SEPTEMBER 2024 — POLLUTION IN VICTORIA

SCIENCE VICTORIA

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In This Issue

POLLUTION IN VICTORIA

The smog from cars and trucks, the lead in our soil from leaded fuel, the sewage overflows, the agricultural and stormwater runoffs, the light and sounds from humans at night, and the remains of macro- and microplastics *everywhere*. This is just a fraction of pollution sources in our state.

In this edition of *Science Victoria*, we look at our polluted environments: the sources, impacts, and potential solutions to the pollution problems.

ON THE COVER

Yallourn Power Station has been powering & polluting Victoria since 1928. Currently owned by China Light and Power (CLP), it is due to close in 2028. Photograph: Jeremy Buckingham via flickr (CC BY 2.0)

Upcoming Submission Deadlines

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

OCTOBER 2024	DUE DATE
VIctoria's Ecosystems	*5pm, 12 September*
NOVEMBER 2024	**DUE DATE**
Science & Policy	*5pm, 18 October*

From the Editor

SCOTT REDDIEX
Editor-in-Chief — Science Victoria

In regard to the treatment of our environment, much is excused with the phrase, *"they didn't know any better at the time"*. These statements often come with the implications of *"had they known about these impacts, they wouldn't have done it"*, and *"we won't make the same mistakes"*.

This is why the levels of pollution in Victoria are particularly jarring. If governments, industries, and individuals of the past are excused because "they didn't know any better", then what is the excuse now?

'Pollution' is the release of harmful substances into the environment, at a rate faster than it takes for the substance to become harmless. The air we breathe, the land we grow our food on, and the water that connects everything, contain various levels of different pollutants released over the past 200 years.

Not-so-fresh air

The impacts of air pollution to human health are significant. A 2023 report from Melbourne Climate Futures found that, in Australia, vehicle emissions are responsible for 11,105 premature deaths in adults each year.[1] It's also responsible for 66,000 active asthma cases annually, and these numbers will only rise unless changes are made.

The report notes that there are proven mitigation strategies – such as banning diesel vehicles, anti-idling legislation, active transport initiatives, minimising pollution around schools – but these have not seen meaningful implementation here.[1]

Dirty business

An example of a lingering pollutant is the amount of lead (Pb) in Melbourne's soil: mostly as a result of 70 years of leaded petrol usage, it means that 20% of backyard veggie gardens tested had a concentration of lead warranting further investigation.[2]

If you have concerns about what's in your soil, Victorians can send a sample for testing to the GardenSafe citizen science team at the Environmental Protection Agency (EPA).[3]

There's something in the water...

As the 2022 flooding of the Maribyrnong River highlighted, climate change brings greater risk of damaging rain and floods. What follows is all manner of waste entering waterways, including sewage, plastics, building material, and a range of chemicals from residential, commercial, and industrial sources. While this is nothing new,[4,5] the risks significantly increase without intervention.

This month, we take a look at some of the things that are polluting our state, and some of the ways we can monitor and address pollution for the benefit of all ecosystems.

We hope you enjoy this edition of *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.

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

A duck swimming amongst the rubbish in Moonee Ponds Creek near Macaulay Station.
Photograph: Dan Gordon via flickr (CC BY-NC 2.0).

Pollution: Is it Really Getting Worse?

ROB GELL
President, The Royal Society of Victoria

It seems I've been concerned about pollution of our environment since I was an undergraduate – that's a long time ago.

Like many others, my introduction to the long-lasting harm caused by pesticides and other chemicals was Rachel Carson's 1962 book *Silent Spring*.[1] Remarkably, many of those threats remain, as do all of the other major environmental impacts and pollution problems I learned about half a century ago!

Pollution and waste is the third component of the United Nations 'triple planetary crisis', together with climate change and biodiversity loss.[2] It's also the third pillar of the RSV's Strategic Plan.[3]

Pollution now accounts for one in six deaths worldwide.[4] Air pollution is the largest cause of disease and premature death. Plastics are a particular threat. Plastics manufacture is a growing source of greenhouse emissions on the planet and now contaminates our food, our land, and particularly our oceans.[5]

Bushfire smoke mixed with the 'usual' smog from traffic, industry, and other sources over Melbourne. Photograph: timallenphoto via Shutterstock.

Air quality

The 2023 Victorian State of the Environment Report (SoE Report)[6] describes our air quality as 'good', relative to international standards, and not so good when we have bushfires. Unfortunately, there are 'gaps' in the Environment Protection Authority's (EPA) air quality analysis, and the problem requires a systems response. EPA Victoria has expanded its air quality monitoring network in recent years, and there are now 'Airwatch' monitoring sites around Victoria.

Doctors for the Environment Australia has released a new report on the dangerous air pollution and health impacts of fossil fuel burning in power stations.[7]

Water quality, forever chemicals, and runoff

There is an altogether lack of reporting, quality and scope of data, and transparency on the state of water in and around Victoria. Water pollution incidents, fish deaths, licensed discharges (and breaches of discharge limits), and trends in compliance are not sufficiently reported.

Water pollution is not a 'key topic' of the SoE report. 'Water quality' of inland waters is measured and discussed to an extent, however the data sources are fractured, limited, and generally anthropocentric. Coastal waters are not a key topic of the report - these are left to the State of the Marine and Coastal Environment report.

Reports are also not regular: our last Index of Stream Condition was released in 2013, based on 2010 data. EPA Vic's most recent Beach Report and Yarra Watch summary is from the 2020-2021 season.

The EPA Vic does provide a range of publications on emerging contaminants in recycled water and the concentration of per- and poly-fluoroalkyl substances (PFAS) in our environment.[8,9] PFAS are now found in water, air, fish, and soil across the globe. While mostly in low concentrations, these chemicals are long-lasting, and may be harmful to the health of humans and other animals.

Research on PFAS continues in Victoria and elsewhere. In the USA, landfills have recently been found to contain large amounts of these "forever chemicals".[10]

The extent to which agricultural chemicals and herbicides (such as glyphosate) used by authorities reach our state's waterways remains a critical issue for the health of our aquatic systems.

Swimming in it

A more apparent water pollution issue is revealed through the regular EPA Vic Beach Report forecast. Stormwater runoff into Port Phillip Bay increases pollution loads from a range of materials that collect on our roads and streets. It is not understood what the implications of this forecast for Port Phillip Bay swimmers means in the context of the bay's ecosystem.

The State of the Marine and Coastal Environment 2021 Report records that water quality is generally 'good or very good' in Port Phillip and Westernport.[11] The Gippsland Lakes are another matter, where nutrient inputs from agriculture induce blue-green algal blooms.[11] In addition to pollutants in solution, the report estimates that more than 2.5 billion litter items and microplastics flow into Port Phillip Bay from the Yarra and Maribyrnong Rivers each year. About 85% are microplastics, largely from industrial precincts.[11]

Flooding in Melbourne in November 2022 resulted in the closure of beaches around Port Phillip Bay. Photograph: jax10289 via Shutterstock.

Sewage wastewater

Other important discharges into Victorian aquatic environments are the sewage wastewater from Melbourne Water's Western Treatment Plant at Werribee (700 ML/day), Barwon Water's Black Rock outfall at Breamlea (70 ML/day), two South Gippsland Water outfalls to the Ninety Mile Beach (70 ML/day), and from acid-sulphate soils into the Gippsland lakes.

The National Outfall Database includes a map which shows a total of nineteen ocean outfalls in Victoria.[12] This begs the question, for how much longer can we continue to discharge human waste into the marine environment?

The Clean Ocean Foundation published its open letter to Federal Minister for Environment and Water The Hon Tanya Plibersek MP earlier this year, imploring her to take a leadership position on water recycling in Australia, and to to embrace purified recycled water (PRW) as a vital component of a scientifically sound water sustainability strategy.[13] The minister replied that indeed we "should be global leader in the area". Stand by.

Sewage treatment at Western Treatment Plant, Werribee. Photograph: Jason Patrick Ross via Shutterstock

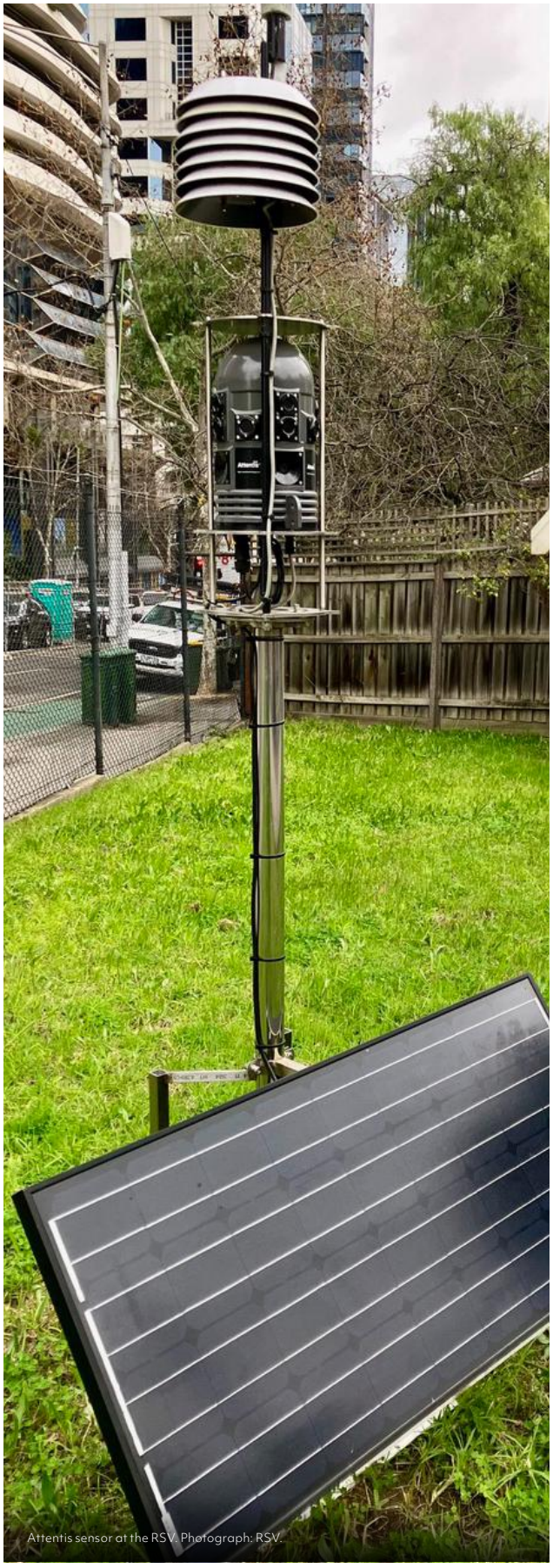
Melbourne's lights at night. Photograph: Graham Holtshausen via Unsplash

Light and sound

Light pollution is often overlooked when we consider human impacts on our environment. It has a significant impact on our native species. Our July issue of *Science Victoria* discussed the effect of light pollution on Bogong moths,[14] and elsewhere in this edition Dr Catriona Nguyen-Robertson takes a look at the wider impacts of light pollution on our ecosystems.

Similarly, noise pollution is acknowledged as a significant contributor to physical and mental health and well-being, acknowledged as affecting millions of people in Europe.[15] Noise was the type of pollution most frequently reported to EPA Victoria in 2020–21. The traffic noise risk threshold is 55 dB, and the SoE Report assesses the risk as 'fair', however, this is based on 2011 road traffic data and low resolution health data. Greater Melbourne's population alone has grown by more than 1 million since 2011.

Our monitoring networks are not robust.



Attentis sensor at the RSV. Photograph: RSV.

Environmental sensing at the RSV

The RSV has installed an Attentis multi-sensing device at the eastern end of our site at 8 La Trobe St, Melbourne. The sensor provides real-time monitoring of weather information and air quality, and also has a 360° view camera with time lapse capability. Data from the sensor (and other Attentis sensors around Australia and New Zealand) is consistent with Bureau of Meteorology and EPA data, and World Meteorological Standards approved.

The data network serves as a resource for individuals and organisations. The Latrobe Valley Information Network was the first regional network constructed in early 2019, delivering fire and flood detection, air quality, and microclimate weather.[16] The network has detected three fire ignitions in the past three years and provided valuable information for the CFA, SES, Victoria Police and Ambulance Victoria. Additional regular users of the network include Energy Australia and AEMO.

Access to the data from the Attentis multi-sensor is available from the 'Attentis - Smart Sensors' app through either the Apple App Store or Google Play.

More work desperately needed

Pollution of our air, land, water, and sky is no longer the same problem that I learned about in the 1970s. The scale has changed. With an expanding population and a massive acceleration in resource consumption in our current economic model, it's now a global problem – and an acknowledged existential crisis. Remedial action will need to be substantially greater than what we have achieved in recent decades.

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Book Review: Guide to Native Orchids of Victoria

BY PROFESSOR TIM ENTWISLE

A review of Guide to Native Orchids of Victoria, by Gary Backhouse.
Published in 2023 by CSIRO Publishing, Clayton South. ISBN: 978-1-4863-1685-4

It sometimes feels like colour guides to Australian native orchids are published as often as new species of these fascinating and beautiful plants.

In fact, the number of colour guides might be a dozen (or two), covering various parts of Australia, while the number of new orchid species in Victoria alone in the last thirty years is something like 200.

In Backhouse's first book of this kind, co-authored with Jeff Jeanes and published in 1995, there were 270 species recognised for Victoria. This was already a sizable increase from 172 in 1962, 149 in 1930, and 77 in 1886. By 2016, in his first, sole-authored, self-published book covering the same territory – Bush Beauties: The Wild Orchids of Victoria – there were 410 all up, including 345 formally published names and 65 waiting for a moniker.

This crisply written and edited new book documents a grand total of 447 species: 387 named, 60 of them still waiting (such as *Prasophyllum* species 'Murchison', or the petite leek orchid, now from a single population of about 50 plants near Murchison in central Victoria). There is a single photograph for each species, or alleged species, as there was in the 1995 book with Jeff Jeanes but unlike his Bush Beauties (and some of his online compilations) which include a number of images for each species. While it's good to show some of the variation within a species, and not all features are obviously a portrait-style photograph of a single flower, this frugality does make the book more compact and ultimately easier to use as you flip through the pages.

And flip you need to do, because there is no identification key of any kind to narrow down your selection. This is typical for such books, and probably sensible. Keys don't work very well for orchids, and few people other than botanists use them anyway. What it does mean is that you must come to this book with some basic orchid knowledge and an ability to discern what is different between the pictures. That would include most people attracted to this publication.

The descriptions and notes are far more succinct than in previous iterations as well. This helps to keep the book to a size easily carried and used in the field. What is left out are some of the comparisons with 'like species' and much of ecological detail. All of which was interesting and useful, but if the number of species is going to rise, and the book to remain portable, something has to give. The absence of synonyms – alternative names for the same thing – will again be for reasons of conciseness, but it can be a little frustrating when moving from this book to others or the web for more information.

The distribution maps remain, which pleases me. Alphabetic ordering of genera makes sense given most

The Red-cross Spider-orchid (*Caladenia cruciformis*), endemic to Victoria. Photograph: Trex21 via Wikimedia Commons (CC BY-SA 3.0)

users will readily identify an orchid to this taxonomic level. While in larger genera, similar looking species are gathered together rather than defaulting to alphabetic order, which helps considerably with the likes of spider orchids and greenhoods. I'm less convinced by the odd use of lower-case single letters for directions (e.g., 'e' for east, rather than the more usual capital 'E') but perhaps that is an editor's decision.

I'm not going to critique the taxonomy. Partly because I'm a little rusty these days on the new species, and partly because it's a fool's errand. Many of the species described in recent years are limited in distribution and number of individuals, making it difficult to assess their cogency and utility. The diversity is certainly out there but as to how to best represent this in a taxonomic scheme remains an unfinished project. Still, I am pleased that a conservative and pragmatic approach has been taken to the circumscription and nomenclature of genera.

Personally, I can't wait to take this book into the field. Not only to use the best available name as a gateway to all that is known about the orchid, but to reflect, yet again, on how these orchids so successfully seduce pollinators and humans alike. This is a beautiful work of scholarship and the compilation of many years of acquired knowledge by one of Australia's best (and most productive) naturalists.

▶ *Professor Tim Entwisle recently left Royal Botanic Gardens Victoria after ten years as Director & Chief Executive, and over three decades running botanic gardens in Sydney, London, and Melbourne. Tim has written extensively on the unsuitability of Australia's seasonal system, including a book, Sprinter and Sprummer: Australia's Changing Seasons (2014, CSIRO Publishing).*

Tim returned to this topic in his latest publication, 'Evergreen: The Botanical Life of a Plant Punk' (2022, Thames & Hudson), where he describes what drew him to a life in botany, and botanic gardens, with a bit of music and algae thrown in.

You can read more of Tim's writing for Science Victoria, at ***rsv.org.au/sprummertime***

Photograph: Karl Hedin via Unsplash

Science Victoria STEMM Photography Prize

WIN $300 AND CELEBRATE THE WORLD OF STEMM.

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

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

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

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

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

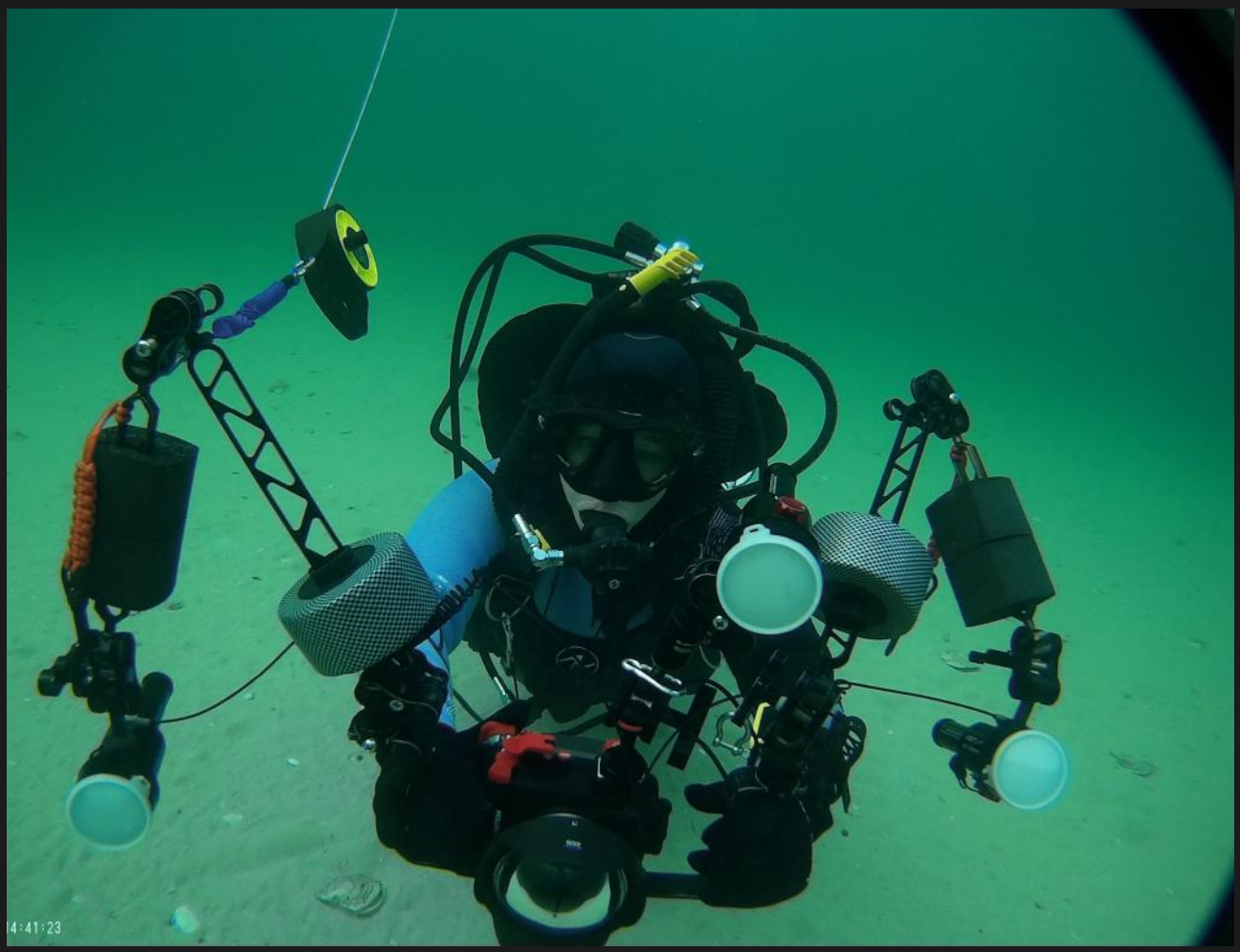
Images must be original photographs that capture your day-to-day work in STEMM. These are not stock photos or overly posed images. Instead, they show what working and studying in a STEMM field is actually like.

PRIZE:
$300 prize, and a certificate.

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

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

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



Dr Elodie Camprasse from Deakin University's Marine Research and Innovation Centre studying spider crabs in Port Phillip Bay. Photograph: Dr Elodie Camprasse.

Science on Show at Melbourne Museum, presented as part of National Science Week. Scientists showcased some of their rarest and most fascinating specimens, and discussed how they are helping species survive and thrive. Photograph: Dr Catriona Nguyen-Robertson.

Photograph: National Cancer Institute via Unsplash.

Academia and Research-led Innovation – Can You Do Both?

Academic research drives transformative breakthroughs but can you have an academic career and be deeply involved in both the R (research) and D (development) of your research-led innovation?

Join the conversation with panellists Anita D'Aprano, Darren Kelly, Antoinette Tordesillas, Ray Dagastine and David Simpson whose careers have spanned academic research and roles as clinicians, founders and industry collaborators in diverse fields across science, engineering and medicine.

DATE/TIME:
Wednesday 4 September 2024, 3pm - 5pm

PRICE:
Free

LOCATION:
The Studio
Melbourne Connect
700 Swanston St
Parkville, VIC 3010

BOOKING LINK:
eventbrite.com.au/e/academia-and-research-led-innovation-can-you-do-both-tickets-965602722737

mparzuchowski via Unsplash

Don't read this: AI and the end of human literacy

We are exposed to an unprecedented amount of information through the internet and social media, but current research indicates that actual reading (the conversion of data to knowledge) is declining. As we grapple with the ethics of AI and algorithmic decision-making, research shows that activities that have traditionally informed basic literacy and civic fluency are under threat.

Tracie D. Hall, winner of the prestigious Medal for Free Speech and Expression from the Roosevelt Institute, draws on her long-standing work on book censorship and the criminalisation of reading across leading democracies, to look at what the rise of machine-learning could mean for civic literacy in order to refresh and recast her 'fight of the century' for the right to read freely.

DATE/TIME:
Thursday 5 September 2024, 6:45pm - 7:45pm

PRICE:
Free

LOCATION:
Elisabeth Murdoch Building (Building 134),
University of Melbourne
Parkville VIC 3052

BOOKING LINK:
eventbrite.com.au/e/dont-read-this-ai-and-the-end-of-human-literacy-tickets-964666061157

Photograph: Michael Coghlan via flickr (CC BY-SA 2.0)

The Challenge of Public Science Communication

In this lecture presented by Laureate Professor Peter Doherty, Nobel Prize winner (Medicine, 1996) and Australian of the Year (1997), we will hear about the challenges of public science communication.

Emphasising the crucial role of experts in advocating for evidence-based perspectives on global issues such as climate change and pandemics driven by international travel, Professor Doherty will highlight the evolving media landscape and address the complexities of misinformation and conspiracy theories.

This presentation will be presented both in-person at Monash Caulfield campus, and simulcast online.

DATE/TIME:
Tuesday 17 September 2024, 6pm - 8:30pm

PRICE:
Free

LOCATION:
Monash University Caulfield campus
900 Dandenong Rd,
Caulfield East VIC 3145
(Simulcast online)

BOOKING LINK:
monash.edu/education/events/public/the-challenge-of-public-science-communication

Photograph: James Baltz via Unsplash

Smart Fertilisers: Fertile ground for sustainable agriculture

Modern farming practices require nitrogen fertilisers, and their use is projected to increase by 70-100% by 2050. Unfortunately, around half of the nitrogen compounds – such as ammonia and nitrates – in these fertilisers are lost into the environment.

These losses are not only expensive for farmers and consumers but, more importantly, the environmental impact is substantial: ammonia is a precursor for particulate matter ($PM_{2.5}$), while nitrates cause surface water eutrophication and groundwater pollution.

Additionally, microbes convert nitrogen fertiliser into gases like nitrous oxide, which has 300 times higher global warming potential than carbon dioxide.

To lower the greenhouse gas footprint of agriculture, reduction of nitrogen losses has become an important goal. This seminar will present a selection of strategies to improve nitrogen management in soils to increase agriculture's sustainability.

DATE/TIME:
Thursday, 26 September 2024, 6pm - 8pm

PRICE:
Free

LOCATION:
Arts West Building (West Wing) (Building 148b)
The University of Melbourne
Parkville VIC 3052

BOOKING LINK:
eventbrite.com.au/e/smart-fertilisers-fertile-ground-for-sustainable-agriculture-tickets-927800455137

RSV Events

The RSV hosts many STEMM-related events, public lectures, and meetings throughout the year. These are held at the RSV Building at 8 La Trobe St, Melbourne (unless otherwise indicated), and simulcast online. Our public lectures comprise the "Scientists in Focus" component of the Inspiring Victoria program in 2024.

Missed an RSV event?

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

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

youtu.be/7Mg0KHon6RU
Science, Media and the Law: Lessons from the Kathleen Folbigg Case

youtu.be/tMJN6RixaUE
Australian Drylands Rivers: Alive and Kicking

youtu.be/JL6SiKT9jSI
Aiming Higher: Improving Science Education in Victorian Schools

youtu.be/_cWif2yGmH0
Space To The Rescue: Australia's Dependencies on Space Technology

youtu.be/CDE446enrt0
Holocene Climatic Fluctuations in the Australian Region

youtu.be/OdSsdcSUO0o
Reimagining Humanity in the Age of Generative AI

Awards & Prizes

The Writing Prize 2024

APPLICATIONS CLOSE *25 October 2024*

The Writing Prize will be awarded for the best writing on the question: What should be the roles and responsibilities of Australian media in reporting on and responding to the real-life impacts of climate change?

The Writing Prize is for Australians aged forty years and under. The winner will receive $10,000 and their writing featured on **www.writing.org.au**.

Entries can be from an individual or groups of two, three or four people.

We welcome original writing between 4,000 and 5,000 words on the above question. Extensive referencing is not required. Where references are included we prefer Oxford (Endnotes).

Entries are required in a word document by 25 October 2024 to: **helen@futureleaders.com.au**. Please include your name, age and contact details. Entry in The Writing Prize is free.

The Writing Prize is designed to encourage younger Australians to write about significant societal issues. It is part of www.writing.org.au, a philanthropic initiative about facts, opinions and ideas.

- For more information, visit **www.writing.org.au/the-writing-prize-2024**

Photograph: National Cancer Institute via Unsplash.

Photograph: Gilles Rolland-Monnet via Unsplash.

Saving Native Species – Emergency Actions for Threatened Species

APPLICATIONS CLOSE *27 June 2025*

Saving Native Species – Emergency Actions for Threatened Species provides organisations with grants between $5,000 - $600,000 to help deliver the prevention of extinctions of plants and animals.

- For more information on this and other Saving Native Species Program grants, visit **dcceew.gov.au/environment/biodiversity/threatened/saving-native-species**

NHMRC 2024 Standard Equipment Grants

APPLICATIONS CLOSE *25 September 2024*

All administering institutions receiving NHMRC research funds are eligible to receive Equipment Grant funding between $5,000 - $300,000.

The objectives of these grants are to support institutions to:

- be strategic in the purchase of larger items of equipment that will benefit health and medical research in Australia;
- purchase equipment that will be used collaboratively;
- where possible, purchase Australian-made equipment; and
- provide ongoing service, upgrades, maintenance and repair costs for equipment used on NHMRC funded Research Activities.
- For more information, visit **grants.gov.au** and search' **GO7110**'.

Bioremediation

A pollution solution

BY DR CATRIONA NGUYEN-ROBERTSON MRSV
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Our environment is being constantly bombarded by pollutants. They are found in the deepest oceans, high in the atmosphere, throughout urban areas, and in the most remote locations on Earth. Once pollutants enter the environment, they are carried across vast distances. Pollution is a global problem.

Site of the Deepwater Horizon oil spill (2010) in the Gulf of Mexico. Photograph: Green Fire Productions via flickr (CC BY 2.0).

Debris from the 2011 Tōhoku earthquake and tsunami, which caused the Fukushima Daiichi nuclear disaster, four years later. While the debris can be sorted and processed, disasters of this magnitude release a wide range of chemicals and metals into the ground, water, and sky. Photograph: UCLA Newsroom via flickr (CC BY-NC-SA 2.0).

Our polluted planet

Earlier industrialisation and poor environmental management have left a legacy of contamination. Over three million sites around the globe are classified as contaminated (over 2.8 million estimated in the EU alone)[1] - and this number is a significant underestimate. Because the environmental and health hazards associated with contaminated sites vary so widely, they can be difficult to recognise - especially when the functions of the former industrial site halted long ago.

To make matters more difficult, pollutants are becoming increasingly complex as humans develop new compounds that can leach into the environment. Most of these sites therefore remain untreated.

For centuries, most people regarded the environment as resilient, and that "little spills" of chemicals here and there would not cause great harm. The 1989 Exxon Valdez oil spill was a turning point: 11 million gallons of crude oil spilled from an oil tanker, impacting over 2000 km of Alaskan coastline.[2] It was the largest offshore oil spill ever recorded in the USA, until the Deepwater Horizon oil spill in 2010 dumped 134 million gallons of oil into the Gulf of Mexico.[3]

Clean-up on aisle... everywhere

With these massive offshore oil spills in addition to the constant waste generated by agricultural farms, textile factories, and even households, it became clear that the environment cannot simply bounce back from our level of waste.

The typical approach of dealing with environmental waste was often to sweep it under the carpet – to literally bury it. While a cheap solution, it is unsustainable, especially as chemicals inevitably eventually leach into the surrounding environment. Heating contaminated soil to high temperatures in a process referred to as 'thermal desorption' can also remove contaminants, but it is very expensive, and renders the soil useless. Therefore, a more viable method of removing environmental contaminants is called for.

Biological remedies for contaminated localities

Professor Andy Ball and his team at RMIT are working on solutions to environmental pollution at different sites around the world, primarily through the process of 'bioremediation'. Bioremediation is the process of using biological organisms or systems – most often bacteria, microalgae, fungi, and/or plants – to remove pollutants from an environment.[4] These organisms break down the contaminants into non-harmful products, with the benefit of working 24/7 for free.

An estimated 9.2×10^{29} - 31.7×10^{29} (92 and 317 with 28 zeros after it) bacteria live on the planet.[5] Over billions of years, they have evolved to use everything at their disposal on Earth as nutrients to survive and thrive.

Fortunately for us, this includes our waste.

One third of current bioremediation projects target petroleum waste. With microbes having lived side-by-side with crude oil for millions of years, we have been able to identify and harness bacteria that consume it. Part of the reason that crude oil can be difficult to clean up from the environment is that it is not homogenous — it is a mix of chemicals. Some bacterial species can use carbon from crude oil as a fuel source of their own, and convert toxic pollutants into harmless products like water and carbon dioxide. It is a matter of identifying which ones can help.

Prof Andy Ball (second from left) and his team in 2021. Photograph: Prof Andy Ball/RMIT.

Bioremediation case studies

The work of Prof Ball and his team often begins in the lab. They identify microbes that can break down specific types of waste, along with the nutrients that help them do so faster, and then move into the field.

Prof Ball's research team, led by Dr Claire Bird, did precisely this, starting by growing microorganisms in a flask with a small amount of waste oil. By the end of the project, the team was spraying a mixture of those microbes and all the nutrients they needed onto diesel-contaminated soil. From those humble beginnings in a lab, 1000 m^3 of contaminated soil eventually became clean enough for use in gardens.[6]

At a petroleum facility on Jurong Island in Singapore, another of Prof Ball's former students, Dr Greg Poi, has implemented a large-scale bioremediation project. Ground water at the site was contaminated with petroleum compounds (collectively known as 'total petroleum hydrocarbons'). By incubating a cocktail of microbes with the contaminated ground water in a tank, and providing a fresh supply of microbes every month, Dr Poi and Prof Ball created a consortium of 22 microorganisms that successfully treated 200,000 L of water.[7]

Dr Poi has since transferred his bioremediation success to contaminated soil, worked as an industry consultant to oil corporations such as Exxon-Mobil, Shell and Vopax, and established his own bioremediation company in Singapore.

Ever-evolving solutions for an ever-changing problem

Given the scale of the pollution problem, Prof Ball believes that it is important to commercialise and translate the findings of his team's laboratory research for use in the field. But the basic research never stops, especially given that new and increasingly complex compounds are being produced and released into the environment.

As an example, chlorinated compounds have become ubiquitous in the environment, and are difficult to treat. Chloroethenes, used in dry cleaning and degreasing agents, are now common in groundwater and are extremely harmful to humans and the environment due to their carcinogenic properties.

Over ten years ago, a group of bacteria (*Dehalococcoides*) were found to be able to remove the damaging chlorine groups from chloroethene in the environment. While these bacteria species are commercially available to buy and add to groundwater, Prof Ball has decided not to use them in Australia, as they might not be indigenous to the environment. He did not want to be creating a different problem by adding bacteria to the environment that didn't belong. Instead, he focused on existing microbial communities rather than relying on a single species, and managed to manipulate existing microbe communities in ground water sampling sites across Victoria to do the same thing.[8]

Sunflowers (*Helianthus annuus*) can take up heavy metal pollutants from soil.[9] Photograph: Stefano Zocca via Unsplash.

Chlorophyll-tration

Plants can also be used for bioremediation, cleaning up hazardous contaminants in soil, air, and water through a process called phytoremediation. The process takes advantage of the ability of certain plants, known as hyperaccumulators, to accumulate and concentrate certain elements and compounds from the environment. Hyperaccumulator plants extract metal compounds from deep in the soil and transport them into the stem, leaves and flower. Not only does this process help to clean the environment, the accumulated metals are essentially being "farmed" and can be repurposed.

The sunflower plant (*Helianthus annuus*), for example, can take up heavy metal pollutants such as arsenic, nickel, zinc, cadmium and lead from soil, and is often used to clean up environmental contamination.[9] Sunflowers are also particularly adept at extracting radioactive metals, like the radioactive caesium and strontium isotopes found in Chernobyl and Fukushima after the Chernobyl Nuclear Power Plant disaster of 1986 and Fukushima explosion of 2013 respectively. Fields of sunflowers were planted to soak up these radioactive metals from the ground and were then harvested and safely disposed of.

Waste plant matter, such as mouldy straw, can also be repurposed for bioremediation, as they are full of plant-associated bacteria and fungi that can also break down pollutants. While there is success for removing some contaminants by plants alone with bioremediation, the use of plants in conjunction with plant-associated organisms offers great potential for the hydrocarbons found in coal, crude oil, and gasoline.[10]

Mopping up the mess we've made

Given that it is anthropogenic activity that pollutes the environment, it is only fitting that we turn to natural solutions to help restore it to how it used to be.

Prof Ball's research is focused on the sustainable remediation of contaminated environments, applying cutting edge tools to reduce environmental pollution in urban environments. As we continue to pollute the environment with emerging microplastics, pharmacological products, and other chemicals, we need new solutions for these newer pollutants. Synthetic biology (e.g., improving naturally-occurring enzymes - essentially a human collaboration with nature) might be the answer, and Prof Ball is excited to see how the field evolves.

'We are still polluting our environment – day in and day out – with new, emerging pollutants. Every individual needs to reflect on the waste they are contributing and minimise their footprint,' says Prof Ball.

The consequences of pollution go far, but with people like Prof Ball on the case, we might be able to clean up our act - literally.

▶ *This article follows a presentation to the RSV titled "Bioremediation: Restoring Contaminated Ecosystems, Naturally", delivered by Professor Andy Ball (RMIT University), awardee of the 2021 RSV Medal for Excellence in Scientific Research. His work ensures that we become "better custodians of our environment," as The Hon. Lily D'Ambrosio MP noted when presenting him with the award. You can watch Prof Ball's presentation at* ***youtu.be/8ZoBy_ewLvc****.*

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Blinded by the Lights

The Impacts of Light Pollution

BY DR CATRIONA NGUYEN-ROBERTSON MRSV
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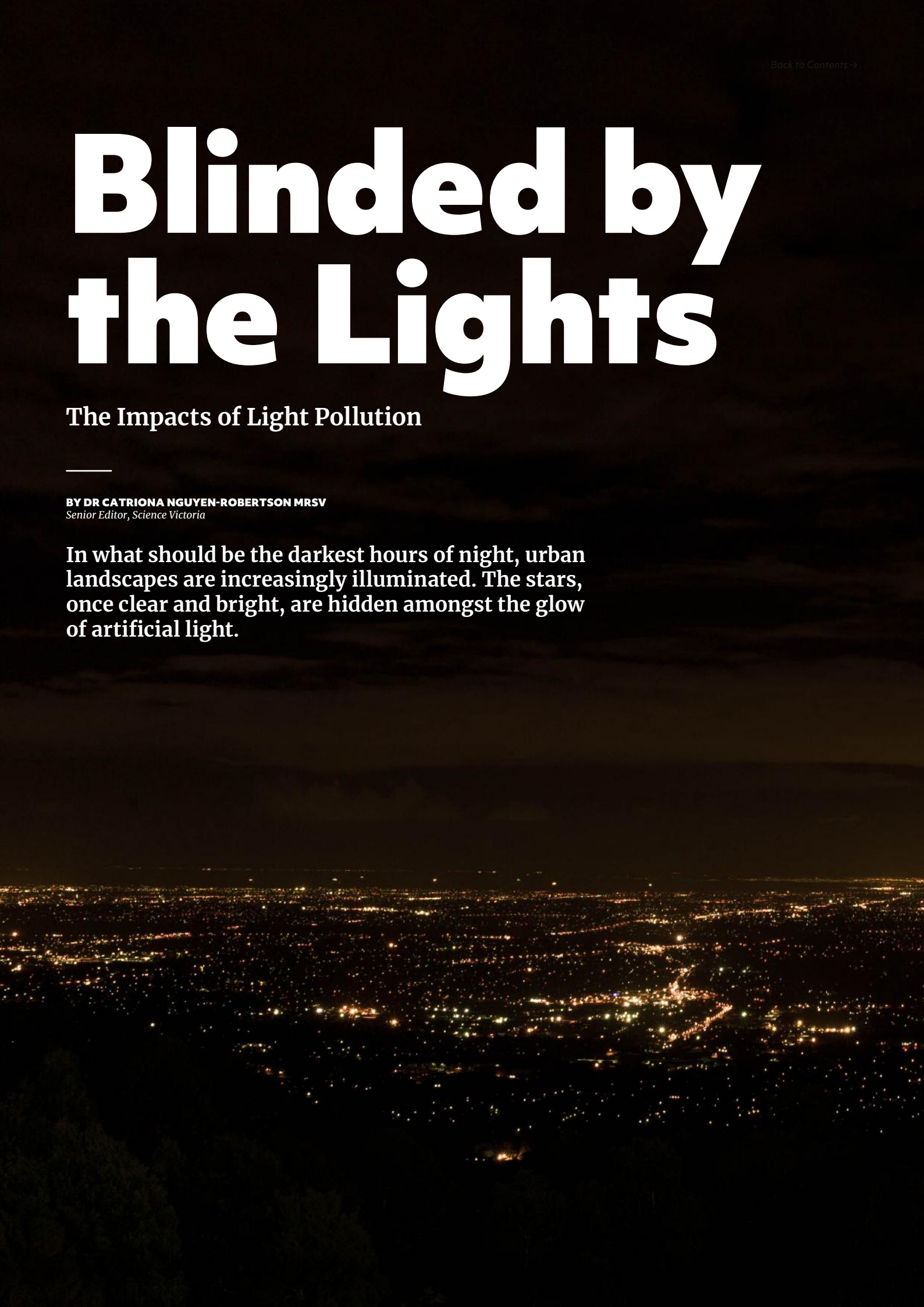
In what should be the darkest hours of night, urban landscapes are increasingly illuminated. The stars, once clear and bright, are hidden amongst the glow of artificial light.



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Melbourne's skyline at night from Mt Dandenong.
Photograph: James Liu via flickr (CC BY-NC-ND 2.0)

We have so many lights on at night: lights on in our homes, lamps on our streets, and blazing signs scattered through the city. This is light pollution, and it disrupts the natural rhythms of animals, and leads astray those who use the stars and Moon to navigate.

We need to return to darker skies – skies without the hazy "sky glow" created by artificial lights.

Drowning light from the stars

Have you ever seen the Milky Way from Melbourne city?

The artificial sky glow is so bright that it overpowers light emitted by stars far away. Only in "dark skies", away from the bright lights of cities, can you see the Milky Way arcing across the sky, made of billions of distant stars and vast interstellar dust clouds.

More than 80% of the world's population does not have access to dark skies, and more than a third have never seen the Milky Way with their own eyes.[1]

In Melbourne, only a couple of hundred individual stars are visible to the naked eye. But away from the bright lights of the city (or if you were in Melbourne 200 years ago), you can see over 2,000.[2]

For many cultures, a sky filled with stars (including the Sun), the Moon, planets, and meteorites, is considered a part of the natural environment – just as important as the land below.

Careful observations of the night sky over millennia are embedded within the traditions and cultures of First Peoples. They create meaning in the sky above that guides them in life on the ground below, as the knowledge is tied in with seasonality, animals, weather, plants, animals, navigation, and values. But will these stories and this knowledge persist if the stars can no longer be seen?

The shadows of light pollution on wildlife

The glow of urban landscapes intrudes upon the natural world – far beyond the last light street light.

We know that artificial light at night can disrupt our sleep – imagine if your neighbours' lights glared into your bedroom every night as you try to sleep. In addition to this nuisance, artificial light has quantifiable negative effects on human health. When exposed to even dim lights, we sleep for less time and less deeply, increasing risks for sleep disturbances and chronic conditions.[3]

Understandably, it also impacts animals. We are being *that* neighbour to our local fauna. Wildlife relies on natural light for their patterns of rest and activity, their growth and reproduction, and navigation.

Artificial light masks day length and other natural light cues used by animals to regulate their daily activity and annual reproduction. For nocturnal species, the night is a time of activity, a crucial part of their daily rhythm. But under the relentless glare of urban light pollution, their behaviours change and their instincts falter. Native mammals are most active in low light conditions (at night, dusk, and dawn). Brightly lit areas expose them to predators, including daytime predators that can now better hunt at night. Even for herbivores, light pollution can reduce food availability by altering the timing of plant reproduction, flowering, and fruiting.[4]

Animals that rely on dark skies for navigation are losing their way. After hatching on the beach, turtle hatchlings crawl towards the brightest direction, which should be light from the night sky reflected on the ocean.[4] But lights from on-shore confuse them, causing them to travel away from the water or crawl in circles.

The sky glow also prevents fledgling seabirds from taking their first flight, as they only fly under the cover of darkness.[4] Dung beetles, the first known species to navigate using the Milky Way,[5] are losing their guide the more it becomes washed out. Bogong Moths that travel to and from the Australian Alpine Region are being drawn to the light of cities – and this impacts Mountain Pygmy-possums that rely on the moths making the trip to have food.[6]

All species in an ecological community rely on each other, and so artificial light doesn't just impact isolated species – it's disrupting entire ecosystems. It is also fragmenting habitats and isolating populations, as many animals cannot cross artificially illuminated areas.

"...but someone's got to do it." Dung beetles were one of the first species known to navigate using the Milky Way.[5] Photograph: Brian Ralphs via flickr (CC BY 2.0).

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Native mammals like the lesser hairy-footed dunnart *(Sminthopsis youngsoni)* are most active in low light conditions, and more visible to predators in brightly lit areas. Photograph: Dash Huang via flickr (CC BY-NC-SA 2.0).

Looking at the north-east sky in Melbourne just after sunset (7:15pm, 17 August) with (Left) and without (Right) light pollution taken in Melbourne Planetarium. Photograph: Dr Catriona Nguyen-Robertson.

Satellites – the "stars" that outshine the stars

On some nights, the brightest objects in the sky may be neither planets nor stars.

It is not merely the lights that we use here on Earth that are a problem. Internet and telecommunications satellites that orbit hundreds of kilometres above our planet also light up the sky.

Currently, there are nearly 8,000 active satellites in low Earth orbit, with plans for many more.[7] These satellites reflect the bright sky glow from below. Recently deployed satellites are as bright as stars that we see with our eyes and are even among the brightest objects in the night sky.[8]

Not only does this further confuse animals that are relying on stars, it interferes with stargazing and astronomical research. Members of the International Dark Sky Alliance predict that the performance of a major, ten-year astronomical sky survey starting this year will be diminished by at least 7.5% due to satellites being dotted across the sky.[9]

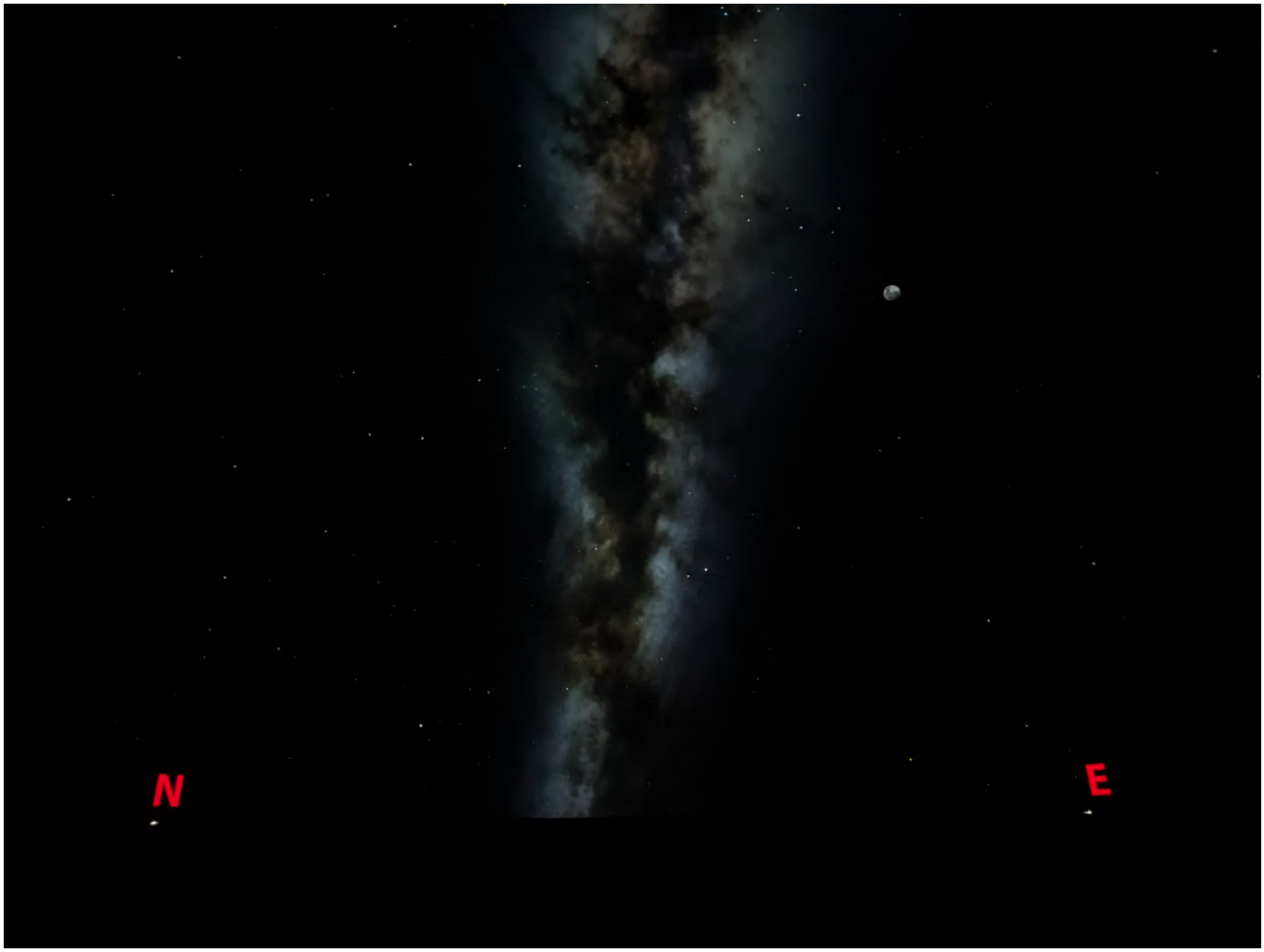
With thousands of satellites planned, low Earth orbit traffic is getting busier, and we need to work to find mutual solutions that avoid such a scenario. One option is to make satellite surfaces darker, which would reflect less visible light - however, this process would generate heat, thereby potentially impacting observations in infrared light. Another possible solution is to add mirrors that allow the satellites to change the direction of the reflected light so that it is not pointing directly at the Earth.

With artificial satellites around the Earth becoming a bright, new form of light pollution, we need to consider how this impacts not just scientists, but also the animals and plants that rely on natural light and stellar objects for their navigation through life (sometimes literally).

A return to dark skies

As the glow of city lights continues to encroach on dark skies, the consequences of light pollution become ever more apparent. We can make seemingly simple changes:

- Turn off unnecessary outside lights – start with natural darkness and only add light for specific purposes. Only light areas that you need, and when lighting them, use low-intensity lighting and keep the light close to the ground.



- Block light from getting outdoors through your windows.
- Switch to amber light rather than white light (i.e., removing blue light) so as not to be as disruptive to animals' sleep patterns, as blue light interrupts sleep more.
- Cover light sources so that the light is directed towards the ground.

While we can make changes like switching white light to amber to minimise sleep disruption for animals, the benefits are not universal. For example, while magpie sleep is more disrupted under white light compared to amber light, both types of light are equally disruptive for sleep in pigeons.[10] The absence of light is better than any light.

The artificial illumination of light pollution drowns out the dark sky. As city lights blaze and glow, animals lose their way and are forced to adapt their behaviours, and the light of distant stars is suffocated by the brightness we created. Preserving our dark skies is for the benefit of all living things on Earth. Light pollution can be easily addressed with the flick of a switch.

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Keep the Noise Down!

The other side of ocean pollution

BY NEELE ELBERSGERD
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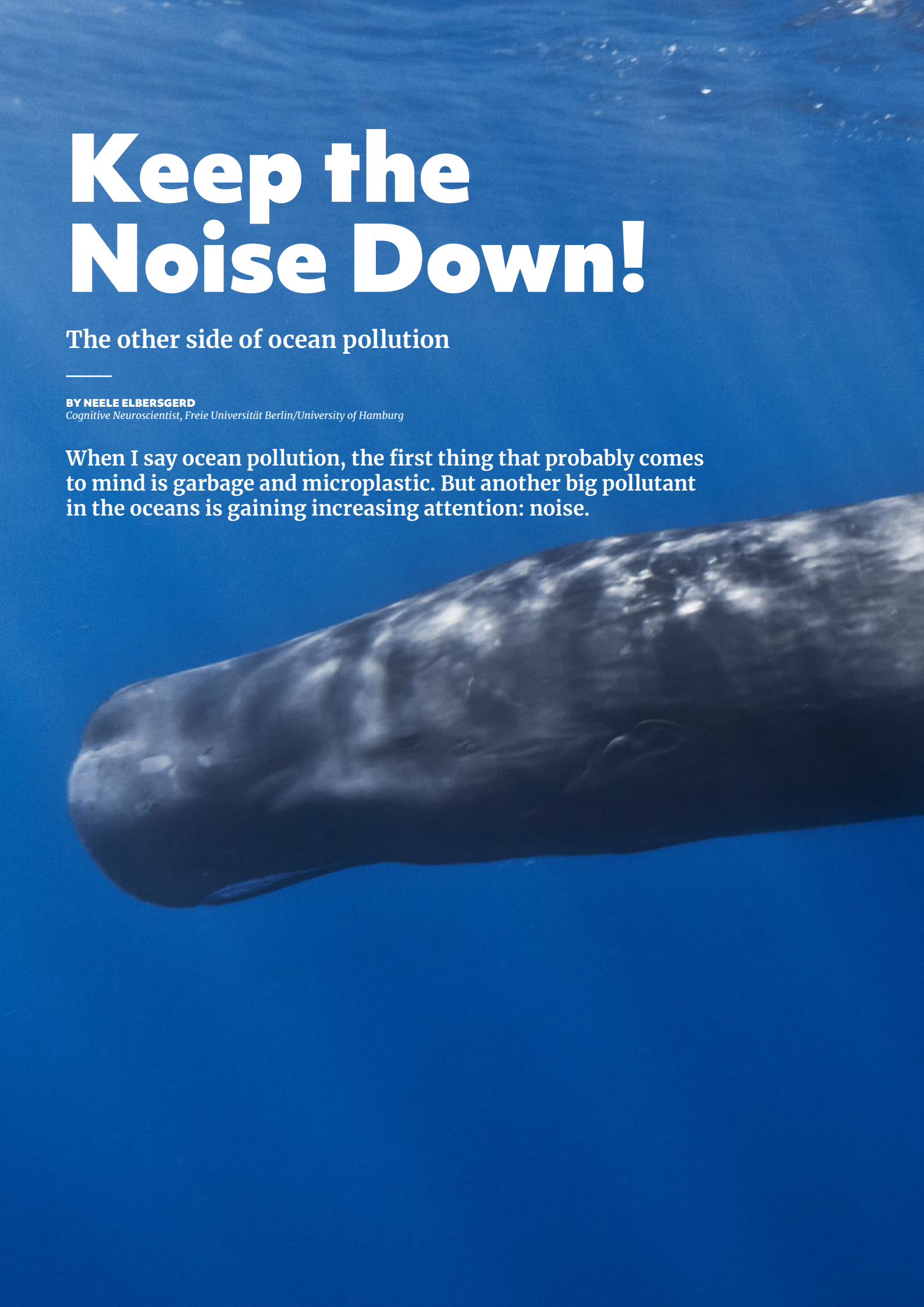
When I say ocean pollution, the first thing that probably comes to mind is garbage and microplastic. But another big pollutant in the oceans is gaining increasing attention: noise.



Sperm whale mother and calf. Photograph: Gabriel Barathieu via Wikimedia Commons (CC BY-SA 2.0).

Our oceans are loud places. Whales, dolphins, fish, and even corals produce sounds that shape underwater life. And while some humans love listening to "underwater soundscapes" (e.g., dolphin and whale sounds), the anthropogenic (human-made) noise that marine animals have to endure is anything but comforting.

Humans are noisy intruders

Anthropogenic sounds from transport, construction, offshore exploration, and mining have made the once peaceful environment a loud cacophony of sound that is extremely damaging for marine wildlife.

There are three major sources of human-made noise:[1]

- Propellers of ships, especially when dirty or damaged
- Seismic airguns which are used to map out the ocean floor in search of oil and gas
- Pile driving; a process used to build foundations of ocean infrastructures (like wind farms or oil rigs)

The increased anthropogenic noise in marine environments, and its consequences, are often connected to trading route hotspots. In contrast, where there are no ships, the marine soundscapes remain pristine.[2]

How noise impacts the oceans

The impact of industrial noise pollution on marine wildlife is alarming. The noise levels stress over 150 species - not only whales and dolphins, but also invertebrates like jellyfish, octopuses, and coral reefs.[3]

Animals who rely on sound to communicate get disoriented, leading to aimless swimming or mass strandings.

Anthropogenic noise reduces animals' ability to communicate or use echolocation: animals try to avoid areas if they are sufficiently loud, and it dampens their detection of environmental cues that inform navigation.[4]

For example, noise slows down whale migration times by up to 20 per cent, and may even trap whales behind a 'wall of noise' if levels continue to rise.[4]

Predator and prey detection, feeding behaviours, as well as mating, are increasingly disturbed. All of these are made understandably more difficult with the sound of seismic airguns nearby.

Solutions: so close yet so far

Unlike with plastic, noise reduction can be tackled quickly and - if addressed - should show effects immediately. A report from the U.N.'s Convention on the Conservation of Migratory Species of Wild Animals (CMS) outlines possible solutions:[1]

- Cleaning and checking propellers regularly for damage
- Slowing down ships by 10%, which will reduce noise impact by 40%
- Using quieter marine vibrator systems to map out the seabed instead of seismic airguns
- Restricting areas of drilling to less sensitive habitats and away from migration routes
- Using BLUE Piling (using a large water mass as a ram to drive down piles instead of steel hammers)

The detection of undersea oil deposits, and the construction and usage of oil rigs, generate significant amounts of underwater noise that disrupts marine life. Photograph: Ed Dunens via flickr (CC BY 2.0).

We have solutions – but implementing them is another thing. These new technologies are not yet widely available and introduce additional costs.

Additionally, one of the best and worst parts about the ocean is that it belongs to everyone. Implementing and reinforcing regulations on an international level is hard and takes a lot of time.

But we should not be – and we are not – giving up.

Several national and international projects have formed over the past years, like Saturn in Europe, or the Global Partnership for Mitigation of Underwater Noise from Shipping (GloNoise Partnership).[5,6] Their goal is to raise awareness, study solutions, and communicate them to the big players in the marine economy.

With every decibel dropped, we can bring a little bit of peace back to the deep blue.

▶ *If you're interested to hear what some of these underwater noises sound like, you can listen to recordings of natural and human-made underwater noises at* ***oceanexplorer.noaa.gov/gallery/sound/sound.html***

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A juvenile humpback whale in the waters near French Polynesia.
Photograph: Oliver Tsappis via Unsplash.

1925

Rain and/or Shine

SCOTT REDDIEX MRSV
Editor-in-Chief, Science Victoria

Spanning more than 150 years, the *Proceedings of the Royal Society of Victoria* frequently highlights the power of using the scientific method to understand our universe.

Given the rapid rate that scientific understanding and technology have progressed over the last century, papers in the *Proceedings* more often than not come from a time when less was known about a topic, fewer resources were available to support research, and far more effort was required.

A great example of this comes in 1925 from meteorologist Edwin T. Quayle, who started with a simple question: how does solar activity influence rainfall?

To address this, he collected data on both the Sun, and on rainfall across the country.

To assess solar activity, he determined the solar cycle through the presence of sunspots. These dark spots on the Sun's surface vary in number across the ~11-year solar cycle, with their numbers peaking in the middle of the cycle, corresponding to the greatest level of solar activity.[1] Their number then drops close to zero at the end of a cycle and beginning of a new one, at which point the polarity of the Sun's magnetic field flips.

Quayle divided what he saw as a 12-year sunspot period into three parts: the first corresponding to the rise in the number of sunspots to its peak, the second the decline, and the third the *"period of minimum sunspottedness"*. With this definition, he next compared rainfall between the three periods at sites around the country.

By 1925, Australia was dotted with weather stations that recorded measurements of meteorological conditions like rainfall and temperature. Quayle selected 75 weather stations, whose records covered 35-82 years, providing data covering multiple solar cycles. Next, he aligned the averaged annual rainfalls (or the winter rainfalls for a minority of locations) with each sunspot period, and studied the differences.

After much work tabulating and graphing his findings, and commenting on the results of specific locations, Quayle noted *"that the rainfall of the whole of the continent is affected in some way by the solar activity; [and] that it is not affected everywhere in the same way."*

With 100 years since his presentation of his paper to the RSV, have his findings endured? Like many things, the answer seems to be, "potentially, but there's more to it". There does seem to be some relationship between rainfall and the solar cycle, however there is greater influence from factors like sea surface temperatures, the El Niño–Southern Oscillation (ENSO), and others.[2,3]

FROM:
Proceedings of the Royal Society of Victoria, Volume 37 (New Series), 1925. Article X - Sunspots and Australian Rainfall. By E. T. Quayle.

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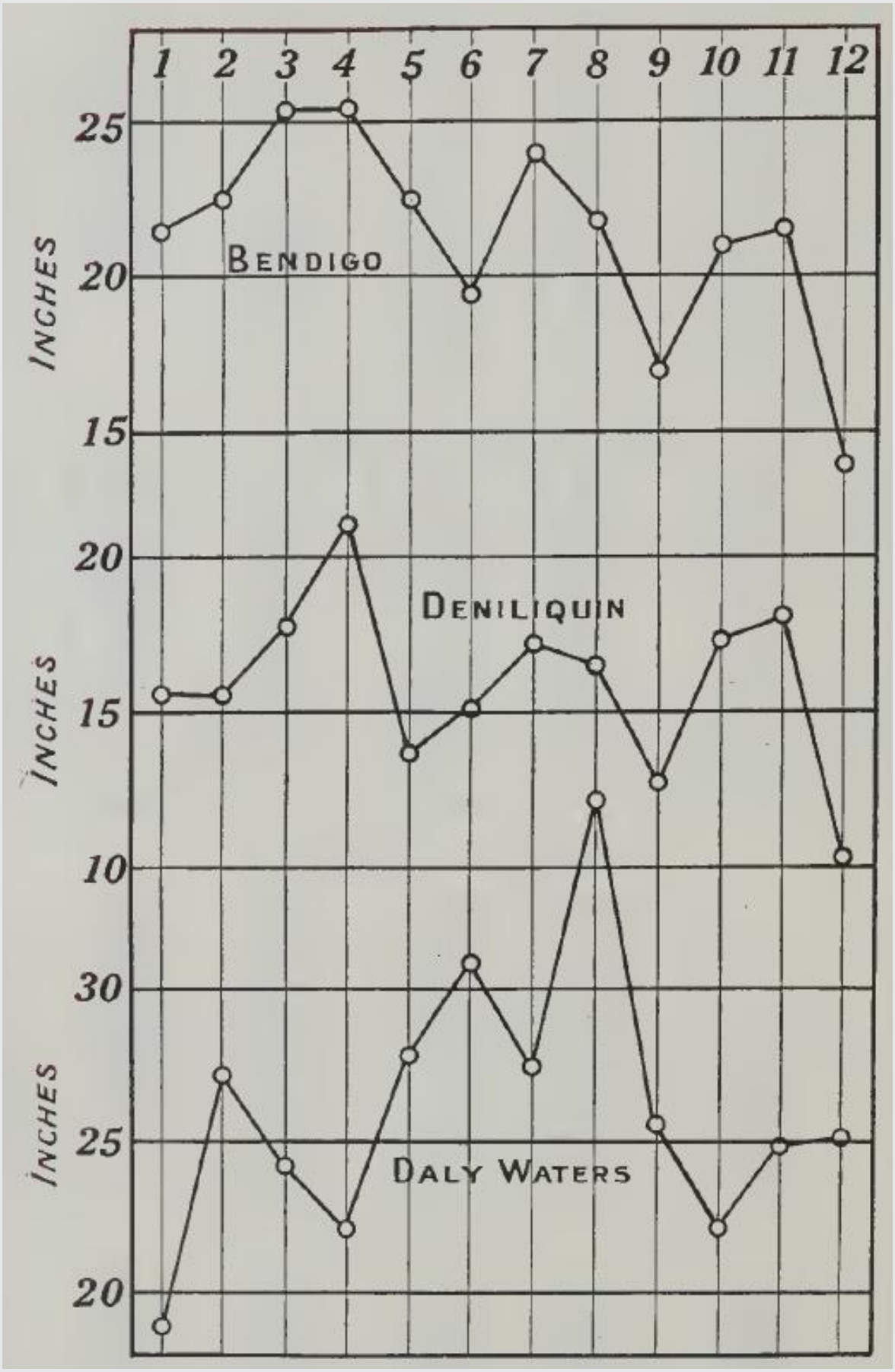
OPPOSITE:
Rainfall variation observed across successive 'sunspot cycles' in Bendigo VIC, Deniliquin NSW, and Daly Waters NT. Source: Proceedings of the Royal Society of Victoria, Volume 37 (New Series), 1925.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Inspiring Victoria

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

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

PUBLIC LIBRARIES VICTORIA
plv.org.au

NEIGHBOURHOOD HOUSES VICTORIA
www.nhvic.org.au

PARLIAMENT OF VICTORIA
parliament.vic.gov.au

MUSEUMS VICTORIA
museumsvictoria.com.au

ROYAL BOTANIC GARDENS VICTORIA
rbg.vic.gov.au

ZOOS VICTORIA
zoo.vic.gov.au

QUESTACON
questacon.edu.au

SCIENCE TEACHERS ASSOCIATION OF VICTORIA (STAV)
stav.org.au

Victoria the T-rex at the Melbourne Museum. Photograph: Scott Reddiex/Science Victoria.

A Wild Start to National Science Week

Ensuring that species Survive and Thrive in the wild

DR CATRIONA NGUYEN-ROBERTSON MRSV
Chair, National Science Week Victorian Coordinating Committee

Under the gaze of a giant *T. rex* aptly named 'Victoria', National Science Week was officially launched in Victoria on the 9 August at Melbourne Museum.

Attendees were welcomed to the museum by Dr Nurin Veis, Director of the Museums Victoria Research Institute. The location was fitting for the launch of National Science Week, given the stories of history, culture, and science housed by the museum.

The event was an opportunity to hear from the different *Inspiring Victoria* program partners about their work, and what they had planned for National Science Week.

Dr Djuke Veldhuis, Chair of the *Inspiring Victoria* Partnership Board reminded us of what National Science Week is all about: highlighting how science and society come together and shape all our lives.

This intersection can be explored in so many ways – from learning how to be sustainable in your daily life, to understanding the myriad plants and animals that shape our state. With hundreds of events around Victoria, National Science Week is a wonderful opportunity for the curious to explore, learn, and engage in science each year.

Spotlight on Survival

The major program presented by *Inspiring Victoria* for this year's National Science Week was *Survive and Thrive*. Whether we're talking about people, flora and fauna, ecosystems, or the relationship between humanity and the natural world, one thing holds true: we're stronger together.

Australia's biodiversity is declining. Around 100 endemic Australian species have been listed extinct – not even counting invertebrates, which would increase the number 10-fold. A further 1,700 plant and animal species are currently classed as 'threatened'. As no species exists in isolation, entire ecosystems are at risk. We have much work to do to save our species.

Representatives from three *Inspiring Victoria* partnership organisations shared their work on ensuring that species *Survive and Thrive*.

Zoos Victoria

Dr Marissa Parrot showcased the conservation work of Zoos Victoria, dedicated to the recovery of 27 threatened native animal species, including the Eastern Barred Bandicoot. The home of the Eastern Barred Bandicoot once stretched from Melbourne to the South Australian border. The species was declared 'Extinct in the Wild' in 2013, but has since been reclassified as 'Endangered', thanks to the dedication of Zoos Victoria and their partners.

This is a first for a threatened Australian species.

Marissa has since turned her attention to the Bogong moth and mountain pygmy-possum. Each spring, the moths used to migrate to Victoria's alpine regions in the billions. At the same time, mountain pygmy-possums – Australia's only hibernating marsupial – also wake from hibernation, hungry for the nutritious Bogong moths to eat. The pygmy-possums are classified as 'Critically Endangered', with fewer than 2,000 left in the wild, and their most urgent threat is the loss of their food source. During spring 2018, in the worst affected population, more than 95% of females lost their young when moths largely failed to arrive.

To combat the destructive cycle, Zoos Victoria have produced "Bogong bikkies", which are delivered by ZENA (Zoo Emergency and Nutrition by Air). These biscuits mimic the same nutrients of moths, and helped the pygmy-possums survive the aftermath of the Black Summer bushfires.

Zoos Victoria are working hard to protect both species, including using data from citizen scientists to better help the moths with Moth Tracker – we can all do our bit.

You can read more about the plight of the Bogong moths and mountain pygmy-possums from Dr Marissa Parrot and her colleagues in July's edition of *Science Victoria*.

Royal Botanic Gardens Victoria

Dr Noushka Reiter told the story of three orchids that she is working to save at the Royal Botanic Gardens Victoria. There are over 1600 flora species in Victoria threatened with extinction – many of them orchids. Victoria has more than 400 species of native orchid, with many occurring nowhere else on the planet.

Orchids have the smallest seeds of all flowering plants, and a reliance on single pollinator species (i.e., only one species pollinates the plant), and/or a single fungal species at their roots to germinate. This makes many orchids quite vulnerable to changes in their ecosystem.

On 24 June this year, Noushka and a team of scientists introduced the critically endangered Frankston Spider-orchid (*Caladenia robinsonii*) back into the wild. It was once commonly found in Frankston, Black Rock and along the Mornington Peninsula, but the species had declined to less than 300 plants due to habitat destruction. Reintroducing the orchid into its native bushland was the culmination of seven years of research: of the orchid, its pollinator, and the fungi that supports its germination.

Noushka's aim is to create self-sustaining populations of many threatened plant species. The team has grown over 30,000 orchids and introduced them to over 40 sites across the state to give them a fighting chance.

Museums Victoria

Australia is estimated to be home to 600,000 species of flora and fauna, yet 70% do not have a scientific species name. It is through a name that a species is given meaning and becomes part of our perception of nature.

Dr Ken Walker, taxonomist and Senior Curator of Entomology at Museums Victoria, wants all species to have names, because "how can we conserve a species that does not have a name?". He spoke of the power of data from museum collections and citizen scientists in ensuring that we can identify and name species.

If we continue at the current rate, it will take 400 years to name them all and many will have become extinct in that time (while new ones may emerge).

Museums are wonderful archives of the past: where did a species occur and when? The gaps in data of where species occur today are now being filled thanks to citizen scientists. Increasingly advancing technologies, such as genetic sequencing and artificial intelligence, together with citizen science might speed things up.

Once a species has a name, we can identify it and track its status through our era of rapid change, to better help them to survive and thrive.

Planting seeds of curiosity and a captive interest in science

Everything within an ecosystem is interconnected. Plants are a source of food and shelter for animals, and animals aid in seed pollination and distribution. Animals (including humans) and plants rely on other animals and plants being available at certain times of the year. If one cog is broken, the whole system can break.

- *National Science Week is a part of the Inspiring Australia program, a community science engagement initiative funded in Victoria by the Commonwealth Department of Industry, Science and Resources and the Victorian Department of Education. There was a vibrant range of events on offer for communities across the state – thank you to all who joined in the celebrations!*

INSPIRING VICTORIA BOARD MEMBERS (L-R): Kate Phillips (Museums Victoria), Dr Catriona Nguyen-Robertson (Royal Society of Victoria), Mike Flattley (Royal Society of Victoria), A/Prof Djuke Veldhuis (Chair), Émer Harrington (Royal Botanic Gardens Victoria), Cameron MacRae (Neighbourhood Houses Victoria), & Andres Lomp (Parliament of Victoria). Not pictured: Dr Angela Savage (Public Libraries Victoria), Jesse Jorgensen-Price (Questacon), Joanne Phillips (Science Teachers Association Victoria), & Mel Wyatt (Zoos Victoria). Photograph: Scott Reddiex/Science Victoria.

Rare, Threatened, and Just Plain Weird

National Science Week at the Parliament of Victoria

BILL BAINBRIDGE
Senior Communications Adviser, Parliament of Victoria

Growling grass frogs, a bearded dragon and even a 'chickenosaurus' made their debuts in Parliament this week.

The trio made their appearances as part of a sustainable species exhibition in celebration of National Science Week.

The exhibition was a collaboration between Zoos Victoria, Museums Victoria, Science Gallery Melbourne and Parliament of Victoria. It explored what we can learn from the past, do in our present, and think about in the future to ensure species not just survive but thrive.

Cheryl Laks, Education Innovation Leader from Zoos Victoria, says protecting our natural habitat isn't just for scientists, but can include the whole community.

"We're highlighting our 'Safe Cat, Safe Wildlife' campaign. We know that when cats are out roaming not only can things happen to them via injuries and fights and car accidents and so on, but also there is a deep impact on wildlife as well," she said.

Recent research has found that roaming pet cats kill 546 million animals a year in Australia, 323 million of which are native animals. The 'Safe Cat, Safe Wildlife' campaign supports cat owners to keep their pets indoors.

"This campaign is really influential around protecting species, the Leadbeater's Possum especially," she said.

"So it's a campaign around sharing with the community, who want to not only keep their cats safe, but also help Victoria's wildlife at the same."

Dr Nurin Veis, Director of Museums Victoria Research Institute, says the museum's work spans everything from understanding the fossil record to helping protect and preserve the contemporary realm, including documenting newly identified species and monitoring the current state of biodiversity in southeastern Australia.

"We document and record them and we know precisely geographically where all the species are located, including insects, because we need our biodiversity to be thriving, rich and alive because those environments are what we rely on for our food, for our air, for our clean water," she said.

"It really brings to life what an amazing, special place this is on the planet."

Jesse Chambers, Deputy Head Learning Programs with Science Gallery Melbourne, said their exhibition was about imagining the possibilities, and the risks, associated with science.

Science Gallery Melbourne has taken its recent 'Not Natural' exhibition and turned it into a student workshop.

The workshop takes the idea of the 'chickenosaurus', a theoretical experiment to reactivate ancient dinosaur genes in modern birds, and allows students to imagine combining two animals into something new: a chimaera.

A bearded dragon (top) and a Museums Victoria researcher discussing their work (bottom) at Parliament House. Photographs: Andres Lomp/Parliament of Victoria.

"Before they do that, we have conversations with them about the implications of bringing it back. So just because we can do all of this awesome stuff with science, should we?," he said.

"They think about what impact would it have on the environment if we were to bring in a new species into a country like Australia, which has such a delicate ecosystem. They think about what would be the impact on people and also on the economy if you were to bring back a creature that hasn't been evolved to live in an environment like Australia."

The exhibition, he says, is a perfect fit for Parliament, because it highlights the link between civics and citizenship and science.

"They go hand in hand with one another and, at Science Gallery, all of our exhibitions are interdisciplinary. All of our exhibitions combined multiple different disciplines because that's how the world works."

▶ *This article was originally published at* ***parliament.vic.gov.au/news/environment/science-week***

Call for Scientific Papers

AVAILABLE ONLINE AT 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.

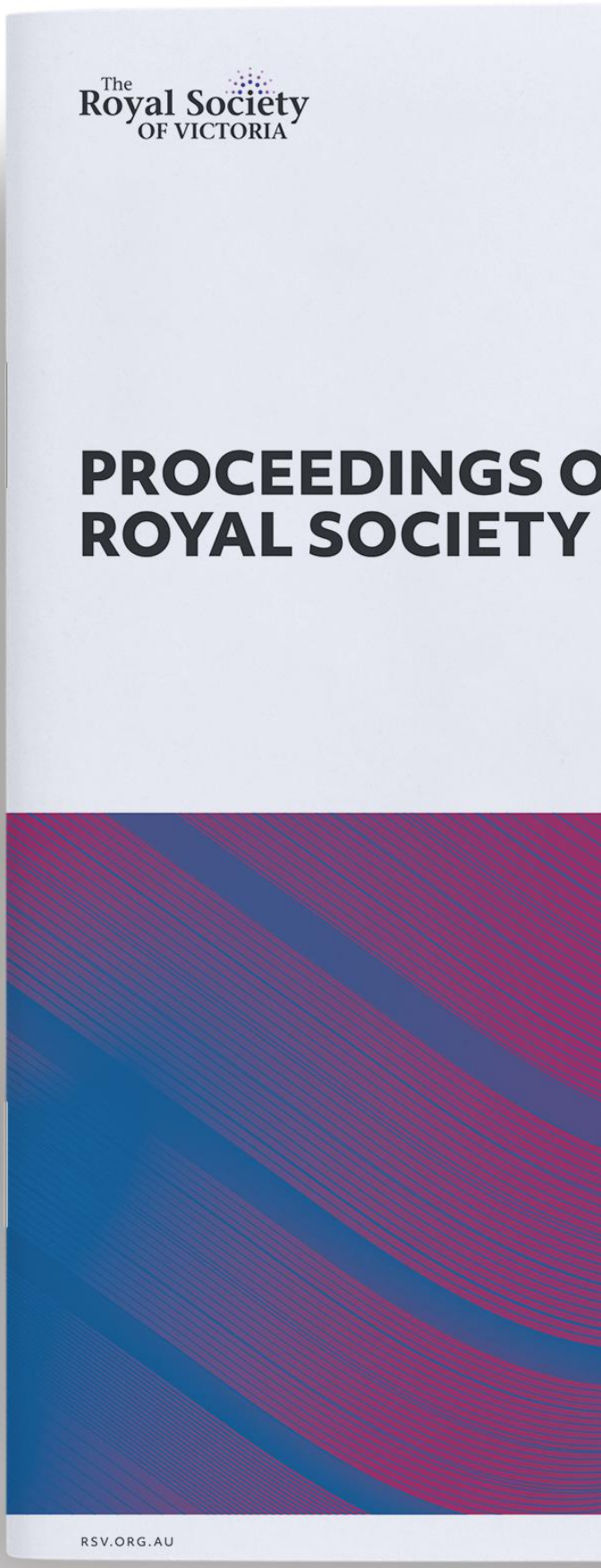
The journal began in 1855 as an irregular publication under the title *Transactions of the Philosophical Society of Victoria,* with the present name adopted in 1889. Since then, volumes of the journal have been published annually, often across one or more parts.

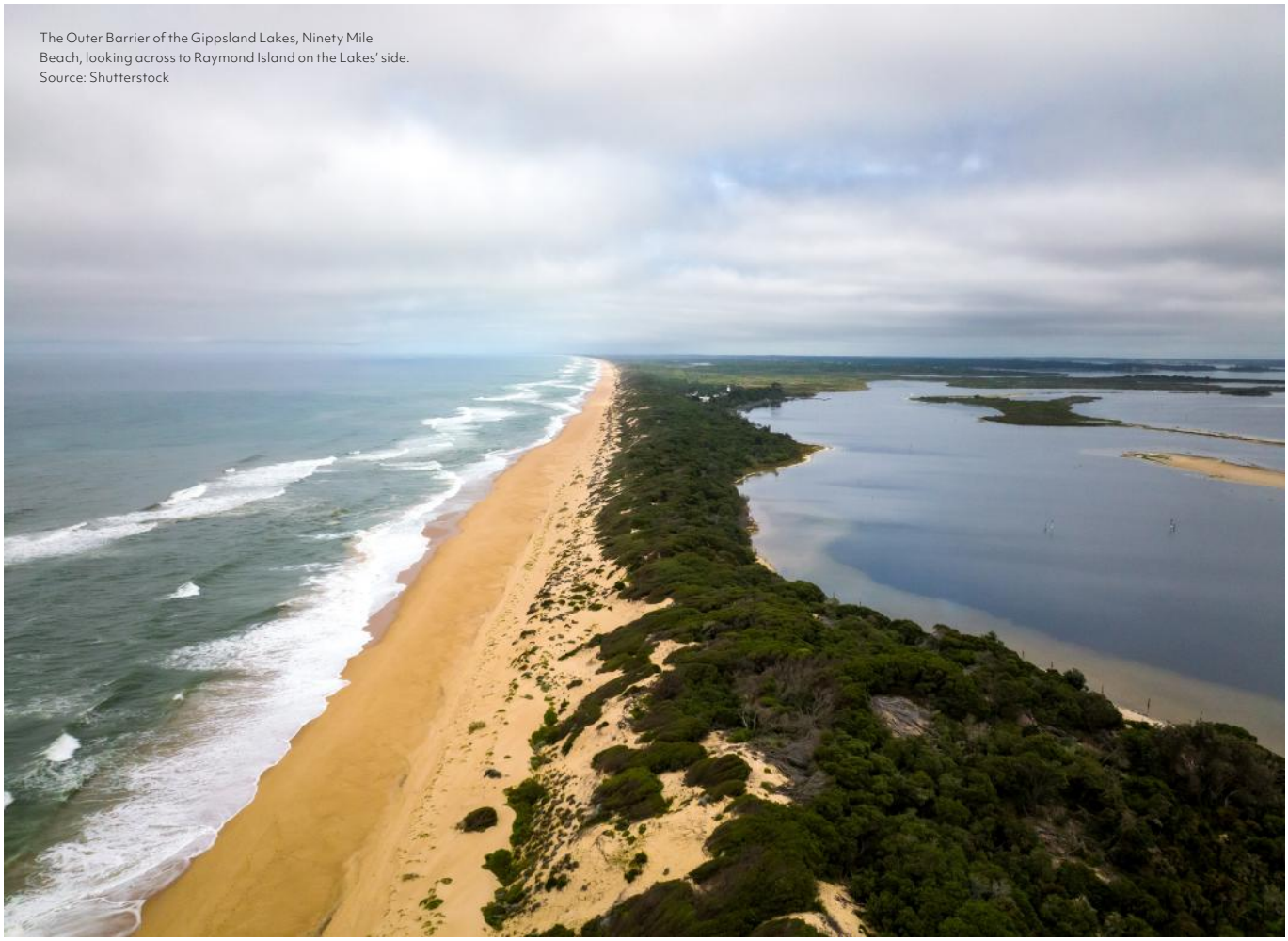
The online content published by CSIRO Publishing extends back to Volume 118, 2006, and is available at **publish.csiro.au/rs**.

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

Submissions

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





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

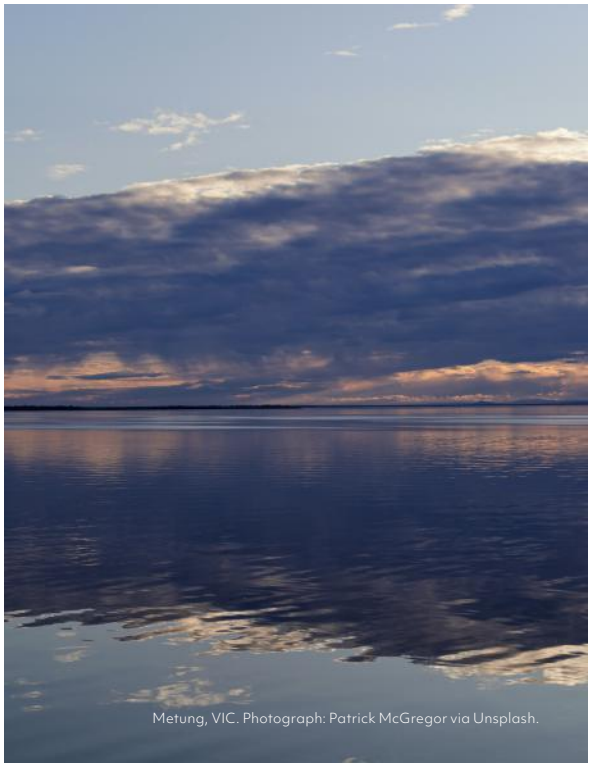
The Future of the Gippsland Lakes

PROCEEDINGS OF THE ROYAL SOCIETY OF VICTORIA, VOLUME 136

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

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

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



Metung, VIC. Photograph: Patrick McGregor via Unsplash.

Papers from Volume 136

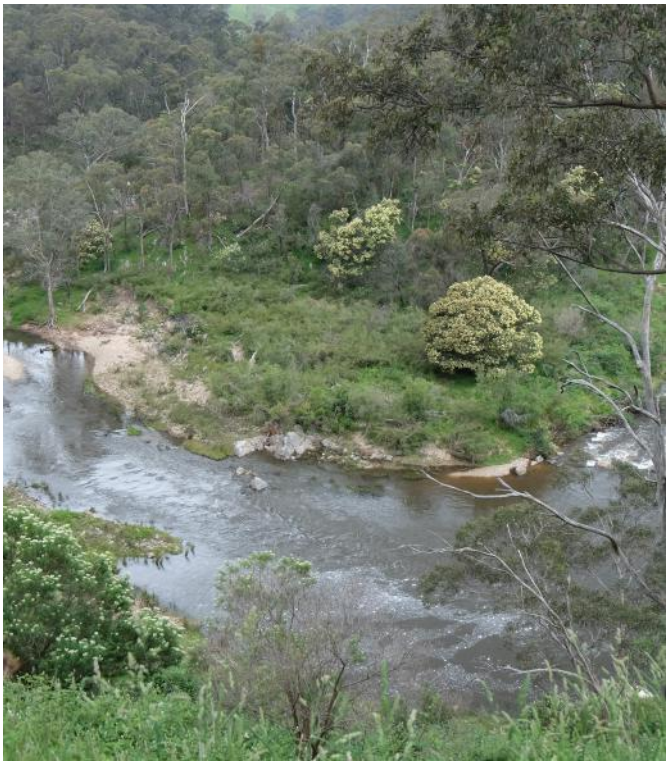
Water-cycle and climate-change impacts on the Gippsland Lakes

BY JAMIE PITTOCK

The environmental health of the Gippsland Lakes substantially depends on freshwater inflows. The quantity and quality of this water is being reduced by the impacts of agriculture, mining, and water transfers to Melbourne.

These impacts will be exacerbated by both the direct impacts of climate change and thirsty measures adopted by society to respond to climate change. Changes in water use and increased investment in natural resources management are needed to effectively adapt.

► You can read this open access paper in the *Proceedings of the Royal Society of Victoria* via CSIRO Publishing at **publish.csiro.au/rs/pdf/RS23019**.



The Tambo River. Photograph: Jacqui Szyrpallo via flickr (CC BY-NC 2.0)

Yea, Victoria. Photograph: Rhondda via flickr (CC BY-NC 2.0, cropped)

Notanopliid brachiopods and associated fossils from the Yea area, central Victoria: a key to resolving age and correlation problems in a complex geological setting

BY CLEM EARP

When did life move from the sea to the land? Some claim evidence for this important step in evolution can be found around Yea, in central Victoria, and this study for the first time connects the geology at Yea with the rest of Victoria to significantly improve the dating of its fossil life. The fossils at Yea are internationally significant, and the improved dating contributes to the global timeline of evolution.

► You can read this open access paper in the *Proceedings of the Royal Society of Victoria* via CSIRO Publishing at **publish.csiro.au/RS/pdf/RS23021**.

Current Government Consultations of Interest to Victoria's Science Community

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

Damien Tait via Unsplash

CONSULTATION CLOSES 6 SEPTEMBER 2024

Victoria's Future Climate Tool

Have your say to help improve Victoria's Future Climate Tool, making the latest climate projections data available to all Victorians.

engage.vic.gov.au/victorias-future-climate-tool-update

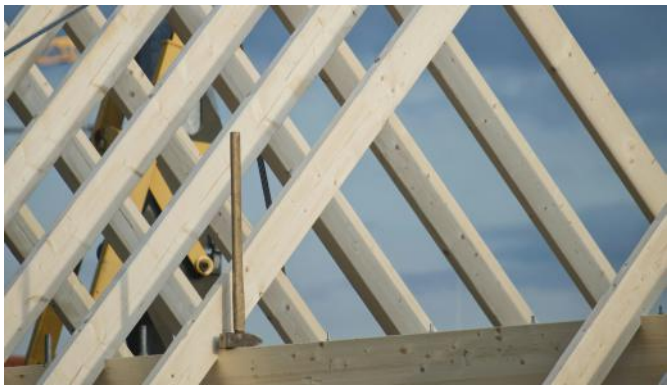
John Cameron via Unsplash

CONSULTATION CLOSES 16 SEPTEMBER 2024

Warracknabeal Energy Park

Public comment is invited on the draft Scoping Requirements for the Warracknabeal Energy Park Project environment effects statement (EES).

engage.vic.gov.au/warracknabeal-energy-park-ees-scoping-requirements



Yves Cedric Schulze via Unsplash

CONSULTATION CLOSES 29 SEPTEMBER 2024

Activity Centres

Find our more and have your say on planning for more homes close to jobs, services, and public transport.

engage.vic.gov.au/activitycentres

Tania Melnyczuk via Unsplash

CONSULTATION CLOSES 15 NOVEMBER 2024

Review of New Customer Contributions

The Essential Services Commission is reviewing new customer contributions (NCC) for water, sewerage and recycled water connections and we want to hear from you.

engage.vic.gov.au/review-new-customer-contributions

Submission Guidelines

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**.

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.*

Guidelines for Authors

Opinion Articles

Recommended length: 600 - 1,800 words

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

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

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

Letters

Recommended length: 200 – 1,000 words

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

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

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

What I've Been Reading

Recommended length: 600 - 1,800 words

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

Images and Figures

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

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

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

References

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

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

Submission Deadlines

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

Everything *Animalia* in Victoria, particularly native fauna.

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

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

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

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

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

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

JULY 2024	DUE DATE
Building Scientific Competency	*14 June*

Empowering individuals and communities to understand the scientific method.

AUGUST 2024	DUE DATE
STEMM Throughout Victoria	*19 July*

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

SEPTEMBER 2024	DUE DATE
Pollution in Victoria	*16 August*

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

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

The many and varied ecological niches across Victoria

NOVEMBER 2024	DUE DATE
Science & Policy	*18 October*

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

DECEMBER 2023	DUE DATE
Science & Business	*15 November*

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

Hold Your Next Event at the Royal Society of Victoria

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

Services Available

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

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

The Facilities

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

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

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

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

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

The Burke and Wills Room

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

SUITABLE FOR

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

CAPACITY

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

The Ellery Lecture Theatre

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

SUITABLE FOR

Presentations, seminars, lectures.

CAPACITY

Any Booking	*≤90 people*

The Millis Room

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

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

The Cudmore Library

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

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

The Von Mueller Room

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

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

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

WHO WE ARE

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

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

WHAT WE DO

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

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

WHERE YOUR DONATIONS GO

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

HOW TO SUPPORT

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

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

Become a Member of the RSV

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

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

New Individual Members

DR THOMAS WARE
Patent Attorney, FPA Patent Attorneys

MR BLAIR DARRAGH
Applications Specialist, AFAC

PROFESSOR ARNOLD DIX
Barrister & President, International Tunnelling Association

DR DESPINA ANASTASIOU
Advisory Board Member, ARC Centre of Green Chemistry

ADAM TARANTO
PhD Candidate, The University of Melbourne

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

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

Smoke over Melbourne CBD as a result of bushfires in January 2020. Photograph: Philip Mallis via flickr (CC BY-SA 2.0).

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