TropWATER

Centre for Tropical Water and Aquatic Ecosystem Research

REPORT 2014–15

JAMES COOK UNIVERSITY
AUSTRALIA

TropWATER

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Cultural acknowledgement

TropWATER wishes to acknowledge the Australian Aboriginal and Torres Strait Islander peoples as the Traditional Owners of the lands and waters where we operate our business. We honour the unique cultural and spiritual relationship to the land, waters and seas of First Australian peoples and their continuing and rich contribution to James Cook University and Australian society. We also pay respect to ancestors and Elders past, present and future.

Disclaimer

Report compilation: Ian McLeod, Agnès Le Port, Susan Lesley and Damien Burrows.
Report design: Tony Cowan, Zephyrmedia.
Cover Photo: A juvenile Krefft's river turtle rests on a lily pad in Ross River, Townsville. Photo: Dr Matt Curnock, Tethys Images.

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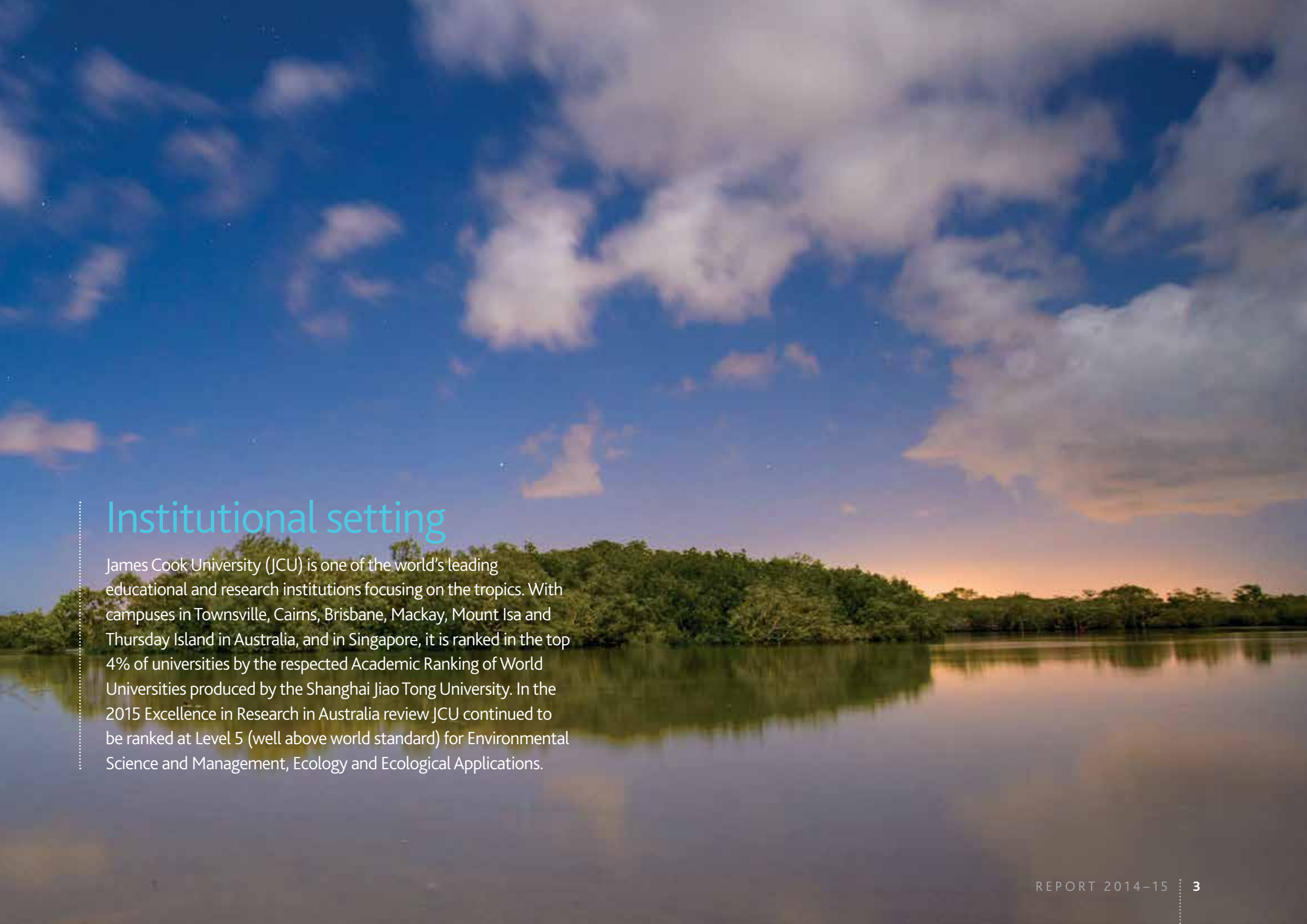
Solutions for Communities, Government and Industry

Who we are

TropWATER – The Centre for Tropical Water and Aquatic Ecosystem Research, is an amalgamation of aquatic expertise from across James Cook University. It brings together over 130 research and support staff and 63 post-graduate students. TropWATER provides a unique opportunity for multidisciplinary research activities by integrating JCU's aquatic expertise into one cohesive research group, which covers the full spectrum of freshwater, estuarine and marine waters, with expertise from ecology, water quality, hydrology, engineering, physics, oceanography, modelling and resource economics.

Our mission

TropWATER aims to conduct influential research in fields related to water science, resource management and the ecology of water ecosystems, with a special focus on achieving sustainable use of water resource systems and water ecosystems. Our overall goal is to secure the future of water ecosystems and maintain their critical functional processes. Our Centre has a strong, but not exclusive, focus on tropical water systems, both in Australia and internationally. It is concerned with major issues in water science, including water resources, water quality and aquatic biodiversity, in relation to economic, social and environmental needs, constraints and change.



Institutional setting

James Cook University (JCU) is one of the world's leading educational and research institutions focusing on the tropics. With campuses in Townsville, Cairns, Brisbane, Mackay, Mount Isa and Thursday Island in Australia, and in Singapore, it is ranked in the top 4% of universities by the respected Academic Ranking of World Universities produced by the Shanghai Jiao Tong University. In the 2015 Excellence in Research in Australia review JCU continued to be ranked at Level 5 (well above world standard) for Environmental Science and Management, Ecology and Ecological Applications.

From the Director

It is with great pleasure that I introduce the second report of the Centre for Tropical Water and Aquatic Ecosystem Research (TropWATER). Although re-organised in 2012, TropWATER's core operations are embedded in a long history stretching back to 1987. TropWATER originally focused upon freshwater ecosystems but has since expanded into estuarine, seagrass and coastal marine ecosystems, which, when combined, now form a larger part of our operations than does freshwater.

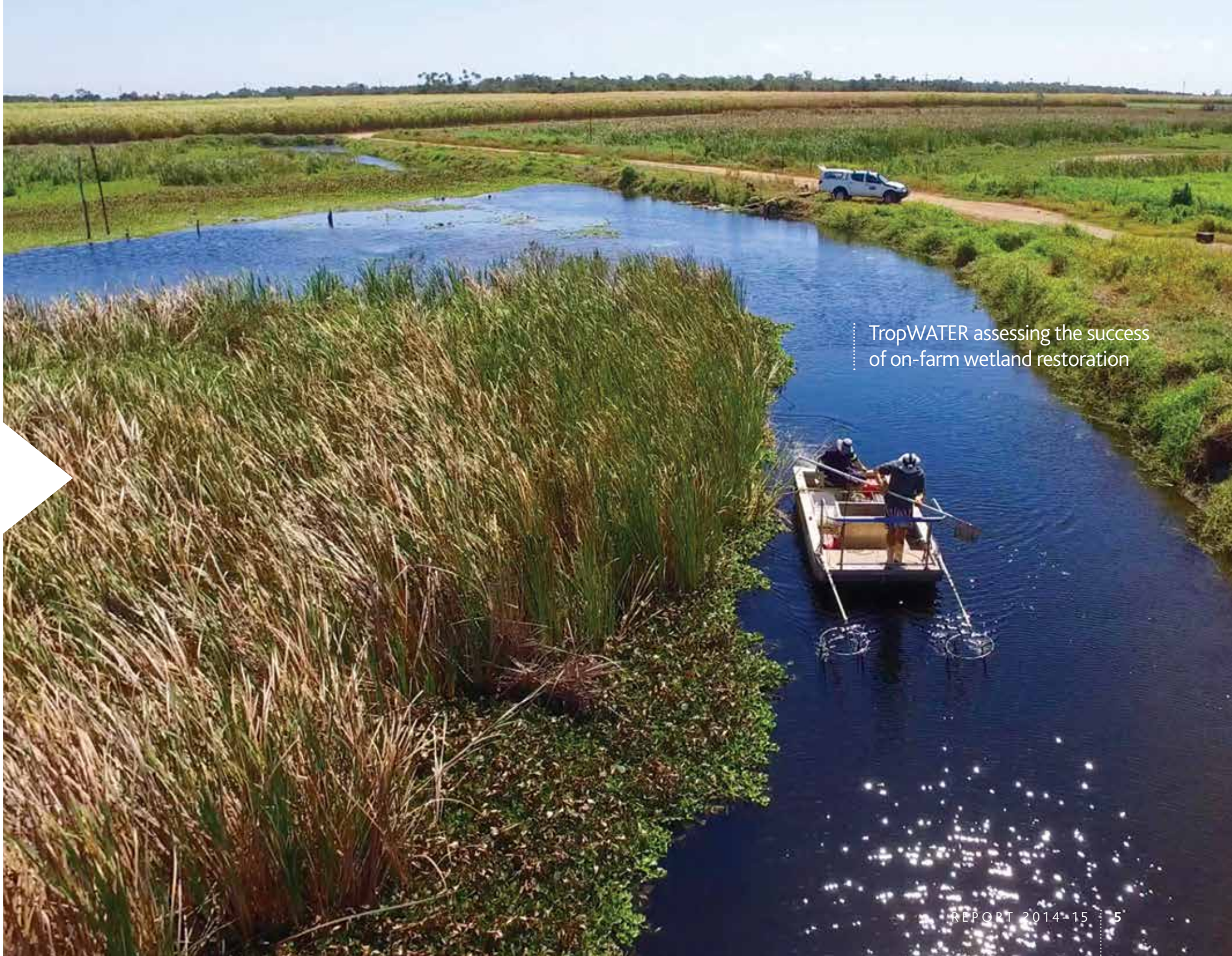
TropWATER brings together all the aquatic expertise spread across various research and teaching units at JCU into one cohesive research group. Thus, TropWATER consists of staff that are employed directly by the Centre and staff who are employed in other (mostly teaching) units at JCU. The long-established core unit has been maintained as a separate financial and research entity under the TropWATER umbrella. Currently there are more than 80 staff employed directly by TropWATER and 50 members from various other JCU units. In addition, 63 postgraduate students are affiliated with TropWATER.

Despite the long history and recent restructure, TropWATER still adheres to its original philosophies of providing solution-oriented knowledge services for northern Australia; creating research outputs from non-traditional funding sources; and building regional capacity for scientific expertise. Our longevity, breadth of capacity and ability to expand into new research areas can be attributed to our success in attracting industry and other sources of non-traditional research funding. This is testament to our long-held view that diversifying our sources of research funding will provide long-term viability. Attracting such funding comes from being very well connected with the needs and requirements of stakeholders and clients and takes a dedicated effort to establish and maintain the necessary professional relationships.

In what are very testing times for tertiary institutions and research providers, I believe our continued strong performance and growth is testament to our well-established reputation in delivering practical applied outcomes to a wide range of clients (government, industry and community) that provide this non-traditional funding. Dedication to our original founding mission of being a provider of knowledge, and both basic and translational research to northern Australia, has proved a reliable long-term strategy.

Whilst our growth as a Centre has been very pleasing, I am most pleased at the breadth of topics that TropWATER now covers. We are approximately equally well spread across freshwater, estuarine and nearshore coastal ecosystems and many of our projects and staff work across this continuum. Equally pleasing is the spread we have achieved across ecology, chemistry, hydrology, oceanography and socio-economic sciences, again with many staff straddling these disciplines, breaking down boundaries. I hope this report can do justice to the true breadth and impact of our work, and our degree of connectedness to the groups we partner with, in tropical Australia and more broadly throughout the tropics internationally.

Professor Damien Burrows
Director of TropWATER and Team Leader of the Freshwater Ecology Group



TropWATER assessing the success of on-farm wetland restoration

People

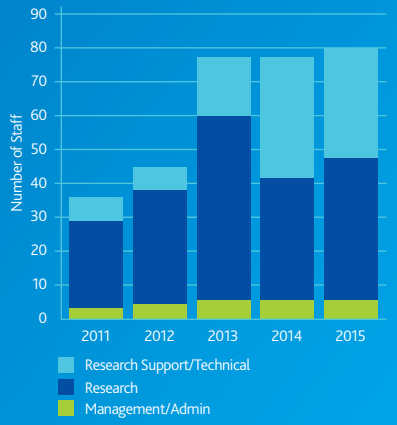
TropWATER staff and members collaborate and work in many locations around the world

The map shows research collaborations by institution from the past 7 years.

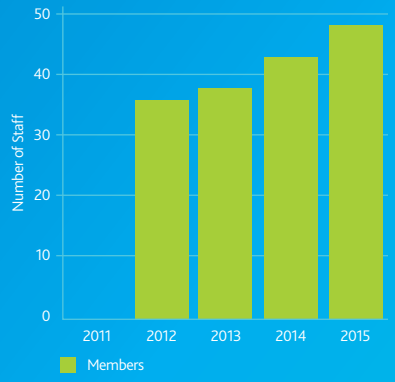
Note: Map points are indicative of the countries or states that institutions are associated with.

Most TropWATER staff are based at the new spacious and modern Australian Tropical Sciences and Innovation Precinct (ATSIP) on JCU's Townsville Campus. This building sees us co-locating with CSIRO and includes a custom-built aquarium complex and a state of the art water quality laboratory. Nearly 30 staff are based at JCU's Cairns Campus, where our seagrass research group and laboratory is located.

TropWATER Staff 2011–2015



TropWATER members 2011–2015



TropWATER Staff 2014–15

Director

Professor Damien Burrows

Principal Research Scientists

Mr Jon Brodie
Mr Barry Butler
Dr Rob Coles
Dr Norm Duke
Professor Bradley Pusey
Dr Michael Rasheed
Dr Jim Wallace
Dr Eric Wolanski

Senior Research Scientists

Mrs Katie Chartrand
Dr Catherine Collier
Dr Aaron Davis
Dr Michelle Devlin
Dr Brendan Ebner
Dr Cassie James
Dr Jessie Jarvis
Dr Stephen Lewis
Mr Len McKenzie
Dr Jane Mellors
Dr Thomas Stieglitz
Dr Shelley Templeman
Dr Paul York
Dr Nathan Waltham
Ms Jane Waterhouse

Research Scientists

Dr Zoe Bainbridge
Mrs Catherine Bryant
Ms Alex Carter
Dr Faye Christidis
Dr Eduardo Da Silva
Miss Jaclyn Davies
Dr John Dowe
Dr Roger Huerlimann
Dr Agnès Le Port
Mr Jock Mackenzie
Ms Skye McKenna
Dr Ian McLeod
Dr Dominique O'Brien
Dr Damien O'Grady
Dr Caroline Petus
Mr Jason Schaffer
Ms Naomi Smith
Dr Susan Sobtzick
Miss Helen Taylor
Dr Colette Thomas

Adjunct Scientists

Dr Kathy Burns
Dr Jennifer DeBose
Mr Colin Creighton
Professor Jon Kovacs
Dr Judd Kenworthy
Mr Emre Turak

Technical Officers

Mr Jaap Barenrecht
Ms Kathryn Berry
Mr Tory Chase
Mr Michael Civiello
Mr David Clarke
Mrs Caroline Coppo
Mr James Donaldson
Miss Kerri-Lee Dyer
Dr Marnie Freckelton
Ms Annegret Jaeppelt
Mr Brandon Jarvis
Ms Louise Johns
Mrs Basiita Komugisha
Mr Lucas Langlois
Ms Jessica Leech
Mr Paul Leeson
Mr Mark Leith
Ms Jane Lloyd
Miss Kelsey Miller
Mr Glenn Morgan
Miss Tansyn Noble
Miss Alana O'Brien
Mr Colton Perna
Mr Trent Power
Mrs Carissa Reason
Miss Tonia Sankey
Ms Emma Scott
Mr Lloyd Shepherd
Mr Tony Squires
Ms Alysha Sozou
Mrs Maria Suarez Duque
Ms Zoe Tasker
Ms Sarah Toxward
Miss Samantha Tol
Mr Dieter Tracey
Mr Steven Vandervalk
Miss Alice White
Mr Adam Wilkinson
Mr Christopher Williams
Ms Apanie Wood
Mr Rudi Yoshida
Ms Rahel Zemoi

Water Quality Laboratory

Mr Patrick Cunningham
Miss Fiona Small
Miss Tara Tangney
Mrs Michelle Tink

Management/Administration

Mrs Tricia Boyd
Ms Susan Lesley
Dr Agnès Le Port
Dr Ian McLeod
Ms Karen Wood

Members

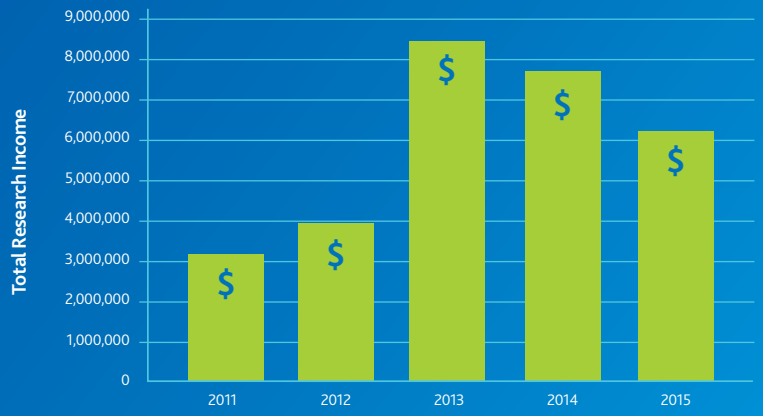
Dr Katya Abrantes
Associate Professor Ellen Ariel
Dr Ronald Baker
Dr Adam Bennett
Dr Adrian Bass
Ms Martha Brians
Ms Amanda Buckland
Dr Taha Chaiechi
Dr Bithin Datta
Professor Rocky de Nys
Dr Amy Diedrich
Dr Jose Domingos
Professor Lynne Eagle
Dr Richard Faulkner
Associate Professor Mark Hamann
Dr Julia Hazel
Dr Neil Hutchinson
Ms Jasmine Jaffres
Professor Dean Jerry
Mr Ross Johnston
Dr Karen Joyce
Dr Jud Kenworthy
Professor John Kovacs
Dr Rebecca Lawton
Dr HanShe Lim
Professor Wenxian Lin
Professor Helene Marsh
Mrs Rachael MacDonald
Mr Simon MacDonald
Dr Niels Munksgaard
Associate Professor Paul Nelson
Ass. Professor Michael Oelgemoeller
Dr Nicholas Paul
Dr Murray Prideaux
Associate Professor Wayne Read
Professor Peter Ridd
Mr Michael Santarossa
Dr Phil Schneider
Dr Janine Sheaves
Professor Marcus Sheaves
Associate Professor Scott Smithers
Professor Natalie Stoeckl
Professor Ninghu Su
Dr Sizhong Sun
Dr Anne Swinbourne
Dr Ariella van Luyn
Dr James Whinney

Income

TropWATER is comprised of over 80 directly employed staff and nearly 50 members who are employed through other JCU organisational units. See the 'From the Director' section for further details.

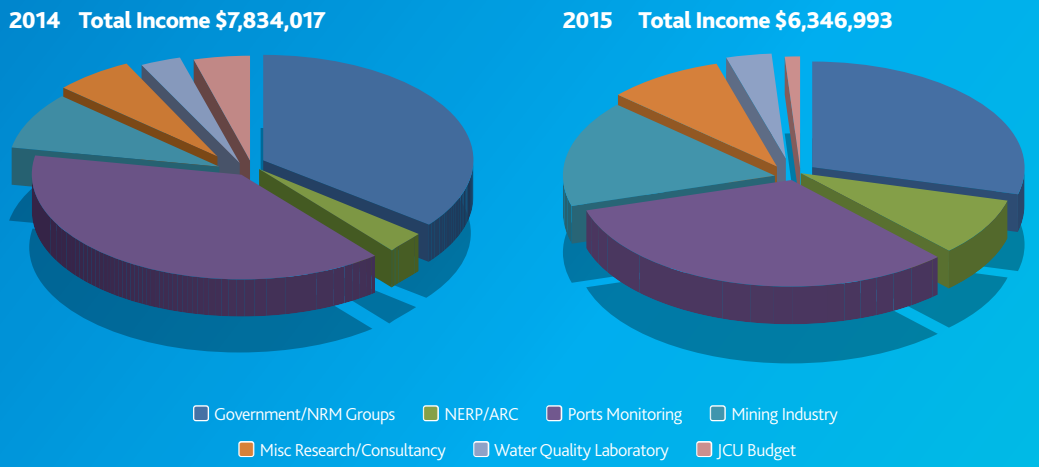
TropWATER research income

TropWATER staff research income



TropWATER member research income

TropWATER staff research income by category



TropWATER headquarters Townsville

2014–15 Highlights

Projects

- TropWATER Director Professor Damien Burrows was appointed as the Hub Leader for the National Environment Science Programme (NESP) Tropical Water Quality Hub. This 6-year $32-million-dollar research programme focuses on improving the water quality of the Great Barrier Reef and its catchments. Damien is also a member of the Federal Government Independent Expert Panel for the Great Barrier Reef.
- We grew our international presence with projects in 22 countries; Indonesia, Papua New Guinea, New Zealand, Germany, Palau, Tonga, Samoa, Fiji, Solomon Islands, Guyana, Mexico, France, Nepal, Laos, Maldives, China, Palau, Belgium, Vietnam, Nigeria, Thailand and Australia.
- We leveraged our core strength of understanding the ecology and dynamics of coastal systems to show leadership in the growing field of coastal repair by providing expert advice and input into coastal wetland restoration projects, and running a workshop and special session on marine restoration at the Australian Marine Science Association conference in 2015. Our researchers continue to publish strongly in this field.
- In 2015 our seagrass scientists in partnership with Deakin University coordinated a workshop involving over 30 of Australia's key researchers to identify gaps in our seagrass research knowledge.
- TropWATER's Mangrove Watch program – a community-science partnership, has expanded considerably. We have undertaken extensive mangrove and coastal health assessments in 7 countries (Vietnam, Tonga, Samoa, Fiji, Vanuatu, Solomon Islands and New Caledonia) as well as conducted training courses on this methodology in Thailand, India and the USA. Within Australia, we have applied this approach to >10,000 km of shoreline across Queensland, the Northern Territory and Western Australia, working with numerous government, community, industry and Indigenous groups in delivering the program.
- We continued our long-standing monitoring of seagrass meadow health around most Queensland ports. Many of these meadows have been monitored for more than a decade providing an invaluable dataset on long-term trends and changes. This research not only delivers key environmental information for the management of port activities but has also resulted in significant advances in the science and knowledge of tropical seagrass ecology.
- We performed a range of services for several major mining and refinery operations in northern and western Queensland. These services included water quality analyses and field studies, monitoring the health of aquatic communities around mines and refinery sites, and analyses of stream sediments. Such activities not only assist with environmental monitoring obligations, but also provide valuable scientific data in remote areas where such data are scarce.
- Developing northern Australia has become a leading political and social issue in recent years. Having worked on applied environmental issues in northern Australia for 30 years, we are well placed to be contributing to this debate. Many of our projects have a strong focus on reducing and managing irrigation development, expected to be a key feature in northern development. Additionally, we are major knowledge-providers to the mining and ports industries, covering the full spectrum of habitats from catchment to coast.
- We have continued to play a leading role in reducing runoff of herbicides and pesticides to coastal ecosystems and the Great Barrier Reef. Advances in the 2014-2015 period included improved monitoring techniques of herbicide presences in creek and wetland systems, and use of precision agriculture approaches to reduce herbicide losses from cane farms. Several of these studies continue to influence State and Federal Government policy. Our staff also played key editorial or authorship roles in a recent multidisciplinary journal Special Issue in the Journal of Agricultural and Food Chemistry dedicated to better understanding of pesticide behaviour and management in tropical environments.
- We continued to provide expert advice and fill critical knowledge gaps in regard to the health of the Great Barrier Reef, in particular tracing the sources of pollutants (sediments, nutrients, pesticides, microplastics, pharmaceuticals, other industrial chemicals) from different land uses (i.e. cattle grazing, sugar cane, horticulture and urban) within catchments.
- TropWATER has increased expertise in stormwater management through the use of water sensitive urban design features such as rain gardens and green roofs which play a crucial role in purifying urban runoff, reducing runoff volumes and restoring natural hydrologic processes. A recent TropWATER review paper focused on practices in Singapore in the Journal of Hydrology provides a summary of such practices in the tropical city state with implications for practices of other tropical sites facing similar issues related to high intensity rainfall and temperatures.
- We are a major research provider in the Torres Strait, working on a wide range of projects covering seagrass ecology, dugong and marine turtle management, mangrove and coastal health, marine water quality, shipping risks, freshwater habitats, invasive fish and Indigenous ranger monitoring programs.

Publications

- TropWATER researchers continued to publish strongly with over 400 journal articles in 2014 and 2015 (including over 150 by TropWATER staff), and over 90 technical reports and other publications.
- Eric Wolanksi's book 'Estuarine Ecohydrology: An Introduction' was launched. The ecohydrology concept recognizes that the estuarine ecosystem health is driven by links between the biology and the physics, that human activities in the entire catchment need to be considered, and that the best course of action is to manipulate the system to reinforce its ability to cope with human stresses.
- Norm Duke produced the The World Mangrove App 'Mangrove ID', a botanical guide providing more than 800 images and botanical descriptions of all 85 mangrove species found worldwide.
- Kathryn Burns wrote her memoir 'Science and sails: memoir of a pioneer woman oceanographer in a changing world.'
- Eric Wolanski wrote a book 'Estuaries of Australia in 2050 and Beyond'. This book is a synthesis of iconic Australian estuaries and bays by eminent Australian scientists.
- Rob Coles was the lead author of a review paper 'Twenty years of seagrass networking and advancing seagrass science'.
- Kathryn Berry's paper 'Microplastic ingestion by scleractinian corals' was named as a Springer Top Mentioned Article in 2015.
- Shelly Templeman contributed to the State of the Tropics report launched in 2014 by Nobel laureate Aung San Suu Kyi.

Awards

- Helene Marsh was elected as a Fellow of the Australian Academy of Science. This appointment recognises her research excellence as one of Australia's leading scientists.
- TropWATER Director Damien Burrows was awarded the prestigious James Cook University 2014 Award for Excellence in Leadership in recognition of his vision and the leadership shown while building up TropWATER.
- Rocky de Nys and Nick Paul received a United Nations Association of Australia World Environment Day Award for their ground-breaking research into using algae to treat wastewater.
- Zoe Bainbridge was awarded her PhD *cum laude* and received the University medal.
- Amelia Wenger, Marina Farr, Manish Kumar Jha and Ruth Kamrowski were named on the JCU Dean's list for producing outstanding PhD theses.
- Max Burns was a winner of the National Science Communication Challenge in 2015 and received the TropEco Excellence Award for students in 2014.
- Ellen Ariel and Amy Diedrich received JCU Teaching and Learning Awards in 2015.
- Jennifer Gilbert received a Pride of Australia Medal for her research and work on turtle conservation.
- Aaron Davis received a Smithsonian Fellowship to study the impact of fertilisers on the Great Barrier Reef, in the USA.
- Michael Oelgemoeller was awarded second place in the JCU Reperio Competition.

Rocky de Nys (left) and Nick Paul (right) accepting their UN Award

Research Themes

Our research portfolio covers areas from freshwater to coastal marine waters, from biological communities to water quality and physical process, as well as socio-economic systems underpinning our management of natural resources. In order to demonstrate the diverse research areas of the Centre, these are aligned into eight research themes.

Freshwater Ecology

Management of agriculture, mining and water extraction impacts on freshwater ecosystems, including habitat protection, wetland restoration and invasive species.

Coastal and Estuarine Ecology

Tropical estuaries, coastal wetlands and near-shore ecosystems, and approaches to their protection and repair.

Seagrass Ecology

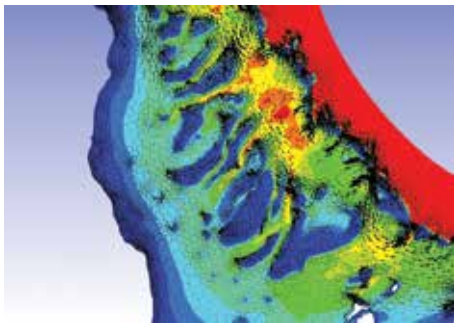
Monitoring and applied research of tropical seagrass ecosystems with a focus on advising management agencies responsible for coastal development and port management.

Catchment to Reef Processes

Tracing the sources of pollutants (sediments, nutrients and pesticides) from different land uses, measuring their impact on aquatic habitats such as mangroves, seagrass and coral reefs and providing management solutions to reduce their losses and impacts.

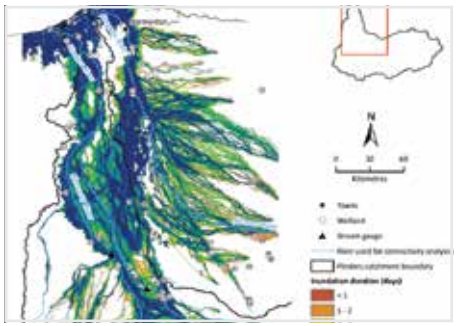
Water Quality, Mining and Contaminants

Management of water quality in agricultural and industrial settings. Modelling of surface and groundwater contaminant transport.



Oceanography

Physical oceanography of the Great Barrier Reef and tropical estuaries. Developing high-tech, low cost monitoring tools.



Hydrology

Sustainable use of surface and groundwater resources. Measuring effects of hydrological processes on aquatic ecosystems and detecting surface-groundwater interactions.

Socio-economic Systems

Interactions between people and aquatic systems. Engaging with local communities to learn more about the way in which people affect and are affected by their environment.

Key Partnerships

National

Australian Institute of Marine Science (AIMS)

TropWATER and AIMS staff have many research collaborations on the impacts of natural and human-related activities on marine, coastal and catchment environments.

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Collaborations with CSIRO include assessing the environmental implications of proposed agricultural development along the Flinders and Gilbert waterways in the Gulf of Carpentaria and treating pollutant run off to GBR catchments.

Department of Environment (DoE)

TropWATER's DoE funded research activities include climate change and human related factors which may have an impact on the GBR and aquatic waters in northern Australia.

Great Barrier Reef Marine Park Authority (GBRMPA)

Supports TropWATER research which assesses and monitors the impacts of land management practices on water quality and marine ecosystem health in the Marine Park.

Reef and Rainforest Research Centre (RRRC)

Provides TropWATER support for NESP funded research programs in PNG, the Torres Strait, northern Australia and the Great Barrier Reef catchment and estuarine wetlands.

Indigenous groups

The Mungalla Aboriginal Corporation, Balkanu Cape York Development Corporation, Yarrabah Aboriginal Shire Council, Jabalbina Yalanji Aboriginal Corporation, Djunbunji Land and Sea Program, Ewamian Rangers and the Gidarjil Development Corporation fund and provide field support for research.

SeagrassWatch

TropWATER staff are at the core of the program overseeing protocols and strategies including managing and validating data, providing and developing training, and coordinating communities and scientists.

MangroveWatch

A key component of the program is its close partnership between TropWATER scientists and community volunteers at many locations in Queensland, the Torres Strait and the USA.

Queensland Port Authorities (North Queensland Bulk Ports Corporation, Gladstone Ports Corporation, Ports North and Port of Townsville)

A key research partner funding many of TropWATER's seagrass, marine habitat and water quality programs.

Torres Strait Regional Authority

TSRA fund mapping and assessing the resilience of seagrass meadows to climate change, to monitoring water quality, intertidal seagrass and other emergent wetland communities within the Torres Strait.

Maritime Safety Queensland (MSQ)

Supports TropWATER research surveying coastal intertidal reefs to map and quantify habitats at risk of shipping accidents and oil/chemical spills.

Natural Resource Management (NRM) regions

TropWATER is working in conjunction with NRM bodies across Queensland, with farmers, graziers and industry groups to implement and test new management techniques aimed at improving water quality in coastal and marine ecosystems.

Great Barrier Reef Foundation (GBRF)

TropWATER research supported by the GBRF focuses on developing indices of seagrass health that can be used to evaluate future responses to climate change on the GBR Marine Park.

Sugar Research Australia (SRA)

Is collaborating with TropWATER researchers to establish and monitor runoff trials aimed at developing alternative herbicide management strategies to replace PSII herbicides in the Wet Tropics.

Australian Universities including the University of Queensland, Griffith University, Murdoch University and the University of Tasmania

Are collaborating on a number of projects including those which focus on seagrass habitat monitoring on the Gold Coast, repair efforts to shellfish reefs at a number of Australian sites, and dugong surveys in Western Australia.

International

Papua New Guinea National Fisheries Authority

in conjunction with the Australian Centre for International Agricultural Research (ACIAR), is supporting a TropWATER project aimed at empowering PNG business and community groups to sustainably develop and manage the expanding sport fishing industry in PNG.

Earthwatch Institute

TropWATER scientists are funded by Earthwatch to lead teams of individuals who actively participate in surveying the status and condition of mangroves and freshwater wetland habitats in northern Queensland and the Torres Strait.

The Nature Conservancy (TNC)

TropWATER and the TNC's research collaborations include supporting repair efforts for threatened marine ecological communities, shellfish reefs and saltmarshes.

International Union for Conservation of Nature (IUCN)

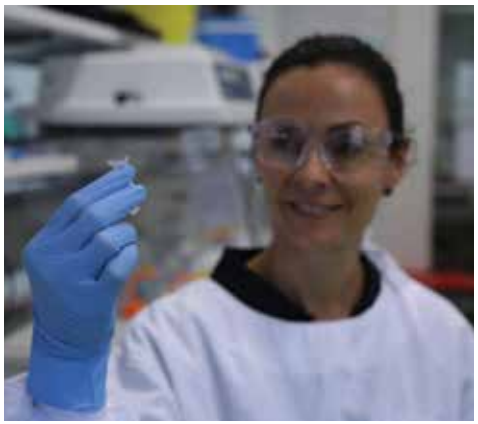
TropWATER researchers are funded by the IUCN to facilitate floristic surveys and map mangroves and tidal wetlands in Tonga, Samoa, Fiji, Vanuatu and the Solomon Islands.

World Wildlife Fund (WWF)

TropWATER researchers are working with the WWF to ascertain risk factors associated with the declining health of green turtle populations in GBR catchment areas.

Highlighted Research

Environmental DNA: revolutionising how we investigate life underwater




TropWATER researchers are refining cutting-edge genetic techniques for the identification and monitoring of species found in northern Australian waters. Researchers are using a new method of environmental DNA (eDNA) metabarcoding to allow sampling of large waterbodies to gather important information such as the invasion of pest species, the presence of rare and threatened species, or how human disturbance is affecting these species' populations.

eDNA comprises of DNA that has been released by an organism into the environment via faeces, hair, mucus, urine, skin/scales or gametes. This eDNA can be extracted directly from soil, sediment, and water samples without needing to capture or sight the target organism. This technology revolutionises the way we conduct field surveys and in many situations is more sensitive and cost-efficient than traditional field survey techniques that require the target organisms to be caught or sighted.

We are currently using this novel method to investigate four main areas of research:

Surveillance tool for detecting pest species

Invasive aquatic species are a major concern for Australian waterways and the ability to detect invasive species before they become established is critical for successful control. The use of eDNA as a surveillance tool for tilapia and other pest fish species in Australia may enable new outbreaks to be detected much earlier than by using traditional methods and at a stage where the populations are geographically contained and can be controlled.

Monitoring of rare and threatened species

Rare species are by their nature often hard to find or detect using standard sampling methods. eDNA use allows the detection of species at low densities and allows management action to be made without having to capture and potentially damage threatened species.

Detecting barriers to fish passage

The damming of Australian waterways has caused large impacts on aquatic species which need to migrate along river systems in order to reproduce. eDNA will allow researchers to look at how isolated fish populations are above and below barriers such as dams and use management techniques such as fish passages to correct this before population declines occur.

Assessing species composition

eDNA metabarcoding can be used to assess complete species assemblages (e.g. all fish, all molluscs, all insects), in environmental samples. This allows researchers to monitor areas threatened by pollution or other human influences. It can also be used as a tool to assess the species diversity in areas proposed for various types of development.

LEARN MORE AT **environmentalDNA.com.au**

Developing northern Australia




Photo: Mark Ziembicki


The development of northern Australia is a key political and social agenda with significant ramifications for the health and management of aquatic ecosystems and the beneficial services that humans derive from them. TropWATER is ideally placed for this role, having a long history working on the management of aquatic resources in the major irrigation districts of northern Australia, including Burdekin, Mareeba-Dimbulah, Wet Tropics and Mackay for over 28 years. Our focus is upon planning for new developments, and management solutions that improve environmental, social and economic outcomes in existing developed areas. All of the lessons learned in these diverse studies will be invaluable in planning for new developments that minimise environmental impacts.

TropWATER has been providing solutions for water resource management in northern Australia for 28 years

Our recent work covers three key areas:

Gulf of Carpentaria

TropWATER were partners in the Commonwealth-funded North Australia Water Futures Assessment and we have recently partnered with CSIRO in the $6 million Flinders-Gilbert Agricultural Resource Assessment, a comprehensive examination of the feasibility of irrigation development in those two northern catchments. These studies pioneered new applications of remote sensing to quantify the formation and development of in-stream waterholes that provide vital habitats for aquatic species during the long northern Australian dry season. TropWATER also collected comprehensive waterhole water quality and temperature data that allowed us to identify which waterholes provided the most suitable fish refugia, in both the current climate and a future warmer climate, and additional studies on the potential impact of irrigated water abstraction in those catchments.

Catchment runoff to marine environments

We are recognised as the leading research group studying management solutions to reduce contaminant runoff to downstream aquatic environments. This is particularly focused upon the Great Barrier Reef, but our expertise is transferable (and required in other locations). The major catchments of the Great Barrier Reef are the most likely candidates for further significant agricultural expansion in northern Australia, creating a difficult conundrum for managers and providing an acute need for our research into improved farm and runoff management.

Improved wetland management within developed catchments

There are many opportunities for improved wetland management in developed catchments. Each case has a different environmental context, requiring the application of novel solutions. Our work here covers water delivery management, aquatic weed control, fish movement and passage barriers, poor water quality and bund wall removal.

A local perspective on development pressures

By Professor Damien Burrows

Photo: CSIRO

In recent years, there has been a significant and growing interest in developing northern Australia. The level of such interest has waxed and waned over 150 years or so, but this time it feels more persistent. In the present debate, we seem to have concluded, and this appears to have become fixed in the mind of the general public that northern Australia is dry, remote, undeveloped, and with limited infrastructure and other requirements to support substantial development. While that well describes most of northern Australia, there are significant sections that do not meet that description. It is interesting, for example, that Cairns, which is geographically located in the north, is not always thought of as truly northern Australia. We have come to define northern Australia by its remoteness, yet this is an incomplete and distorted picture of the thriving urban centres and agricultural enterprises that exist in some northern areas. If you drive from Sarina (south of Mackay) to the Daintree (north of Cairns), a journey of some 11–12 hours, you will (apart from dry sections surrounding Townsville and Bowen) pass through an otherwise unbroken chain of agricultural development with numerous thriving urban communities. That level of development does not disqualify it from being 'northern Australia'. Townsville and Cairns are the 13th and 14th most populous cities in Australia, with four major and a dozen minor towns in between. They are easily reached by air, road, rail or sea. They may be a long journey from 'southern Australia', but they are not remote.

The two largest extant irrigation schemes in the north – the Burdekin and Mareeba-Dimbulah – are centred within a one-hour drive from Townsville and Cairns respectively, not to mention the extensive agriculture of the coastal floodplains between these two cities. Two of the biggest agricultural developments proposed for northern Australia (in the Flinders and Gilbert catchments) are within five to six hours' drive of these two cities. Likely future development is not even that far afield. The Burdekin Falls Dam, already the second largest in northern Australia, is just two hours from Townsville. Raising its existing dam wall by just two metres would double its storage volume, and there are ample suitable soils and existing infrastructure to support this expansion. The proposed Nullinga Dam, one of the high priorities of the federal government's northern agenda, is just one-and-a-half hours from Cairns, set amongst an already well-established irrigation area.

Northern Australia is a diverse landscape across a huge area that cannot easily be defined. Not all of it is as pristine as usually portrayed. I am not saying that I welcome irrigation expansion and altering river flows, only that in the debate, we must recognise that parts of northern Australia have been successfully developed. These areas will be the focus for further development and we can learn from the experiences of these industries to inform likely future expansion. As scientists, we risk betraying an inner green ideology if we adhere to old mantras about the north not being suitable for development, and that all the rivers likely to be targeted are wild. Each proposal should be assessed on its merit, not pre-judged by history or the romance of wild and remote rivers.

Learning from past mistakes to inform future growth

By Professor Damien Burrows


Photo: Wiki Commons


Photo: SA 2.5

I am not talking here, about historical examples like Camballin Barrage or Fogg Dam or Lakeland (actually a moderate success, depending on one's definition of such). There are three major irrigation areas in northern Australia – the Ord River scheme, the Burdekin-Haughton scheme and the Mareeba-Dimbulah irrigation scheme. All three provide enough examples of how irrigation development could be better planned and managed – we don't need to look to southern districts for answers.

In the Burdekin-Haughton for example, the 1978 report of the development committee including leading aquatic scientists (a sort of early environmental impact statement), claimed that not only would the Burdekin Falls Dam be clear, but that it would actually improve the clarity of the river below the dam. When the dam first filled and remained highly turbid all year, this was attributed to lingering effects of the construction process. A few years later, limnological research showed that due to the flow and sedimentary characteristics of the catchment, the dam would always be highly turbid, as it has been for most of the time since. For 159 km below the dam, the river is now persistently turbid, when naturally it was clear. Water from the river is pumped into numerous delta distributaries for delivery to farms on the floodplain. The floodplain waterways and numerous deepwater lagoons and wetlands are also now persistently turbid when naturally, they were clear. This catastrophic impact is due to the highly seasonal nature of flow in the dry tropics, with large volumes of turbid wet season flow trapped by the large volume dam and unable to be diluted by the clear, but very small, dry season inflows.

How did we so badly misunderstand the system? You might say well, we didn't know better in the 1970s, our knowledge has advanced since then so we won't make the same mistakes. I am not convinced by this. For starters, most northern impact studies have not attempted to predict the limnological characteristics of the proposed impoundment, despite this being an obvious starting point for impacts on the river below. I don't think we can accurately predict the actual impacts of a particular development. Sure, we have volumes of scientific data on the wide range of impacts out there, so in a generic sense, we understand what can happen, but each development is different. It has different crops planted, catches, stores, and distributes water in different ways, occurs in different flow regimes, and delivers to different receiving environments. Predicting the specific impacts of any proposal remains elusive, especially when most proposals are simply to deliver water. What the customers receiving that water may do with it, or how they manage their farm/industry is an unknown at the development stage, yet is ultimately the determinant of many ecological outcomes.

In lieu of making accurate predictions, adaptive and responsive management is required once a development is underway. Having studied two of the major irrigation schemes in northern Australia (Burdekin and Mareeba-Dimbulah, plus irrigation in the wet tropics) over many years, I'd say it has been the cumulative impacts of tailwater dispersion, diverted flows, altered fire regimes, small fish passage barriers and instream weed infestations that have negatively affected aquatic ecosystems. These 'small' impacts receive little attention in impact assessments. If we are to understand how to better develop and manage irrigation areas in northern Australia, we need to be studying and understanding the existing examples we have, not just referring to southern examples. There have not been any commissioned studies into the impacts of the Burdekin or Mareeba schemes on their downstream environments (the Ord faring only a little better), or any review of what should be done differently in future developments. Anything that we currently know has come from incidental studies carried out in those waterways, and years of local observation by regional scientists like myself. A systematic overview of what has worked and what hasn't in existing northern areas, would be invaluable in ensuring we don't repeat the mistakes 'of the north'.

Solutions for Communities, Government and Industry

Providing solutions for the mining and resource sector

TropWATER has a 25-year history of providing robust ecological monitoring programs to help the resource sector proactively reduce their risks. Clients are based across northern Australia and work sites include mines, refineries, ports, transportation agencies and related government agencies. We have a wide diversity of skills and experience to design and implement environmental assessment programmes. What sets us apart from environmental consultancies is the value-adding research activities and outcomes that are linked to compliance assessments. As part of a well-respected university, we have a reputation for independent, objective expert advice. Most of our clients are long-term and some have been working with us for decades.

Our key services for the mining and resource sector:

- Surface water quality analysis
- Sediment quality and contamination
- Aquatic fauna assessments
- Vegetation – land and aquatic
- Understanding flows and related processes
- Invasive organisms monitoring
- Quality assurance
- Compliance interpretation
- Wider environmental condition and value assessment
- Regulatory reporting
- Baseline assessments
- Adaptive techniques
- On the ground training
- Receiving environment assessments

We design robust ecological monitoring programs to help companies proactively reduce their risks.

Management of ports and coastal facilities

The expansion of port facilities across northern Australia is a high profile issue, especially on the northeast coast in proximity to the Great Barrier Reef.

We are uniquely placed to develop the applied science and monitoring solutions required for successful environmental management of ports, with science expertise across the broad range of fields required and a strong track record of turning that science into applied solutions for ports and shipping management.

We have developed specific cutting-edge monitoring equipment and maintain a fleet of vessels and monitoring equipment in house to maintain capability.

We have been developing long-term datasets that not only answer management-related questions, but that have greatly advanced the fundamental science around marine ecology, especially that of seagrasses, which form the largest component of our work in ports.

TropWATER currently conducts environmental monitoring in all the major ports of north Queensland - Gladstone, Hay Point, Mackay, Abbot Point, Townsville, Mourilyan Harbour, Cairns, Thursday Island, Weipa and Karumba.

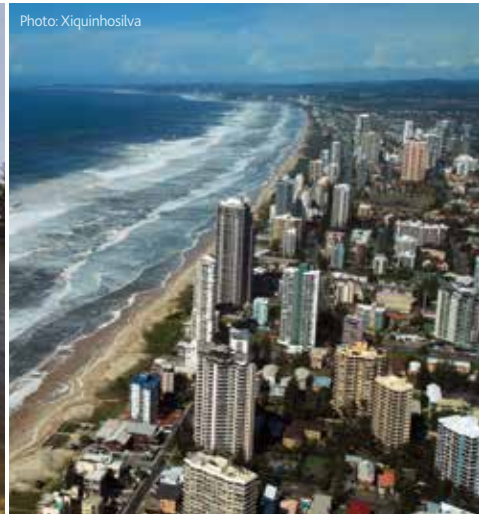
Our port-related research includes:

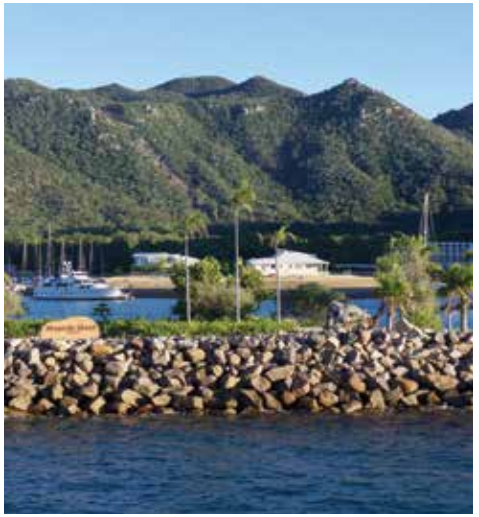
- benthic habitat mapping
- seagrass monitoring
- mangrove health assessment
- dugong and turtle health and population monitoring
- water quality
- long-term logging of turbidity and light penetration characteristics
- artificial engineered seascapes as fish habitat
- dredging monitoring
- modelling and remote sensing analysis of sediment plumes.

More than 50 of our team have been involved in these various activities. Our staff sit on technical expert panels related to port development in Gladstone, Karumba, Weipa, Hay Point, Abbot Point, Cairns, and Darwin Harbours. With continued expansion and necessary maintenance dredging of port facilities, this will remain an area of focus for us.

Our staff have been providing expert advice and working with port authorities on applied research and monitoring programs for over 20 years.

Urban coastal environments





The modern day coastal seascape comprises a mix of natural ecosystems, along with an expanding footprint of urban and industrial infrastructure. As coastal cities grow rapidly and a greater proportion of people come to live in coastal urban environments, this poses both a great management challenge to maintain existing habitats, and also a great opportunity to increase habitat quality and availability through improved planning and design of urban and industrial structures. Many of these engineered structures (e.g., foreshore developments, ports, marinas, artificial reefs, residential canal estates) have been built with little spatial planning or consideration of their impact or the opportunity for offering habitat benefits.

We have been mapping artificial infrastructure along Australia's east coast, and conducting studies into the habitat opportunities offered by various types of structures and how this can be enhanced, especially as habitat for fish. Our scientists are working positively with managers and industry to tackle these challenges, so that such developments offer greater opportunities to provide viable habitats for our future.

10% of the Great Barrier Coastline has been modified for urban and coastal development

Repairing Australia's coasts

Photo: U.S. Army photo/Patrick Bloodgood

Photo: Louisiana Office of Coastal Protection and Restoration

Coastal and estuarine habitats such as freshwater marshes, mangroves, saltmarshes, coral and shellfish reefs and seagrass meadows play important roles in supporting marine life and fish production, storing carbon, regulating water quality and curbing coastal erosion. However, these valuable habitats have been in serious decline due to destructive fishing practices, coastal development, pollution and agriculture. Repair efforts have begun in some locations, with the promise of significant benefits. Further advances, however, hinge on increasing public awareness and on joint investment among governments, businesses and the community.

Understanding the dynamics and ecology of coastal systems and habitats are some of our core strengths. Our goal is to provide the critical knowledge needed to effectively understand, protect and repair damaged coastal habitats in Australia and internationally.

Mangrove and saltmarsh restoration

TropWATER is a leader in tidal wetlands research with a strong focus on mangrove and saltmarsh habitats. This expertise ranges from botanical taxonomy, biogeography and evolution, distribution, ecology and dynamic production processes, shoreline habitat monitoring and rehabilitation, to assessments of risks and threats from pollution, coastal development and climate change. Most of our projects involve community groups and local Indigenous rangers and many involve industry and managers where best practice strategies and methods are applied. TropWATER scientists regularly work with industry and government managers on expert panels for projects for port operational projects, and risk evaluation assessments. A particular recognized expertise is the assessment of the impacts and recovery of mangroves and saltmarsh from large oil spills with numerous key projects in impacted sites worldwide. Another key capacity is defining the most rigorous scientific methods for keystone evaluations of health and condition of tidal wetlands. This includes evaluations of carbon content in vegetation and sediments where mangroves and saltmarsh are acknowledged sinks for natural carbon sequestration. We have a strong and dedicated emphasis in using key indicators of change observed in tidal wetlands to better inform researchers, community, industry and managers of the range of pressures and threats influencing coastal areas.

Seagrass restoration

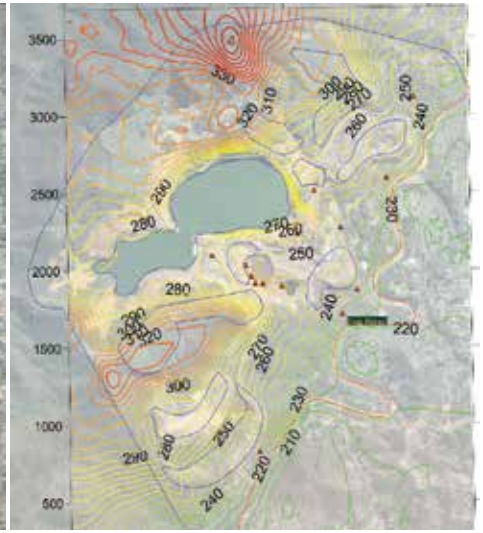
TropWATER is a research leader in assessing the health of seagrass ecosystems. Our seagrass ecology group based in Cairns, monitors seagrass meadows throughout the Great Barrier Reef and Queensland. They also work with industry on best-practice environmental management and are involved in broader national and international seagrass monitoring programs. A recently completed, National Environment Science Program (NESP) project has synthesized all the seagrass mapping data from the group's research programs stretching back to the mid 1980's. Our scientists provide the secretarial support for the global World Seagrass Association, provide specific advice to specialist working groups and maintain expertise in habitat assessment and repair. Last year, our lead seagrass scientists in partnership with Deakin University coordinated a workshop involving Australia's key researchers to identify gaps in our seagrass research knowledge. The workshop outcomes will be presented in a scientific paper providing guidance for research directions.

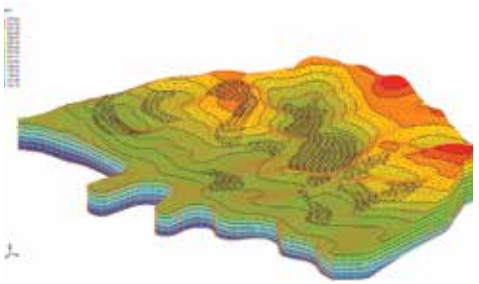
Shellfish reefs restoration

In 2015, TropWATER worked in partnership with The Nature Conservancy and experts from around Australia to review and synthesize existing knowledge of shellfish habitats. Regional reviews were produced for most of Australia and a series of expert workshops built a picture of Australia's shellfish reefs before their decline in the late-1800s. This included the species they harboured, Indigenous use, repair efforts to date and the potential value of ecological services provided. This project was funded by the National Environment Science Program (NESP): Marine Biodiversity Hub. Ongoing work will provide critical research to support the scaling up of repair projects in Australia. To learn more about this work view the website: **shellfishrestoration.org.au**

Advanced tools for characterising sources of water contamination at mine sites


Photo: Jeremy Buckingham





Mines in Australia are generally well managed in regard to their impacts on ground and surface water quality. However, when contamination happens, control and remediation can be complex and expensive. In addition, some abandoned mines in Queensland and the Northern Territory have significant residual contamination issues. It is difficult to reliably detect the nature and strength of contamination sources and the pathways for contamination of groundwater and nearby rivers. Thus, most remediation projects have been largely unsuccessful.

In order to address these complex problems related to water quality, TropWATER in collaboration with the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC-CARE) are developing comprehensive and easy-to-use computer software and methods to address ground water contamination. This work has advanced the feasibility of addressing large-scale and complex water quality issues. Although these tools have been developed for northern Australia, they are broadly applicable for the development of effective and efficient remediation measures worldwide.

For more information contact Dr Bithin Datta:
bithin.datta@jcu.edu.au

We have developed a suite of new tools and methods that make it computationally feasible to address characterization and management of complex water contamination issues at a regional scale.

Socio-economic systems and reef resilience





Photos: Dr Matt Curnock, Tethys Images

Our socio-economic research team has investigated the importance of water clarity to visitors to the Great Barrier Reef.
The team also tested to see if objective measures of water quality (water turbidity data from the Australian Institute of Marine Science) influenced willingness to pay.

The results suggest that people assumed a 'fair' and/or 'equitable' payment system (requiring all users to pay too) when consenting to pay for water clarity improvement. The team also found that people's stated perceptions of water clarity and the interaction between them have a significant influence on willingness to pay. Those for whom water clarity was very important and who were very satisfied with water clarity during their visit were willing to pay more to preserve it. The importance variable interacts with subjective perceptions that drive behaviour. Further deterioration in water clarity in the Great Barrier Reef could adversely affect the tourism industry and the average visitor would be willing to pay up to $14.50 per visit to help improve it.

Potential future reductions in ocean water clarity were perceived by residents as having a more negative impact on their wellbeing than a 20% increase in prices.

Working with our International Neighbours

Sportfishing for sustainable livelihoods

The Sportfishing for Sustainable Livelihoods Research Hub is a multidisciplinary consortium that conducts cutting-edge research to support the development of sportfisheries, to provide stable alternative livelihoods and new income streams for local people throughout the tropical Pacific region.

As well as helping build the resilience of local people in developing countries, the Hub's research provides extensive capacity-building across science, business and tourism, and generates significant environmental benefits by providing local people with new perspectives on the value of natural resources and an understanding of how to preserve them.

The Hub works in collaboration with local government, business and community groups, as well as not-for-profit and aid organisations, to empower local people to sustainably develop, grow and manage sportfishing businesses.

We provide a broad range of relevant expertise that range from fisheries biology, ecosystem ecology, and genetics, through social science, tourism and business studies, to environmental economics.

Our flagship project focuses on Papua New Guinea's iconic Niugini black bass, *Lutjanus goldiei*.

LEARN MORE AT **niuginiblackbassresearch.com**

Oil palm: a modelled crop

Photo: Sue Berthelsen

APSIM Oil Palm has been downloaded by people in 11 countries, including 5 of the 6 largest producers.

Oil palm is a globally important crop, but questions are often raised about its environmental sustainability. To help growers maximise the yields of their plantations while minimising detrimental environmental impacts, Australian scientists, led by TropWATER's Dr Paul Nelson, recently developed a model of oil palm cultivation.

The oil palm system model was built using the internationally recognised Agricultural Production Systems Simulator (APSIM) framework. The model, called APSIM Oil Palm, enables producers to evaluate effects of soil type, climate and management on crop yield, as well as the water balance, nutrient balance, soil organic matter and greenhouse gas emissions. This valuable tool has not previously been available to oil palm growers.

APSIM Oil Palm can also be used to assess knowledge gaps and guide research, and as a tool for education. It is currently being used to assess the effects of environmental conditions and management practices on yield and losses of nitrogen to the environment over the course of the crop cycle.

A training course held in Jakarta in December 2014 attracted 20 participants from Indonesia, Malaysia, Colombia and Liberia. It is hoped that with training and further education this model will be used in other oil palm growing countries, to help improve sustainable production of this important crop.

The model was developed as part of a project aimed at improving sustainability of soil and water management in oil palm agro-ecosystems of Papua New Guinea. The project addressed the need to maintain or improve the condition of soil and aquatic ecosystems in oil palm growing regions. Oil palm is an increasingly important crop for livelihoods and rural development and communities rely on healthy functioning of the agro-ecosystem. Growers need information that will help them make decisions that benefit both productivity and the environment. Given that this is one of the most important industries in the tropics, the researchers have focused on contributing a science-based approach to its management.

This research was carried out in partnership with Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO) and the Papua New Guinea Oil Palm Research Association, funded by the Australian Centre for International Agricultural Research.

Dr Nelson (top right) and his research team have experience and expertise in quantifying the effects of land management practices on:

- Runoff water quality, especially nutrients and sediment
- Carbon cycling processes and greenhouse gas emissions
- Land and soil condition

The oil palm system model can be used to predict the effects of oil palm growth and management on hydrology and water quality

For more information contact Assoc Prof Paul Nelson:
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Rapid biodiversity survey in Guadalcanal, Solomon Islands

Robson Hevalao measuring the mouth size of a sample of eels.

Dr Brendan Ebner from TropWATER collaborated with partners from the University of the South Pacific, The American Natural History Museum and the Solomon Islands Community Conservation Partnership to conduct a rapid assessment of the upper Tina River catchment, Guadalcanal in the Solomon Islands. The rapid assessment involved 50 people including international researchers and local landholders being helicoptered into remote mountainous rainforest.

Fish were surveyed primarily by direct observation while snorkeling. Dip netting was used to collect voucher specimens, and in some cases remote video cameras were used to detect shy species. Local guides spearfished for eels and substantial data was collected from these specimens prior to their consumption.

Eleven fish species were recorded during the study, more than expected at 700–1300 m above sea level. Some of these fishes have only occasionally been encountered by scientists, and some represent range extensions to the Solomon Islands.

The rapid assessment provided an opportunity to advance our knowledge of species that are shared with Australia. Furthermore, the terrestrial ecologists and taxonomists on the trip were helpful in providing a more complete picture of prey availability and input to the streams than is usually possible with a small aquatic researcher team acting in isolation. Dr Ebner said that the highlight of his trip was working with Solomon Islanders such as team leader David Boseto and scientist Robson Hevalao and Fijian researchers Lekima Copeland and Bindiya Rashni.

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Featured Research

Photo: Matt Curnock

Mangrove and saltmarsh research, monitoring and management

Mangroves and tidal wetlands support human communities and provide essential habitat and primary resources for a host of animals. However, they are threatened by direct damage coupled with unchecked human development in combination with regional effects from global climate change and sea level rise. Research investigations, assessments of habitat condition, and rehabilitation projects conducted by our scientists directly address these threats. Top research publications, development of innovative assessment methods, and broad community outreach programs place our scientists at the forefront of international achievement toward better management of these important ecosystems.

Capabilities of TropWATER scientists include:

- Environmental/ecological assessment of tidal wetland ecosystems for their ecological services and conservation;
- Shoreline condition surveys and monitoring change to coastal margins and fringing mangroves, including development of the Shoreline Video Assessment Method (S-VAM);
- Remote sensing and mapping of coastal vegetation, change detection, indicators of stress, particularly for tidal wetlands;
- Ecology, phenology, taxonomy, distribution, biogeography, morphometrics and genetics of mangrove plants;
- Evaluation of impacts from storms, droughts, flooding and other natural disturbances affecting mangrove habitat, and their longer term responses including recovery;
- Effects of large oil spills & herbicide pollution on mangrove habitat – impacts and recovery;
- Rehabilitation of mangrove habitat and restoration of degraded habitat, working with managers and community members;
- Engagement of community volunteers and Indigenous rangers in effective monitoring and rehabilitation of tidal wetlands and other shoreline habitats;
- Development of innovative guides for the identification of mangrove plants.

TropWATER initiated the establishment of the Australian Mangrove and Saltmarsh Network and the running of its first national conference in 2014. TropWATER also operates MangroveWatch to support engagement of community volunteers and Indigenous rangers in the management and greater understanding of mangrove ecosystems.

Mangroves of New Caledonia

TropWATER's Dr Norm Duke is currently developing a taxonomic guide book about mangroves and tidal wetlands of New Caledonia based on his fieldwork working with local partners in that country

Daintree's Hidden Coast with Earthwatch Australia

This program undertakes surveys 2-3 times each year with postgraduate student groups and citizen scientist volunteers from Earthwatch Australia. Shoreline Video Assessment Methodology and blue carbon surveys are used to assess the Daintree's mangrove forests. It has now been running (in various forms) for more than 20 years, providing an invaluable long-term dataset in one of Australia's most iconic environments – the Daintree.

Rehabilitation of damaged mangrove sites in northern New Caledonia

This program involves field surveys along with nursery and rehabilitation works near the Koniambo mine site. Partners include EMR Mine-R-Eaux Nord SARL and Koniambo Nickel SAS. TropWATER scientists with MangroveWatch have developed 'The Mangrove App!' the first and only smart device App as an e-book guide to all 80 mangrove plant species in the World.

Mangrove Click! Australia

This is another collaborative project between TropWATER and MangroveWatch Ltd. It involves the imminent publication of an App for iPhones and iPad devices that lists, describes and illustrates all mangroves in Australia plus additional features to facilitate species identification amongst MangroveWatch and other volunteers throughout Australia. Project partners include the Norman Wettenhall Foundation and Wildlife Preservation Society of Queensland.

Threatened species research and management


Photo: Matt Curnock


Photo: Julien Willem


Photo: Simon Fraser University


Photo: Brendan Ebner

TropWATER houses a number of researchers with specialist skills in threatened aquatic species ecology. Our researchers also contribute to wider thinking and writing about societal processes in conservation of freshwater, estuarine and marine biodiversity.

Sea turtles

Sea turtles are a group of charismatic animals which includes multiple threatened species. TropWATER has a multi-expert base researching sea turtles. For instance, Associate Professor Mark Hamann and Dr Julia Hazel have substantial experience in movement and behaviour of threatened sea turtles and applied conservation issues such as those surrounding large scale plastic pollution and vessel interaction with turtles in marine systems. Associate Professor Ellen Ariel has an active involvement in turtle virology of aquatic reptiles including the vulnerable green sea turtle. Researcher Martha Brians is working with the Great Barrier Reef Marine Park Authority to create an interactive map of cumulative threat hotspots for turtles on the reef so that it can be used in management and policy making.

Dugong

The Dugong is a threatened marine mammal typically associated with seagrass beds upon which they graze. A number of TropWATER researchers including Professor Helene Marsh, Dr Susan Stobtzick and Dr Christophe Cléguer have active interests in the ecology and conservation of this high profile coastal species, as well as dolphins and whales. This includes long-term monitoring of dugong populations in the Great Barrier Reef and north-west WA waters.

Sawfishes

Sawfishes are large-bodied marine, estuarine and in some cases freshwater dwellers threatened with the possibility of worldwide extinction. Professor Dean Jerry has developed eDNA markers for detecting the presence of freshwater sawfishes in large rivers in order to more accurately determine their abundance and distribution. Dr Brendan Ebner also has substantial experience with field based collection and tagging of freshwater sawfish, green sawfish and dwarf sawfish, in coastal Pilbara, the south-western Kimberley and Gulf of Carpentaria rivers and estuaries, in conjunction with Murdoch University and the Queensland Government. Highlights have been the discovery of a nursery ground for green sawfish in the Pilbara, and determining the habitat use of the juvenile phases of three species of sawfish.

Freshwater fauna

Freshwater ecologists at TropWATER have made significant contributions to threatened freshwater species research and management. This includes spearheading the discovery, mapping and nomination of cling goby species for state and federal listing in relation to populations in the Australian Wet Tropics. The Opal cling goby is critically endangered under the EPBC Act and another three species are listed under Queensland threatened species legislation. Small populations of these cling gobies exist in Australia as a function of limited suitable habitat in the form of steep coastal streams in rainforest catchments. Jason Schaffer is the resident expert on rare and threatened freshwater turtles, and studies the taxonomy, movement, physiology and biogeography of Australian freshwater turtles including the critically endangered Southern snapping turtle and the vulnerable Fitzroy River turtle. Dr Brendan Ebner and James Donaldson are experienced in working on threatened freshwater fishes in northern Australia and the Murray-Darling Basin. Relevant work includes providing water resource managers with viable solutions to ensuring human water supply in coexistence with threatened fishes and turtles.

Developing tools for effective management of seagrass ecosystems

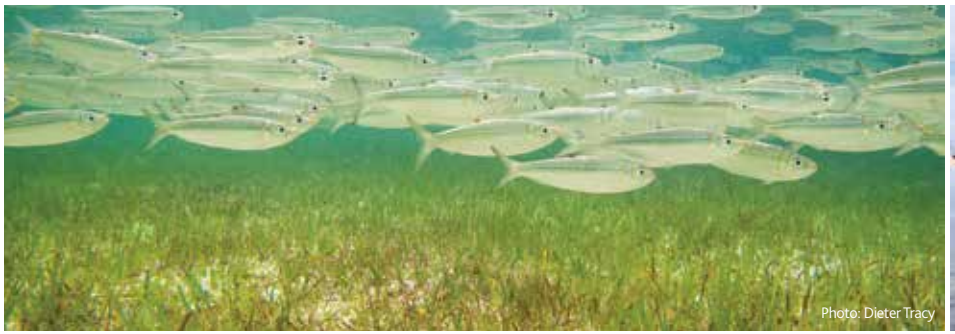


Photo: Dieter Tracy


Photo: Dieter Tracy

Establishing seagrass light requirements for tropical Australia

The Seagrass Ecology Group is leading the way in establishing critical light thresholds for tropical seagrass and working with government and industry to ensure effective targets are set and applied in management during coastal developments leading to improved environmental outcomes. This work has included:

- The development of the first active-management program for a major dredge campaign to use ecologically relevant light triggers for tropical seagrass;
- Synthesising the current knowledge on light requirements for Great Barrier Reef seagrasses to provide a guiding document for implementation across the state;
- The world's first investigations into establishing management thresholds for protection of deep-water (>15 m) seagrasses.

New approaches to measure seagrass stress

TropWATER together with their research partners from the University of Technology Sydney have developed new molecular tools to assess stress in tropical seagrasses. These tools can assess if seagrasses are stressed from water quality impacts weeks in advance of traditional monitoring techniques, and before actual declines in seagrass abundance occur, allowing effective windows to address impacts providing much-improved outcomes. This work, funded by ports-related industry groups, has developed breakthrough approaches that allow a turnaround time from assessment to management action to occur within 24 hours.

Understanding resilience is a critical component for seagrass management. TropWATER have developed several major research programs in partnership with government and industry to better understand the key components of seagrass meadow resilience. For example, little is known about how seagrass seeds stored in the sediment (the seedbank) influence meadow resilience in tropical Australia. Research programs are currently looking at the spatial and seasonal dynamics of the seedbank and the viability of those seeds for a range of species and meadow types. We have adapted and developed new techniques to analyse and test seedbanks and are linking this information to current monitoring programs to enhance advice on seagrass management.

Seagrass mapping for management

TropWATER's seagrass maps are part of Queensland's ecological "infrastructure". They are used to model connectivity, assist with zoning and management, understand change through time, assess the impact of water quality and coastal development, and assess/predict vulnerability of turtle and dugong populations. The Seagrass Ecology Group has for more than 25 years led the way in developing mapping tools and products for the management of seagrass ecosystems. These mapping products include:

- Mapping major new areas of seagrass in the northern Torres Strait and Papua New Guinea to assist with dugong and turtle management;
- Developing new techniques to map and quantify dugong feeding in seagrasses with next generation photogrammetry, helicopters and drones;
- Creating habitat risk maps for the national Oil Spill Response Atlas (OSRA). With funding support from the Australian Maritime Safety Authority and Maritime Services Queensland, TropWATER has conducted surveys and developed a series of atlases for the highest shipping risk areas in the Great Barrier Reef to aid in the planning of oil spill and shipping accident response;
- Creating new composite seagrass maps for Queensland. All of the seagrass information collected by the group for the past 25 years from the Torres Strait and Queensland's east coast has been synthesized with new GIS products including species areas and density in publically available layers.

The Seagrass Ecology Group is leading the way in establishing critical light thresholds for tropical seagrass and working with government and industry to ensure effective targets are set and applied in management during coastal developments leading to improved environmental outcomes.


Photo: Paul Dymond


Photo: Jane Mellors

Turtles and dugong consume and pass through their digestive system hundreds of thousands of viable seagrass seeds every day and they can be transported as far as 650 kilometres from where they were consumed.

TropWATER maintains a fleet of survey ready vessels, camera systems, UAV's, aerial sampling equipment and a dedicated GIS team to continue to provide mapping services for seagrass and coastal habitats.

Connectivity among Great Barrier Reef seagrass meadows

Cyclones Larry and Yasi which crossed the coast between Cairns and Townsville in 2006 and 2011 respectively did enormous localised damage to coastal seagrasses. Rapid surveys identified around 3000 hectares of seagrass in intertidal meadows were destroyed. How meadows recover from disturbance is not well understood at this scale (100s of kilometres). We used three approaches to better understand recovery and to improve our ability to give management advice.

We (A) modelled the likely movement of seagrass propagules using hydrodynamic modelling; (B) this information was used in a network analysis to examine which meadows were the most likely to supply propagules or to act as "stepping stones"; and (C) dugong and turtle faecal matter collected from the water was examined to see if it contained seagrass seeds and if those seeds were viable.

This work shows that seagrass propagules can move with water currents and by the drag from wind. They travel mostly in a northerly direction and can travel nearly 1000 kilometres, although most would only remain viable up to distances of 100 kilometres. Coastal meadows, including those around ports, are important for propagule supply or as key sites identified through network analysis.

This research is ongoing and has important implications for seagrass management and will improve the advice we give on the need and methods to intervene and assist recovery of meadows by restoration methods.

TropWATER Water Quality Laboratory

Our Water Quality Laboratory provides both a water quality analysis service for JCU's research and consulting projects, and a commercial analytical service to government agencies and industry. While our focus is on the analysis of water, wastewater and related samples, our staff expertise also includes experience in many facets of water quality research. This includes providing support for studies that examine freshwater streams, rivers, wetlands and reservoirs, ground waters and marine waters. The laboratory analysed over 8400 samples in the 2014-15 period.

Laboratory Manager: Mrs Michelle Tink

Capabilities and expertise

- Design and implementation of monitoring programs
- Sampling of water, sediment and biota
- Analysis of waters, wastewaters, sediments and biological tissue samples
- Interpretation of analytical results and statistical analysis of water quality data
- Testing of water and wastewater treatment efficiencies

In addition, Laboratory staff have established working links with other JCU Centres and analytical facilities. This enables them to draw on the experience of specialists from a wide variety of disciplines, which provides the capability to address the diversity of water quality issues and adopt a holistic approach to water quality evaluation.

Equipment and resources

Our Water Quality Laboratory is located in modern, custom-built laboratories in the Australian Tropical Sciences and Innovation Precinct (ATSIP). The new facilities include capacity for standard titrimetric, colorimetric and gravimetric analysis techniques, supported by a range of high quality modern instrumentation, which enhances the efficiency of routine analyses and provides sophisticated state-of-the-art investigation capabilities.

Equipment

- Flow Solution 3700 Analyzer
- Turner Designs Trilogy Fluorometer
- 2 x three channel O.I. Analytical Flow Solution IV, Segmented Flow auto-analysers
- Shimadzu UV-Vis Spectrophotometer
- Gallery Discrete Analyser (allowing us to offer a 24 hour turn around for FRP, NOX & NH_3 analysis)
- Access to freezers and refrigerated storage areas allowing efficient storage of large numbers of samples
- In June 2015 we commissioned a new Flow Solution 3700 Segmented Flow Analyser with FlowView software
- In December 2015 a Turner Designs Trilogy Fluorometer was purchased to enable us to measure Chlorophyll-a in marine waters down to 0.025µg/L

Research support

In order to provide expert advice, develop new techniques and process research-related analyses, the Water Quality Laboratory works closely with research staff and postgraduate students from JCU and other universities. In recent years, support has been provided for a wide range of projects, including those associated with:

- Sediment and nutrient run-off from farmed and grazed upper-catchment areas to the Great Barrier Reef
- Identifying pesticides in river systems in agricultural areas
- Monitoring water quality in flood plumes following extreme water events (e.g. cyclone Yasi)
- Environmental impacts on wetland areas surrounding mining and other industrial activities

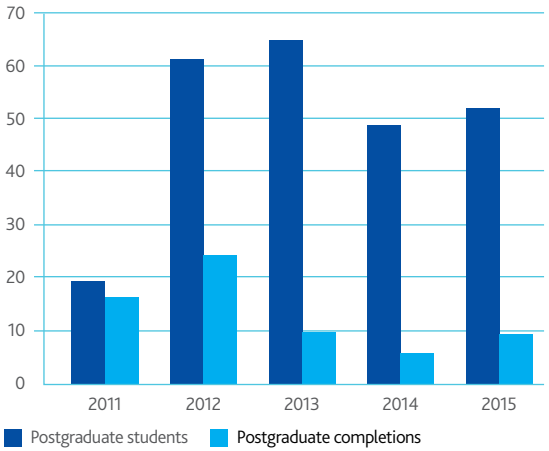
Commercial clients

Water quality services provided for commercial clients in government and industry are primarily related to the environmental monitoring of water for physiochemical parameters and metals, nutrients, salts and bacteria. Examples of clientele and services provided include sugar mills, aquaculture facilities and mining operations, the horticulture industry (water and bore water), and water quality testing for swimming pools.

Graduate Training

Photo: Matt Curnock

TropWATER fosters a vibrant research and professional development environment for postgraduate students. We have a strong emphasis on mentoring and providing high-quality training and opportunities for the expansion of career skill sets. Our students are exposed to real-life management situations. Our approach is inclusive with students attending strategy meetings and staff retreats. Many of our students work part-time for TropWATER during their studies and some continue their careers with TropWATER after graduation. We are the first professional employers for many JCU graduates.



Number of Postgraduate students and completions in 2014-2015

TropWATER had 56 PhD candidates and 7 MSc candidates from 2014 to 2015.

Dr Zoe Bainbridge – Advance Queensland Fellow

Zoe Bainbridge completed her thesis in 2015, titled Tracing the sources, transport and dispersal of suspended sediment from the Burdekin River catchment into the Great Barrier Reef lagoon. The thesis project utilised novel sediment budget and clay-mineral based tracing techniques to characterise and source Burdekin River fine sediments most likely to directly affect coral reef and seagrass ecosystems of the central Great Barrier Reef. Zoe was awarded her thesis *cum laude* and received the University Medal. Recently, she was awarded a QLD government Advance Queensland research fellowship to continue this sediment tracing research. The project will focus on the fractionation processes that occur when terrestrial sediments are transported into the marine environment, with the aim to identify the specific catchment sources of ecologically-damaging fine sediment to best utilise limited on-ground investment funding across the large GBR catchment area. The fellowship will be undertaken in collaboration with Prof. Jon Olley at the Australian Rivers Institute (Griffith University). The Advance Queensland fellowships have a strong stakeholder engagement component, and Zoe will be working closely with North Queensland Dry Tropics, and State Government DEHP and DSITI offices.

Student members 2014–15

PhD

- **Ahmed Adeeb Abdulwahid**
  Night-time destratification in a thermally-stratified riverine environment due to surface cooling and turbulence.
- **Getachew Agegnehu**
  Impacts of biochar and compost on soil fertility, crop performance and carbon sequestration in tropical agricultural soils.
- **Zaher Al-Agwan**
  Management effectiveness evaluation of the marine protected area of Socotra Island, Yemen.
- **Mahsa Amirabdollahian**
  Development of integrated methodologies for optimal monitoring and source characterisation in contaminated groundwater systems under uncertainty.
- **Aladin Andrisoa**
  Biogeochemical and ecological effects of coastal groundwater discharge into Mediterranean lagoons.
- **Alex Angell**
  Quantitative changes in amino acids related to nitrogen content and growth rate in the green seaweed *Ulva ohnoi*.
- **Md. Shamim Ahasan**
  Survey of the enterobacteriaceae in the gut of healthy and compromised green turtles (*Chelonia mydas*) and investigation into the cause and treatment for gastrointestinal disorders.
- **Zoe Bainbridge**
  Tracing the sources and fate of suspended sediment from the Burdekin River catchment to the Great Barrier Reef lagoon.
- **Hector Barrios-Garrido**
  Use and abuse of marine turtles: Assessing the success of indigenous and first nation communities-based conservation programs.
- **Kathryn Berry**
  Effects of coal dust on tropical marine organisms.

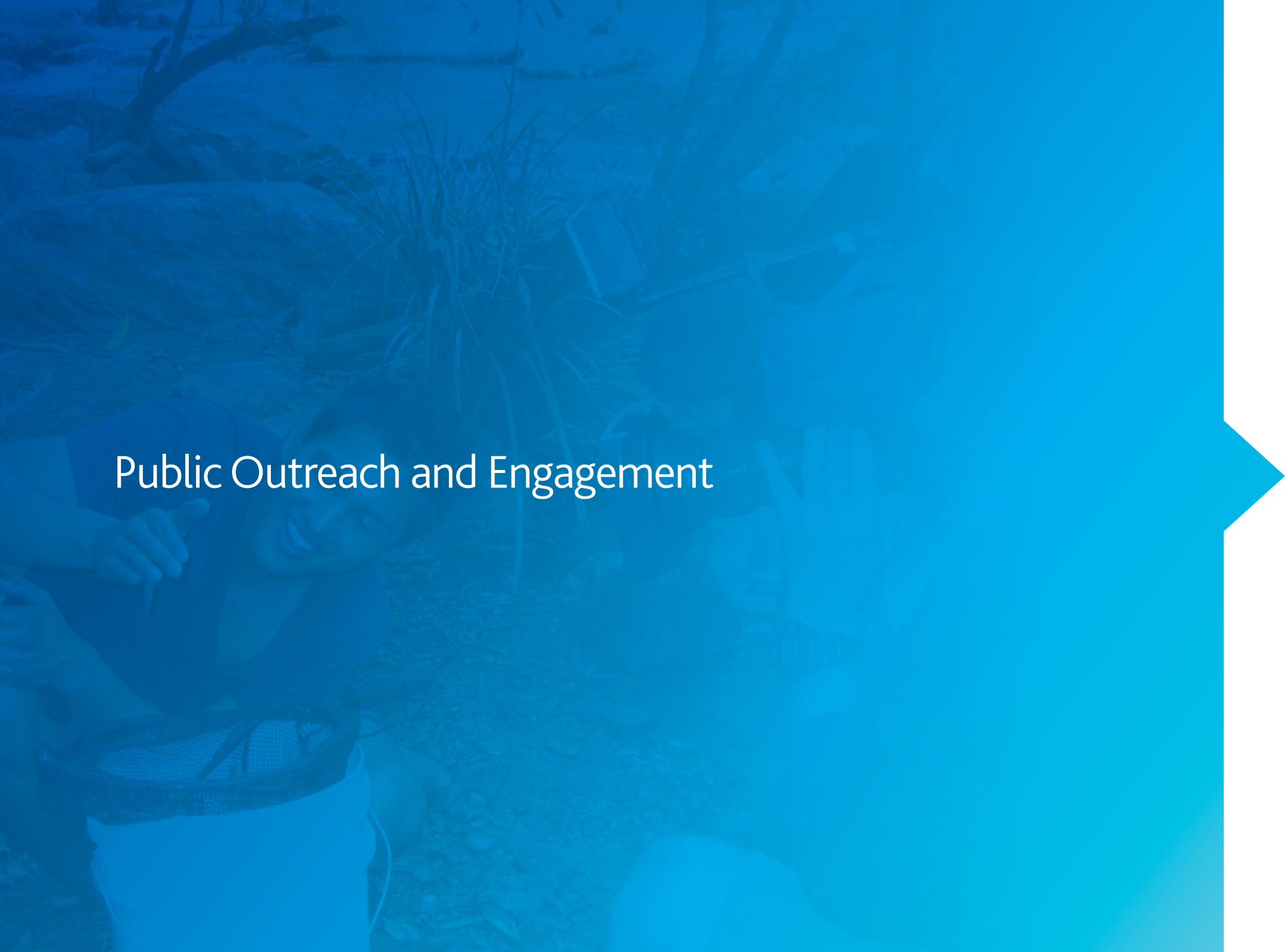
- **Juanita Bité**
  The quality of seagrass as a dugong food resource: The importance of the effects of season and water depth.
- **Melissa Boss**
  Marine conservation finance: Securing marine ecological and socio-cultural outcomes through innovative and strategic finance.
- **Michael Bradley**
  Critical components of the coastal seascape.
- **Christina Buelow**
  The role of avifauna in coastal ecosystem connectivity.
- **Max Burns**
  Investigations of struvite dissolution kinetics.
- **Diana Castorina**
  An investigation of the influence of regional and personal characteristics on internal migration in Australia.
- **Christophe Cléguer**
  Informing dugong conservation at several spatial and temporal scales in New Caledonia.
- **Geoffrey Collins**
  Vulnerability of an iconic Indo-Pacific fish (barramundi, *Lates calcarifer*) to climate change; Assessing physiological responses to hypoxia in genetically distinct populations from northern Australia.
- **Michelle Cooper**
  Sediment dynamics of a large tropical river system.
- **Kay Critchell**
  Impacts and risk of the microplastic portion of marine debris to marine organisms.
- **Hoc Tan Dao**
  Genetics and recruitment of spiny lobsters (*Panulirus ornatus and P. homarus*) in South East Asia/Australia.
- **Benjamin Davis**
  Temporal nekton dynamics in tidal floodplain wetlands.
- **Dominique D'Lima**
  Irrawaddy dolphin-human interactions at Chilika Lagoon, Orissa, India.
- **Alexia Dubuc**
  Dissolved oxygen as a constraint for fish utilisation of mangrove forests.
- **Cheryl Fernandez**
  Investigating the contribution of natural capital to human well-being: A case study in the Metro-Iloilo Guimaras Area, Philippines.
- **Boga Figa**
  Population dynamics and resilience of the river herring (*Nematalosa papuensis*): A keystone tropical freshwater species.
- **Karin Gerhardt**
  A holistic approach to shark fisheries science and management: The role of contemporary indigenous knowledge.
- **Jeremy Golberg**
  Social indicators, marketing and movements: how climate change communication affects the behaviour of Great Barrier Reef user groups.
- **Rie Hagihara**
  Linking behavioural based and population based assessments to achieve conservation of dugongs.
- **Rachel Hay**
  The engagement of women and technology in agriculture.
- **Fidelis Jarvani**
  Quality of drinking water and treated recreational water in rural areas of Hunter New England region of New South Wales: Risks, determinants and intervention strategies.
- **Diane Jarvis**
  Designing better systems for assessing the economic and social impacts of natural resource exploitation: A case study of mining within the Great Barrier Reef region.
- **Karina Jones**
  Environmental influences on the epidemiology of fibropapillomatosis in green sea turtles (*Chelonia Mydas*) and consequences for management of inshore areas of the Great Barrier Reef.
- **Basiita Komugisha**
  Genetic characterisation and artificial breeding of *Bagrus dokmak* (Forsskal, 1775) from Uganda East Africa.
- **Qian Li**
  Social and ecological 'compensatory' mechanisms in the Chinese mining industry.
- **Rachael Macdonald**
  Water turbidity in the inshore Great Barrier Reef.
- **Hasan Mahmud**
  Investigation of displacement ventilation and cooling systems.
- **Ross Marchant**
  Image analysis using monogenic signals.
- **Carlo Mattone**
  The invertebrate community of mangrove forests and their susceptibility to dissolved oxygen.
- **John McLean**
  Influence of southern oscillation on tropospheric temperature.
- **Noto Prabowo**
  Cation retention and supply by Sumatran soils under oil palm.
- **Heather Robson**
  The use of environmental DNA as a tool in detecting invasive species and community structure in freshwater ecosystems.
- **Emma Ryan**
  Inshore reef growth on the central Great Barrier Reef: Identifying the signatures of sea level constraint, sea level change, storms and human impacts.
- **Mohammad Saleem**
  Determinants of sustainable consumer behaviour.
- **Jason Schaffer**
  Assessing the ecological effects of river regulation and anthropengic disturbance on bimodally respiring freshwater turtles in the Fitzroy and Burdekin River catchments in tropical Northeastern Australia.

- **Jodie Schlaefer**
  The sources and physical tolerances of *Chiron ex fleckeri*, a stinging jellyfish.
- **Katrin Schmidt**
  The ecological role of tadpoles in rainforest streams.
- **Takahiro Shimada**
  Spatial ecology and conservation of sea turtles in coastal foraging habitat.
- **Alifereti Tawake**
  Livelihood benefits of adaptive co-management of hand collectible fisheries in Torres Strait and Fiji.
- **Samantha Tol**
  Relative importance of different seagrass re-establishment in tropical Queensland.
- **Claudia Trave**
  Evaluation of survival rate and physiological effects of catch and release practices on three different target species.
- **Paul Whittock**
  Understanding risk to marine turtles from expanding industrial development in northern Western Australia.
- **Natalie Wildermann**
  Flatbacks at sea: Understanding ecology in foraging populations.
- **Jessica Williams**
  Sea turtle conservation in Mozambique.
- **Daniel Zeh**
  The use of automated acoustic tracking and GPS/ARGOS tracking to describe and quantify threats to dugongs in Queensland.

Master of Science

- **Adriana Chacon**
  The economic and social impact of the marine protected areas: a case study of Costa Rica.
- **Jakob Fries**
  Detecting impacts of agricultural runoff and nutrient pollution in tropical Australian Estuaries.
- **Jennifer Gilbert**
  Disease and threats to marine turtles and post rehabilitation success with the use of satellite tracking.
- **Victoria Hrebien**
  Quantifying the effect of seagrass productivity on growth and survival of foraminifera *Marginopora vertebralis*.
- **Emma Kiup**
  Maximizing nutrient use and soil fertility by managing nutrient stocks and movement in smallholder coffee and food garden systems.
- **Bronwyn Masters**
  Greenhouse gas emissions from soil in mango and banana fields: effects of nitrogen fertiliser type and mulching.
- **Jennifer Walker**
  Fish ecology and food web dynamics of tropical estuarine sand flats.

Dugong research



Public Outreach and Engagement

TropWATER takes public outreach and engagement seriously, delivering scores of public talks and hundreds of conference and workshop presentations. We manage numerous capacity building projects with Torres Strait Islanders and Indigenous communities around northern Australia. We have been involved in a number of forums (e.g., Reef Rescue, Reef Water Science Policy) where we have presented results to farmers and industry stakeholders. We have been working with agriculture industry groups such as Canegrowers and Agforce Queensland and individual farmers, including conducting on-farm experiments and delivering public talks to share results with local communities, then providing this critical information to government departments for management plans and reporting. In addition, the following staff have served on boards and panels:

- Rob Coles and Mike Rasheed provided advice on port management through independent panels, port advisory committees and direct advice to State and Commonwealth Government agencies reflecting TropWATER's reputation as a provider of quality science.
- Len McKenzie maintains the Seagrass-Watch website providing a gateway into much of the latest information on seagrass monitoring. Len and others in the team in Cairns provide the Secretariat for the World Seagrass Association and are active in seagrass issues globally.
- Rob Coles is a member of the Gladstone Healthy Harbour Partnership Scientific Advisory Panel and the Wet Tropics Healthy Waterways Management Committee.
- Michael Rasheed is on the Mackay Healthy Waterways technical working group.
- Natalie Stoeckl, Helene Marsh and Damien Burrows are all on the federal government's Independent Expert Panel, advising the Minister for the Environment on matters relating to management of the Great Barrier Reef.
- Jane Waterhouse and Colin Creighton are members of the Queensland Government's Great Barrier Reef Water Science Taskforce, and Jon Brodie is on that panel's Review Group.
- Helene Marsh is a member of the Federal Government's Threatened Species Scientific Committee.

Photo: Courtesy of Radio 4MW Torres Strait

Frank Nona, Charlie Hankin, Troy Stow, Dr Michael Rasheed and David Amber.

Seagrass-Watch

Seagrass-Watch is a scientific monitoring and science-based education program, where scientists, coastal managers and local stakeholders from across the globe collaborate to assess the status of their seagrass meadows to provide an early warning of coastal ecological decline. Developed in Queensland over 15 years ago, the program uses standardised global monitoring protocols at over 350 sites across 19 countries. Anyone can participate in Seagrass-Watch, as it responds to local needs, and includes some elements of citizen science. Seagrass-Watch implements a standardised, non-destructive, seagrass assessment and monitoring protocol that has rigorous quality assurance and quality control procedures. The program identifies areas important for seagrass species diversity and conservation. The information collected can be used to assist the management of coastal environments and to prevent significant areas and species being lost.

Seagrass-Watch HQ, the global headquarters of the program, is hosted at TropWATER in Cairns, and led by Len McKenzie and Louise Johns. The role of Seagrass-Watch HQ is to develop scientifically rigorous protocols and strategies for seagrass resource assessment, to manage and validate data, provide and develop training, facilitate the establishment of networks and to continue the development and expansion of the program. Seagrass-Watch HQ also ensures that the program is producing data of high quality, ensuring time and resources are not wasted.

The Seagrass-Watch program provides early alerts about coastal environmental problems before they became intractable. For example, during the dredging and reclamation stages of a coastal development in the Whitsundays, monitoring identified the onset of sedimentation on adjacent seagrass meadows and early intervention ensured they were not completely lost. The program has improved our understanding of seagrass ecosystem dynamics, including seagrass recovery after losses from flooding and other climatic events. The consequences of global climate change are also being tracked. Findings from the program have contributed to Ramsar and World Heritage Area assessments, regional and local management plans and reports on the health of the GBR. The program also works closely with Indigenous groups throughout tropical Australia, assisting with the management of dugong and turtle habitats. Collaborations as exemplified by Seagrass-Watch are essential to protect our valuable seagrass meadows. For more information, visit **seagrasswatch.org**.

MangroveWatch


TropWATER scientists are directors of MangroveWatch, an independent Australian NGO registered with the ATO as a Limited not-for-profit Company for the promotion of partnerships between scientists, community volunteers and indigenous rangers to gain more effective monitoring and rehabilitation of coastal and estuarine shorelines. More than 500 people have been trained for MangroveWatch monitoring, including Indigenous enthusiasts like land-sea rangers, and many active retirees. MangroveWatch holds comprehensive resources on the ecology and identification of mangroves, as well as its extensive monitoring and research initiatives throughout Queensland, across Australia, plus a number of international sites. The core business of MangroveWatch has involved application of the Shoreline Video Assessment Method (S-VAM). With some groups, we have also used the Long Plot Method for measuring mangrove forest structure along with sediment coring, for carbon evaluations. Using these methods, we have undertaken detailed mangrove and coastal health assessments in 8 countries (Vietnam, Tonga, Samoa, Fiji, Vanuatu, Solomon Islands, New Caledonia, USA) as well as conducting training courses on the core methodologies in Thailand and India. Within Australia, we have applied these approaches to shorelines across Queensland, the Northern Territory and Western Australia, working with numerous government, community, industry and Indigenous groups in delivering the program, especially along remote northern coastlines. Part of the MangroveWatch brief has also been the publication of guides for the identification of mangrove plants, using current and innovative technology tools like smart device apps. For more information about MangroveWatch activities, please visit **mangrovewatch.org**.

Science Communication

Media exposure

TropWATER places a high value on maintaining a strong public profile. This is evidenced by the number of collaborations with government departments, community and industry groups and the number of presentations to local and regional forums.

The Centre also has a strong media profile. From 2014 to 2015, member activities were cited in hundreds of newspaper and website articles, and members participated in at least 100 television and radio interviews. Many projects and publications are promoted via media releases supported by powerful images and video.

Case Study: Australian crawl, walking fish threat from Papua New Guinea.

"A fish that can live out of water for up to six days and crawl across dry land is being closely watched by James Cook University scientists as it moves south from PNG towards Australia".

This story went viral, was featured on 487 websites and had a potential cumulative audience of over 3 billion. As James Cook University's biggest story it was worth the equivalent of $28.7 million in advertising.

TropWATER Online

Our website **TropWATER.com** has continued to grow in content and use. There were over 160,000 website page views during 2014-15. The website contains hundreds of pages of information and >1000 scientific documents available for download. News and events are constantly updated and most projects are described in detail. TropWATER also maintains an active presence on **Twitter** (>3000 followers), **Facebook**, and **Youtube**.

- **facebook.com/TropWATER**
- **twitter.com/TropWATER**
- **youtube.com/user/TropWATERjcu**

TropWATER scientists were first to the scene of a large-scale mangrove dieback in northern Australia

7000 hectares of mangrove forests over a 1000km front have simultaneously suffered dieback – a globally unprecedented event

In late 2015, we received reports and photos from various community sources in the Gulf of Carpentaria concerned about dieback of mangrove forests in their local areas. These reports were from various locations and the timing was coincident. Further contact with local sources, followed by analysis of remote sensing imagery and additional aerial field inspection has revealed that more than 7000 hectares of mangrove forests have suffered dieback along a 1000km front stretching from Karumba in the east to the Roper River in the west. The dieback occurred around the same time along this broad front in late 2015 and the worst affected areas are on the Northern Territory side of the gulf coast. This damage represents about 9% of the total area of mangrove forest in that region. We have never heard of mangrove dieback on this scale before, making it globally unprecedented. The follow-on effects to biodiversity, fisheries, indigenous interests and shoreline protection are likely to be significant. TropWATER are following this story, which is gaining much media and public attention. We will investigate the causes, study the flow-on effects of the dieback and monitor the recovery trajectory over the coming years.

See video imagery of the dieback at this link: **https://goo.gl/rcR4IC**

Publications

Eric Wolanski with his new book, *Estuarine Ecohydrology An Introduction*

Staff Publications

Books

1. **Burns, K.A.** (2015) Memoir of first woman oceanographer in a changing world. Science and Sales. http://www.smashwords.com.
2. **Duke, N.C.**, Nagelkerken, I., Agardy, T., Wells, S., & H. van Lavieren (2014) The Importance of Mangroves to People: A Call to Action. United Nations Environment Programme (UNEP) World Conservation Monitoring Centre, Cambridge, 128 pages.
3. **Duke, N.C.** (2014) 'World Mangrove iD: expert information at your fingertips' Google Play Store Version 1.1 for Android, Oct 2014. MangroveWatch Publication, Australia – e-book. ISBN 978-0-9923659-1-2.
4. Edelman, A., Gedling, A., Konovalov, E., McComiskie, R., Penny, A., Roberts, N., **Templeman, S.**, Trewin, D., & Ziembicki, M. (2014) State of the Tropics Report, James Cook University, Cairns, Australia, 245 pages.
5. **Wolanski, E.** (2014) Estuaries of Australia in 2050 and Beyond. Springer, Dordrecht, 292 pages.
6. **Wolanski, E.**, & Elliott, M. (2015) Estuarine Ecohydrology, 2nd edition. Elsevier Science. ISBN 978044633989. 322 pages.

Book Chapters

1. Bayala, J., & **Wallace, J.S.** (2015) The water balance of mixed tree-crop systems. In: *Tree-crop interactions: Agroforestry in a changing climate* (eds Ong, C.D., Black, C. & Wilson J). CABI, Oxfordshire, UK.
2. **Brodie, J., Lewis, S., Davis, A., Bainbridge, Z., O'Brien, D., Waterhouse, J., Devlin, M.,** & **Thomas, C.R.** (2015) Management of agriculture to preserve environmental values of the Great Barrier Reef, Australia. In *Ecosystems Services and River Basin Ecohydrology*. (eds. Chicharo, L., Müller, F., & Fohrer, N.) Ecosystems Services and River Basin Ecohydrology. Pages 275-292. Springer, Dordrecht, Netherlands.
3. **Davis, A.M.**, **Lewis, S.E.**, **O'Brien, D.S.**, **Bainbridge, Z.T.**, Bentley, C., Mueller, J.M., & **Brodie, J.E.** (2014) Water resource development and high value coastal wetlands on the Lower Burdekin Floodplain, Australia. In: *Estuaries of Australia in 2050 and beyond*. (ed. **Wolanski, E.**). Springer, Dordrecht, Netherlands.
4. **Duke, N.C**. (2014) Mangrove Coast. In: *Encyclopaedia of Marine Geosciences* (eds. Harff, J., Meschede, M., Petersen, S. & Thiede, J.). Springer, Dordrecht, Netherlands.
5. Dunn, R.J.K., **Waltham, N.J.**, Benfer, N.P., King, B.A., Lemckert, CJ & Zigic, S. (2014) Gold Coast Broadwater: Southern Moreton Bay, Southeast Queensland, Australia. In: *Estuaries of Australia in 2050 and beyond*. (ed. **Wolanski, E.**). Springer, Dordrecht, Netherlands.
6. **Wolanski, E.**, Ducrotoy, J-P. (2014). Estuaries of Australia in 2050 and beyond – A synthesis. Pages 1-16. In: *Estuaries of Australia in 2050 and beyond*. (ed. **Wolanski, E.**). Springer, Dordrecht, Netherlands.

Journal Articles 2015

1. Alvarez-Romero, J.G., Pressey, R.L., Ban, N.C., & **Brodie, J.** (2015) Advancing land-sea conservation planning: Integrating modelling of catchments, land-use change, and river plumes to prioritise catchment management and protection. *Plos One* 10(12): e0145574. doi: 10.1371/journal.pone.0145574.
2. Barnett, A., Abrantes, K.G., **Baker, R.**, Diedrich, A.S., Farr, M., Kuilboer, A., Mahony, T., **McLeod, I.M.,** Moscardo, G., Prideaux, M., Stoeckl, N., van Luyn, A., & Sheaves, M. (2015) Sportfisheries, conservation and sustainable livelihoods: a multidisciplinary guide to developing best practice. *Fish and Fisheries*. doi: 10.1111/faf.12140.
3. Bartley, R., Croke, J., **Bainbridge, Z.,** Austin, J., & Kuhnert, P. (2015) Combining contemporary and long term erosion rates to target erosion hot-spots in the Great Barrier Reef catchments. *Anthropocene* 10, 1-12. doi: 10.1016/j.ancene.2015.08.002.
4. Boyero, L., **Pearson, R.G.**, et al. (2015) Latitudinal gradient of nestedness and its potential drivers in stream detritivores. *Ecography* 38, 949–955.
5. Boyero, L., **Pearson, R.G.**, et al. (2015) Leaf litter breakdown in tropical streams: is variability the norm? *Freshwater Science* 34, 759-769.
6. **Carter, A.B.**, Carton, A.G., McCormick, M.I., Tobin, A.J. & Williams, A.J. (2015) Maternal size, not age, influences egg quality of a wild, protogynous coral reef fish, *Plectropomus leopardus*. *Marine Ecology Progress Series* 529, 249-263. doi: 10.3354/meps11277.doi:10.1080/03721426.2015.1074338.
7. **Coles, R.G., Rasheed, M.A., McKenzie, L.J.**, Grech, A., **York, P.H., Sheaves, M., McKenna, S.,** & **Bryant, C.** (2015) The Great Barrier Reef world heritage area seagrasses: Managing this iconic Australian ecosystem resource for the future. *Estuarine, Coastal and Shelf Science* 153, A1-A12.
8. Connolly, N.M., **Pearson, R.G.**, Loong D., Maughan, M., & **Brodie, J.** (2015) Water quality variation along streams with similar agricultural development but contrasting riparian vegetation. *Agriculture, Ecosystems and Environment* 213, 11-20. doi: 10.1016/j.agee.2015.07.007.
9. Connolly, R.M., & **Waltham, N.J.** (2015) Spatial analysis of carbon isotopes reveals seagrass contribution to fishery food web. *Ecosphere* 6(9), 148. doi: 10.1890/ES14-00243.1.
10. **Creighton, C.**, Boon, P.I., Brookes, J. D., & **Sheaves, M.** (2015) Repairing Australia's estuaries for improved fisheries production - what benefits, at what cost? *Marine and Freshwater Research* 66, 493-507. doi: 10.1071/MF14041.
11. Critchell, K., Grech, A., Schlaefer, J., Andutta, F.P., Lambrechts, J., **Wolanski, E.**, & Hamann, M. (2015) Modelling the fate of marine debris along a complex shoreline: Lessons from the Great Barrier Reef. *Estuarine, Coastal and Shelf Science*, 1-13. doi: 10.1016/j.ecss.2015.10.018.
12. Dafforn, K.A., Mayer-Pinto, M., Morris, R.L., & **Waltham, N.J.** (2015) Application of management tools to integrate ecological principles with the design of marine infrastructure. *Journal of Environmental Management* 158, 61-73. doi: 10.1016/j.jenvman.2015.05.001.
13. Dao, H.T., Smith-Keune, C., **Wolanski, E.**, Jones, C.M., & Jerry, D.R. (2015) Oceanographic currents and local ecological knowledge indicate, and genetics does not refute, a contemporary pattern of larval dispersal for the ornate spiny lobster, *Panulirus ornatus* in the South-East Asian Archipelago. *Plos One.* doi: 10.1371/journal.pone.0124568.
14. **Davis A.M.**, **Pearson, R.G**. Kneipp, I.J., Benson, L.J., & Fernandes L. (2015) Spatiotemporal variability and environmental determinants of invertebrate assemblage structure in an Australian tropical river. *Freshwater Science* 34, 634-647.
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1. 15/02 Port of Weipa long-term seagrass monitoring: 2000-2014. Taylor, H.A., Rasheed, M.A., & Carter, A.B.
2. 15/03 Port of Karuma long-term seagrass monitoring: November 2014. Sozou A.M., McKenna, S.A, & Rasheed, M.A.
3. 15/05 Long term seagrass monitoring in Port Curtis: Quarterly permanent transect monitoring progress report 2009 to 2014. Davies, J., Sankey, T., Jarvis, J., Bryant, C., & Rasheed, M.
4. 15/06 Seagrasses in Port Curtis and Rodds Bay 2014. Annual long-term monitoring, biannual Western Basin, and updated baseline survey. Carter, A.B., Davies, J.D., Bryant, C.V., Jarvis, J.C., McKenna, S.A., & Rasheed, M.A.
5. 15/08 Port of Abbot Point proposed dredge footprint: Seagrass survey - December 2014. McKenna, S.A., & Rasheed, M.A.
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7. 15/08 Development of a molecular biology tool kit to monitor dredging-related light stress in the seagrass*Zostera muelleri ssp. capricorni* in Port Curtis. Final Report. Pernice, M., Schliep, M., Szabo, M., Rasheed, M., Bryant, C., York, P., Chartrand, K., Petrou K., & Ralph, P.
8. 15/09 Long-term seagrass monitoring in the Port of Mourilyan - 2014. York, P.H., Scott, E., & Rasheed, M.A.
9. 15/10 Seagrass habitat of Cairns Harbour and Trinity Inlet: Annual and Quarterly Monitoring Report 2014. Jarvis, J.C., Rasheed, M.A., & Sankey, T.
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12. 15/18 Reef Plan Herbert Water Quality Monitoring Program (HWQMP) Final Report for monitoring undertaken between 2011 and 2014. O›Brien, D., Nash, M., Di Bella, L., & Brodie, J.
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14. 15/24 Torres Strait dugong sanctuary - Deepwater seagrass monitoring - 2010-2015. Carter, A.B., Taylor, H.A., & Rasheed, M.A.
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31. 15/52 Extraction and identification of microplastics from sea turtles: method development and preliminary results. Caron, A.G.M., Thomas, C.R., Ariel, E., Berry, K.L.E., Boyle, S., Motti, C.A., & Brodie, J.E.
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37. 15/60 Shellfish Reef Habitats. A synopsis to underpin the repair and conservation of Australia's environmentally, socially and economically important bays and estuaries. Gillies, C.L, Creighton, C., & McLeod, I.M.
38. 15/61 Australia's saltmarshes: a synopsis to underpin the repair and conservation of Australia's environmentally, socially and economically important bays and estauries. Creighton, C., Gillies, C., & McLeod, I.M.
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2. 14/04 Port of Karumba long-term seagrass monitoring: November 2013 - March 2014. Taylor, H.A., McKenna, S.A., & Rasheed, M.A.
3. 14/05 Links between water quality and marine turtle health. Brodie, J., Ariel, E., Thomas, C., O'Brien, D., & Berry, K.
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5. 14/06 Long-term seagrass monitoring in the Port of Mourilyan - 2013: April 2014. York, P.H., Davies, J.N., & Rasheed, M.A.
6. 14/08 Development of a molecular biology tool kit to monitor dredging-related stress in *Zostera muelleri ssp. capricorni* in the Port of Gladstone Interim Report. Schliep, M., Rasheed, M., Bryant, C., Chartrand, K., York, P., Petrou, K and Ralph, P.
7. 14/09 Seagrass habitat of Cairns Harbour and Trinity Inlet: Annual & Quarterly Monitoring Report 2013. Jarvis, J.C., Rasheed, M.A., McKenna, S.A., & Sankey, T.
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27. 14/48 The effects of climate on seagrass in the Torres Strait 2011-2014. Carter, A.B., Taylor, H.A., McKenna, S.A., York, P.Y., & Rasheed, M.A.
28. 14/53 Gladstone Healthy Harbour Partnership pilot report card ISPO11: seagrass - Final Report. Bryant, C.V., Jarvis, J.C., York, P.H., & Rasheed, M.A.
29. 14/54 Baseline assessment of benthic communities (algae and macro-invertebrates) in the Port Curtis Region - November 2013. McKenna, S.A., Bryant, C.V. Tol, S.J., & Rasheed, M.A.
30. 14/55 Torres Strait mapping: Seagrass consolidation 2002-2014. Carter, A.B., Taylor, H.A., & Rasheed, M.A.
31. 14/56 Gladstone western basin & channel duplication BPAR monitoring - August-October 2014. Davies, J.N., Bryant, C.V., & Rasheed, M.A.
32. 14/58 Indigenous community capacity building to assess dugong and sea turtle seagrass habitats for sea country management. McKenzie, L., Johns, L., Yoshida, R., Smith, N., & Langlois, L.
33. 14/61 Environmental DNA (eDNA) survey of tilapia in the Fitzroy Basin. Noble, T., & Jerry, D.
34. 14/62 Environmental DNA (eDNA) survey of tilapia infestations in the Fitzroy River Basin. Jerry, D., & Noble, T.
35. 14/63 Environmental DNA (eDNA) survey of tilapia in the Lower Pioneer Catchment. Jerry, D., & Noble, T.

Member Publications

Book Chapters

1. **Lawton, R.J.**, Pratchett, M.S., Delbeek, J.C., Pratchett, M., Berumen, M., & Kapoor, B. (2014) Harvesting of butterflyfishes for aquarium and artisanal fisheries. In: Pratchett, M.S., Berumen, M.L., and Kapoor, B.G., (eds.) Biology of Butterflyfishes. CRC Press, Boca Raton, FL, USA, pages. 269-291.

Journal articles – 2015

2. **Abrantes, K., Barnett, A., Baker, R.,** & **Sheaves, M.** (2015) Habitat-specific food webs and tropic interactions supporting coastal-dependent fishery species: An Australian case study. *Review in Fish Biology and Fisheries* Volume 25(2), 337-363.doi: 10.1007/s11160-015-9385-y.
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