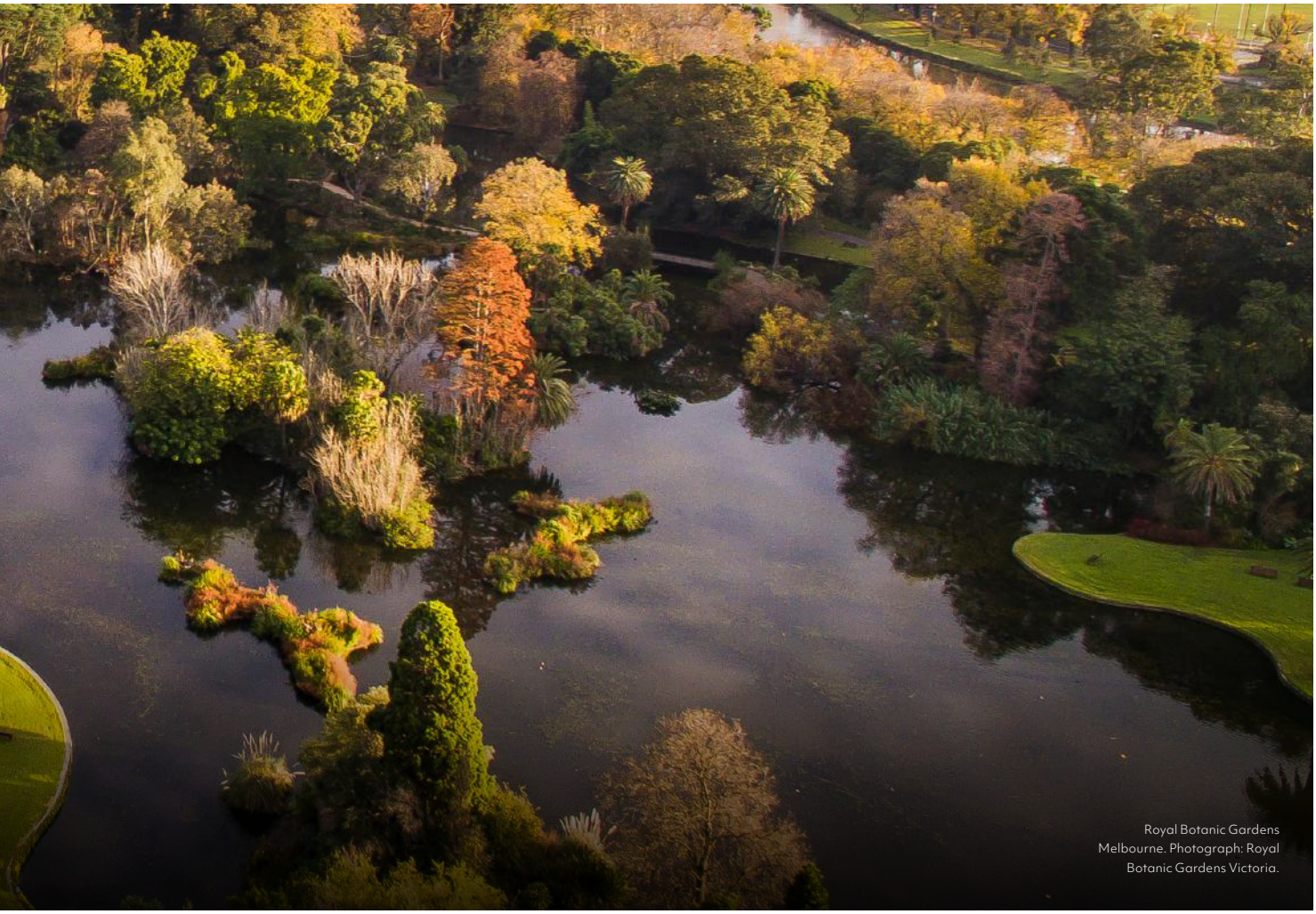
The climate is changing, and botanic gardens are particularly vulnerable. In the coming years, plant species in botanic gardens and urban landscapes will likely confront temperatures they have never experienced before.

Botanic gardens are unique as centres for scientific knowledge and research, playing vital roles in *ex situ* conservation (away from the plant's natural habitat), and providing important connection to nature for visitors.

In December 2018, the inaugural botanic gardens Climate Change Summit was held at Royal Botanic Gardens Melbourne. At the summit, 13 international botanic gardens and botanic organisations agreed to form the Climate Change Alliance of Botanic Gardens (CCABG).[1]

The CCABG is now a global information-sharing network by which over 500 botanic gardens, arboreta, and similar institutions can share their experiences with managing, mitigating, and planning for climate change. Members may be well-resourced and well-funded, or volunteer-run sites with no budget at all. By facilitating knowledge sharing, the CCABG aids its members to adapt to the challenges associated with climate change.

The issues our world faces are unprecedented and borderless. The lessons learned in the context of a botanic garden are applicable to landscapes beyond their own garden gate. Collaboration between botanic gardens across the globe is essential in understanding how plants will grow and survive in a warming climate.



Royal Botanic Gardens Melbourne. Photograph: Royal Botanic Gardens Victoria.

Why is it so important that botanic gardens around the world adapt to climate change?

In a botanic garden, some aspects of climate can be mitigated. But for the most part, climate cannot be avoided, only endured. Our landscapes are facing climatic conditions not previously experienced, and if we do not plan for these conditions, then these incredibly important landscapes – and the scientific resources they contain – will be severely degraded.

If botanic gardens are to continue their scientific knowledge and research, conservation efforts, and connecting visitors to nature, they must adapt.

What lessons can we apply to the broader landscape?

According to the UN's IPCC Working Group, under the extreme climate future, where temperatures are forecast to increase by over 3.0 °C by 2070 (assuming worst case emissions),[2] 20% of tree taxa and 26% of other taxa will be at high risk of extinction.

Botanic gardens need to assess the climate vulnerability risk of their living plant collections so that they can identify priority areas for management intervention.

Photograph: Royal Botanic Gardens Victoria.

Royal Botanic Gardens Victoria's Cranbourne Gardens. Photograph: Alpha via flickr (CC BY-NC 2.0).

The Climate Assessment Tool (CAT) was therefore commissioned to provide guidance on the likely suitability of plants for the predicted future climate of a given location.[3]

The CAT considers current known occurrences of plant species – such as those observed in the wild, in botanic gardens, and in general cultivation – and compares the current climate of these known occurrences to the predicted climate. It uses temperature as a proxy for environmental pressures to consider how a species would be influenced. What previously would have taken hours of research and data compilation, the CAT provides in moments. It gives valuable climate information about a given site, and an idea of the likely performance of a taxon in a future climate. The CAT removes a lot of the guesswork from species selection, and can inform decision making, while noting that each site is unique, and many other factors will need consideration when undertaking landscape succession.

The CAT is publicly available online and for free, and has been used by botanic gardens and arboreta, and also city councils and local municipalities, universities and landscape designers.

Similarly, the Landscape Succession Toolkit was published by the CCABG, with thanks to funding from Botanic Gardens Australia and New Zealand.[4] The Toolkit offers a holistic analysis of the many ways in which climate change may affect a botanic garden, and guidance on how to pre-emptively manage these impacts. Like the CAT it is available online for free and is an excellent starting point for those unsure of where to start with climate adaptation.

Climate change affects everyone, and the CCABG recognises this, and works to strengthen the community by facilitating information sharing, networking and collaboration. The lessons learned by one garden may be exactly the solution another needs, and working together to share this knowledge and develop tools like these benefits everyone.

What decision-making is involved in the protection and management of living plant collections?

A botanic garden is a managed living system. Some plants have the potential to live for centuries, and those are the timeframes which need to be considered when selecting a species to plant. A tree planted now must establish in today's climate, but also not only survive, but thrive in the climate 30, 50, 100 years from now. There are many factors to consider when selecting a plant to add to the landscape or a collection; future climate suitability needs to be among those factors.

Melbourne's climate has been warmer and drier in the past 30 years, a trend that is predicted to continue. Redefining our living collections to focus on plants which are suited to this coming climate ensures that we are still able to provide plants for scientific research, maintain ex situ collections for conservation, and provide the public with a world-class landscape.

What research are you currently doing to understand how plants and/or botanic gardens are adapting to climate change?

Research is ongoing and never-ending, and given the pervasive nature of climate change, such learning informs everything we do. One of the most valuable resources any botanic garden has is their horticulturists. The staff who work directly with the plants, and observe them closely from season to season, are a wealth of specialised observational knowledge, and often have an intimate understanding of the nuances of a site.

Our horticulturists trial new plants in the landscape and learn not only what succeeds, but what fails and why. It is the expertise and work undertaken by horticulturists which takes theory and turns it into action in the landscape.

What changes have you noticed in the Royal Botanic Gardens Victoria already at this point (in the last 10–20 years)?

Melbourne's climate has become drier and warmer in recent decades, and this trend is predicted to continue. An extensive and detailed overhaul of the botanic gardens' irrigation practices during the Millennium Drought[5] has safeguarded much of the landscape from this decline in precipitation, but alternative sources of water are still being sought to augment current supplies.

The rise in temperatures makes itself known in myriad ways. As one example, the deciduous oak trees on the Oak Lawn of the Royal Botanic Garden in Melbourne have begun to drop their leaves later and later into the cooler seasons, with some trees never entirely losing their leaves. What effect this will have remains to be seen.

Will we see a shift in the plants that we see in the Royal Botanic Gardens Victoria?

Melbourne Gardens was established in 1846, and the original planting palette – much of which is still present today – reflects taxa from a cooler and wetter temperate climate. As our older trees deteriorate with age, we must consider what species are to replace them. Some species may still be suited to the future, while others are already struggling in our summer heat. The white oak (*Quercus aff. alba*) that fell in 2019 is an example of this, as it has been replaced with three different oak species that are better suited to the future climate.

Likewise, projects within the landscape are focused on bringing the same resilience to our garden beds. The Australian Drylands Project currently under development will feature native plants that have evolved in drier and hotter climates, and is an excellent opportunity to educate the public and ourselves about plants which are entirely new to Melbourne Gardens.

These changes are important, gradual, and necessary. The purpose of landscape succession or adaptation is to change the Gardens now in order to stay the same for future generations to learn from and simply enjoy.

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The Proceedings of the Royal Society of Victoria is our refereed journal, published twice annually by CSIRO Publishing.

The Society invites contributions for the *Proceedings* from authors across the various disciplines of biological, physical and earth sciences, including multidisciplinary research, and on issues concerning technology and the applied sciences.

Contributions on topics that are relevant to Victoria and the south-eastern Australian region are encouraged. The journal also publishes Special Issues and themed collections of papers commissioned by the Council of the Royal Society of Victoria. It is published online in May and November, with two issues constituting a volume.

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.

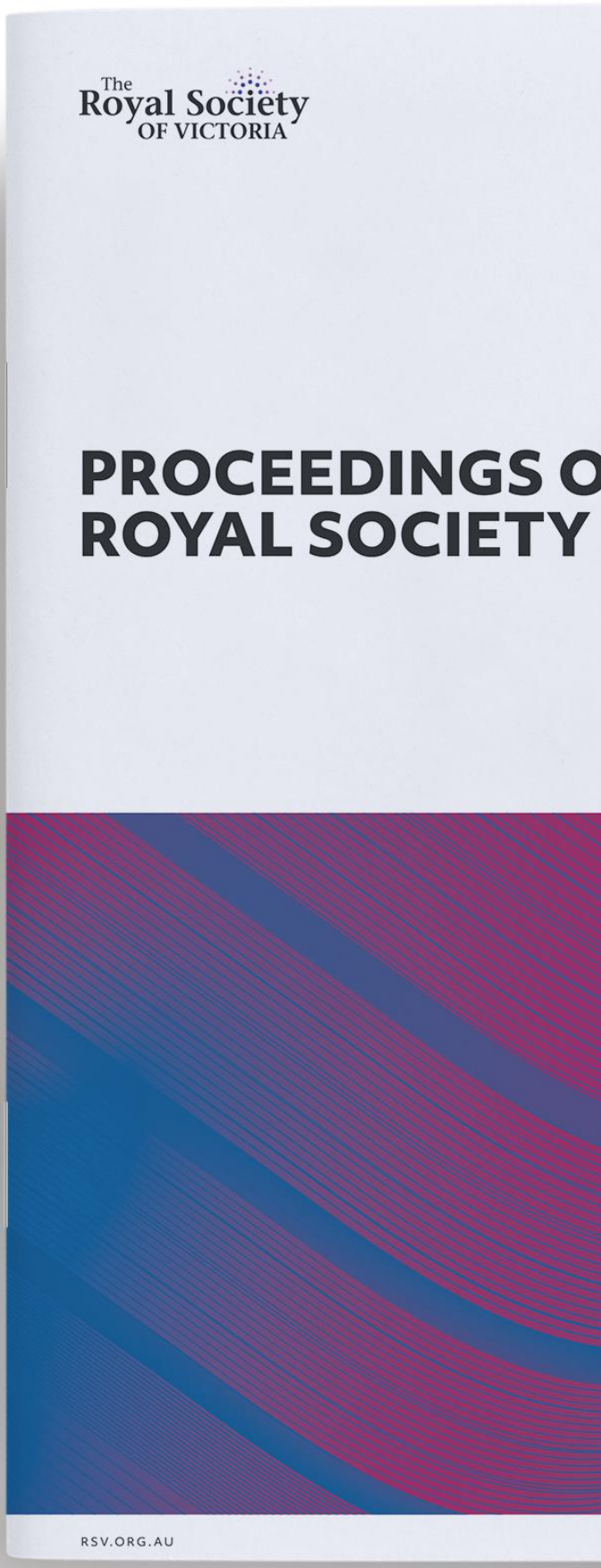
The journal began in 1855 as an irregular publication under the title *Transactions of the Philosophical Society of Victoria,* with the present name adopted in 1889. Since then, volumes of the journal have been published annually, often across one or more parts.

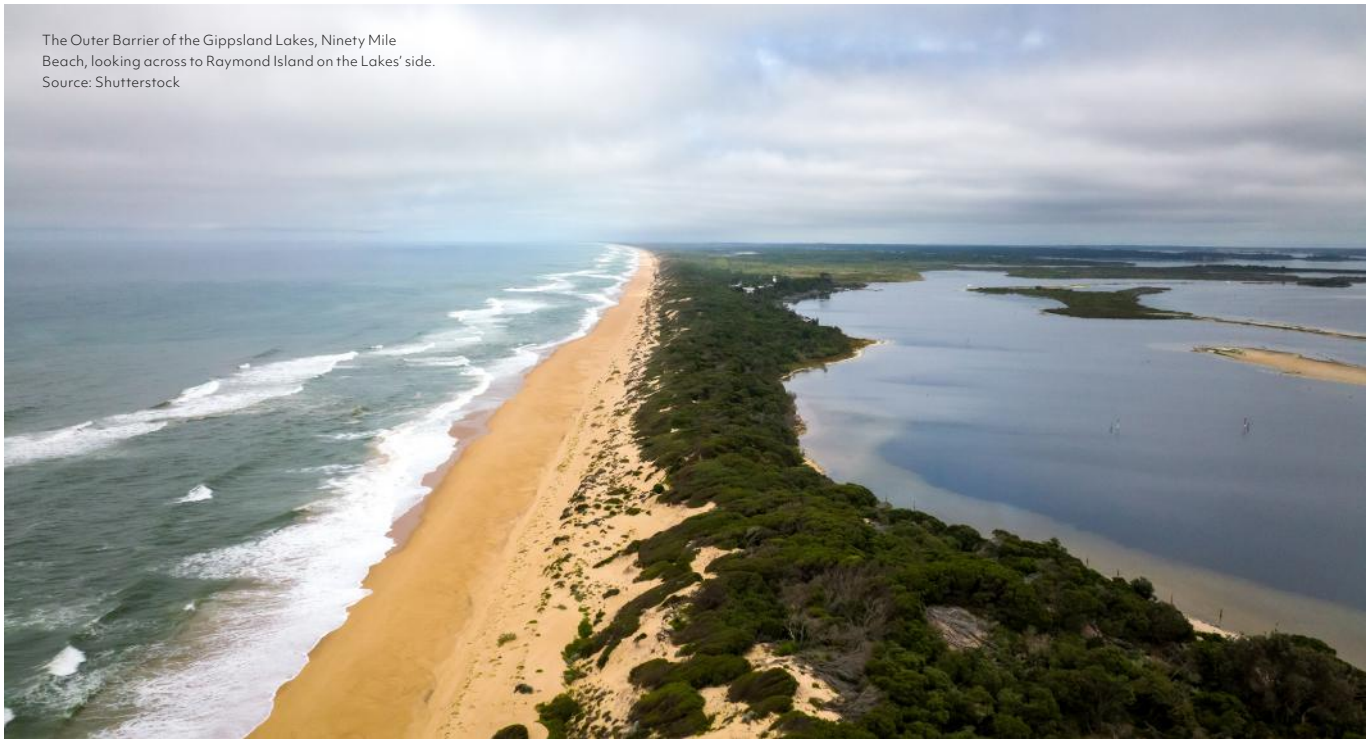
The online content published by CSIRO Publishing extends back to Volume 118, 2006, and is available at **publish.csiro.au/rs**.

All volumes of the *Proceedings* and its predecessors from 1854 to 2006 are also available free online at **biodiversitylibrary.org/creator/6984**.

Submissions

Those interested in submitting papers should review the Author Instructions at **publish.csiro.au/rs/forauthors/AuthorInstructions**. Manuscript submissions for the Proceedings are now made using the ScholarOne platform. Any enquiries regarding submission can be made to **editor@rsv.org.au**





The Outer Barrier of the Gippsland Lakes, Ninety Mile Beach, looking across to Raymond Island on the Lakes' side. Source: Shutterstock

The Future of the Gippsland Lakes

Proceedings of the Royal Society of Victoria, Volume 136

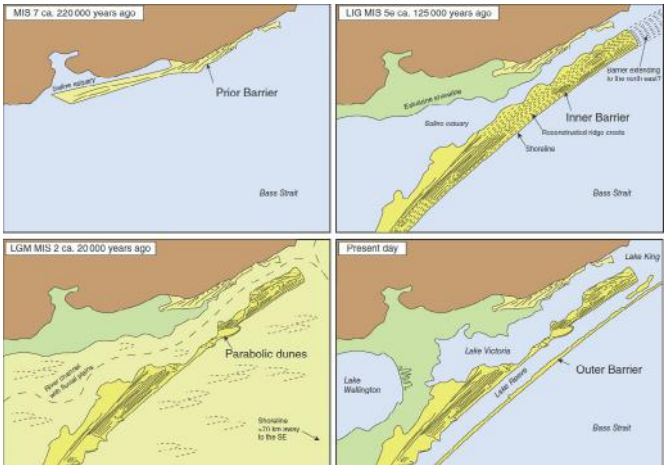
The first papers from Volume 136 of the Proceedings of the Royal Society of Victoria are now available online, open access from CSIRO Publishing, hosted at publish.csiro.au/rs/collection/12070. This volume is the first to be released under CSIRO Publishing's new 'publish-as-you-go' model, progressively collecting the volume over the course of the year.

This collection on the Gippsland Lakes compiles papers commissioned following the roundtable held at the Royal Society of Victoria on 26 May 2023, involving research expertise along with First Nations (Gunaikurnai) representation. It summarises the geomorphological character of the Lakes system, the current state of estuarine health, and anticipates the impacts of intensified human activities, a drying regional climate and rising sea levels on the interaction of the marine and freshwater ecological conditions.

The Society's report from the roundtable, titled 'Securing the Future of the Gippsland Lakes,' is also available at **rsv.org.au/gippsland-lakes**.

Metung, VIC. Photograph: Patrick McGregor via Unsplash.

Papers from Volume 136



A picture of the changes to the Gippsland Lakes landforms during the past three sea level highstands going back to 220,000 years ago. Photograph: David M. Kennedy, Bruce Thom, Rob Gell, and Neville J. Rosengren

Coastal geomorphology and geology of the Gippsland Lakes region: a review and future directions

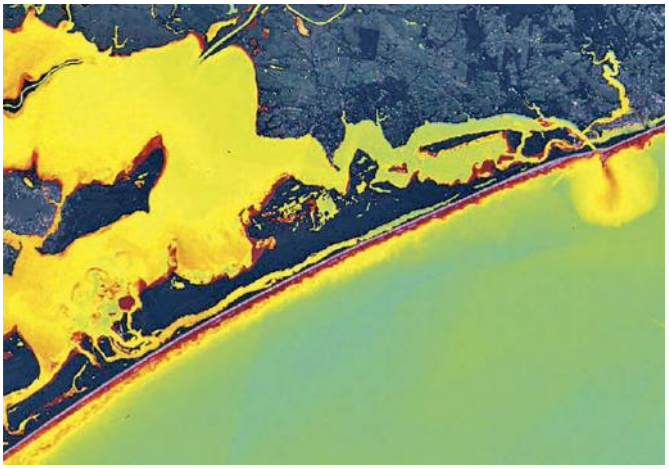
BY DAVID M. KENNEDY, BRUCE THOM, ROB GELL, AND NEVILLE J. ROSENGREN

The Gippsland Lakes present one of the most diverse coastal environments in Australia. They contain extensive Ramsar-listed wetlands, beaches, dunes, fluvial and tidal deltas and a variety of estuarine systems. They are the only active barrier-island system in Australia, presenting the continent's best-preserved beach-dune system, dating back more than 200,000 years.

This review from Professor David Kennedy, Professor Bruce Thom, Rob Gell AM and Neville Rosengren traces how the shape of the modern coast is related to past positions of the sea, and the limited sediment supply remaining on the offshore continental shelf to maintain a barrier system now showing evidence of erosion and retreat.

The authors urge urgent action to understand both current and future landform dynamics, as the beaches may be shifting into a long-term erosional phase, tipping towards outer barrier transgression.

► Read this article for free at **publish.csiro.au/rs/pdf/RS23018**



A satellite image shows contemporary chlorophyll levels in the Gippsland Lakes. The red area indicates where the algae bloom of May-June 2022 was most concentrated, while the green indicates more diluted areas. Photograph: Dept of Energy, Environment & Climate Action

Floods, fires and phytoplankton: some perspectives on water quality in the Gippsland Lakes

BY PERRAN COOK AND JONATHAN SMITH

The Gippsland Lakes form Australia's largest estuary and is a productive recreational fishery. Algae underpin the productivity of this fishery and most of the time go unnoticed. However, in some years, toxic blooms of cyanobacteria ('blue green algae') occur, closing areas of the Lakes to fishing and recreation.

Authors Professor Perran Cook and Jonathan Smith review the factors that drive different algal growth, and how this might have looked prior to European colonisation. Importantly, they consider how future cyanobacteria blooms can be mitigated through revegetation efforts and prudent farm nutrient management strategies across a terrestrial catchment that takes in 20,000 square kilometres in southeastern Victoria.

► Read this article for free at **publish.csiro.au/RS/pdf/RS23020**

Current Government Consultations of Interest to Victoria's Science Community

*Projects open for consultation from **engage.vic.gov.au/project***

Jeremy Bishop via Unsplash

Anthony Indraus via Unsplash

CONSULTATION CLOSES 12 JULY 2024

Marinus Link Project

Have your say on the combined Commonwealth Environmental Impact Statement (EIS) and Victorian Environment Effects Statement (EES) for the proposed Marinus Link Project.

engage.vic.gov.au/MarinusLink-IAC

CONSULTATION CLOSES 19 JULY 2024

Energy Retail Code of Practice Review

Have your say as the Essential Services Commission updates the Energy Retail Code of Practice to support ongoing protections for Victorian electricity and gas customers.

engage.vic.gov.au/energy-retail-code-of-practice-review

Ian Melton via Unsplash

Bogomil Mihaylov via Unsplash

CONSULTATION CLOSES 21 JULY 2024

Greenvale North Part 2 Precinct Structure Plan

Learn about the draft plans for the Greenvale North Part 2 Precinct as part of the final consultation process.

engage.vic.gov.au/greenvalenorthpart2

CONSULTATION CLOSES 31 JULY 2024

Inquiry into Women's Pain Survey

Women face real and enduring challenges when seeking care and support for pain. The Department of Health wants this to change, and the first step is to ask you about it.

engage.vic.gov.au/inquiry-into-womens-pain-survey

Submission Guidelines

We welcome your pitches relating to current scientific research in Victoria, recent scientific discoveries, social and policy issues, technical innovations, and overviews of impactful research.

Science Victoria's articles are written in plain, non-academic language, and thoroughly referenced (see: References).This is not a platform for scientific journal articles or media pieces. For more information on what we're looking for, see below.

Pitch it to us!

Have an idea for an article?
We want to hear from you!

Briefly outline your key message, why it should be shared in *Science Victoria*, and the proposed article type. Pitches can be submitted at any time, but check submission deadlines if you're interested in publishing in a particular edition.

All pieces will be reviewed prior to publishing, and may be edited for length and clarity (although we will not alter the message or context of your work).

Send pitches and any questions to **editor@ScienceVictoria.org.au**.

Style Guide

All pieces should have readability in mind. A good litmus test is knowing that most people have read a piece or been to a presentation that managed to make the most interesting topics incredibly boring and/or confusing. This is what you want to avoid.

A general guide for readability is that it should be understood by an educated 16-year-old – or ask a friend or family member to proofread!

Feature Articles

Recommended length: 600 - 1,800 words

Feature articles are more in-depth pieces on a specific topic related to STEMM. A key aspect of feature articles is the narrative – this isn't a journal article, so think about the story that your article is trying to tell.

Avoid using jargon, as it will quickly alienate anyone who isn't an expert in that field. Explaining one or two otherwise irreplaceable terms is fine.

Use of sub-headings and figures to break up longer pieces is strongly encouraged.

Not quite sure about the tone for your piece? Have a look at articles published in previous editions of *Science Victoria*, or in other scientific publications for a general audience, like *The Conversation, Cosmos, New Scientist, or Scientific American.*

Guidelines for Authors

Opinion Articles

Recommended length: 600 - 1,800 words

In contrast to a feature article, an opinion piece conveys your informed opinion on, or experiences with, a particular topic. Clearly state your argument, outlining the details of the problem you are addressing, and build to a strong conclusion.

For greatest impact, your choice of topic should be one that is broadly relevant to STEMM-related fields in Victoria. Examples of possible topics include how to address a climate-change related problem in Victoria; successes and failures common to STEMM engagement initiatives; ethical problems related to scientific projects or careers in STEMM; your experiences of a career in STEMM and thoughts on how to better support the next generation of researchers; existing STEMM-related studies or approaches that you believe could be applied in Victoria.

We welcome well-informed opinion articles from all authors, particularly from those with significant expertise in a given area. Articles may reference your own work; however, these are not promotional fluff pieces.

Letters

Recommended length: 200 – 1,000 words

Letters have minimal restrictions on style, structure, or subject matter. You are encouraged to submit your thoughts/questions/comments that broadly relate to STEMM in Victoria. Potential subject areas include responses to articles in previous editions of *Science Victoria*, seminars at scientific events, science-related issues and policies, or topics you'd like to see in future editions.

Letters are also the best format to share current or recent news relating to science, with an emphasis on science in Victoria or news that impacts Victoria's scientific community. News could relate to funding announcements/grant outcomes, new STEMM-related projects, high-impact publications relevant to Victoria, successes of Victorian scientists, or relevant STEMM-related policy news.

Where a specific question is asked, we will try to have the appropriate person respond to your letter.

What I've Been Reading

Recommended length: 600 - 1,800 words

This is a column for you to tell us about a book broadly relating to STEMM that you've read. These pieces typically include a summary of the book and its ideas, as well as your interpretations or conclusions. Possible questions to consider: Do you think the author was correct in any assumptions? Was the author's style of writing approachable? Did they do the subject matter justice? Who would you recommend this particular book to? What did it mean to you? What did you learn?

Images and Figures

Images are strongly encouraged, however please only provide files that are either completely original, in the Public Domain, or covered by an appropriate Creative Commons license. Images must include details of the source, license, and any relevant descriptions.

If suitable images are not provided, we may include relevant Public Domain/Creative Commons images.

All images must be of sufficient size and quality – as a rough guide, aim for >1.3 MB in file size.

References

Please reference primary sources/journal articles for any non-trivial scientific claims, or for publications that prompted your writing of the article. If references aren't provided, we will request them for specific statements.

References for all articles should use a modified APA 7th edition format: reference list in author-year format, with numbered in-text citations. Refer to articles in previous editions for examples. Please do not submit pieces that use MS Word's References/Footnote/Endnotes feature, as it forces us to manually re-write your references.

Submission Deadlines

MARCH 2024	**DUE DATE**
Victoria's Fauna	*16 February*

Everything *Animalia* in Victoria, particularly native fauna.

APRIL 2024	**DUE DATE**
The Four Planetary Crises	*15 March*

Biodiversity Loss, Climate Change, Pollution & Waste, and The Rise of Misinformation

MAY 2024	**DUE DATE**
Accessibility & Inclusion in STEMM	*19 April*

Supporting the education, employment, and engagement of everyone in STEMM.

JUNE 2024	**DUE DATE**
Victoria & Climate Change	*17 May*

The impacts of, research on, and responses to climate change in Victoria.

JULY 2024	**DUE DATE**
Building Scientific Competency	*14 June*

Empowering individuals and communities to understand the scientific method.

AUGUST 2024	**DUE DATE**
STEMM Throughout Victoria	*19 July*

The opportunities for learning and engaging with STEMM across the state.

SEPTEMBER 2024	**DUE DATE**
Pollution in Victoria	*16 August*

The different pollutants, sources, impacts, and responses required.

OCTOBER 2024	**DUE DATE**
Victoria's Ecosystems	*13 September*

The many and varied ecological niches across Victoria

NOVEMBER 2024	**DUE DATE**
Science & Policy	*18 October*

From lab bench to front bench: how scientific understanding can positively influence policy.

DECEMBER 2023	**DUE DATE**
Science & Business	*15 November*

Creating a sustainable industry, start-ups, med-tech, patents, and ethics.

Hold Your Next Event at the Royal Society of Victoria

The RSV engages communities with scientific knowledge through aligned partnerships, events, festivals, conferences, and education programs.

Services Available

We also provide a number of services to ensure your event is a success. Some of the services we provide are:

- Event management
- Meeting venues
- Grants and awards administration
- Social media campaign management
- Broadcasting and video production
- Recruitment of scientific panels
- Convening community engagement and deliberation processes where scientific work contributes to social, environmental, and economic impacts and benefits.

The Facilities

The RSV's facilities are available for hire to organisations, companies, or private groups.

Audio-visual and seminar equipment is available for use, including videoconferencing facilities for hybrid Zoom/MS Teams meetings.

There is a commercial kitchen on the ground floor, suitable for your own use or by a caterer. Limited parking is available on-site, and a commercial parking operator is adjacent on La Trobe Street.

▶ Take a Virtual Tour of the building at: **matterport.com/discover/space/royal-society-victoria**

▶ Email rsv@rsv.org.au to discuss your needs and ideas!

The Burke and Wills Room

The beginning and end of the ill-fated Victorian Exploring Expedition of 1860-61 is a beautiful, multi-function space with an adjoining kitchen, suitable for a range of events.

SUITABLE FOR

Workshops, roundtables, luncheons, dinners, seminars, and functions.

CAPACITY

Workshops	*≤30 people*
Dinners	*≤60 people*
Catered Functions	*≤80 people*

The Ellery Lecture Theatre

First-floor lecture theatre, with raked seating, speaker's podium, and audio/visual equipment. Perfect for lectures, presentations, and conferences.

SUITABLE FOR

Presentations, seminars, lectures.

CAPACITY

Any Booking	*≤110 people*

The Millis Room

A versatile room on the ground floor, with views of the Carlton Gardens. Suitable for smaller meetings, group/individual work, or seminars.

SUITABLE FOR	CAPACITY	
Meetings, group/individual workspace, and seminars.	*Any Booking*	*≤15 people*

The Cudmore Library

A picturesque room with videoconferencing and projection equipment. Great for larger meetings and seminars, with in-person or hybrid attendees.

SUITABLE FOR	CAPACITY	
Meetings, seminars, and videoconferencing.	*Any Booking*	*≤15 people*

The Von Mueller Room

A light-filled room on the first floor, perfect for smaller meetings and seminars, or group/individual work.

SUITABLE FOR	CAPACITY	
Meetings, seminars, and videoconferencing.	*Any Booking*	*≤15 people*

Support Victoria's Science Society in 2024 and help us to engage individuals and communities with STEMM

WHO WE ARE

Founded in 1854, the Royal Society of Victoria (RSV) is our state's science society.

We are a membership based, non-government organisation, advocating for the importance of science, technology, innovation, and building the skills for Victoria's future industries, governments, community leaders, and research superstars.

WHAT WE DO

We manage the Inspiring Australia program in Victoria (inspiringvictoria.org.au), meaningfully engaging communities with science.

We encourage, profile, and celebrate the achievements of Victorian scientists through public lectures, awards, and prizes, which are supported by the donations and bequests to the RSV Science Foundation.

WHERE YOUR DONATIONS GO

Your donations allow us to continue the work we have been doing for Victoria for more than 160 years. This includes hosting organising/hosting/running STEMM events, running a public lecture series (in-person and online), producing the magazine *Science Victoria*, celebrating Victorian scientists through awards and prizes, publishing Victorian science in our academic journal (the Proceedings of the Royal Society of Victoria), and empowering the next generation of scientists.

HOW TO SUPPORT

We also support a number of smaller organisations, which are listed at **rsv.org.au**.

You can donate online now at **rsv.org.au/support-the-rsv**, or alternatively contact us at **rsv@rsv.org.au** for information about other payment methods.

Become a Member of the RSV

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.

	STUDENT $40 PER YEAR	FULL $120 PER YEAR	ORG. $1000 PER YEAR	SCHOOL $1000 PER YEAR	AFFILIATE $500 PER YEAR
Special Membership rates at RSV and affiliate events.	✓	✓			
Networking opportunities – national and local.	✓	✓	✓	✓	✓
Recognition of membership through use of post-nominal affix	MRSV	MRSV			
Science Victoria Digital Edition (Printed copy available for an additional fee).	✓	✓	✓	✓	✓
Free monthly printed copies of *Science Victoria* for school libraries.				✓	
Recognition of achievements through awards programs.	✓	✓			
Discounted advertising in *Science Victoria*			✓	✓	✓
Discounted facility hire at 8 La Trobe Street, Melbourne.			✓	✓	✓
Discounted membership rate for eligible full-time students.	✓				
Discount on purchases from CSIRO Publishing	✓	✓			
'Schools Supporting Schools' Membership Program*				✓	
Listing of membership on the RSV.org.au website.			✓	✓	✓

New Individual Members

MS ELIZA THOMPSON
PhD Student, The University of Melbourne

MS RACHEL PEIRIS
PhD Student, The Florey Institute

DR MATTHEW WENHAM
Senior Manager - Biosecurity & Products of National Significance, CSL

MR DARCY WATCHORN
PhD student, Deakin University

MR FINBAR O'HANLON
Corporate advisor/Strategist

PROFESSOR BARRY HART
Director, Water Science

MR ANTWAN MALOUHI
Director, BTD Technology

MR JEREMY TANG
Student & Management Consultant, University of Melbourne

MR BRETT COLE
Occupational Hygienist and Biologist, Biosafety International

MR MARTIN LENARD
Retired Geologist

MR WILLIAM (BILL) GRANT
Research Fellow, Federation University

MR THOMAS CAHIR
PhD Student, Bionics Institute/ University of Melbourne

For more information: **rsv.org.au/how-to-join**

* The 'Schools Supporting Schools' membership program allows a school to sponsor the membership of one or more schools at a discounted rate of $750/ year, allowing less-resourced schools the same benefits and opportunities of RSV membership.

New Organisational Member

COMMON SENSE

Common Sense Events

commonsenseevents.com.au

Common Sense Events have reverse-engineered networking and taken out everything you don't like to make it work, so people can really connect and make abundant relationships that are going to change how they think, work and connect. We provide a proven system to gain more referrals, win a higher % of deals and decrease client churn. Relationships last forever, a transactional sale lasts just once.

Affiliates

CCA | CLIMATE COMMUNICATIONS AUSTRALIA

Climate Communications Australia

climatecommunications.org.au

Climate Communications Australia is a not-for-profit charity dedicated to mitigating the harmful impacts of climate change. We aim to reduce the 'psychological distance' of climate change by making the impacts and the solutions clear and relevant.


EXIT
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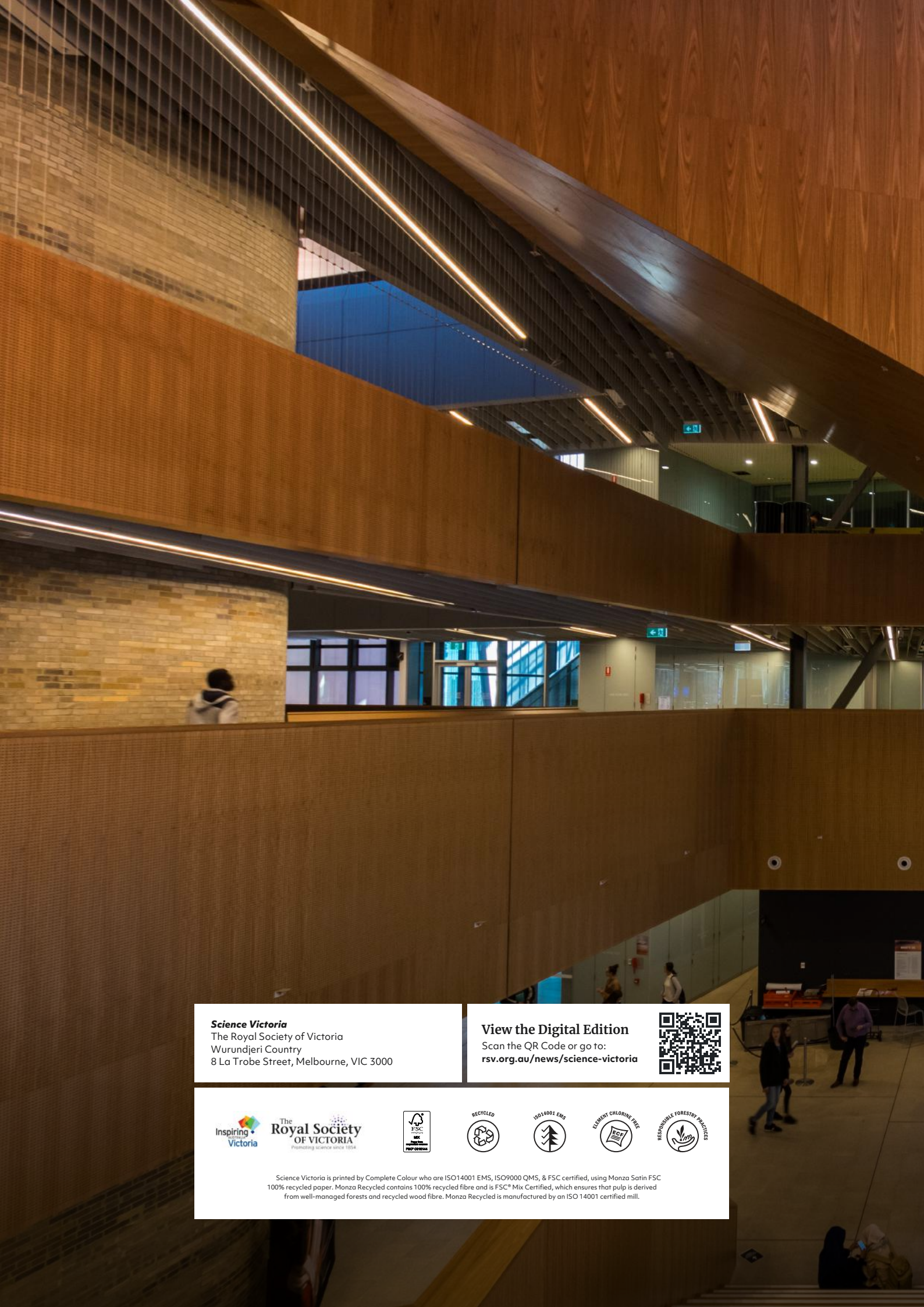
LA TROBE
READING ROOM



Science Victoria
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Wurundjeri Country
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Scan the QR Code or go to:
rsv.org.au/news/science-victoria

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