

Research Institute for the  
Environment and Livelihoods

# Annual Report 2023



Charles Darwin University and the Research Institute for the Environment and Livelihoods acknowledge the Traditional Custodians across the lands and waters on which we live and work. We acknowledge First Nations peoples' long tradition of sustaining communities and the environment over tens of thousands of years. First Nations peoples are the first educators and first innovators and the holders of knowledge that contributes to the improvement of local, national, and global communities. We extend our respects to Elders past and present, and to all First Nations peoples.





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Cover: A section of the Daly River is seen from above. This image was runner-up in the RIEL Photo Competition 2023. Photo: Cameron Baker.

This page: A black wallaroo hops around on rocks at Injalak Hill, West Arnhem Land. This image was the winner of the RIEL Photo Competition 2023. Photo: Allyson Malpartida.

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A saltwater crocodile rests on a bank. This image was part of the RIEL Photo Competition 2023.  
Photo: Tahylia Casey.

# Message from the Director

The Research Institute for the Environment and Livelihoods (RIEL) occupies a unique space at Charles Darwin University (CDU) and in the Northern Territory.

RIEL's work supports natural resource management, sustainable development, biodiversity conservation, and food systems, benefitting a wide range of partners and communities across northern Australia and the near Asia-Pacific.

In this report, we bring you a summary of highlights from our work in 2023. As diverse as these stories are, they are just a peek at the significant volume of research carried out at RIEL through our projects. We invite you to connect with us throughout the year to find out more about the diversity and impact of the research carried out by RIEL researchers and partners.

In 2023, our research was funded by \$37.1 million in active projects, including \$11.2 million in external research income for new projects. One notable new project funded under the Australian Research Council Linkage scheme was 'Improving desert fire management with culturally directed science', which received more than \$744,000 in funds. Other key examples were the 'Water Security for Northern Australia Program', which received a grant of \$1.7 million for its implementation phase, and 'Integrating emerging aviation technology into ghost-net detection, survey, and retrieval operations around the Groote Archipelago' led by the North Australian Centre for Autonomous Systems

(NACAS) which was awarded more than \$399,000.

This level of support allows RIEL to continue providing objective research to the public and to our funders. This is of critical importance to the resilience of our communities, the health of our ecosystems and the future of our climate, at a time when rigorous, high-quality research in the field of environmental science has never been more vital.

RIEL is home to a significant number of expert researchers, many of whom are award-winning leaders in their fields. Our academic staff members can be research focused, meaning they predominantly focus on carrying out research, or research active, which means they not only research but also teach – both of which are vital to our outcomes and impacts. Our adjunct and honorary members also make valuable contributions to research projects while at the same time providing key connections between RIEL and other important organisations.

Our researchers have diverse backgrounds, diverse skill sets and engage with diverse partners. While we are bound by academic integrity principles in the work we do and the public comment we make, there is immense value in an organisation like RIEL, and CDU

more broadly, facilitating a variety of evidence-based perspectives to contribute to public debate in northern Australia without organisational constraint.

We were proud to see some of our research staff and students receiving awards in 2023. Some of these included PhD candidate Lucinda Middleton (National Geographic Young Explorer and Sustainable Fisheries and Communities Trust Scholar), Nur Isiyana Wianti (Department of Foreign Affairs and Trade Allison Sudradjat Prize), Janine Abecia (CDU's best Higher Degree by Research thesis award), Pham Thu Thuy (Australian Climate Action Alumni Award) and Prof Jenny Davis (International Fellow Award from the US Society of Wetland Scientists). In another big milestone, the North Australia and Rangelands Fire Information (NAFI) group reached its 20th anniversary.

As you read through these pages, you will see some superb examples of research, such as a project focusing on threatened ghost bats and involving the mining industry and other key stakeholders, or collaborative work on the abundance and species richness of subterranean ants. Among many others, we also highlight research on mangroves, which are critical ecosystems not only for coastal protection but also for carbon sequestration and storage, as well as a First Nations-led marine water quality surveillance program that links sea changes to pathogen biosecurity threats.

RIEL also continues to be a place that supports and fosters the achievements of research students. In this report we are pleased to showcase a number of student stories – from Tayhlia Casey who finished her honours project on estuarine crocodile population recovery, to Kade Skelton who finished their PhD on north Australian dtellas, and Gehan Abdelghany who was approaching the end of her PhD on Australian native rice as of the end of 2023. In an example of alumni success, we also share the journey of RIEL alum Dr Brien Roberts, who completed his PhD on barramundi in 2021 and has since gone on to work as a research scientist with NT Fisheries.

Many readers will also know that RIEL hosts a number of other important centres and services. We're pleased to be able to stand behind the Research Institute for Northern Agriculture, NACAS, NAFI, the Darwin Centre for Bushfire Research, and Bioscience North Australia, among others. While each of these groups stands alone, their research and impacts are woven together with RIEL's work, and we are stronger for it.

I am immensely proud of all RIEL staff, adjuncts, and student members for their achievements in 2023. I thank all members, as well as all partners and funders, for our ongoing work toward our common goals. Together, we are continuing to improve our knowledge and understanding of the vital ecosystems and beautiful landscapes that we live in, across northern Australia and beyond.



Professor Sam Banks  
Director, Research Institute for  
the Environment and Livelihoods

# Who are we?

RIEL is part of the Faculty of Science and Technology (FST) at CDU, based in the Northern Territory (NT) of Australia.

RIEL is nationally and globally recognised as a leader in tropical environmental research in northern Australia and the near Asia-Pacific region. The institute's work spans tropical, semi-arid and arid regions, and the livelihoods of communities who rely on these environments.

RIEL produces research and supports researchers who help to preserve environments and biodiversity across the region, and who contribute to sound policy, planning and sustainable management, based on robust scientific evidence.

RIEL's members include academic staff, professional staff, higher degree by research (HDR) candidates, honours students, and adjunct and honorary members.



RIEL had 77 staff members in 2023. This includes research-focused academics working at CDU on externally funded programs and teaching-focused academics from CDU's Environment discipline. These academic staff contribute to significant research projects, offer consultancy services, supervise HDR and honours students, and teach into undergraduate courses. This also includes a small number of professional staff who provide operational support across RIEL.



RIEL had 71 student members in 2023. This includes 63 HDR candidates completing PhD and masters projects, as well as 8 honours students. RIEL's students come from the NT, across Australia, and around the world to undertake innovative research projects and contribute to bodies of research in the region. RIEL's student members are enrolled at CDU through FST and are supported in their research by RIEL.



RIEL had 68 adjunct and honorary members in 2023. Adjunct and honorary members are affiliated with RIEL and contribute to RIEL research. These members come from a wide range of sectors, from around Australia and internationally, including government, non-government organisations, and other research organisations.

Within the institute, RIEL members participated in a number of important committees in 2023.

- ➔ RIEL's Gender Equity and Inclusion Committee works to improve equity and inclusion among all RIEL members.
- ➔ RIEL's Assets Committee coordinates the maintenance, repair and replacement of assets such as vessels, vehicles and equipment. The safe and strategic management of these assets is critical for RIEL members in carrying out field work and laboratory work.
- ➔ RIEL's Boat Committee manages the compliance and usage of RIEL's boat fleet. These are essential resources for marine and freshwater researchers.

Across the university, RIEL members also took part in key initiatives and mechanisms.

- ➔ CDU's Research and Innovation Committee promotes and fosters excellence, impact and innovation in research.
- ➔ CDU's Academic Board works to protect, promote and enhance the excellence of the core academic activities of teaching, learning and research.
- ➔ The Vice-Chancellor's Advisory Committee advises on the strategic development and advancement of the university.

# Where do we work?

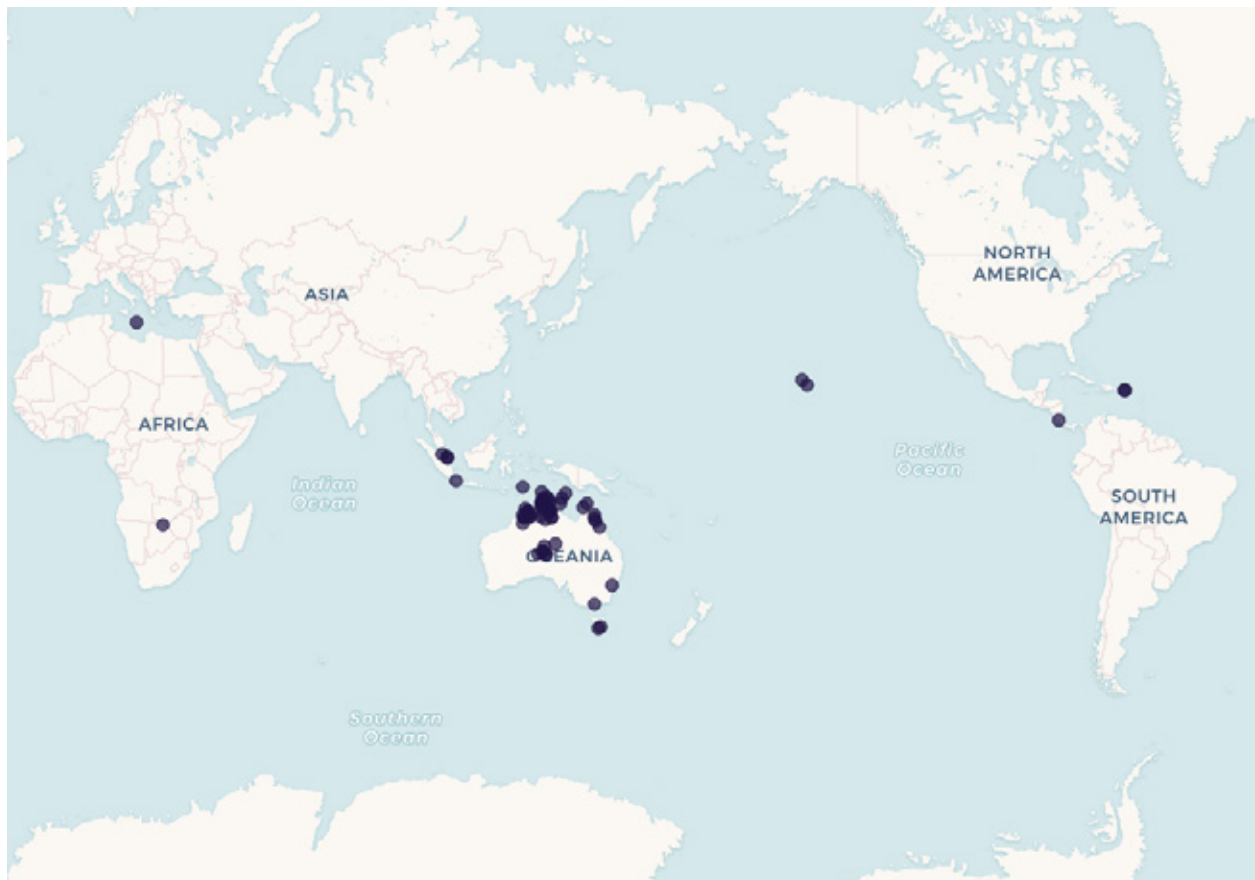
RIEL researchers carry out projects across northern and central Australia, the near Asia-Pacific region, and beyond.

The institute's researchers are primarily based at CDU's Casuarina campus on Larrakia Country in Darwin and at CDU's Alice Springs campus on Arrernte Country.

Many RIEL projects are closely connected with First Nations partners and are undertaken in collaboration with Traditional Owners and First Nations community members.

RIEL's projects and research collaborations also have long and enduring connections with Timor-Leste and Indonesia, among other countries.

While projects are concentrated in northern and central Australia, there is also a significant number of projects occurring elsewhere in Australia, and in tropical and arid zone research sites around the world.



RIEL research projects are concentrated in northern Australia and spread around the globe. Images: Alys Young.

# Research performance

## Research income in 2023



# \$37.1 million

in active research projects

including **\$4.1 million** for the Research Institute for Northern Agriculture

Of the total **\$37.1 million**, **\$11.2 million** was external research income for new projects in 2023, including

- ➔ **\$1.6 million** from the Australian Research Council
- ➔ **\$2 million** from the Cooperative Research Centre for Developing Northern Australia
- ➔ **\$1.2 million** from the Department of Climate Change, Energy, the Environment and Water
- ➔ **\$1.2 million** from the National Environmental Science Program's Resilient Landscapes and Marine and Coastal Hubs
- ➔ **\$1.6 million** from the NT Government
- ➔ as well as funding from the Australian Centre for International Agricultural Research (ACIAR), National Emergency Management Agency, First Nations environmental management organisations and development corporations, and other diverse funding sources

**Of the total, RIEL also received \$816,000 for non-research consultancy and extension in 2023.**

## Publications in 2023



# 162

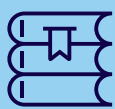
 peer-reviewed journal articles

of which 147 were in Q1 journals including 7 in the high-impact *Science*, *Nature*, and *Proceedings of the National Academy of Sciences* (PNAS) journals



# 24

book chapters



# 3

books



# 13

articles in The Conversation

## Publication highlights included:



**Legge, S.,** Rumpff, L., **Garnett, S.T., Woinarski, J.C.Z.,** 2023. Loss of terrestrial biodiversity in Australia: Magnitude, causation, and response. *Science* 381, 622–631.



**House, J.,** Kleiber, D., Steenbergen, D.J., **Stacey, N.,** 2023. Participatory monitoring in community-based fisheries management through a gender lens. *Ambio* 52, 300–318.



**Solano, V., Duvert, C.,** Birkel, C., Maher, D.T., **Garcia, E.A., Hutley, L.B.,** 2023. Stream respiration exceeds CO<sub>2</sub> evasion in a low-energy, oligotrophic tropical stream. *Limnology and Oceanography* 68, 1132–1146.

## Students in 2023



**63** enrolled HDR candidates

**44**

were domestic students

**19**

were international students

**7**

HDR completions

### HDR completions comprised:

- ➔ Julia Fortune – *Intertidal Sediments and Fringing Mangroves of Darwin Harbour are Hot Spots of High Denitrification that Support Oligotrophic Condition*
- ➔ Sydney Collett – *The movement ecology of granivorous finches in the northern Australian savannas*
- ➔ Elnaz Saki – *Synthesis of Nanoemulsions to Enhance Dermal Application of Phytochemicals Available in Australian Native Plants: Characterisation, Evaluation and Comparison of their Biomedical Activities*
- ➔ David Simma – *Vibrio ecology in the Darwin Harbour area*
- ➔ Catherine Joyce – *Energy Justice, Off-grid, On Country: Analysing Energy Systems of Provision in Remote Australia*
- ➔ Sarah Fischer – *Smoke and Mirrors: The Effect of Urbanisation and Fire on the Bird Assemblages of the Darwin Region*
- ➔ Ruth Patterson – *Doing more with less: Using interdisciplinary technology to optimise oceanographic research in remote locations*



**8** enrolled honours students

**5** scheduled honours completions

### Honours completions comprised:

- ➔ Mick Taylor – *Conservation of Northern Long-necked Turtle (Chelodina rugosa): Micronutrient and Heavy Metal Analysis*
- ➔ Tayhlia Casey – *The spatiotemporal relationship between estuarine crocodile density and localised primary productivity*
- ➔ Anastasia McDonald-Spicer – *Turning the Tables on Analysing Turns: Validation and Investigations into using Wearable Sensors in Ballet*
- ➔ Emma-Louise Berchmans Daly – *Use of remote sensing to investigate the spatial and temporal dynamics of natural recovery in mangroves impacted by the 2015-2016 Gulf of Carpentaria dieback event*
- ➔ Bryn Pickering – *Evaluating the short-term success of a translocation of Brush-tailed Rabbit-Rats at Cobourg Peninsula*

# Research impact

RIEL's research consistently leads to clear and significant impacts. In 2023, among the numerous ongoing projects, examples included research on the transmission of lumpy skin disease virus in Thailand, global mapping of Indigenous Peoples lands, and effective cat control on the Tiwi Islands.

## Project assesses biting midges' potential to carry lumpy skin disease virus

A collaborative project between Thailand and Australia is collecting data to identify species potentially involved in transmission of lumpy skin disease virus, which will help to inform management strategies for the disease and to assess the likelihood of the virus spreading via highly mobile biting midges.

The emergence of lumpy skin disease (LSD) – an infectious and serious disease that causes skin lumps, scabs and ulcers – in cattle in Southeast Asia has prompted concerns over the impacts of the disease on local livestock and the potential for it to spread further in the region, including to Australia where it has not yet been detected.

Insect vectors are considered the most likely method of introduction of the virus into Australia. However, data on the species of vectors involved in transmission is at an early stage, and no particular group of species is currently regarded as the primary vector responsible for transmission. Of most concern from a regional perspective is the potential involvement of highly mobile species such as *Culicoides* biting midges which are known to carry viruses over long distances.

A recent outbreak of LSD in Thailand provided an opportunity to glean hard data on the potential involvement of *Culicoides* species in local transmission. This information will assist Thai authorities in developing management strategies for LSD and will help other countries to assess the potential for incursions of the virus via windborne spread of biting midges. Identifying potential vectors of a virus requires the accumulation of evidence which pinpoints those species that are most likely to be involved. This project will produce a list of species that can be targeted for further studies, which will help to prove the status of a vector species.

The project is being funded by the Australian Department of Agriculture, Fisheries and Forestry and managed by CDU, which has established contracts with Ramkhamhaeng and Chulalongkorn universities in Thailand and with RIEL adjunct Assoc Prof Glenn Bellis to conduct the work.

Data is now being gleaned from a network of light



A trap is used to collect insects in Burirum, Thailand.  
Photo: Arunrat Thepparat/Ramkhamhaeng University.

traps set at strategic sites around Thailand. The team conducted monthly collections from five of these sites for 12 months. The work has yielded 71 species of *Culicoides* – including several known pest species, some of which are also present in Australia – with specimens tested for the presence of host blood and the virus.

## Mapping of Indigenous Peoples lands impacts global policy

The influence of research on policy and change on the ground can sometimes take many years. One measure of impact is the quality of the research that builds on the original work.

In this light, 2023 proved a big year for a global map of Indigenous Peoples lands published by a RIEL-led team in 2018 in *Nature Sustainability*. Showing where Indigenous Peoples lands are in the world has had significant and wide-reaching impacts on global policy and research.

The work first emerged from preparation for the World Parks Conference in 2013. Asked to provide a global overview of Indigenous Peoples lands, the research team found that none existed, but that policymakers were crying out for such a document.

RIEL's Prof Stephen Garnett and GIS specialist Dr Ian Leiper forged ahead, and worked with postgraduate students to create one. Later, influential global advocates joined the effort to ensure the work had

credibility and legitimacy. The team had no dedicated funding, but saw the knowledge gap and set out to fill it whenever time allowed.

The first major policy application was in the first report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Coauthors of the paper who were part of the IPBES effort described tears of joy among Indigenous Peoples when the map's analyses were accepted.

A few years later, at a climate change meeting in Glasgow, US\$1.7 billion was pledged to help Indigenous and local communities protect biodiverse tropical forests, citing analyses of the map as justification for the investment.

To try to ensure no unintended harms to Indigenous Peoples occur as a result of the map's use, analysts all sign a conditions-of-use form. Conversations around that form often lead to collaborations, which is why 2023 stood out in particular.

Numerous collaborative publications that year in the world's top journals showed that Indigenous Peoples lands have higher levels of tropical biodiversity and sustain key biodiversity areas, and are more likely to retain biodiversity values in the face of intensified agriculture and armed conflict. However, traditional knowledge is under pressure and the transition to renewable energy is a new source of concern.

Such analyses are helping to direct investment and strengthen the push for stronger rights of Indigenous Peoples to their lands worldwide.

### **Sustained efforts support cat control on the Tiwi Islands**

A decade-long journey, beginning in 2013 with the first camera-trap detection of a feral cat on the Tiwi Islands, has led to targeted management efforts and has resulted in rangers conducting effective cat control and native mammal surveys.

The research commenced with a PhD project carried out by Dr Hugh Davies, which aimed to better understand the health of Tiwi native mammal populations and the threats they faced. That work confirmed that mammal populations remained in a relatively healthy state compared to elsewhere in northern Australia, but identified the first worrying evidence of native mammal decline on Melville Island – the largest of the Tiwi Islands – which was previously regarded as a safe haven for native mammals that had disappeared from the mainland.

The decline of the threatened brush-tailed rabbit-rat, in particular, was linked to feral cats. Growing concerns about cats guided further research, leading to estimates of cat density and potential drivers of cat abundance on the Tiwis, such as frequent severe fire and feral herbivore (buffalo and horse) activity. Subsequent work



A brush-tailed rabbit rat on Bathurst Island.  
Photo: Georgina Neave.

carried out by PhD candidate Georgie Neave found no evidence of mammal decline on Bathurst Island in the Tiwi Islands, likely because of very few feral cats, indicating that it remains one of Australia's most important mammal refuges.

Collectively, these efforts have increased understanding of how cats use these landscapes. For instance, Ms Neave's work has shown that cats preferentially use game trails created by feral herbivores. It has also involved using GPS collars as part of Tiwi Cat Week – an initiative that won the Tiwi Rangers a Territory Natural Resources Management award in 2023.

Alongside members of the Tiwi Rangers and Tiwi Land Council, a number of RIEL researchers have been involved in work on mammals on the Tiwi Islands over the past decade, including PhD candidates, academic staff, and alumni. Tiwi Resources – which works to gain economic opportunities for the Tiwi people from the use of their land – with support from Dr Davies and Ms Neave, also secured a large grant during this time from the Australian Government's Saving Native Species Program to conduct more cat control.

Partners and funders of this work have included the Tiwi Land Rangers, Tiwi Land Council, Tiwi Resources, Australian Research Council, Wettenhall Environment Trust, Indigenous Land and Sea Corporation, Commonwealth Scientific and Industrial Research Organisation (CSIRO), CDU, University of Melbourne, University of New England, Australian Wildlife Conservancy, and the NT Government.

As of 2023, there was evidence of strong community awareness of cat impacts on Tiwi animals, and strong support for effective control. Feral cat control efforts continue to grow through targeted Tiwi-led management. Members of the Tiwi Rangers are highly trained in humane cat control methods and in conducting surveys such as live-trapping and camera-trapping. Once cats can be fully controlled, it is hoped that mammal numbers will rebound on Melville Island.



A road leads toward Running Waters on the Finke River. This image was shortlisted in the RIEL Photo Competition 2023.  
Photo: Jenny Davis.

# Research strengths

RIEL's research is grouped into key strengths, each of which encompasses a diverse collection of research groups and projects.



## Biodiversity and conservation

This strength covers the conservation and management of tropical and arid biodiversity, along with specialist environmental monitoring services and advice.

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## Communities and livelihoods

This area provides impact-orientated environmental and livelihoods research, and specialist advice on the development of rural agricultural and natural resource-based enterprises.

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## Savanna and arid ecology

This work is focused on savanna burning and carbon, greenhouse gas emissions and land-use change, modelling carbon cycles, plant and animal adaptation, invasive species management and restoration ecology.

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## Water and catchments

This strength looks at surface and groundwater interactions, water quality assessments, aquatic ecology, threatened species conservation, pollution and source tracking.

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## Research Institute for Northern Agriculture

RIEL hosts the Research Institute for Northern Agriculture (RINA), which specifically supports agriculture and aquaculture research in northern Australia.

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## North Australia Centre for Autonomous Systems

The North Australia Centre for Autonomous Systems (NACAS) brings new research capacity in autonomous systems to northern Australia, and enables drone-based research across CDU.

# Biodiversity and conservation



As one of RIEL's research strengths, biodiversity and conservation covers the conservation and management of tropical and arid biodiversity, along with specialist environmental monitoring services and advice.

## Within this strength, RIEL researchers offer knowledge and advice on:

- Ecological monitoring and management
- Terrestrial ecology
- Animal movement and behaviour
- Threatened species conservation and management
- Genetic analysis in conservation science
- Invasive plant and animal management
- Native vegetation restoration
- Post-mining environmental service restoration
- Spatial planning and area-based management
- Invertebrate bio-indicators

## RIEL's projects and opportunities in this area include:

- Aligning Australia's threatened species assessments with global standards
- Identifying major drivers of species threat and extinction, for improved management
- Improving conservation and management of threatened marine species
- Identifying and delineating important habitat for marine species
- Developing climate change adaptation strategies for threatened species
- Predicting ecological impacts of climate change on aquatic and terrestrial ecosystems in northern Australia and globally
- Understanding growth performance and physiological range of weed species for targeted management
- Rehabilitating mine sites
- Developing innovative technologies and analysis techniques to understand land use and climate change impacts on native flora and fauna
- Assessing biodiversity responses to fire management regimes
- Using ants as indicators of environmental change
- Understanding genetic diversity of threatened species and integrating genetics into conservation planning
- Collaborating with First Nations ranger groups, development corporations and Traditional Owners on environmental and primary production research

## Research highlights

### Assessing impacts of mining on ghost bats

An ongoing ecology and conservation project is aiming to fill knowledge gaps that currently hinder the study and research of bats. The key goal of the project is to facilitate accurate assessments of the impacts of mining development on ghost bats, focusing on the Pine Creek region in the NT, a stronghold for the threatened ghost bat.

The project began in early 2023, and as of the end of the year researchers had resurveyed over 50 ghost bat historical roost sites for occupancy and colony size estimates to update information on the regional population size. They also collected genetic material for population and roost use analyses for the ghost bat, and initiated the process of forming a national ghost bat recovery team and drafting a national recovery plan.

The research team comprises Dr Nicola Hanrahan, Prof Sam Banks and Paul Barden of RIEL; Laura Ruykys of the NT Government; and Emer McGowan of Agnico Eagle. As many as 35 bat ecologists and enthusiasts from the

Australasian Bat Society also supported the resurveying of roost sites as part of the Ghost Bat Blitz initiative.

“A better understanding of ghost bat population dynamics, roost choice and foraging ecology will be beneficial for both industry and the conservation of the ghost bat as it will facilitate more accurate impact assessment and conservation planning while improving the efficiency of the assessment process,” said Dr Hanrahan.

Moving forward, the team aims to collate more accurate population, distribution and ecological data for the ghost bat; to finalise a national recovery plan for the ghost bat; and to create a publicly accessible resource for identifying NT bats through acoustic identification.

This work is funded by Agnico Eagle Mining Limited, and is carried out in partnership with the Australasian Bat Society and the NT Government.

A ghost bat is examined during the Ghost Bat Blitz initiative. Photo: Jon Luly.



## Understanding the factors facing green turtles in the NT

Green turtles are an important food resource for First Nations peoples and are a species of cultural importance across northern Australia. However, there is still very little known about their ecology in the NT.

A PhD project titled 'The Habitat Use and Genetics of Foraging Green Turtles (*Chelonia mydas*) in the Northern Territory' is focusing on better understanding the factors influencing foraging green turtles in the NT – such as diet, migration, or anthropogenic threats – to create ecosystem-based management and operational conservation management plans.

PhD candidate Natalie Robson is carrying out this research from 2022 to 2025, supervised by Prof Sam Banks and Dr Carol Palmer at RIEL. Two key sites of the project are Trepang Bay in Garig Gunak Barlu Marine Park and Field Island in Kakadu National Park, while additional survey sites are located in Bynoe Harbour, Darwin Harbour, the Tiwi Islands, Goulburn Islands and Wessel Islands.

Most fieldwork for the project was completed by the end of 2023. In 2024, achievements are expected to



A green turtle in Garig Gunak Barlu Marine Park in the Northern Territory. Photo: Natalie Robson.

include data analysis and the publication of several research outputs, including on habitat mapping and habitat use, while research outputs on genetics and anthropogenic threats will be completed by early 2025.

This project is funded by an Australian Research Council Linkage Grant, in partnership with Kakadu National Park, NT Parks and Wildlife, Taronga Conservation Society Australia, Gumurr Marthakal Rangers, Larrakia Nation Rangers and Sea Darwin.

## Species spotlight

### Tagging and surveys reveal hidden river sharks

Of the more than 500 shark species worldwide, the Speartooth Shark (*Glyphis glyphis*) is one of only four that live in rivers. It is a nationally threatened species which inhabits northern Australian macrotidal rivers from the Kimberley to the Gulf of Carpentaria.

The Speartooth Shark has a restricted geographic range and is also a naturally rare species. Each river within its range represents a distinct population with low numbers of breeding adults.

Senior Research Fellow Dr Peter Kyne and PhD candidate Julia Constance of RIEL's Northern Shark and Ray Research Group are working on a long-term tagging program that has revealed the seasonal habitat use and movement of sharks in large rivers. Speartooth Sharks inhabit rivers in the dry season before moving to the estuary in the wet season.

Surveys of the Roper River in 2023 also revealed a previously unknown population of the Speartooth Shark.



A Speartooth Shark (*Glyphis glyphis*) caught and released during surveys. Photo: Peter Kyne and Grant Johnson.

# Communities and livelihoods



This research strength provides impact-orientated environmental and livelihoods research, and specialist advice for rural agricultural and natural resource-based enterprises.

**This research aims to generate knowledge and applied solutions to key challenges in the tropics such as poverty, equity, wellbeing, food security, environment management and improved livelihoods. Within this area, researchers' specialist knowledge and advice covers:**

- ➔ Natural resource-based enterprise development and sustainable livelihoods
- ➔ Gender, food security and marine-based livelihoods
- ➔ Ecosystem services and their role in human wellbeing, including ecosystem services concepts and valuation approaches, particularly from Indigenous perspectives
- ➔ Nature-based solutions including payments for ecosystem services, nature-based economies or nature repair opportunities
- ➔ Livelihood strategies in smallholder agricultural systems
- ➔ Participatory land and sea management and Indigenous and local knowledges
- ➔ Capacity building for natural resource management in terrestrial and marine environments
- ➔ Social impact assessment, qualitative and quantitative methodologies, socioeconomic surveys and participatory action research
- ➔ Program and policy review and evaluation
- ➔ Restoration, rehabilitation and collaborative management of mangroves
- ➔ Involvement in United Nations-led global initiatives to highlight Indigenous peoples and local communities' perspectives and values of natural resource management

**RIEL's work in this area includes:**

- ➔ Supporting enterprises in aquaculture, fisheries and plant production in the Arafura and Timor seas region of northern Australia, Indonesia and Timor-Leste
- ➔ Farmer perspectives and practice to improve production in smallholder farming systems in Timor-Leste
- ➔ Working with First Nations communities to develop nature-based economic opportunities
- ➔ Understanding the impacts of mining on First Nations communities
- ➔ Working with First Nations communities to strengthen land and sea management outcomes
- ➔ Contributing to the sustainability of ecosystem services for the benefit of Indigenous communities and livelihoods in Australia and the Asia-Pacific
- ➔ Indigenous knowledges and traditional foods
- ➔ Engaging with First Nations peoples and local communities to contribute to biodiversity conservation
- ➔ Understanding how First Nations communities will be affected by climate change
- ➔ Researching the benefits that threatened species conservation can deliver to people globally
- ➔ Rehabilitation of blue carbon habitats for sustainable livelihoods
- ➔ Implementing a world-first program for a savanna burning carbon industry in northern Australia, and other savanna landscapes around the world
- ➔ Developing digital technologies to improve livelihoods of local communities in the Asia-Pacific



Fishing vessels are moored in the coastal waters of Pepela village, Nusa Tenggara Timur, Indonesia. Photo: Dedi Adhuri.

## Research highlights

### Understanding drivers of transboundary fishing in Australian waters

The highly collaborative project ‘Towards improved livelihoods for Indonesian fishers in Nusa Tenggara Timur Province, Indonesia’ emphasises a co-design approach between Australian and Indonesian researchers.

The project, which runs from March 2023 to October 2024, engages a multidisciplinary social science research team to exchange knowledge and build capacity to situate Indonesian illegal and legal fishing activities in Australian waters within a place-based assessment of livelihood trajectories. The work also identifies the changing conditions that have led to an increase in illegal activity in Australian waters as a viable livelihood pathway, and evaluates opportunities for addressing behavioural drivers in the context of future livelihood interventions.

RIEL’s Prof Natasha Stacey leads this project alongside Dr Dedi Adhuri of Indonesia’s National Research and Innovation Agency (BRIN). The team includes RIEL research fellow Dr Kylie McKenna; RIEL alum Dr Ria Fitriana; Dr Achmad Zamroni and Widya Safitri of BRIN; and Jotham Ninef and Tegar Nalle of Nusa Cendana

University. The work is funded by ACIAR’s Social Systems Program.

“The project, grounded in social science approaches, will make a significant contribution to the literature by uncovering the complex mix of actor and opportunity-based drivers which influence decision making and risk assessments by fishers,” said Prof Stacey.

“Drawing on our extensive experience in sustainable livelihoods, the focus of forthcoming work is to provide recommendations for the Indonesian and Australian governments and other stakeholders on how to better engage coastal communities in livelihood improvements and reduce reliance on illegal fishing,” she added.

As of 2023, the project had completed a literature review on deterrence approaches to illegal fishing, co-designed methodology and tools for data collection and engagement, engaged a wide range of research end users, and completed field data collection in five coastal communities in Nusa Tenggara Timur. By late 2024, the team expects to conduct final field visits and report back to communities and stakeholders.

### Research helps to assess impacts of mining on wellbeing

An ongoing PhD project is evaluating the role of ecosystem services from mining landscapes for the wellbeing of First Nations communities in northern Australia.

In Australia, mining can disrupt the link between ecosystems and First Nations peoples by degrading the natural environment that is integral to people’s cultural, spiritual, and daily lives. This research project is contributing to developing a framework for assessing the impacts of mining on the wellbeing of First Nations peoples, beyond the environmental or social impacts.

Mining operations can lead to deforestation, water contamination, and habitat destruction, which can compromise ecosystems and can further impact the wellbeing of First Nations communities by disrupting people’s connections to cultural and spiritual places, traditional learning, songlines, and storytelling. The destruction or alteration of sacred sites and landscapes can erode people’s cultural identity and heritage. Additionally, pollution and environmental degradation can pose significant health risks. Economic disruptions caused by losing traditional livelihoods can further weaken community resilience and social cohesion.

RIEL PhD candidate Samy Andrés Leyton Flor is undertaking the project titled 'Evaluating Ecosystem Services for Indigenous Communities Living in Mining Landscapes in the Northern Territory' from 2022 to 2025, supervised by RIEL's Assoc Prof Kamaljit Sangha along with Prof Ruth Wallace of the Northern Institute and Dr Kirsty Howey of the Environment Centre NT.

"Mining activities not only disrupt ecosystems but also profoundly impact the cultural, spiritual, and material wellbeing of Indigenous Australians," said Mr Leyton Flor. "This necessitates a comprehensive approach to understanding and mitigating socioecological consequences."

Looking at the McArthur River Mine in Borroloola, NT, as a case study, this research is for the first time estimating the cost of socioeconomic and ecological losses of mining, offering a detailed picture of losses or gains from mining operations.



PhD candidate Samy Leyton Flor (*left to right*) with Traditional Owner Josephine Davey, Assoc Prof Kamaljit Sangha, and Traditional Owner Jack Green after an engagement meeting in Borroloola, NT. Photo: Family of Jack Green.

## Ecosystem spotlight

### Mapping mangrove restoration and protection opportunities

Mangroves are critical ecosystems not only for coastal protection but also for carbon sequestration and storage, as fisheries refugia, wildlife habitat, and for water regulation.

The International Union for Conservation of Nature Red List ecosystem assessment has determined that 50% of the world's mangrove ecosystems assessed are classed as either vulnerable, endangered, or critically endangered, and are therefore at risk of collapse. RIEL alum and postdoctoral researcher Dr Benjamin M Brown is working toward restoration and protection of mangrove ecosystems in Indonesia, which hosts some of the largest and most diverse mangrove forests in the world.

Dr Brown has served as lead mangrove expert for the Government of Indonesia, a role in which he developed a strategic approach, methods, and regulations to assess and map mangrove forest landscape restoration, protection, and sustainable utilisation opportunities. This work has identified 75,000 hectares (ha) of restoration opportunity and 400,000 ha of protection opportunity in four target provinces in Indonesia as part of a US\$419 million World Bank financed project, 'Mangroves for Coastal Resilience' (M4CR).

In particular, Dr Brown's work has contributed to the development of new regulations to allow

for the implementation of eco-hydrological rehabilitation of mangroves and human-assisted natural revegetation, including mechanisms for guaranteed and equitable participation of women during planning, implementation and monitoring, which began in 2023.

Other achievements of this work include successfully advocating for the inclusion of 1,200 coastal field schools to be implemented for sustainable livelihood development across 324 villages as part of M4CR.



Muftahul Khair Tasangka (*left*), a volunteer from Indragiri Islamic University, and Regista, monitoring and evaluation officer from Blue Forests, undertake post hydrological mangrove rehabilitation monitoring in Sapat, Riau, Indonesia. Photo: Wahyudin/Blue Forests.

# Savanna and arid ecology



This work is focused on savanna burning, plant and animal diversity and functional ecology, landscape ecology, carbon dynamics, genomics, invasive species management and restoration ecology.

## Within this research strength, RIEL focuses on:

- Amphibian and reptile ecology and physiology
- Arid zone ecology
- Animal movement and behaviour
- The use and impact of fire as a land management tool
- Invasive plant and animal management
- Native vegetation restoration
- Threatened species management
- Refugia and biodiversity
- Ant biodiversity and bioindicators
- Geospatial and Earth observation data analytics

## Research projects and opportunities in this area cover:

- Assessing ecosystem responses to changes in fire frequency, climate and land use change
- Quantifying and modelling carbon and water cycles in north Australian ecosystems
- Researching environmental impacts and behavioural adaptations of invasive and feral animal and plant species
- Examining the impacts of deforestation on greenhouse gas emissions and water resources in northern Australia
- Investigating the restoration of ecosystems and ecosystem services following mining
- Studying physiological adaptations of amphibians and reptiles to savanna and arid environments
- Developing innovative methodologies to evaluate climate change impacts on turtle breeding in the Amazon
- Implementing a world-first program for a savanna burning carbon industry in northern Australia
- Understanding the role of biodiversity hotspots and refuge 'islands' in a 'sea' of savanna
- Leveraging space technology and big data analytics for mapping and monitoring essential biodiversity variables
- Documenting undescribed ant diversity and using ants as indicators of restoration success

## Research highlights

### Culturally directed science project informs fire management

A major ongoing project is using science, directed by the cultural and management priorities of First Nations partners, to improve understanding of how fire regimes have changed in the desert since European colonisation, and how that is affecting vegetation structure and native fauna, including culturally important species.

That information is being used to inform the fire management targets, and to enhance reporting, of ranger groups. The project, titled 'Improving desert fire management with culturally directed science', is

taking place in four Indigenous Protected Areas (IPAs) – Karajarri, Ngurrara, Nyangumarta, and Ngurrpa – in the Great Sandy Desert of Western Australia. It began in the second half of 2023, and will continue until 2027.

The project team includes Prof Sarah Legge, Prof Sam Banks, Prof Brett Murphy, and Dr Kristina Macdonald of RIEL, together with rangers and Traditional Owners from the four IPAs, Hamsini Bijlani and Dr Malcolm Lindsay of Environs Kimberley, and Hannah Cliff of the Indigenous Desert Alliance.

After developing a collaborative research agreement between all partners in 2023, the team lost no time in beginning the field research, and has already carried out three biodiversity surveys to sample fauna and vegetation at 24 sites with contrasting fire histories.

Team members have also carried out a preliminary analysis of contemporary fire regimes, to describe what effect the current fire management is having on fire regimes, and whether they are moving toward the regimes produced by people when they were living nomadic lifestyles on Country. The rangers of the four IPAs used this analysis to help shape their burn planning for 2024.

The research is funded by the Australian Research Council Linkage Projects, along with substantial contributions from all six partners.



Karajarri Rangers, Jai and Twalen, check funnel traps at a biodiversity sampling site. Photo: Sarah Legge.

## Uncovering the diversity of subterranean ants

Australia's monsoonal tropics are home to the richest ant fauna on Earth. The fauna is strongly arid-adapted and, because of this, its exceptionally high diversity is maintained right along the rainfall gradient down to the northern border of Australia's central arid zone.

However, that finding is based on studies of above-ground species and would not be expected to apply to the specialist subterranean fauna, which is mesic- rather than arid-adapted.

The 'Ant diversity along the savanna rainfall gradient' project focuses on the pattern of subterranean ant diversity along the NT's savanna rainfall gradient and compares it with that of above-ground ants.

The project took place at 15 sites spaced along the rainfall gradient, all the way from Darwin to Tennant

Creek, from 1,700 to 500 mm mean annual rainfall.

The research team – comprising Dr François Brassard, Giovanni Destour, Tanvi Patel, and Prof Alan Andersen – carried out fieldwork, sample processing and identification in late 2023.

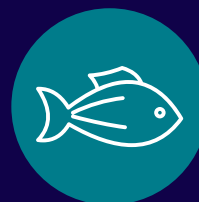
The team found that the abundance and species richness of the subterranean fauna decreased with decreasing rainfall, in striking contrast to the above-ground fauna.

"It is fascinating to find that the subterranean fauna has an opposite response to above-ground assemblages. Subterranean ants follow the traditional response of fewer species in drier habitats, but the incredibly arid-adapted above-ground fauna increases in diversity in drier regions," said Dr Brassard.



The furnace ant, *Melophorus bagoti*, is a thermophilic species adapted to the arid environments of Australia. Photo: François Brassard.

# Water and catchments



This strength looks at surface and ground water interactions, water quality assessments, aquatic ecology, threatened species conservation, pollution and source tracking.

## Using the latest technological advances, this research strength explores:

- Aquatic ecology
- Animal movement and behaviour
- Animal–microbe interactions
- Population dynamics
- Microbiological and molecular analyses in aquatic environments
- Water quality
- Effect of human disturbance on aquatic ecosystems
- Catchment and groundwater processes
- Carbon dynamics in riverine settings
- Wetland condition and health of groundwater dependent ecosystems
- Estimating groundwater recharge
- Impacts of climate change on water resources
- Projections of future water availability

## Some of the key projects and opportunities in this area include:

- Analysing atmospheric moisture sources, rainfall patterns, groundwater origin and plant water usage
- Using environmental DNA to monitor terrestrial and aquatic species for strategic baseline assessment
- Assessing environmental water requirements for aquatic ecosystems and sustainable fisheries management
- Using new technologies and methodologies for monitoring fish movement
- Predicting impacts of climate change on aquatic food webs, ecosystems, carbon dynamics and nutrient cycling
- Conducting research on mangrove ecosystems, including restoration and carbon sequestration
- Informing conservation and management of threatened marine species, including sharks and rays
- Improving groundwater security through a citizen science project that enables people who depend on groundwater in northern Australia to record and share groundwater information
- Determining safety of aquatic foods in relation to effluent discharge
- Detection of cyanotoxins in wastewater targeting genes in synthesis pathways
- Molecular detection/enumeration of faecal indicators
- Detection of soil-transmitted parasitic worms in wastewater from remote communities
- The occurrence of opportunistic pathogens in drinking water
- Microbial source tracking in freshwater springs and pools, in drinking water and sewers
- Drinking water, bore water and water tank microbiome analysis including iron cycling bacteria
- Biofilm formation in drinking water distribution systems
- Frog-toad and reptile skin microbiome dynamics over space and time
- Fish skin and gut microbiome dynamics in relation to parasite load
- Migratory shorebird gut microbiome (*Vibrios*) in relation to migration and season
- Microbes in the nesting mounds of orange-footed scrub-fowl
- Assessing the potential impact of climate change on groundwater recharge in northern Australia

- ➔ 'Big data' assessments of groundwater recharge across the Australian continent
- ➔ Investigating catchment residence time in tropical catchments
- ➔ Investigating groundwater recharge and informing conceptual models of arid zone hydrogeology
- ➔ Determining the amount of terrestrial carbon that leaks into rivers across Australia
- ➔ Refining the net carbon sequestration potential for Australia
- ➔ Investigating water resources use and management in the Lower Burdekin Delta, Queensland, with a focus on sustaining intensive agriculture through droughts and floods
- ➔ Determining the source waters of the Doongmabulla Springs Complex in the vicinity of the Carmichael coal mine
- ➔ The development of scientific capability in freshwater ecology and the use of new technologies in natural resource management in northern Australia

## Research highlights

### Water quality surveillance program draws on traditional knowledge

A First Nations-led marine water quality surveillance program is drawing on traditional knowledge about sea changes and linking these to pathogen biosecurity threats.

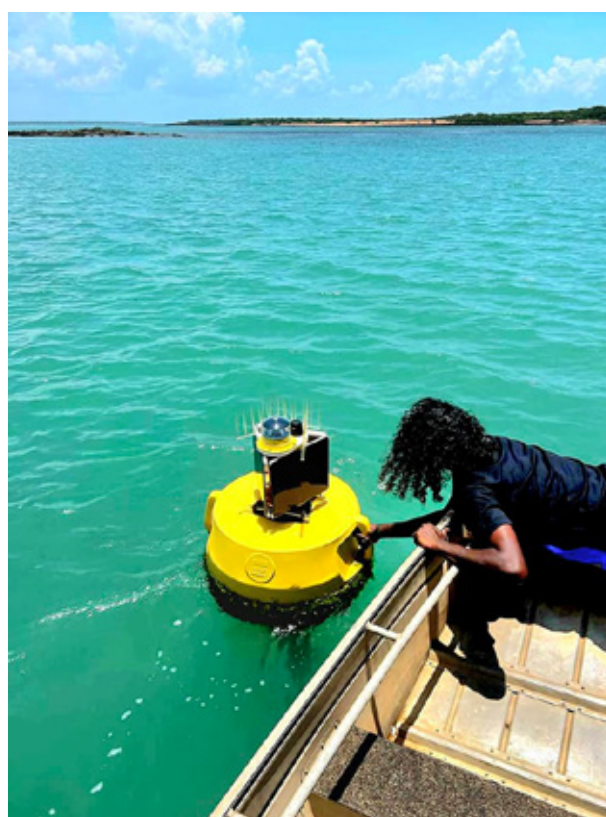
Led by the Yagbani Aboriginal Corporation (YAC) on South Goulburn Island, the 'Managing climate-change driven pathogen biosecurity threats in the north' project began in June 2023 and is expected to continue until 2025. As of late 2023, the team had already installed a water testing buoy, conducted instrument maintenance training, and collected water and oyster samples which were sent to the Bioscience North Australia (BNA) labs to test for bacteria and potential pathogens.

The research team includes Bunug Galaminda, Warruwi Traditional Owner Jenny Inmulugulu, Steve Westley, Brenda Westley and Brando Westley of YAC, along with Prof Karen Gibb, Dr Anna Padovan, Zarah Tinning and Dr Mirjam Kaestli of BNA at RIEL. The work is funded by the Department of Agriculture, Fisheries and Forestry.

The team is working toward using the analysed results to inform a marine biosecurity early warning workflow to minimise the risk of disease for animal and human health. It is also codeveloping with CDU TAFE an on-Country biosecurity surveillance training workflow linked to the biosecurity surveillance project activities.

"As a lab-based person, working on this project led by the Yagbani Aboriginal Corporation has opened my eyes to a different way of thinking about how it's possible to work across multiple fronts and communicate with different partners to achieve so many great outcomes – it's been fantastic," said Prof Gibb.

This important work will help to tackle increasing risks to health from climate-change driven pathogen biosecurity threats.



Darrion Yibarbuk checks a water quality research buoy on South Goulburn Island. Photo: Brenda Westley/YAC.

## Study produces world's largest database of groundwater recharge rates

An innovative project has produced long-term estimates of groundwater recharge rates at nearly 100,000 locations in Australia, resulting in the largest dataset of its kind in the world.

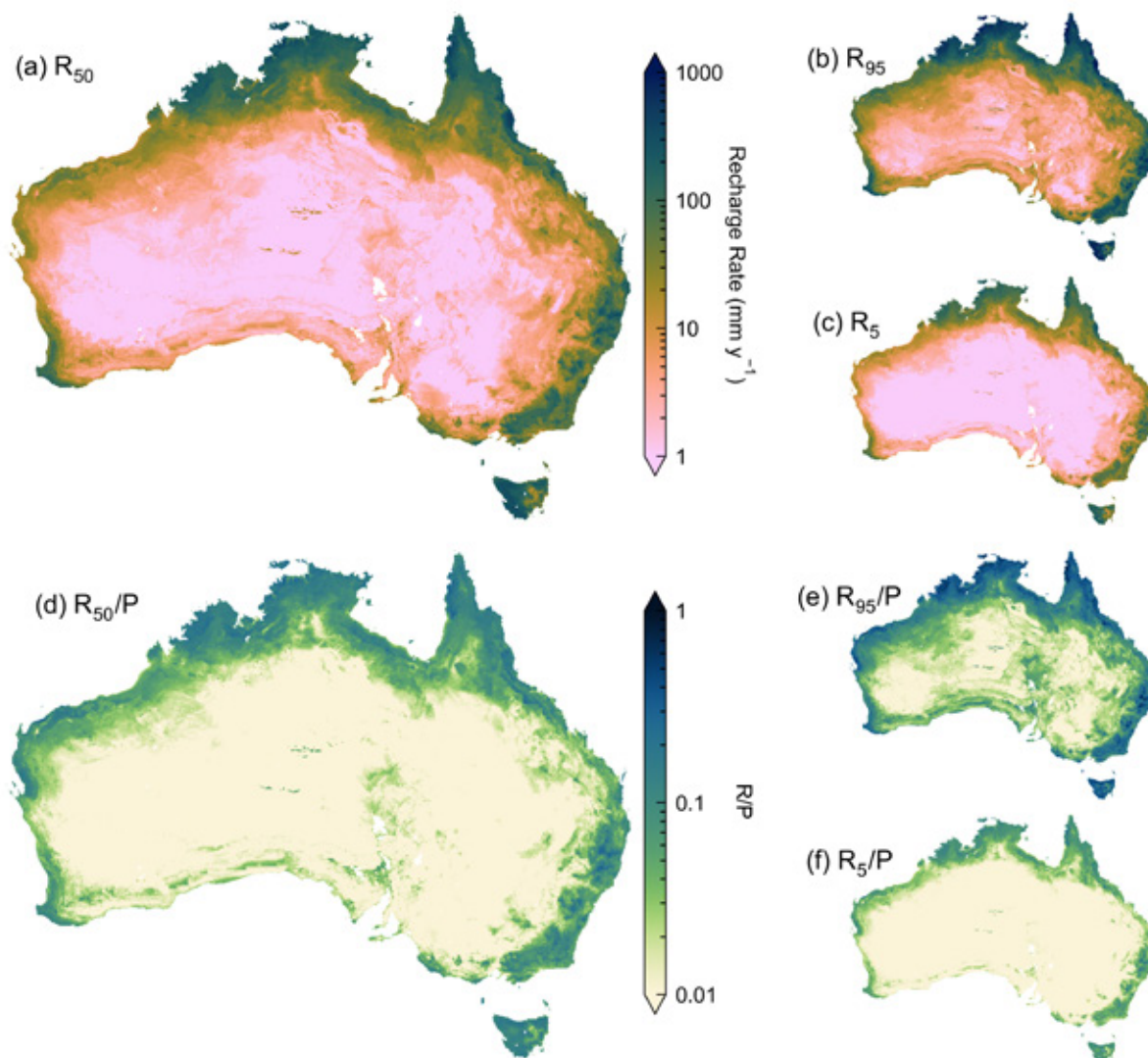
As part of PhD candidate Stephen Lee's project 'Exploring continental-scale groundwater recharge using Australia-wide hydrogeological and hydrogeochemical data', researchers published an open-access article titled 'A high-resolution map of diffuse groundwater recharge rates for Australia'.

The study focused on collating publicly available groundwater chloride data which would otherwise be rarely used in government databases. The goal was to use this data to estimate long-term rates of groundwater recharge for locations across Australia. It also aimed to explore the control of different environmental variables such as climate, vegetation and soils on the rates of recharge.

The team – including Mr Lee, Dr Dylan Irvine and Dr Clem Duvert of CDU, as well as Dr Gabriel Rau of the University of Newcastle and Prof Ian Cartwright of Monash University – carried out this work in 2022 and 2023, ahead of publishing in early 2024. The research was supported by the Cooperative Research Centre for Developing Northern Australia, which is part of the Australian Government's Cooperative Research Program through the Water Security Program.

"We've provided the largest groundwater recharge dataset produced anywhere, and we've also produced a modelled map of recharge that can be used as a starting point in investigations where no recharge estimates are available," Dr Irvine explained.

The team has received positive feedback indicating that tools which they openly shared will be very valuable to groundwater consultants. The research outputs are also expected to be useful to water resource managers, consultants and academics.



High-resolution modelled recharge maps for Australia. Image: Stephen Lee.

# Research Institute for Northern Agriculture

As a new research strength at CDU, the Research Institute for Northern Agriculture (RINA) covers primary production across northern Australia, including specialist research and training in horticulture, broadacre cropping systems, invasive species and biosecurity, commercial aquaculture, and pastoral production systems and sustainability.



## **Tropical aquaculture**

Biology, animal behavior and animal welfare in tropical aquaculture systems

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## **Tropical biosecurity**

Surveillance, diagnostics and ecology of invasive species, genomics and environmental DNA (eDNA)

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## **Cropping systems**

Crop physiology, agronomy and soil science

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## **Sustainable pastoral systems**

Pasture production, animal nutrition and sustainability of livestock systems

#### RINA's projects and opportunities in these areas include:

- Developing hatchery protocols for Black Jewfish culture
- Development of technologies for monitoring animals in aquaculture ponds
- Supporting Indigenous aquaculture for local food security, nutrition and employment
- Studying behavioral phenotypes and environmental enrichment to improve aquaculture production and sustainability
- Understanding the distribution and gene flow of insect vectors of tropical diseases in northern Australia
- Improving environmental and biosecurity monitoring using eDNA
- Improved diagnostics and taxonomy for agricultural and environmental biosecurity
- Understanding the water use of rain-fed cotton in the NT
- Drone and remote sensing approaches for crop monitoring
- Converting cotton trash and other agricultural waste for mushroom cultivation
- Digesting sugar mill waste to develop biofertiliser
- Improving productivity and associated co-benefits for beef production systems in Asia
- Improving productivity, profitability and sustainability of northern beef systems
- Investigating novel approaches to management of non-organic wastes from remote cattle stations

## Research highlight

### Detection of animal disease using eDNA

All living animals and plants shed fragments of their DNA into their environment through dead skin, hair, saliva, scat, leaves or pollen. These traces make up eDNA, which has great potential for early detection of invasive species and supporting biosecurity surveillance.

This project assessed on-farm sampling methods for eDNA detection of animal disease with a focus on livestock troughs. An easy-to-follow eDNA sampling protocol was developed for stakeholders and primary producers. The collected water samples could effectively

detect bacterial and viral eDNA from on-farm water troughs. The volume of water filtered did not influence detection, and small volumes were as effective as larger volumes at detecting bacterial eDNA.

The suggested sampling approach could be used to obtain eDNA samples from multiple properties across a large landscape. This project provides the foundations for building eDNA capability for animal disease detection in northern Australia.



Prof Maxine Piggott works with cattle at Katherine Rural Campus. Photo: Karen Cavanagh.

# North Australia Centre for Autonomous Systems



Vast distances, sparse population, harsh climate, and poor road infrastructure in northern Australia make air transport critical for the health, prosperity, and social fabric of remote communities. However, air transport in remote Australia is limited by aging aerodrome infrastructure, skill shortages, and rising costs.

Emerging aviation technologies have great potential to enhance effectiveness and efficiency, reducing the costs of transport, freight, and critical data collection across a wide range of industries and sectors in northern Australia. The North Australia Centre for Autonomous Systems (NACAS) carries out research and training to solve the barriers to the adoption of emerging technologies, enhancing their uptake for everyone.

NACAS conducts a wide range of drone-related research and training programs with various stakeholders. The centre's primary goals are to develop the capacity and infrastructure to enable regular long-distance air freight

of items using Remotely Piloted Aircraft Systems (RPAS) and to use RPAS for regular surveys or surveillance of large areas, possibly a long way from the pilot.

By the end of 2023, NACAS had grown into a leading drone innovation hub, focusing on the application of RPAS to healthcare, environmental monitoring, agriculture, and biosecurity. The cross-disciplinary research and training team helped transform the operational and business models of industry and government partners to meet the challenges of adopting and deploying the new generation of aviation technology.

## The NACAS team works on the following themes:

- ➔ Drone delivery and transport, which focuses on health services, pharmaceuticals, blood/pathology, parcel/e-commerce, and disaster response
- ➔ Remote sensing, which covers developing systems for agriculture, environmental services, asset surveys, maritime surveillance, border security, emergency response, and fire management
- ➔ Engineering, which investigates advanced composites, control systems, and drone communications
- ➔ Training, which includes Certificate III in Aviation (Remote Pilot), Remote Pilot Licence (RePL), Drones in Schools program, First Nations PreSTEM program, Diploma of Advanced Manufacturing, micro-credentials, and TAFE Robotic 3D Printing
- ➔ Cybersecurity and artificial intelligence (AI), which is a partnership with the NT Academic Centre for Cyber Security and Innovation

NACAS runs three uncrewed aerial vehicle (UAV) flight test ranges (FTRs) in northern Australia. These FTRs offer expansive areas with no human habitation, sparse infrastructure, and very low air traffic, which makes them ideal for testing the flight of UAVs beyond the visual line of sight of the pilot.

- ➔ Katherine UAV FTR, located on CDU's Katherine Rural campus, 230 km south of Darwin and 14 km north of Katherine
- ➔ Pine Creek FTR, which is a 30 km flight corridor between the Katherine Rural campus and Pine Creek, enabling a point-to-point flight route
- ➔ Darwin UAV FTR, located 37 km from Darwin city and Darwin International Airport

The NACAS Lab is situated at CDU's Casuarina campus and houses state-of-the-art facilities for designing, constructing, and testing UAVs. The lab is only a 30-minute drive from the Darwin UAV FTR.



NACAS team members work at the unmanned aerial vehicle flight test range at the Katherine Rural campus.  
Photo: Isabella Mellios.

## Research highlights

### Ghost nets

A project centred on ghost nets is, in partnership with the Anindilyakwa Land and Sea Rangers, using drones and AI to identify and quantify the volume of marine debris on remote and difficult-to-access coastlines. Ghost nets are abandoned, lost or discarded fishing nets which can cause injury or death to marine species that may become entangled in them. This project is funded by Parks Australia.

### Drones for health

Focusing on drones for health, another project is looking at using drone technologies for medical delivery in northern Australia. This can reduce the time it takes for medical goods to be delivered to remote communities and can significantly lower transport costs. The Australian Government and NT Government fund this project.



A barrage is seen from a drone at Shady Camp in the NT, in this image submitted to the RIEL Photo Competition 2023. Photo: Tayhlia Casey.

# Collaborations

## Partner organisations

RIEL collaborates and engages with a wide range of partners. The institute's valued partners come from across government, First Nations, industry, non-profit, community and research organisations.

**In 2023, some examples of the institute's many valued partners and collaborators included:**

- ➔ Arnhem Land Fire Abatement Northern Territory
- ➔ Australian Centre for International Agricultural Research (ACIAR)
- ➔ Australian Institute of Marine Science
- ➔ Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- ➔ Department of Climate Change, Energy, the Environment and Water
- ➔ Department of Agriculture, Fisheries and Forestry
- ➔ First Nations land councils including current projects with the Tiwi Land Council, Northern Land Council and Central Land Council
- ➔ Fisheries Research and Development Corporation
- ➔ Indigenous Carbon Industry Network
- ➔ Northern Territory Government
- ➔ Terrestrial Ecosystem Research Network
- ➔ Territory Natural Resource Management
- ➔ Thamarrurr Development Corporation
- ➔ Yagbani Aboriginal Corporation

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## Consultancy services

RIEL is known for offering high-quality consultancy services and expert advice in relation to the environment and livelihoods. Organisations can commission research, training or reviews from RIEL.

These services not only support strong outcomes for commissioning organisations, but also contribute to building local capacity in research and to increasing understanding of local ecosystems.

**RIEL's consultancy service centres include:**

- ➔ Darwin Centre for Bushfire Research
- ➔ Bioscience North Australia
- ➔ Aboriginal Research Practitioners Network
- ➔ North Australia Centre for Autonomous Systems

**Other examples of the available services include:**

- ➔ Blue carbon
- ➔ Feral animal management
- ➔ Biodiversity assessment
- ➔ Diversified farming systems
- ➔ Remote environmental monitoring
- ➔ Vegetation mapping and analysis
- ➔ Genetics and eDNA

# Students and alumni

Every year, RIEL is home to numerous students who are working toward completing honours, master by research, or PhD qualifications. The institute also remains closely connected with many of its alumni. The journeys of four student and alumni members are highlighted below.

## Honours research presented at international crocodile conference

After completing a Bachelor of Environmental Science at CDU in 2022, Tayhlia Casey decided to take the next step with a Bachelor of Science Honours in 2023.

Supervised by Dr Mariana Campbell, Dr Cameron Baker, and Prof Hamish Campbell of NACAS and RIEL, Tayhlia's project explored the environmental influences of the estuarine crocodile population recovery in the NT. The study found that estuarine crocodiles are crucial in enhancing riparian vegetation communities through top-down and bottom-up processes.

In recognition of her dedication and achievement, Tayhlia received an academic award for the best honours thesis in animal science. She also had the opportunity to present her research at the International Union for Conservation of Nature Species Survival Commission's Crocodile Specialist Group conference in Darwin the following year, which she says was a highlight of her honours journey.



Reflecting on her time studying at CDU and RIEL, Tayhlia says she deeply appreciated the hands-on research and fieldwork, and feels she gained invaluable experience working alongside notable researchers. Following her honours project, Tayhlia commenced work as a research assistant at NACAS, and also works as an environmental consultant at CDM Smith.

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## Dynamic landscapes offer unique look at Top End geckos

After researching the effects of saltwater crocodile presence on prey behaviour for an honours project at CDU in 2017, Kade Skelton returned to RIEL in 2019 to continue their studies as a PhD candidate.

Kade's PhD research, 'How Hydric & Thermal Physiological Traits of North Australian Deltas Compare Across Species & Environments', was supervised by RIEL's Prof Keith Christian from CDU's Casuarina campus and Assoc Prof Christine Schlesinger from CDU's Alice Springs campus, as well as Prof Craig Moritz of the Australian National University. The project involved measuring the water loss rates and preferred temperatures of Top End geckos and comparing these values across species, seasons, and environment.

The dynamic and expansive natural landscape of the NT provides unique opportunities for ecological research. In the case of Kade's PhD, the strong seasonality of the Top End was of particular interest, as Kade found that geckos can readily adapt to the desiccating conditions of the dry season by changing their physiology. However, the



geckos rely on the availability of suitable microhabitat to regulate their body temperature.

Since submitting their thesis at the end of 2023, Kade has reconnected with key academics from their time as an honours student to secure further work and research opportunities at CDU, focused on crocodiles.

## Agronomy project investigates cultivation of native rice

Gehan Abdelghany was awarded a Research Training Program scholarship, which are granted to students of exceptional research potential, for her PhD project 'Agronomic investigations of Australian native rice species to support Indigenous enterprise development in Northern Australia'. The project commenced in 2020 and was expected to be completed by mid-2024, under the supervision of Dr Sean Bellairs and Dr Penny Wurm at RIEL.

The project investigates the cultivation protocols of Australian native rice in order to develop options for their commercial production by First Nations enterprises. In particular, this research supports the potential commercial cultivation of Australian native *Oryza* in northern Australia. It also emphasises the importance of optimising agronomic factors such as planting density and Nitrogen rate in maximising the grain yield and quality of Australian native rice species.

Since arriving in Darwin from Egypt, Gehan embraced opportunities to showcase her project, including presenting at conferences and student showcases. She was a finalist in CDU's 3-minute thesis competition in



2022, is a regular contributor to the *Commercialisation of Native Rice Newsletter*, and has been interviewed for radio and television. She has also published one of her PhD chapters in a Q1 journal.

"Gehan understands the importance of research communication for impact, and has taken every opportunity to present and promote her work," said Dr Bellairs.

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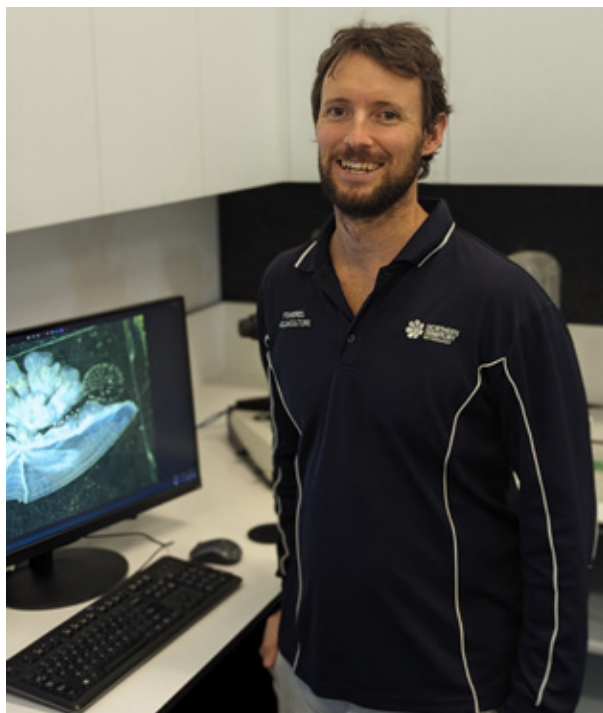
## Barramundi research supports sustainable fishery management

Dr Brien Roberts completed his PhD thesis, 'Drivers of catadromous migration in barramundi in the wet/dry tropics of northern Australia', at RIEL from 2016-2021 under the supervision of Assoc Prof David Crook, along with Prof Sam Banks, Assoc Prof Alison King, Assoc Prof David Morgan, Dr John Morrongiello, and Dr Thor Saunders.

The research examined the ecological and evolutionary drivers of migration patterns of barramundi between freshwater and saline environments across northern Australia, and investigated linkages between migration, hydrology and fishery productivity.

A key finding of the project was that whilst barramundi do not require access to fresh water to complete their lifecycle, individuals that do so achieve faster growth rates, and mature at younger ages compared to individuals that reside within saline estuarine or coastal habitats. This pattern provides a stark contrast with riverine migratory fishes in most other parts of the world, which typically grow faster at sea after migrating out of freshwater rivers.

The results underscore the remarkable productivity of northern Australia's floodplain rivers, and highlight the ecological and economical importance of their conservation – especially in the face of increasing demand for fresh water and a changing climate.



Having worked closely throughout his PhD research with the NT Government's Fisheries NT, Brien has since joined Fisheries NT as a research scientist. In this role he has been involved in research in both aquaculture and wildstock fisheries, and is currently undertaking research to support the sustainable management of the Barramundi Fishery.

# Outreach and engagement

RIEL conducts a variety of outreach and engagement activities throughout the year, from seminars and conferences to media coverage. Some key activities are highlighted below.

## Research seminars

In 2023, the RIEL Seminar Series continued to serve as a forum for sharing the latest research on environmental and natural resource management issues, drawing on local, national and international speakers. RIEL hosted 22 seminars over the year, in which 32 speakers presented their research. Seminars were offered both on campus and online, and were open to students, staff, and the public.

Presenters included PhD candidates, early career researchers and senior academics from CDU; representatives of other tertiary institutions such as the Australian National University, Ibaraki University, East China Normal University and Western Sydney University; and organisations such as the Bureau of Meteorology and CSIRO.

Presentations included “Groundwater dependent ecosystems” from Dr Tanya Doody of CSIRO, “Positive welfare: the next step for farmed fish” by RINA’s Prof Sunil Kadri, and “Ground-level governance of Arnhem Land Fire Abatement savanna burning projects: fire for the future” by PhD candidate Taegan Calnan.

## Strategic events

RIEL, RINA and the Darwin Centre for Bushfire Research were supporters of several major events in 2023 – the North Australia Savanna Fire Forum, Northern Australia Food Futures Conference, and the Territory Natural Resources Management Conference. RIEL researchers not only presented their work at these events but team members were also available to promote and discuss opportunities to study with or partner with the institute.

RIEL also facilitated several smaller-scale events throughout the year, including a visit from ACIAR commissioners, a networking session with CSIRO representatives, and a visit from editors of academic journalism website *The Conversation*.

In the middle of the year, aligning with CDU’s Casuarina Open Day, the institute held the RIEL Photo Competition to highlight the environments in which researchers work. RIEL members and members of the public voted on a shortlist of 10 images – a process that generated scores of conversations about fieldwork experiences as well as the landscapes, flora, and fauna that are often the focus of research projects. Bringing attention to



PhD candidate Acacio Da Costa Guterres and postdoctoral research fellow Dr Nicola Hanrahan share information about RIEL during the Territory Natural Resources Management Conference 2023.

environments across northern Australia, the winning image depicted a black wallaroo in West Arnhem Land by Allyson Malpartida, while the runners-up were an image of the Daly River from above by Dr Cameron Baker and a green tree ant in Kakadu from Dr François Brassard.

Towards the end of the year, the institute held the RIEL Conference 2023 as a research-sharing day for RIEL members and key partners. The daylong event featured researchers from each of RIEL's research strengths, followed by a dedicated session on partnerships with representatives from the Department of Climate Change, Environment, Energy and Water; CSIRO; Museum and Art Gallery of the Northern Territory; Northern Land Council; and CDU's Office of Research and Innovation.

### Media coverage

RIEL saw positive media engagement over the course of the year, with 195 direct mentions of RIEL, as recorded by CDU's Media, Marketing and Communications team. Highlights of this coverage included "DNA database reveals origins of crocs caught in Darwin Harbour" in the NT News and "The first marine fish has been declared extinct in a tipping point for marine biodiversity" in *Cosmos Magazine*.

The media team also recorded significant coverage of the work of particular RIEL researchers. For instance, work by Dr Peter Kyne achieved 177 mentions in the media, reaching a potential audience of more than 539 million readers. This was driven by articles including "International Research Team Embarks On Quest To Save Elusive Shark Relative" from Forbes and "Sawfish, guitarfish and more: Meet the rhino rays, some of the world's most oddly shaped and highly endangered fishes" in *The Conversation*.

Meanwhile, research from Dr Carol Palmer saw 486 mentions in media, which had the potential to reach an audience of over 183 million. This was the result of articles such as "Researchers link delayed blue whale migration past Timor-Leste to a warming ocean" from the Australian Broadcasting Corporation. In another example, work by Dr Hugh Davies saw 149 media mentions, potentially reaching over 132 million people worldwide, propelled by pieces like "Buffalo farts stir cull calls" in the *Katherine Times*.





Researchers release a northern brown bandicoot.  
This image was shortlisted in the RIEL Photo  
Competition 2023. Photo: Alex Carey.

**To find out more about RIEL's research, contact us at:**

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