

APRIL 2024 — THE FOUR PLANETARY CRISES

# SCIENCE VICTORIA

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Anthropocene Now

Diverse Reptiles Down Under

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Kinglake National Park, Victoria, following the 2009 Black Saturday bushfires. Photograph: Nick Pitsas/CSIRO via Wikimedia Commons (CC BY 3.0 DEED).



## This Edition: The Four Planetary Crises

Climate Change. Loss of Biodiversity and Extinction. Pollution. The Rise of Misinformation. In this edition, we focus on these four human-driven crises that currently threaten life on Earth, and what needs to be done to meaningfully address them.



## On the Cover

A warming climate means melting glacial ice and rising sea levels. Antarctica is losing 150 billion tons/year, while Greenland is losing 270 billion tons/year. Photograph: NOAA via Unsplash.



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MAY 2024	DUE DATE
Accessibility in STEMM	5pm, 19 April

JUNE 2024	DUE DATE
Victoria & Climate Change	5pm, 17 May

# From the Editor

**SCOTT REDDIE**

Editor-in-Chief — Science Victoria

Regardless of anything humanity does in the next 50 years, the Earth will still be here. It's a rock, making laps of a ball of fire, in the blackness of space, without any concept of money or deadlines or its own existence.

Earth will be fine. However, it's another story for the life riding on board, which is almost completely wiped out with semi-regularity. Each of these mass extinction events wiped out >75% of all species that were alive at the time, with many minor extinction events scattered inbetween for good measure. These extinction events have been triggered by things like asteroids, volcano eruptions, and ejections from supernovae. We are currently in the midst of an extinction event, the Holocene Extinction, which is the direct result of human activities.<sup>1</sup> The extent of life we extinguish is yet to be seen.

In this edition of *Science Victoria*, we look at the causes, impacts, and what needs to be done to address the four planetary crises. Like the four horsemen of the apocalypse, these crises are the major threats to life on Earth, including humanity.

Climate change, loss of biodiversity, and pollution were designated the triple planetary crisis by the UN to describe the major threats to the global environment caused by humans.<sup>2</sup> Meaningful action to address these threats is hampered by the rise of misinformation and disinformation, whether it be through political discourse, industry-mediated obfuscation of science, or general confusion and ignorance.

We're past the point of hoping that things work themselves out. Strong political and regulatory change is required now to limit the impacts of climate change. The science is solid, the need is critical, but we still need to overcome the fact that a tiny percentage of the human population profit from these planetary crises.

This month, wildlife ecologist and conservationist Professor Euan Ritchie reflects on what is needed to address biodiversity loss and climate change, while Dr Catriona Nguyen-Robertson addresses the causes of climate change and the impacts of pollution. I take a look at misinformation and disinformation, and RSV Young Scientist Research Prize finalist Ella Plumanns Pouton discusses how fire impacts plant life cycles.

We also hear from *Inspiring Victoria* partner Zoos Victoria on their education and outreach programs, and from researchers at Museums Victoria on reptilian fossils. All this, plus many awards and grant opportunities, upcoming events, and more.

For an in-depth report on the current state of biodiversity reviews, responses, and policies in Victoria, the RSV's position paper '*Towards Conservation and Recovery of Victoria's Biodiversity*' is available at [rsv.org.au/biodiversity-recovery](https://rsv.org.au/biodiversity-recovery).

We hope you enjoy this month's edition of *Science Victoria*.

## REFERENCES:

<sup>1</sup> 1. McCallum, M. L. (2015). Vertebrate biodiversity losses point to a sixth mass extinction. *Biodiversity and Conservation*, 24(10), 2497–2519. doi.org/10.1007/s10531-015-0940-6

<sup>2</sup> 2. What is the Triple Planetary Crisis? (2022, April 13). United Nations Framework Convention on Climate Change (UNFCCC). [unfccc.int/news/what-is-the-triple-planetary-crisis](https://unfccc.int/news/what-is-the-triple-planetary-crisis)

## SCIENCE VICTORIA

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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.



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# Four Strategic Pillars for Four Planetary Crises

**ROB GELL AM MRSV**  
President — The Royal Society of Victoria

This month's *Science Victoria* theme of course parallels the RSV's revised Strategic Plan,<sup>1</sup> which frames our initiatives and work program under four strategic pillars:

1. Climate Change and how we mitigate it and help Victoria adapt to it,
2. Threats to Victoria's Biodiversity and how better environmental stewardship might protect it,
3. Victoria's continued liveability and how we tackle Pollution and Waste, and
4. The Rise of Misinformation and how we counter it so society can make informed decisions.

Fortunately, Victoria's efforts to mitigate climate change through transformation of the state's energy generation from fossil fuels to renewable energy is well underway.

In 2017 Victoria legislated a target of 20% below 2005 emissions level by 2020. Victoria's emissions have been falling since 2010, and 30% reduction in emissions by 2017 exceeded the 2020 target. Future targets are to be 28-33% below 2005 leaves by 2025, 45-50% below by 2030 and Net Zero by 2045.

This may illustrate the importance of setting targets and perhaps even 'stretch goals'. China, like Victoria, is far exceeding its targets for solar and wind installation. In China, 1,310 GW of solar

and wind was installed between 2020 and 2023 – well ahead of the targeted 1,200 GW by 2030.

Unfortunately, our record on investment in habitat for biodiversity is not as positive, despite the good intentions of Biodiversity 2037.<sup>2</sup>

Some of the Victoria Government's own proposals for the development of Port of Hastings have been rejected on the basis of impacts to Westernport Bay Ramsar sites, which I discussed in last month's edition of *Science Victoria*.

## Not-so-fresh air

'Pollution and Waste' was designated a global existential crisis in 2022 by the United Nations Environment Programme (UNEP). At the time, the UN Secretary-General António Guterres warned that the triple crisis (Climate Change, Nature and Biodiversity Loss, and Pollution & Waste) is humanity's number one existential threat.<sup>3</sup>

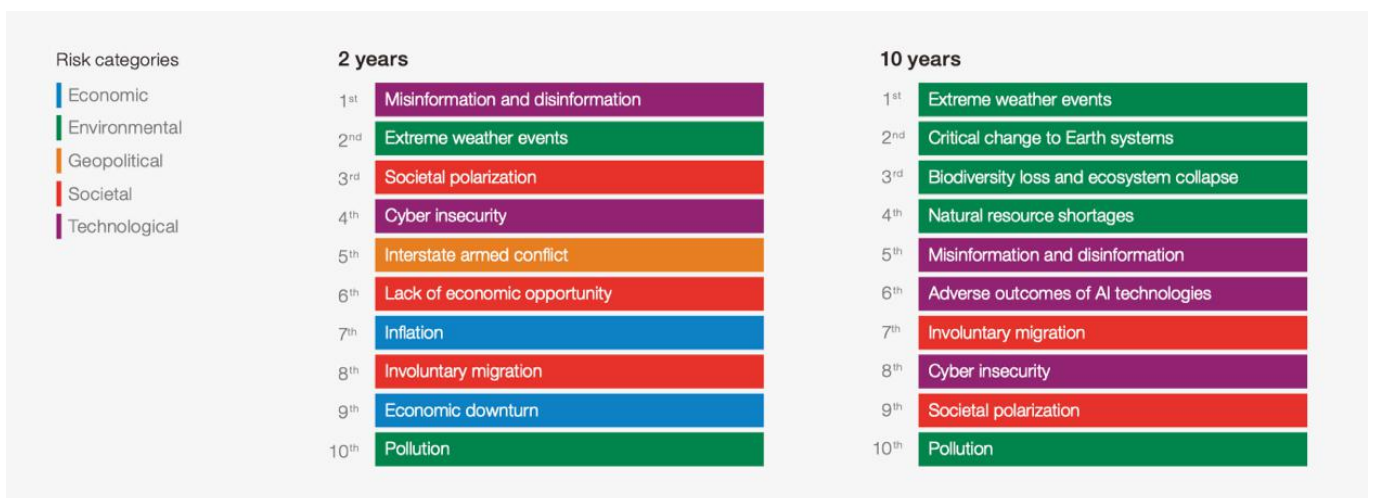
It seems remarkable that air pollution is still a major global problem - it has been so since I was an undergraduate! It's a problem in Australia too, although our air is generally cleaner when compared to other parts of the world. Short-term exposure to fine particulate matter in polluted air kills >1 million people each year worldwide.<sup>4</sup> Individuals exposed to dust, bushfire smoke, or

other pollutants for just a few hours each day can suffer health impacts – and that hundreds of those are Australians.

A major contributor to air pollution deaths is the pollution generated by the mining of coal. It's estimated that US coal plants are responsible for the deaths of over 460,000 people in the last two decades.<sup>5</sup> This alone should be sufficient reason to continue development of technologies associated with all aspects of a transition to renewable energy instead of fossil fuels.

Closer to home, it has recently been revealed that air quality levels at Melbourne's Southern Cross Station are alarmingly poor – and have been for far too long. A report by the ABC found that NO<sub>2</sub> levels in the station's bus interchange facility far exceed safe levels, where it was recorded as 1,200 parts per billion averaged over 24 hours, for the last 12 years. This means the air is 3.5 times worse than what is deemed to be 'extremely poor' levels.<sup>6</sup> While the air around the train platforms is better than the bus interchange facility, levels are still close to the EPA's limits for outdoor areas.

The Lancet's Planetary Health report in 2022 puts the number of global deaths from all forms of pollution at 9 million in 2015, making pollution the world's largest environmental risk factor for disease and premature death.<sup>7</sup>

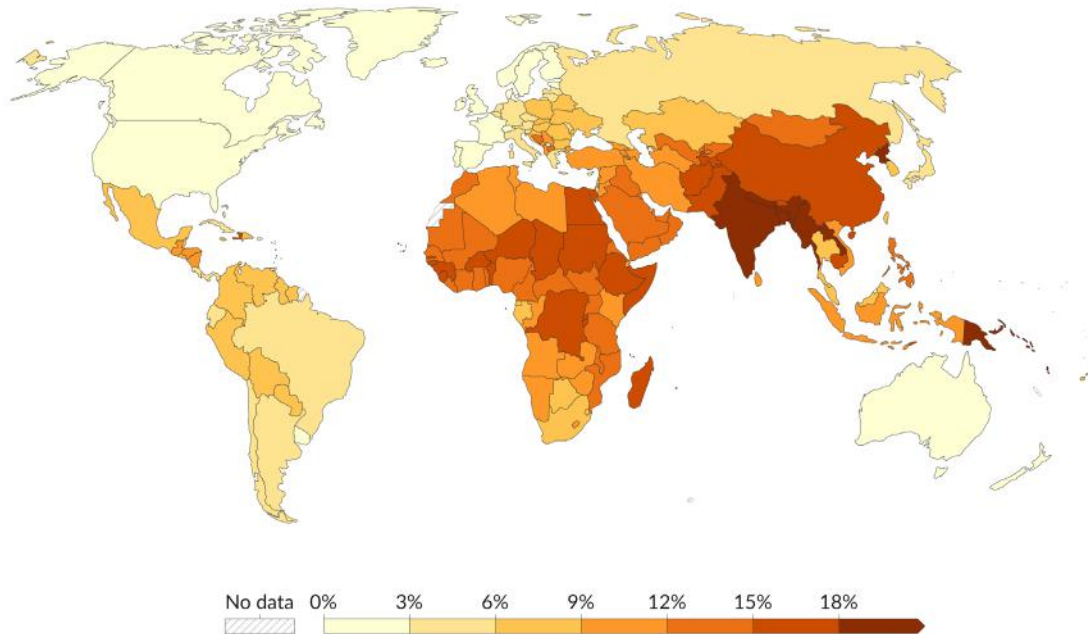


Global risks ranked by severity over the short and long term. Source: World Economic Forum Global Risks Perception Survey 2023-2024.

## Share of deaths attributed to air pollution, 2019



Share of deaths, from any cause, which are attributed to air pollution – from outdoor and indoor sources – as a risk factor.



Data source: IHME, Global Burden of Disease (2019)

OurWorldInData.org/air-pollution | CC BY

The RSV has recently installed an Attentis® environmental sensing unit on the east end of our property. These devices report air quality, weather, noise, and vibration together with 360° video and thermal detection - in real time! In the coming months, we will make this data available to RSV members and the wider community.

### Cleaning up waste

Paired with our pillar addressing pollution is how we manage the vast amounts of waste humanity generates. Waste has accumulated all over the world, and plastic is being found everywhere: in our oceans, on the Antarctic snow, and in our bloodstreams. Through the UNEP there are now efforts to establish a Global Plastics Treaty by

the end of 2024. To date there has been little progress, despite global agreement of the real need for a 'turning point'. I hope our lack of success over decades of global climate talks is not a model for these much-needed negotiations.

In the meantime, there are many leading models providing targets, guidance and models for circular economy thinking and 'Zero Waste'.

### Tackling misinformation

Finally, our fourth pillar – addressing the Rise of Misinformation – points to the RSV's role in our society: the promotion of evidence-based decision-making.

I recall the quote from Baroness Susan Greenfield that we are entitled to our own beliefs but not entitled to

our own facts! Whether social media has provided the opportunity for every individual to have his or her own belief or not, facts are facts.

This is a major global problem and was the subject of considerable discussion at the World Economic Forum in Davos, Switzerland in January (discussed in my column in February's *Science Victoria*).

As usual your ideas are welcome as we continue to rebuild the RSV as a valuable independent voice supporting the need for evidence-based decision making based on good science. Please email me at [president@rsv.org.au](mailto:president@rsv.org.au), or consider contributing a Letter to the Editor in an upcoming edition on any STEM issue.

We look forward to hearing from you.

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- 7 Fuller, R. (2022). Pollution and health: a Progress Update. *The Lancet Planetary Health*, 6(6). [doi.org/10.1016/S2542-5196\(22\)00090-0](https://doi.org/10.1016/S2542-5196(22)00090-0)



# Coasting into the Future

## The Nature of Change in Port Phillip Bay

GEOGRAPHY VICTORIA

### On Saturday March 2, 2024, Geography Victoria hosted a day-long trip to different sites on Port Phillip Bay.

The trip was led by Dr James Driscoll, Monash University and RSV President Rob Gell, who shared their extensive knowledge and expertise on geology, geomorphology, and climatology.

Starting at the Sea Scout Boat Shed Beaumaris near Table Rock (in the drizzling rain!), we examined the rock shelf on which the beach rests, which is made of Gellibrand Marl. This hardstone which extends across most of southern Victoria has been laid down over the course of approximately 25 million years. Despite the top surface being approximately 7.2 million years old, there are clearly visible nodules and tracks made by marine creatures burrowing into it at the time. These Miocene burrowings are even more visible in the Marl rock shelf at Ricketts Point.

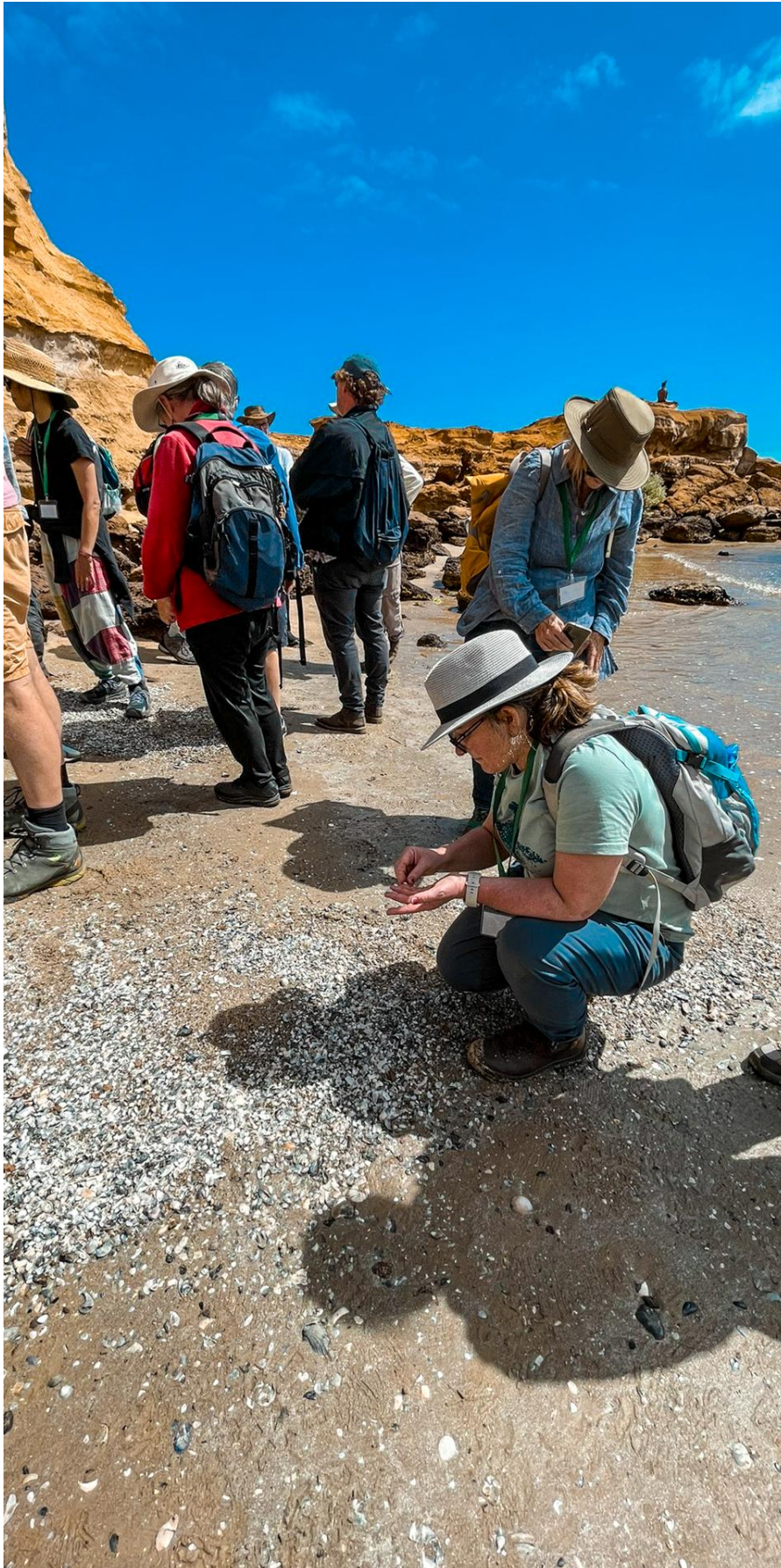
The Gellibrand Marl has been overlaid with Sandringham Sandstone, forming the cliffs along this part of the coast. Now in brilliant sunshine, we clambered around the beach and cliffs at Red Bluff, famous for its iconic rock stacks and pinnacles, called hoodoos, which have been eroded by wind, rain and runoff. The sandstone, which is rich in iron, (resulting in the red/brown colouring), was deposited over the course of approximately one million years. The bottom layers were set down in shallow marine conditions. The layers above are where freshwater silts were deposited from the land side. The division between the marine layers and the terrestrial layers is clearly visible. Remarkably, it is possible to see areas where waves have eroded their shapes into the rock during a particularly violent storm. Another fascinating feature of the sandstone is the array of trace fossils from crustaceans making noduled burrows (*Ophiomorpha*) and tunnels (*Skolithos*) in the sediment.



Photograph: Penny Beeston







The field trip involved a fair bit of climbing but even the oldest of us managed to scramble our way up and down again without incident. What an amazing place Red Bluff is and even more amazing when experts point out all the geological features.

The beaches and cliffs all around Port Phillip Bay are a portrait of a landscape in flux over millions of years. However, there is a sense that erosion patterns are speeding up due to climate change. Sea level is rising due to melting glaciers and every one-centimetre increase results in a one-metre retreat of the coastline (on a shallow gradient). Erosion of the upper cliffs by wind and rain is being retarded by the programme of planting with indigenous bush flora, but at water level the situation is more complex. We examined various protective structures that have been put in place, such as seawalls, breakwaters, and groynes. However, they have the effect of changing water flow patterns, thereby shifting erosion to a different location. As it is impossible financially to protect the entire coastline, difficult strategic decisions will have to be made.

The enthusiasm and knowledge of the trip leaders was inspirational, encouraging the whole group into a spirited investigation of a very wide area of interlinked subjects, shifting between scientific data, observation, and discussion of the ramifications of what we were seeing. It was a fabulous day, and we learned a lot from James and Rob. It was fun, informative, and aimed at a level that we could understand. Everyone I spoke to agreed that it was a wonderful day!

► This event was a collaboration between Geography Victoria and Life Saving Victoria/Victorian National Parks Association/Association of Bayside Municipalities as part of a Coastcare grant.

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### Upcoming Geography Victoria Events:

#### **SATURDAY MAY 4:**

Visit the Australian Synchrotron, in a chance to go inside our world-class national research facility (in partnership with the RSV)

#### **FRIDAY JULY 19:**

Take a deep dive into the Metro Tunnel Project

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Photograph: Karl Heidin via Unsplash

# Science Victoria STEM Photography Prize

## Win \$300 and celebrate the world of STEM.

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

In 2023, we introduced the 'Snapshots of STEM' 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 STEM. These are not stock photos or overly posed images. Instead, they show what working and studying in a STEM field is actually like.

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**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 by emailing [editor@ScienceVictoria.org.au](mailto:editor@ScienceVictoria.org.au).

**SUBMISSION DATE:**  
By 15 November

**ENQUIRIES:**  
For any questions about submissions for the *Science Victoria* STEM Photography Prize, please contact [editor@ScienceVictoria.org.au](mailto:editor@ScienceVictoria.org.au).

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Professor Euan Ritchie (Deakin University) and a stripe-faced dunnart (*Sminthopsis macouroi*). Photograph: Euan Ritchie





Dr Joanna Sumner and Colin Silvey from Museums Victoria taking a scale clipping from an Eastern Brown Snake (*Pseudonaja textilis*) at Gippsland Lakes. Photograph: Mark Norman/Museums Victoria.



# Science and Comedy: A ‘humerus’ learning experience

**Both science and comedy are done by people. They require a willingness to adapt and tinker with ideas until things work. And for the best results, people need to experiment and think outside of the box.**

Scientific research is often inaccessible to the public who are unable to bypass jargon, paywalls of academic journals, and other forms of gatekeeping. Good communication of science is imperative for evidence-based policy and a well-informed public. Why not do it through comedy?

Humour captivates and engages people’s attention. When complex scientific concepts are presented in a humorous way, they become more relatable and easier for the audience to understand and remember. Laughter also creates a more enjoyable learning experience, making people more receptive to new information.

Humour can also break down barriers and reduce intimidation associated with science. Some people may perceive science as dry, serious, and difficult to comprehend. By incorporating comedy, science communicators create a welcoming and inclusive environment where everyone feels comfortable participating in the discussion.

Convinced that science and comedy make a great duo? Multiple scientist-comedians are presenting shows during the Melbourne International Comedy Festival that you can attend this month to make you laugh, gasp, and think.

## Trick or Treatment

**25 - 31 MARCH**

Big pharma gets a bad rap, but what about big chakra? Come on a science comedy journey through the wild and weird and occasionally effective world of alternative medicine with Alanta Colley as your test subject. Science comedian and public health expert Alanta is curious about what makes alternative medicines so alluring, which ones work, which ones don’t and the mysterious power of the placebo effect.

Although Trick or Treatment may be over, we encourage you to be on the lookout for Alanta’s future gigs, especially Sci Fight, a quarterly Science Comedy Debate where scientists and comedians come together to debate serious issues in a ridiculous manner.



**MORE INFORMATION:**

[comedyfestival.com.au/2024/shows/trick-or-treatment](https://comedyfestival.com.au/2024/shows/trick-or-treatment)

Alanta Colley (Supplied)



## Atomically Correct

**27 MARCH - 7 APRIL**

This is the (nuclear) fusion you’ve been waiting for! A science comedy that explores how, even though we’re mostly nothing, we all still matter. Unravel the mysteries from inside the atom with Rachel Rayner, Science Explainer. Just like there are up quarks and down quarks in protons and neutrons, there will be ups and downs as Rachel breaks open the truth and beauty of the atom with a splash of sequins.



**MORE INFORMATION:**

[comedyfestival.com.au/2024/shows/atomically-correct](https://comedyfestival.com.au/2024/shows/atomically-correct)

Rachel Rayner (Supplied)





Stupid Old Studios/Luke Morris



## The Wine Science Show

**29 MARCH - 21 APRIL**

Pop the champagne as The Wine Science Show bursts into town. Luke Morris blends science and history as he tells the story of a red wine pioneer - whose story is being written out of history. In the investigation of what they did and what has happened to this lost scientific leader, Luke touches on physics, pollination, psychology, cyber security and neuroscience. Learn about how memories are made and lost, where new grape varieties come from, and if Champagne should be used to fight wars, plus many other tidbits.



**MORE INFORMATION:**

[comedyfestival.com.au/2024/shows/the-wine-science-show](https://comedyfestival.com.au/2024/shows/the-wine-science-show)

## The Scientwits: Lights Camera...Chaos!

**2 - 21 APRIL**

Scientist Sam (Sammy Harrison), a science teacher by day and stand-up comedian by night, simply wants to broadcast a serious science TV show. However, Sam's assistant, Captain Chaos (John Burgos), constantly - 'accidentally' - derails them with far more explosive and flammable ideas. Science experiments will go up in smoke. This one-of-a-kind, high-energy, and interactive sketch comedy show for kids (big and small) is not to be missed - you might learn some science too.



**MORE INFORMATION:**

[comedyfestival.com.au/2024/shows/lights-camera-chaos](https://comedyfestival.com.au/2024/shows/lights-camera-chaos)



The Scientwits/Chris Parker Photography

## Future Science Talks: Comedy Edition

**18 - 19 APRIL**

Over 20 scientists from Melbourne have partnered with comedians to infuse humour and laughs into scientific talks. With a formula of 80% science and 20% comedy, it will be 100% entertaining and educational "infotainment".

Why can't a climate scientist simply tell us what's up with the weather? What happens when an Australian immunologist develops an allergy to sunscreen? Researchers will discuss the therapeutic potential of MDMA (ecstasy), Australian dinosaurs, treatments for paediatric brain cancer, the search for answers about the universe and black holes, and more. Each talk is on a unique topic. No two talks are the same!



**MORE INFORMATION:**

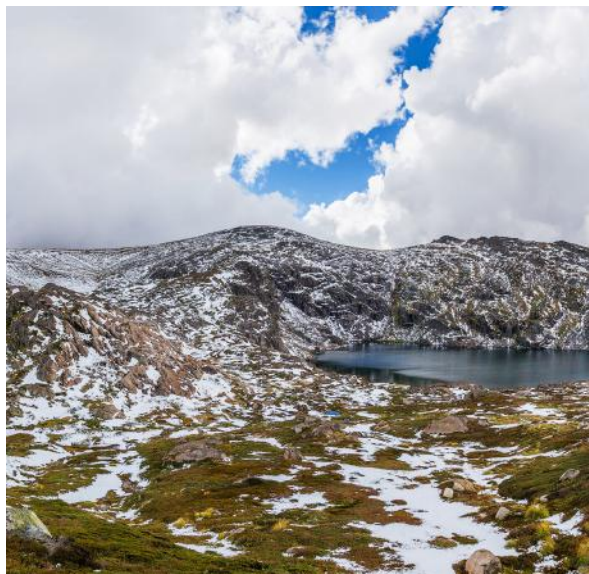
[comedyfestival.com.au/2024/shows/future-science-talks-comedy-edition](https://comedyfestival.com.au/2024/shows/future-science-talks-comedy-edition)

David Crisante, Future Science Talks



► Get ready to laugh, let loose, and learn with science comedy shows in the Melbourne International Comedy Festival. We could finish up with a good science joke...but all the good ones Argon.





## Holocene Climatic Fluctuations in the Australian Region

From ~8,200 to ~5,500 years ago, temperatures were higher than today, on the land and in the oceans. Lake levels and rainfall were extraordinarily high, and vegetation was very different to the present day in many places. In contrast, air temperatures in Antarctica were at the opposite to those in Australia, and atmospheric CO<sub>2</sub> levels were at their lowest for the entire Holocene. This period of time is referred to as the Holocene Hypsithermal.

Join acclaimed palaeontologist and 2023 RSV Medallist Professor Patrick De Deckker as he illustrates how human activities in southeastern Australia changed well after the Hypsithermal, with more sedentary activities along the major rivers and an enhancement of food production in organised settings suggestive of villages, in stark contrast with human migrations across North Africa during the Holocene.

**DATE/TIME:**

Thursday 18 April 2024, 6 pm - 7:15 pm

**PRICE:**

In-Person: \$10 (non-members) / \$5 (RSV members)  
Online: \$5 (non-members) / Free for RSV members

**LOCATION:**

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

**BOOKING LINK:**

[rsv.org.au/events/holocene-climatic-fluctuations](https://rsv.org.au/events/holocene-climatic-fluctuations)



**ABOVE:** Blue Lake and snow covered mountains. Kosciuszko National Park, Australia. Photograph: Greg Brave via Shutterstock.



## World Species Congress 2024

The World Species Congress, hosted by Reverse the Red ([reversethered.org](https://reversethered.org)), will amplify our collective conservation efforts and facilitate critical connections that accelerate our impact for species.

Reverse the Red is a coalition of organisations, groups, and agencies, co-chaired by IUCN Species Survival Commission and the World Association of Zoos and Aquariums, committed to accelerating and amplifying successful species recovery efforts through collaboration, innovation, and national capacity support.

196 countries committed to the Kunming-Montreal Global Biodiversity Framework ([cbd.int/gbf/targets](https://cbd.int/gbf/targets)), agreeing to meet Target #4 by 2030, meaning that threatened species are recovering, genetic diversity is being protected, and human-wildlife conflict is being managed.

The World Species Congress offers a forum for collaboration and a roadmap for success for anyone striving to create a healthier planet. We will celebrate and learn from successful strategies, tools, and partnerships in order to replicate, amplify, and accelerate action.

**DATE/TIME:**

8am Wednesday 15 May - 7am Thursday 16 May 2024

**INFO & BOOKING:**

[reversethered.org/world-species-congress-2024](https://reversethered.org/world-species-congress-2024)





# What's On

The RSV hosts many STEMM-related events, public lectures, and meetings throughout the year. Most RSV events are hybrid, held both in person (at 8 La Trobe St, Melbourne) and broadcast online via Zoom and Youtube. Our public lectures comprise the “Science in Focus” component of the Inspiring Victoria program in 2024.

## April

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### Holocene Climatic Fluctuations in the Australian Region (RSV Research Medallist 2023 Lecture)

*Please note that this event has been rescheduled from December 2023 to April 2024.*

Professor Patrick De Deckker, the 2023 winner of the RSV Medal for Excellence in Scientific Research, will present a lecture to RSV members and guests on the **18th of April at 6pm**, at which the Medal will be presented.

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**DATE**

18 April 2024

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**TICKETS**

[rsv.org.au/events/holocene-climatic-fluctuations/](https://rsv.org.au/events/holocene-climatic-fluctuations/)

## Later

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### RSV Phillip Law Postdoctoral Award Lecture

*Please note that this event has been rescheduled from November 2023 to mid 2024.*

The winner of the RSV's Phillip Law Postdoctoral Award for 2023 will present their work to a special meeting of the RSV at a public lecture. This will be professionally filmed and shared online.

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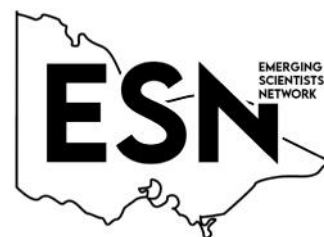
**DATE**

TBA

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**TICKETS**

[rsv.org.au/awards-and-prizes/phillip-law-award](https://rsv.org.au/awards-and-prizes/phillip-law-award)



Are you a current uni student or recent graduate, looking for future pathways and opportunities in science?

**The Emerging Scientists Network is for you.**

Find us on Facebook at:  
[tinyurl.com/6ya4kkyp](https://tinyurl.com/6ya4kkyp)

## Missed an RSV event?

You can catch-up on presentations from world-leading minds at [youtube.com/@RoyalSocietyVic](https://youtube.com/@RoyalSocietyVic)

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

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**YOUTU.BE/JL6SIKT9JSI**

*Aiming Higher: Improving Science Education in Victorian Schools*

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**YOUTU.BE/ODSSDCSU000**

*Reimagining Humanity in the Age of Generative AI*

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**YOUTU.BE/HJNBCCQ5N8G**

*Green Chemistry: Reinventing the Chemical Industry*

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**YOUTU.BE/1SYKWQKZF48**

*Glaciers and Ice Sheets in a Warming World*

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# Awards & Prizes

## National Science Week School Grants

**APPLICATIONS CLOSE**

12 April 2024

The Australian Science Teachers Association (ASTA), with funding assistance from the Australian Government's Inspiring Australia program, provides grants for school-initiated National Science Week activities in August 2024.

These grants are available to ALL Australian schools (preschools to senior secondary), with all applications and amounts awarded on comparative merit.

The grants are designed to support teachers and schools to deliver engaging STEM events and activities that align with the National Science Week vision. They are intended to be a contribution to the running of a National Science Week activity or event in a school, and not the sole means of support.

► For more information, visit: [asta.edu.au/programs/national-programs/national-science-week/school-grants](https://asta.edu.au/programs/national-programs/national-science-week/school-grants)



TAL via Unsplash.

## Australian Museum Eureka Prizes

**APPLICATIONS & NOMINATIONS CLOSE**

12 April 2014

The Australian Museum Eureka Prizes are the country's most comprehensive national science awards, honouring excellence across the areas of research & innovation, leadership, science engagement, and school science.

Presented annually in partnership with some of the nation's leading scientific institutions, government organisations, universities and corporations, the Eureka Prizes raise the profile of science and science engagement in the community by celebrating outstanding achievement.

18 prizes are on offer across the categories of Research & Innovation, Leadership, Science Engagement and School Science.

► Full details and submissions are available at: [australian.museum/get-involved/eureka-prizes/](https://australian.museum/get-involved/eureka-prizes/)



National Cancer Institute via Unsplash



Soapbox Science 2023 Melbourne participants. Photograph: STEM Sisters



## Soapbox Science

**APPLICATIONS CLOSE**

3 May 2024

**Applications are now open for Speaker and Volunteer positions at Soapbox Science 2024.**

Soapbox Science is a novel public outreach platform that transforms public spaces into arenas for learning and scientific debate. It follows a grassroots approach, inspired by the historic tradition of soapbox talks, to bring cutting-edge science to the public, with a twist – all speakers are women and non-binary scientists. This initiative not only promotes science but also champions gender equality in STEM fields, providing role models and breaking down barriers for future generations.

Join us in making science accessible to everyone and inspire the next generation of scientists. We're looking for dynamic speakers and dedicated volunteers to make our 2024 events our best yet.

Proudly brought to you by STEM Sisters and Soapbox Science.

► For more information, visit [stemsisters.org.au/soapbox-science-melbourne](https://stemsisters.org.au/soapbox-science-melbourne)

## David Syme Research Prize

**NOMINATIONS CLOSE**

30 April 2024

**Nominations are now invited for the 2023 David Syme Research Prize.**

The Australia-wide prize recognises the best original research in Biology, Physics, Chemistry or Geology produced (published) in Australia during the past two years (1 January 2022 - 31 December 2023).

The winner will receive \$10,000, and a medal.

- Full details and the nomination form are available at: [scienceunimelb.smartygrants.com.au/DSyme2024](https://scienceunimelb.smartygrants.com.au/DSyme2024)
- Enquiries should be directed to: [science-internalfunding@unimelb.edu.au](mailto:science-internalfunding@unimelb.edu.au)

## Global Science & Technology Diplomacy Fund - Strategic Element

**SUBMISSIONS CLOSE**

31 May 2024

**Expressions of interest are now open for the Global Science & Technology Diplomacy Fund - Strategic Element.**

\$6 million in grants are now available to grow international collaboration in our region, enhance Australia's standing as a science and technology leader, and drive innovation and commercialisation in priority areas.

Grants from AUD \$100,000 to \$1,000,000 are available for eligible Australian organisations collaborating on key areas of science and technology with priority partner countries across the Asia-Pacific region.

Applicants must focus on one of five priority themes and include at least one priority partner country. The themes are Advanced manufacturing, Quantum computing, Artificial intelligence, Hydrogen production, and RNA (including mRNA) vaccines and therapies. The eligible partner countries are Brazil, Indonesia, Japan, South Korea, Malaysia, New Zealand, Singapore, Thailand, and Vietnam.

- For more information, visit [glodip.org.au](https://glodip.org.au)





# Surviving an Existential Crisis

## Tackling Biodiversity Loss and Climate Change

**PROF. EUAN RITCHIE**

*Deakin University*

Nature gives us meaning, it makes our lives richer, more magical. And of course, we are a part of nature: embedded and intertwined. It is simply nonsense to think of people and nature as separate entities. Our very existence and economies are wholly dependent on Earth's species and ecosystems.<sup>1</sup>

But we betray and abuse this relationship: there's no question that we are rapidly destroying our only home,<sup>2</sup> and in turn, erasing extraordinary biodiversity which has been shaped over millions of years by evolution. Akin to burning down and bulldozing galleries and museums and the precious and unique works they contain, the environmental harm humanity inflicts is reckless, foolhardy, and unforgivable.

Humanity has brought about and is now entrenched within two existential crises: biodiversity decline and extinction, and climate change. I don't wish to catalogue the damage, nor eulogise what's already likely gone forever, since this is covered extensively in grim detail elsewhere. Instead, I offer personal reflections and provocations for some of the key areas that require urgent attention and change.

### The critical importance and challenges of storytelling

A fundamental characteristic of humans is the value and importance we place upon storytelling. As an ecologist and conservation biologist it is confronting to acknowledge that ultimately, changing hearts and minds and overcoming the many environmental problems we confront is rarely contingent on more data collection.<sup>3</sup> I do not seek to diminish the vital role of research for understanding our world and *hopefully* better informing conservation decision-making. After all, this is what I've been doing for most of my working life. But climate change is a matter of basic physics and chemistry.

In 1896, more than 120 years ago, Swedish scientist Svante Arrhenius outlined how increasing levels of carbon dioxide in the atmosphere would drive up global temperatures.<sup>4</sup> And in 1974, ecologist Daniel Janzen discussed how habitat destruction would both imperil species and risk the extinction of ecological interactions, which are mostly invisible.<sup>5</sup> It is these relationships between species — competition, predators and prey, symbioses and mutualisms, parasites and their hosts — that the health and integrity of ecosystems hinges upon. Like a complex, interwoven tapestry, pull on a thread and you risk the whole thing unravelling.

The kaleidoscope of colours as one swims over a coral reef.

Thousands of flapping grey-headed flying foxes silhouettes moving across a dusk sky in Naarm (Melbourne).

The extraordinary song of a lyrebird and the smell of its forest home immediately following rain.

Being stirred and serenaded by a choir of magpies at dawn.

A gardener's gratitude for ladybugs gobbling aphids.

*Nature is truly remarkable.*

Superb lyrebird (*Menura novaehollandiae*) in Kallista. Photograph: Geoffrey Moore via Unsplash

The notion that scientists should simply communicate more effectively to help solve the climate and extinction crises is also simplistic and naïve. Despite active attempts by employers and organisations to silence and suppress scientists,<sup>6</sup> over recent decades and with the advent of modern, social, and online media, increasing numbers of us have also become expert and effective science communicators. Facebook, TikTok, X (Twitter), YouTube: scientists have embraced these platforms, which typically have audiences that dwarf those of traditional media.

But on these very same platforms, scientists now battle trolls, bots, and misinformation. Feral horses *do* destroy fragile alpine habitats and endanger native wildlife, cats that are kept inside to not pose a risk to native wildlife will be safer and healthier, dingoes aren't 'hybrid, mongrel, wild dogs'. Every day, scientists roll up their sleeves, and at times risk genuine personal and professional harm. The abuse and bearing witness to the destruction of what many of us know and love intimately can take a heavy toll.<sup>7</sup>

It is undoubtedly why poor mental health is rife among environmental and climate scientists and why many have chosen to change careers.<sup>8</sup>

Finding a voice and platform in the mainstream media is another challenge altogether. As opposed to social media, television and newsprint are dominated by a minority of moguls that have been shown to trade in misinformation. Despite surveys revealing the public have a large and unsatisfied appetite for science stories,<sup>9</sup> this is not reflected in programming. The very real, ongoing, and accelerating decline of life on Earth is regularly hidden. Media reform laws that mandate a far greater diversity of voices and content are urgently required.

## Science and politics

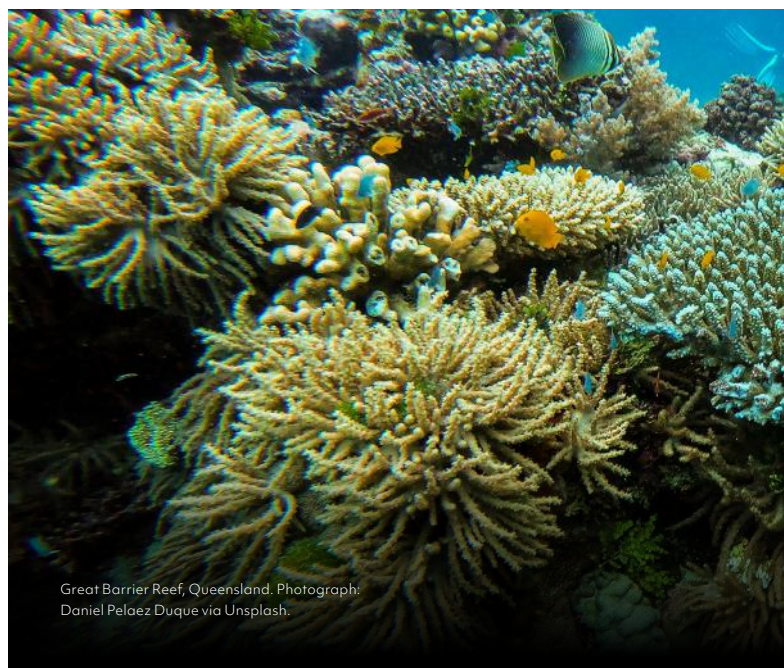
Inextricably linked with the challenges and complexities of media and effective science communication is our political system. In Australia, both Labor and the Liberal-Nationals coalition receive hundreds of thousands of dollars in political donations from fossil fuel companies annually.<sup>10</sup> It should therefore come as little surprise to us then, that successive Ministers for the Environment have baulked at the proposition that they should have a legal duty of care to children, and to ensure that their decisions provide for a safe, secure, and sustainable future for all.<sup>11</sup> It might also explain why they have celebrated UNESCO's declaration that the Great Barrier is not in danger, despite all the evidence demonstrating it unquestionably is.<sup>12</sup>

Those that fight and protest for the environment and climate are regularly punished and locked up, while many politicians continue to ignore scientific warnings and instead lock in increasing greenhouse gas emissions and the further destruction of habitats and ecosystems, including the Great Barrier Reef.

Science and scientists will continue to be sidelined in favour of vested interests unless we see substantial reform and improvements to laws concerning political donations, truth in advertising during election campaigns, and anti-corruption.

However, the blame does not lie solely with politicians. Scientists must also bear responsibility for our predicament, and where possible, drive change. We must not reinforce simplistic and flawed narratives.

It's been argued that the ultimate root cause of environmental and climate calamity is one of overpopulation,



Great Barrier Reef, Queensland. Photograph: Daniel Pelaez Duque via Unsplash.

but this sidelines inequality. It's a simple fact that a minority of people consume a disproportionate amount of the world's resources, and as a result have a gigantic environmental footprint. Yes, we need to have rational and respectful discussions about what constitutes a sustainable human population size, but just as importantly we must confront the issue of consumption and the mindless pursuit of constant economic growth.

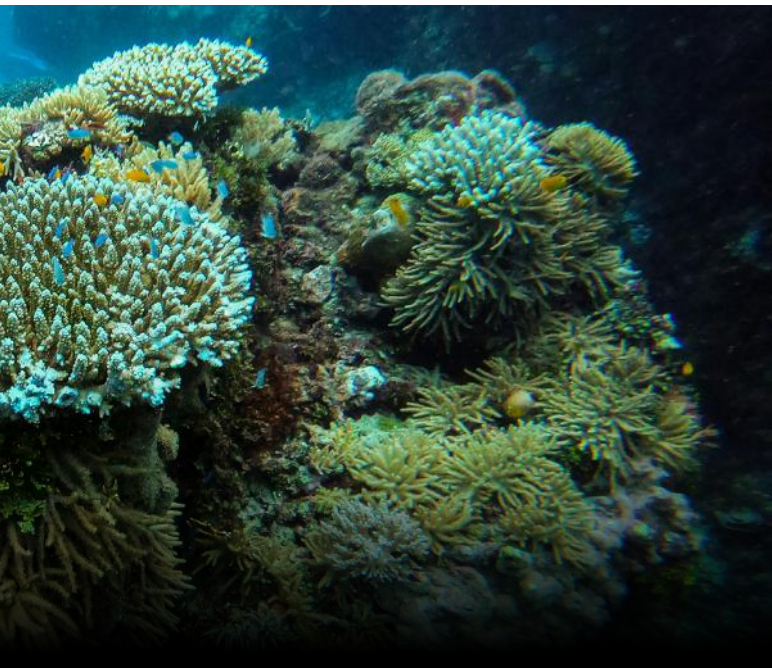
Likewise, arguing that we can't afford to save all species and should triage ignores the fact that in Australia alone we are committing to spending hundreds of billions on nuclear submarines, fossil fuel subsidies, and tax concessions for the wealthiest.<sup>13</sup> Yet we are told we need a nature repair market to sufficiently fund the conservation of biodiversity.<sup>14</sup>

It's been estimated that for ~\$2 billion per annum we could greatly improve the chances of survival for many of Australia's more than 1,900 threatened species.<sup>15</sup> There is no shortage of money, *per se* – the issue is what we value and what governments choose to invest in. We have some control over this of course, as each time we vote we have an opportunity to elect representatives whose values and priorities best align with ours.

It has been argued that scientists shouldn't get involved in politics, and that we should avoid advocacy and activism. But such a notion denies history. Science and politics have always been connected, and the environment and climate are no different. Scientists are not automatons; like everyone we have personal values, and we should be prepared to state what these are and to take up the evidence-based fight for what we seek to nurture and protect.<sup>16</sup> Environmental and conservation advocacy and activism does not automatically preclude scientific objectivity, it is a matter of being transparent and adhering to the principles, practices, and ethics of the scientific process.

A great strength of the scientific process, if practised correctly, is that it cares not for our own personal feelings, biases, and beliefs. We should always let data and evidence guide us.





## Maintaining hope and driving change

In the dire predicament we find ourselves in, the risk of despondency and apathy are ever present, but I and many others within the ecological, climate and conservation communities remain hopeful. We must celebrate the wins. For example, there were once fewer than 40 northern hairy nosed wombats alive, at the time making it among the most critically endangered species in the world, but now its numbers have passed 300 and its prospects of survival are much improved.<sup>17</sup>

Furthermore, rapidly developing technologies and approaches such as artificial intelligence, drones, and genome editing, offer once unimaginable possibilities for assessing ecosystems and managing and conserving species, and ultimately, even more conservation success stories.

Along the way, we should also support each other to take calculated risks, and learn from, not punish, our failures. Far too often the conservation community turns on its own. Yes, we should try and resurrect a thylacine-like animal, because whether we achieve the ultimate goal, the advances made along the way will almost certainly benefit and help conserve living species. The thylacine de-extinction project is not a distraction, nor does it take money away from other more pressing needs: rather the failures to care, act and invest have existed for a long time and have other root causes.

We must continue to tap into the many positives of citizen science. The success of the Australian Museum's frog id app (> 670,000 calls submitted, > 1,000,000 frogs and over 200 species confirmed to date) is genuinely inspiring. This program has contributed many good news stories for frogs, including following the devastation of the 2019-20 fires, where the persistence of the vulnerable southern barred frog, and endangered mountain frog and giant barred frog were confirmed.<sup>18</sup>

Most importantly, we have so much still to learn, and great opportunities exist to do things differently. Nowhere is this more obvious in Australia. First Nations peoples have cared for Country for more than 60,000 years, but cultural practices and values continue to be affected by the ravages of colonialism,

and attitudes and actions that persist to this day.<sup>19</sup> For conservation to advance we must reconcile with this continent's history, and as new environmental laws take shape, Aboriginal and Torres Strait Islander peoples must be active and adequately supported participants and drivers of change.<sup>20</sup>

Our environment will never be the same as it was, or how many of us might remember it, and we should mourn and not forget what our collective actions have caused. But the choices we make now will determine the future we inherit. Far from feeling that all is lost, speak and act for the voiceless, and care for, and defend what you love.

► *Euan Ritchie is a Professor of Wildlife Ecology and Conservation at Deakin University and a Eureka Award-winner for Environmental Research.*

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# Climate Change

## What...or Who...is to Blame?

**DR CATRIONA NGUYEN-ROBERTSON MRSV**

Senior Editor, Science Victoria

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**Last year (2023) was the warmest year on record, with the global average temperature 1.35°C above the pre-industrial average (1850–1900).<sup>1</sup> How much of this warming can be attributed to human activity?**

According to the latest Intergovernmental Panel on Climate Change (IPCC) Report: *'Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming, with global surface temperature reaching 1.1°C above 1850–1900 in 2011–2020.'*<sup>2</sup> The report does not shy away from the fact that *'observed warming is human-caused'*.

There are many factors that contribute to climate change – both in the past and in the present. Greenhouse gases in the atmosphere act like a blanket, trapping warmth. Without them, the temperature would be a cool -18°C, unable to sustain life as we know it.<sup>3</sup> They were present before humans came along, however, many things in our modern world produce extra greenhouse gases, like the burning of fossil fuels.

Compared to other processes that produce greenhouse gases or warm our planet, how much are we to blame?

### Warmth from the Earth's core

The Earth formed around 4.5 billion years ago as rock, dust, and gas clumped together into a hot, giant ball. It was only during the first 50–100 million years that the Earth cooled down enough from its initial 1,500°C to form a solid mantle and outer crust, still with molten magma at its core.

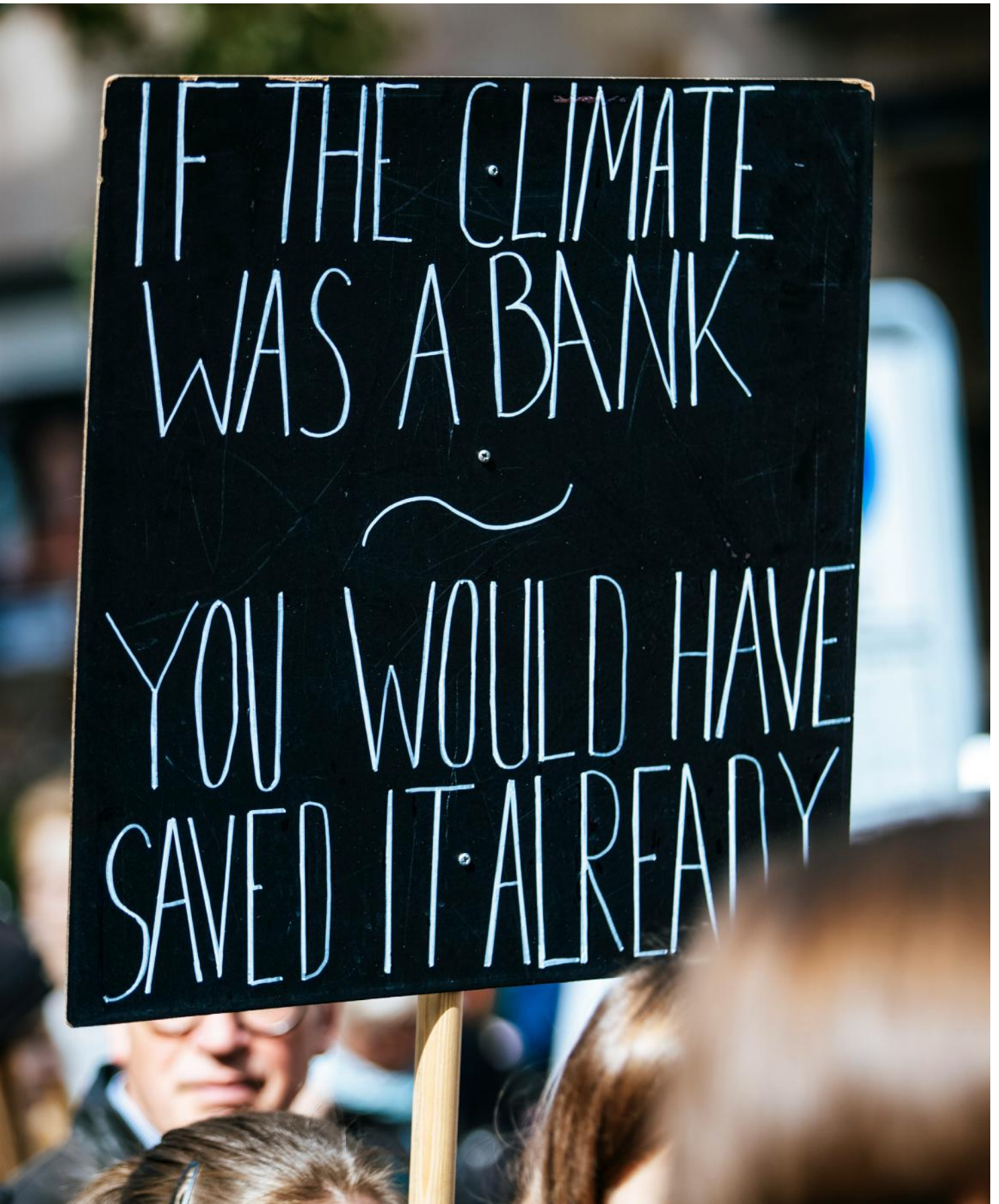
Residual heat from the planet's formation, as well as heat released from the radioactive decay of elements (e.g. uranium, thorium, and potassium) in the planet's crust and mantle are sources of internal heat. They contribute a mere 0.03% of warmth to the atmosphere compared to incoming heat from the Sun.<sup>4</sup>

This heat from the Earth's core dissipates into the atmosphere extremely slowly – too slowly to cause the warming we are seeing.



Global climate change protest, September 2019. Photograph: Markus Spiske via Unsplash.





## Basking in sunshine

An enormous amount of solar radiation is released from the Sun, reaching Earth as heat energy. Some heat is absorbed, especially by oceans, and most is reflected, radiating back out to space. Over the period of an 11 year-cycle, solar radiation levels fluctuate by up to 0.15%.<sup>5</sup>

Global surface temperature changes have fluctuated slightly with this cycle in the past, but since the late 20th century, the global surface temperature has deviated on an upwards trajectory, unaffected by the 11-year cycle.<sup>5</sup>

The change is not large enough to cause any long-term changes to Earth's climate.

## An orbital dance of the Sun and Earth

Small variations in how Earth moves around the Sun influence its climate over great timespans. Three types of variations in Earth's orbital movements, known as the Milankovitch cycles, affect how much solar radiation reaches the top of Earth's atmosphere and where it reaches.<sup>6</sup>

Earth's annual lap around the Sun isn't perfectly circular. Over time, the pull of gravity from Jupiter and Saturn causes Earth's orbit to shift from nearly circular to slightly elliptical, affecting the distance between the Sun and Earth.<sup>6</sup>

The angle of Earth's tilt also varies. The greater the tilt, the more extreme our seasons are, as each hemisphere either receives more solar radiation during summer when it is tilted towards the Sun, or less when it points away in winter.<sup>6</sup>

Lastly, as Earth rotates, it wobbles slightly upon its axis – like an off-balance spinning top. This makes seasonal contrasts more extreme in one hemisphere (currently the southern hemisphere) and less extreme in the other.<sup>6</sup>

All three Milankovitch cycles span timeframes of tens to hundreds of thousands of years. While they are likely responsible for triggering the beginning and end of glaciation periods (Ice Ages), they cannot account for Earth's current period of rapid warming.

## Asteroid impacts

Most meteorites that reach Earth are small, and burn up in the atmosphere. But when a large asteroid smashes into the Earth, it ejects an enormous amount of dust, ash, and other material into the atmosphere. Asteroids with a diameter bigger than 1 km strike Earth roughly every several hundred thousand years.<sup>7</sup> The greater the asteroid, the greater the time span in between.

The last known impact of an object of 10 km or more in diameter was at the Cretaceous–Paleogene extinction event 66 million years ago – the asteroid that accelerated the demise of the dinosaurs. It slammed into rocks rich in carbonates, releasing immense quantities of carbon dioxide (CO<sub>2</sub>), and triggered vast wildfires, releasing even more. Global temperatures rose by 5°C, and the Earth stayed that hot for 100,000 years.<sup>8</sup>

But we haven't had a major asteroid impact like that for millions of years – not recently enough to cause the global warming we see now.

## Volcanic gas and ash emissions

Gases and dust particles thrown into the atmosphere during large volcanic eruptions influence climate, creating both heating and cooling effects. Dust and ash particles spewed

from volcanoes high into the atmosphere can shade incoming solar radiation, causing a temporary cooling effect. The catastrophic volcanic eruption of Mount Tambora in Indonesia in 1815 released 60 megatonnes of gases, ash, and other rock and aerosols into the atmosphere, plunging the entire world into a three-year winter (0.7°C) before temperatures began to rise again.<sup>9</sup>

The “super-eruption” of another Indonesian volcano, Toba, 74,000 years ago has been the largest known natural disaster in the past 2.5 million years.<sup>10</sup> Toba ejected so much volcanic ash into the atmosphere that it cooled the world by 3–5°C.<sup>11</sup>

Volcanoes can also have a warming effect when eruptions spew greenhouse gases, like CO<sub>2</sub> and sulphur dioxide, into the atmosphere. Over millions of years this may contribute global warming, but the annual flux of CO<sub>2</sub> emissions from volcanoes is under 260 million tonnes per year – much less than the 40 billion tonnes per year from human activities.<sup>12</sup>

There have been no major greenhouse gas-producing volcanic eruptions in the last 250 years – volcanoes can't be blamed for warming since the pre-industrial era.

## Biological processes

We breathe in oxygen (O<sub>2</sub>) and breathe out carbon dioxide (CO<sub>2</sub>). Most life on the planet undergoes metabolism, consuming oxygen to survive. However, some organisms also go the opposite way: taking in CO<sub>2</sub> for photosynthesis.

Before photosynthesis evolved, oxygen levels in the atmosphere were very low and CO<sub>2</sub> levels were high. In Earth's early days, the atmosphere was composed of gases from volcanoes: hydrogen sulphide, methane, and 10–200 times as much CO<sub>2</sub> as today's atmosphere.<sup>13</sup> Primitive photosynthesis did not produce oxygen, but as photosynthetic algae evolved around 2.5–1 billion years ago, oxygen started to build up in the atmosphere while carbon dioxide fell. Eventually, the amount of oxygen present in the atmosphere enabled animals to evolve.

But changes in atmospheric gases levels through biological processes are slow, as they are long-term shifts in response to evolution – they have not contributed to current warming. That said, deforestation and land clearing have led to increased CO<sub>2</sub> by way of removing trees that would otherwise act as a carbon sink.

## Humans

Lastly, we come to us: the anthropogenic (human-made) source of greenhouse gases. Three culprit gases have increased dramatically since the industrial revolution and contribute to global warming: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O). While “carbon emissions” are often discussed in the context of climate change and climate action, methane has over 28 times the heat trapping capacity of carbon dioxide, and nitrous oxide has 265 times the capacity.<sup>15</sup>

Anthropogenic carbon dioxide can be distinguished from natural sources based on isotopes – or chemical variants – of carbon: the lightest and most common version of carbon (<sup>12</sup>C), and heavier variant (<sup>13</sup>C). When we burn fossil fuels, we release a large amount of carbon dioxide containing the lighter (<sup>12</sup>C) carbon isotope, which tips the ratio of the two variants in the atmosphere. Since the beginning of the industrial era in 1750, and much more rapidly since 1950, this ratio has been increasingly favouring the lighter variant – correlating with the increased burning of fossil fuels.<sup>16</sup>



We therefore know that anthropogenic carbon dioxide has increased – and it is the major cause of the increasing atmospheric carbon dioxide.

### If we are to blame, what can we do about it?

The United Nations ActNow campaign encourages people to save energy and change energy sources at home, eat plant-based foods, consider travel options, and reduce, reuse, repair and recycle.<sup>17</sup>

All of these suggestions are ‘good’, and as more individuals spend their money on these options, companies will respond to the changing consumer habits. If everyone in a town suddenly became vegetarian and only rode bicycles, you’d expect to see more greengrocers and bike stores pop up (while butchers and car dealers would have to adapt).

However, this thinking puts the onus solely on individuals. These individual changes can be good, but they’re nowhere near enough to meaningfully impact climate change.

## We need collective action at all levels – local, state, national, and international.

Policymakers may have established agreements and targets to cut emissions and limit warming (e.g., the Paris Agreement), but we need strong action to meet these targets. We need multiple solutions, and for those solutions to be enacted.

Australia currently hits hard in terms of climate change: our carbon emissions are higher than 90% of countries, and among the highest per capita in the world.<sup>18</sup> The easiest, most efficient and cost-effective ways for Australia to reduce greenhouse gas emissions are:

- ▶ Transitioning away from fossil fuel generated electricity to renewable energy and storage technologies.
- ▶ Electrify our transport systems (and use renewable energy to power them).
- ▶ Reforestation and regenerative agriculture would counteract the roughly 13% and 9% that agriculture and deforestation currently contribute to emissions.
- ▶ Lastly, we actively need to transition away from both using and exporting fossil fuels.

Individuals can make individual changes, but we also need to pressure decision-makers to create change too. We can vote for policymakers who will enter into climate negotiations and adopt policies that protect the planet. We can join others to pressure governments to end fossil fuel subsidies, and to support key industries to transition to sustainable practices. We can ride a bike, and remember our reusable coffee cups, but we also need to write to the people we elect to act in our planet’s best interests.

Earth has experienced climate change before. These changes have been slow, caused by continental migration, Earth’s orbital behaviour around the Sun, volcanism, and evolution. Global temperatures have risen and fallen - often accompanied by mass extinction events. While we may give ourselves the benefit of the doubt, scientific evidence points to humans as the key drivers of our currently changing climate. It’s up to us to consider how we will address it.



▶ This article was inspired by a presentation to the Royal Society of Victoria delivered by Professor Raymond Cas (Monash University) in September 2023. You can watch his presentation in full at [youtu.be/e-183\\_0Sr1c](https://youtu.be/e-183_0Sr1c) (or in brief at [youtu.be/hjLx4P0dkCY](https://youtu.be/hjLx4P0dkCY)).

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# Clearing the Air

## The Silent Perils of Air Pollution

**DR CATRIONA NGUYEN-ROBERTSON MRSV**

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As I cycle around Melbourne, I sometimes wonder whether the health benefits of my exercise are negated by the polluted air that I breathe in on roads with high traffic volume.





I have travelled to cities where the smog is so thick that it lingers visibly in the air, and triggers asthma that I never knew I had. Smoke from the devastating 2019-2020 Black Summer bushfires exposed millions of people to air pollution across eastern Australia – I was among many who sought a suitable mask to wear outdoors.

From the smog looming over cities to smoke inside our homes, air pollution poses a major threat to our health and our climate. The combined health impacts of ambient air pollution and household air pollution contribute to an estimated 7 million premature deaths annually.<sup>1</sup>

This makes it the world's greatest environmental cause of preventable disease and premature death.<sup>2</sup>

In this edition of *Science Victoria*, we discuss the four planetary crises. Climate change and air pollution go hand-in-hand: they make each other worse. Climate change leads to more frequent and severe bushfires, which contribute to air pollution. But similarly, policies that reduce air pollution are also vital for mitigating climate change as they share common drivers, such as fuel combustion.

## What is air pollution?

Air pollution refers to the presence of harmful or excessive quantities of pollutants in the air that endanger human health, the environment, and the planet. Pollutants can come from naturally occurring events like bushfires and volcanic eruptions, but they are primarily generated by human activities such as industrial processes, vehicle emissions, and the burning of fossil fuels.

Air pollutants consist of both airborne particles, called particulate matter (PM), and gases.


Inhalable particles vary in size and are a common measure of air pollution. Sources of larger, coarse particles are mainly pollen and wind-blown dust from erosion, agricultural spaces, roadways, and mining operations. The finer particles can be derived from combustion of fuels and chemical reactions between gases already in the atmosphere.

Gases that contribute to air pollution can sometimes be imperceptible – colourless, odourless, and/or tasteless – yet toxic. Carbon monoxide (CO) is produced by the incomplete combustion of fuels such as wood, petrol, charcoal, and natural gas, with the predominant source of CO in the air coming from motor vehicles. Other common polluting gases include nitrogen dioxide (NO<sub>2</sub>) and sulphur dioxide (SO<sub>2</sub>), both of which are released from fuel combustion. Lastly, ground level ozone (O<sub>3</sub>), not to be confused with the ozone layer in the atmosphere, contributes to smog and is produced when other gas pollutants react in the presence of sunlight.<sup>3</sup>

This is not an exhaustive list of pollutants. Formaldehyde, lead, mould, black carbon, and other pollutants are also listed by the World Health Organisation as air pollutants.<sup>3</sup> And they all have an impact on our health.

## How does air pollution impact us?

PM is capable of penetrating deep into the lungs and entering the bloodstream, before spreading to other parts of the body.<sup>4</sup> Pollutant gases also directly damage the respiratory tract – and CO can cross into the bloodstream, where it makes



A toxic haze shrouds China's inland industrial towns. Photograph: Jerry Zhang via Unsplash.

it difficult for our blood cells to bind to oxygen, essentially depriving tissues of oxygen. In addition, these pollutants can work in tandem to damage lung cells, as seen by a recreation of lungs in a lab that were impacted by NO<sub>2</sub> and PM.<sup>5</sup>

In the short-term, exposure to air pollution irritates the respiratory tract. As I discovered in Beijing (which, at the time, had a “red alert” air quality warning)<sup>6</sup> it can exacerbate allergies, allergic rhinitis (runny nose), eczema and asthma, and long-term exposure increases the risk of developing these in the first place.<sup>7</sup>

Air quality affects our health throughout our lives. Even before birth, the growth, development, and overall health of unborn babies is impacted by ambient air pollution.<sup>7</sup> Young children who are exposed to particulate matter, carbon monoxide, or ozone for as little as one day can also incur a higher risk of disease in adulthood.<sup>7,8</sup> Air pollution can alter the regulation of their immune systems, stunt lung development, and increase blood pressure, suggesting that even at a young age, the immune, respiratory, and cardiovascular systems are negatively impacted by exposure to air pollution.<sup>8,9</sup>

Later in life, air pollution increases the risk of non-communicable diseases. Heart disease, stroke, type 2 diabetes, lung disease, and cancer are all leading causes of illness and death for Australians – and exposure to air pollution increases our risk for all of these.<sup>9</sup> Air pollution also increases the risk and severity of respiratory infections such as pneumonia, influenza, and COVID-19.<sup>10</sup>

At a population health level, air pollution exacerbates health inequities. Some of the most vulnerable people in Australia are at higher risk of worse health outcomes from air pollution exposure, including socially disadvantaged populations and First Nations Australians.<sup>11</sup> Around the world, people living in low- and middle-income countries disproportionately bear the burden of air pollution with as much as 89% of air pollution-related premature deaths occurring there.<sup>12</sup>

## What can we do about it?

There is extensive evidence on the short-term and long-term health impacts of air pollution – now we need to decide what we will do with this evidence. Energy generation, transport systems, climate change – many factors feed into the quality of the air that we breathe.

**No single policy will adequately tackle the problem, and we therefore need coordinated approaches to make our air safer.**

Air is shared - most sources of outdoor air pollution are well beyond the control of individuals. We need policymakers in sectors like energy, transport, waste management, urban planning, and agriculture to implement policies to reduce air pollution. The use of clean technologies that reduce industrial smokestack emissions, shifting to clean modes of power generation, supporting scientifically-informed policies to reduce the frequency and severity of bushfires – there are many actions we can collectively take.

Something to consider is that children are particularly vulnerable to air pollution and will suffer the health consequences of today's air quality in the future. Yet environmental policies have traditionally not taken them into account, as the data that informs policy have been derived from studies on adult humans (or adult animals), without considering children's distinct physiology.

Additionally, air pollution decisions should ideally be informed by specific risk assessments to children's health and set out a framework to protect children and adolescents – especially in child-centric settings like schools. We need to be constantly assessing the data. A review in 2022 revealed that inhalation of PM increases rates of diseases and death even when inhaled at levels below existing standards,<sup>13</sup> and the US Environmental Protection Agency has tightened its guidelines in January this year as a result.<sup>14</sup>

We inhale six litres of air every minute on average.<sup>15</sup> Even small amounts of pollution in air can have a major impact on our health over time. The air that we breathe is communal, and air pollution affects everyone. The Centre for Safe Air, funded by the National Health and Medical Research Council, has recently been established to support the translation of scientific evidence into policy and practice.<sup>16</sup> We need coordinated leadership across sectors and evidence-based action to ensure that we all can enjoy the benefits of safer air.

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# The Rise of Misinformation & Disinformation

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In this edition, we're looking at four crises currently faced by our planet. For three of these, it's relatively easy to see the threat: declining biodiversity is threatening the existence of species; air, water, and soil pollution are impacting the health of every living thing; and climate change is increasingly throwing the Earth's systems into chaos. They really feel like the horsemen of an apocalypse.

The fourth of these crises – the rise of misinformation – might sound less catastrophic than its counterparts, but it is arguably the horseman who preceded the others. Understanding, curbing, and countering misinformation is vital if we stand any hope of meaningfully addressing these planetary crises.

What is misinformation? What problems does it cause? And, most importantly, what can we do about it?

## The mis- and dis- of information

'Information' informs an audience about something. It is data that has been processed and given context so that it conveys meaning. The numbers 12, 18, and 90 are seemingly random data, but with the context of 12 goals, 18 behinds, 90 points, those numbers inform the audience of Collingwood's winning score in the 2023 AFL Grand Final.

The difference between misinformation and disinformation is intent. Both refer to false, inaccurate, or misleading information; misinformation is shared without the intent to deceive, while disinformation is created and shared with the intention of deliberately deceiving or misleading others. If misinformation is like manslaughter, then disinformation is like murder – either way, the information is dead.

The spread of false information is nothing new, nor are large scale campaigns that utilise misinformation and disinformation as a tool. Wartime propaganda is one example: during World War 2, broadcasts in Germany by 'Der Chef' ('The Chief') sounded like military chatter, but were actually made by a German defector to spread fake news and sow discord within the Reich.<sup>1</sup>

Disinformation campaigns are not limited to countries at war. Over the last century, we have seen campaigns to obscure the truth or outright deceive the public and alter health policy from many industries, most notably the fossil fuel sector, tobacco, alcohol, and sugar.

## Sickly sweet

Sugar intake has been associated with obesity and other diseases for more than 2000 years, but the cost and limited availability of refined sugar restricted its widespread use in 'Western' diets until American cane plantations enabled mass production.<sup>2,3</sup>

The 20th century saw sugar production costs decrease further, the invention of high-fructose corn syrup (HFCS), and the increased availability of processed foods and drinks containing added sugar. This coincided with a rise in cases

of obesity, diabetes, and coronary heart disease, with many studies indicating a connection.<sup>4,5</sup>

In response, the sugar industry (i.e., companies including food and beverage manufacturers, and those involved in sugar crop farming and refinement) maintained a multifaceted campaign to obscure the science and undermine public health policy on sugar.<sup>6</sup>

A central part of this campaign was the generation of disinformation, and supporting the spread of misinformation through trade associations, front groups, and PR firms. This included companies establishing in-house 'research institutes', which would then publish misleading studies and communications that downplayed or ignored the health impacts of sugar.

A 2008 fact sheet from the Nestle Research Centre confronts the warnings about sugar's connection with obesity, stating that "the data on which these warnings are based are limited", and that "messages to reduce sugar consumption to prevent body weight gain, although seemingly plausible, are therefore contrary to the evidence provided by current epidemiological research."<sup>6,7</sup>

Another successful tactic of the disinformation campaign was to 'shift the blame' for obesity and other diseases to fat from sugar – which contributed to the marketing of 'low fat' and 'no fat' (but higher sugar) products we are all familiar with.<sup>8,9,10</sup>

Our consumption of sugar is now decreasing, thanks in part to new sugar-free sweeteners and public health campaigns. However the actions of the sugar industry is just one example of how disinformation can become widely shared misinformation, like "fat makes you fat".

## Reasons behind the rise

With a long history of misinformation and disinformation, why has it now increased to the level of a planetary crisis?

The University of Melbourne's A/Prof Andrew Perfors puts it down to two fundamental reasons: the advent of the internet, and our difficulties in determining which information we should believe.<sup>11</sup>

Put simply, it comes down to technology and psychology.

The internet and social media have rapidly accelerated the spread and escalated the risks posed by misinformation. Once restricted to legacy media formats, incorrect information is now able to quickly (and repeatedly) reach its audience and disrupt societies, as we witnessed during the COVID-19 pandemic.

Facebook, Twitter, TikTok, YouTube, Instagram, LinkedIn, Google Search and Google News, Snapchat, and Apple News are key digital platforms for news and information for many Australians, as detailed by the Australian Communications and Media Authority (ACMA) in their 2020 position paper on addressing misinformation.<sup>12</sup> As unregulated as they can seem, these platforms have at least some ability to flag inaccurate,



misleading, or inappropriate content. In contrast, content shared on encrypted messaging platforms like WhatsApp and Telegram is significantly harder to address.

On all of these digital platforms, disinformation can be introduced by a malicious group or individual, and then shared within and across platforms by many different people – who may have no intention to mislead or deceive – as misinformation.<sup>13</sup> This can result in a single piece of misinformation being seen repeatedly by a single viewer in a short span of time, which unfortunately makes it even harder to identify it as false.<sup>14</sup>

When we are bombarded rapidly with information across different platforms every day, we're not taking the time to perform a critical assessment on the validity of every story. It's incredibly difficult to prove or disprove the majority of what we read, and so we use some mental shortcuts to quickly separate fact from fiction... but these can let us down.

The mental shortcuts we take to reach decisions are what psychologists call 'heuristics'. Our tendency to believe a piece of information we see repeatedly is an example of heuristic decision making – we tend to favour things that we are 'familiar' with, even if it's something we first read a few days ago. In other words, we tend to think that if everyone's saying it, then it must be true.<sup>14,15</sup>

We also tend to believe things that are easier for us to process. It's a big reason why communicating scientific expertise is most effective when the science is embedded within an engaging narrative, written with simple language and minimal jargon. It's also why misinformation conveyed as part of a compelling narrative is more effective.<sup>16</sup>

With misinformation impacting public health,<sup>17</sup> impairing our response to climate change,<sup>18</sup> and sowing discord around the world,<sup>19</sup> how can we protect ourselves and our communities?

## Stemming the rising tide of misinformation

If we attribute the rise of misinformation to technology and psychology, then any response needs to address both of these factors.

Managing the technology element without blanket bans on websites requires nuance – especially when the offending sites are not hosted in Australia, nor subject to our national regulatory frameworks and jurisdiction for enforcement.

The federal government's *Communications Legislation Amendment (Combatting Misinformation and Disinformation) Bill 2023* was released as an 'exposure draft' in June 2023, with the aim of both defining misinformation and empowering the ACMA to address it.<sup>20</sup> Consultation on the draft closed in August 2023, and received many submissions from digital platforms, media outlets (including the ABC and SBS), and the general public.<sup>21</sup> The bill is expected to be introduced to parliament in 2024, and we will have to wait and see what powers the ACMA will be given – and how effectively they address misinformation in practice.

Addressing the 'psychology' aspect largely focuses on building resilience to misinformation in the population. In other words, helping people identify misinformation so that we're all a little less susceptible to it.

At a population level, it means things like building critical thinking into education, so that students know how to effectively fact-check the claims they encounter. It's not enough to rote-learn an answer – you need to show your working out, which makes logical fallacies a little easier to spot.

A recent report from the University of Canberra's News and Media Research Centre provides recommendations on how to support resilience to misinformation at the population level, including encouraging students to fact-check new or



A 2008 fact sheet from the Nestle Research Centre confronts the warnings about sugar’s connection with obesity, stating that “the data on which these warnings are based are limited”, and that “messages to reduce sugar consumption to prevent body weight gain, although seemingly plausible, are therefore contrary to the evidence provided by current epidemiological research.”<sup>6,7</sup>

unfamiliar claims, and even creating a dedicated agency to build information literacy in the population.<sup>22</sup>

On an individual level, we need to be aware of the cognitive shortcuts we take every day, and understand how we can improve our own decision making. Slowing down the rate we are bombarded with information is a good start. Rather than swiping from one headline or social media post to the next, we can pause and process the new data.

Check the source of the information, and the author’s credentials – a TV chef might not be an authority on vaccination. Have some healthy scepticism around sensational claims (e.g., a ‘miracle cure!’ should warrant further investigation), and know how to recognise a trustworthy source of scientific information.<sup>22,23</sup>

Best of all: when in doubt, don’t share it.

Finally, STEM professionals need to do better with communicating their expertise with a general audience. We need to remember that the majority of high quality, peer-reviewed research sits behind paywalls, written in very technical language. If you aren’t clearly explaining your work to everyone in accessible language, then it’s likely not being heard. Or worse – it has been misinterpreted, and misrepresented.

Misinformation and disinformation have existed as long as our ancestors have been able to communicate, and it’s going to continue existing for as long as our species persists. We therefore need to make an active effort to ensure that we are all better equipped to identify it and limit its spread, so that we minimise its very real impacts on our societies.

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# Anthropocene Now

**DR CATRIONA NGUYEN-ROBERTSON MRSV**  
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With **MIKE FLATTLEY**  
CEO, The Royal Society of Victoria

**There is an argument made by planetary scientists that we are living in a new epoch of geological time, one of our own making. The term ‘Anthropocene’ (*anthropo* meaning ‘human’) has been proposed as a new geological epoch that describes this recent period of Earth’s history, in which humans have significantly impacted the planet’s climate and ecosystems.**

The term was formally coined in 2000 by biologist Dr Eugene Stoermer and atmospheric chemist and Nobel Laureate Dr Paul Crutzen. They proposed that we began moving away from the Holocene, the current epoch of a stable, accommodating climate that has lasted for 11,700 years since the end of the last major ice age, with the commencement of the industrial revolution in 1750. This view correlates with the buildup of greenhouse gases observed in ice core samples representing the period.

There has been sustained and intense debate among the scientific community as to whether the industrial era, or even the post-WWII years of the 20th century, should be officially designated as the beginning of a new geological epoch. To be classified as such, it must be demonstrated that human activities have impacted the planet to the extent that changes are reflected in the rock strata.

In 2009, an interdisciplinary Anthropocene Working Group of researchers was established within the International Commission on Stratigraphy, which oversees the official geologic time chart. The Working Group voted to accept the idea in 2019, and work to provide scientific evidence robust enough for the Anthropocene to be formally ratified by the Commission’s parent body, the International Union of Geological Sciences (IUGS), as an Epoch within the Geologic time scale.<sup>1</sup>

In late 2023, referencing the geochemical changes to



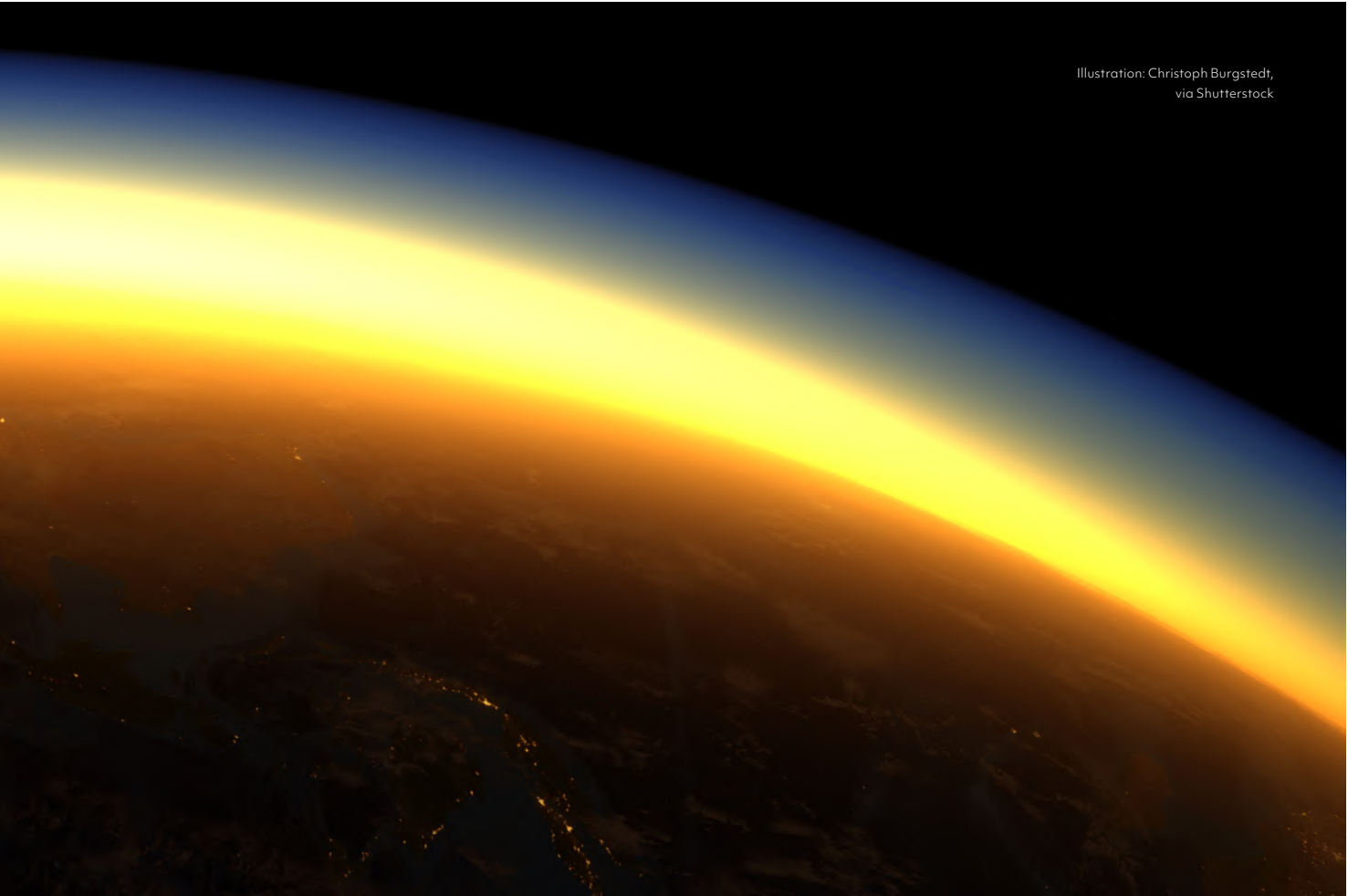


Illustration: Christoph Burgstedt,  
via Shutterstock

sediments at the bottom of Crawford Lake in Ontario, Canada, the Working Group submitted its proposal to a governing committee of the IUGS, who voted not to support the definitions presented by the Working Group as a fitting signpost of when, and how, a proposed new epoch began.

According to the New York Times, IUGS committee member and Earth scientist Professor Mike Waller argued that “human impact goes much deeper into geological time. If we ignore that, we are ignoring the true impact, the real impact, that humans have on our planet.”<sup>2</sup>

The Working Group did indeed take a holistic look at human impacts. Modern human activity skews the chemistry of the Earth’s atmosphere, oceans, and environment - rapidly and drastically. They examined socio-economic and Earth System trends (e.g. greenhouse gas emissions, climate, coastal zones, and biosphere integrity), all of which demonstrate a ‘Great Acceleration’ towards a hotter climate system and a degraded, ill-functioning biosphere.<sup>3</sup>

In 2021, the late Professor Will Steffen presented his climate science work to the Royal Society of Victoria, demonstrating that ‘the Anthropocene is not stable. It is trajectory away from the Holocene.’ The current rate of temperature and atmospheric carbon dioxide increase is almost unprecedented in Earth’s entire 4.5-billion-year geological history. The only other time global temperatures and conditions changed this dramatically was when an asteroid hit the area now known as

the Yucatan peninsula in the Gulf of Mexico, 66 million years ago, famously triggering an age of mass extinction and a rapid increase of 5 °C in global temperatures that lasted for roughly 100,000 years.<sup>4</sup>

This asteroid impact is neither characterised as an epoch nor as an era in geological time. It was an event that catalysed a very dramatic global change, which is the point many scientists are now making: our planet is currently in a fast transition to a new state. It is an event that is yet to settle into new, long-term patterns that will define the ‘new normal’, either as an epoch or as a far more dramatic change in state that establishes entirely new cycles and interactions between the Earth’s systems.

This is a slow process for us to observe on the scale of human lifetimes, but it happens in the blink of an eye from the perspective of planetary history. While we can continue to informally refer to the event we’re all living through as ‘the Anthropocene,’ for now the formal geological epoch remains ‘the Holocene.’

### Reaching a tipping point

The Paris Agreement of 2015 is an international treaty with the aim of limiting global warming to 1.5 °C above pre-industrial levels. Many climate prediction models suggest that we will reach a warming of 3 °C – or, at worst, 4.5 °C – on our current trajectory towards the end of the 21st century. While climate change has been a feature of our planet since



The impact crater of the Chicxulub asteroid - the one that ended the dinosaurs - is just off the coast of the Yucatan Peninsula, near the town of Chicxulub Puerto, Mexico. Photograph: LawrieM via Wikimedia Commons (CC BY-SA 4.0 DEED).

it established oceans and an atmosphere, most life on Earth has not evolved to adapt to such rapid changes in conditions. Crucially, once a certain point is reached, Earth's systems will have been set in motion to all reach a cascading "tipping point" - and there will be no going back.

All of Earth's systems are connected. The cascade is likened to a line of dominos falling down if only one is knocked over. If the northern ice sheets melt, the influx of fresh water will destabilise the North Atlantic jet streams, a key part of global heat and salt transport by the ocean. This will in turn destabilise the West African monsoon, triggering drought, and reduce rainfall over the Amazon. It could also disrupt the East Asian monsoon and cause heat to build up in the Southern Ocean, which could accelerate Antarctic ice loss. Alarmingly, this is already happening.<sup>5</sup>

Prof Steffen was a part of a team of 29 internationally renowned scientists who first proposed the nine planetary boundaries for processes that regulate the stability and resilience of the Earth system. Crossing these boundaries increases the risk of generating large-scale, abrupt, or irreversible environmental changes that will most likely contribute, in turn, to the decline or collapse of civilisation.<sup>6</sup>

He warned us that we are approaching a fork in the road, where our emissions and actions will determine Earth's future. Whether our descendants inherit a stabilised Earth with a moderate climate or a more hostile "hothouse" Earth is now up to our generation. We must avoid pushing the planet beyond a tipping point from which there is no return.<sup>7</sup>

Avoiding this tipping cascade requires fundamental changes

to society. Equity problems between nations need to be taken into consideration rather than swept under the carpet, given that there is a correlation between a country's relative wealth and its contribution to pollution and carbon emissions.<sup>8</sup>

Working towards a more sustainable future requires not only advances in science and technology, but also more fundamental changes in societal structures and core values. Prof Steffen urged a move towards the 'Doughnut Framework' developed by economist Kate Raworth, which proposes an economy that supports the needs of people without overshooting the Earth's ecological boundaries.<sup>9</sup> Ultimately, we should shift from a human-centric focus to a life-centric focus.<sup>10</sup>

Prof Steffen reminded us that Aboriginal and Torres Strait Islander people have already been doing this in Australia for over 65,000 years. They represent the only human cultures to maintain ancestral traditions through an ice age and into the interglacial period of the Holocene. They have developed methods for low-impact adaptation and ways of nurturing the land over millennia. Listening to and learning from the persistence approach of Indigenous Australians might illustrate the way forward towards a more life-centric society.

Evidence gathered by Professor Will Steffen and many other accomplished scientists reveals that we are already in a state of planetary emergency. We have to act now to avoid pushing Earth's systems to their limit, or else 'we might tip the whole planet'.

► *This updated article follows a presentation to the Royal Society of Victoria on 8 April 2021 titled "The Anthropocene: Where on Earth are we going?" delivered by Professor Will Steffen (Australian National University). You can view his presentation online at [youtube.com/watch?v=HvD0TgE34HA](https://www.youtube.com/watch?v=HvD0TgE34HA)*

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## RSV Young Scientist Research Prize Finalists

The Royal Society of Victoria annually awards four competitive prizes to final year PhD students in all areas of the Biomedical & Health Sciences, Biological Sciences (Non-human), Earth Sciences, and Physical Sciences. In September 2023, we heard from last year's eight finalists about their brilliant work in these fields. Over the following months, they have been sharing a written summary of their presentations in Science Victoria. For more information about the RSV's Young Scientist Research Prize, visit [rsv.org.au/young-scientist-research-prizes](https://rsv.org.au/young-scientist-research-prizes)

# How Fire Shapes Plant Life Cycles

**ELLA PLUMANN'S POUTON MRSV**

RSV Young Scientist Research Prizes (Biological sciences)  
2nd place

## Fire is a key driver of plant diversity, and many plants have adaptations that help them thrive in fire-prone ecosystems.

However, changes to fire activity, including a higher frequency of hotter fires like The Black Summer Fires of 2019-2020, threaten thousands of plant species worldwide.

Plants display an array of traits that help them cope with recurring fire. Studying fire-response traits may help us understand the ways in which fire influences species – or groups of species – and make predictions of plant change over large areas.

Some species can resprout post-fire, and some retain their seeds in woody fruits until fire passes. Others are less well-equipped to handle fire. Mountain Ash, the tallest flowering plant in the world and one of the best at storing carbon, cannot resprout post-fire and takes a long time to mature, making it more vulnerable to fire.<sup>1</sup>

To understand the future of plant populations under fire regime change, we need to understand changes across the plant life cycle, for a range of species and across ecosystems - from ungerminated seeds to mature trees, both above and below ground.

I studied how fire impacts heathland plants across their life cycles in Gariwerd - otherwise known as the Grampians. Knowing how plants are impacted by fire allow us to understand how frequently heathland environments can tolerate fire, and what type of fire.

Gariwerd has an incredible diversity of plants and has a long history of applied fire. First Peoples\* have used fire to care for Gariwerd for over 60,000 years. However, some areas have not experienced cultural firing practices since the arrival of Europeans. Present patterns of fire are primarily shaped by wildfires and governmental planned burns. There have been several large wildfires in Gariwerd in the last twenty years.

I found that fire patterns affect plants across their life cycle: from seed to germination and establishment, to the transition to mature plants. For example, fire had a substantial influence on the proportion of mature plants at a site, highlighting the importance of considering what plants are doing, not just where they are.



Ella Plumann's Pouton studies how fire activity in Gariwerd (The Grampians) impacts plant species. Photograph: Karey Shandler/Verse Photography.

The influence of fire depended on the kinds of traits that plants exhibit. For example, resprouting ability influenced how frequently species above ground could tolerate fire, and seed longevity influenced how frequently species could tolerate fire below ground. Using these traits to make predictions of fire-driven plant population change enables land managers and scientists to incorporate ecological knowledge into fire-related management and decisions.

Lastly, I quantified the kinds of fire patterns suitable for Gariwerd plants. Less time between fires poses a risk to some plants, particularly to non-resprouting species that store their seed in their canopy and those that mature slowly.<sup>2</sup> But it's a balance: long periods without fire can negatively impact other kinds of species.

In the face of more frequent, severe wildfires globally and the biodiversity crisis, understanding the types of fire regimes that support different plants across the entirety of their life cycle provides scientific foundations for fire management. Understanding how fire drives ecological change will allow us to support biodiversity into the future and prevent the extinction of flora across ecosystems in Victoria.

\*The Djab Wurrung, Eastern Maar, Gunditjmarra, Jaadwa, Jardwadjali, Jupagulk, Wergaia, and Wotjobaluk peoples.

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1975

# Making a List, and Checking it 490 Times

BY SCOTT REDDIE MRSV  
Editor-in-Chief, Science Victoria

While it's often said that “you don't know what you've got till it's gone”, understanding an ecosystem is better summarised by the slightly less catchy “you don't know what you've got until you've thoroughly examined, catalogued, and quantified everything in a given area”.

The 1975 *Proceedings* included one such catalogue, in the form of a 20-page 'short communication' from botanists Alexander 'Cliff' Beaglehole, Geoff W. Carr, and Robert F. Parsons. The communication, titled “A Check-list of the Vascular Flora of the Holey Plains, Gippsland, Victoria”, detailed the abundance and location of 490 vascular plant species found in the Holey Plains State Park, south-west of Sale.

Creating the sizeable list was a team effort. It was assembled following multiple field trips by the authors in 1972-73, and combining the data with “some unpublished records of Mr. and Mrs. O. Thompson and J. Galbraith”. “The list is based on five days' field work in February 1972 (by A.C.B.) and in 1973 included three days in March (by A.C.B.), three days in May (by G.W.C. and R.F.P.), one day in June (by G.W.C.) and nine days in December (by G.W.C.).”

The 422 native and 68 'alien' species were spread across different plant communities within the plains, and their abundance grouped into categories. “As a guide to the use of abundance categories, very common indicates that the species was seen in thousands, common that it was seen in hundreds, rare that it was seen in dozens, and very rare that it was seen in numbers of less than two dozen.”

Following such a thorough assessment of the area, it comes as little surprise that new species of vascular plants were identified. “The survey discovered what are likely to be new species of both *Pomaderris* and *Prostanthera*, the latter apparently known only from the Holey Plains. A new species of *Helichrysum* related to *H. acuminatum* was found in Long Swamp. Prior to this, and a recent record from French Island, it was known only from five widely scattered records in far southwestern Victoria. All three taxa are so far undescribed.”

With the impacts of climate change and loss of biodiversity increasingly felt, catalogues like this provide vital snapshots into ecosystems past, allowing us to identify and quantify changes over time.

**FROM:** *Proceedings of the Royal Society of Victoria*, Vol 87 (New Series), 1975. Short Communication: A Check-list of the Vascular Flora of the Holey Plains, Gippsland, Victoria. By A. C. Beaglehole, G. W. Carr, and R. F. Parsons

**OPPOSITE:** Source: *Proceedings of the Royal Society of Victoria Vol 87 (New Series)*, 1975.



Check-List of Vascular Flora, Holey Plains

SPECIES	GRID			PLANT COMMUNITY										
	T17	T18	X10	G	N	EN	C	E	BG	BV	V	S	W	M
<i>Scaevola hookeri</i>		x	x					r				vc		
<i>S. ramosissima</i>			x		vr								vr	
<i>Schizaea asperula</i>			x		r	vr								
<i>Schoenus apogon</i>	x	x	x		r					r			c	
<i>S. brevifolius</i>	x	x	x		vc			vc		c		vc		
<i>S. maschalinus</i>		x	x					c				c	r	
<i>S. tenuissimus</i>		x			c	r		r				r		
<i>S. tesquorum</i>		x	x			r						c		
<i>Scairpus antarcticus</i>		x				r					vr			
<i>S. cernuus</i>		x										vr		
<i>S. fluitans</i>		x												r
<i>S. inundatus</i>	x	x	x		r			c		c		c	c	c
<i>S. nodosus</i>		x			vr						c	r		c
<i>S. platycarpus</i>		x										vr		
<i>Selaginella gracillima</i>			x									r		
<i>S. uliginosa</i>	x	x	x		c	c		vc				vc		
<i>Selliera radicans</i> +		x										c		
<i>Senecio biserratus</i>		x			vr									
<i>S. glomeratus</i>	x	x	x		r			vr		r		vr		
<i>S. hispidulus</i>	x	x	x	r	r		r	r	r	r		vr		
* <i>S. jacobaea</i>	x	x	x		vr			vr	vr			c	r	c
<i>S. lautus</i>		x	x		vr						c	r		
<i>S. minimus</i>	x	x	x					r				vr	r	r
<i>S. quadridentatus</i>	x	x	x		r		vr			r				
* <i>Setaria geniculata</i>	x	x			r	vr				r				
* <i>Silene gallica</i>		x			vr									
* <i>Sisyrinchium iridifolium</i>	x	x								r			vr	

The table of 490 specimens found in the Holey Plains State Park. The legend for the shorthand: vc = very common, c = common, r = rare, vr = very rare, \* = naturalised alien, + = record of O. Thompson or J. Galbraith.

T17, T18 and X10 are the grid rectangles of the Plant Survey Council of Victoria partly covered by the survey.

Plant communities are shown as:

**G** = *Eucalyptus globoidea*;

**N** = *E. nitida*;

**EN** = *E. cephalocarpa*-*E. nitida*;

**C** = *E. consideniana*;

**E** = *cephalocarpa*;

**BG** = *bridgesiana*-*E. globoidea*;

**BV** = *E. bridgesiana*-*E. viminalis* var. *racemosa*; **V** = *E. viminalis* var. *racemosa*;

**S** = Swamps;

**W** = Watercourses;

**M** = Merrimans Creek about 5-6 km east of Willung.



## Inspiring Victoria

[inspiringvictoria.org.au](http://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](http://rsv.org.au)).

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

**PUBLIC LIBRARIES VICTORIA**  
[plv.org.au](http://plv.org.au)

**NEIGHBOURHOOD HOUSES VICTORIA**  
[www.nhvic.org.au](http://www.nhvic.org.au)

**PARLIAMENT OF VICTORIA**  
[parliament.vic.gov.au](http://parliament.vic.gov.au)

**MUSEUMS VICTORIA**  
[museumsvictoria.com.au](http://museumsvictoria.com.au)

**ROYAL BOTANIC GARDENS VICTORIA**  
[rbg.vic.gov.au](http://rbg.vic.gov.au)

**ZOOS VICTORIA**  
[zoo.vic.gov.au](http://zoo.vic.gov.au)

**QUESTACON**  
[questacon.edu.au](http://questacon.edu.au)

**THE ARTHUR RYLAH INSTITUTE FOR ENVIRONMENTAL RESEARCH**  
[ari.vic.gov.au](http://ari.vic.gov.au)

**SCIENCE TEACHERS ASSOCIATION OF VICTORIA (STAV)**  
[stav.org.au](http://stav.org.au)



A Bearded Dragon (*Pogona barbata*) found during a Museums Victoria survey in Grampians National Park. Photograph: David Paul/Museums Victoria.





# Diverse Reptiles Down Under

## From Unexplored Fossil Museum Collections to a Rediscovered Species

**ROCÍO AGUILAR**  
**DR JESSICA FENKER**  
and **A/PROF JANE MELVILLE AM**  
*Museums Victoria*

**Australia is the land of lizards, home to over 800 lizard species differing in shape and size, each suited to their different habitats.**

In the unique and mostly fragmented ecosystems across eastern Australia, reptile and frog species exhibit exceptional levels of niche localisation compared to other vertebrates, with different species only found in single habitat pockets. How did all this diversity arise?

We still have limited understanding of past ecological and community dynamics that led to the biodiversity exhibited in the Australian landscape today. But Australian paleontological museum collections are vast, and that is where our research begins...

### **Historical herpetology at MV**

At Museums Victoria, we are studying the impacts of Quaternary climate change on shaping herpetological (reptilian and amphibian) communities along a 3,000 km stretch of eastern Australia. The Quaternary Period has been a time of turbulent, dramatic changes in climate. Many are familiar with the beginning of the Quaternary Period by way of the Pleistocene Ice Age – the last ice age, which began about 2.6 million years ago. Amounting to less than 0.1% of all geologic time, the Quaternary Period continues to this day. We map reptile communities of the past, throughout this time, to help anticipate the future and safeguard Australia's biodiversity.

Using existing palaeontology collections from Melbourne and Queensland Museums, and in collaboration with the University of Melbourne, we are integrating 3D imaging, ancient-DNA, and new machine-learning analytical approaches to quantify changes in these communities over the past 500,000 years. This is the first comprehensive assessment of how herpetological communities of eastern Australia have changed over this period.

We have developed a high-throughput pipeline to sort through and CT scan previously unexplored fossils housed in museum collections. These CT scans generate 3D images, which we are then able to analyse with different approaches. We have also established an ancient DNA lab to be able to sequence the DNA of Holocene fossils (from the last 11,700 years of Earth's history) and historical museum specimens.





The Reptile research team in Milarri Gardens: Juan Valbuena, Joanna Sumner, Jane Melville, Rocío Aguilar, and Rebecca Rose. Photograph: Benjamin Healley/Museums Victoria.

Thanks to recent advances in technology, we are also now looking to incorporate artificial intelligence (AI) image recognition into our study.

These new methods are helping us understand how past climates contributed to herpetofauna biodiversity, and what the future of these species may look like. These results are critical to developing comprehensive conservation plans to future-proof biodiversity.

### The rediscovery of a species

Until last year, the Victorian Grassland Earless Dragon (*Tympanocryptis pinguicolla*) hadn't been seen for decades. Much of the Melbourne grasslands that it had called home have long since been ploughed and paved over.

The grassland earless dragon was until 2019 believed to be a single – and endangered – species. But after extracting the DNA from specimens held in museums across Australia, our team proved that the grassland earless dragon was not a single species, but several distinct species.<sup>1</sup> One of which was the Victorian grassland earless dragon.

The Victorian grassland earless dragon belongs to a genus of small-to-medium lizards in the family *Agamidae* (known as dragon lizards), where many of its relatives face conservation concerns due to their isolated and restricted distributions. This dragon was believed to be extinct, with the last recorded sighting occurring 54 years ago.

But last year it was rediscovered!<sup>2</sup>

The rediscovery of the Victorian Grassland Earless Dragon underscores the critical importance of biodiversity preservation in the face of rampant habitat loss and degradation, especially considering the similar disappearance of the Bathurst Grassland Earless Dragon (*Tympanocryptis mcartneyi*), that has not been seen since the 1990s. This group of lizards are amongst the most endangered reptiles in Australia.

Our collaborative efforts between Museums Victoria and Zoos Victoria using innovative methods to detect and protect endangered species like these lizards are crucial. We use genetic analyses to better understand the diversity of reptiles, and environmental DNA surveys to look for evidence of them in the wild. Our rediscovery of the Victorian Grassland Earless Dragon emphasises the importance of comprehensive conservation strategies to safeguard not only these unique creatures, but also the fragile ecosystems they inhabit, ensuring a diverse and healthy environment for future generations.

► *Jane Melville is the Senior Curator, Terrestrial Vertebrates (Herpetology) at the Museums Victoria Research Institute. Rocío Aguilar is a Research Associate and ARC Research Coordinator, and Jessica Fenker is an ARC Research Fellow, Herpetology, both in Jane Melville's Lab.*

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#### REFERENCES:

- <sup>1</sup> Melville, J, et al. (2019). Taxonomy and conservation of grassland earless dragons: new species and an assessment of the first possible extinction of a reptile on mainland Australia. *Royal Society Open Science*, 6. doi.org/10.1098/rsos.190233
- <sup>2</sup> Wintle, B. and Bekessy, S. (2023, June 25). Victoria has rediscovered a dragon – how do we secure its future? *The Conversation*. theconversation.com/victoria-has-rediscovered-a-dragon-how-do-we-secure-its-future-208097



# Fluttering Hope

## Zoos Victoria and school communities join forces to save a butterfly from extinction

**NICOLE COWAN AND CHRIS VELLA**

Zoos Victoria

The sharp decline of biodiversity in Australia poses significant threats to the health of ecosystems and all species within them.

The Victorian State of the Environment 2023 Report paints a bleak picture, yet hope remains.<sup>1</sup> Zoos Victoria, a zoo-based conservation organisation, is committed to securing a future rich in wildlife.

Zoos Victoria is working to protect Victorian wildlife and has identified 27 critically endangered priority species, one of which is the Golden-rayed Blue butterfly (*Candalides noelkeri*). This beautiful butterfly is found in a small area in the Wimmera region of western Victoria, and is the only butterfly known to be endemic to Victoria. It lives in remnant floodplains that border a handful of salt-lakes in Victoria's west and faces multiple threats, including habitat loss and fragmentation.<sup>2</sup> Making it particularly vulnerable to extinction is that the butterfly's entire lifecycle is wholly reliant on only one plant: the Creeping Boobialla (*Myoporum parvifolium*). Without it, the larvae cannot survive.

### Fighting extinction together

Zoos Victoria offers people a tangible way to help species: simply buy a tote bag. The Totes for Wildlife community conservation program has been running since 2019 and over 60,000 tote bags have been purchased.<sup>3</sup> Each year, a different animal is featured and sale profits fund in situ conservation projects that support that species. The Golden-rayed Blue butterfly was featured in 2022, supporting the planting of thousands of Creeping Boobialla plants in the Wimmera region, providing important food and habitat for the butterfly.

Totes for Wildlife funded the collection of cuttings of locally growing Creeping Boobialla to propagate and cultivate, ready for planting. Working with the Hindmarsh Landcare group, the Zoos Victoria Threatened Species team identified three schools close to their ideal habitat: Rainbow P-12 College, Natimuk Primary School, and Horsham Primary School. These schools were invited to be a part of the habitat restoration and monitoring work for the Golden-rayed Blue butterfly.

The three schools developed a range of curriculum-linked lesson plans to engage their students in caring for the Golden-rayed Blue butterfly. Each school took a slightly different approach to integrate this project into their curriculum.



The Golden-rayed Blue Butterfly. Source: Zoos Victoria

Horsham Primary School's Year 4 students focused on the Creeping Boobialla, and the Year 5-6 students focused on adaptations of the Golden-rayed Blue butterfly. These adaptations include structural adaptations like caterpillars camouflaged on the plant, behavioural adaptations like synchronising flight periods with the flowering of the Creeping Boobialla, and physiological changes like pupae pausing growth until conditions are right.<sup>4</sup>

Students from Rainbow P-12 College learned about metamorphosis, and Natimuk Primary School focused on butterfly life cycles and animal features to create posters that were placed around the planting sites.

Rainbow P-12 College is now expanding their involvement in this species' conservation with a project being delivered through Years 7-10 to further understand the life cycles of the butterfly.

Zoos Victoria provides free online animal teaching resources for teachers and educators, customised for different year levels (early childhood, primary, secondary, and VCE). These can be accessed at [zoo.org.au/education/animal-teaching-resources](https://zoo.org.au/education/animal-teaching-resources).

► Nicole Cowen and Chris Vella are part of the Zoos Victoria Education Strategic Team. Chris works as the Fighting Extinctions Schools Coordinator and Nicole is the Education Programs Coordinator.

► The Zoos Victoria Fighting Extinction Schools Program is funded by the Department of Education and the Victorian Catholic Education Authority.

#### REFERENCES:

<sup>1</sup> Commissioner for Environmental Sustainability. (2023). Victorian State of the Environment Report. [ces.vic.gov.au/soe2023](https://ces.vic.gov.au/soe2023)

<sup>2</sup> Douglas, F. (2022) Survey of the Golden-rayed Blue Butterfly (Lepidoptera: Lycaenidae) in North West Victoria during December 2021, Zoos Victoria Report

<sup>3</sup> Zoos Victoria. (2024). Totes for Wildlife. [zoo.org.au/totes-for-wildlife](https://zoo.org.au/totes-for-wildlife).

<sup>4</sup> Golden-rayed Blue Butterfly Year 7-10 Learning Toolkit. Zoos Victoria. [zoo.org.au/education/animal-teaching-resources/year-7-10](https://zoo.org.au/education/animal-teaching-resources/year-7-10)

# Call for Scientific Papers

AVAILABLE ONLINE AT [PUBLISH.CSIRO.AU/RS](https://publish.csiro.au/rs)

**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](https://publish.csiro.au/rs).

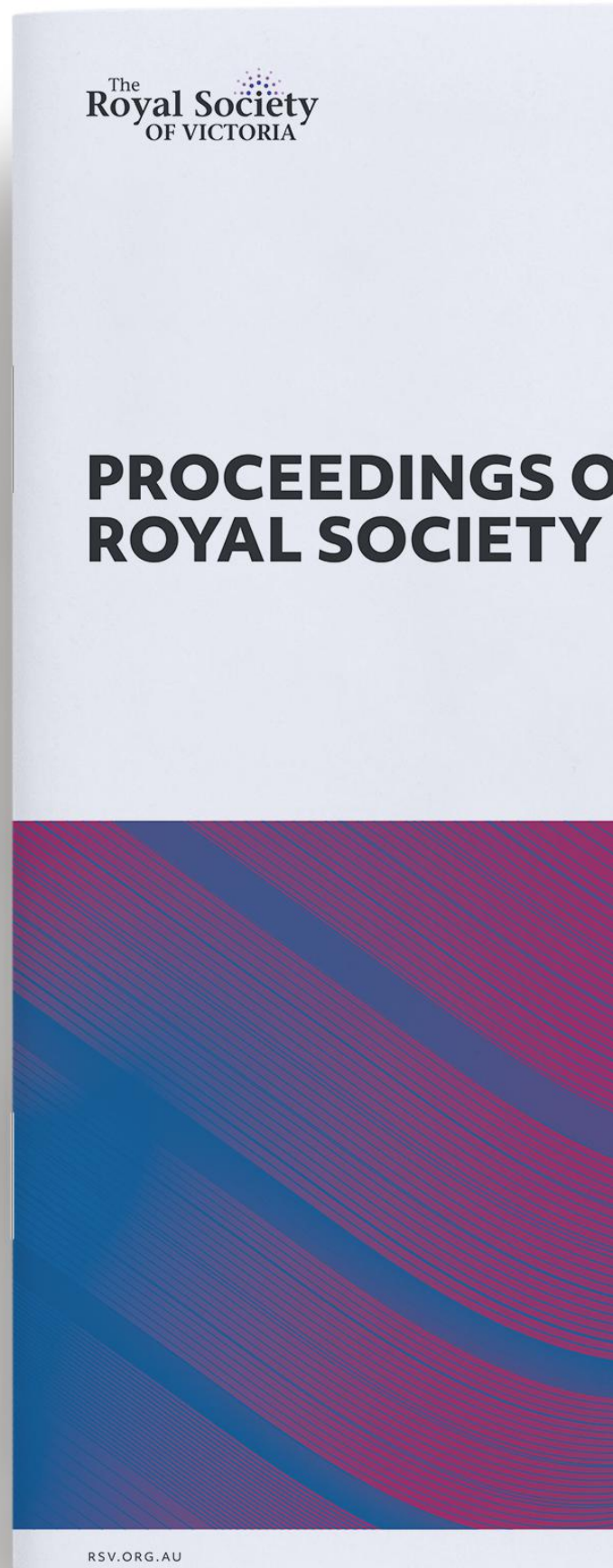
All volumes of the *Proceedings* and its predecessors from 1854 to 2006 are also available free online at [biodiversitylibrary.org/creator/6984](https://biodiversitylibrary.org/creator/6984).

## Submissions



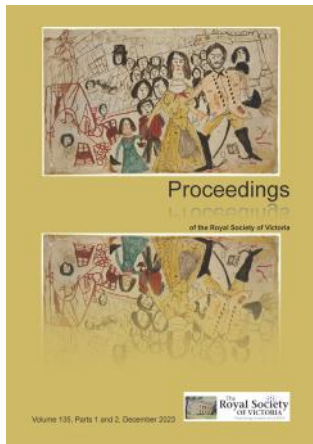
Those interested in submitting papers should review the Author Instructions at [publish.csiro.au/rs/forauthors/AuthorInstructions](https://publish.csiro.au/rs/forauthors/AuthorInstructions). Manuscript submissions for the

Proceedings are now made using the ScholarOne platform. Any enquiries regarding submission can be made to [editor@rsv.org.au](mailto:editor@rsv.org.au)



RSV.ORG.AU





REFERENCES:

<sup>1</sup> Andrea Wulf, 'The Forgotten Father of Environmentalism' in *The Atlantic*, 23 December 2015 ([theatlantic.com/science/archive/2015/12/the-forgotten-father-of-environmentalism/421434/](https://theatlantic.com/science/archive/2015/12/the-forgotten-father-of-environmentalism/421434/)).

<sup>2</sup> 'durch Fällen der Wälder, durch Veränderung in der Vertheilung der Gewässer und durch die Entwicklung großer Dampf- und Gasmassen an den Mittelpunkten der Industrie' quoted in Frank Holl (2018), *Alexander von Humboldt und der Klimawandel: Mythen und Fakten* HiN XIX, 37.



Baron Alexander von Humboldt (1769 - 1859). Artist: Julius Schrader. Open access image courtesy of The Metropolitan Museum of Art.

## Honouring Humboldt Research for a Sustainable World

**Volume 135 of the Proceedings of the Royal Society of Victoria is now available online, open access from CSIRO Publishing, hosted at [publish.csiro.au/rs/issue/11551](https://publish.csiro.au/rs/issue/11551).**

This volume is substantively dedicated to the theme 'Humboldtian Research Towards a Sustainable World,' drawn from the proceedings of the 19th Biennial Conference of the Australian and New Zealand Associations of von Humboldt Fellows in 2022.

There is an additional paper from Dr Thomas Darragh and Dr Ruth Pullin, translating letters from the celebrated German painter Eugene von Guerrard, then based in Australia, to the Ethnological Museum in Berlin from 1878 – 1880, along with the collected abstracts from colleagues presenting at the RSV's 2022 symposium on 'Next Generation Biocontrol of Invasive Vertebrate Pests.'

Alexander von Humboldt has been referred to as 'the forgotten father of environmentalism.'<sup>1</sup> As early as 1844, he wrote that humans change the climate 'by cutting down forests, by changing the distribution of water bodies, and through the production of large vapour and gas masses at the centres of industry.'<sup>2</sup> Humboldt also described the greenhouse effect in his opus magnum, 'Kosmos'. And time and again in his writings and in his lectures, he emphasised the interconnectedness of all living creatures on this planet. In times when the effects of climate change become ever more visible and palpable around the globe, it is imperative that the global academic community addresses the topic of sustainability in all its dimensions.

Dr Thomas Hesse  
*Deputy Chair, Alexander von Humboldt Foundation*

## Papers from Volume 135

### **A world without bees: new insights from Australia for managing sustainability in a changing climate**

**ADRIAN G. DYER, MANI SHRESTHA, JAIR E. GARCIA, SCARLETT R. HOWARD, MALIKA NISAL RATNAYAKE, AND ALAN DORIN**

*Monash University/University of Bayreuth/The University of Melbourne*

**Abstract:**

Insect pollination is essential for many flowering plants that underpin agriculture and food production, as well as the ecological management of terrestrial environments. Traditionally, honeybees (*Apis mellifera*) and bumblebees (*Bombus terrestris*) are used as managed species for agricultural crop pollination. With increased awareness

of the value of pollination in a changing world, it is important to better understand alternative pollinators, especially how different species tolerate changing environmental conditions. This review encapsulates a decade of comparative research that was principally conducted in Australia.

▶ Read this article for free at [publish.csiro.au/RS/pdf/RS23003](https://publish.csiro.au/RS/pdf/RS23003)

### **Sustainable chemical synthesis: making molecules using visible-light irradiation**

**DANIEL L. PRIEBBENOW**

*Monash University*

**Abstract:**

The discovery of new strategies to increase the sustainability of chemical manufacturing is of critical importance to many sectors. Photochemistry offers significant potential, as the irradiation of molecules and catalysts with visible light (considered a safe and renewable chemical reagent) can provide access to known molecules in a more sustainable fashion or novel molecular scaffolds that cannot be accessed via traditional means. Our studies into the reactivity of acyl silanes has led to the discovery of a series of new photochemical methods to access unique molecular scaffolds using only visible-light irradiation, circumventing the use of precious metal catalysts and additives

▶ Read this article for free at [publish.csiro.au/RS/pdf/RS23004](https://publish.csiro.au/RS/pdf/RS23004)

### **GENOME BANKING OF ANCESTRAL HAPLOTYPES FOR FUTURE SURVIVAL**

*Erwin A. Paz, Lani A. Wade, Anthony J. Lloyd, Sally S. Lloyd and Roger L. Dawkins*

▶ pp. 34-37

[publish.csiro.au/RS/pdf/RS23005](https://publish.csiro.au/RS/pdf/RS23005)

### **GERMANTOWN REVISITED**

*Gabrielle L. McMullen*

▶ pp. 7-14

[publish.csiro.au/RS/pdf/RS23001](https://publish.csiro.au/RS/pdf/RS23001)

### **STORIES ABOUT SYMMETRY**

*Rebecca A.H. Waldecker*

▶ pp. 15-19

[publish.csiro.au/RS/pdf/RS23002](https://publish.csiro.au/RS/pdf/RS23002)

### **AUSTRALIAN INDIGENOUS EDIBLE HALOPHYTES — NUTRITIOUS AND FUNCTIONAL FOR A SUSTAINABLE FUTURE: ANTIOXIDANT CAPACITY AND ANTIMICROBIAL PROPERTIES**

*Sukirtha Srivarathan, Anh Dao Thi Phan, Maral Seididamyeh, Olivia R.L. Wright, Yasmina Sultanbawa and Michael E. Netzel*

▶ pp. 41-46

[publish.csiro.au/RS/pdf/RS23007](https://publish.csiro.au/RS/pdf/RS23007)

### **THE ROLE OF NUCLEAR POWER IN A SUSTAINABLE FUTURE**

*Anthony W. Thomas*

▶ pp. 47-49

[publish.csiro.au/RS/RS23008](https://publish.csiro.au/RS/RS23008)

### **A SUSTAINABLE WORLD REQUIRES DARKNESS AT NIGHT**

*John B. Hearnshaw*

▶ pp. 50-57

[publish.csiro.au/RS/pdf/RS23009](https://publish.csiro.au/RS/pdf/RS23009)

### **PHOTONIC RESERVOIR COMPUTING FOR ENERGY EFFICIENT AND VERSATILE MACHINE LEARNING APPLICATION**

*Kathy Lüdge*

▶ pp. 38-40

[publish.csiro.au/RS/pdf/RS23006](https://publish.csiro.au/RS/pdf/RS23006)

### **WHERE ARE WE AT WITH SHAPE-MEMORY ALLOYS IN THIS 'HIGH-TECH' WORLD?**

*Trevor R. Finlayson*

▶ pp. 58-63

[publish.csiro.au/RS/pdf/RS23010](https://publish.csiro.au/RS/pdf/RS23010)

### **WAVES THAT APPEAR FROM NOWHERE**

*Nail Akhmediev*

▶ pp. 64-68

[publish.csiro.au/RS/pdf/RS23011](https://publish.csiro.au/RS/pdf/RS23011)

### **SUSTAINABILITY FROM A CELL PERSPECTIVE**

*R.J. Clarke*

▶ pp. 69-71

[publish.csiro.au/RS/pdf/RS23012](https://publish.csiro.au/RS/pdf/RS23012)

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[publish.csiro.au/RS/pdf/RS23011](https://publish.csiro.au/RS/pdf/RS23011)





## Current Government Consultations of Interest to Victoria’s Science Community

Projects open for consultation from [engage.vic.gov.au/project](https://engage.vic.gov.au/project)



Andréas Brun via Unsplash



Zac Porter via Unsplash

**CONSULTATION CLOSES 26 APRIL 2024**

### Victorian Cat Management Strategy

Have your say in shaping Victoria’s first cat management strategy

[engage.vic.gov.au/cat-management-strategy](https://engage.vic.gov.au/cat-management-strategy)

**CONSULTATION CLOSES 29 APRIL 2024**

### Central Highlands State Forests

Help shape the future of state forests in the Central Highlands

[engage.vic.gov.au/central-highlands-forests](https://engage.vic.gov.au/central-highlands-forests)



Taso Katsionis via Unsplash



Erin Baker via Unsplash

**CONSULTATION CLOSES 30 APRIL 2024**

### Lake Eppalock Technical Assessment

Have your say on options to better protect downstream communities from future flooding.

[engage.vic.gov.au/lake-eppalock-technical-assessment](https://engage.vic.gov.au/lake-eppalock-technical-assessment)

**CONSULTATION CLOSES 5 MAY 2024**

### Parks Victoria Volunteer Strategy 2024-28

Share your thoughts on volunteering in parks.

[engage.vic.gov.au/parks-victoria-volunteer-strategy](https://engage.vic.gov.au/parks-victoria-volunteer-strategy)



# 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.

## 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*.

### 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](mailto:editor@ScienceVictoria.org.au).



## 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 STEM-related fields in Victoria. Examples of possible topics include how to address a climate-change related problem in Victoria; successes and failures common to STEM engagement initiatives; ethical problems related to scientific projects or careers in STEM; your experiences of a career in STEM and thoughts on how to better support the next generation of researchers; existing STEM-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 STEM 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 STEM-related projects, high-impact publications relevant to Victoria, successes of Victorian scientists, or relevant STEM-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 STEM 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

<b>MARCH 2024</b> <i>Victoria's Fauna</i> Everything <i>Animalia</i> in Victoria, particularly native fauna.	<b>DUE DATE</b> 16 February
<b>APRIL 2024</b> <i>The Four Planetary Crises</i> Biodiversity Loss, Climate Change, Pollution & Waste, and The Rise of Misinformation	<b>DUE DATE</b> 15 March
<b>MAY 2024</b> <i>Accessibility &amp; Inclusion in STEM</i> Supporting the education, employment, and engagement of everyone in STEM.	<b>DUE DATE</b> 19 April
<b>JUNE 2024</b> <i>Victoria &amp; Climate Change</i> The impacts of, research on, and responses to climate change in Victoria.	<b>DUE DATE</b> 17 May
<b>JULY 2024</b> <i>Building Scientific Competency</i> Empowering individuals and communities to understand the scientific method.	<b>DUE DATE</b> 14 June
<b>AUGUST 2024</b> <i>STEM Throughout Victoria</i> The opportunities for learning and engaging with STEM across the state.	<b>DUE DATE</b> 19 July
<b>SEPTEMBER 2024</b> <i>Pollution in Victoria</i> The different pollutants, sources, impacts, and responses required.	<b>DUE DATE</b> 16 August
<b>OCTOBER 2024</b> <i>Victoria's Ecosystems</i> The many and varied ecological niches across Victoria	<b>DUE DATE</b> 13 September
<b>NOVEMBER 2024</b> <i>Science &amp; Policy</i> From lab bench to front bench: how scientific understanding can positively influence policy.	<b>DUE DATE</b> 18 October
<b>DECEMBER 2023</b> <i>Science &amp; Business</i> Creating a sustainable industry, start-ups, med-tech, patents, and ethics.	<b>DUE DATE</b> 15 November

# 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 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 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](https://matterport.com/discover/space/royal-society-victoria)

▶ Email [rsv@rsv.org.au](mailto:rsv@rsv.org.au) to discuss your needs and ideas!



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

### 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](http://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 STEM 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](http://rsv.org.au).

You can donate online now at [rsv.org.au/support-the-rsv](http://rsv.org.au/support-the-rsv), or alternatively contact us at [rsv@rsv.org.au](mailto:rsv@rsv.org.au) for information about other payment methods.



### 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

Meetings, group/individual workspace, and seminars.

#### CAPACITY

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

Meetings, seminars, and videoconferencing.

#### CAPACITY

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

Meetings, seminars, and videoconferencing.

#### CAPACITY

Any Booking ≤15 people

## 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 <b>\$40</b> PER YEAR	FULL <b>\$120</b> PER YEAR	ORG. <b>\$1000</b> PER YEAR	SCHOOL <b>\$1000</b> PER YEAR	AFFILIATE <b>\$500</b> 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			
<i>Science Victoria</i> Digital Edition (Printed copy available for an additional fee).	✓	✓	✓	✓	✓
Free monthly printed copies of <i>Science Victoria</i> for school libraries.				✓	
Recognition of achievements through awards programs.	✓	✓			
Discounted advertising in <i>Science Victoria</i>			✓	✓	✓
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

**MR SHAVEEN SASANKA BOGAHAPITAIYA GAMAGE**  
PhD Candidate, The University of Melbourne

**DR DAVID HOLMES**  
Managing Director, Climate Communications Australia

**MR RICHARD BROAD**  
Project Manager, Mildura Rural City Council

**MR PETER WILLIAMS**  
Freelance Solar Energy Consultant

**PROFESSOR KENNETH HINCHCLIFF**  
CEO, Trinity College, University of Melbourne

**DR IRIS RAFALIA**  
General Practitioner



For more information: [rsv.org.au/how-to-join](https://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.

### Notice of the RSV's AGM

**RSV Members are advised the Society's 2023 Annual General Meeting (held in 2024, reviewing last year's performance), will be held on the evening of Thursday, 9 May 2024.**

The meeting will be held via Zoom. Members must register to attend, noting a quorum of 50 required for business to proceed.

Full members, student members, organisational member representatives, and RSV Fellows are all entitled to attend and vote. Please register to attend online at [rsv.org.au/events/2023-annual-general-meeting](https://rsv.org.au/events/2023-annual-general-meeting). Meeting papers will be posted here also.

If you cannot attend, please nominate your proxy on the online form provided by the RSV at [rsv.org.au/proxy-form-2023-agm/](https://rsv.org.au/proxy-form-2023-agm/) by no later than **5pm, Wednesday, 8 May 2024**. This will help us to reach our quorum.









**Science Victoria**  
The Royal Society of Victoria  
Wurundjeri Country  
8 La Trobe Street, Melbourne, VIC 3000

**View the Digital Edition**  
Scan the QR Code or go to:  
[rsv.org.au/news/science-victoria](https://rsv.org.au/news/science-victoria)



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