Australian Coral Reef Society

Annual Newsletter

Number 47, April 2018

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Australian Coral Reef Society

Note: Aboriginal and Torres Strait Islander readers should be aware that this publication may contain images or names of people who have passed away.

Editorial foreword

Dear Members,

Since our last Newsletter the fear of concurrent bleaching for another year did thankfully not come to fruition, while accounts of bleaching did roll in these were localised and not on the global scale seen in the years preceeding. Instead our minds and research has turned to understanding and documenting the recovery of Australian reefs following the disturbance. Many reef researchers are focusing on understanding our changing reefs - how they may look and function in the future - and developing new approaches and methods to bolster resilience and recovery. While these novel approaches do not claim to be the solution to the impacts caused by climate change, they are methods we may none the less need to incorporate in our quest to protect reefs. In this issue we include a number of special reports from the reef research community on their research paths in trying to understand reef recovery (pg 40-45).

In 2017 the ACRS was grateful for the amazing turn out at its annual conference, hosting a record number of speakers in Townsville. This destination also enabled us to build stronger ties with research partners including GBRMPA, AIMS and a number of NGO groups. On pages 7-8 attendees of the conference describe their experiences. The ACRS was also active in submitting a number of pertinent submissions which can be viewed on page 6.

This year we have continued with our Female Scientist in the Spotlight questionnaire and give you insight into the lives of some inspiring female reef scientsts. Read more on pages 21-25. This edition we are thrilled to have a great variety of reef stories in Reports from the Reef - catch up on the latest science (pages 26-38). This year's newsletter also includes a GBRMPA special report detailing some of their main activities over the past year, driven mainly by their Reef Blueprint (read more on pg46-47). And of course it would not be a complete Newsletter without news from our Research Stations (pg 48-53).

We look forward to the upcoming 2018 conference in Exmouth where many of you will take a dive with whale sharks and mantas, and explore the unique scenery of the area. We have also made a few adjustments to our regular meetings, adjoining the annual AGM with the annual ACRS Conference. We hope this enables more councillors and ACRS members to attend and partake.

Finally we have also launched our new website! The main driver behind this was councillor Maria Palacios. She did an amazing job bringing a fresh and modern face to the ACRS. Thank you Maria!

We hope you enjoy this addition of the ACRS annual Newsletter!

Happy reading.

Carrie Sims, Newsletter Editor

Newlletter Team: Paloma Matis, Samantha Goyen and Maria Palacios Otero

The Australian Coral Reef Society boasts a talented membership, both in the sciences and other pursuits. Many of the photos in this edition of the newsletter were taken by ACRS members.

Cover photo: 2017 ACRS Conference Photo Competition entrant and PhD student, Mikaela Nordberg, captured this close up photo of *Acropora millepora* releasing gamete bundles during the 2016 October coral spawning at the Australian Institute of Marine Science, Townsville.

Message from the President

There is little doubt the past few years have been some of the most challenging for coral reefs, both nationally and internationally. The increasing frequency of severe and widespread thermal bleaching events paints a bleak picture for the future of reefs. While there are numerous initiatives aimed at promoting the resilience and recovery of reefs, direct actions addressing climate change remain the elephant in the room. Public statements indicate most Australian politicians are aware of the impacts climate change is having on coral reefs and give us some hope. However, this view is not reflected in government policy that continues to place short-term economic development ahead of the environment. The ACRS and the broader scientific community have a critical role to play in tackling such policy dissonance. By continuing to investigate, and raise awareness of the effects of ongoing climate change on Australian coral reefs and the communities and industries that derive a benefit from them, I believe we can make change.

It has been another busy year for the ACRS with the development of several submissions to government agencies on topics ranging from the Australian Marine Parks Network (AMPN) draft management plans to the independent review of the governance of the Great Barrier Reef Marine Park Authority. We also sent three councillors to the annual Science meets Parliament event in Canberra (13-14 February), and met with Hon Mark Butler MP (Shadow Minister for Climate Change and Energy) in Brisbane to discuss the key issues that are impacting Australia's coral reefs. On behalf of the ACRS I would like to thank all those councillors and members who have given their time and energy to the preparation of submissions and policy briefs.

Despite the challenges facing coral reefs, the last 12 months have been very successful for the ACRS. The 90th ACRS conference held in Townsville (16-19th July) was one of, if not the, largest meeting ever with approximately 200 delegates attending. The conference was a huge success, with many exceptional presentations over the two days, highlighted by keynote presentations from Terry Hughes, Britta Schaffelke, and Nick Graham. I would like to extend my gratitude to our sponsors and to the council, in particular Selina Ward and Jenni Donnelson for their efforts in making the Townsville conference such as success. The 91st ACRS conference will be held in Exmouth from the 15-17th May, and is shaping up to be another successful meeting, and the first ACRS conference to be held in WA in over a decade.

The ACRS has performed exceptionally well in 2017 with a strong membership and healthy financial position. Thank you to our Treasurer Jenni Donelson, Membership Manager Stephanie Duce, and Secretary Selma Klanten for their tireless efforts in these roles. I would also like to acknowledge and sincerely thank our Web Manager Maria Palacios for coordinating the development of our new website. I am sure you will agree it is a great improvement. Thank you to Carrie Sims and her team for compiling the newsletter, Becky Fox and her team for assessing the student research and travel grants, and David Booth for coordinating and assessing the ACRS medal nominations. I would also like to make special mention of Ross Hill who has served on council for > 10 years, and has remained on council despite moving away from research several years ago.

Andrew Hoey

ACRS President

Photo:V. Huertas

Australian Coral Reef Society in 2017

As a scientific society, ACRS is active in many streams not just research. We frequently make submissions to government departments and press releases to the media regarding issues which affect Australian coral reefs; send councillors to attend the annual Science Meets Parliament to discuss current reef issues with parliamentarians; host an annual conference bringing together the reef science community to present and discuss recent research efforts; and recognise through various awards the achievements of all people connected to the reef. In the following pages we highlight the activities of the ACRS in 2017.

2017 Australian Coral Reef Society Council

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Coral reef scientists: how will you lead change?

ACRS Councillor Dr Sarah Hamylton

Senior Lecturer, University of Wollongong

This opinion piece is a part of ACRS' Scienstists Commentary, and is an edited version of an opion piece recently published in Nature (Hamylton, S. M. 2018, Nature, 554: 137)

The news that half of the coral on the Great Barrier Reef has now died from bleaching may prompt some of us to question the utility of our work as coral reef scientists. Reef scientists have spent decades studying the potential impacts of climate change on coral reefs: observing corals in aquaria, designing experiments on reef flats, diligently swimming down belt transects making notes about communities. We warned of what would happen, and it did. As someone who has been mapping, monitoring and modelling the effects of climate change on reefs for almost two decades, much of that work seems futile now. The ***'super wicked'*** problem of climate change has begun to wreak visible havoc over the last couple of years. It is widely acknowledged that the root cause of coral bleaching on the Great Barrier Reef is climate change, driven by anthropogenic carbon emissions. This is the ultimate collective action problem. It is global in scope and socially complex. ***Developing a solution to this problem requires a strong central authority that does not exist and time is running out.***

The focal breadth of Anna Krien's Quarterly essay "***The Long Goodbye: Coal, coral and Australia's Climate Deadlock***" neatly demonstrated that the fate of Australia's Great Barrier Reef is embedded in political and economic dynamics. Global climate and energy policy govern the fate of coal-fired electricity generation and investment in renewable energy infrastructure. In Australia, decisions on proposals to mine coal in the Galilee Basin or develop solar thermal plants in Port Augusta are widely reported as being influenced by political donations, royalties, taxes and corruption. The problem of coral bleaching on the Great Barrier Reef is a people problem that ***weighs heavily on the national conscience and has implications for Indigenous communities, tourism operators, fishers, farmers, miners, workers, local councillors and federal politicians.*** Acknowledging this provides comfort to reef scientists. It prompts us to think about potential alternative roles in which we can make a difference.

As David Ritter (CEO of Greenpeace Australia) wrote in response to the Quarterly Essay "the presence of an effective opposition to big business's vested interests cannot be taken for granted. Indeed, attempting to silence democratic challenge is clearly part of the coal industry's strategy… The price of liberty is eternal vigilance, and the democratic space can never be taken for granted, even in Australia". ***Becoming a council member of the Australian Coral Reef Society (ACRS) has provided me with a supportive avenue for advocacy, offering a different form of vocal expression of the science I have carried out.*** The world's oldest society for protecting coral reefs, the council of the ACRS is an informed and well-connected group of individuals who care deeply about coral reefs. They have a track record of standing up for change. In 2015, they gave a voice to over three hundred concerned scientists in the 'Coal versus Coral' war when the Great Barrier Reef Marine Park Authority had approved a proposal to dump 5 million tonnes of dredged sediment from Abbot Point into the Great Barrier Reef World Heritage Area. This environmentally-disastrous decision was reversed when the ACRS made their view known, alongside conservationists, tourism operators, grassroots organisations such as Get Up!, Greenpeace and the Indigenous climate group Seed Mob. To keep up the pressure, we wrote to Prime Minister Malcolm Turnbull urging immediate action to curb climate emissions.

It is ***important not to confuse scientific objectivity with political objectivity.*** If we do so, there is a danger that we remain silent when coral reef scientists have the unique knowledge needed to make a difference to one of Australia's most valued coastal assets. As Charlie Veron told ABC's Radio National in 2016: "I am someone who can actually do something about it. I am someone who is listened to and I have made a difference. And so I have to keep on doing that. It's not as if I can say, "to hell with it", and go and do some gardening". ***We cannot walk away because we have responsibility to lead change. How will you lead the change you want to see?***

Australian Coral Reef Society Submissions

- **ACRS submission to the Australian Marine Parks Network (AMPN) draft management plans**

- **ACRS support for revision of Scientific Diver Training Standard (AS/NZS 2815.6:2013)**

- **ACRS letter to PM Malcolm Turnbull requesting immediate action to reduce carbon emissions to protect the Great Barrier Reef**

- **ACRS submission to the independent review of the governance of the Great Barrier Reef Marine Park Authority**

- **ACRS science-based policy plan for Australia's coral reefs**

All submissions are downloadable from the ACRS website www. australiancoralreefsociety.org

Photo: K. Cameron

ACRS 90th Conference Highlights Townsville, 2017

These are just a few of the many stunning images ACRS members submitted for the conference photo competition. Photo credits (top to bottom): V Huertas, L Richardson, C Caballes, L Stoltenberg.

In 2017 the ACRS hosted their 90th Conference in Townsville. This destination was chosen not only as it is well known as the 'home' of many a marine scientist but to build stronger connections with our partners in reef research, including AIMS and GBRMPA, to name a few. As you will see from the following attendee reviews, the conference was a huge success and drew a record number of speakers.

"This was my first ACRS conference but it was a good way to start! I had both an enjoyable and valuable two days listening to some great talks and networking with people both from my field and other fields. I presented a poster, which was also a first for me and although I was a little daunted before, I found the whole experience great fun. Everyone I spoke to was really interested and asked some great questions about my project. I found it really helpful to see my PhD from other people's viewpoints and got some good feedback on my ideas. I found the whole conference had a really friendly atmosphere and was welcoming to both students and researchers and I hope I will get the opportunity to go again next time!" **Tess Hill**

"As a first-time conference attendee I wasn't quite sure what to expect when I found out that my abstract had been accepted for the 2017 ACRS conference. Simultaneously excited and terrified is probably the closest description that comes to mind. To, as a student, get the chance to meet and present in front of so many of the prominent researchers in the field was a fantastic experience for me especially as the conference was such a welcoming and supportive environment. Meeting and hearing talks by both the inspiring members of the society as well as students, not to mention the key note speakers, was a great learning experience that I thoroughly recommend to any commencing PhD student. The reception of me and my seminar talk at the conference has encouraged me greatly and I look forward to attending future ACRS conferences." **Mikaela Nordborg**

"I live in a small coastal town in northern NSW, where marine biologists are not exactly rare but neither are we common. The opulent smorgasboard of coral reef science on offer at ACRS conferences is therefore always a treat, and 2017 did not disappoint. I really valued the networking opportunities with renowned and established senior scientists, as well as with other early career researchers like myself. I scribbled pages of notes during the many excellent presentations and filled up my phone with pics of PowerPoint slides - these have already been helpful in informing my research on returning home. Huge thanks to the organisers for pulling ACRS2017 together, the conference was enjoyable, stimulating and exciting, despite the dark times we all know corals are currently facing." **Kerry Cameron**

"The 2017 ACRS Conference was a fantastic experience to initiate my career in communicating my scientific research to others. I was extremely impressed with the quality of talks and the diversity of subjects covered in such a short period of time. I could listen to a talk about modelling the population dynamics of Crown-of-Thron starfish, then change rooms and hear about the evolutionary histories of parrotfishes; truly diverse. Coming from JCU, it was great to learn about all the research that is produced from the Marine department at the university. It allowed me to connect the research I hear about to the faces I commonly see around campus. Additionally, I really enjoyed networking and meeting people from other Universities and institutions. Conferences are some of the only occasions we as researchers get to meet and converse with people from different institutions, so I found the social events equally as helpful as the talks. This was a great intro into communicating my research to others and I am eagerly looking forward to attending next year's conference!" **Christopher Hemingson**

ACRS would also like to extend its sincere gratitude to its conference sponsors.

ACRS 2017 Conference Prize Winners

- Michael McWilliam – Vicki Harriott Award sponsored Outstanding Presentation Award – $500 cash "Regional differences in the diversity and redundancy of coral functional roles"
- Maarten De Brauwer – Scuba Pro sponsored Outstanding Presentation Award– "Biofluorescence as a survey tool for cryptic marine species"
- Christopher Hemingson – Remote Area Dive sponsored Outstanding Presentation Award– "Biogeographic patterns in major marine realms: function not taxonomy unites fish assemblages in reef, seagrass and mangrove systems"
- Sofia Jain-Schlaepfer – Lizard Island Research Station Award – "Managing noise stress in fish embryos: Fish embryos show stress responses to recreational boat noise that differ with engine type"
- Mikaela Nordborg – Orpheus Island Research Station Award – "The phototoxic effects of hydrocarbon fuels on coral larval settlement"
- Kerry Cameron – One Tree Island Research Station Award – Outstanding Presentation for Field Based Research – "Restoring corals on degraded reefs with enhanced supply of larvae"
- Wing Yan Chan – Heron Island Research Station Award – "Generating novel genetic diversity through hybridization as a tool to increase coral climate resilience"
- Tessa Hill - Reef & Rainforest Research Centre Best Student Poster prize - "Predation pressure of butterflyfish on coral communities may decrease under ocean acidification"

Colouring-in competition winners:
Lucy Jackson
Ahlii
Thanks to ReefHQ for providing each winner with a family pass.

Photo competition winners:
Overall winner: Victor Huertas
Science in Action: Mikaela Nordborg
Macro: Ciemon Caballes
Diversity: Christopher Brunner
People's choice: Maarten De Brauwer

Colouring in competition winner Lucy with ACRS President Andy Hoey and Councillor Dr Stephanie Duce

Student talk prize winners with ACRS President Andy Hoey

The ACRS Medal for Science Advocacy

Dr Russell Kelley

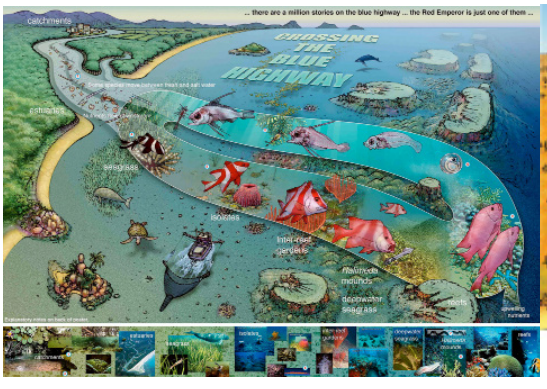
Since 2015, the ACRS has awarded a prestigious medal to recognise high achievers in the research and conservation of Australian coral reefs each year. The 2017 ACRS medal for Science Advocacy was awarded to Dr. Russell Kelley for his exceptional role communicating coral reef science, and contributions to science education and conservation.

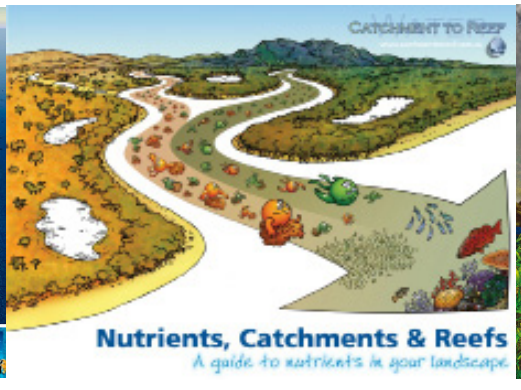
Russell has been a member of the ACRS since the early 80's starting out his career as a coral reef geologist at Queensland University working on the famous raised reef terraces of the Huon Peninsula, PNG. Initially fascinated by the geological "big picture" of how reef systems survive in time and space, the late 80's found him moonlighting as a biologist in the "novel compound / drug discovery" programs at JCU and later AIMS where he broadened his interests in natural history to include the dark art of coral identification.

In 1990 he quit "institutional life" bought a boat and went sailing all over the GBR and Torres Straits returning two years later to join a nascent underwater film making group as science communicator and field director. This led to a decade writing, directing and producing natural history television with a company that developed the world's first underwater High Definition television systems. Along the way his passion for mixing science and technology led to many interesting collaborations with the extended scientific community starting with the James Cook University coral reproduction group in the late eighties / early nineties. Back then the idea of taking large broadcast video cameras underwater was radical and expensive, but it improved the standard of underwater imaging and enabled exciting new vistas like the use of medical boroscopes and optic fibre lighting to reveal the polyp world in new and interesting ways. See "Down among the polyps" at: www.russellkelley.info/video/natural-history/sex-on-the-reef/

Russell's geological background left a lot of fingerprints on his storytelling typically as an overlay of big-picture context and meaning. The 1993 film Sex on the Reef contains a very early use of 3D computer animation in the natural history genre to illustrate the importance of mass spawning and dispersal to sessile marine organisms grappling with plate tectonics and climate change. While primitive by todays standards this pre Jurassic Park animation set off ripples in the biological story telling community. See: www.russellkelley.info/video/animation/sex-on-the-reef/

In the dawn of the digital era mainstream television was slow to take up the story telling opportunities made possible by animation and multi-layered digital composites. This led to a collaboration with Digital Dimensions to visualise larval dispersal and asexual cloning using digital techniques in the 1997 film





Ocean Empires. While outwardly a traditional natural history of reefs, Ocean Empires is an early example of dynamic multi-layered natural history storytelling in the way it represented the planktonic world. See the clips at www.russellkelley.info/video/animation/ocean-empires/

Around this time Russell approached the ACRS for assistance to publish a graphic illustrating the connectivity of reefs with other habitats and the importance of these connections to ontogenetic migration. The Blue Highway was reprinted three times and used extensively as a communication tool by the GBRMPA during the rezoning of the GBR marine park. Subsequently, it has been repurposed and republished in many publications around the world. See: www.russellkelley.info/print/the-blue-highway/

Over the next decade Russell's science communication activities focussed on visualising research into catchment processes and the connections between land and sea. See http://www.russellkelley.info/print/burdekin-water-quality-plan/ Many of Russell's striking collaborations with artist Gavin Ryan can be seen here: www.russellkelley.info/print/

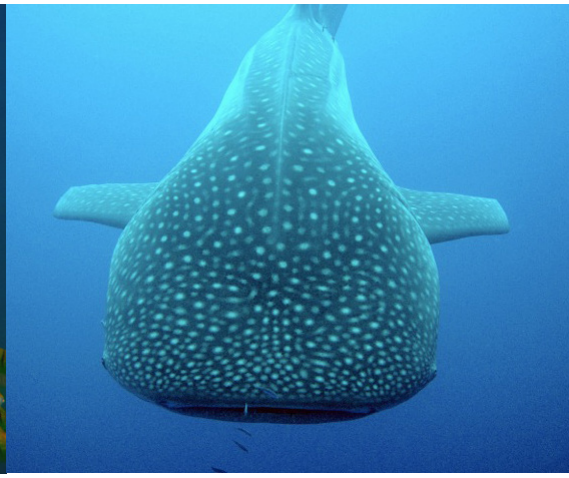
Since 2000 Russell's work (with life partner and marine park manager Rachel Pears) has had an ocean literacy focus centred around capacity building using the Coral Finder and the Reef Finder - two publications supported by the ACRS. The Finder guides are novel in that they are not just books but Visual Decision Tools (VDT's). By minimising text and using well crafted image sequences VDT's like the Coral Finder have made challenging subjects like coral identification much more approachable. By interrogating a visual index (think visual hyperlinking) and minimising technical text, the users can be empowered to solve complex problems like coral and biodiversity ID with little formal training. To date Russell and Rachel have trained over 600 people in coral identification and their guides are used in over 60 countries. See: www.byoguides.com

With the advent of the internet and our hyper-digital lifestyle the traditional role of a dedicated "science communicator" has gradually eroded. Today the responsibility for science communication is falling more and more on scientists themselves (have you tweeted yet today?) leaving less opportunity for the kinds of collaborations to be seen at www.russellkelley.info Today Russell is increasingly involved in corporate communications for companies that have specialist marine factual requirements. According to Russell there are more BYOGUIDES in the pipeline including the 'Beach Finder: a guide to gifts from the sea.' and, "if I can find a way to pay for it" the 'Acropora Finder - an easy-to-use introduction to the 60 most common and widely distributed Acropora species'.

To purhcase one of Russell's guides head to his website: http://www.byoguides.com/

Australian Coral Reef Society
91st Conference & AGM





Come join us in Exmouth for whale shark season and another great conference!

Ningloo Centre, Exmouth, WA
15-17 May 2018

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Australian Museum Lizard Island Research Station

Welcome Function
at Froth Craft Micobrewery
Tuesday 15 May 2018

National Student Mentoring Day - Coral ID Course
Sponsored by ARC Centre of Excellence for Coral Reef Studies
Tuesday15th May 2018

AGM
at the Ningaloo Centre
Thursday 17th May 2018

#ACRS2018
follow our official conference hashtag

Conference keynote speakers include
Professor Daniel Pauly, University of British Columbia
Professor Jessica Meeuwig, University of WA
Professor Graeme Cumming, ARC Centre of Excellence for Coral Reef Studies
Associate Professor Tracey Ainsworth, University of NSW
Dr Shaun Wilson, WA Deptartment of Parks and Wildlife

Photo Competition
Deadline: 4 May 2018. Email entries to: austcoralreefsoc@gmail.com

Whale Shark Tours
15, 18 and 19 May 2018. Book when registrering online.

ACRS members love whale sharks (photo credits L to R: A Cresswell, K Wolfe, R Ferari).

Science Meets Parliament 2018

Trading wetsuits and field gear for formal attire and gala dresses is not something marine scientists do every day (perhaps for good reason) but this year three Australian Coral Reef Society Councilors did just that. Rebecca Fox, Samantha Goyen and Stephanie Duce joined over 240 other scientists from around Australia for the 19th annual Science meets Parliament (SmP) event in Canberra. Hosted by Science and Technology Australia, the event gives STEM professionals the opportunity to meet with politicians and the training to communicate their science and (hopefully) make those meetings count.

ACRS Councilors attending SMP 2018 (left to right): Dr. Stephanie Duce, Samantha Goyen and Dr. Rebecca Fox

Day One was devoted to thinking about the challenges of communicating science to politicians and preparing us for upcoming meetings with parliamentarians. We had motivating presentations and panels featuring the crème de la crème of Australian science including Chief Scientist Dr Alan Finkel who gave us four pieces of advice to ensure a happy "marriage" between scientists and parliamentarians

1) Uphold the integrity and rigor of the scientific method, don't exaggerate or trivialize findings, be they good or bad;
2) Be in it for the long haul, don't expect political meetings to pay off until years into the future;
3) Communication is key, keep your audience in mind and put your content into their context;
4) keep up the maintenance and renovations, identify priorities and plan investments into the future.

On Day Two the meetings between scientists and our assigned parliamentarians took place. Steph met with Brian Mitchell a Labour MP from Tasmania; Sam met with Trevor Evans, the Liberal member for Brisbane and Becky with Labour MP Peter Khalil, member of House of Representatives' Energy and Environment Standing Committee. The meetings were all positive and informative with the politicians interested to hear about what we were working on and updates on the state of the GBR, specifically the science and technology providing

the solutions to best deal with the current problems facing the reef. A highlight of the day was attending the inspirational and visionary address to the National Press Club by Professor Emma Johnston who encouraged long-term, coordinated investment by government into science creating "the ultimate renewable resource: knowledge".

An overarching and positive theme of the event was diversity in STEM, particularly encouraging women and people from indigenous and minority backgrounds to excel in STEM careers. The event's organisers can be congratulated for putting their words in to action with an inspirational crowd of amazing female scientists, journalists and politicians presenting, chairing and participating in all the sessions. Other highlights included:

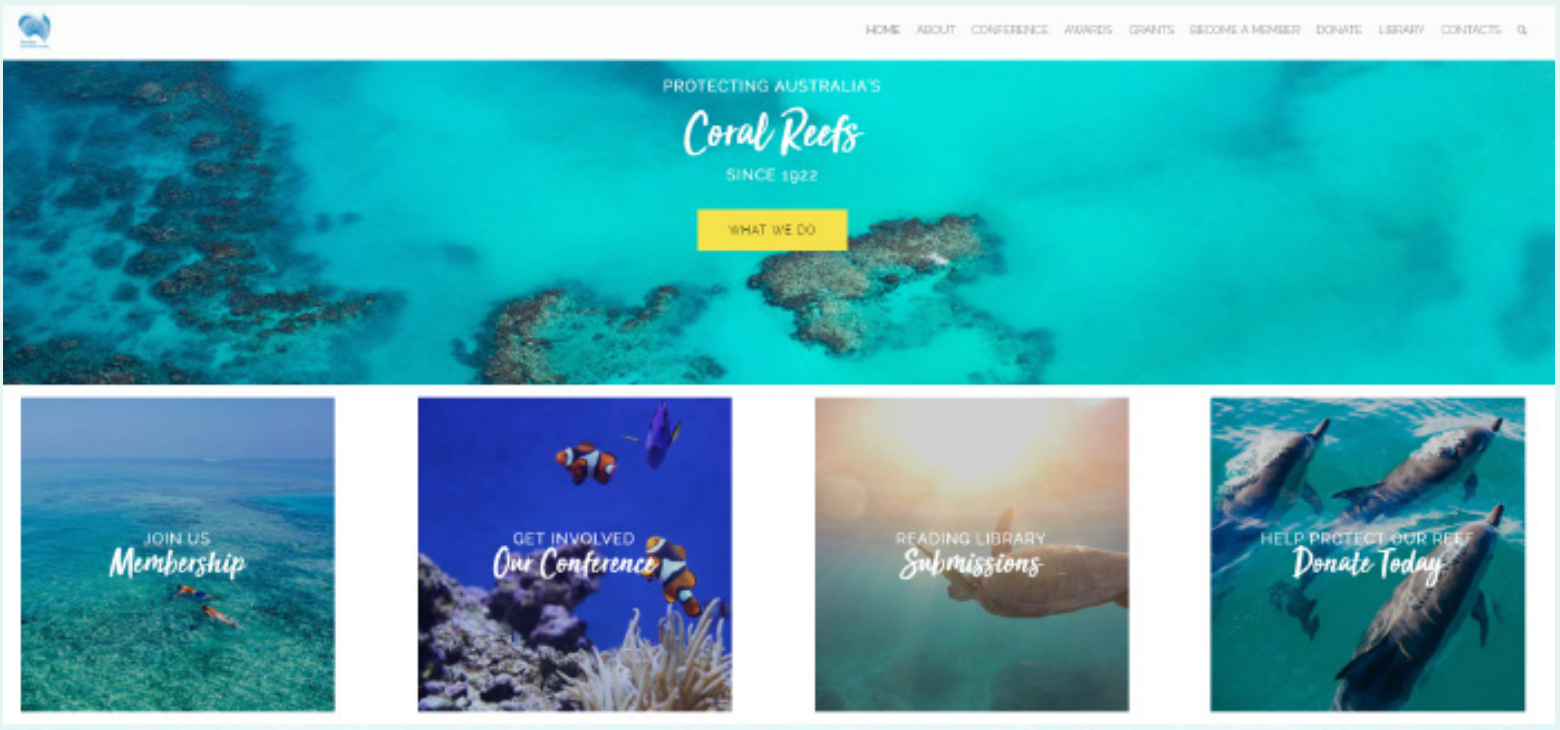
- A tasty gala diner in the Great Hall at Parliament House including addresses by the leader of the Labour Party the Hon. Bill Shorten, and Minister for Jobs and Innovation the Hon. Michaelia Cash
- The announcement of continued funding for the Superstars of STEM program, supporting Australia's leading women in STEM
- A thrilling, inside look at the frenetic rush when the bells start to ring and parliamentarians have four minutes to get to the chamber and make their vote count
- A front row seat in the Public Gallery for a dramatic Question Time
- A colourful wall of doughnuts presented for morning tea at the Australian National Gallery.

We thank the ACRS Council for this opportunity to attend the event and to represent the ACRS to our nation's politicians and scientific community, especially as it is International Year of the Reef. For the three of us, the experience was eye-opening both in terms of thinking about how science is perceived by non-scientists and how we can deal in solutions, rather than just communicating problems. They say that you can't understand a person's point of view until you have walked at least a mile in their shoes. As scientists we are trained in the importance of detail, but in the frenetic world of policy and policy-making, the reality is that you must be across many issues simultaneously and the agenda is constantly changing. While we think of the future, politicians are running the present. You need to be able to summarise your science and its ability to transform the world in 30 seconds – can you do it?

Left to right: Mr Matthew Sherlock (CSIRO Marine Research, Tasmania), Professor Barbara Messerle (Dean, Faculty of Science and Engineering, Macquarie University), Mr Brian Mitchel MP (Labour Member for Lyons, Tasmania), Dr Stephanie Duce (Australian Coral Reef Society)

The Australian Coral Reef Soceity's new website is live!

What a change! The new ACRS website has all the old features and more. We hope you enjoy our fresh new look, spend time exploring our submissions from past and present, and keep informed with upcoming conferences and other events.



Take a look at the ACRS 2017 student award reports

2017 photo competition winner: C. Caballes. Category: Macro

Terry Walker Award
Emmanuel Marquez Legorreta

"Visual Learning in a Changing World"

Hunting for fish with a hand net is not that easy!

One of the aims of my PhD is to investigate visual learning in reef fish and locate areas in their brain involved in this process. Fish are a very interesting model to study this subject, as some fish are capable of learning to discriminate complex visual stimuli like optical illusions or human faces (1, 2). A reef fish species, the Ambon Damselfish, uses facial patterns to recognize each other (Figure 1A) and can learn to discriminate a pair of stimuli in only a few days after being caught! (3). Some studies have suggested that some reef fish, including Ambon Damselfish, may have impairments on their vision and learning abilities due to ocean acidification (4, 5). So, as part of my PhD, I performed behavioural experiments where I trained Ambon Damselfish to test some of the neuroanatomical and environmental factors involved in their visual learning abilities. Thanks to the ACRS Terry Walker Award, I was able to run some of these experiments at the Heron Island Research Station. I collected Ambon Damselfish while snorkelling and on SCUBA, then proceeded to train them using food rewards, very similar to how you would train your dog (Figure 1B-D).

I separated the fish in different training groups and when they reached specific learning criterions we dissected their brains for histological processing. This was done to be able to locate areas of the brain that were active while the fish was learning the discrimination task. This will help us understand how fish process visual learning in normal conditions and can be used as a reference point for studies testing environmental changes. It will also help us understand how their little brains are able to solve these tasks.

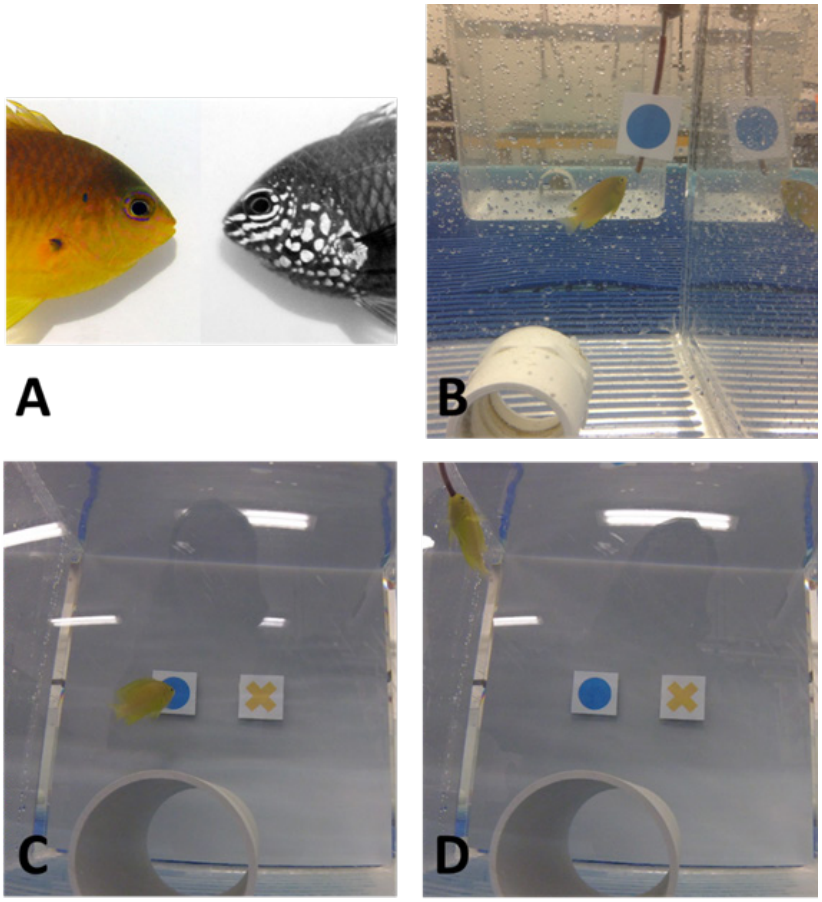


Figure 1: A: Facial patterns of Ambon damselfish; B: Fish being trained; C: fish in the discrimination task; D: fish receiving food after correct choice.

I am sincerely grateful to the Australian Coral Reef Society for providing me with the opportunity to perform this research using the funding from the Terry Walker Award. This research was also supported by the School of Biomedical Sciences, University of Queensland and the HIRS scholarship. I would like to thank Heather Middleton for her assistance in the field, as well as the staff at Heron Island Research Station. Fish were collected under the Great Barrier Reef Marine Park Authority permit G15/37305.1

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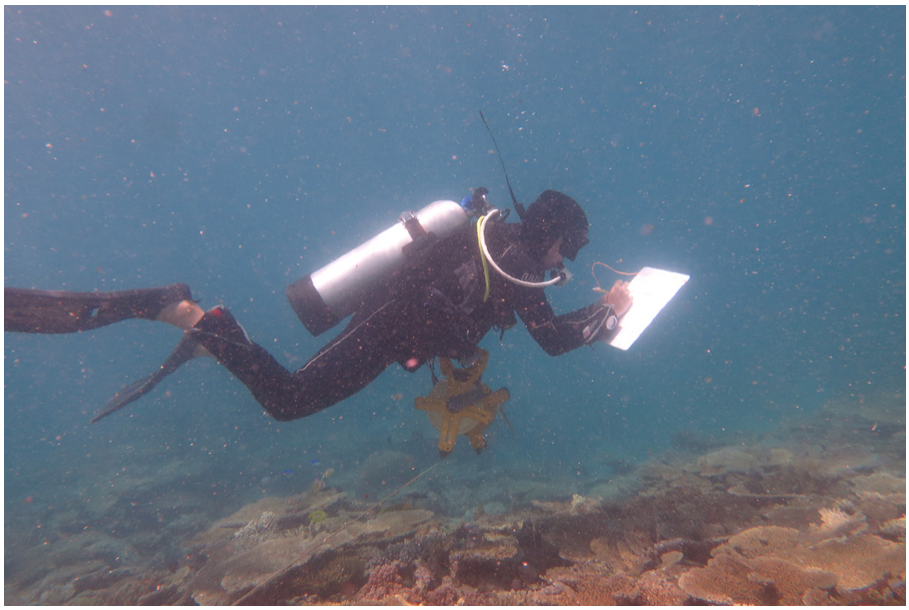
Temperature-driven variability in the consumption rates of herbivorous fishes along a latitudinal gradient of Great Barrier Reef.

Alexia Graba-Landry and Andreas Dietzel prepping data sheets on Wistari Reef. Credit: Andrew Thompson, 12/2017

Ocean warming is one of the greatest threats facing marine ecosystems. Increasing temperatures are already impacting species-level performance, distributions and abundances, which further alters community composition and trophic interactions. Low-latitude biomes (including coral reefs) are predicted to be the most sensitive to increasing temperatures as they have evolved under relatively invariable conditions. Herbivorous fishes play a pivotal role in structuring coral reef communities by regulating algal biomass. Understanding how increasing temperatures impact herbivore-algal dynamics is a crucial, yet understudied, aspect of determining how coral reefs will function in a warmer world.

To determine just how sensitive this process is to temperature, and whether low-latitude populations may be more at risk, feeding of different herbivorous fishes was quantified along a latitudinal gradient on the GBR, which spans 1,200 km and varies from 3-4ºC in sea surface temperature. Feeding was quantified at three reef crest sites at three latitudinal regions: Lizard Island (North), Trunk Reef and Rib Reef (Central) and Heron Island (South). Fish species were selected based on their abundances at each site and to represent distinct functional feeding groups (i.e., detritivore, browser and cropper), including: *Ctenochaetus striatus* (Lined Bristletooth: detritivore), *Siganus doliatus* (Barred Rabbitfish: cropper) and *Naso unicornis* (Bluespine Unicornfish: browser). As each species targets a different food source with similar observed patterns in feeding across latitudes, differences may be more likely attributed to changes in temperature as opposed to changes to the food source itself. Herbivore abundance and benthic surveys were also conducted to assess whether resource availability and/or competition may also be driving latitudinal patterns in feeding.

Preliminary findings suggest that temperature may be the main driver determining latitudinal patterns in feeding of these herbivorous fishes, with southern populations feeding at a slower rate than northern populations across all three different functional feeding groups. This could suggest that northern populations are closer to their thermal optimum as they are feeding at a greater rate to support energetic demands in warmer conditions. Thus, northern populations may be more at risk from increasing temperatures – already sitting at their upper thresholds.



Alexia conducting herbivore abundance surveys on Heron Island. Credit: Andreas Dietzel, 12/2017.

Browsing school of Naso unicornis and Naso tonganus on Heron Island Reef. Credit: Alexia Graba-Landry,

Additionally, northern populations may be under greater consumer pressure post-coral bleaching, as dead coral skeletons are rapidly overgrown by turf algal assemblages. These findings help to better understand the influence of temperature on herbivore-algae dynamics on coral reefs, and to provide baseline data on feeding rates in a changing ocean. This should be used to inform and improve climate change management on the GBR, and beyond.

Acknowledgements

Thanks to the Australian Coral Reef Society for funding research at Heron Island Research Station. This project was also funded by the Holsworth Wildlife Research Endowment and the Lizard Island Reef Research Foundation. Huge thanks to my supervisors, Andrew Hoey, Morgan Pratchett, and volunteers at all latitudes: Zoe Loffler, Eva McClure, Elena Smith, Josh Themes, Joel Kidgell, Kelly Hannan, Cassy Thompson, Andreas Dietzel and Andrew Thompson for their assistance in the field, as well as the staff from the Kirby Research Vessel, and both Lizard Island and Heron Island Research Stations.

Alexia Graba-Landry and Andreas Dietzel deploying cameras and conducting fish observations at Heron Island Reef. Photo by Andrew Thompson, December 2017.

ACRS Research Prize
Zoe Loffler

"Herbivory of Juvenile Brown Seaweeds"

There is little doubt that coral reefs are under increasing pressure from global climate change, and a range of local stressors including nutrient and sediment runoff, fishing, crown-of-thorns starfish outbreaks and cyclones. The combined effects of these stressors are reducing the cover of live coral and opening up space for the settlement of other benthic organisms, in particular macroalgae, or seaweeds. If the growth of these macroalgae goes unchecked it can quickly proliferate and dominate entire reefs. As such, studies investigating the contribution of herbivores to the removal of macroalgal biomass on coral reefs are vital. Several recent studies have revealed that only a limited suite of herbivorous fish species consume large canopy-forming macroalgae (i.e. browsers) and may be capable of reducing macroalgal biomass and reversing macroalgal-dominated states. The vast majority of herbivorous fishes feed on surfaces covered by the epilithic algal matrix (EAM - a conglomerate of filamentous algae, macroalgal propagules, microbes, detritus, sediment and invertebrates). These grazing fishes are thought to remove small seaweed propagules within the EAM and thereby prevent the establishment of adult macroalgae, however, there is little direct evidence that grazing fishes actually remove macroalgal propagules when feeding.

Figure 1: Newly settled *Sargassum* propagules growing on settlement tiles (tiles with crevices not pictured). Photo: Alexia Graba-Landry

Research on the survival of early life stages of macroalgae has been limited by the small size and cryptic nature of recently-settled macroalgal propagules. As such it is currently unknown which species, if any, of grazing fishes contribute to the mortality of macroalgal propagules, or how the complexity of the microhabitat to which propagules settle may influence the susceptibility of juvenile seaweeds to grazing fishes. For example, crevices have been shown to reduce mortality in newly settled corals. Using the brown, canopy-forming seaweed, Sargassum, as a model species, my research aims to investigate the susceptibility of Sargassum propagules to grazing fishes, identify which fishes consume Sargassum propagules (juveniles <3mm tall) within the EAM, and determine whether microhabitat complexity (i.e. crevices) can offer Sargassum propagules refuge from herbivores.

This research was conducted at Lizard Island in the northern Great Barrier Reef. Sargassum with mature receptacles (i.e., reproductive) was collected from nearby inshore reefs and placed into a large (300L) aquarium. Terracotta

settlement tiles (10x10x1cm) with four crevices (4mm deep) along the length of their upper surfaces were placed on the bottom of the aquarium. A cold-water shock was used to stimulate the Sargassum to release propagules into the aquarium, and the propagules were allowed to settle on the tiles. After three-weeks, the number of propagules on the exposed upper surface of the tiles and in the crevices was quantified using replicate 4x25 mm ($1cm^2$) quadrats under a dissecting microscope. To determine the susceptibility of three-week old Sargassum propagules to grazing fishes, the tiles were placed on both the reef crest and reef flat for five days. Half of the tiles were caged (to control for handling effects) and half were exposed to herbivores. The exposed tiles were videoed once per day using GoPro cameras to identify the fishes removing the propagules. After the five days, the tiles were collected and the propagules re-quantified.

Preliminary results show that the survival of *Sargassum* propagules was higher for those growing in crevices than on the exposed upper surfaces of tiles. Further, the survival of propagules within crevices on exposed tiles was directly comparable to those on caged tiles, suggesting that the crevices offer a refuge from herbivory. Although video analysis is not yet complete, preliminary analysis suggests that it is likely the feeding of blennies such as *Ecsenius stictus,* rather than larger grazing fishes, that is responsible for the removal of propagules at these early life stages (Fig. 2). If these initial video observations are representative of the feeding on the tiles, my results suggest that these small, and often overlooked fishes could play a critical role in preventing the establishment of macroalgae on stressed reefs. Additional experiments investigating other aspects of herbivory of *Sargassum* propagules are ongoing.

I would like to sincerely thank the Australian Coral Reef Society for their contribution to this research through the ACRS award, my supervisors Andrew Hoey and Morgan Pratchett, all my volunteers: Alexia Graba-Landry, Eva McClure, Joel Kidgell, Kelly Hannan and Gigi Torras-Jorda, and the staff at Lizard Island Research Station.

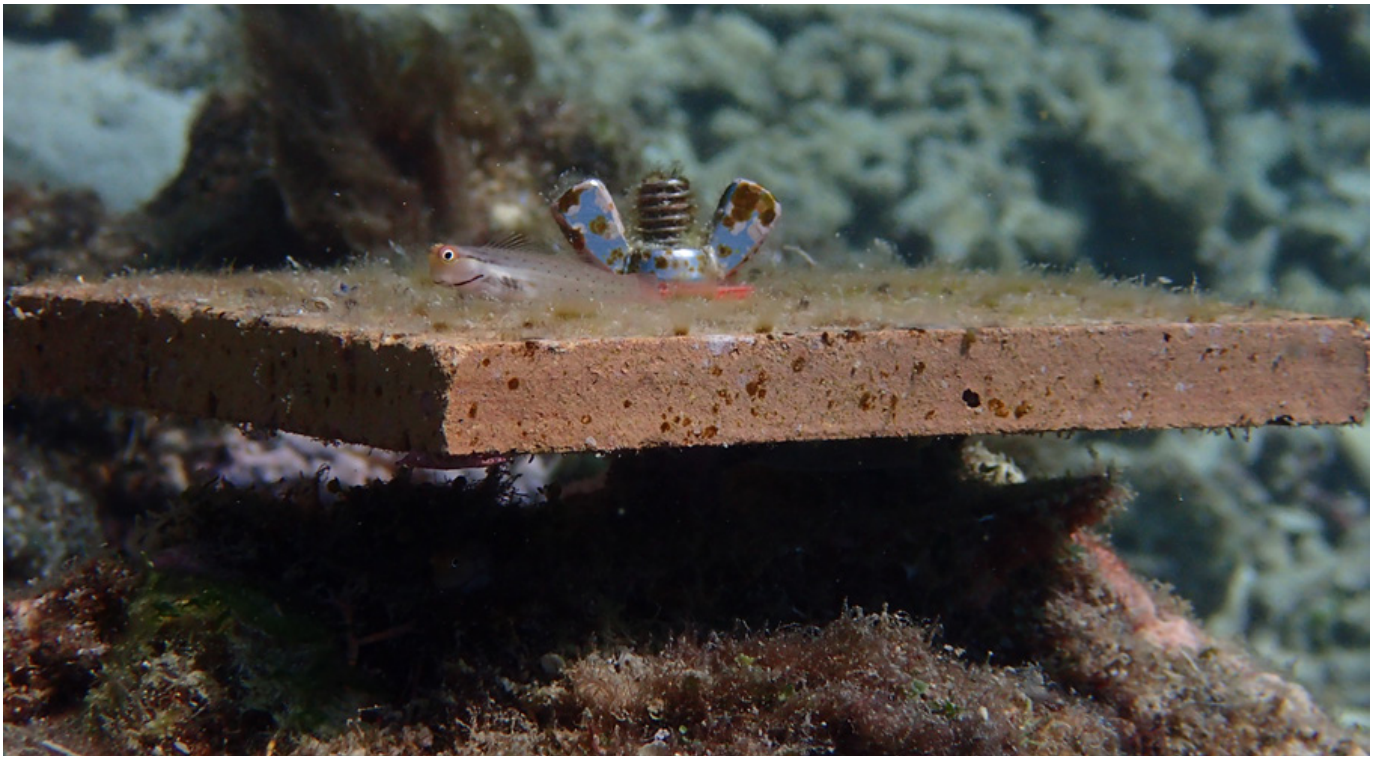


Figure 2: Blennies, such as *Ecsenius stictus* (pictured here) were responsible for the reduction in the density of *Sargassum* propagules on exposed settlement tiles. Photo: Meryl Larkin

Recipients of the ACRS 2018 Student Research Awards will be announced at the upcoming ACRS 2018 Conference.

Female Scientists in the Spotlight

Dr Verena Schoepf
Research Program 2 Leader, ARC Centre of Excelence for Coral Reef Studies
School of Earth Sciences and UWA Oceans Institute,
The University of Western Australia

Tell us about yourself and your current work.

I am currently a Research Fellow at the University of Western Australia and a Program Leader in the ARC Centre of Excellence for Coral Reef Studies. I study how reef corals are impacted by climate and environmental change, with a particular focus on the effects of marine heatwaves and ocean acidification. My research aims to identify the environmental drivers and eco-physiological mechanisms that enable resistance to warming and acidifying oceans and promote the adaptive capacity of corals in a changing ocean.

Who or what has motivated or inspired you to carry out your research?

I grew up in Austria, far away from the nearest coral reefs. However, as a kid I used to read books by Hans Hass, the Austrian equivalent of Jacques Cousteau who pioneered underwater filming and research and inspired thousands of people to learn more about the ocean, including myself. When I went snorkelling on a coral reef in the Red Sea for the very first time, I knew that I wanted to dedicate my career to studying these fascinating, colourful ecosystems – which is what I ended up doing.

What do you think are some of the biggest obstacles facing female scientists today and how do you think they can be overcome?

While so much has improved for female scientists over the last few decades, there are still many STEM fields where female scientists are significantly underrepresented, especially in more senior positions. I think this is a huge problem because young women interested in these career paths lack good role models. Other big obstacles are subconscious bias and the lack of flexible work arrangements that enable female scientists to have a family without jeopardizing their careers, so these are some of the key areas that we need to focus on. It is great to see that there are more and more fantastic initiatives out there to address these issues, such as the "Superstars of STEM", so hopefully we will see a lot of progress over the next years/decades.

What is your most embarrassing fieldwork or lab-work story?

Hmm… this is an interesting question! I'm not sure about the most embarrassing story but perhaps the funniest fieldwork story

was when I conducted population density surveys of the coral-eating gastropod *Drupella cornus* in the Red Sea. At one point, my transect line went straight over a big anemone with big staghorn colonies right next to it. I had to get up close to check for *Drupella* inside the branches and underneath the colony. Suddenly, I got attacked by the clownfish from the neighbouring anemone – it just kept swimming angrily at my mask and wouldn't let me do my work! I had to laugh so hard that my mask flooded completely, my buoyancy got messed up and I ultimately went up to the surface – thank God it was only a couple of meters deep!

What is your favourite aspect of your research?

One of my favourite aspects of my research is that I get to do fieldwork in absolutely amazing reef locations all around the world – and these are often places that would otherwise be very difficult to access. One of my favourite field sites is the Kimberley region in NW Australia, which has the world's largest tropical tides (up to 12m) and represents one of the toughest coral reef environments in the world. It is a magical place that continues to fascinate me – and seeing how tough Kimberley corals are gives me some hope for the future of coral reefs.

Dr Elizabeth M.P. Madin

Australian Research Council DECRA Fellow
Department of Biological Sciences
Macquarie University

Tell us about yourself and your current work.

I'm an ARC DECRA postdoc at Macquarie University in Sydney. In May of this year, I'll be starting a faculty position at the Hawaii Institute of Marine Biology at the University of Hawaii. I've loved being at Macquarie for my DECRA, and in Australia for the better part of the last 17 years, and I'm really excited about this next chapter in life.

Who or what has motivated or inspired you to carry out your research?

When I was 13 years old, I read Sylvia Earle's book "Sea Change" about how humans are affecting the world's oceans. The main thing I took from that book was that the ocean can't keep up with our growing demands for seafood from wild-caught populations, and as a result I stopped eating seafood to do my teensy-tiny little part to help. As I grew up, I realised that I had to do something bigger than just change my own diet if I wanted to really help solve this problem. Nowadays, a lot of my research is focused on the effects of fisheries on coral reefs and other marine ecosystems. I don't think it's enough to just do research on the topic, but it's where I've been able to start. In the coming years I'm hoping to increasingly turn my and others' research findings into actual solutions for the oceans.

What do you think are some of the biggest obstacles facing female scientists today and how do you think they can be overcome?

Well, I think human biology has a lot to do with female career progression, namely holding women back relative to men. By that I mean that women's childbearing years tend to overlap with the time during which many of us do our Ph.D.s, postdocs, and apply for faculty positions or other jobs. Some of us will want to have families, and having a baby necessarily takes time away from work - and that's not a bad thing! But since we can't change biology...we have to find ways to balance our different life and work goals. So I think two things we can do to keep our careers progressing are to 1) realise that there are different 'seasons' to life, and one can't necessarily do everything at the same time (but can at different times, if you're persistent), 2) if one intends to have a family and be a scientist, finding a partner who's supportive of your goals and willing to share family responsibilities equitably is absolutely key. Then, try to have fun while juggling it all!

What is your most embarrassing fieldwork or lab-work story?

Oh geez, there are too many to know where to start. I once nearly sunk a research dinghy at a tiny island in the middle of the Pacific (I didn't check where the research assistant put the bung in, and it turns out it was in the wrong hole…). I've nearly knocked down a boat shed while launching a research boat with a tractor. When I first started my Ph.D., I was so scared of being eaten by a shark that I'd suggest my field assistants get in first "to scope out the site" (sorry, guys!). The rest of my mishaps may not have reached their statute of limitations just yet - I'll save those for another issue!

What is your favourite aspect of your research?

Feeling that I'm (hopefully) doing something useful for the oceans of the world, and getting to spend time with an amazing bunch of committed and fun collaborators from all over the world while doing it.

Dr Maria Beger

University Academic Fellow in Marine Conservation Biology
University of Leeds

Tell us about yourself and your current work.

I am currently a University Academic Fellow in Marine Conservation Science at the University of Leeds in the UK. The position is essentially a mix of Senior Lecturer and Research Fellow, with a reduced teaching load. My work mostly focusses on developing better approaches to incorporate ecological processes into conservation decision making. Thus, I work in the field (e.g. doing surveys), I do modelling (for example, because spatial planning needs spatially continuous data to be predicted across a landscape from surveys), and develop/test new methods in spatial planning itself. Recently, I have focused a lot more on climate-change related processes on reefs and how to predict and manage them.

Who or what has motivated or inspired you to carry out your research?

I definitely get inspired by the reef itself – when I was uninspired and felt that I lacked direction and ideas after I had my kids (which meant I had less time to think, and a lot less time to chat and network with other scientists) I 'prescribed' myself a dive trip to Palau. That did the trick – there is nothing like observing reef creatures to bring the focus and passion to save them back.

What do you think are some of the biggest obstacles facing female scientists today and how do you think they can be overcome?

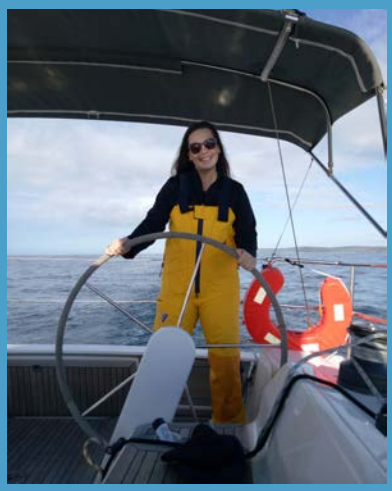
Coral reef science actually has a lot of great female role models, but the professorial ranks are generally male dominated. I think that in much of academia, and other professions, females are disadvantaged by losing time by having/caring for children, unconscious bias from all ends (including their own), and the lack of institutional/national structures to make up for these things. How can they be overcome? Well I could give you some politically incorrect option over a beer…. Generous support through institutional policies would be good, and growing a thick skin is also good. I think though that for each female scientist it is good to ensure having fun, and being inspired by their science. Let's not lose track of the fact that reefs are amazing, discoveries are fun, and there are a lot of nice people to collaborate with out there who don't care what gender you are.

What is your most embarrassing fieldwork or lab-work story?

I can't tell you the most embarrassing one, it's too embarrassing (and disgusting)… I don't get easily embarrassed, actually. Perhaps an interesting fieldwork story is when I went on a fieldtrip to PNG, and was out in an open tinny all day with some collaborators and locals. As my son was only 8 months at the time, I needed to pump to relieve the pressure. There is really no way to hide the titties in that case, so I had to get them out and start pumping. The men all looked away (the Australians) or stuck their noses right in (the locals), but eventually everyone got used to it and thought it was funny.

What is your favourite aspect of your research?

Most definitely the fieldwork, because of the challenges and inspiration it brings. I also like analysis, and seeing the data actually shows what I think I have observed or not…



Caitlin Alinya Lawson

PhD Candidate, Climate Change Cluster
University of Technology Sydney

Tell us about yourself and your current work.

I am a PhD student in the Climate Change Cluster at the University of Technology Sydney and I have just started the third year of my candidature. My research is investigating the myriad of volatile compounds that are produced by corals, their *Symbiodinium* and

their associated bacterial consortia. I am documenting the vast array of volatiles that we are just discovering these amazing organisms produce.

Who or what has motivated or inspired you to carry out your research?

When I was 12, my family went on a trip up to Lady Musgrave Island in the Southern Great Barrier Reef, this was an amazing trip and kicked off my obsession with the reef. When I was 17, and again when I was 18, I got to go back to LMI with my high school, over these three trips I could see changes in the reef and that was the moment I decided I would spend my life doing something, anything, that would, in some way, help protect these systems.

What do you think are some of the biggest obstacles facing female scientists today and how do you think they can be overcome?

I have never felt like I have faced any obstacles as a result of my gender. I have male supervisors but I know they respect me and my work, I see the many incredible female scientists in this field so I have never felt that my desire and drive to be a scientist will be hindered by my gender. I think the only concern would be if I choose to have children, taking the time away from research could be difficult for my career. That being said, I know of many scientists who have children and very impressive careers so I know that it would not stop me, but I am aware of the challenges.

What is your most embarrassing fieldwork or lab-work story?

I can't think of any embarrassing stories but I had quite a special moment recently on Heron Island, it was stormy and I was walking down to my coral tanks for my 6am PAM measurements and some turtle hatchlings had gotten confused and wondered into the research station. I could see the seagulls eyeing them off so I had a fun 20 minutes running around in the pouring rain collecting hatchlings before taking them to the top of the beach so they could start their journey!

A HUGE THANK YOU TO ALL THE FEMALE SCIENTISTS WHO RESPONDED TO THE ACRS SPOTLIGHT QUESTIONS.

Photo: C. Brunner

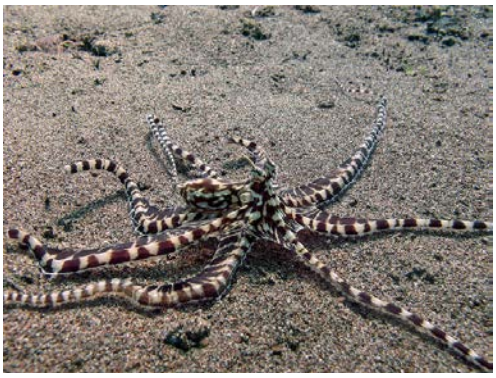
Reports from the Reef

Story behind the photo on the previous page.
2017 photo competition winner: Maarten De Brauwer. Category: People's Choice.

During fieldwork in the Lembeh Strait (Indonesia) investigating cryptobenthic fauna on soft sediment habitats, I was doing an exploratory dive to check out a new site. The site is a near a harbour and littered with all kinds of rubbish, ranging from plastic bags and diapers to small fishing vessels that had fallen into disrepair. Despite the unsavory surroundings, the site was exceptionally rich in marine life. This yet undescribed Tambja nudibranch was crawling over a small rocky outcrop, offering the perfect opportunity to get low and get a close-up of the beautiful little critter.
Other info: shot was taken with a Canon G16 in an Isotta housing and an Inon diopter. f6.3, ISO 200, 1/200

Sand, critters, and a bit of coral… tales of a soft sediment researcher.

Maarten De Brauwer
Curtin University . critterresearch.com . maarten.debrauwer@curtin.edu.au



I have been an ACRS member for a few years now, even though most of my PhD-research is on habitats with an average coral cover of less than 1%. My previous research and other work was heavily focused on coral reefs, but somehow I drifted from coral reefs to sand. I still fully intend to remain an active ACRS members for many years to come, here is why…

My name is Maarten, I am finishing up my PhD at Curtin University in Perth, but I grew up far away from any coral reef. I originally graduated as a biology teacher in Belgium, then stumbled into the life of a dive instructor, worked for conservation organisations in Southeast Asia, and somehow ended up as a volunteer for UQ conducting cleaner wrasse research on Lizard Island. Working alongside fantastic researchers (many of which are members of ACRS) and learning about their work was without a doubt the strongest motivation for me to pursue a PhD in marine science.

While I absolutely love coral reefs and colourful fish, my PhD focuses on less pretty ocean denizens: cryptobenthic fauna. More specifically the cryptic species on sandy habitats, that drive a valuable branch of dive tourism in Southeast Asia. The term "**muck diving**" might not sound familiar to you, but it does to more than 100,000 scuba divers that come to Southeast Asia every year to watch and photograph rare critters living on sandy bottoms. **This industry is worth more than $150million (USD) per year and provides jobs to thousands of local people (De Brauwer et al. 2017).** Divers spending a lot of money to dive on sand instead of coral reefs sounds like madness to most people. But these mad divers are rewarded with species we rarely encounter on coral reefs. If you are into fish, you can focus on seahorses, frogfishes, or ghostpipefishes. If inverts are your thing, there's a plethora of nudibranchs, cephalopods, and plenty of undescribed crustaceans. If you are into corals, you're wasting your money...

Besides socio-economic aspects of muck dive tourism, my PhD-research investigates the drivers of cryptobenthic fish assemblages on soft sediment habitats. These assemblages can be almost as diverse as those on the Great Barrier Reef, although their abundances are far lower. **Cryptobenthic fauna is hard to survey, which is why I am interested in developing new methods to improve detection rates for cryptic fishes**. Inspired by methods to detect juvenile corals, I found out that biofluorescence is far more prevalent in cryptic fishes than non-cryptic ones, and that this fluorescence can be used to survey cryptobenthic species (De Brauwer et al. 2018).

So why am I still an ACRS member if I'm having such a great time playing in the sand? Soft sediment habitats are the largest habitat in shallow tropical seas. Larger in fact than coral reefs, seagrass beds and mangroves combined. Very little is known about these habitats, most people assume they are empty and uninteresting, but I can assure you this is not the case. **The links between sand and other habitats, especially coral reefs, are yet to be fully studied and could bring us some interesting and surprising insights on how ecosystems interact.** Understanding the importance of soft sediment habitats to coral reefs and the people dependant on these ocean resources is challenging yet it provides exciting future research prospects!

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All photos were provided by Maarten and can be viewed on his website

A 3D coral model to investigate the role of hydrodynamic disturbances in coral reef communities.

Anna Cresswell (PhD Candidate), Damian Thomson, Michael Renton
Anna.Cresswell@csiro.au
School of Biological Sciences, University of Western Australia
Ningaloo Outlook Project, CSIRO Oceans and Atmosphere and BHP

Corals grow into all shapes and sizes – structures that are essential for creatures that live in and around coral reefs (Fig. 1). The majority of climate change predictions show a future with more frequent and more severe acute climatic disturbances, such as cyclones and heat waves. These events can lead to selective mortality of particular shapes and sizes of corals; for example corals with branching forms, that have a small attachment to the seafloor, are more vulnerable to water movement. However, these corals that reach out for space, will often grow faster than those which have large attachments to the seafloor. In this sense, there is a broad trade-off between growing quickly (and competitively) with being more vulnerable to disturbance.

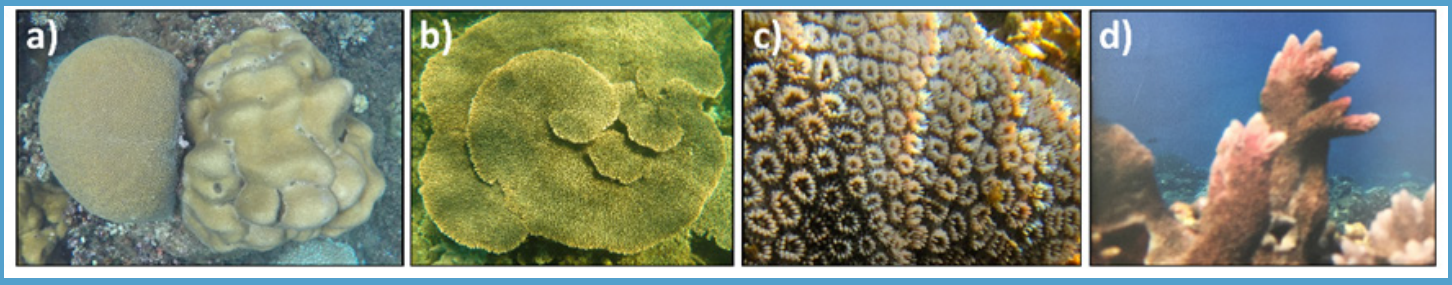

Figure 1. Four typical coral morphological groups: a) hemispherical, b) tabular, c) encrusting and d) columnar.

Given that corals have very slow growth rates and that field observations capturing growth and competition are difficult, a modelling approach provides an opportunity to explore changes in coral community structure. We have developed a three-dimensional (3D) model to investigate the trade-off between fast growth and vulnerability, as well as the processes that promote coexistence of different coral shapes in a reef community. Using an approach similar to the established field of functional-structural terrestrial plant modelling, we built a model which considers the role of light, shading and hydrodynamic disturbances in a 3D community of interacting coral colonies. While the model does not create perfect replicas of real coral, it generates representatives which interact and compete with each other through time in the 'model world' (see Fig. 2, opposite page).

Understanding the growth, competition and mortality of organisms at a 3D level is important in understanding an organism's role as an engineering species and the mechanisms that lead to the maintenance of structural integrity.

This work was presented at the 2017 Australian Coral Reef Society conference in Townsville in July, and again at the the 22nd International Congress on Modelling and Simulation in Hobart in December 2017. For more information on the model see our conference paper*, where we outline its capability of capturing different growth forms of corals in a community.

We acknowledge the support of the BHP-CSIRO Ningaloo Outlook Marine Research Partnership.

*Cresswell, A. K., Thomson, D. P. , Trevenen, E. J. and Renton, M. A functional-structural coral model. In Syme, G., Hatton MacDonald, D., Fulton, B. and Piantadosi, J. (eds) MODSIM2017, 22nd International Congress on Modelling and Simulation. Modelling and Simulation Society of Australia and New Zealand, December 2017, pp. 237–243.
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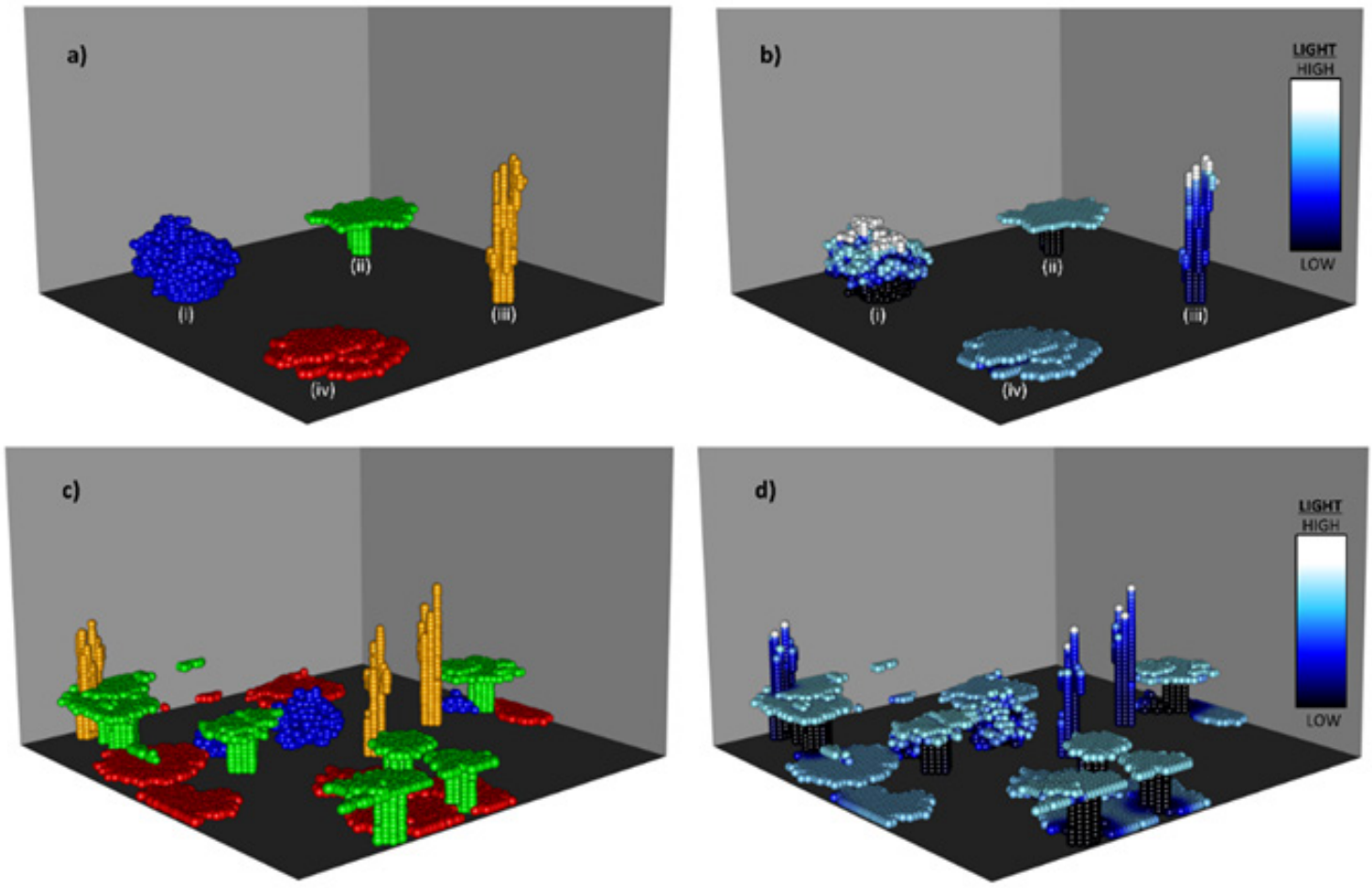

Figure 2. Model output (a) Four major growth forms (i) a massive/ hemispherical colony (blue), (ii) a tabular coral (green), (iii) a columnar coral (orange) and (iv) an encrusting coral (red). (b) Light absorption for the same growth forms in a). (c) Model output shown for 20 corals in a community showing tabular forms in green, hemispherical in blue, encrusting in red, and columnar in orange. (d) shows the same community of corals coloured according to the amount of light they are absorbing at that location.

2017 photo competition winner: C. Brunner.
Category: Diversity.
The picture has been taken during a dive at Fakarava, French Polynesia on the 11th April 2016. It demonstrates very well the variety of forms and colours as well as the great biodiversity of tropical coral reefs. Stony *Porites* and plating *Pachyseris* form the basis of this reef, which is covered by a broad variation of red crustose coralline algae. The complex habitat of this reef provides shelter for the territorial soldier fish and butterflyfish which becomes particularly important at night.
The picture has been shot with an Olympus OM-D EM-1 and a 7.5mm Samyang fisheye lens in a Nauticam housing.

Shining the light on fish: investigating the impacts of artifical light at night (ALAN) on coral reef fishes.

by Team ALAN
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Snorkel selfie credit: Jack O'Connor. The team in Moorea

We've all been there. "Keep phones and laptops out of the bedroom" is probably familiar advice we've all heard from our therapists, when seeking help for PhD-anxiety-driven-insomnia (No? Maybe it was just me…). I don't think I need to inform you that the prevalence of digital screens, LED and fluorescent lighting in our lives can disrupt our natural sleep and wake cycles (Zielinska-Dabkowska, 2018); we've all heard the warnings. Fortunately for us, we can evade some of the detrimental effects of artificial lighting by simply flipping the light switch off when we are ready to sleep. **But what would happen to us if there was no light switch? Would we move? Would we stay and accept sleepless nights? Would we adapt? Would we eventually die?**

These are all relevant questions that can be applied to animals who are increasingly having to cope with brighter nights. Like us, the vast majority of organisms on Earth have evolved in day-and-night cycles. The night time environment, however, has been altered for many organisms, with the relatively recent invention and proliferation of electric lights. In fact, **the Earth is getting artificially brighter at a rate of 2.2% per year** (Kyba et al., 2017), and light pollution is extending its reach into many ecosystems, altering the natural patterns of light and dark to which most organisms are adapted.

Photo 1: Fish are attracted to an artificial light illuminating the underwater world in the lagoon in front of a high-end hotel in Tahiti. Photo credit: Emily Fobert

The marine environment is not exempt from this ecological light pollution. With growing urbanised coastlines and increasing marine infrastructure emitting light at night, there is a growing need to understand the extent and ecological impacts of artificial light at night (ALAN) in marine systems. (Davies et al., 2015; Gaston and Bennie, 2014) (Photo 1).

In April, and again in September 2017, we travelled to Moorea, French Polynesia to find out how fish deal with artificial light intruding on their naturally dark environment. We conducted light

Photo 2: Juvenile convict surgeonfish (*Acanthurus triostegus*), VIE tagged for a predation experiment following a 10-day light exposure treatment in the lab.

exposure experiments in the lab and the field to gain a better understanding of how ALAN can 1) impact the physiology, behaviour, and fitness of reef fishes, and 2) shape diurnal and nocturnal fish communities. Initial results from our lab experiments, which exposed settlement-stage coral-reef fish (the convict surgeonfish *Acanthurus triostegus*; Photo 2) to control (light-dark cycle) or ALAN (light-light cycle) treatments show that **even short periods of exposure to ALAN (up to 10 days) can have potentially harmful impacts on growth, behaviour and endocrine function.**

To follow up on these experiments, we deployed an array of purpose-built underwater lights on coral reefs around Moorea for a 4-week long BACI-design field experiment to look at impacts of ALAN on fish in the wild (Photo 3). We conducted daily surveys on unlit and lit natural reefs, to record the composition of the diurnal and nocturnal fish communities over time, as well as settlement and survival of newly recruiting fish. This data should shed some light on how ALAN might impact the distribution patterns of reef fishes, through migration, predation, or recruitment processes.

Artificial light at night is increasingly recognised as a major source of anthropogenic pollution around urban areas on land, however, we still know very little about the effect it has on marine systems. **Our research findings so far suggest it should likely be added to the growing list of anthropogenic stressors that marine organisms need to face.** Furthermore, it could be a stressor that we can easily remove from the equation. By asking some basic but fundamentally important questions about how fish respond to ALAN, we hope this research leads to mitigation strategies that minimize the effects of light pollution in the marine environment.

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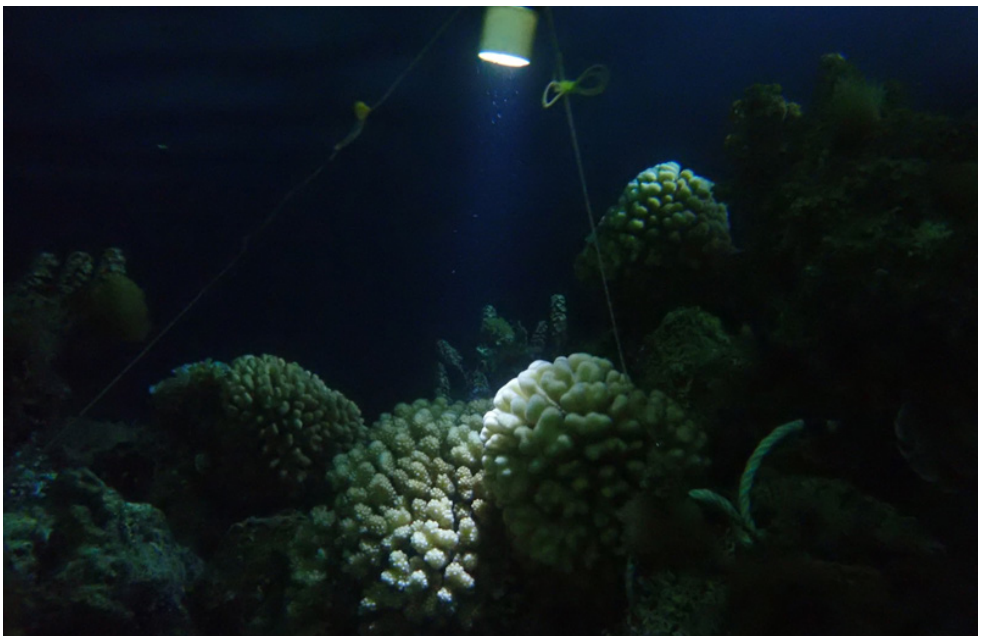


Photo 3: Underwater light illuminating a natural reef for our field experiment. Photo credit: Jack O'Connor

The Reef Fish Ecology and Evolution Lab

James Cook University – Prof. David Bellwood, Dr. Orpha Bellwood et al.

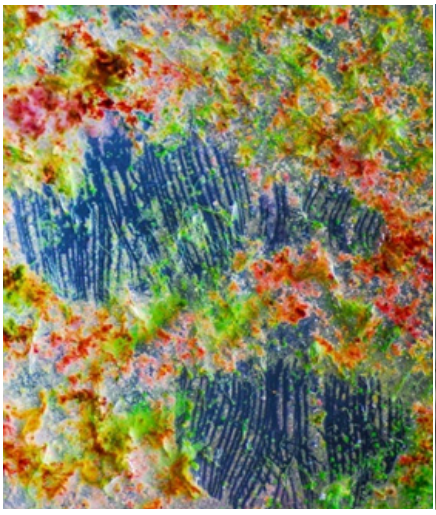
Written by Christopher Hemingson

BACKGROUND

We are the Reef Fish Ecology and Evolution Lab, or as we refer to ourselves, the "Bellwood Lab". Our research covers a wide variety of disciplines, ranging from histology and morphology, to ecology and even biogeography and evolution. Ultimately, we are united by our focus on coral reef fishes as a study system and the functions they perform - both past and present. Here, we present some of our lab's most recent research spanning many levels of coral reef fish ecology and evolution.

BRISTLETOOTH SURGEONFISH: THE REEF CLEANERS

Lab member Sterling Tebbett has devoted much of his research to studying the bristletooth surgeonfish, *Ctenochaetus striatus*. This surgeonfish species is commonly found throughout the Great Barrier Reef. Although it can look nearly identical to its cousin, Acanthurus nigrofuscus, it feeds almost exclusively on a different food item - detritus. *C. striatus* can be thought of as a 'reef broom', sweeping up fine particulates that settle within the algal turfs that cover most reef substrates (known as the Epilithic Algal Matrix). As seen in the image below, streaks are left when their bristle-like teeth sweep across reef surfaces, brushing up detritus, sediment and loose diatoms/microalgae. This function is important to reef processes, as it prevents the EAM from becoming clogged with debris. However, Sterling also found that when the load of inorganic sediment becomes too high, feeding by *C. striatus* declines. Essentially, these fishes stop cleaning the reefs when they become too dirty. This has a number of implications, like preventing coral larvae from settling to letting the algal turfs grow out of control. Sediments are becoming a real threat to coral reefs. Increased dredging, coastal development and intensive land use are increasing the amount of sediment that makes it out to reefs. If this continues to increase, we too may see a decline in feeding by these reef cleaners in the near future. Sediment reduction offers an attainable goal for stress reduction to coral reefs in this multi-stressor era.



Feeding scrapes left by *C. striatus* in aquaria

***Ctenochaetus striatus* – Striated Surgeonfish**

MAXIMUM PREY SIZE IN PREDATORY CORAL REEF FISH

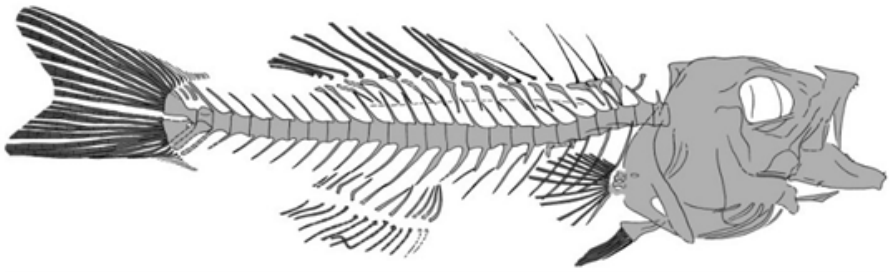
Mike measuring the vertical oral gape of a coral trout

Ecomorphology is the study of the linking relationship between the morphology of an organism and the ecological role it performs within its environment. Lab member Michalis Mihalitsis' (Mike) research focuses on the ecomorphology of predatory reef fishes. Predators are often influential in shaping biological communities and therefore warrant further study. Mike asked the question: "what is the largest prey size a predator can successfully consume?". Mike went about this by measuring numerous potential morphological constraints that would limit the size of prey. Overall, he found that prey size in predators is most likely limited by the first gape prey would encounter - the mouth. Also, the maximum prey size is most likely around 20 – 25% of the predator's body size. That is essentially the equivalent of eating a footlong sub from Subway – in one bite! Quite impressive!

JUVENILES AND THEIR JOURNEY HOME

Lab member Robert Streit is a spatial ecologist, meaning he thinks about processes in relation to space and time. With a focus on herbivorous fishes, he specifically investigates how fishes interact with and move about the reef. Robert wanted to know "how strong is the sense of home for juvenile reef fishes"? To test this, Robert and his team captured over 300 juvenile fishes from the reef. In the lab, they tagged each fish with a unique subcutaneous marker, which essentially are fish tattoos! After they had gotten used to their new ink, the fishes were released at varying distances away from their home site in which they had been captured (10m, 50m, 100m, 150m). During the following days, each displacement site as well as their home site were surveyed for any marked individuals. Surprisingly, Robert found that many of these young fishes already have quite a strong sense of what they deem is 'home' only a few days after settling onto the reef. He found that in some species, up to 67% of all marked individuals returned to their home site in which they were collected. This means that some individuals traversed up to 150 metres successfully, which represents over 3500 times the length of their body. To put this in perspective, that is the equivalent of a newborn baby crawling its way home from the day-care almost two kilometres away (but we didn't test this)! By and large, juvenile reef fishes are quite capable little creatures, which possess a strong sense of home and a stronger sense of adventure.

Tagged *Siganus doliatus* sporting their new ink



Reconstruction of *Zornzinilabrus furcatus* based on the fossil holotype

IMPLYING FUNCTIONS FROM FOSSILS

Fossils represent a window into the past, giving us a glance into how the world used to look and work. One of the richest reef fish fossil deposits is in a rather surprising location – Monte Bolca, Northern Italy. More than 30 million years ago, Monte Bolca was submerged under the Tethys Sea; the ancient marine diversity hotspot. Between 65 and 30 mya, the Tethys Sea gave rise to many of the tropical coral reef fish families we recognise today. Unsurprisingly, many fossil species have been described from the Monte Bolca formation. The latest is a new genus and species of labroid fishes that was described from a fossil found in this deposit. *Zornzinilabrus furcatus* represents one of the earliest branching lineages within Labridae. Its forked tail suggests it was a planktivore; feeding in the water column away from the reef which would indicate the earliest form of this feeding mode within this family.

Some of the current lab members on a fossicking trip to Richmond, QLD. July 2017. In order from left to right: Alexandre Siqueira, Christopher Hemingson, Victor Huertas, Renato Morais, Sterling Tebbett, Mike Mihalitsis, Robert Streit

Visit our webpage to learn more about our research and the papers herein - *www.thebellwoodreeffishlab.*

Exploring Novel Approaches for the Analysis of Animal Colour Patterns

Cedric van den Berg (PhD Candidate)
School of Biological Sciences & The Queensland Brain Institute, University of Queensland

Only within the last handful of decades have humans started to observe animals through the eyes of other animals to investigate the purpose of their colouration. We achieve this by using mathematical approximations to describe the processing of light in the earliest stages of animal vision. Starting with the careful characterisation of the light environment, followed by measurements on how much of this light gets reflected off a surface into the eye of an animal observer, we can then calculate the transmission of that light through the animal eye and calculate how much of that incoming light gets absorbed by photoreceptors. Knowledge of the properties of those receptors and how their signals are processed then allows to approximate animal vision such as colour vision, an animals' ability to discriminate between bright and dark as well as the sharpness of an animal eye. The development of such modelling approaches has always followed technical advances, such as the advent of personal computers or portable spectrophotometers some 30 years ago. Digital photography has become increasingly powerful and cheap. The advance in visual modelling that followed this technological revolution in the early 2000s was the use of carefully calibrated digital images by visual ecologists to model photoreceptor stimulation of non-human observers. **This opened a new field of methodology that is now able to reliably calculate photoreceptor stimulation for every single pixel inside an image**. Comparable quantitative modelling was previously only achieved by using hyperspectral cameras that far exceeded the cost of a mid-range digital camera, especially when taking them outdoors e.g. on a dive.

Figure 1 A small collection of nudibranch molluscs found at the east coast of Australia. Clockwise from left: *Chromodoris kuiteri; Goniobranchus splendidus; Nembrotha kubaryana*

I conducted my Master's thesis on the evolution of colour pattern complexity in nudibranch molluscs with the goal of shedding some light on the evolution of the incredible diversity of colour and shape in this family of shell-less marine gastropods. Nudibranchs or 'seaslugs' come in more than 3'000 described species and many of them defend themselves with toxic compounds or nematocysts that they obtain from their diet. As such, nudibranchs span the entire spectrum of either being extremely well defended and colourful or not defended at all but extremely hard to spot or any combination and shade of colour and level of defence in-between. **I wondered what colour pattern design principles would correlate with the levels of defence nudibranch species would deploy?**

Looking at the complexity of their colour patterns at various levels such as colour, luminance and geometry and how this correlated with the toxicity and palatability of the slugs became the goal of my thesis. To achieve that, I used a spatiochromatic (combining information about space and colour) pattern analysis that used information of the size, colour and luminance of pattern elements in a digital image to parameterise the colour pattern geometry of any given pattern in high detail. It also allowed me to approximate how the combination of colour, luminance and pattern contrast together both within an animal colour pattern but also between an animal and its visual background and would allow me to estimate its conspicuousness. However, using my digital camera's RGB pixel values to segment my images into an arbitrary number of colour pattern elements seemed somehow anthropocentric. **Where does one colour patch start? Where does it end? And shouldn't I do this using animal vision?** I started reading and soon learned about the use of calibrated digital photography. It seemed like the perfect solution to achieve some level of confidence of how I interpret the infinitely complex nudibranch colour patterns and the corresponding natural backgrounds on coral reefs.

Figure 2 Testing a prototype of an underwater camera system on Lizard Island (GBR)

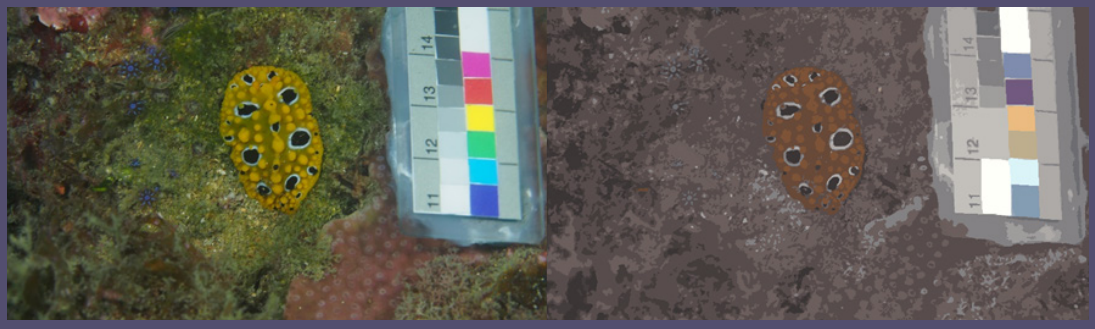


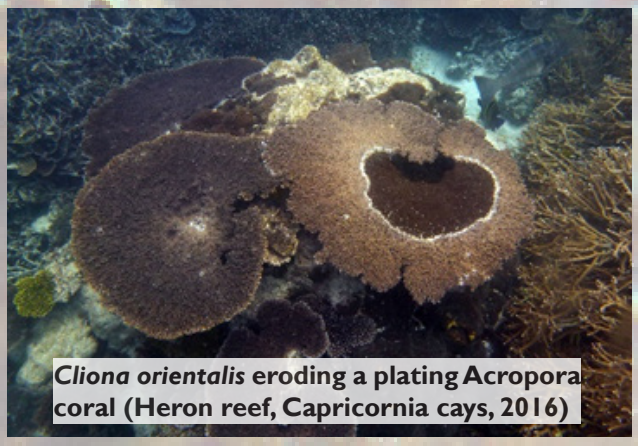
Figure 3 An example of using animal vision to segment calibrated digital images. Left: Calibrated image of a nudibranch. Right: The same image where the pixel values have 1) been translated into triggerfish (*Rhinecathus aculeatus*) photoreceptor stimulation 2) Translated into the photoreceptor stimulation at 5m depth natural light 3) Segmented according to colour and luminance discrimination thresholds of the triggerfish 4) Translated back into an RGB image. Triggerfish have trichromatic vision, just like us. However, they can't really see red which is the main reason why there's no red in the right image.

I picked up on this idea for my PhD, which I started in 2016. As a result, my work these days revolves around combining carefully calibrated underwater photography with visual modelling and behavioural experiments to enable the development and application of spatiochromatic colour pattern analyses. **One of the key aims is to fuse these advances into a publicly available comprehensive analytical framework for the quantitative analysis of animal colour patterns.** I am particularly interested in investigating the function, design and evolution of defensive colouration in nudibranch molluscs such as warning colouration and camouflage. To calibrate the visual models and their underlying assumptions I am using triggerfish to conduct a range of behavioural experiments aimed at increasing our knowledge of reef fish vision as well as informing the underlying assumptions of the visual modelling used to simulate their vision as potential predators of nudibranchs. This new methodology allows us to investigate the design, function and evolution of animal colour patterns on a new quantitative and qualitative level. Through my PhD I have been able to discover my passion for professional scientific and technical diving as well as underwater photography. I try to use my photography (Fig. 4) to help spread fascination and awareness about all things marine conservation by supporting local citizen science projects, marine conservation NGOs and various science communication and outreach platforms.

Figure 4 Some pictures I shot at Lizard Island during the devastating 2016 mass bleaching event. The beauty of these animals together with the death and destruction right next to them left me speachless most days. Clockwise from top left: An anemone fish; A tiny 2cm large squid; A hard coral

Exploring bioerosion by excavating sponges on the Great Barrier Reef

Michelle Achlatis: PhD candidate . Coral Reef Ecosystems Lab . University of Queensland . m.achlatis@uq.edu.au



***Cliona orientalis* eroding a plating Acropora coral (Heron reef, Capricornia cays, 2016)**

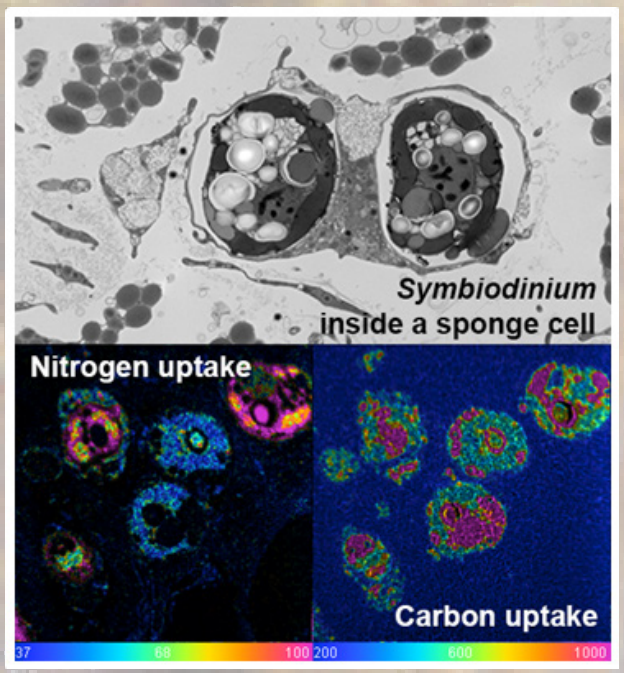
If you are a fan of shape-shifting marine organisms, look no further than sponges of the genus *Cliona*. Each of the below pictures shows a patch of the same velvety brown sponge, the bioeroding species *Cliona orientalis* on the Great Barrier Reef. **Yet the sponge assumes completely different forms, reflecting the diversity of coral skeletons that it erodes.** The excavating activity of such sponges increases the porosity of the coral frameworks, resulting in honeycombed limestone structures that are more susceptible to physical stressors such as storms and cyclones.

The bioeroding sponge *Cliona orientalis* in competition with an array of coral species (Wistari Reef, Capricornia Cays, 2016)

While most bioeroding sponges cause polyp death by eroding the structural support of coral tissue from beneath, some (like *Cliona orientalis*) also encrusts the dead limestone surface and continue to advance laterally. *Cliona orientalis* hosts a large population of photosymbionts and so this growth form maximizes their light-harvesting potential. Ironically, most of these symbionts are dinoflagellates of the genus *Symbiodinium*, which are famous for stimulating coral growth.

Can it be that Symbiodinium supports reef bioerosion as well as reef growth?

This is one of the main questions I have been working on as part of my PhD research, which in summary constitutes an exploration of the metabolic dynamics of bioerosion by excavating sponges on present and future coral reefs using *C. orientalis* from Heron Island as my model species. First we designed experiments were we artificially inhibited photosynthesis and found that bioerosion rates of the sponge decreased hand in hand. Then we set out to investigate how inorganic carbon and nitrogen are taken up by the sponge holobiont, confirming that *Symbiodinium* is the main photosynthetic player and that fixed material is being shared with the hosting sponge cells. Finally, we tested the strength of the partnership between sponge and *Symbiodinium* by exposing sponges to future ocean conditions that would cause disruption of the symbiosis in corals. Although the sponges were markedly more tolerant than corals, after prolonged warming to end-of-the-century levels they bleached too. *Cliona* bleaching on today's reefs is still a rare event though and is not well-documented, so if you have seen signs of bleaching in such sponges during the recent coral bleaching events please drop me a line!



Although Symbiodinium cells are just over 5µm in diameter, with the aid of recent integration between isotopic labelling, electron microscopy and nanoscale secondary ion mass spectrometry, we can visualize the nitrogen and carbon assimilation capacity inside the sponge

Special thanks to Sophie Dove, Ove Hoegh-Guldberg, Mathieu Pernice and Christine Schönberg as well as the Australian Research Council, the Centre of Excellence for Coral Reef studies and the Ecological Society of Australia for ongoing support.

Background photo credit: Dorothea Bender-Champ

Coral larval supply and recruitment following typhoon disturbance in Palau

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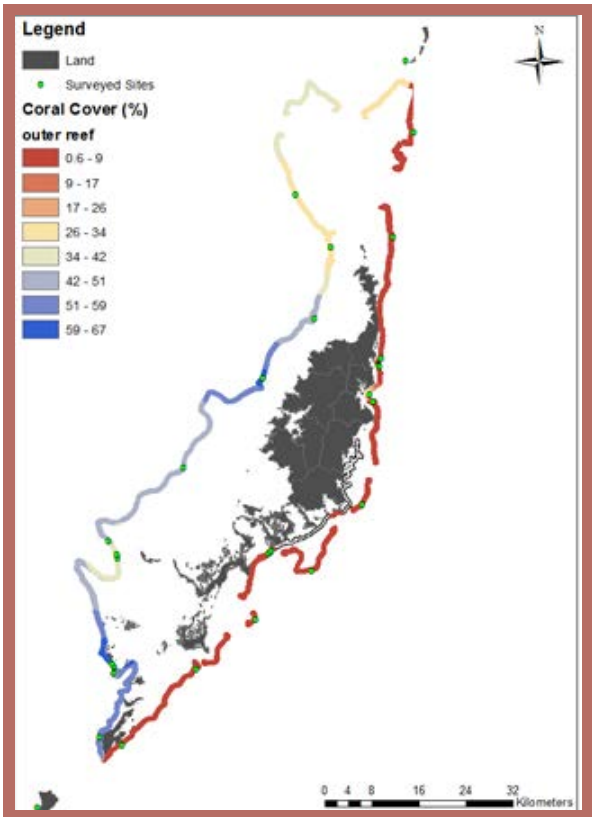
Marine Gouezo and Dawnette Olsudong (PICRC Research Assistant) surveying juvenile corals

Rates of larval dispersal, settlement and recruitment in coral populations can strongly influence the persistence of coral communities and their recovery post disturbance. The eastern outer reefs of Palau were extensively damaged by two super-typhoons in 2012 and 2013, reducing mean coral coverage to about 6% (Gouezo et al. 2015). As these typhoons were the most intense to impact Palau since at least the 1950s, it is not known how the damaged coral reefs will recover. This study explores how different spatial and temporal scales involved in coral recruitment contribute to reef recovery. Specifically, **I aim to characterize how geographic and hydrodynamic differences in larval supply and coral settlement on reefs around the archipelago drive recovery trajectories.**



Map showing the live coral cover in Palau

A coral larval supply model parametrized with observed environmental conditions during the spawning seasons and the cover of major coral groups in the archipelago is being developed, to detect areas of larval import and retention around the outer reefs of Palau. The monthly sampling of tagged coral colonies throughout 2017 and 2018 inform the reproductive state of coral populations through time, needed to parametrize the coral larval supply model. Settlement tiles attached onto 12 outer reefs sites at 7-8 m depth, are deployed and retrieved every four months over two years, to quantify in-situ coral settlement on the outer reefs. The density of juvenile corals is recorded every two years using five 3 m2 belt transects at two depths since 2002-2005 by the Palau International Coral Reef Center (PICRC) long-term monitoring program.

Together, **combined field data with predictive models will show how hydrodynamic forces influence the distribution and settlement of coral recruits throughout the outer reefs of Palau**. For now, findings show that larval supply and coral settlement within the north-eastern sub-region of the archipelago is low, underpinning a predicted slow pace of recovery compared with reefs located in the center and south-eastern sub-regions where larvae supply and coral settlement are high. Three to four years after the typhoon disturbances, the density of juvenile corals has reached levels similar to pre-disturbance times at only a third of our study sites.

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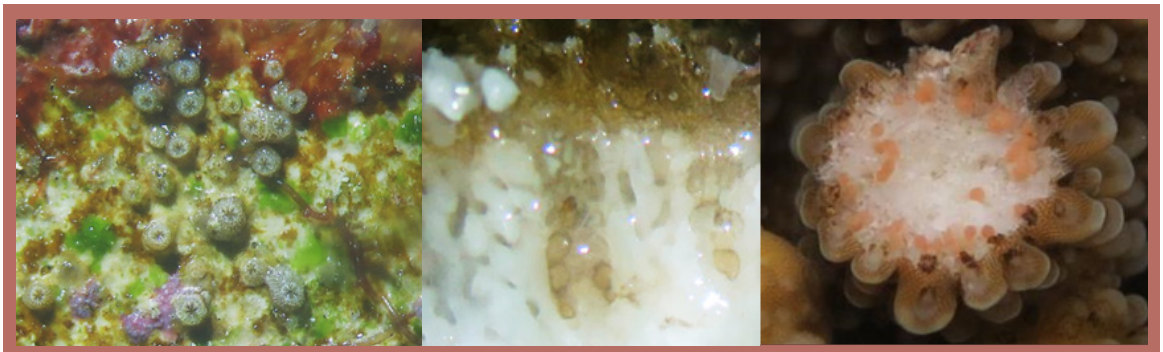

Left to right: Close-up view of Acropora spat skeletons on a tile; Visible pigmented gametes in a Montipora (middle) and Acropora (right) colonies

2017 photo competition winner: M. Nordborg. Category: Science in Action.
Researchers from the Australian Institute of Marine Science Townsville collecting specimens in preparation for the 2016 coral spawning season. Trunk Reef, Australia.
Adult corals were collected by hand from mid-shelf and inshore reefs during early-mid October in 2016 and brought to the National Sea Simulator at the Australian Institute of Marine Science (AIMS), Townsville, on board the R/V Cape Ferguson. Gametes were collected from multiple species of coral on spawning nights and used for a range of research projects, including the effects of petroleum hydrocarbons on coral larvae, assisted evolution, thermal tolerance and the effects of sediments on coral reproduction. While coral spawning is always high-paced, and sometimes chaotic, the facilities and support available at AIMS as well as the researchers, or "spawners", who work all those late nights make it an extremely rewarding and fun experience.

Following the bleaching: coral recruitment, reef habitat complexity and searching for super corals

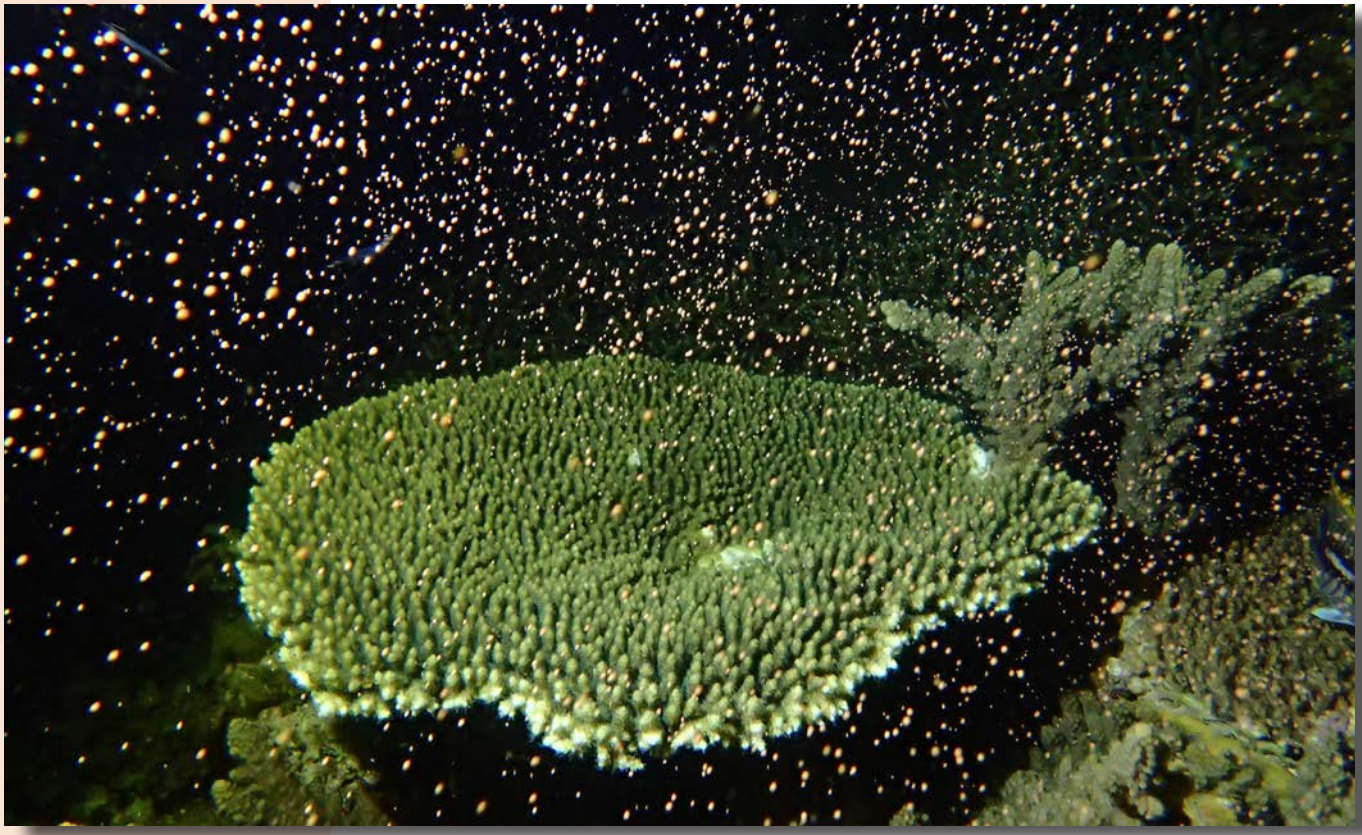

Photo: K. Cameron

The biological and ecological limitations to coral larval success and dispersal

Rachel M Woods
PhD Candidate
Marine Quantitative Ecology
Macquarie University

Coral reef ecosystems are under stress from anthropogenically induced climate change, including changes in ocean chemistry and pollution in the form of run off. Scleractinian reef building corals form the basis of this ecosystem, providing the structural complexity and habitat for many organisms. However, the effects of climate change and most significantly increasing sea surface temperatures and cyclonic activity has led to the large-scale destruction of the reef and high levels of coral mortality.

Recovery from such large-scale disturbances relies on the abundance and dispersal of coral larvae from unaffected reef areas to repopulate devastated regions. For this reason, **the main goal of my research and PhD is to explore how environmental, ecological and geographic factors can inhibit or assist in the success and dispersal of coral larvae both in current reef systems as well to novel environments under changing conditions.**

Increased sea surface temperatures can lead to the bleaching of adult coral colonies through the loss of symbiotic zooxanthellae. Bleached corals often die and vital functions including growth and reproduction, are compromised in colonies that survive. In 2016 the Great Barrier Reef experienced its worst mass bleaching event on record. The number of reefs severely affected by bleaching were over four times higher than in previous large-scale bleaching events in 1998 and 2002. **Through my PhD fieldwork I was able to capture changes in coral larvae recruitment before and after thermal disturbance.** These datasets allow me to explore how changes in environmental conditions leading to coral bleaching can alter adult coral populations. It also helps me track how these changes can affect the successful recruitment of coral larvae. Coral larvae can disperse large distances to seed disturbed areas, and so can buffer against local extinction. As part of my PhD I have been able to quantify changes in recruitment before and after the mass bleaching event as well as how this differs to historical patterns and the potential recovery of the reef.

I have been fortunate to complete my PhD research at the Australian Museum Lizard Island Research Station, in the Northern Great Barrier as part of an amazing team of researchers from all over the world. Over the last 3 years we have collected coral larvae recruitment data from 21 locations surrounding Lizard Island to compare the effects of the bleaching on recruitment as well as how patterns of recruitment have changed over a 20-year time frame from 1995 through to 2017. **Through this study we have observed a decline in overall recruitment on settlement tiles placed on the reef, prior to the annual mass spawning in November of each year with a 100-fold reduction observed after the mass bleaching in 2016.** While this decline is significant we are still seeing some recruitment to badly affected reefs highlighting the resilience of this reef system.

My project will continue to monitor the recovery of the reef surrounding Lizard Island and we are hopeful that with each year we will see more coral larvae recruiting to affected areas. This research will give insight into which coral species are the winners and losers and therefore most likely to repopulate affected reef areas.

Diving to retrieve one of the recruitment tiles laid out on the reefs of Lizard Island.

One of the many recruitment tiles I placed out on reefs surrounding Lizard Island.

Reef Records: The subtleties of change in coral reef habitat complexity by big events

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Marine Quantitative Ecology
Department of Biological Sciences, Macquarie Uni
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@MQSciEng @MQBiology

In 2016, I was preparing to go to the Great Barrier Reef (GBR) for the first time – something I have been dreaming about since I was a child, only this time I was going as a researcher. But it was also in 2016 when elevated sea surface temperatures (SST) set in motion the worst coral bleaching event in the recorded history of the GBR. Scientific reports estimated 47-83% coral mortality throughout the GBR's northern section. This section included my PhD field study area, 21 reef sites encircling Lizard Island. The coral reefs at Lizard Island were already badly damaged following the almost direct hits by consecutive category 4 cyclones; Ita in 2014 and Nathan in 2015. **Against this backdrop, I prepared myself to face a decaying reef instead of the coral reef from my bucket list.**

Nonetheless, when I first jumped in the water in November that year, I was captivated by beauty. I knew the reef was highly degraded, but I still saw interesting corals, sharks, and many colourful fish. Without a clear idea of the previous state of the reef, this became my baseline. Our team spent three weeks on the Island that month. We gathered a large variety of data for my research project, which was rooted within an ongoing long-term effort led by Joshua Madin and Maria Dornelas since 2012.

Back at Macquarie University, I processed the images taken in the field yearly from 2014 to 2017 using photogrammetric techniques to derive scaled photo-mosaics and 3D reconstructions of the monitored reef sites, each capturing about 130 square metres of reef. **These two data products, which we coined "Reef Records" because of the spiral motion the cameras track the reef, let us visualize and quantify change in benthic cover and 3D complexity.** Each Record was spatially georeferenced to match the exact field location through time. It was then that I realised the severity of the damage. **Some of the reef sites were simply unrecognisable from one year to the next** (Fig. 1), and I too cried.

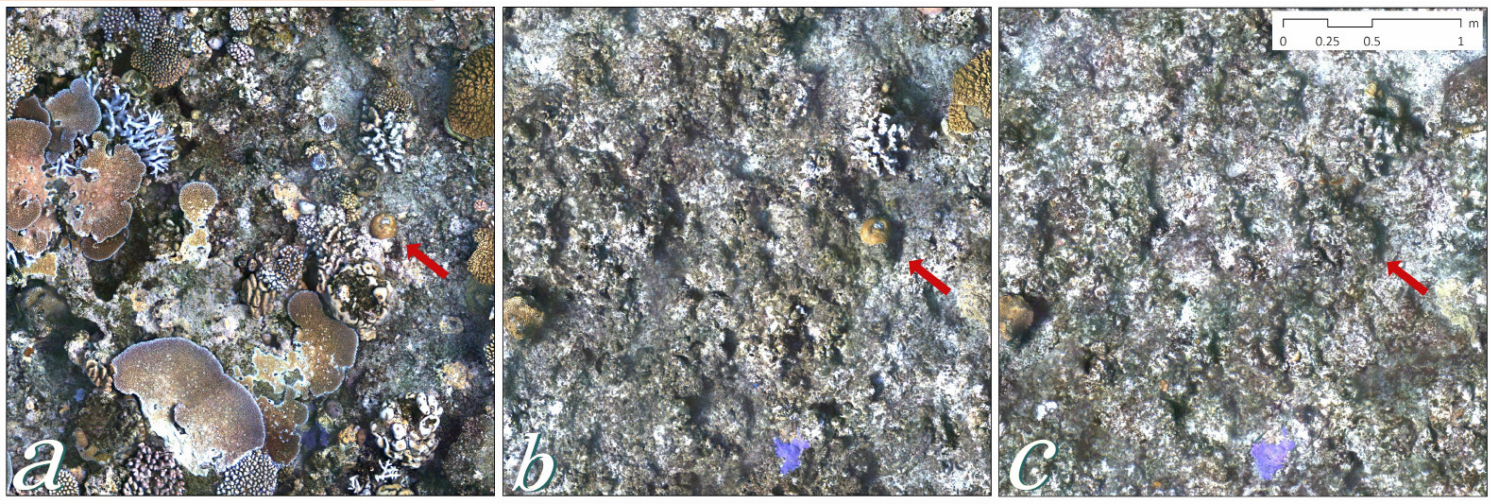


Figure 1. Photomosaic timeseries of a section of the southwest reefs at Lizard Island showing the severity of coral damage following; (a) Cyclone Ita in 2014, (b) Cyclone Nathan in 2015, and (c) severe mass coral bleaching in 2016.

In a broad range of terrestrial and marine communities, including coral reefs, geometrically complex habitats contain more species and at higher abundances than simple flat habitats. However, climate change projections forecast an increase in the frequency and intensity of tropical storms and anomalous SST that can trigger mass coral bleaching. These large-scale climate-induced disturbances can quickly destroy vast areas of reef-building corals, rendering these habitats vulnerable to flattening and impaired functioning, lower biodiversity, disrupted recovery and reduced ability to provide ecological goods and services that have been valued in the billions per year.

We have yet to learn how coral reef communities will respond to the trends that have been projected by climate scientists. My research aims are twofold: (1) to assess and quantify fine-scale spatial patterns of change in coral reef habitat complexity and composition as derived from the Reef Records and other environmental data, and (2) to determine if local habitat responses can be reliably traced remotely and at larger scales with spaceborne imagery. Ultimately, **I hope to produce a better understanding of the mechanisms underlying coral reef habitat complexity response and recovery potential under a novel climate regime.** Determining how major disturbances drive ecological change is necessary to identify suitable approaches to managing coral reef ecosystems in the face of climate change.

There are plenty of reasons to remain hopeful about the future of coral reefs, but we must reduce CO2 emissions quickly. Not all changes found in the Records are negative, nor do all areas respond similarly. Many corals survived the traumas of the past and are steadily growing (Fig. 2), others show signs of recovery. **Thanks to images worth a thousand words, I have learned to put my baselines in historical context.**

Figure 2. Timeseries of a section of the northern reefs at Lizard Island which were severely damaged by Cyclone Ita in 2014, showing continuous coral growth following (a) Cyclone Nathan in 2015, (b) severe mass coral bleaching in 2016, and (c) yet another, milder coral bleaching event in 2017.

Acknowledgment. I am honoured and grateful to have been awarded the 2017 Ian Potter Doctoral Fellowship at the Australian Museum's Lizard Island Research Station, which is helping fund fieldwork-related expenses and expand my horizons. I would like to thank all who have contributed to the Reef Records efforts in the past for the valuable dataset and for welcoming me into the team. The Reef Records data collection methods were developed in collaboration with the Australian Centre of Field Robotics, University of Sydney.

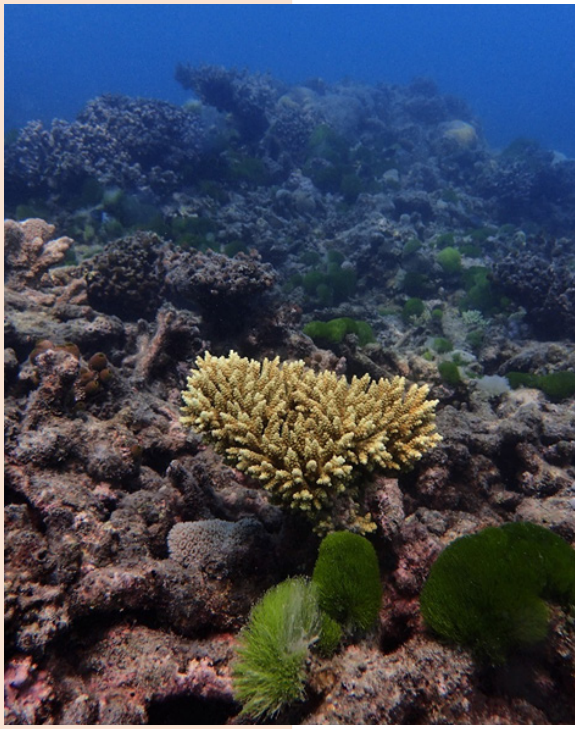
The Great Barrier Reef Legacy
Search for the Super Coral Expedition

Samantha Goyen, PhD Candidate & Dr. Emma Camp, Research Associate, University of Technology Sydney

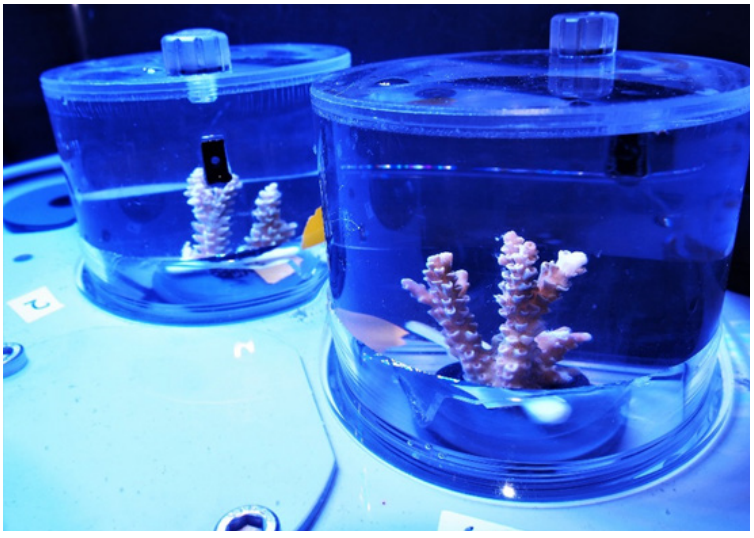
In November 2017, a 21-day expedition left Port Douglas for the far northern Great Barrier Reef (GBR) and Torres Strait in search of the 'Super Coral'. Launched by the Great Barrier Reef Legacy, a not for profit organisation, **our mission was to identify coral species that have survived consecutive years of coral bleaching and provide the first detailed assessment of the region, which was hardest hit by the recent thermal stress events.**

The M.Y. Flying Fish, normally chartered as a luxury yacht, was generously donated by the Northern Escape Collection and allowed us to get to parts of the reef rarely accessed, transecting the outer, mid and inner sections. The crew of 'The Fish' had no idea what they were in for when an eclectic group of scientists, educators, media professionals and tourism operators commandeered the yacht, turning it into a floating laboratory. With teams mapping the reef using satellite and drones to others doing turtle tracking and documenting fish populations, there were a number of creative modifications made to the super yacht. The most extreme of these was the conversion of the bathtub in the executive suite into an experimental setup for coral incubations and the ships bar providing bench space for a microscope. The upper deck also became a wet lab and liquid nitrogen area for the processing of samples!

With such a unique collaborative effort the achievements were significant. Among them, **certain coral species were identified as survivors across all of the sites we visited, such as Acropora tenuis, a species that will help us understand traits supporting coral tolerance.**



***Acropora tenuis* as a sole survivor. Photo: Emma Camp**



Measuring coral physiology in the bathtub. Photo: Emma Camp

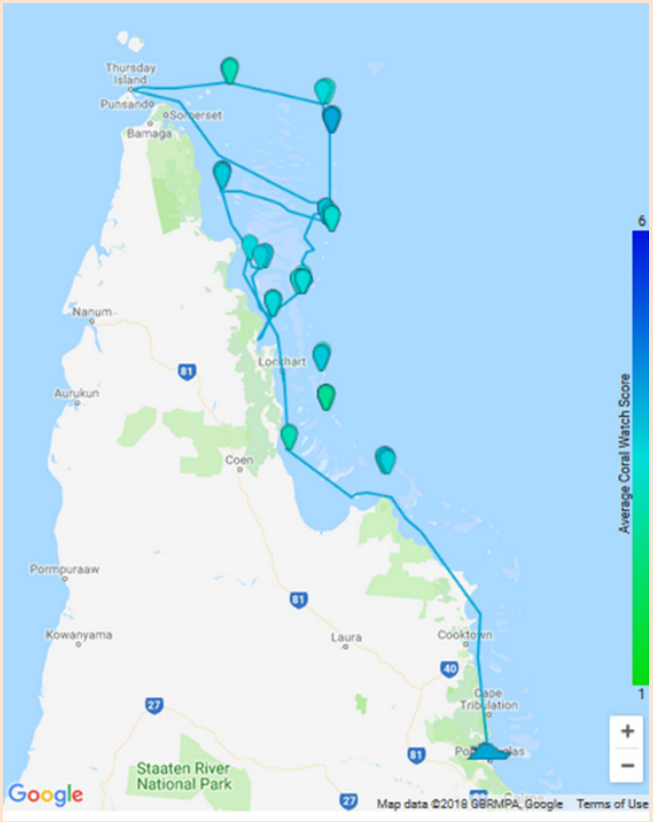
On board we measured the metabolic rates of these species and their molecular compositions are now being determined back on land. Live colonies were also collected for spawning and reef restoration technique development.

Incredibly, 30 km of reef was mapped using in-water transects, some sections to a resolution of 2 cms with drones. Also, **the most diverse branching coral**

site ever documented was found which is home to new species of corals! We were all kept very busy both in the water and out.

In a ground-breaking initiative, the entire expedition was communicated directly to the public as we went, reaching audiences far and wide. On our arrival back to Port Douglas we were fortunate enough to present our findings at a public symposium receiving a fantastic response from members of the public who share our passion and concern for the reef. Here is the YouTube link to the first official video of the expedition so take a look! **https://www.youtube.com/watch?v=Cd5rBAUy108.**

What we found varied considerably from one site to the next. We saw a large number of completely degraded reefs, which we often termed the 'coral graveyards'. We found reefs in sub-optimum states that retained some coral cover and diversity. Often these sites had signs of coral recruitment or corals with egg development indicating a capacity for reproduction. There were also pristine reefs that had us all jumping for joy, in absolute awe at the beauty of the far north.



A map showing the sites and distance covered by the GBR Legacy expedition.

There are pockets of hope in the far north which will help increase reef resilience into the future but they are in need of urgent protection. At this critical time for the future of the GBR, we must understand the response of these systems to stress, be able to communicate our science well and provide research backed solutions.

This Great Barrier Reef Legacy expedition was an amazing example of how effective collaborative efforts can be to achieve this. It is one of the most powerful tools we have in our fight to save the reef.

Some of the team following a successful dive finding new corals

On behalf of all the participating teams, we would like to thank the GBR Legacy, The Northern Escape Collection and the crew of 'The Fish' for bringing science to the reef and showing the world what can be achieved with such commitment and passion!

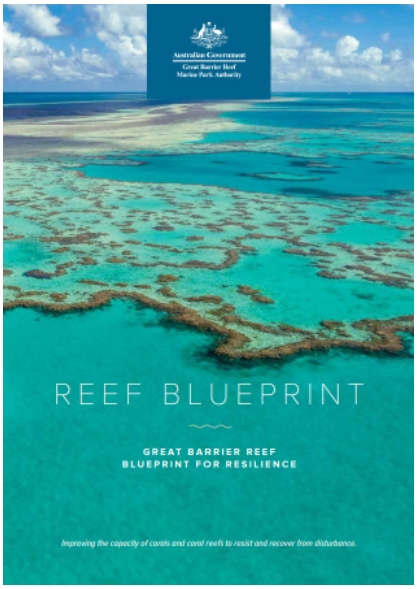
A reef in excellent condition in contrast to a 'coral graveyard'. Photo: Emma Camp

Australian Government
Great Barrier Reef Marine Park Authority

GBRMPA Special Report
Managing for a resilient Reef

The Great Barrier Reef Marine Park Authority is Australia's lead management agency for the Great Barrier Reef, one of the world's greatest natural treasures. For more than 40 years, the Marine Park Authority has managed this biologically diverse icon and multiple-use area using the best available scientific information and input from marine managers, researchers, experts and Traditional Owners.

After back-to-back years of coral bleaching and impacts of compounding pressures from a range of sources, the Marine Park Authority convened a Reef Summit in 2017 with over 70 national and international experts to determine what more can be done to build reef resilience, in addition to the suite of actions already underway. The resulting Reef blueprint for resilience — released in late 2017 — signals a new direction for managing this great natural icon and outlines 10 key initiatives for Reef management, focused on actions that deliver maximum benefits for Reef resilience.



The Blueprint's 10 key initiatives fall into four broad areas comprising of building a resilient network, on-ground actions, empowering people and fostering change. The actions include:

1. Identifying and protecting a resilience network
2. Dramatically enhancing compliance
3. Ramping up crown-of-thorns starfish control
4. Protecting key species for reef recovery
5. Active, localised restoration
6. Accelerating actions to address climate change
7. Fostering partnerships for actions and innovation
8. Adapting policy and legislation
9. Developing decision-support systems
10. Building awareness and support

By working with partners to undertake these actions, the Marine Park Authority aims to strengthen the Reef's resilience, build on existing management arrangements such as crown-of-thorns starfish controls, enhance fishing compliance and establish innovative approaches to better support and protect coral reefs in the face of a changing climate.

Our strong message is: together we can secure the future of the Reef – we have to try harder, do more and act now.

The Blueprint's explicit focus on coral reefs reflects both their critical state, and the fact that coral reefs are the cornerstones of the Reef's broader ecological, social, economic, cultural and heritage values. It clearly highlights key environmental actions, helping give focus to government, industries and communities who wish to be involved in Reef protection.

The Blueprint's centrepiece is identifying and better protecting a resilience network, made up of individual reefs in the Marine Park that play a vital role in regenerating other reefs damaged after major disturbances. Generally, these are reefs less exposed to high water temperature and cyclones because of their location or depth and have high coral cover.

These reefs are well-connected to other downstream reefs by ocean currents — coral larvae (baby corals) from these reefs travel on the ocean currents and settle on other downstream reefs.

The reefs identified as part of the resilience network will be protected though enhanced compliance with zoning, crown-of-thorns starfish control, stewardship approaches to protecting key species such as herbivores and corals, and, in the future, implementing restoration actions.
Following recommendations of the Blueprint, further funding was provided in early 2018 to ramp up the crown-of-thorns starfish control program as the coral-eating starfish are an ongoing high risk to Reef health.

An expanded crown-of-thorns control program will see a boost in the efforts to target the coral-eating starfish. Under this program, the top priority is maintaining coral cover and keeping starfish numbers below ecologically sustainable thresholds on ecologically and economically valuable reefs in the Marine Park.

The Marine Park Authority will educate and work with those out on the water, such as fishers, about the importance of species, such as plant-eating fish that aid recovery by controlling seaweed after bleaching.

These collective protections will ensure those reefs identified as part of the resilience network are better able to deal with pressures and, through their role supporting other reefs downstream, will help other reefs recover from impacts.

The Marine Park Authority will lead implementation of the initiatives, with the plan's success depending on partners committing similarly-focused expertise, resources and efforts.

The initiatives in the Blueprint will only work if there is strong global action to adopt renewable energy and reduce greenhouse gas emissions.

Global action on climate change is vital —including implementation of the Paris Agreement to reduce greenhouse gas emissions and work towards reducing temperature increases closer to 1.5°C — not just the 2°C overarching target.

By focusing our efforts on building the resilience of coral reefs, we will give the entire Great Barrier Reef ecosystem its best chance of coping with the challenges ahead.

For more information on Great Barrier Reef health and management visit www.gbrmpa.gov.au

News from our research stations

KIMBERLEY MARINE
RESEARCH STATION ● CYGNET BAY

2017 Wrap up

It has been another incredible year for KMRS. A number of new studies were established and the interns at KMRS continued their environmental monitoring programs to keep check on the marine ecosystem health in the area.

Corals

At the start of the year the interns began analysing data from the 2016 bleaching event searching for signs of recovery and identifying species richness to monitor ecosystem health. Visiting scientist Dr. Verena Schoepf also returned to her studies on intertidal and subtidal corals with help from KMRS and discovered thermally tolerant 'super' corals in Cygnet Bay. However these corals were shown to still be vulnerable to extreme heat stress events. The monthly coral monitoring program was continued throughout the year to track significant changes to the local coral community. Fortunately, there have been no further observations of bleaching since the 2016 bleaching event.

Oysters

Continuing last year's study on the spatial and temporal variation in settlement of rock oysters, results have indicated spat recruitment is most abundant in mid-shore zones. Two more studies on this species of rock oyster also emerged this year conducted by Masters students Ashleigh Haddon and Andrew Bossie from UWA with the support of KMRS. Ash's study investigates interspecific competition of the rock oyster while Andy's research looks at preference of settlement substrate for oyster spat.

Plastic Surveying

A plastic survey conducted in three separate sites around Cygnet Bay found minimal amounts of plastic and debris and no records of any small plastics. This indicates the area is relatively free of plastic pollution from both off-shore and land-based sources.

Monitoring Projects

Water quality monitoring continued to collect data for water temperature, salinity, and pH, every month to determine any changes occurring over the seasons and years. These samples were also used to monitor and identify phytoplankton species to produce baseline data to be shared with the Australian open data set.

KMRS Scientists

• The interns were able to contribute to Christine Shoenburg's (UWA) study on the impacts of bioeroding sponges on the strength of pearl oyster shells

• Visiting scientists James McLaughlin and Jim Greenwood (CSIRO) presented findings of many years of study around the Dampier Peninsula for the benefit of KMRS and the local community.

• Scientists Mike Travers and Dion Boddington (Division of Fisheries) also visited to explore the application of environmental DNA to identify species in King Sound region.

• Dr. Chris Cornwall also came to the region to study seasonal variations in the amount of carbonate around waterfall reef.

Year in conclusion

The year began with an above average wet season with 271.2mm and 286.8mm of rainfall in January and February respectively and ended with Cyclone Hilda sweeping through in December. Despite the adverse weather the many research projects have been quite successful. Over the year 9 different interns from diverse backgrounds came to the research station. Our interns are the fundamental backbone of KMRS and we thank them for their hard work and dedication! To keep up to date follow us on social media or sign up for our newsletters at www.kmrs.com.au.

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Kimberley Marine Research Station

@KMRS2009

@kimberleymarineresearchstation

Coral Bay Research Station

2017 was a busy year for the Murdoch University's Coral Bay Research Station, with numerous local and national projects using our facilities throughout the year. Our more mobile resources are also regularly hired out; boats and dive equipment have been used throughout the region and also further afield for studies including dolphin research and surveys.

2017 was an active year for Project Manta at Ningaloo, which operates out of the Coral Bay Research Station. Many additional sightings and data were collected, in spite of the unusually low number of mantas visiting the area this year. Station Manager (and Project Manta industry collaborator) Frazer McGregor managed some legendary tag recoveries in very remote locations, and was also able to sample an oceanic manta that paid us a visit. Two Murdoch University Honours students, Alex Thornton and Tarryn Coward, were based in Coral Bay this year, studying manta ray feeding ecology and their use of cleaning stations in the Coral Bay area. Our two UQ-based Project Manta PhD students also conducted field work in Coral Bay: Amelia Armstrong is focusing on genetic diversity and connectivity of mantas, and Asia Armstrong is studying plankton ecology.

Supporting our research, we hosted two Earthwatch expeditions in Coral Bay; the volunteers contributed to our shark and ray research, providing support for our student projects and helping us stay on top of our manta ID database. In addition to Earthwatch, we are currently hosting an intern, Sarah Franzen, who is helping Frazer with field sampling and database management over the summer. We hope to expand our opportunities for internships at the research station in the future.

Left to right: Mobilizing the CBRS fleet for a big day on the water (Earthwatch expedition); The October 2017 Earthwatch team, celebrating the end of a successful expedition; Station Manager Frazer McGregor showing off one of the acoustic tags being deployed as part of the Project Manta – Mantas of Ningaloo ARC project.

The unit is at third year undergraduate level and we welcome undergraduate students with second-year biology or ecology experience.
2018 is looking like it will be another busy year, with resumption of Flinders University's Northwest Dolphins project based in Exmouth at the northern end of Ningaloo. The station has available accommodation for small groups, basic office and laboratory facilities, including a small library, three boats and a 4WD Hilux.

Follow our news and activities on Facebook: Coral Bay Research Station and Project Manta WA.

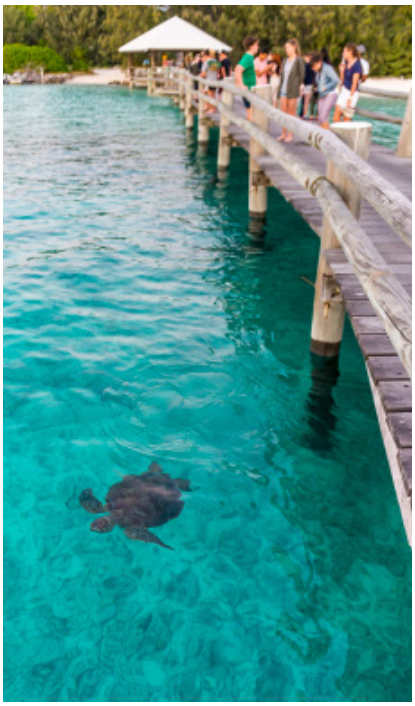
Dr Mike van Keulen
Director, Coral Bay Research Station

Left to right: Examining the impacts of a boat ramp on the intertidal platforms in Coral Bay, 10th Tropical Marine Biology field course. 10th annual Tropical Marine Biology field course team.

Heron Island Research Station

2017 was another busy year for Heron Island Research Station (HIRS) with a diverse group of researchers visiting; showcasing the breadth of studies that can be carried out from the facility. This year we opened up the Research Station with a new informative tour for Resort guests. This is a fun and interactive way to give the public a glimpse at the activities occurring on the Station and the remarkable work undertaken by our researchers. The tour gives the public an insight into the unique environment they are visiting, the challenges it faces, and the many dedicated people who are teaching us more about it every day. The level of interest in the facility and the incredible research that is conducted here has been overwhelming. We'll be constantly updating and renewing the tour content so be sure to help out the HIRS Education or Scientific Officers if they drop by while you're on station to learn more about your research!

In June, the Research Station was thrilled to receive a sustainability award at Ecofest, Central Queensland's largest free environmental event. The award was given in recognition of the Station's effort in achieving sustainable outcomes, a movement we intend to continue into the future. 2017 also saw a new partnership with the Great Barrier Reef Foundation that led to the development of the Live Learning Library, a purpose-built open-access data repository. The Library is already housing baseline data from the Station's solar panels and weather station. In the future we aim to build up the Library with data submissions from visiting researchers and student groups. Please feel free to contact us if you have any data that you are interested in submitting.



We also farewelled a number of long term staff from the Research Station this year. Station Manager Liz Perkins, Deputy Station Manager/Scientific Officer Bec Tite and Maintenance Officer Sam Chapman departed the Station to take on new and exciting career challenges. As such, you will see some new faces on your next visit to the station, all eager to meet you and to assist in your work.

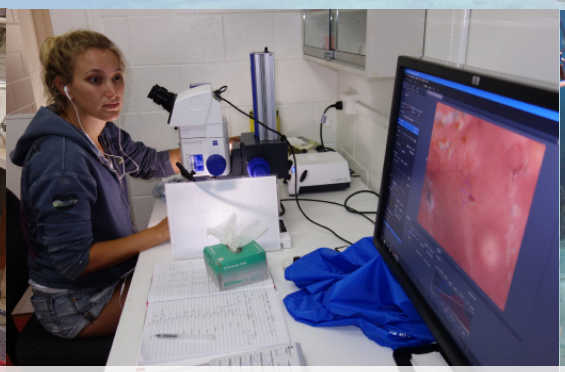
Looking to the future, the Research Station has been investigating some largescale facility-wide projects to allow us to continue to support our many researchers and their diverse activities. 2017 saw some big wins for these plans and we will be working on some significant upgrades over the coming years to our solar power and saltwater intake system. The upgrade process has begun with the recent retirement of one of the station's 20 year old Southwinds, which has been replaced with a 6.5m purpose-built rigid inflatable. The new vessel is able to carry seven divers or four people with space for equipment.

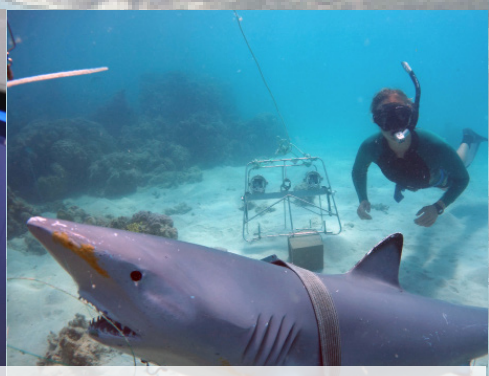
As always, Station staff are excited to learn about upcoming research and the role we can play to support you, so please get in touch. We look forward to welcoming the coral reef community back to the station in 2018.

Lizard Island Research Station

During February to April 2017 and for a second year in a row corals at and in the vicinity of Lizard Island died due to elevated sea temperatures. Although the number of corals lost was not as high as during the previous summer this was mainly because those corals susceptible to bleaching had died 12 months earlier. On a brighter note, the small corals that had managed to survive grew strongly throughout the remainder of the year.

The Station's Fellowship program began in 1984 and since then 113 Fellowships and grants have been awarded for research to be conducted at LIRS. Three new Doctoral and Postdoctoral Fellows **undertook research at LIRS during 2017. These studies focused on corals, fish and algae and they** all investigated impacts or recovery from cyclones and mass coral bleaching. Knowledge gained from these studies will better help us understand how coral reefs respond to these disturbances.





Left to right: Jose Paula & Tiago Repolho (University of Lisbon) investigating responses of cleaning mutualisms to ocean; Tessa Page (Griffith University) studying coralline algae acidification; Emily Lester (University of Western Australia) quantifying risk effects behaviour in coral reef fish (photo credits: L. Vail)

Disturbances to the Reef were the impetus for other, non-core Station visitors. These included environmentalists, artists **and a poet, all of whom came to see first-hand what was happening to this section of the Reef. Their output is informing** a different audience about the challenges facing the Reef.

Although the COTS outbreak at Lizard finished in 2015, LIRS continued to support COTS research through funding received from the Ian Potter Foundation. Four COTS projects were undertaken in 2017 under this program with three of them being conducted in the vicinity of Cairns to Townsville due to lack of COTS at Lizard. Sven Uthicke (AIMS) undertook research at Lizard in order to detect COTS DNA from plankton samples. Early results suggest that this technique might provide an early warning signal for the next COTS outbreak.

LIRS continues to transition from two-stroke to more fuel efficient four-stroke outboard motors. By the end of 2017, only three of its sixteen outboards were two-stroke.

Construction of a dedicated cyclone shelter was completed late in 2017. It is the 14th designated cyclone shelter in Queensland. The shelter can hold all a full complement of Station visitors plus staff although typically there will be a staged-evacuation of visitors with only those with compelling reasons staying (e.g. long-term aquarium experiment). The shelter is located above the 1 in 10,000 year storm surge zone event **and it is rated at Category 5 +. Construction of the shelter was funded by the Ian Potter** Foundation and the Lizard Island Reef Research Foundation.

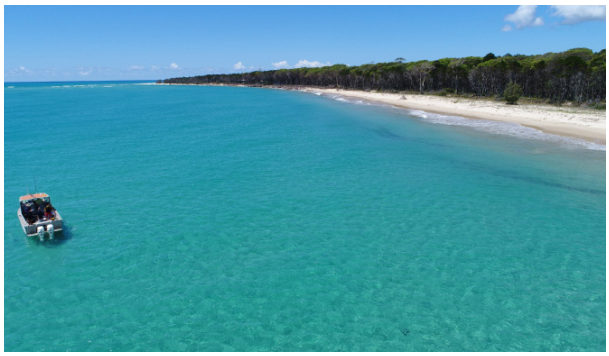
In 2017 researchers from 31 institutions in 8 countries conducted 74 research **projects, and 125 publications were added to the LIRS contributions list. Lizard Island** Field Guide (lifg.australianmuseum.net.au) now provides photos and information on almost 2,200 local species. The Field Guide is becoming increasingly popular with **researchers and their assistants as a tool to help identify the area's flora and fauna.**

Top to bottom: Fabio Cortesi and Martin Luehrmann (UQ Brain Institute); Derek Sun, Pauline Narvaez & Marina Richardson (UQ) investigating the relationship of cleaner wrasse and gnathiid isopods

Dr Anne Hoggett & Dr Lyle Vail, Directors
Web: www.australianmuseum.net.au/Lizard-Island-Research-Station

Background credit: C Shuetrim

Moreton Bay Research Station



A beautiful day on Moreton Bay. (credit: C. Heatherington)

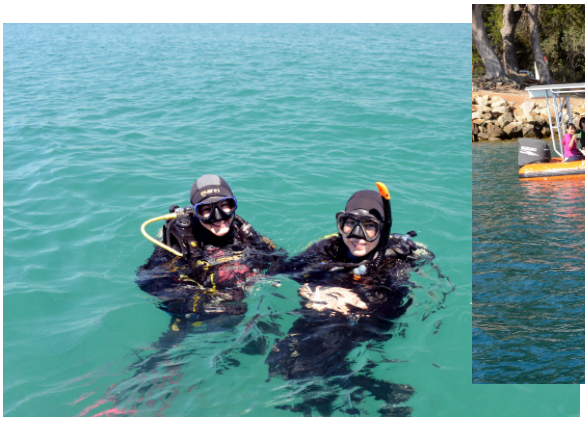
It's been another busy year for research at Moreton Bay Research Station (MBRS). Our location on the second largest sand island in the world makes the Station a fantastic location for researching a diverse range of marine and terrestrial habitats.

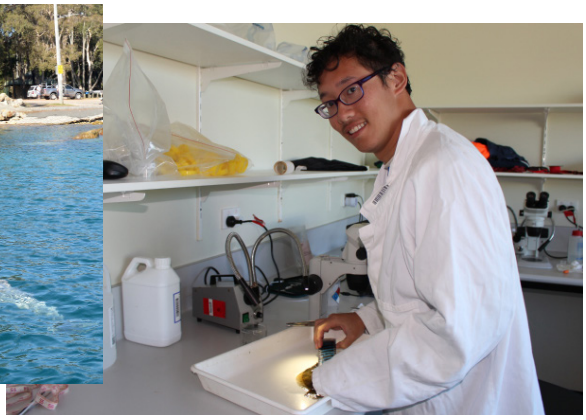
Six papers were published this year on the seagrass of Moreton Bay with one team nominated for a Healthy Land and Waterways award. Topics of papers ranged from fish and invertebrate biodiversity in intertidal seagrass, through to the importance of seagrass beds as fish corridors, and the effects of habitat complexity and connectivity on biodiversity in seagrass meadows.

Dr Chris Roelfsema from The University of Queensland and Jennifer Loder from Reef Check Australia discovered and mapped out new parts of the coral reef system in Moreton Bay. The researchers hope that the study will help inform conservation decisions to protect the small but important reef system. We also had researchers who conducted a diverse array of work at the Station featured on popular science TV shows Totally Wild and Scope. In July, the UQMBRS Marine Mammal Forum was a huge success and is promising to turn into an annual event. Sharing scientific and traditional knowledge, the forum was part of the Quandamooka Festival's Whale Welcoming Ceremony and attracted over 100 people.

Sheridan Rabbitt being filmed for Totally Wild

Our outreach programs with Dunwich State School included the 2017 Steam-Athlon. With help from MBRS researchers, students investigated the effectiveness of seagrass friendly moorings, the result of which had them designing their own mooring. The top three student designs were then handed over to UQ Science Workshops who built working prototypes to student's specifications. Dunwich was awarded second place overall out of 12 teams from around the SEQ region - a fantastic team effort! We also said goodbye to long-time staff member Kathryn Crouch this year who moved on to an exciting new position and welcomed three new staff members; Sheridan Rabbitt as Station Assistant - Education, Cameron Cottrell as Station Assistant - Boating and Diving, and Jennie Bell as Administration Officer. Station staff, both old and new, have thoroughly enjoyed working with our research clients in the last year and look forward to welcoming you back in 2018.

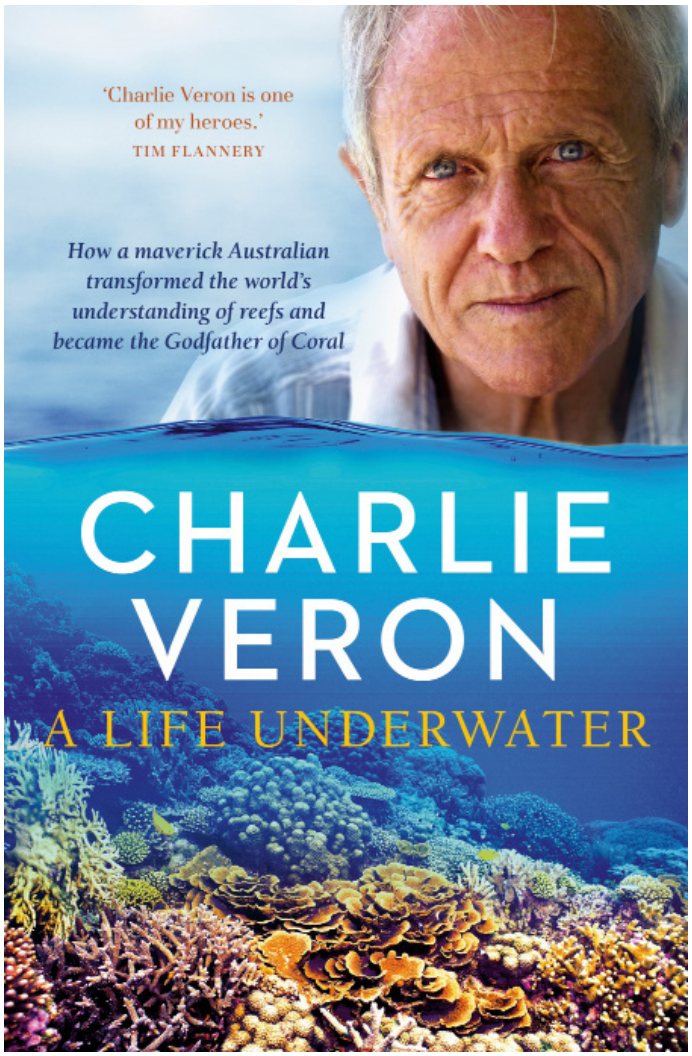




Left to right: Divers on the Bay investigate one of the local reefs (credit: L. Trippett); A dolphin passes by one of the MBRS vessels during a field trip (credit: L. Trippett); UQ researcher Russell Yong Qi Yung dissecting a fish (credit: M.

Book Review: A life underwater by Charlie Veron

Review by ACRS Councillor Selina Ward



A Life Underwater is one of those fabulous books that will stay with you – that will keep coming back to your thoughts. I know Charlie, so I could see him as I read but, for the reader for whom he is a stranger, I believe that they will feel that they have got to know someone very special. This is a book that will touch everyone for its triumphs, its adventures but also its sadness.

Charlie's writing style is very engaging so that it's hard to put the book down and get on with the relatively mundane. Like one of those great British movies, it makes you laugh, think deeply and cry within the few hundred pages. A non-scientist will be fascinated that anyone could live such an exciting life, full of experiences most could only dream about, full of fearlessness that usually resides in action movies and novels. The science is readable and interesting to the non-scientist who should be able to make sense of many complex ideas.

For the reef scientist, seeing how Charlie's enormous contribution to our knowledge fit in with his field trips, personal experiences, academic relationships and positions he held can only add to the admiration we feel for him and a deeper understanding of his work. One of the most striking elements of the book, which could not fail to arouse strong emotions in all scientists, is the description of the profound changes that have occurred in science over the years since Charlie started his work. As a scientist a couple of decades behind Charlie, I have been painfully aware of the changes during my career.

The limitations now placed on our field work, the huge increase in regulation and occupational health and safety have made a big difference, but the contrast in the two decades between the starts of our careers is even more staggering.

It was incredible to read the accounts of Charlie's amazing trips to previously unexplored reefs and islands where so much of the ground-breaking work was done to create the knowledge on which so many of us in the reef community depend. But reading these accounts also made me feel sad with the certainty that this sort of work is unlikely to be possible again under the current systems of rules, regulations, litigation, OHS, funding limitations and short PhD candidatures. Charlie's story makes it hard to believe otherwise.

The reader is left profoundly happy that Charlie was born in the period he was, as his uncompromising pursuit of his scientific independence and what he believed was right may have found many more barriers today and we may have been deprived of his achievements. I feel grateful to Charlie for sharing his incredible life story with us, the endless adventures, the many successes, the battles, the special places dearest to him and the terrible sadness. It was clear that there must have been great strength to keep living such a full and productive life.

I recommend A life underwater for the top of your reading list.

2017 photo competition winner: V. Huertas. Category: Overall Winner.
I had dived on this reef a few times before, so I knew exactly where to go to find a school of painted sweetlips (*Diagramma pictum*). I found them sheltered under a ledge. I took several photos from up close, as they generally don't mind the divers' attention. Suddenly, this fish took a 'step' forward as if he wanted the spotlight exclusively on him. This is when I took this photo. I like sweetlips. Not so much because of their lips, but more because of their goofy-looking snout. In this case, the shade provided by the ledge helped to darken the background and, with a little bit of editing, I was able to highlight its face.

We invite you to keep in touch

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