Research Institute for the Environment and Livelihoods

Annual Report 2022







cdu.edu.au/riel

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: Buffel grass transforms an arid ecosystem in Central Australia. Photo: Ellen Ryan-Colton.

This page: A white-browed crake balances on a lily pad. Photo: Peter Kyne.

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Researchers walk across distinctively coloured laterite soil. Photo: Hayley Geyle.

Message from the Director

From environmental, cultural and economic perspectives, Charles Darwin University (CDU) is situated in the most exciting and, arguably, most important location in Australia for a research-intensive university. The Research Institute for the Environment and Livelihoods (RIEL) at CDU provides world-class research and research training to support natural resource management, sustainable development and biodiversity conservation across the tropical and arid ecosystems in which we live and work.

RIEL engages with a wide range of partners across government, First Nations, industry, non-profit, community and research organisations, and the institute's research informs policy and decision-making. Looking back on 2022, it was an exciting year of new collaborations and growth in existing programs in the institute's key research areas both in northern Australia and internationally, all of which contributed to furthering the impacts of this critical work.

Among the many new initiatives in 2022, RIEL and CDU's Northern Institute partnered with the Commonwealth Scientific and Industrial Research Organisation to support new early career researchers focused on water in the north. This added to a large and multidisciplinary water research group within RIEL that is set to play a key scientific role in supporting the informed debate, planning and management of water resources in northern and central Australia in the near future.

The year also saw the formal establishment of the North Australian Centre for Autonomous Systems (NACAS). Led by RIEL's Prof Hamish Campbell, NACAS brings new research capacity in autonomous systems to northern Australia and is significant within the University in facilitating research collaborations and training opportunities across disciplines.

RIEL's international research has featured a strong focus on partnerships in Indonesia as well as Timor-Leste for many years and the post-COVID era has seen the development of some important new research in these locations. For instance, Dr Leigh Vial joined RIEL in 2022 and has established an Australian Centre for International Agricultural Research funded program on farm labour productivity in rural Timor-Leste.

The Darwin Centre for Bushfire Research's long-standing partnership with First Nations fire managers has also expanded to Timor-Leste, as part of a globally significant program to 'export' northern Australian expertise in fire management, research and information systems to support savanna fire management for carbon emissions abatement across South-East Asia, Africa and Central America.

RIEL now hosts the new Research Institute for Northern Agriculture, which commenced work in 2022 and will add a new dimension to CDU's research capacity by developing critical research expertise in tropical agriculture and biosecurity in northern Australia.

Focusing on our people, RIEL celebrated the career progression of a number of staff in 2022, recognising the major contribution of RIEL academics to CDU and the broader community through research and teaching.

Among higher degree by research candidates, 13 RIEL members completed their PhD theses in 2022. As an institute focused on research and research training, the success of PhD candidates both during and after their time at RIEL is a source of pride. This cohort of graduates has already moved onwards and upwards to make contributions in academia, government and other sectors in Australia and overseas.

I hope you enjoy reading through the selection of achievements and collaborations in this Annual Report. RIEL is made up of a remarkable community of staff, students and adjuncts, and I thank each and every person for their contributions.

Building on a highly impactful 2022, RIEL continues to be known as a research leader in northern Australia and the near Asia-Pacific, and together we will continue working to improve our understanding of tropical and arid ecosystems and the livelihoods that depend on them all across our region.

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



Looking back on 2022, it was an exciting year of new collaborations and growth in existing programs in the institute's key research areas both in northern Australia and internationally.



Who are we?

The Research Institute for the Environment and Livelihoods (RIEL) is based at Charles Darwin University (CDU) in Darwin, the Northern Territory (NT). RIEL is nationally and globally recognised as a leader in tropical environmental research in northern Australia and the near Asia-Pacific region.

RIEL's research spans tropical, semi-arid and arid regions and the livelihoods of the communities that rely on them. Sustainable management is needed to preserve these environments and the biodiversity they support. Sound policy, planning and management must be based on world-class scientific evidence. RIEL produces research and develops scholars that help to meet this need across the region.

The institute sits within CDU's Faculty of Science and Technology and comprises academic staff, professional staff, higher degree by research (HDR) candidates, Honours students, and adjunct and honorary members.



included research and teaching academics from CDU's Environment discipline as well as research-focused academics working at CDU on externally funded programs. Academic staff

contribute to internationally significant research initiatives, supervise HDR candidates, teach into undergraduate courses, and offer consultancy services. The team also includes a small number of professional staff responsible for research, management, and operational support across RIEL.

In 2022 RIEL was home to 711 HDR candidates and Honours students, both domestic and international, undertaking innovative research projects and contributing significantly to bodies of research in the region.



adjunct and honorary members from a wide range of sectors, both within and outside Australia, including state, territory, and Commonwealth government, nongovernment

organisations and research organisations.

RIEL members participated in a number of important committees within the institute:

- The Gender Equity and Inclusion Committee, which aims to improve equity and inclusion among the staff and students of RIEL, with a particular focus on gender equity.
- The Assets Committee, which contributes to the development of a strategic asset management plan and reviews applications for the repair, replacement, maintenance or service of RIEL assets such as vessels, vehicles and equipment for work health and safety, communication, field work and laboratories.
- The Boat Committee, which provides strategic guidance and manages the RIEL boat fleet, including the necessary maintenance, operations, compliance, safety and usage of the fleet.

RIEL members were also involved in various universitywide initiatives and mechanisms:

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The Research and Innovation Committee, which promotes and fosters excellence, impact and innovation in research.



Academic Board, which works to protect, promote and enhance the excellence of the core academic activities of teaching, learning and research.



The Vice-Chancellor's Advisory Committee, which advises on the strategic development and advancement of the University.

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Where do we work?

RIEL works across northern Australia and beyond. RIEL researchers are primarily based at CDU's Casuarina campus on Larrakia Country in Darwin, and at CDU's Alice Springs campus on Arrente Country.

The institute's international research collaborations have a long-standing focus on Timor-Leste and Indonesia, and also have links to tropical and arid zone research around the world.



In 2022, while a majority of RIEL members' project sites were in northern and central Australia, there was a significant number of projects in other parts of Australia. Project sites were also recorded in international locations including Timor-Leste, Indonesia, Puerto Rico, Hawaii and Botswana. Image: Alys Young.

Research performance

Research income in 2022



Publication highlights included:

 Coyne, C., Williams, G., Sangha, K.K., 2022. Assessing the Value of Ecosystem Services From an Indigenous Estate: Warddeken Indigenous Protected Area, Australia. *Frontiers in Environmental Science* 10.

This paper investigates the value of ecosystem services from an Indigenous Protected Area in northern Australia, providing valuable insights for policy makers, land managers, and future development programs, and highlights the importance of land managed by Indigenous peoples in Australia and worldwide. **Legge, S.**, Rumpff, L., **Woinarski, J.C.Z.**, Whiterod, N.S., Ward, M., Southwell, et al., 2022. The conservation impacts of ecological disturbance: Time-bound estimates of population loss and recovery for fauna affected by the 2019–2020 Australian megafires. *Global Ecology and Biogeography* 31, 2085–2104.

Following the 2019–2020 Australian megafires, this paper estimated population losses and recovery in fire-affected fauna, to inform conservation status assessments and management, and to help prevent extinction and support recovery efforts.

 Hutley, L.B., Beringer, J., Fatichi, S., Schymanski, S.J., Northwood, M., 2022. Gross primary productivity and water use efficiency are increasing in a high rainfall tropical savanna. *Global Change Biology 28*, 2360–2380.

Recognising the contribution of tropical savannas to the global carbon cycle, this paper examined interannual variability and externally forced long-term changes in carbon and water exchange from a high rainfall savanna site in the seasonal tropics of north Australia, to increase understanding of their current trajectory with climate change and anthropogenic pressures.

 Von Takach, B., Ranjard, L., Burridge, C.P., Cameron, S.F., Cremona, T., Eldridge, M.D.B., et al., 2022.
Population genomics of a predatory mammal reveals patterns of decline and impacts of exposure to toxic toads. *Molecular Ecology* 31, 5468–5486. This study measured genomic diversity in the northern quoll—an endangered marsupial carnivore that is declining severely due to the spread of introduced toxic cane toads—to contribute to decision-making for the conservation of northern quolls and other declining native mammals across northern Australia.

 Bonis-Profumo, G., do Rosario Pereira, D., Brimblecombe, J., Stacey, N., 2022. Gender relations in livestock production and animal-source food acquisition and consumption among smallholders in rural Timor-Leste: A mixed-methods exploration. Journal of *Rural Studies* 89, 222–234.

This study explored how gender relations inform livestock production and the acquisition and consumption of animal-source foods in four villages in Timor-Leste, and highlighted that a focus on women's empowerment in nutrition-sensitive programs could contribute to better quality diets in some areas.

Higher degree by research (HDR) in 2022 71 And the second state of the second state

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HDR completions comprised:

- Kimberley Hunnam, Optimising the Timor-Leste sardine fishery for enhanced food security.
- Rohan Fisher, *Improving savanna fire management* capacity thorough participatory geosimulation and 3D tactile geo-visualisation.
- Robin Leppitt, *The habitat requirements and potential threats of the endangered Alligator Rivers Yellow Chat* Epthianura crocea tunneyi.
- Brien Roberts, Drivers of catadromous migration in barramundi in the wet/dry tropics of northern Australia.
- Shandala Loving, Integrating telemetry, remote sensing and landscape genetics for assessing feral pig (Sus scrofa) movement ecology.
- Sarah Bonney, Ants as the little things that run the world: Ecological responses to experimental suppression of a dominant faunal group in an Australian savanna.

- Kyle Tyler, Reproductive ecology of Australia's wet-dry tropical freshwater fish: insights into hydrological and other environmental determinants of fish recruitment.
- Rebecca Rogers, Harnessing the potential of weather surveillance radar to monitor waterbirds in Australia.
- Katherine van Wezel, Women Caring for Country on the Frontier: A Case Study of Intercultural Collaboration with Waanyi and Garawa Peoples.
- Bruce Pascoe, Community ecology of the avifauna of Acacia shrublands in central Australia.
- Robert Van Zalinge, Ecological requirements of the Sarus Crane in Cambodia: Is conservation meeting its needs?
- Janine Abecia, *Life history and morphological trait adaptations of paternal mouthbrooding fishes in the rivers of northern Australia.*
- Gianna Bonis-Profumo, *Child and maternal dietary quality and its relationship with women's empowerment in agriculture in rural Timor-Leste.*

Research impact

From year to year, RIEL sees tangible and consistent impacts from many of its research projects. Among the numerous ongoing examples are an online service that provides critical fire activity information, a project that supports oyster aquaculture systems and business opportunities, and an expanding project that develops marine management and monitoring in the Top End.

Website tracks fire activity on more than 75% of continent

In northern Australia and across the Australian rangelands, the ability to view and track current fire activity is invaluable to land managers, ranger groups and pastoralists. Over more than 20 years, the North Australia (and Rangelands) Fire Information (NAFI) website has become a critical information tool for land managers across northern and central Australia. The service supports fire management across diverse sectors covering over 75% of the continent.

NAFI meets the needs of fire managers by displaying maps of fire activity such as hotspots (locations of recently burning fires) and burnt area maps based on information from satellites. These regularly updated maps of fire activity across Australia's savannas and rangelands are readily available to land managers and the general public via firenorth.org.au. Its data underpins the Commonwealth's savanna burning methodology for the carbon industry, and provides critical information for the Australian Fire Danger Rating System across Western Australia and the NT.

Usage of the service continues to grow, with the number of computers and servers using NAFI's web-based maps increasing significantly in recent years. In 2022, as many as 61,156 distinct computers were recorded as accessing the maps, and there were likely many more individual users. The service is widely used by pastoralists, First Nations rangers, and agency staff who manage fire. The Australian Royal Commission into National Natural Disaster Arrangements has also identified NAFI as a significant source of natural hazard information for Australian land managers.

NAFI is hosted by CDU through RIEL. Burnt area mapping is created by RIEL's NAFI staff, while hotspots are sourced from Landgate Western Australia and Geoscience Australia. The basic public good component of the service is funded by the Federal Government, with significant funding also received from industry and enduser organisations including savanna burning projects, ranger groups and national parks. NAFI supports tangible economic benefits through better use of resources and better asset protection from fire. The service is also key for savanna burning projects in securing carbon credits.

Oyster aquaculture increases business opportunities

Aquaculture can provide strong and sustainable employment opportunities for remote communities in the NT. The Tropical Rock Oyster Development (TROD) project was first established to help meet demand in First Nations communities for low-technology oyster aquaculture systems, and as of 2022 was leading to positive business opportunities.



Blacklip Rock Oysters are collected during the TROD project. Photo: Samantha Nowland.

While the NT Government's Darwin Aquaculture Centre has made significant progress on hatchery production, and the Yagbani Aboriginal Corporation is on track for commercial production of Blacklip Rock Oysters, there are constraints to industry expansion. This relates in part to the perceived risks of shellfish food safety in the tropics. Internationally, tropical rock oysters have a poor safety reputation, particularly in relation to *Vibrio* bacteria which occurs naturally in warm waters. If present in harvested shellfish, *Vibrio* bacteria can cause illness when products are eaten raw.

With support from the Fisheries Research Development Corporation (FRDC), RIEL researchers from the Environmental Chemistry and Microbiology Unit led by Prof Karen Gibb joined the collaborative TROD project to help investigate low-technology sea-based aquaculture systems and particularly to sample Blacklip Rock Oysters from 10 locations across the NT. The team assessed shellfish quality, including *Vibrio* testing. The work aimed to support food safety and quality control of end products in the emerging Blacklip Rock Oyster industry in the region.

The results of the research support the economic sustainability of community farmers and the livelihoods of First Nations peoples in northern Australia. Business development opportunities have been positive among wholesalers and restaurants in Darwin, while opportunities are also emerging in Western Australia and Queensland.

In the NT alone, tropical rock oysters are expected to create 500 new aquaculture jobs and to add more than \$217 million in production value, with increased quality control and food safety playing an important role in this expansion. The FRDC-funded research is due to be completed in December 2023.

Marine project involves more ranger groups

Many marine megafauna are listed as threatened or migratory, yet they play important ecological roles in marine ecosystems and can often hold cultural significance for First Nations communities. Marine megafauna include species like sea turtles, dolphins, whales and manta rays. RIEL's Marine Megafauna Project, with team members Dr Carol Palmer, Natalie Robson and Prof Sam Banks, focuses on science and training to inform the development of monitoring and conservation programs for these charismatic species in NT waters. The project draws on scientific methods including genetics, global positioning system (GPS) tracking and dietary DNA metabarcoding to understand patterns of movement, foraging behaviour and key habitat requirements of marine megafauna in the Top End.

The management and monitoring of these species must occur with strong collaboration. The Marine Megafauna Project is funded by an Australian Research Council (ARC) Linkage Project grant to RIEL and partners including the Gumurr-Marthakal Rangers, Parks Australia (Kakadu National Park), NT Parks and Wildlife (Garig Gunak Barlu National Park) and the Larrakia Rangers, together with scientists from Macquarie University, James Cook University, Edith Cowan University, the Australian Institute of Marine Science and the Taronga Conservation Society.

The project has also seen impacts associated with a ranger exchange program that links with the ARCfunded research program. The collaborative team has expanded through funding to Larrakia Nation Aboriginal Corporation (Larrakia Rangers) to bring in new groups including the Kenbi Rangers, Tiwi Resources and the Mardbalk Rangers, to further develop marine scientific research and monitoring capability around the Top End coastline.



An Australian humpback dolphin, a species endemic to Australia, splashes in waters off the Top End coast. Photo: Carol Palmer.

Researchers enter a sandy gorge at Simpsons Gap in Tjoritja/West MacDonnell National Park. Photo: Allyson Malpartida.

Research strengths

RIEL's research is grouped into four key strengths and one additional institute.



Biodiversity conservation

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



Communities and livelihoods

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



Savanna and arid ecology

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



Water and catchments

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



Tropical agriculture and biosecurity

The Research Institute for Northern Agriculture (RINA), currently sitting within RIEL, builds on the institute's strengths in environment and livelihoods research to support agriculture and aquaculture in northern Australia.



As one of RIEL's four research strengths, biodiversity 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 specialist knowledge and advice on:



This wide variety of work carried out in 2022 included highlights such as protecting shark and ray areas, and a thesis project on the greater bilby.

Research highlights

Australia and globally

Putting sharks on the map

Area-based management offers an opportunity to protect and conserve biodiversity. Sharks and their relatives—rays and chimaeras (hereafter 'sharks')—are a diverse group of high conservation concern, with an estimated 37% of species threatened with extinction globally. To define areas of critical importance for sharks, the International Union for Conservation of Nature (IUCN) Species Survival Commission Shark Specialist Group launched the Important Shark and Ray Areas (ISRA) project in 2022.

RIEL's Dr Peter Kyne is working as an ISRA project team member, joining an international group of researchers and geographic information system (GIS) specialists to map areas of importance for sharks. ISRAs apply a set of criteria to delineate areas based on the vulnerability (i.e., threatened status), range-restriction, life history (e.g., reproduction), and special attributes (distinctiveness or high species diversity) of the sharks occurring in the area. The ISRA Criteria provide a 'framework to identify discrete, three-dimensional portions of habitat important for one or more shark species, that have the potential to be delineated and managed for conservation'.

The project's inaugural regional delineation in 2022 mapped areas in the Central and South American Pacific Ocean, from Mexico to Chile. A total of 65 ISRAs were delineated, covering a diversity of habitats and highlighting areas of importance for species like the critically endangered scalloped hammerhead and largetooth sawfish. Areas appear on the Important Shark and Ray Area e-Atlas, an open access tool for exploring areas important for sharks, at sharkrayareas.org/e-atlas. The ISRA project is funded by the Shark Conservation Fund, a philanthropic collaborative pooling expertise and resources to meet the threats facing the world's sharks and rays. The Shark Conservation Fund is a project of Rockefeller Philanthropy Advisors. The project is continuing to work through 13 regions globally to put sharks on the map.



The Important Shark and Ray Areas e-Atlas is an open access tool for exploring areas important for sharks. Image: sharkrayareas.org.

Project investigates extent of threats on greater bilby

The Conservation Ecology of the Greater Bilby (Macrotis lagotis) is an ongoing PhD project by Hayley Geyle looking at the greater bilby—an iconic yet threatened species of both cultural and ecological significance in Australia.

The range of the greater bilby has contracted significantly since European colonisation, likely due to a combination of changing fire regimes, predation by introduced predators and livestock grazing. However, the extent and interactive effects of these threats on bilbies are not well established. A lack of understanding of how many bilbies remain in the wild also hinders informed management decisions and presents challenges in monitoring bilby responses to threats or management interventions.



A bilby is captured in a night-time image in central Australia. Photo: Hayley Geyle.

The project works closely with Territory Natural Resource Management (TNRM), the Central Land Council (CLC), Indigenous rangers and Traditional Owners to undertake fieldwork in the Tanami Desert, a vast and isolated area that extends across the NT and Western Australia. The project is supported by TNRM and the Holsworth Wildlife Research Endowment. The thesis aims to address some of the research gaps by investigating predator-bilby interactions in response to Indigenous-led fire management, and by using noninvasive genetic sampling—extracting DNA from bilby poo—to better understand bilby population dynamics. As of 2022, the team had collected more than 25,000 nights of camera-trapping data, both before and after fire events, as well as more than 1,000 bilby poo samples.

Species spotlight

Thorny devils show softer side

Ngiyari is the local Pitjantjatjara name for the thorny devil (*Moloch horridus*). Ngiyari are highly significant for First Nations peoples in central Australia, seen for example through historical records of Anangu men and boys performing ngiyari inma (ceremony) in the remote communities of Pukatja (Ernabella) and Fregon.

Although listed under 'least concern' on the IUCN Red List due to their wide distribution, like many cryptic species—especially in understudied desert regions their true status is unknown. Ngiyari can live for up to 20 years. They subsist on a diet of small black ants, and are known for their ability to drink by standing in puddles with water being transported through capillary action across the skin to the mouth.



A devilish ngiyari displays its thorns during research activities in central Australia. Photo: Christine Schlesinger.

RIEL researchers are focusing on ngiyari as part of a project on Anangu Country in the jointly managed Uluru-Kata Tjuta National Park, working in partnership with the park as well as the independent Aboriginal-owned Nyangatjatjara College. This project seeks to understand how ngiyari respond to extreme conditions, particularly in central Australia where temperatures and sequences of very hot days are increasing, and how environmental change is impacting biodiversity.

Ngiyari are hard to study because they are only active at certain times of the year and are difficult to find. To overcome such challenges, the research is using a citizen science component—with observations made throughout the year by local residents, including local rangers and college students, using a variety of tracking methods.

Communities and livelihoods

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

Within this area, researchers' specialist knowledge and advice covers:

Restoration, rehabilitation and collaborative Participatory land and sea management management of mangroves Gender, food security and rural livelihoods Capacity building for natural resources Natural resource-based enterprise development management in terrestrial and marine **RIEL's work in this area includes:** Working with First Nations communities to Rehabilitation of blue carbon habitats and strengthen land and sea management outcomes livelihoods Contributing to the sustainability of ecosystem Engaging with First Nations peoples and local communities to contribute to biodiversity services for the benefit of Indigenous communities conservation and livelihoods in Australia and the Asia-Pacific Implementing a world-first program for a savanna Understanding how First Nations communities will be affected by climate change burning carbon industry in northern Australia Researching the benefits that threatened species Developing digital technologies to improve livelihoods of local communities in the Asia-Pacific conservation can deliver to people globally Supporting natural resource-based enterprises in

Highlights among the range of work carried out in 2022 included an ecosystem services project in northern Australia, and a livelihoods improvement project in Timor-Leste.

Research highlights

Nations communities

Codeveloping a nature-based economies business model

aquaculture, fisheries and plant production in First

Developing ecosystem services economies for northern Australia is a project led by Assoc Prof Kamaljit Sangha and Prof Jeremy Russell-Smith in northern Australia. Funded by the ARC under a Discovery Program grant, the project aims to advance economic opportunities for remote First Nations communities by developing a culturally appropriate ecosystem services framework also known as a nature-based economies framework.

The project applies an integrative approach to address socioeconomic and ecological issues affecting remote First Nations peoples as well as northern Australia's unique biodiversity, land and water resources. Researchers are codeveloping an inclusive ecosystem services business model in collaboration with First Nations and business stakeholders that accounts for a diverse range of ecosystem services and aligns with First Nations and business contexts.

The expected outcomes include a business framework for collaborative regional ecosystem services market development with a unique set of indicators and measures, and an assessment of the ecosystem services market status and opportunities for First Nations communities.

RIEL and CDU's main partners on this project are University College London, the North Australian Indigenous Land and Sea Management Alliance Ltd and First Nations organisations.

Livelihood improvement in Timor-Leste

Evaluation of livelihood zones and rural household trajectories to determine future research questions for livelihood improvement in Timor-Leste is a project led by RIEL's Dr Leigh Vial, along with Marcia Exposto e Silva and Prof Andrew McWilliam, which is an ACIAR Small Research Activity (SRA).

At present, various agencies provide resources in Timor-Leste to help address the country's low agricultural productivity and to improve food and nutrition security for the population. This SRA forms the first stage of a planned larger ACIAR project to improve smallholder livelihoods in Timor-Leste through increased labour productivity, with a focus on innovation in soil management and improvement. The project's partners include Universidade Nacional Timor Lorosa'e (UNTL) and the Australian Department of Foreign Affairs and Trade's (DFAT) Farming for Prosperity (TOMAK) program.



Marcia Exposto e Silva discusses fertilizer with farmers in Baucau, Timor-Leste. Photo: Ambrosio Alexandre da Silva/TOMAK.

To generate appropriate agricultural research questions for increased labour productivity and livelihood improvement, the SRA has—in six locations across three key livelihood zones—considered what has driven rural households into or out of poverty, what affects their food security and sovereignty, detailed the current farming system, assets, constraints and opportunities. It then found the farmers' preferred research questions in a participatory selection process. Finally, it will document the impact of previous research for development projects in these locations.

The SRA and the larger project aim to provide recommendations to ACIAR and other research and development organisations on future research, development initiatives and investments in Timor-Leste. Three municipalities were selected: Ainaro, Maubisse, for the upland high altitude livelihood zone; Baucau, for the inland irrigable watersheds livelihood zone; and Manufahi, for the southern rainfed livelihood zone.

Species spotlight

Native rice demonstrates potential as a high-value product

Australian native rice species (*Oryza australiensis, O. meridionalis and O. rufipogon*) hold potential as a high-value traditional grain supplied as culturally identified food products by First Nations enterprises for Australian native plant and gourmet markets.

Native rice species grow in natural wetlands throughout the tropics in the NT, Queensland and Western Australia. However, harvesting commercial quantities from wild populations is hazardous due to the presence of crocodiles, and difficult due to variable water levels affecting access when the grain is mature. While there is some desire for cultivation of native rice by First Nations enterprises and communities, basic agronomic information on the species is lacking.

A Future Food Systems Cooperative Research Centre project is developing knowledge to lay the foundations for the commercialisation of Australian native rice as a high-value, low-volume, culturally identified and nutritious food. The rice is thought to have added nutritional value due to its reddish-brown coat. It changes to a lavender-brown colour when cooked, and is described as having a delicious nutty flavour and aroma.

RIEL's Dr Sean Bellairs and Dr Penny Wurm lead this research to develop agronomic knowledge about native rices, especially for First Nations enterprises interested in cultivation and commercialisation. Major field and greenhouse trials have been undertaken by RIEL Research Officer Sonam Adhikari Rana and PhD student Gehan Abdelghany. The team also comprises other researchers and students from CDU, the NT Department of Industry, Tourism and Trade (DITT) and the Queensland University of Technology. The project is a collaboration with commercial partners Pudakul Aboriginal Cultural Tours and Myera Pty Ltd.

Trials have investigated planting density, nitrogen rate and seedling establishment using CDU plant science nursery facilities, and field trials have been undertaken at the DITT Coastal Plains Research Farm.



An expanse of native rice grows near Fogg Dam in the NT. Photo: Penny Wurm.

Savanna and arid ecology

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



The many highlights from this research area include a major ecosytems monitoring network and a project on exporting northern Australian savanna management to the world.

Research highlights

Litchfield Savanna SuperSite conducts detailed environmental monitoring

The Australia-wide Terrestrial Ecosystems Research Network (TERN) provides research infrastructure to monitor changes to the environment and climate. This is based on data collected from facilities like the 'SuperSites' that conduct highly detailed environmental monitoring. RIEL researchers from the landscape water and carbon dynamics group manage the Litchfield Savanna SuperSite, which has been operational since 2015 and is located within Litchfield National Park, around 80km south of Darwin, as part of TERN.

The Litchfield Savanna SuperSite is an area that was originally selected in light of long-term monitoring by the Darwin Centre for Bushfire Research (DCBR). It represents northern Australia's dominant ecosystem type, namely a high-rainfall, frequently burnt tropical savanna. Considering the extent of tropical savanna in northern Australia, understanding the impacts of fire on sequestration, vegetation and fauna is a priority of this work. This site is complemented by four other locations across the Top End along a north-south rainfall gradient, all managed by RIEL.

The site's infrastructure includes an eddy-covariance flux tower that monitors carbon sequestration and water use, six surveillance monitoring plots, and soil water content and temperature sensors. Data collection is funded by TERN. The flux station is part of the Australian OzFlux Network and also contributes to the international FLUXNET network that comprises over 600 sites equipped with similar sensor arrays. RIEL's Prof Lindsay Hutley and Matthew Northwood manage the site and ensure site data streams are maintained.

Ongoing work is addressing questions such as how vegetation structure, climate drivers, and fire regime can influence the savanna carbon sequestration rate and water use. In 2022 a highlight was analysing light detection and ranging (Lidar) scans that provide 3D images of vegetation before and after severe fire to provide detailed assessment of fire impacts. This work was published by RIEL PhD candidate Linda Luck, in collaboration with Dr Shaun Levick of the CSIRO.

Partners at the Litchfield Savanna SuperSite are the NT Government, the University of Western Australia, Dr Stefan Maier of maitec and CDU. TERN is supported by the Australian Government through the National Collaborative Research Infrastructure Strategy.

Supporting fire management in southern Africa

Throughout 2022, RIEL's Darwin Centre for Bushfire Research (DCBR) supported Australian nongovernmental organisation the International Savanna Fire Management Initiative (ISFMI) to develop commercial landscape-scale fire management, emissions reduction and sustainable livelihood projects, particularly in southern Africa. Research activities in southern Africa undertaken by the DCBR's Prof Jeremy Russell-Smith and Cameron Yates have focused on fieldwork toward the development of an emissions accounting methodology, in support of the enhanced management of extensive fire-prone miombo woodlands. These woodlands span around 2 million km2, extending from the Democratic Republic of the Congo and Tanzania in the north to Mozambique in the east, Angola in the west, and Zambia, Namibia and Botswana in the south.

As part of the same program, PhD candidate Othusitse Lekoko commenced fieldwork in the Chobe region of northeast Botswana. This project explores the impacts of regional fire regimes on woody biomass and soil organic carbon stocks, utilising permanent monitoring plots established in regional forestry reserves in 1992.

With funding support from Australia's DFAT, RIEL has also assisted the ISFMI to undertake an assessment of savanna fire management and associated carbon market opportunities in Timor-Leste and Papua New Guinea. The program involves Dr Penny Wurm, PhD candidate Acacio Guterres, Dr Andrew Edwards, Dr Peter Jacklyn and Prof Russell-Smith.



An active fire burns in an Australian savanna area. Photo: François Brassard.



A phascogale is released at night during research efforts. Photo: Georgie Neave.

Species spotlight

Enigmatic marsupials observed on Melville Island

The northern brush-tailed phascogale (*Phascogale pirata*) is a small and feisty carnivorous marsupial endemic to the savanna woodland of the NT. It is one of the least studied marsupials in northern Australia.

There have been only two records of the northern brushtailed phascogale on mainland Australia in the last 15 years, despite widespread fauna surveys, including the deployment of remote cameras that would likely detect the species. The species is considered vulnerable under IUCN criteria and, along with other small mammals in northern Australia, has been undergoing declines for the last three decades.

The most significant population of the northern brush-tailed phascogale now exists on Melville Island, Australia's second largest island, which lies approximately 100km north of Darwin in the Tiwi Islands. RIEL researchers have been studying the plight of the Tiwi Islands' small mammals over the last eight years. In 2022, Prof Sam Banks, Dr Teigan Cremona, Dr Hugh Davies, and PhD candidates Georgie Neave and Alex Carey collaborated with the Tiwi Land Rangers to investigate the impacts of fire on these mammals. After three years of mammal trapping on the islands, Ms Neave was delighted to capture a lactating female phascogale for the first time. This was followed by the observation of another female with five baby phascogales.

Given how little is known know about the ecology and conservation status of the species, these observations have provided valuable information to guide future research. The team will conduct further targeted trapping into 2023 to provide more insights into this rare and enigmatic species.



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	Microbiological characteristics		
€	Animal movement and behaviour	Water quality		
Ð	Population dynamics	Effect of human disturbance on aquatic ecosystems		
Some of the key projects and opportunities in this area include:				
Ð	Analysing atmospheric moisture sources, rainfall patterns, groundwater origin and plant water usage	Conducting research on mangrove ecosystems, including restoration and carbon sequestration		
Ð	Using environmental DNA to monitor terrestrial and aquatic species for strategic baseline assessment	Informing conservation and management of threatened marine species, including sharks and rays		
Ð	Assessing environmental water requirements for aquatic ecosystems and sustainable fisheries	Improving aquatic food safety, through microbial risk assessment, in Darwin Harbour		
	management	Identifying key factors to improve pathogen and		
⇒	Conducting the longest running survey of freshwater fish diversity and abundance in northern Australia	nutrient removal to optimise pond technology performance		
Ð	Using new technologies and methodologies for \Rightarrow	Source tracking and analysing the distribution of opportunistic pathogens in drinking and		
Ð	Predicting impacts of climate change on aquatic	recreational waters		

Of the wide range of research being undertaken under this strength, highlights include a groundwater security project and a project on the role of streams in the Australian carbon cycle.

Research highlights

nutrient cycling

Groundwater project involves community in data collection

The Northern Australia Community Groundwater Security Project, supported by philanthropic funding from The Ian Potter Foundation, seeks to increase understanding of the quantity and quality of groundwater resources available to local communities and the environment across northern Australia through community-based data collection and interpretation.

Though groundwater accounts for the vast majority of liquid freshwater on Earth, and is the source of a significant proportion of the water used by humans, it is often considered 'out of sight and out of mind' because it is underground. Access to fresh water for drinking is vital for the existence of towns and remote communities in northern Australia. Water plays an important role in cultural stories and connection to Country for First Nations peoples and is also essential for the cattle industry, mining, agriculture and horticulture. Community concerns include the depletion and contamination of aquifers, and the loss of groundwaterdependent ecosystems, by rapidly developing industries.

This project seeks to 'make the invisible visible' through direct community involvement with groundwater data collection. The remoteness and vastness of the tropical and arid regions of northern Australia means that community engagement is the only way groundwater information can be collected effectively; people power far exceeds the ability to install infrastructure to collect this much-needed water quality data. The use of eDNA to detect stygofauna in the water will also increase the understanding of the distribution of species and will extend the work undertaken previously on this fauna.

The first task of the project was to build a project app and website to enable community members to record groundwater data at their bores and to follow the project results. This collaborative work, involving RIEL's Prof Jenny Davis, Dr Erica Garcia, Dr Dylan Irvine and Roanne Ramsey alongside members of CDU's Energy and Resources Institute, is increasing understanding and knowledge of groundwater across the north and making a valuable contribution to water security.

Improving estimates of carbon storage in Australia

The potential of terrestrial ecosystems to store atmospheric carbon dioxide is likely to be overestimated in Australia. This is because soils tend to leak some of the stored carbon into streams and rivers, where it is eventually returned to the atmosphere—a process that is not integrated into current models.

This means that initiatives that support projects based on their potential to store carbon dioxide in biomass and soils are likely to overestimate offsets. To address this issue, RIEL's Dr Clément Duvert is investigating the role of streams in the Australian carbon cycle, aiming to improve estimates of carbon storage on land.

Understanding the extent and location of carbon storage on land is key to implementing sustainable land management practices that preserve carbon stocks. It also contributes to understanding of the global carbon cycle, enabling predictions about future atmospheric CO2 concentrations and their impact on the climate. Dr Duvert has partnered with international researchers who have led similar activities at the University of Washington in the United States and at the Swedish University of Agricultural Sciences in Europe. He is also working closely with RIEL's Prof Lindsay Hutley and Dr Francesco Ulloa-Cedamanos, along with collaborators from CSIRO and TERN. This ongoing work to determine the amount of terrestrial carbon that leaks into rivers across Australia has received funding from the Australian Research Council.

Species spotlights

Tiny aquatic fauna discovered in NT aquifer

Groundwater fauna, comprising a diverse variety of tiny aquatic animals known as stygofauna—most of which are new to science—have been discovered in the Cambrian Limestone Aquifer (CLA) in the NT.

RIEL's Prof Jenny Davis and Dr Stefanie Oberprieler, together with CSIRO researchers, used novel fishing methods and innovative DNA analyses to sample the groundwaters of the CLA. The team collected samples from 26 groundwater bores spanning approximately 500km, from the subtropical Mataranka region in the north to the semi-arid Barkly Tablelands (Barkly Stock Route) in the south. The largest species found (at nearly 20mm in length), was a shrimp, *Parisia unguis*. This predatory shrimp is at the top of a complex food chain within the aquifer. It was a momentous discovery for researchers given that there are few places left where a whole community of new species can be found.



Dr Stefanie Oberprieler uses a small net attached to a fishing rod to collect stygofauna from an open bore in the Beetaloo region. Photo: Jenny Davis.

The stygofauna of the region are the ultimate climate change survivors, having moved underground as the surface waters of ancient inland Australia dried out. The presence of the same stygofaunal species at widely separated sites across the CLA indicates high subterranean connectivity. As a consequence, further work is needed to quantify the risk of contamination impacts on stygofauna from possible industrial spill events and, more broadly, how groundwater extraction may alter subterranean aquatic habitats. The formal description of at least 12 new stygofaunal species is needed, together with a comprehensive DNA sequence library to enable future monitoring programs to use eDNA metabarcoding.

This work is critical because stygofaunal species, together with the microbial biota, underpin the ecosystem services provided by this groundwater resource. The CLA underlies the Beetaloo region, which has been a focus of the onshore gas industry in the NT. This collaborative project was funded by the Gas Industry Social and Environmental Research Alliance (GISERA).

Powerful predators tracked in northern Australian waters

Billfish, a group of saltwater predatory fishes, are famous for their sword-like facial protuberances as well as their impressive speed and size. They include sailfish, one of the fastest fish in the ocean, and the black marlin, which can reach up to 700kg in weight. Despite their popularity among recreational fishers who typically catch and release these trophy fish, a limited amount is known about the movement and ecology of billfish in northern Australia. That lack of knowledge prompted a research project led by Dr Keller Kopf with PhD candidate Matt Hammond—who has received a PhD top-up from the Australian Institute of Marine Science (AIMS) to support the project—working in collaboration with citizen scientist recreational fishers, the Department of Industry Tourism and Trade, AIMS, the Amateur Fishermen's Association of the Northern Territory (AFANT) and fisheries ecologists.

The powerful fish are not only very difficult to hoist onto a boat for monitoring purposes, but are difficult to catch at all as they are known to rarely take an interest in fishers' bait. Nevertheless, with northern Australian waters thought to be abnormally productive for certain billfish, researchers are aiming to learn more about the movement of these highly migratory predators, some of which are considered vulnerable species.

The team began tracking billfish using both acoustic tags and satellite tags in 2022, with work set to continue in the coming years. Over time, the research will contribute to global knowledge on billfish, and is expected to help inform decision making in the recreational fishing and tourism space in northern Australia.



A sailfish is tagged and released off the Top End coast in 2022. Photo: Bomber Farrell.

Cattle are pictured at CDU's rural campus in Katherine, NT.

Tropical agriculture and biosecurity

The Research Institute for Northern Agriculture (RINA) was established at CDU in 2022 and is hosted by RIEL to develop research capability in agriculture, aquaculture and biosecurity in northern Australia.

As a partnership with industry, NT Government and CDU partners, supported by the Australian Government Department of Education, RINA will foster a greater focus on agricultural research in the NT that supports the growth agenda of the broader industry, including First Nations enterprises, and sustainable development.

This initiative aims to help northern Australia realise its potential as a food production heartland in the Asia-Pacific region. The NT is one of the most dynamic and untapped resources for Australia to grow its agricultural industry, but the region needs specialists with the expertise and leadership to turn this potential into opportunities. At present, a strong southern bias in agricultural research means that many advantages and opportunities of northern Australia's agricultural future are yet to be fully discovered.

RINA works with stakeholders to identify risk and adapt innovation from knowledge banks located around the globe for the unique northern Australian environment. The institute will help to evaluate opportunities in markets, ensure a resilient supply chain, and look for value adding opportunities for rural communities. RINA is working to transform northern Australia's agricultural future by finding innovative opportunities to exploit the NT's competitive advantages. The institute's research capabilities cover aquaculture, biosecurity, grazing sustainability and broadacre cropping.

Aquaculture

Aquaculture in northern Australia is growing rapidly in volume and value while also expanding into new species, including Indigenous-led developments.

Biosecurity

Northern Australia is recognised as a high-risk zone for the introduction of exotic pests and pathogens, due to its vastness, remoteness and high vulnerability.

Grazing sustainability

The NT's beef industry is worth \$1.2 billion, and employs 10,000 people directly and indirectly throughout the supply chain.

Broadacre cropping

The cropping sector in northern Australia has huge potential but faces unique challenges. Unlocking cropping opportunities in the north should address key issues like water availability, soil sustainability, transport logistics and land tenure policy.

This rainforest creek in Far North Queensland is one of the sites in an ongoing project looking at the role of streams in the carbon cycle. Photo: Clément Duvert.

RIEL consultancy services

RIEL is known across the NT for offering high-quality consultancy services relating to the environment and livelihoods. This includes training as well as expert advice and review. Organisations are able to commission research, training or reviews from RIEL.

The provision of these services not only delivers strong outcomes for organisations, but also continues to build local capacity in research and contributes to a greater understanding of the ecosystems of northern Australia.

RIEL consultancy service centres include:

Darwin Centre for Bushfire Research

The Darwin Centre for Bushfire Research (DCBR) delivers applied fire management research and training opportunities to land managers in northern Australia, Asia and southern Africa. The centre focuses on the development of scientifically based savanna burning carbon emissions reduction from carbon abatement and sequestration projects, through field sampling, analysis and methodology development.

Environmental Chemistry and Microbiology Unit

The Environmental Chemistry and Microbiology Unit (ECMU) is a high-impact research consultancy aimed at protecting the natural assets that underpin the economy of the NT. The unit specialises in metal, stable isotope, microbiological and molecular analyses in aquatic and terrestrial environments, including analyses of sediment, water and biota. The ECMU has provided specialist chemistry and microbiology services to government, councils, industry, individuals, researchers and students for over 25 years.

Aboriginal Research Practitioners Network

The Aboriginal Research Practitioners Network (ARPNet) is a platform for community-based First Nations peoples involved in participatory action research, evaluations and planning. First Nations research practitioners have developed a new research practice and toolbox to undertake research in culturally appropriate ways without losing scientific rigour and depth. ARPNet research practitioners offer their services to work in partnership with other research groups or individuals on projects across Arnhem Land. The network also provides cultural training to researchers working on Country as well as training in participatory action research. Other consultancy services delivered in 2022 included:

\rightarrow	Blue carbon
\rightarrow	Feral animal management
\rightarrow	Biodiversity assessment
\rightarrow	Diversified farming systems
\rightarrow	Remote environmental monitoring
\rightarrow	Vegetation mapping and analysis
\rightarrow	Genetics and environmental DNA



PhD student Zarah Tinning works on Blacklip Rock Oyster tissue as part of an FRDC-funded project awarded to RIEL's ECMU. Photo: Cynthia Coyne.

RIEL partners

RIEL collaborates and engages with a wide range of partners across government, First Nations, industry, non-profit, community and research organisations. Of the many, some key examples include partnerships with the Arafura Swamp Rangers Aboriginal Corporation and with the Northern Territory Government.

Arafura Swamp Rangers Aboriginal Corporation partnership

The Arafura Swamp Rangers Aboriginal Corporation (ASRAC) is an Indigenous ranger group that brings together traditional Indigenous knowledge and Western scientific knowledge to look after Country across inland, freshwater and swamp areas.

RIEL is one of the partners that ASRAC works with to carry out this work. Both ASRAC and RIEL have accessed each other's expertise over the course of many years and projects. Currently, one such example is a RIEL PhD project investigating the impacts of feral water buffalo on the culturally significant northern long-necked turtle.

RIEL and ASRAC are also working together on establishing future opportunities including a spatial information system to support and enhance monitoring of biodiversity outcomes and ways to further saltwater crocodile research on Gurruwiling (the Arafura Swamp), which is one of the key breeding areas for the species in the NT.

CDU and Northern Territory Government Partnership Agreement

The CDU and Northern Territory Government (NTG) Partnership Agreement provides the framework for a cooperative and collaborative relationship to support the economic, social and environmentally sustainable development of the NT.

RIEL represents CDU on a Natural Resource Management collaboration committee and Primary Industries collaboration committee under the Partnership Agreement. These committees serve to identify common strategic objectives for research and workforce development in natural resource management and primary industries through developing jointly supervised PhD projects, identifying complementarity in resources and capability for major research projects and collaborating on funding applications to develop new programs and capacity in the NT.

The partnership has been in place for almost two decades, since 2003. It is periodically renewed and updated, with the current agreement covering the period of 2017 to 2024.



Mali Djarrbal, David Bidingal, Peter Guyula and Sammy Guyula, members of the Arafura Swamp Rangers Aboriginal Corporation team, assess the extent of swim channels caused by feral water buffalo on Gurruwiling (the Arafura Swamp). Photo: Helen Truscott/ASRAC.

RIEL alumni and students



Supporting agricultural development in Timor-Leste Dr Odete Guterres

Dr Maria Odete do Céu Guterres is a senior professional at the Timor-Leste Ministry of Agriculture and Fisheries with almost 20 years of experience. In her role as Director General of Agriculture, Dr Guterres is responsible for the direction and development of the agricultural sector in the country, including crop production, horticulture, irrigation and extension services.

She is also a CDU alum, having graduated from a Master of Tropical Environmental Management in 2010 and a PhD in Environmental Science and Agriculture in 2019. Dr Guterres' PhD, titled *Systems for the development of an organic cashew industry in Timor-Leste*, was supervised by RIEL's Dr Renkang Peng, along with cosupervisors Prof Keith Christian and Dr Penny Wurm. The project looked at opportunities to develop organic cashew crops in Timor-Leste and the potential for increased agricultural income and empowerment of cashew farmers.

In 2022, Dr Guterres was awarded a Meryl Williams Fellowship from ACIAR—a prestigious fellowship that supports female agricultural researchers across the Indo-Pacific, contributes to more secure food systems and drives institutional progress toward gender equity. Dr Guterres has chosen CDU as the host university for her upcoming placement as part of the fellowship.

Dr Guterres continues to work on high-level issues impacting agricultural development and local communities, and to coordinate efforts with international development partners in the sector.



Exchanging knowledge in Timor-Leste and the NT Jenny House

Supported by the Crawford Fund, PhD candidate Jenny House in 2022 coordinated a weeklong knowledge exchange in which eight marine management practitioners from Timor-Leste visited RIEL.

The exchange was part of an ongoing research collaboration between CDU and Blue Ventures Timor-Leste on community-based marine management, particularly focusing on women's participation in fisheries monitoring and management. Blue Ventures is a marine conservation organisation that works to support coastal fishers, while Ms House's PhD research looked at gendered participation in fisheries management and monitoring in Timor-Leste.

The unique program covered everything from technical ecological and scientific skills to stakeholder engagement, self-determination and social science. It was a busy week of learning and relationship building activities with numerous researchers, citizen scientists and other natural resource and marine management practitioners in Darwin. Participants also presented their work on fisheries, livelihoods, conservation, and their Communities First approach.

Blue Ventures' work on participatory marine management and monitoring and sustainable livelihoods proved highly relevant for NT researchers and practitioners during the knowledge exchange. Likewise, the Timor-Leste contingent found it valuable to meet with experts and researchers who shared similar values in conservation and collective action.



Identifying opportunities for innovation in fishbased livelihoods Dr Kim Hunnam

Dr Kim Hunnam is a CDU alum who completed her PhD, titled *Small pelagic fisheries in tropical food systems: strengths, challenges and opportunities for Timor-Leste's small-scale sardine fishery,* at RIEL under the supervision of Prof Natasha Stacey as well as Dr David Mills of WorldFish.

The PhD project investigated a sardine-dominated fishery in Timor-Leste with the aim to identify its strengths, challenges and potential opportunities for enhancing local livelihood, nutrition and food-security outcomes. The research found that the fishery comprised over eight species of sardine, for which fishers had different names and knowledge. Where seasonally large catches occurred, typically near mouths of larger rivers, the fishery provided a seasonally important source of household income, nutritious food for domestic consumption, as well as diverse non-material outcomes for household and community wellbeing. Overall, the work identified numerous strengths of the fishery that provide good opportunities to enhance its role in the broader local food system and address existing challenges—such as fishers' concerns for future sustainability.

Building on knowledge, skills and networks developed through her PhD, Dr Hunnam moved into a postdoctoral fellow position at WorldFish, hosted at the University of Wollongong. The role is part of a team implementing an applied research project on fish-based livelihoods in Timor-Leste and Solomon Islands, funded by ACIAR. The project seeks to identify opportunities for innovation in fish-based livelihoods in rural communities and to guide government agencies to better support community-led initiatives for rural development.

Dr Hunnam regularly spends time in both countries working with colleagues on various project activities. This has included setting up research on fish trading in Baucau and Lautem municipalities in Timor-Leste and reviewing past fish handling training in Malaita Province in Solomon Islands.



Blue Ventures Timor-Leste knowledge exchange program participants and RIEL students and staff are pictured following presentations by Dedy Martins and Jenny House as part of the RIEL Seminar Series 2022.

RIEL outreach and engagement

In 2022, RIEL conducted a range of outreach activities including participating in conferences and events, producing stakeholder newsletters and hosting the RIEL Seminar Series. RIEL researchers were also well-represented in the media, providing expert comment on environment and livelihood related topics.

RIEL's quarterly external newsletter, which was distributed to a list of more than 500 stakeholders in 2022, was an effective means of outreach that led to further interest in RIEL publications and stories. The newsletters were successful in drawing attention to key publications to which RIEL researchers contributed, including in academic journals such as *Nature, Science, Ecology and Evolution* and *Diversity and Distributions*. The newsletter also proved effective in promoting interest in stories developed by the CDU Newsroom on subjects including groundwater, native rice and magpie geese.

The RIEL Seminar Series, meanwhile, regularly brought together students, staff and other stakeholders, and served as a forum for sharing research progress and showcasing learnings. The 2022 series comprised 20 different presentations between January and November. Of these, 10 presentations were given by RIEL members, and 10 sessions were presented by representatives of organisations such as the CSIRO, Charles Sturt University, Griffith University and TERN, among others.

In one such seminar, RIEL's Dr Benjamin Brown presented on the results of a mangrove forest landscape rehabilitation opportunity assessment in Indonesia. In another seminar, representatives from Blue Ventures Timor-Leste highlighted work on community-based marine management, ecological monitoring and coastal livelihoods, while later in the year CDU's Dr Guzyal Hill presented on aligning research for public policy impact. Each seminar was open to the public, and most seminars were available both in person and online.



Research vessels and vehicles are seen at CDU's Casuarina Campus during Open Day 2022, one of several events at which RIEL was represented over the year.

RIEL also saw strong media engagement over the year, recording more than 200 articles or broadcasts mentioning the institute specifically, as reported by CDU's Media, Marketing and Communications team. Examples of key stories included "Thousands of new ant species discovered in Australia", "Native rice one step closer to appearing on restaurant menus" and "Research institute seeks experts to protect and grow Northern Australia's agriculture".

Notably, the Media, Marketing and Communications team also recorded a significant amount of media coverage highlighting the work of individual RIEL researchers. For instance, research from Dr Janine Abecia, who was awarded her PhD in late 2022, reached a potential audience of over 238 million readers across three continents. This was driven by coverage in *The New York Times* of Dr Abecia's work on mouth-brooding fishes, particularly male *Glossamia aprion*—known as the mouth almighty—that can use their mouths to carry hundreds of babies.

Similarly, research conducted by Dr Mariana Campbell and Prof Hamish Campbell on the diet of NT saltwater crocodiles reached an estimated 404 million readers around the world through outlets that included ABC Online, Channel 9 News, *Smithsonian Magazine* and *The Guardian*. The work suggested that the diets of these crocodiles are shifting away from marine prey in favour of animals such as buffalo and feral pigs, which has coincided with a sharp increase in crocodile numbers in the NT over recent decades.

Another example was research carried out over the year by Prof Stephen Garnett, which was mentioned in at least 158 media articles, collectively reaching a potential audience of over 505 million readers. In particular, Prof Garnett and PhD candidate Anthony Albrecht's work on the *Songs of Disappearance* album, which showcased the calls of threatened bird species in Australia, received worldwide attention through outlets such as *The New York Times*, National Public Radio in the United States and News18 in India.

An unsealed road stretches into the distance in West Arnhem Land. Photo: Allyson Malpartida.



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

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