



REEF IN REVIEW

THE MAGAZINE OF THE AUSTRALIAN CORAL REEF SOCIETY

2020
#49

The third time is not the charm
Coral bleaching returns to the GBR.
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ACRS Research Awards
2019 award recipients share their
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Science meets Parliament
ACRS goes to the capital.
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*The Australian Coral Reef Society
acknowledges the Traditional Owners of coral
reefs throughout Australia. We pay respect to
their elders, past, present, and emerging.*









Message from the President

Wow, what a challenging and uncertain time to write a President's message. Our reefs are bleaching, and our world has changed immeasurably within a very short period of time. I think now more than ever it is time to stay healthy and safe and take care of those that we love, but also to ensure that our environment continues to have a voice.

The Australian Coral Reef Society (ACRS) and its members play a really important role in this. Our 250+ membership consists of prominent and upcoming researchers and managers who contribute to the understanding and stewardship our coral reefs, which provide so many tangible and intangible benefits. This knowledgebase allows us to provide pertinent advice to policymakers, and the number of submissions this year alone shows just how committed we are to ensuring the long-term future of these ecosystems.

Staying connected as a community will be important in the immediate future, and will require us to look at new ways of interacting. With this in mind, we have decided to hold our AGM by videoconference this year (an invite will be sent shortly). We hope as many of you as possible can attend, especially since our usual conference events, where we share ideas and findings, are currently postponed.

Some of you might even consider electing for Council and becoming part of the new generation of councillors that help keep our Society running. This year will see Dr Sarah Hamylton step into the role of ACRS President. I wish her the best of luck, and I also want to say thank you to all of the councillors that have provided an enormous amount of support over the past couple of years. Some of their achievements are highlighted in this issue, such as running our annual conference, facilitating and judging the ACRS Medals, Research and Travel Awards, representing the Society at national events, writing submissions, and ensuring a steady stream of engaging social media content. However, there are many other tasks that often go unnoticed but are crucial, such as minute taking and looking after our finances, and for this, I am incredibly grateful.

Looking to the future, ACRS will have its 100th year anniversary in 2022. We have already started planning on how to celebrate this milestone, and welcome information from anyone who might be able to provide additional details on the history of ACRS.

While it might potentially be hard to carry out field-research at the moment, to all those that have an odd paper or two worth of data sitting waiting to be rediscovered, or have a PhD chapter that is ready to be written up; I hope this is a time where we can consolidate the outstanding work that our Society is known for. And better still, I hope to see you underwater in the not too distant future!

Anna Scott
ACRS President

Left: Coral reef biodiversity.
© Christopher Brunner
2019 ACRS Photo Competition

Editorial foreword

Dear members,

We want to start by thanking all our members for the wonderful contributions to science, conservation and policy made over the past year. The Great Barrier Reef is being affected by the third mass bleaching event in the last five years (page 8) and our role as scientists, managers, and naturalists is now more important than ever. This year, the Australian Coral Reef Society (ACRS) has continued to play an active role in the future conservation of the reef.

In May 2019, we held our annual ACRS conference at Moreton Island, Queensland. We were thrilled to host five keynote speakers that discussed time sensitive topics on coral reef ecology, communication, and management: Dr Alana Grech (ARC Centre of Excellence for Coral Reef Studies), Russell Kelley (BYO GUIDES/ARC Centre of Excellence for Coral Reef Studies/James Cook University), Professor Amatzia Genin (The Hebrew University of Jerusalem/Interuniversity Institute for Marine Sciences), GBRMPA Special Keynote presentation by GBRMPA's CEO Josh Thomas, and the noteworthy Pat Hutchings, who highlighted the active role that ACRS has played in coral reef conservation for almost a full century! At the conference, we announced the recipients to our competitive ACRS Research Awards (page 17), which are used to support our best and brightest in their quest to better understand Australia's coral reefs, giving access to some of Australia's fantastic research stations.

Last November, two ACRS councillors represented the Society at the annual Science Meets Parliament event in Canberra, where they met with politicians and partook in policy workshops (page 32). ACRS representatives had an opportunity to express their concern that the Australian government's unwillingness to address climate change is contributing to the degradation of the GBR and the erosion of the public's trust in scientific research. The ACRS has provided a commentary to support the key findings of the 2019 Outlook report (page 48)—reiterating the need for immediate climate action to curb the pressures on our coral reefs. Since our last issue, ACRS has distributed a submission to refute arguments put forward by climate denialists (page 50), and published a series of important policy submissions to advocate for measures that would enable Australian researchers' to continue producing high quality research (page 52) and to bring attention to the impacts of stressors such as climate change on coral reef health. Specifically, a submission was prepared for the Senate Rural and Regional Affairs and Transport References Committee (RRAT) regarding the identification of leading practices to ensure evidence-based regulation of farm practices that impact water quality in the Great Barrier Reef (page 54). The RRAT requested that we provide evidence at a public hearing for the RRAT committee's inquiry into water quality and farming impacts.

We understand that it can be tough to stay positive while coral reef degradation continues unabated. Your work is important for managing and overcoming these obstacles. In this issue, we present you a series of stories that we hope will inspire you to continue working vigorously to protect reef ecosystems around Australia.

We hope you enjoy the 2020 issue of Reef in Review, the magazine of the Australian Coral Reef Society.



Victor Huertas



Catheline Froehlich



Brett Lewis



Chris Roelfsema

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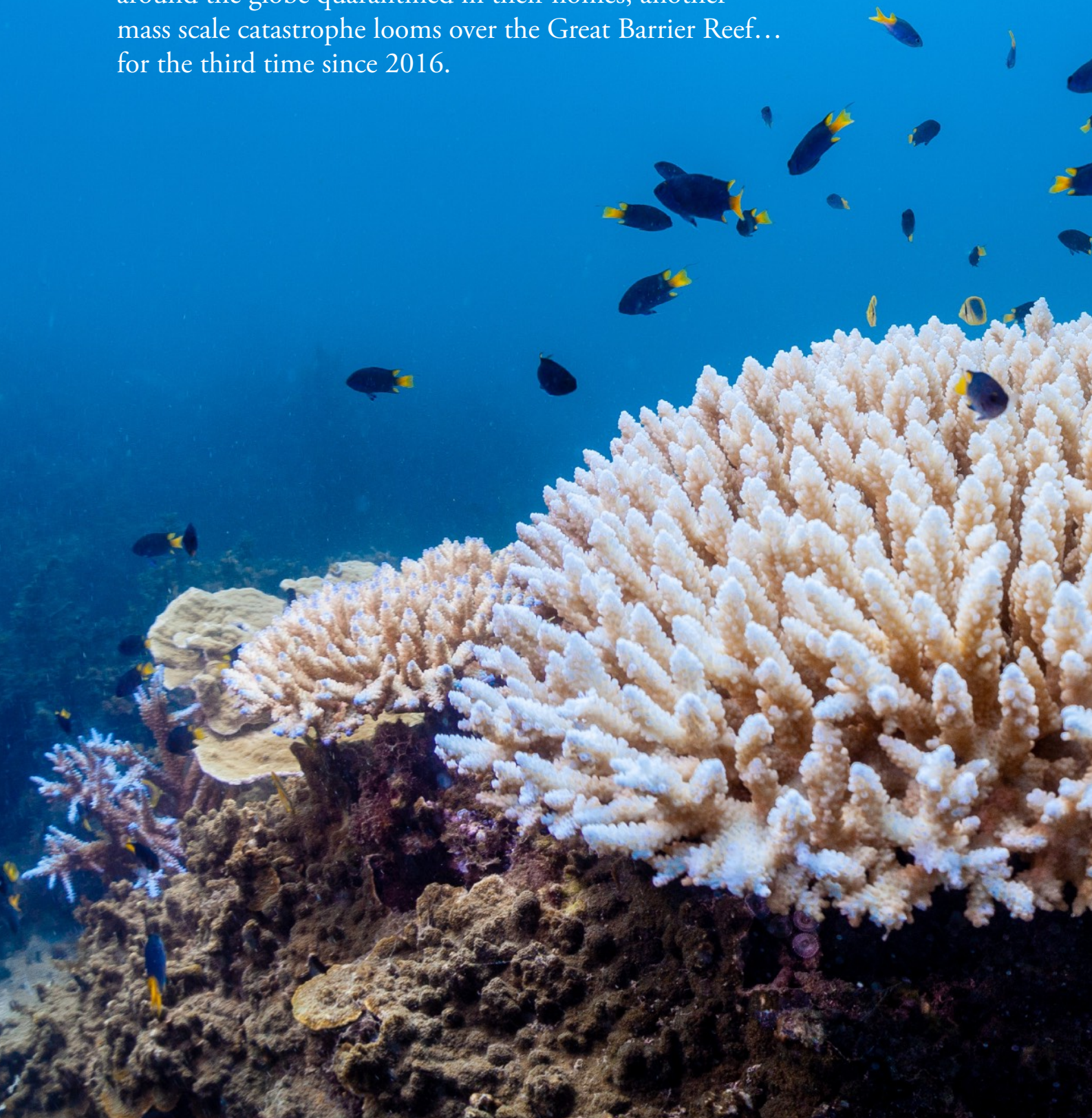
Cover: Pigmy seahorse (*Hippocampus bargibanti*) © Maarten De Brauwer
2017 ACRS Photo Competition

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

The third time is not the charm.

by Victor Huertas

As we struggle to contain a pandemic that has left millions around the globe quarantined in their homes, another mass scale catastrophe looms over the Great Barrier Reef... for the third time since 2016.





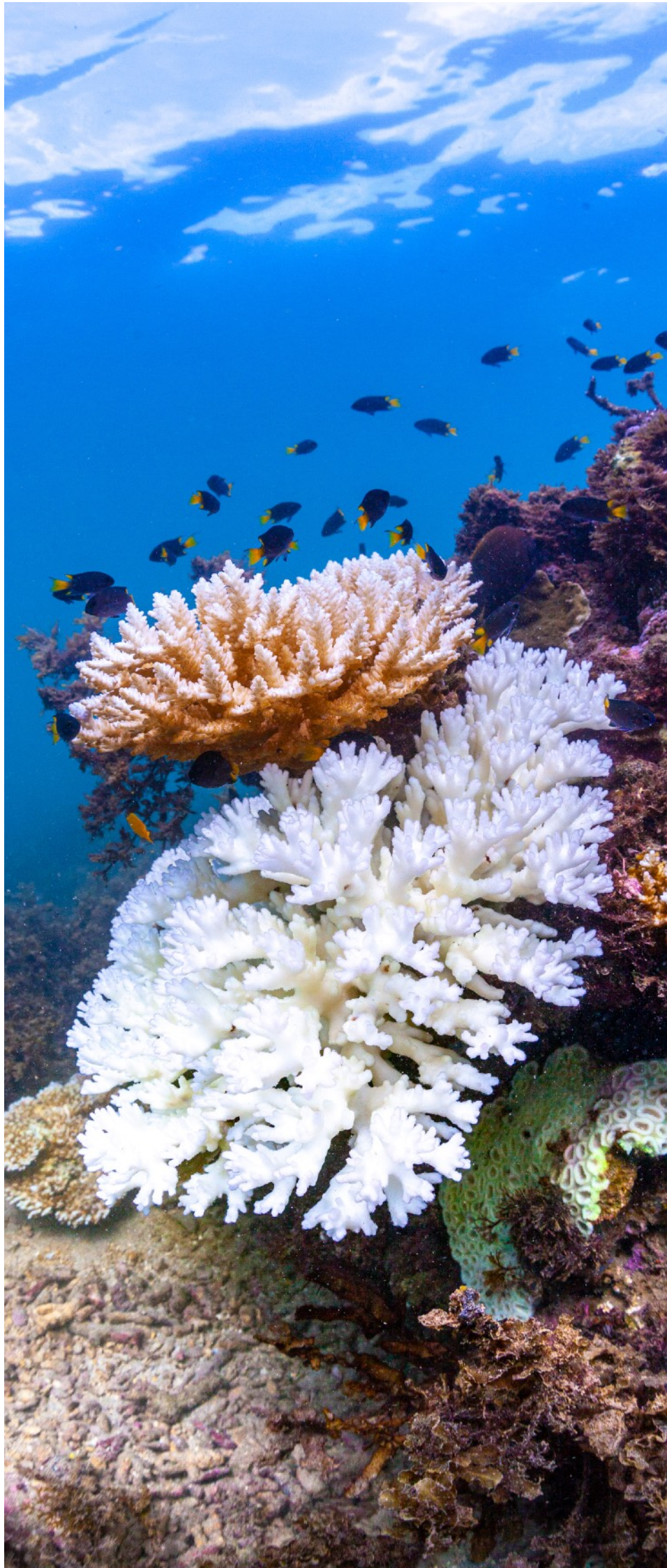
Corals on the Great Barrier Reef and the Coral Sea are bleaching again in 2020, making this the third mass coral bleaching episode in this region since 2016. As of April, bleaching has been reported in many areas along the GBR, including Lizard, Green, and Orpheus Islands in the north all the way to Heron, One Tree, and the Keppel Islands in the south. Offshore reefs in the Coral Sea have also been affected. As I type, Professor Terry Hughes and colleagues are analysing the data collected on a recent aerial survey to assess the spatial scale and severity of this bleaching event.

There is every reason to be concerned about this bleaching event. Many of the affected reefs were recently showing some signs of recovery. It is still unclear what the full extent of this bleaching event will be, but it is unlikely that many of the small colonies that were repopulating these reefs will survive.

This third bleaching event has frustrated reef scientists, serving as yet another reminder that no meaningful steps have been taken to avert the climate crisis. And globally, attentions have diverted, as the Covid-19 pandemic threatens lives and livelihoods worldwide. Still, we must not fall into despair. While the Covid-19 pandemic is testing our ability to coordinate a concerted effort to tackle an external threat, governments, businesses, and private citizens are coming together to face it united. Like the spread of Covid-19, climate change cannot be reverted by a single community. It requires a joint effort at a global scale.

For decades, the scientific community has warned the public of the perils of climate change. So far, our calls to action have failed to resonate among a significant portion of society. Our ability to turn the tide on climate change hinges on our persistence and ability to find creative ways to engage with the public. If we are to steer public opinion toward support for policies to meet the goals outlined in the Paris Agreement, we must continue talking to the public and documenting what we see underwater. When leaders lack political will, the only hope for decisive action to protect coral reefs (and, by extension, other ecosystems) is massive public support for green policies. Raising awareness is an arduous task, but we must continue to seek every opportunity available to educate those who still do not support legislation to fight climate change.

Photos: Corals bleaching at Florence Bay, Magnetic Island, in March 2020. © Victor Huertas



What I saw diving at Magnetic Island in early March compelled me to show the devastation that was taking place to as many people as I could. I published images on social media and provided them to media outlets and NGOs, knowing that few people would have the opportunity to get as up-close and personal with the bleaching event as I would here in Queensland. Images, and the stories behind them, are crucial to shaping the global understanding of this catastrophe. But stories can be shared in different ways,

for those who are not photographers. Great public speakers can volunteer to speak to schoolchildren about marine wildlife, and writers can contact media outlets such as The Conversation to spread the reach of their research. We scientists have a responsibility to reach out to society- and the possibilities for doing so are endless. Let us use this time to strengthen our resolve to communicate to the public and ensure that a sea of change is in our future.



A Coronavirus survival guide for you & your family

Resources to help reduce your anxiety level, stay healthy, manage working at home, and entertain a family in self-isolation.

By Dr. Kirsty Nash
Founder of aKIDemic life
Research Fellow at the Institute for Marine & Antarctic Studies and Centre for Marine Socioecology
University of Tasmania

The coronavirus world is a crazy place - with the situation changing so rapidly, it is hard to keep up. Nonetheless, a few things look certain - chances are you will need to self-isolate, entertain kids who are bored of being stuck at home, and juggle teaching online and research with your family demands. While health professionals and your local authorities are providing the information you need to stay safe, you may be feeling the need for other types of support. Here, we provide activities to help entertain your family while in isolation or observing social-distancing, and some resources to help manage the stress and any anxiety you may be experiencing. And, don't forget to reach out to your work colleagues, particularly if they (or you) are far from family - they may need your support more than ever right now.

We have split these resources into four sections, so click on the appropriate photo to jump to your area of interest:

Addressing anxiety about coronavirus

Are you worried about what COVID-19 means for your young family? You are not alone, both PANDA - Perinatal Anxiety & Depression Australia and Lifeline have resources to help you deal with anxiety and look after your mental health during this time. Or for tips on navigating uncertain times, have a read through the suggestions from Women's Agenda.

Keeping your kids happy, healthy & informed

It's not always easy to know how much to tell your children about illness and similar scary topics, so how can you keep them informed about coronavirus, get them to take hand washing seriously, but not overwhelm them with information? Check out the resources below to help find a balance that suits you and your family.



Let's face it, hand washing is not the most exciting activity, so how can you help your family look forward to standing at the sink? The Teach This website has an amazing array of age-appropriate resources to get your little ones scrubbing those hands!

Kids are going to ask you questions about what is happening - so how can you answer those questions? This article from Vox on 'How to answer 7 big questions kids have about the coronavirus pandemic', is a great place to start. Or have a look at this article from Forbes for some tips on explaining coronavirus and social-distancing to your kids. The Letters to a Prescientist team has put together

a list of resources to help you explain coronavirus to your kids.

If you want to give your kids access to age-appropriate news coverage, then 'Behind the News' aims to help kids aged 8-13 years old understand what is going on in the world around them.

Keeping your family entertained during self-isolation

First things first - how can you balance work and kids when isolated at home? Here are 6 strategies from Women's Agenda to help you develop flexibility and boundaries. Now how are you going to keep your family entertained? Check out the great resources below, and thank you to Professor Gretta Pecl, one of our advisory board, members of the Centre for Marine Socioecology, and some Hobart mothers, who provided ideas for this list.

Ideas For Toddlers

For all those parents out there trying to keep your toddlers entertained - we know how you



aKIDemic life is an online information hub developed by academics for academics. They aim to provide a diverse, accessible and inclusive perspective on navigating academia with kids and other caring responsibilities. aKIDemic Life is advised by a multi-disciplinary team of parents who either work within academia or are health & well-being professionals. Many of their advisors are Australian or work in Australia, but they are actively looking to expand their advisory board to encompass a more diverse perspective.

For more info, check www.akidemiclife.com or connect with them at:



feel - here are some great ideas for short attention spans from the 5 Minute Mum, who has all sorts of quick activities up her sleeve!

Trying to keep away from the TV? Then give audio books a try - while schools are closed audible has free stories available.

And now for one of our favourites - how to make edible slime!

Games, Stories & Random Activities

National Geographic is a mine of activities and information to help you have family fun and learn about the world.

A series of games and printables to keep the younger kids entertained.



The story box library has your favourite stories told by great storytellers. Some of the content is free.

Ever wanted to learn about royal palaces? Well now is your chance!

Want to play like Brian May? Well now you can with mini concerts and tutorials from the man himself on instagram.

A selection of indoor activities to keep boredom at bay.

Here are some great podcasts your kids can listen to, if you are minimising screen time.

If your children are missing their friends, then they can meet up with them in new worlds on the internet.

For a range of non-science activities, check out the ideas curated by Women's Agenda.

Find Some Zen

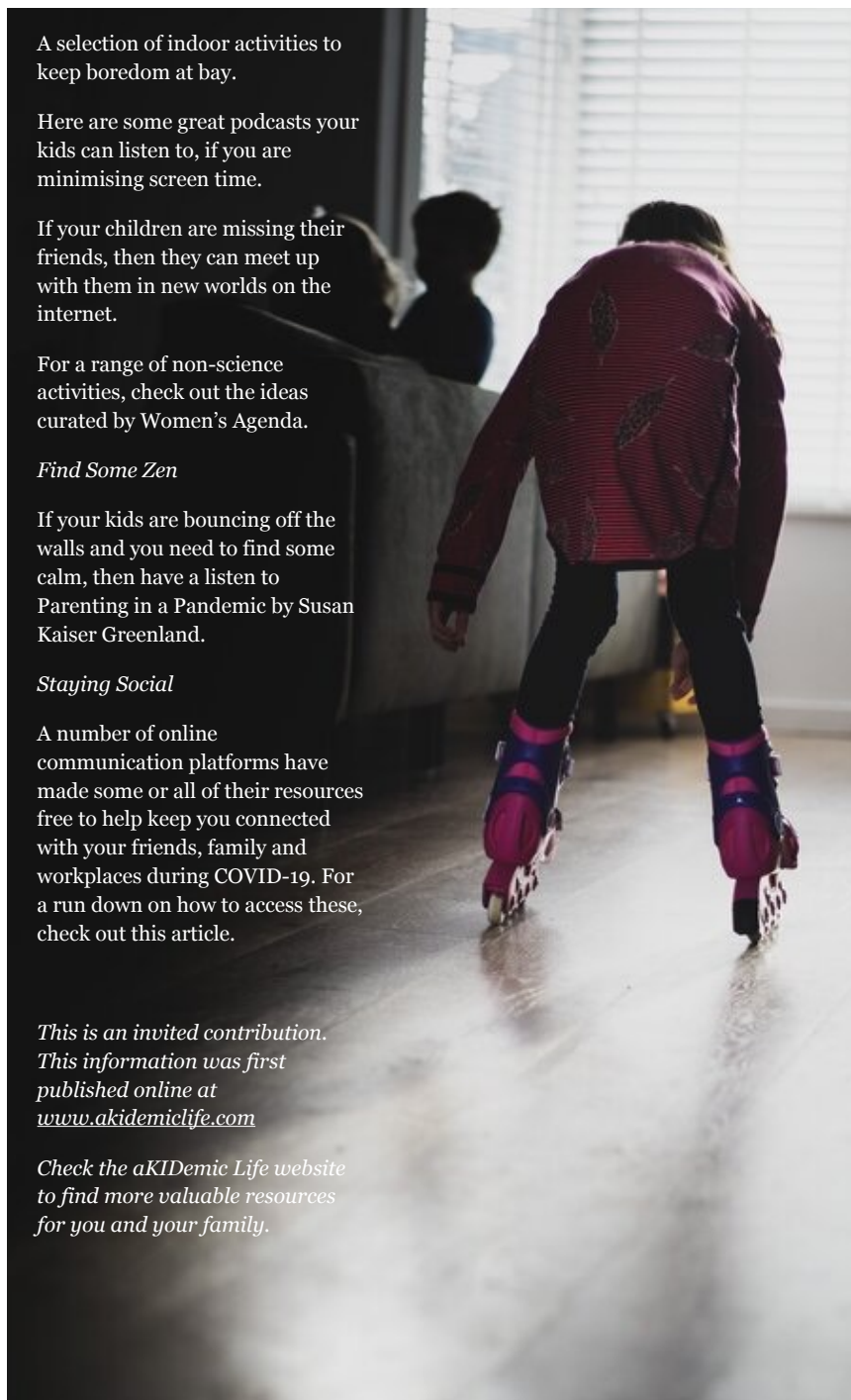
If your kids are bouncing off the walls and you need to find some calm, then have a listen to Parenting in a Pandemic by Susan Kaiser Greenland.

Staying Social

A number of online communication platforms have made some or all of their resources free to help keep you connected with your friends, family and workplaces during COVID-19. For a run down on how to access these, check out this article.

*This is an invited contribution.
This information was first
published online at
www.akidemiclife.com*

*Check the aKIDemic Life website
to find more valuable resources
for you and your family.*





2019 ACRS Established Researcher Medal

PROF. MARIA BYRNE

In 2019, the Australian Coral Reef Society awarded Professor Maria Byrne with the ACRS Established Researcher Medal for her outstanding contribution to the science and management of Australian coral reefs.

Born in Ireland, Professor Byrne is based at the University of Sydney and she is the former Deputy Director of the One Tree Island Research Station. Over the last three decades, Prof. Byrne has emerged as a prominent figure in the biology and ecology of coral reef invertebrates.

Her substantial body of work includes important discoveries on invertebrate evolution and ecology, and has provided us with a better understanding of the impact of climate change on coral reef invertebrates. She is currently a member of the National Coral Bleaching Task Force and serves on the crown-of-thorns starfish scientific committee for the National Environmental Science Program. In

addition to her extensive scientific and academic record, the committee also took into consideration Professor Byrne's longstanding service to the reef science community.

With a jovial and outgoing personality, and a relentless dedication to her students, Prof. Byrne is an outstanding mentor and a role model to fellow scientists and students. After decades of teaching, she continues to inspire new generations of students and early career scientists around the world.

Professor Byrne epitomises the figure of the passionate naturalist willing to dedicate their life to study and advocate for the protection of the marine environment and the organisms that live in it. For these reasons, the Australian Coral Reef Society awarded Professor Maria Byrne with the ACRS Established Researcher Medal, one of our most prestigious awards.



A snakefish sea cucumber (*Holothuria coluber*) erect during a mass spawning event at Lizard Island, Great Barrier Reef. © Victor Huertas



Coral reef science in action.
© Matthew Nitschke
2019 ACRS Photo Competition



2019 ACRS Research Awards

Each year the ACRS supports the research of up to five students through provision of the ACRS Research Awards. The most outstanding proposals are awarded the Terry Walker Prize (\$4,000) or the Danielle Simmons Prize (\$4,000). Up to three additional ACRS Research Awards of \$2,500 each are also awarded.

Below we present you the recipients of the 2019 ACRS Research Awards. In the following pages, you can read articles contributed by each awardee.

Terry Walker Prize

ANNIKA LAMB

Interspecific hybridisation: a tool in coral reef restoration



Danielle Simmons Prize

ALEXANDER FORDYCE

Microbial interactions between corals and micro boring endoliths



ACRS Research Awards

JESS BERGMAN

Acclimation capacity and disease susceptibility of *Pocillopora damicornis* following thermal anomalies on the Great Barrier Reef



RAMONA BRUNNER

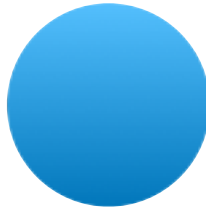
The function of G-Protein coupled receptors (GPCRs) in coral larvae settlement



VICTOR HUERTAS

Investigating trophic partitioning among planktivorous reef fishes





Corals | Reef restoration | Hybridisation

Hybridisation as a tool for coral reef restoration

By Annika Lamb
University of Melbourne & AIMS

In the face of the current rate of degradation of coral reefs, reef restoration approaches are being investigated as tools to preserve these valuable systems into the future. One restoration approach is to breed a resilient stock of corals which can then actively be used to restore reefs. One way of producing resilient stock may be through hybridising colonies of different species.

Hybridisation has been demonstrated to occur occasionally in nature among some species of reef-building corals (van Oppen et al, 2002). Hybrids contain the genes of two different species in their genomes and so can harbour novel genetic combinations that do not occur in their purebred parental species. In the case of the Caribbean hybrid of *Acropora palmata* and *A. cervicornis*, *A. prolifera*, these novel genetic combinations have been shown to convey increased resilience (Fogarty, 2012). Further, it has been demonstrated in the laboratory that coral hybrids grow and survive equally well as, or better

than purebred corals under simulated future climate conditions, where temperatures are elevated and the water is more acidic (Chan et al, 2018). However, if hybrids are to be actively used to restore reefs, then their performance in their natural environment on the reef must first be assessed. The funds from the Terry Walker Award from the Australian Coral Reef Society have allowed me to test the performance of hybrid corals in the field.

In 2018 we collected a number of adult coral colonies from the Great Barrier Reef of the following species: *Acropora tenuis*, *A. loripes*, *A. sarmentosa* and *A. florida*. We brought them back to the National Sea Simulator (SeaSim) at the Australian Institute of Marine Science and a certain number of days following the full moon, they spawned. After collection of their eggs and sperm, we crossed individuals from the same species to create purebred coral larvae. We also crossed the gametes of *A. tenuis* with the gametes of *A. loripes* and

“If hybrids are to be used to restore reefs, their performance in their natural environment must first be assessed.”

the gametes of *A. sarmentosa* with the gametes of *A. florida* to generate hybrid coral larvae.

The swimming coral larvae were introduced to terracotta tiles, where they attached, becoming sedentary coral recruits. In March 2019, we deployed these tiles of hybrid and purebred corals into the ocean on the mid-shelf of the Great Barrier Reef.

We tracked the corals over time to compare the growth and survivorship of the hybrids and purebreds. Unfortunately, 2019's extreme wet season posed

challenging conditions to the juvenile corals in their early months of life. Potentially as a consequence of them being stunted prior to deployment, few corals survived their first months in the ocean such that by the time we came back to census them, there were insufficient numbers left to make this comparison.

We are currently in the process of repeating the experiment. During the 2019 mass spawning event we crossed the same pairs of species to generate new stocks of hybrid and purebred corals. These corals are now healthy and growing in the SeaSim and are awaiting their deployment in the field. We are hopeful that with the knowledge we gained from the last experiment we will be able to successfully outplant and gain valuable information from these corals.

References

Chan WY, Peplow LM, Menéndez P, Hoffmann AA, van Oppen MJH (2018). *Interspecific Hybridization May Provide Novel Opportunities for Coral Reef Restoration*. *Frontiers in Marine Science* 5.

Fogarty ND (2012). *Caribbean acroporid coral hybrids are viable across life history stages*. *Marine Ecology Progress Series* 446: 145-159.

van Oppen MJ, Willis BL, Van Rheede T, Miller DJ (2002). *Spawning times, reproductive compatibilities and genetic structuring in the Acropora aspera group: evidence for natural hybridization and semi-permeable species boundaries in corals*. *Molecular Ecology* 11(8): 1363-1376.



Above: A coral recruit awaiting deployment in the field. © Guy McCutchan



Above: Divers deploying hybrid and purebred corals into the ocean. © Annika Lamb.



Coral bleaching | Endolithic microbes | Symbiosis

Movements beneath the surface: Endolithic responses to coral bleaching

By Alexander “Gus” Fordyce
University of Newcastle

Not-so-deep beneath the surface of the reef in the bones of corals, crabs and clams, are a group of microbes that have long been overlooked. Endolithic (meaning living within rocks) microbes are some of the most creative organisms out there, colonizing the South Pole, hypersaline deserts and the perpetually dark microhabitat inside the skeletons of living corals. But despite the “cool” factor, we know remarkably little about how these microbial partners of corals interact with their living host. We do know, however, that these microbes seem remarkably unstressed by a changing climate – all evidence suggests they will do well in warm, acidic oceans. So what does this mean for the animals that build their habitat? When you focus only on their behaviour as coral reef bioeroders, then we are afforded an image of corals collapsing inwards as they are increasingly hollowed out. But if we consider the possibility of them being symbiotic, sharing nutrients with their host

and acting as a counter-intuitive internal parasol that reduces light stress, we are rewarded with a rather different outcome. The ACRS kindly awarded me the Danielle Simmons Award to try and shed some light upon these nuances by asking a simple question: what happens to these microbes when a coral bleaches?



On a seven-week trip to Heron Island Research Station, I set about simulating a slow temperature-induced bleaching event in three coral species. My hypothesis was that as the coral tissue pales and whitens, we will track a blooming of endolithic algae in the skeleton and they will begin to grow closer to the underside of the intact coral tissue either to its detriment (i.e. more coral cell death) or its benefit (i.e. less coral cell death). Think of it as the accelerated growth of an internal biofilm that comes into contact with the coral. Now, the principle issue with studying endolithic microbial behaviour is that they live inside a rock so they're difficult to get to or watch. To overcome this, I needed to keep them fixed in place while I removed the rock. So how do you knock down a house without hurting the people that are still inside?

First, I cut off a chunk of the coral with a diamond-bladed band saw – smaller tends to be more manageable. Then, you vacuum embed these chunks in agarose, to



keep everything where it should be. It's almost like reverse construction: we've just added scaffolding onto a complete building. As you can see from the attached pictures, this is definitely a process that I need more practice with and probably isn't well suited to being done on a small tropical island. Nonetheless, once I'd set-up my shoddy scaffolding I was able to begin demolition and was immediately taught another lesson - if you produce air bubbles inside agarose, they don't go anywhere. Immersing my embedded corals in hydrochloric acid, I watched with momentary satisfaction as the skeleton began to effervesce. But my smile dropped to a frown as the carbon dioxide bubbles sat happily where the skeleton used to be. Slicing, re-heating, re-embedding – my attempts to optimise eventually lead me to conclude that I simply needed better stuff. Now, armed with a commercial heated vacuum chamber, low-melting point agarose and non-bubbly EDTA, I can have a more expensive go at deconstructing the endolithic

microhabitat. Fingers crossed that months of embedding 144 coral chunks will pay off with some interesting results.

I aim to use a novel technology, light-sheet microscopy, further down the line to track the bloom of this internal biofilm in 3D and get an idea of which members of this microbial community are interacting with coral tissue. The support of ACRS has allowed me to explore ways of overcoming difficulties with studying rock-dwelling organisms and through this project, I hope to generate some new insights into how the coral holobiont is responding to environmental stress. So many fundamental questions about corals have yet to be answered and time is fast running out to address them.

Acknowledgements

The privilege of undertaking this project has been kindly funded by the Australian Coral Reef Society Danielle Simmons Award and an Australian Research Council

Discovery Project (DP180103199). My supervisors, Professors Bill Leggat and Tracy Ainsworth, have been patient guides and collaborators on my foray into the world of endoliths, for which I am very grateful. All collections were approved by the Great Barrier Reef Marine Park Authority (G18/41124.1).



Top: "Rocking out as I collect boring algae". © Gus Fordyce

Right: Endolithic blooms visible in the branches of *Acropora aspera* during the 2020 natural bleaching event on Heron Island. © Gus Fordyce

Previous page: Cross-sections of *Porites lobata* embedded in agarose before deconstructing the endolith's house. © Gus Fordyce



Field work.
© Stephanie Gardner
2019 ACRS Photo Competition





Global warming | Coral physiology | Great Barrier Reef

Jack of all trades? The response of a generalist coral species to different warming scenarios

By Jess Bergman
University of New South Wales

It was a sweltering hot summer for me on Heron Island... but, arguably, I wasn't the one feeling the heat. It was the corals. As the pressures of global climate change and ocean warming degrade coral reef ecosystems worldwide, active management of reef coral populations through restoration is increasing. A major consideration in reef restoration has been the strategic selection of coral species for ecological resilience to bleaching, or the physiological response of corals to ocean warming outside of their comfort zones.

With the help of the ACRS Student Award, I spent a summer at Heron Island investigating the thermal tolerance of *Pocillopora damicornis*, a coral species that is a target of restoration practices due to its success as an environmental generalist. I exposed replicate colonies of *P. damicornis* to two historical summertime sea surface temperature (SST) trajectories recorded on the GBR: protective, in which a sub-bleaching temperature pulse (32°C) precedes bleaching

conditions (34°C); and single, where temperatures gradually increase to the bleaching threshold (34°C). The "protective" bleaching trajectory is historically recorded in the Heron Island lagoon and may confer increased stress tolerance to corals, whereas other reefs of the Great Barrier Reef (GBR) predominantly experience the "single" trajectory.

"A major consideration in reef restoration has been the strategic selection of coral species."

To address the hypothesis that *P. damicornis* colonies exposed to initial sub-lethal temperatures can acquire tolerance to thermal stress, I measured photo-physiological parameters, densities of endosymbionts, and microbial

community shifts throughout each heating trajectory.

While both single (heatwave conditions) and protective heating trajectories (predominant conditions prior to marine heatwave emergence) corresponded with a decline in photosystem performance and symbiont densities in coral colonies, results indicate that thermal tolerance cannot be attributed to endosymbionts alone. I observed apparent differences in the relative abundance of microbial taxa between the trajectories and control group throughout the experiment, suggesting that temperature profile also affects the composition of the coral microbiome. Whether this flexible relationship between the host coral *P. damicornis* and its microbiome is symbiotic or dysbiotic will be determined from further data analysis.

Overall, results suggest that *P. damicornis*, as a tolerant generalist, has a contrasting response to other, more specialist species in terms of bleaching tolerance on the GBR.



This emphasizes the need to focus on complex partnerships between the coral host, symbiont species, and microbial communities that compose the coral holobiont when determining bleaching response of a coral species. From a restoration perspective, addressing how these partnerships change or are conserved in the face of environmental change may facilitate coral adaptation to future reef environments.

Acknowledgements

I would like to sincerely thank the Australian Coral Reef Society and its benefactors for providing me with the opportunity to conduct this research through the ACRS Student Award. I would also like to thank my advisor, Dr. Tracy Ainsworth, for her guidance. This research was also supported in part by the ARC Discovery Grant DP180103199. Corals were collected under the Great Barrier Reef Marine Park Authority Permit G19/41974.1.



Top: The author conducts a quick inspection of the reef. © Jesse Bergman

Above: *Pocillopora* colonies are placed on a tub during the experiments conducted for this study © Jesse Bergman



Coral settlement | Settlement receptors | Great Barrier Reef

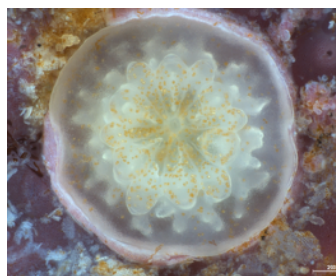
Smell like home: How do coral larvae sense molecules that induce settlement?

By Ramona Brunner
James Cook University & AIMS

Coral recruits are vital for reef recovery. Only if recruitment exceeds the rate of mortality is recovery of disturbed reefs possible. Most coral species reproduce sexually via broadcast spawning, which describes the release of eggs and sperm into the water column, where they develop into coral larvae called planulae. Successful coral recruitment depends on multiple factors. Not only the number of developing planulae is of importance, but also their ability to find a suitable habitat for settlement (permanent attachment to the reef substrate), since this habitat selection determines the survival after metamorphosis (transformation) into sessile coral polyps.

Coral recruits are generally unable to relocate after metamorphosis, so choosing a settlement site is a critical step. Coral larvae are guided to appropriate settlement habitats by species-specific cues such as components of crustose coralline algae or microbial biofilms. Once a coral larva encounters an

appropriate settlement cue, it attaches to the substrate with the aboral side, flattens to a disc-like body shape and undergoes metamorphosis. In the process of metamorphosis, the planula transforms into a sessile polyp by losing larvae-specific features like cilia-mediated movement and developing adult-specific features, such as tentacles and a calcareous skeleton.



Above: 1-month old *Acropora millepora* recruit with symbionts. © Christopher Brunner

While most research on coral settlement in recent decades has focused on the identification of

settlement-inducing molecules, the cellular structures to sense these compounds are still unknown in coral larvae. Therefore, I'm investigating the receptors responsible for sensing settlement-inducing molecules in *Acropora millepora* larvae by applying gene expression analysis, proteomics and pharmacological settlement assays.

My PhD project is like a crime scene investigation. I'm looking for a suspect that was present at the scene at the right time and I'm also testing the response of the potential suspects, as in an interrogation. The major difference is that the settlement receptors are doing good and not committing a crime.

Gene expression analysis was used to identify larval receptors that are in the right place at the right time. The potential settlement receptors are expected to be located at the aboral side, where the planula attaches to the substrate, and be present only when larvae are competent to settle. In an RNA sequencing experiment, I identified



Left to right: The author counts larvae to conduct pharmacological settlement assays; Pharmacological settlement assays to test the response of *Acropora millepora* larvae to receptor-specific drugs; Settlement and metamorphosis of *A. millepora*: Swimming planula larvae (A), Settlement (B), Metamorphosis 0.5h (C), 1.5h (D), 4.5h (E), 6.5h (F) and 82.5h (G) after settlement. Photos: © Cristopher Brunner

883 genes that were upregulated in the aboral larvae half compared to the oral side. Furthermore, gene expression analysis of 25 developmental stages revealed that 169 of the 883 genes contain at least one transmembrane region and are upregulated before larvae are competent to settle and downregulated after settlement.

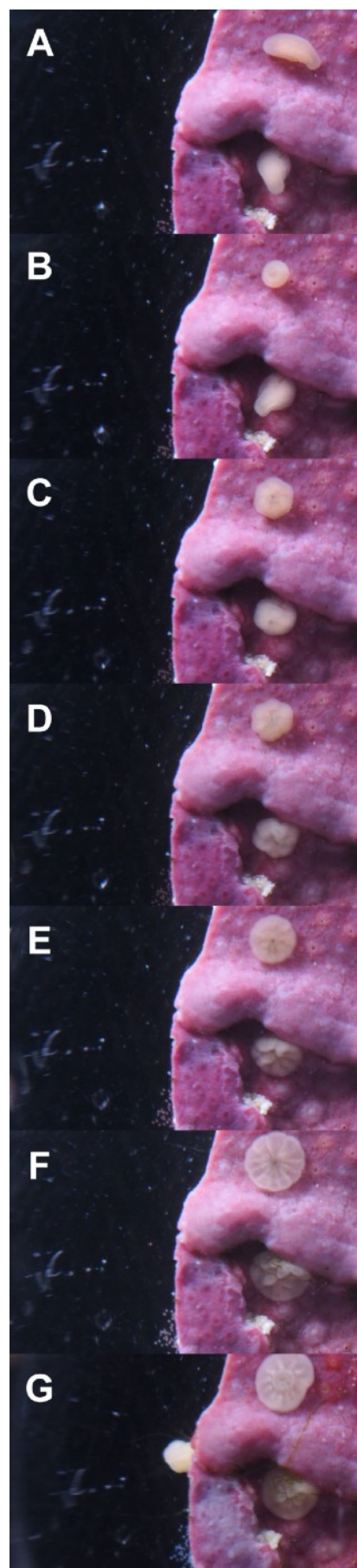
Pharmacological settlement assays tested the response of larvae to receptor-specific drugs. These drugs were chosen based on the gene expression analysis that shortlisted 169 potential settlement receptors. Like a key matches a lock, a drug can bind to the receptor and unlocks cellular signalling pathways. Consequently, the larval behaviour observed in response to the selected compound gives some indication of the kinds of receptors and signalling pathways involved in settlement.

I will present the results of the hunt for the coral larvae settlement receptor at the International Coral Reef Symposium next year. Knowledge about 0.1 nanometre small settlement receptors and the associated settlement-inducing cues

will have applications for reefs as large as 2,300 kilometres in the case of the Great Barrier Reef. Coral research and reef restoration would benefit from the ability to manipulate the location of larval settlement which increases the settlement efficiency of individual recruits in both lab and field settings. Finally, knowledge about settlement-inhibiting cues could inform environmental legislation to limit the discharge of these compounds into the reef.

Acknowledgements

I would like to thank the Australian Coral Reef Society for supporting my research with the funding of the ACRS Student Research Award. Thanks to this grant, I was able to extend the pharmacological settlement assays with further seven drugs addressing specific receptors or compounds of signalling pathways during the last spawning event. I am also thankful for the support from my advisory team Prof. David Miller, Dr. Ira Cook, Dr. Aurelie Moya, Prof. Lionel Hebbard and my collaborator Dr. Andrew Negri from the Australian Institute of Marine Science.





Planktivory | Wrasses | Stable Isotopes

Picnic in the water column: Investigating food resource use among plankton-feeding reef fishes

By Victor Huertas

James Cook University & ARC Centre of Excellence for Coral Reef Studies

It's the 19th of July, 1545. From the shore, Henry VIII watches the Mary Rose sink as the warship prepared to engage the French Fleet in the Solent Battle off Portsmouth. Nearly 400 men would lose their lives. The French claimed the credit for sinking the Mary Rose. The British argued it was a navigational error. It would take more than four centuries to unveil what caused the sinking of Henry VIII's Vice Flagship. The answer came thanks to a stable isotope analysis (SIA).

The isotopic signature from the recovered remains of the crew indicated that a significant portion of men originated from warmer regions in southern Europe (Bell et al., 2009). Researchers argued that poor communication due to the large number of non-English speaking crew may have sealed the fate of the Mary Rose.

Aside from cool archaeological studies, stable isotope analyses provide valuable insights to a broad range of disciplines. In fact,



this tool has enabled important advances in ecological studies.

In a recent paper, Professor David Bellwood and I found that fairy wrasses can secrete a large amount of slime inside their mouths (Huertas and Bellwood, 2020). Importantly, we noticed that within plankton-feeding wrasses (wrasses that eat microscopic particles in the water column) there were noticeable differences in their gut contents. Specifically, we distinguished two different groups: those who mainly targeted small crustaceans such as copepods and amphipods; and those, like fairy wrasses, which mostly ingested marine snow and possibly gelatinous zooplankton (like small jellyfish). We concluded that the slime produced by fairy wrasses may allow them to retain loose clumps of organic matter and gelatinous zooplankton found in the water column. This study also suggested that there may be resource partitioning among planktivorous wrasses on coral reefs.

Here, we wanted to take things a step further. Although plankton may seem like a uniform assemblage, it is actually a very diverse collection of suspended organisms and organic matter. While gut content analysis is a useful tool for assessing food preference, it can only provide a snapshot of the fishes last meal. SIA, on the other hand, provides a record of the food eaten over the last few weeks. Therefore, our aim was to investigate if different planktivorous wrasses have different isotopic patterns. Our hypothesis was that subgroups of planktivores would display distinct isotopic niches consistent with the presence (or absence) of anatomical specialisation documented in the mouths of some of these fishes.

At this stage, this study is still in progress. We are examining the $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ isotopic signature from the muscle of these fishes in order to estimate the breadth of the isotopic niche for each of the species of wrasses we are evaluating.

Thus far, our data indicates that fairy wrasses are indistinguishable from other planktivorous wrasses based on their $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ isotopic signatures. We think that this is because all planktivorous wrasses are tapping into the same resource pool, regardless of the specific items ingested. Still, we continue to add new species and are continually re-assessing our conclusions as new data is incorporated. Contrary to my initial belief, it turns out that I am not allowed 500 years to resolve this enigma. So I plan on publishing the results of this study in the coming months. Stay tuned!

Acknowledgments

I would like to thank the Australian Coral Reef Society for the financial support that is enabling me to conduct this study. I would also like to thank my colleagues Dr. Veronica Radice and Prof. David Bellwood, and the Bellwood Lab folks.

References

Bell, LS, Lee Thorp, JA, Elkerton, A. (2009). *The sinking of the Mary Rose*

warship: a medieval mystery solved? J. Archaeol. Sci. 36, 166–173. <https://doi.org/10.1016/j.jas.2008.08.006>

Huertas, V, Bellwood, DR. (2020). *Trophic separation in planktivorous reef fishes: a new role for mucus?* Oecologia 192, 813–822. <https://doi.org/10.1007/s00442-020-04608-w>



Above: A school of bluntheaded wrasses (*Thalassoma amblycephalum*) feed on zooplankton on the reef crest.

Below: Reef life at Vickis reef, Lizard Island.
Previous page: Fusiliers (F. Caesionidae) ascend through the water column, Lizard Island. Photos: © Victor Huertas







Painted sweetlips (*Diagramma pictum*) resting on a shallow reef © Gal Eyal
2019 ACRS Photo Competition



The world is shaped by science and technology

By Carrie Sims & Dr. Jenni Donelson

The 20th year of Science Meets Parliament (Smp), run by Science and Technology Australia (STA), was the first for Australian Coral Reef Society (ACRS) councillors Dr Jenni Donelson and Ms Carrie Sims. Each year ACRS sends councillors to attend the two-day part policy workshop, part scientist-bonanza mingling occasion and part engagement opportunity with politicians. Smp is STA's flagship event, and you can see and feel, after 20 years, that they have created a nurturing, well-oiled and attractive event.

The first day opened with a Welcome to Country from local Ngambri-Ngunnawal custodian, Paul House who shared his local knowledge and experiences growing up in Canberra and even being born at the old Canberra Hospital. Next was a welcome from outgoing STA President Professor Emma Johnston who immediately highlighted the drops in the Federal Budget investment for science and technology, drops in R&D investment, caps on undergraduate places and the attack on research integrity and ethics – the so-called 'replication crisis'. As challenging topics such as these could come up in meetings with parliamentarians, Professor Johnston suggested a way to respond was to outline the transparent, rigorous and systemic peer review processes we have in place and rebut – “there is no replication crisis”. As scientists, we produce the highest quality research that, while not perfect, is always striving for improvement.



Above: Carrie with Senator Siewert (right-centre) and other Smp delegates (Sally Gainsburg and Jenni Harrison).

Below: J. Romanis, H. Chen, Senator N. Green, J. Donelson and S. Cameron in front an amazing piece of PNG artwork.



A full house at the Hotel Realm Canberra for the first day of Science Meets Parliament.

Today's conveniences are yesterday's magic, the magic of science – Prof Fiona Wood

What came next was an inspirational speech by Winthrop Professor Fiona Wood, that was a highlight of SmP and not quickly forgotten by anyone in the room. Professor Wood is the Director of the Burns Service of Western Australia, and is a plastic and reconstructive surgeon that has, with her passion, changed how we treat burns victims globally. She had many amazing stories about her journey in science, improvements in treating burns victims, highlighted the importance of good planning and left us with many thought provoking messages like - “You can be the world’s best musician but if you remain in a sound proof room no one can hear”.

During day one we also had numerous opportunities to hear from previous attendees of SmP or scientists who regularly cross science-policy borders. While their advice was aimed at preparing us for the following day, there were many practices we could take forward into how we engage with others every day.

A night to remember

The day ended with a sumptuous gala dinner at Parliament House,

and you never know just who you will meet at these events! With a quick chat to Pauline Hanson about Australian coral reefs we were ushered to our seats in the Great Hall. At their respective tables Jenni and Carrie conversed with frog taxonomists, nuclear engineers, mathematicians, botanists, and geologists, all the while sharing their enthusiasm, knowledge and expertise on Australian coral reefs.

The conversation of poor investment and support for science continued at the Gala Dinner during The Honourable Brendan O'Connor's address. Honourable Karen Andrews Minister for Industry, Science and Technology moved the crowd to tears of laughter with her confusion of the acronym AI – her agriculture ties leading her more towards artificial insemination rather than artificial intelligence. We fear a mistake 240 scientists will now make regularly.

You never know who you'll meet!

For the second day, the main focus was on each scientists' meeting with their respective SmP attendees and designated politician. The back rooms of Parliament were buzzing with excitement and nerves. Carrie met with Australian Greens Senator for WA Rachel Siewert. The Senator was engaging, passionate and well-

informed. Senator Siewert has been an advocate for the environment and reefs, working on the UNESCO Shark Bay committee, and she continues to keep her ear to the ground on these issues.

TIPS

Listen to a politician before providing advice. Ask them what is important to them and tailor the information to their electorate/region.

Always be credible and experienced. If you don't know, follow up with them, and connect them with someone who knows.

The best way to pitch is with a story. Everyone can recollect and connect with a story.

Know WHY it matters and the PEOPLE it impacts.

Network, network, network – It is your net-worth.

Science is more than just research. Australia needs great scientists and STEM professionals throughout jobs.



Jenni met with Labour Senator Nita Green, elected to the Queensland Senate in 2019. As a North Queensland resident, Senator Green was keen to discuss the challenges the Great Barrier Reef faces – environmental change, bleaching events and water quality issues. Sen. Green also inquired about the loss of ecosystem for Australia’s terrestrial mammals and the challenges for engaging girls and keeping women in science and engineering.

Gender equity – we need a planned response

After our meetings, we were ushered to the National Press Club for lunch and an address from astronomer and Australian Government Women in STEM Ambassador Professor Lisa Harvey-Smith. She disturbingly highlighted that gender equity problems stem from childhood – with parents more likely to ask boys “how many flowers are there” and girls “what colour are the flowers”. Gender equity needs to start from the home. Professor Harvey-Smith also spoke honestly about the challenges we have with fixing gender equity, highlighting that some of the first steps we take will not be perfect. For example, quotas are useful to start the ball rolling but

we need to evolve with diverse mindsets. The challenge is that “It is not a women’s issue, it is a systemic issue. We don’t need to fix the Women in STEM, we need to fix the system.”

The day ended with a Parliamentary Friends of Science Networking Session, which gave us one final chance to talk to MPs and Senators. We were also able to catch up with the new scientist friends we made over the two days and hear how their meetings had gone. Luckily for us, a replica Lego Parliament was stationed centre of the final event. No wind, no sun – the perfect location for our photo evidence...

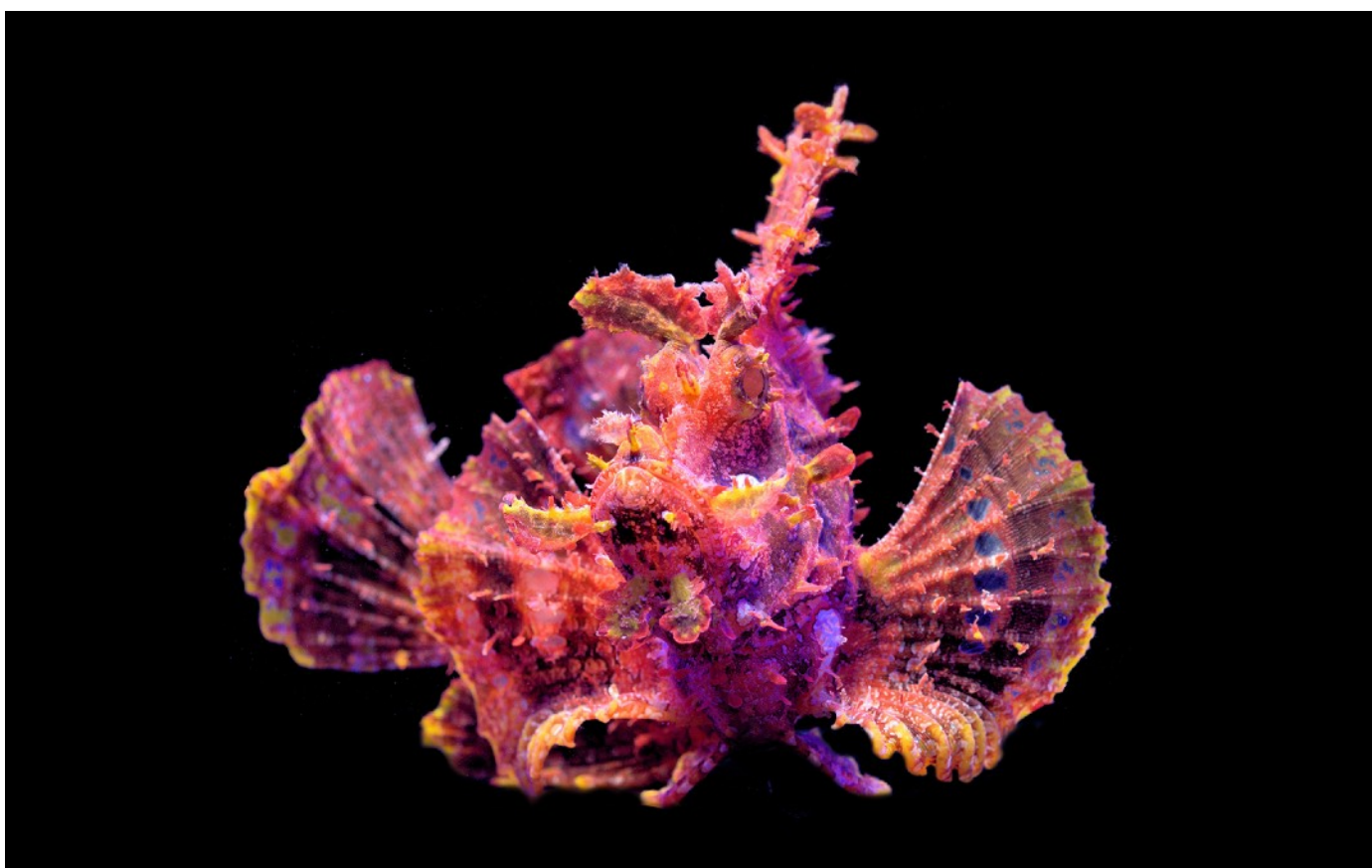
A binding thread throughout the entire SmP was the inaction on Climate Change from our current government and denialism of scientific data and evidence. The two days also highlighted that while we were a diverse group of scientists and STEM professionals we all had the same goals and ambitions in mind – for our work to make a difference. Because...

“Planning our collective impact is essential in moving forward”

– Professor Fiona Wood



Above: ACRS councillors Jenni Donelson (left) and Carrie Sims (right) in front of Lego Parliament, Canberra. **Column to the left:** A photo opportunity outside Parliament entrance was denied to us by the early morning Sun and roaring afternoon winds. Luckily, we returned the following day.



Top: A pair of Ruby longfin fairy wrasses (*Cirrhilabrus rubeus*) © Yi-Kai Tea; **Bottom:** A scorpionfish (*Rhinopias* sp.) © Yi-Kai Tea
2019 ACRS Photo Competition



Above: Sharks hunt silverfish along the shore. © Chico Birrell 2014 ACRS Photo Competition

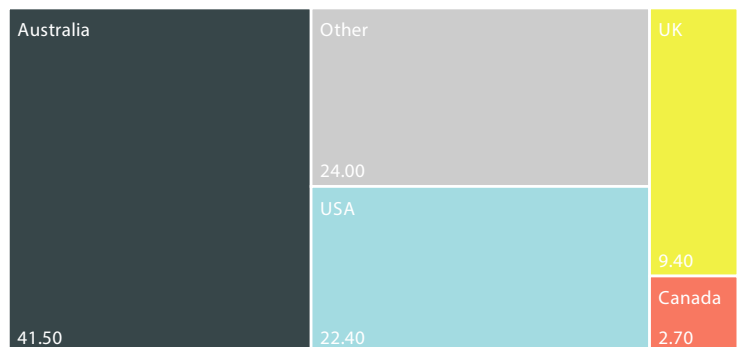
2019 Social Media Report

We consider social media to be an important tool to engage and communicate with members, the public and the broader scientific community. For this reason, we have been building up our social media presence on Facebook since 2010, Twitter since 2014, and most recently on Instagram (2019). Our goal this year was to increase people's connection to our reefs by producing engaging visual posts and media that appeal to a broader community and show our reefs and scientists in action. Using this platform we reached over 300,000 viewers - our largest impact since the back-to-back bleaching events in 2016 and 2017. The ACRS Social Media Team would like to thank all the contributors for providing content to share across our social media. We also would like to promote coral reef research conducted in Australian reefs. If you want to promote your research with us, get in touch on one of our social media accounts.

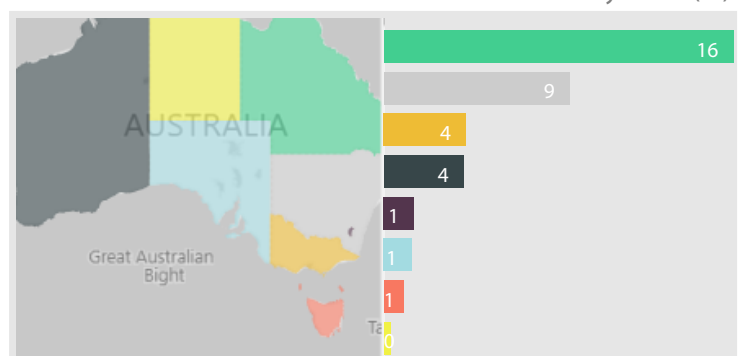
Twitter Analytics

People reached: **+302,300**
 Tweets and retweets: **3,608**
 Highest monthly followers added: **161**
 Followers: **4,876**

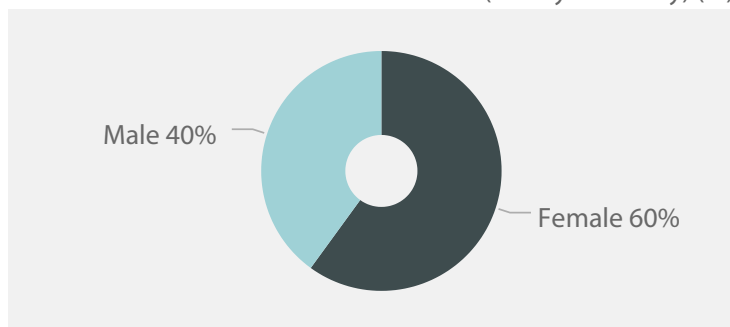
Twitter Followers By Country (%)



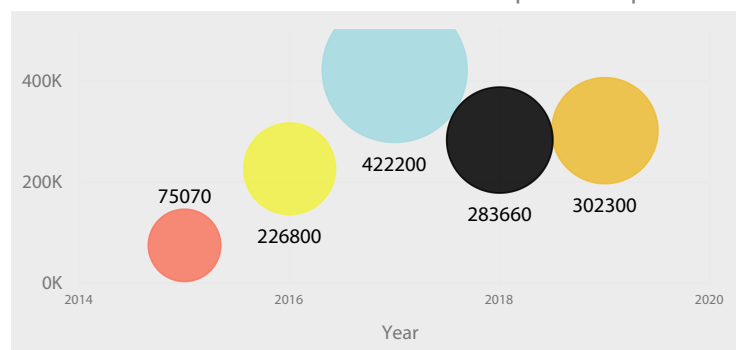
Followers By State (%)



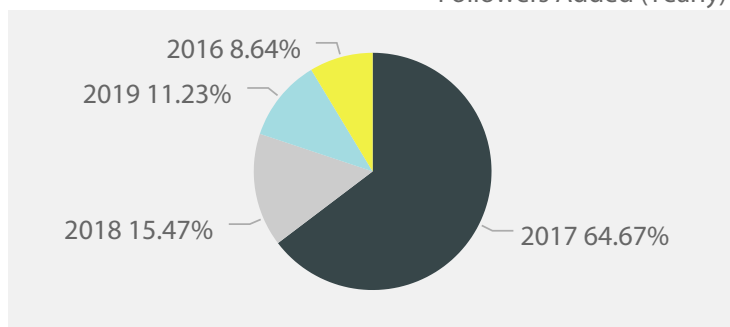
Gender (binary data only) (%)



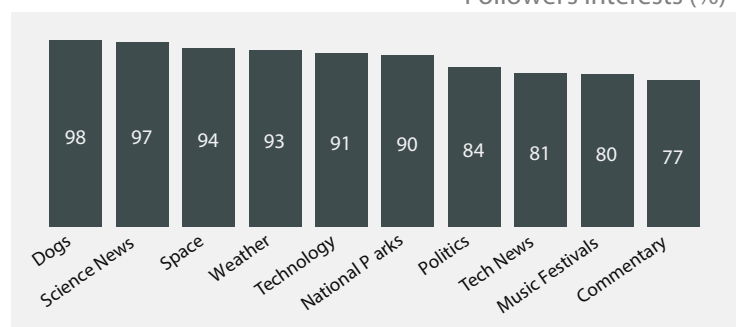
Twitter Impressions per Year



Followers Added (Yearly)



Followers Interests (%)

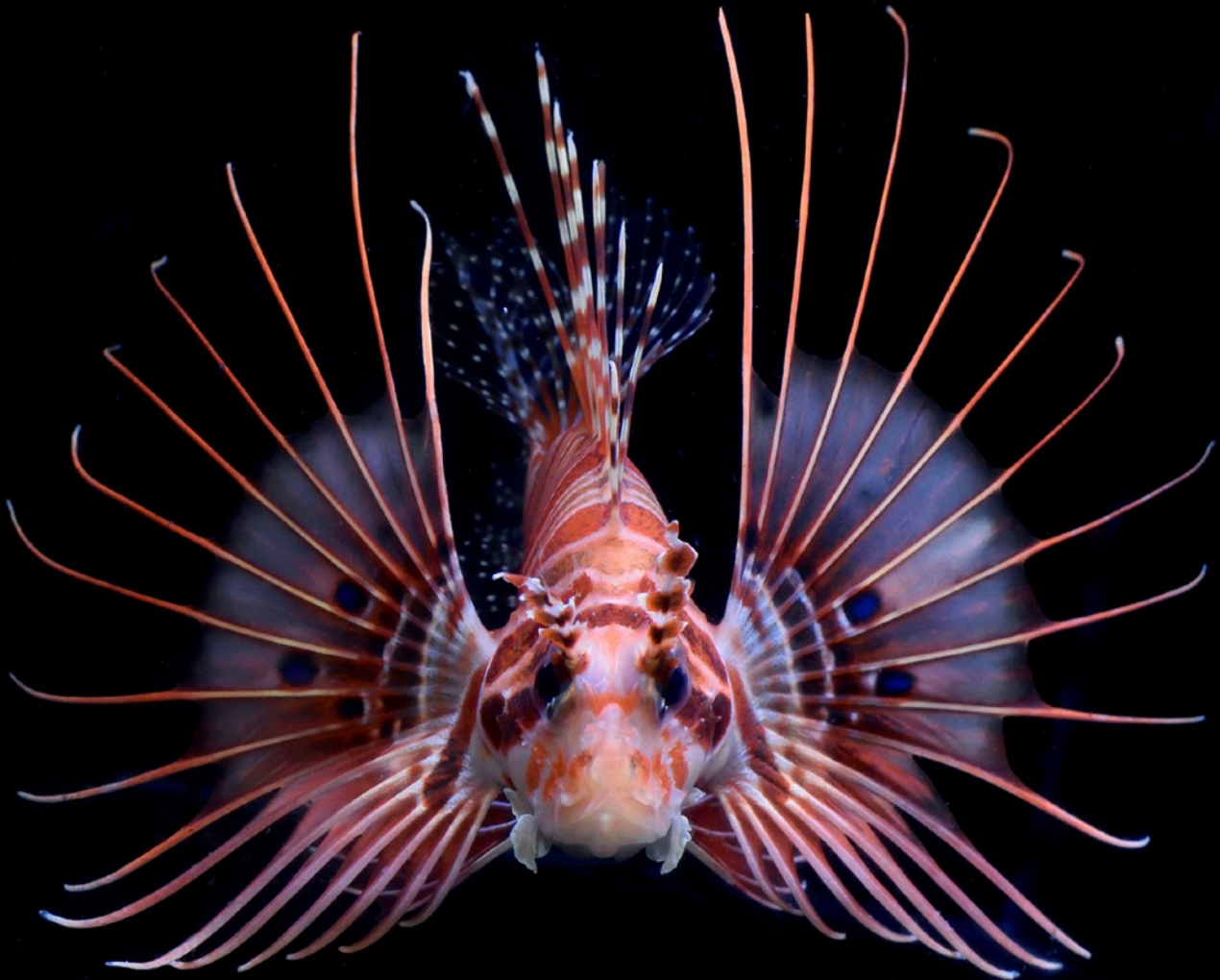


Twitter: @AustCoralReefs

Facebook: @AustralianCoralReefSociety

Instagram: @austcoralreefsociety

2019 ACRS PHOTO COMPETITION



OVERALL Winner

Yi-Kai Tea

The latest edition of the ACRS Photography Competition showcased a broad array of stunning images of reef life captured by many talented ACRS community members. In the following pages we present a selection of the images received, including the winners of each category.

SCIENCE IN ACTION

Winner:

Matthew Nitschke



DIVERSITY

Winner:

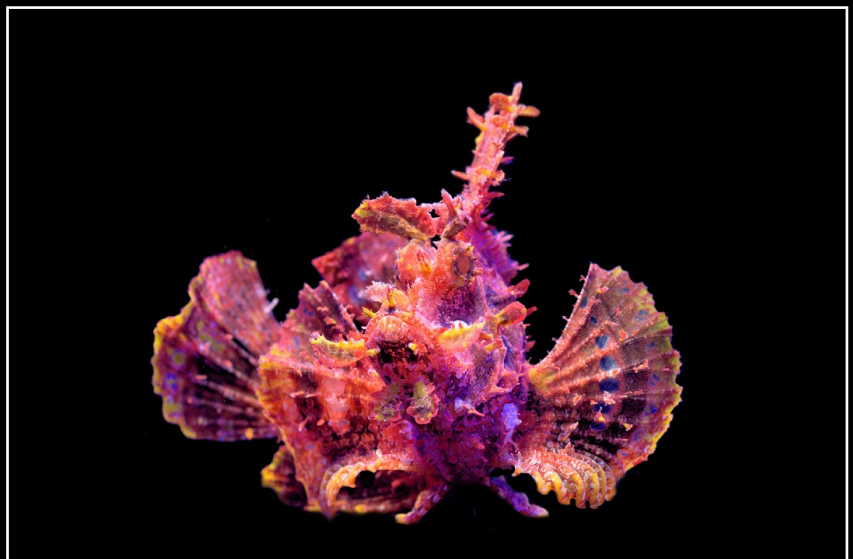
Christopher
Brunner



MACRO

Winner:

Yi-Kai Tea



*Dotted around the coast are our Research Stations.
These 'research refugia' are the platforms for Australian coral reef science.
Their resources, facilities, and amazing personnel enable our understanding
of coral reef systems and the beauty they represent.
In the following pages you can learn about the coral reef research conducted
at these stations in 2019 and keep up to date with their latest news.*



Divers inspect a coral reef.
© Alex Tyrrell/Coral Reef Image Bank



Lizard Island Research Station

By Dr. Anne Hoggett and Dr. Lyle Vail

*Lizard Island Research Station
Managers, Australian Museum*

Coral recovery continues in the Lizard Island area but it remains patchy. Some areas are still almost devoid of corals following successive cyclone and bleaching impacts between 2014 and 2017. But other areas have so many small corals growing strongly that it's easy to envision these places approaching their pre-disaster appearance within a year or so – assuming no further disasters.



Impressions are one thing, data are another. Several long-term projects continued during the year to quantify changes in both coral and fish populations. Two of these have been funded by the Lizard Island Reef Research Foundation so that they can continue into 2020 and beyond.

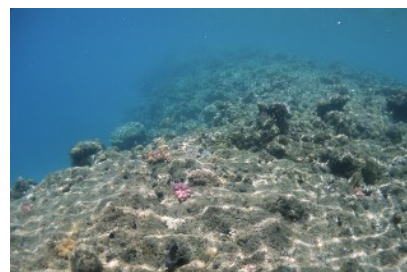
Some numbers for 2019:

- 106 scientists and research students from 38 institutions in 12 countries conducted 84 research projects
- 87 new publications based on research at LIRS were added to the collection, bringing the total to more than 2,380
- 266 species were added to the online Lizard Island Field Guide (lifg.australianmuseum.net.au), bringing the total to 2,796
- 6 new fellowships were awarded for research commencing in 2020, thanks to funding from the Lizard Island Reef Research Foundation (2 to PhD students and 4 to early career researchers)
- 4 new grants were awarded for research into specific areas, also thanks to funding from the LIRRF: plastic pollution, coral community dynamics, fish populations, and eDNA.

Additional grants will be awarded for Crown-of-Thorns Starfish research in 2020.

Above: A green turtle swims under a LIRS research boat at Casuarina beach, off the Lizard Island Research Station. © Victor Huertas;

Below: Coral reef regeneration, although variable, continues around Lizard Island. Reef between South and Palfrey islands (top); North side of Lizard Island (middle), & North Direction Island (bottom) © Anne Hoggett/Lyle Vail



Orpheus Island Research Station

By Jenni Calcraft and Rebecca Tite

James Cook University
Services Coordinator

The Orpheus Island Research Station (OIRS) had a very productive year in 2019 with the installation and commission of a new solar and battery bank system to power the station. We have 263 solar panels installed on buildings around the station producing 65kW output with 150 kWh lithium ion battery storage capacity. This is a great step forward for OIRS in our continuing effort to reduce our environmental impact.

This year we also acquired “Euridyce”, a 6m fibreglass monohull vessel, the latest addition to the OIRS fleet. This 2C vessel will replace the Southwind “Research V”.

For the first time, OIRS also hosted an ADAS Restricted Part 1 diver course upskilling JCU students and staff. This is being followed up in 2020 with additional courses for JCU and AIMS.

Classroom on the Reef

Final installation of the Classroom on the Reef live video camera array was unfortunately followed by a low-level bushfire on the island in November. The fiber optic cable responsible for the feed from Pioneer Bay was significantly damaged and unfortunately has taken this set of



Above: 360 degrees stationary video camera at Pioneer Bay, Orpheus Island. © Jenni Calcraft/Rebecca Tite

camera offline. Works to get this back up and running will happen early this year until then you can check out the wild side of Orpheus Island from the live stream on our “[Classroom on the Reef](#)” webpage.

Research Projects Summary

- Sterling Tebbett continued his work at OIRS assessing algal turf productivity on the reef crest and flat in the exposed and sheltered sides of the island. Sterling was also one of the successful applicants of the Morris Family Trust Student Research Grant.
- Thomas Armstrong from AIMS conducted a pilot experiment on rearing Triton Snail Larvae in cone tanks supplied with various filtration tiers of flow through raw sea water in our temperature control (TCR) laboratories.
- Daniel Montesinos, Stuart Worboys, Matt Barrett from the Australian Tropical Herbarium visited OIRS to establish permanent surveys sites as part of DarkDivNet which is a global network to explore the dark diversity of plant communities.

We have had some big team changes at OIRS and we wish all the best to our departing station officers Marta (7 years) and Bryn (4.5 years). We were sad to see them leave however are excited to welcome our new team

members Heath (Maintenance) and Rhys (Diving).



Above: A manta ray at Orpheus Island. © Jenni Calcraft/Rebecca Tite.



Above: OIRS staff. © Jenni Calcraft/Rebecca Tite.

@jcu_oirs

One Tree Island Research Station

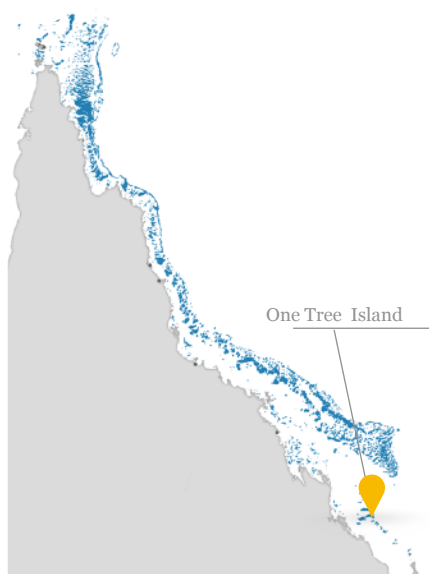
By Heinrich Breuer and Ruby Holmes

One Tree Island Research Station Managers

One Tree Island Research Station (OTIRS) said goodbye to Station Managers Ainsley Carlin and Paul Baker in 2019. We wish them all the best in their next venture and thank them for the great contributions they made to the station. New Station Managers Heinrich Breuer and Ruby Holmes have settled into their new roles and are feeling fortunate to be living and working on such a unique and beautiful island.

OTIRS continues to improve facilities to meet the demands of researchers. Our previous upgrade to the solar-battery system dramatically increased the power available on the island and has paved the way for the much-needed installation of air-conditioning for the dry lab and office areas which will be planned for early 2020. Research and teaching groups have been very happy with the high speed and unlimited internet access which has been available throughout 2019 as a result of a major upgrade and the installation of WiFi throughout all spaces at the Station.

OTIRS has also seen a quantum leap in our ability to support SCUBA based research with the installation of a new bank-based air compressor system in late 2019. The system



Above: Bird's eye view of the One Tree Island Research Station © ABC News/Elena de Bruijne

allows for the filling of tanks much more quickly and safely. In 2020 we are overhauling our wash-up and gear storage areas to make them easier to use. In 2019, OTIRS hosted a variety of research and educational projects:

- PhD student Giles Ross from Western Sydney University analysed soil samples from One Tree and Two Island to investigate soil invertebrate diversity and abundance.
- PhD student Catheline Froehlich and Dr Selma Klanten from the University of Wollongong evaluated the abundance, diversity and distribution of habitat-specialist fishes on the reef.
- Scientists from the Australian National University (ANU) analysed bio-mineral chemistry and Coralline Crustose Algae (CCA) using Perspex domes to study isolate patches on the OTI reef flat. They used the natural day/night changes in temperature and CO₂ to understand how ocean acidification and increasing temperature will impact the reef in future.
- Professor Mike Kingsford and PhD student Kynan Hartog-Burnett from James Cook University continued their research on the spatial and genetic ecology of small bait fishes (*Spratelloides* species).
- Professor Gabi Gerlach from the University of Oldenburg who has been visiting the island for over 15 years, continued her research on the orientation behaviour of reef fishes. This year, she was joined by Professor Eric Warrant who has begun research to see if fish respond to the projection of the Milky Way during orientation.
- PhD student Dionne Deaker and Professor Maria Byrne from the

University of Sydney continued their research analysing Crown-of-Thorns starfish age, behaviour, and population dynamics.

- A paper published in *Sedimentary Geology* 2020 lead by PhD student Kelsey Sanborn and co-author Professor Jody Webster analysed coral cores taken from OTI. The results provided an insight into a better understanding past reef resilience to multiple environmental stresses during the formation of the modern reef.
- The Australian National University, University of Sydney and Harvard University ran another successful year of education programs for university students from around the world. These education programs give students a once in a lifetime opportunity to experience and practice what they learn in their coral reef lectures.

The OTI lagoon and surrounding reef continues to be a unique place to conduct research with one of the healthiest and diverse areas in the GBR. As Kate Holland from the Australian National University stated: "Working intensively on a place like OTI makes real how precious and wondrous coral reefs are". We look forward to facilitating and welcoming researchers and students to this beautiful place in 2020.



Above: OTIRS managers Heinrich Breuer and Ruby Holmes. © ANU/Jimmy Walsh.

Heron Island Research Station

By Selina Ward

*Heron Island Research Station
Academic Director*

It has been a busy and exciting year at Heron Island Research Station (HIRS) since the last issue of Reef in Review with many positive changes and exciting visits, infrastructure changes and purchases.

Media visit

April saw a team from the BBC visit the Station to film part of the documentary [Blue Planet Live](#). The large BBC team showcased the flora and fauna of Heron Island and Heron Reef live to the UK public as well as bringing researchers from all over Australia to the Research Station to discuss their research. HIRS staff played a vital role in ensuring the live crosses ran smoothly during this frantically busy time.

Families at HIRS

You can now bring relatives to the station. We are working towards a permanent arrangement to make the station fully prepared for the presence of children but, in the interim, children will be allowed to stay in the accommodation that is currently suitable. You can include family members details on your application form.

New Equipment

This year, HIRS purchased exciting new equipment, including an underwater Remotely Operated



Above: Aerial view of the HIRS. © Selina Ward

Vehicle (ROV). This light craft will increase research and teaching capabilities at UQ and will be a fantastic tool for researchers who wish to view the reef without getting wet themselves or to extend their ability to conduct underwater activities that are at depth and high risk in nature. These ROVs are considered entry-level equipment and include a platform to attach sensors, video and mechanical manipulating devices for a variety of purposes across a range of scientific and engineering-related activities. The ROVs will also be able to collect small objects from the reef with the aid of a grabber arm, providing another potential use for the submersible craft for our visiting research teams. HIRS has also updated lab equipment after many years of trusted use. This included the replacement of half of our student microscopes mid-year, with the remaining microscopes to be replaced in early 2020. Additionally, HIRS will receive a new high-powered compound microscope, refrigerated centrifuge, mini centrifuge, light sensor and water quality multimeter throughout the year.

Renewable power

In 2019 the power services at HIRS received a major upgrade with the construction and installation of a solar-assisted power station; which means that HIRS is now independently supplying its own power! The solar modules extend across 22 roofs and the system is equivalent to approximately 40 residential solar systems. The batteries, which can switch between charging and discharging in under 25 msec, store enough energy to support the station for 7-12 hours when fully charged, depending on the demands of the station. In addition, the battery electrolyte doesn't degrade like that of other batteries, and will be recycled into new batteries at the end of its 20-

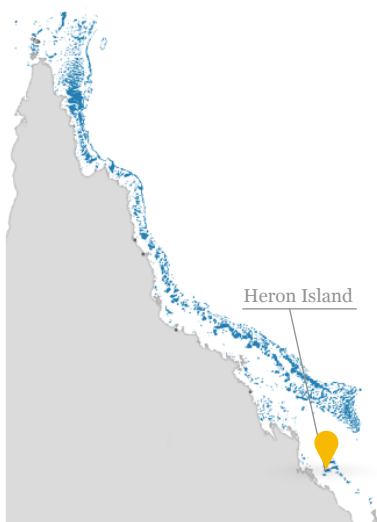
year lifespan. The micro-grid meets over 80% of the station's energy needs with renewable energy. HIRS thanks all of our clients for their patience and understanding during the construction and commissioning phase of this project. Research opportunities now exist to explore solar micro-grid systems on island and remote sites.

New Academic Director

I am now the Academic Director of HIRS. I am a Senior Lecturer in the School of Biological Sciences and have worked at The University of Queensland since 2000. I started research on reefs in Western Australia in the 1980s and have been spending a lot of time at Heron Island since the early 1990s. I currently bring multiple course groups to the station for field intensives including the Stanford in Australia group in spring and a Master's intensive course in Marine Conservation in January. I am a past President, treasurer and secretary of the Australian Coral Reef Society and have organised way too many past ACRS conferences. I am currently on ACRS council.

We haven't had an Academic Director for many years, and I look forward to working with station clients and staff to help fulfil the potential of the station. I will be doing my best to raise funds for station improvements and new projects and will be advocating for a number of positive changes. Into the future we hope to upgrade some of the laboratory facilities, build new accommodation, increase the scholarships available for station time and establish a volunteer program.

I am eager to hear from past, present and potential station visitors to discuss their experiences and gauge what we can do to improve this wonderful facility, so please do not hesitate to get in touch. selinaward@uq.edu.au



Kimberley Marine Research Station

By Liam Rawlins

Kimberley Marine Research Station
Field Research Officer

2019 saw the close of another wonderful year with our research team busy running a range of environmental monitoring and research programs. Our aim was based around the accumulation of baseline data for remote North Western Australia. This included the facilitation of master's students from the University of Western Australia, as well as continued work on a genetic breeding program of juvenile pearl oysters (*Pinctada maxima*).

Rock Oysters

We continued our work on local populations of Rock Oysters (*Saccostrea* spp.), looking into recruitment and survival in the mid shore zones. Additionally, by using settlement tiles across multiple locations, we are assessing the viability of natural recruitment in areas barren of the typical substrate. It is hoped that there may be a potential in the future for commercial growth of the animals as a food source for the local area. This program has run since August 2018 and seen over 800 settlement tiles processed across its 3 main locations.

Corals

Following a bleaching event of local corals in 2016, we set up permanent

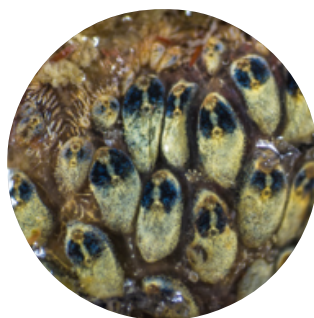


Above: left to right: Millie, Cristian, Ashley, Liam, and Josh –KMRS team out on the cleaning boat working on biofouling project. © Gary Firman.

transects on intertidal coral populations to record and monitor any further bleaching events. This study has seen transects run monthly in the area since 2016 and thankfully has recorded no further large scale events. In addition, 2019 saw the deployment of 144 settlement tiles across 4 local reefs using mounting frames; these showed a total of 411 recruits throughout the year.

Biofouling

A new project undertaken by visiting researcher Cristian Tejada-Pérez aimed to shed light on the biofouling assemblages that grow on pearl oyster farms, including on the farm's infrastructure and oyster valves. It also assessed their early successional dynamic, showing how different species start growing when new substrate is available and the variation of this as the growth matures. With over 160 taxa of invertebrates identified across the hardware and many more to be found, this will likely be a project extended into 2020.



Above: Colonial ascidian found growing on pearling longline during Cristian's biofouling project. © Cristian Tejada-Pérez.



Above: Mermaid Islands hole revealed on a low tide, the reef holds a body of water teeming with life. © Benjamin Delfs.

Pearl Oysters

We're currently looking into the genetic drivers for survivorship during outbreaks of Juvenile Pearl Oyster Mortality Syndrome (JPOMS); a syndrome capable of inducing mortality rates greater than 90% across young hatchery stock on Australian pearl farms. Year 2 of this venture saw the genetic audit of the initial 2018 spawn ready for use as brood stock in 2020, with the hopes of producing the second generation; another delivery of spat from partnered farm in Northern Territory, as well as a cohort of our own family group spawned in the cygnet bay hatchery.

Many Thanks!

As always massive thanks to all the people who contributed to our research station throughout the year. With special mention to all of those who participated in our internship program; Jessica Waters, Amelia Fasth, Megan Vaisey, Joshua Briggs, Joshua Mannolini, Ashley Bachert, Paul Fliedner and Selva Barroso whom are the heart and soul of our station. Thanks for a great year gang and looking forward to 2020!



Above: Corals exposed at low tide off local reef, one of the locations used for deployment of recruitment frames. © Ashley Bachert.

Kimberley Marine
Research Station



www.kmrs.com.au



Kimberley Marine Research Station



@KMRS2009



@kimberleymarineresearchstation

News from the Great Barrier Reef Marine Park Authority

Message from the Authority

The Great Barrier Reef Marine Park Authority would like to thank the Australian coral reef research community for their work over many years to increase our understanding of coral reefs and what management actions the Authority can take to help protect the Great Barrier Reef.

During these challenging times, for both people and the Reef, it is important to support each other. The Authority's focus is on keeping our people safe, our business functioning in the interests of the public and where required contributing to the needs of the wider public service. The Authority is also mindful of the impact COVID-19 is having on our partners, including the science community — some field work has been impacted, experiments affected and workshops and conferences postponed. The Authority remains a strong supporter of the science community — please stay safe and stay connected with Authority staff during this time.

Coral bleaching event

The Great Barrier Reef was put under extreme pressure from heat stress that accumulated over summer, particularly in February and early March 2020 — as a result the Reef experienced its third mass coral bleaching event in five years. [Aerial surveys](#) looked at 1036 reefs (focusing on shallow water corals, down to five metres) and found many areas had moderate to severe bleaching. Importantly, most recognised tourism areas had no, negligible or moderate bleaching.

The Authority produced weekly [Reef Health Updates](#) based on forecasts, water temperature heat mapping, in-water surveys, citizen science, and aerial surveys that included an Authority staff member as an observer. The updates provide up-to-date information to advise the community and the Australian Government on the health of the Reef — regular updates will now continue on a monthly basis until the beginning of summer 2020-21.

Review of Reef 2050 Long-term Sustainability Plan

Following release of the Authority's [Great Barrier Reef Outlook Report 2019](#), the Australian Government (including the Authority) and the Queensland Government are working together to revise the Reef 2050 Long-term Sustainability Plan (Reef 2050 Plan). This review process is currently underway, and has been informed by consultation with the Reef 2050 Advisory Committee, the Independent Expert Panel, Traditional Owners, and targeted stakeholder meetings. This review is part of a scheduled five year review cycle which follows the release of each Outlook Report. The revised Plan will reflect the current state and future management needs of the Reef, including increased focus on science and knowledge as a critical enabler. The draft plan will be released for public consultation in 2020 and the Authority will ensure the ACRS is made aware of its release and how to make comment on this important plan for the Reef.



Above: Coral bleaching on Keeper Reef in March 2020.
© Commonwealth of Australia (GBRMPA), photographer: Chris Jones

Reef Joint Field Management Program

The Reef Joint Field Management Program won the Gold Award for the 2019 Prime Minister's Awards for Excellence in Public Sector Management — recognising its approach to tackle threats to the Reef; delivering unwavering on-ground outcomes and fostering strong relationships.

The Program also celebrated a milestone, with June 2019 marking 40 years since the Emerald Agreement was signed to create an enduring partnership between the Australian and Queensland governments to manage the Reef collaboratively.

With a large World Heritage Area to protect the Program delivers a range of crucial activities, including monitoring and maintaining turtle and seabird breeding islands, eliminating island pests and developing walking tracks. The Program also responds to incidents to minimise harm and delivers vital compliance patrols to maintain the integrity of the marine parks zoning plans.



Above: Prime Minister's award for Field Management.
© Commonwealth of Australia (GBRMPA)

Crown-of-thorns starfish

The Authority's crown-of-thorns starfish control program expanded in November 2018, increasing the number of control vessels and fully implementing Integrated Pest Management science in the program.

Since this time, the program has managed a network of 145 high value reefs to reduce the impact of the starfish on coral. Vessel crews have surveyed 4635 kilometres of high value reef searching for the starfish. When sighted or their presence detected during this surveillance, cull dive teams were deployed. These cull teams spent 15,137 dive hours searching for and culling a total of 134,311 cryptic coral-eating starfish across 6120 hectares of high value reef. Vessel crews use purpose-built apps to upload their field data into the Authority's Eye on the Reef database, enabling efficient adaptive management of crown-of-thorns starfish outbreaks.

Local Marine Advisory Committees

The Authority is advised on Marine Park management issues at a local level by voluntary community-based committees called [Local Marine Advisory Committees](#). The 12 committees across Queensland promote the exchange of information between stakeholders, the Authority and other management partners, while encouraging and empowering local communities to take action to reduce threats and build Reef resilience (as identified in the [Reef Blueprint](#), [Outlook Report](#) and the [Reef 2050 Long-Term Sustainability Plan](#)).

The Authority is often looking for researchers to share their knowledge with Local Marine Advisory Committee members and partners — you can send the information in an easy to read format, through email, Powerpoint presentation, brochure or hand-out.

Email: lmac@gbmpa.gov.au

Reef HQ upgrade

Earlier this year, the Authority secured much needed funding to upgrade Reef HQ Aquarium — the world's largest living coral reef exhibit. The Australian Government allocated \$26.9 million to upgrade the 32-year-old facility. The upgrade will include many back of house facilities, as well as the Turtle Hospital, predator tank and coral reef exhibits. During the temporary closure of up to 12 months from February 2021, the animals and their environments will be maintained.

Reef HQ is the National Education Centre for the Great Barrier Reef, playing a vital role in educating the local, national and international community and tourists on the value of the Reef and what they can do to help protect it for future generations.

The Australian Coral Reef Society comments on the 2019 Great Barrier Reef Outlook Report*

By Dr. Sarah Hamylton & Catheline Froehlich

Every five years, the Great Barrier Reef Marine Park Authority (GBRMPA) publishes their Outlook Report, which provides an up to date snapshot of the health, pressures and risks to the Great Barrier Reef (GBR). It is a key source of information for the Australian coral reef science community, as well as those with an interest in the management and custodianship of the GBR. The outlook report was discussed in the Senate last month (21 October 2019), after attracting national and international media attention, and being the subject of many regional community stakeholder meetings since its tabling in Parliament in August.

On behalf of the ACRS, Dr. Sarah Hamylton and Catheline Froehlich have summarized this report and provided commentary on GBRMPA's outlook for the Great Barrier Reef. Critically, as another hot summer unfolds, the ACRS interprets the central message of the Outlook Report as an urgent call to action: major threats to the region need to be addressed, with the utmost emphasis on reducing carbon emissions to curb climate change and improvements to water quality.

It took a team of five people two years to wade through more than 1400 references and compile this authoritative, evidence-based and independently peer-reviewed 354-page synthesis of the GBR's current condition (Chapters 1 to 4), trends in use and pressures (Chapters 5-6), management effectiveness and residual risks (Chapters 7 and 9) and the long-term future outlook (Chapter 10) for the GBR's ecosystem and heritage values.

What the report found.

The continued trajectory of deterioration in a number of key values, as documented in previous Outlook reports, remains an important message of this report. In 2009, the GBR was considered to be at a crossroads between a positive, well-managed future and a less certain one, but by 2014 it was seen as an icon under pressure. The disheartening message in 2019 is that Australia is now caring for a fundamentally changed and less resilient GBR. The headline-grabbing aspect of this report is that the long-term outlook for the GBR ecosystem is very poor.

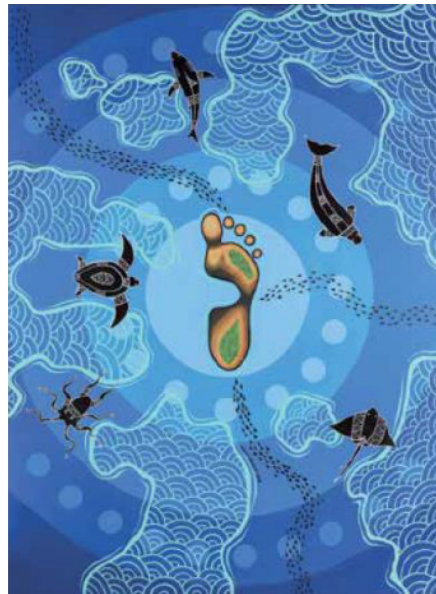
As noted by Professors Emma Johnston and Katrin Meissner:

"As scientists, we are rarely 100 per cent certain about anything, but when we are sure of something it's because there is a huge amount of evidence behind us. And we are sure that the greatest threat to the long term outlook of the Great Barrier Reef is climate change...It is now a question of whether, and how, our ecosystems will adapt to such rapid changes, and whether, and when, our clever choices can slow those changes down." (The Reef Report is

in and ocean scientists are fearful, Sydney Morning Herald, August 30)

Overall, the condition of key habitats has deteriorated from good to poor since 2014, driven by increasing sea temperatures, climatic events and poor water quality. The

Outlook Report highlighted the work of Buckley et al. (2017) on the Spanish Mackerel fishery, which has targeted spawning aggregations, leading to decreased catch rates and bag limits over time and thus fishery expansions further offshore. Fisheries management is improving, but some currently fished species are still experiencing declines and illegal practices remain a concern. Populations of turtles and seabirds have also declined as a result of reduced recruitment. All six species of regional marine turtles are threatened. While climate change remains the greatest threat, other factors, including coastal development and land-based run-off are impacting the regional social, heritage, and economic values associated with these populations.

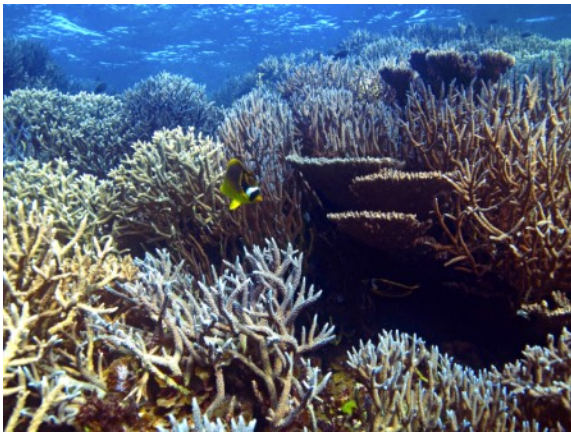


"Step of change" by Nicky Bidju Pryor. Art commissioned for the Great Barrier Reef Marine Park Authority's Reconciliation Action Plan.

On a positive note, continued and sustained pest eradication on islands is proving successful. Pest management at Tryon Island (Capricorn Bunker Group) has

successfully restored flowering *Pisonia* forest that provide important habitat for nesting birds) through the eradication of scale insects and African big-headed ants. The eradication exercise, alongside planting of >3000 *Pisonia* cuttings by the Queensland Parks and Wildlife Service has

* This article was originally published on australiancoralreefsociety.org



Above: A coral reef full of live corals. © Anna Cresswell.

restored forest canopy and increased numbers of black noddies and wedge-tailed shearwaters through providing nesting habitat. Knowledge on how to control the ants, bolster natural predators and effectively restore *Pisonia* forest was successfully applied at the neighbouring Wilson Island.

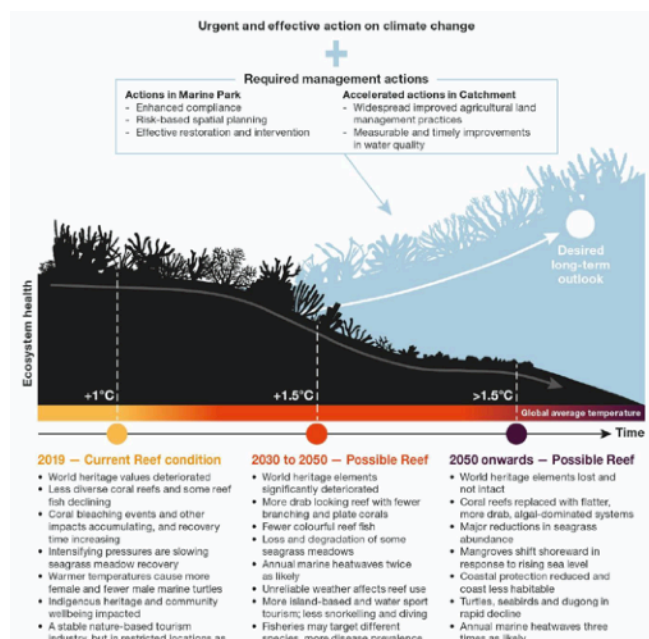
While the value of associated Indigenous heritage (e.g. cultural practices, sacred sites, songlines, structures) has continued to remain in poor condition since previous reports, increased investment in initiatives like the Junior Ranger Programs has encouraged Indigenous youth to explore and engage with Country through a series of activities and educational programs. The program is strengthening the resilience of cultural practices, observances, customs and lore (Chapter 8).

Predictably, climate change emerges as the top risk to the Great Barrier Reef Region's values which manifests as extreme weather patterns, elevated sea surfaces temperatures, and sea level rise. On page 265 (see figure on the right), a diagram neatly illustrates two potential future pathways for the GBR that are contingent on whether risks are adequately mitigated in an adequate timeframe. The business-as-usual trajectory, without the timely mitigation of high-risk threats, indicates the Region may exhibit fewer colourful fish, degraded habitats, more heatwaves, unreliable weather and likely increased prevalence of disease. If this occurs, users of the reef may target previously unexploited species. Thereafter, a less structurally complex and more algal-dominated ecosystem may prevail, with significant shifts in the health of the world heritage site. However, if urgent and effective action is taken to curb emissions and address climate change, in addition to improving water quality and ensuring sustainable use from an ever growing coastal population, an alternative, more positive future pathway may still be within reach for a resilient reef and marine park.

The Outlook Report emphasises the many actions suggested in the Reef 2050 Plan. Just last year, the Reef 2050 Long-Term Sustainability Plan was revised following a mid-term review and highlighted some important actions, including increasing compliance with marine park regulations, risk-based spatial planning and reef restoration, and improving agricultural land management practices in order to improve water quality and reducing the impacts of climate change.

There are inherent difficulties of carrying out such a large-scale assessment and awarding a single grade to reflect the condition of the whole Region. In the future, a more localized approach to grading might better capture the geographic variability within the Region, which covers 346 000 km² from Cape York in the north to Lady Elliot Island in the south.

As another hot summer unfolds, following last year's hottest summer on record, and with NOAA's Coral Reef Watch predicting >90 probability of more coral bleaching over the coming months, The Australian Coral Reef Society interprets the central message of the Outlook Report as an urgent call to action: *major threats to the region need to be addressed, with the utmost emphasis on reducing carbon emissions to curb climate change and improvements to water quality.*



Future pathways for the Great Barrier Reef Region. The two outlook pathways shown provide examples of what the future might look like depending on whether key risks are adequately mitigated within required timeframes. The pathways are indicative and based on a large body of evidence. Reef condition and social values have already changed and will continue to change. The desired outlook pathway is still possible if global, regional and local mitigation and management actions are accelerated and implemented in time.

Peter Ridd's questionable claims*

Statement by the Australian Coral Reef Society on Great Barrier Reef water quality claims

As the world's oldest dedicated coral reef science and conservation group, the Australian Coral Reef Society is deeply concerned that members of the Queensland public are being misinformed about the role of water quality in supporting a healthy Great Barrier Reef.

Supported by the sugar cane industry, Dr Peter Ridd has been making several claims about coral reef science during lectures and in media interviews and articles. Several of Dr Ridd's claims are not true, while others could be characterised as strawmen arguments that ignore much greater challenges faced by the Great Barrier Reef. As the reef is facing fundamental challenges from rapidly warming oceans, it is important that governments take action to support a rapid reduction in greenhouse gas emissions while taking all available steps to reduce the amount of sediments, nutrients and pesticides that reach the reef lagoon.

The Society believes that the public and stakeholders should be informed by the best available science, such as the detailed analysis available in the most recent 2017 Scientific Consensus Statement. The Society was founded in 1922 and currently has more than 250 members, including many of the world's leading coral reef scientists.

Below, the Society provides an analysis of claims made by Dr Ridd in articles published by the NewsMail in Bundaberg and repeated online by other outlets.

Peter Ridd has a list of what he calls eleven questionable claims that reef scientists make. He provides an explanation to discredit these claims. His recent article for NewsMail is a strange mix of claims that are either NOT made by marine scientists working on the GBR (Claim #4 Crown of thorns seastar plagues are unnatural, Claim #5 Pesticides from farms are killing the reef, Claim #6 Pharmaceuticals from human waste is a risk to the reef [there's some risk to corals but very low] and Claim #10 Coral does not recover from mass mortality events such as cyclones and bleaching), or explanations about these claims that are not correct (Claim #5, Claim #7 The water quality of reefs is degraded, Claim #8 Coral cover has declined, Claim #9 Coral growth rates have slowed, Claim #10). In addition, Ridd suggests (for some time now) that no science is to be believed

because he doesn't believe in the scientific process.

He hopes that by falsifying claims made by the coral reef scientists in scientific publications, he can enhance his own credibility by disproving these falsehoods. In this way, attention is drawn away from the actual problem discussed by the science.

An example of something scientists don't say is Claim #4 – "crown of thorns (COT) starfish outbreaks are unnatural".

Yes. COTs are native animals and outbreaks have occurred throughout time. No marine scientist will tell you otherwise. The problem though, is that outbreaks may have become more frequent and more severe in recent decades, so we need to try to understand why and how to stop their intensifying trajectories.

Throughout his claims, Dr Ridd ignores inshore reefs, as if they are not an important component of the World Heritage Area and the Great Barrier Reef Marine Park. This is convenient for his argument that there are no water quality problems for the Great Barrier Reef, discounting the hundreds of published papers investigating and reporting on these problems. He also incorrectly suggests areas like the Whitsundays are not important parts of the GBR, despite the huge tourism industry in such areas.

Another strategy Dr Ridd uses is to overstate a potential problem in his questionable claim, so that the actual level of the problem is considered unimportant. For example, claim 5 that pesticides from farms are killing the reef. A reef scientist would not say that as it would exaggerate the issue, but Dr Ridd then argues that there are almost undetectable amounts in

* Submission originally published on australiancoralreefsociety.org on the 14th of August, 2019

the ocean close to the coast. This is not correct. The inshore pesticide monitoring program has detected many pesticides, including herbicides at all eleven sampling sites. There are high concentrations above water quality guidelines in estuaries and some coastal waters. Herbicides are particularly harmful to seagrasses and symbiont bearing animals such as corals.

Dr Ridd insists that coral cover has not declined on the GBR. In reality, the Australian Institute of Marine Science has been running one of the best and most extensive long-term monitoring programs in the world, and conclusively demonstrated declines of coral cover, with over 50% loss between 1985 and 2012. Most recently, huge coral mortality from the 2016 and 2017 mass coral bleaching events are also ignored by Dr Ridd. The reef science literature for the last 20 years has overwhelming agreement that coral reefs are facing devastating loss in coral cover. Dr. Ridd says that coral growth rates have not declined but in fact increased last century. Growth rates did increase last century, but many recent studies have shown that growth rates have dropped by about 20% in the last three decades.

As mentioned above, Questionable Claim 10, that coral doesn't recover from mass mortality events such as bleaching or cyclones, is also a non-starter. Assuming that he means 'reefs' when he states that dead coral will not recover, this is also something a marine scientist would NOT say. Reefs can recover from many high mortality events, provided circumstances are right, they can get a supply of coral larvae, and they are not hit by a subsequent mortality event soon after. His statement that after EVERY mass mortality event, recovery has been rapid and strong is simply not true. His follow-up that bleaching events are perfectly natural and

likened to bushfires is also false. Mass bleaching events are directly linked to ocean warming and were not recorded before 1979, at which point sea temperatures started to exceed minimum thresholds for bleaching temperatures. Recent work has also shown that reef recovery rates are becoming slower over time and bleaching events more frequent, rendering reefs in a constant state of catch up.

Dr Ridd says: Crown of Thorns Starfish are a native species and are as Australian as kangaroos and koalas.

They are not a feral animal like cane toads or rabbits. Geological evidence indicates they have occasionally reached plague proportions for thousands of years before European settlement

After rejecting the scientific process and questioning the validity of all science and therefore reef science, Ridd ends his piece by declaring that reef science in Australia needs to have more vigorous quality audits. He gives no examples of reef science that he feels is actually flawed. We need to consider the hundreds and hundreds of publications on the science of the GBR which come from experts from around Australia and overseas from a large number of universities and institutions. These works have been published in very high impact journals. For example, many of the most important papers from the 2016 and 17 bleaching events were published in the two most highly ranked (most prestigious) journals of science - Nature and Science. These works are always reviewed by editors and then experts in the field, who are the leading scientists in these fields in the world.

Dr Ridd suggests that we should have panels to check reef science (just in case journals like Science and Nature get it wrong) but control already happens on many levels. Every four to five years a detailed Scientific Consensus

Statement is created by a large team of scientists and policy makers. In this process, a panel of experts get together to go over all the recent work and develop the consensus statement after much review and discussion.

Additionally, there is a state government lead process called the Independent Science Panel that assesses all the data and recent work on water quality.

At a federal level, there is the Independent Expert Panel run by the former Chief Scientist Ian Chubb. This panel covers all GBR work rather than just water quality.

Thus, there are many layers of review and assessment and collaboration already on top of the peer review undertaken by the journals for the published work. Dr Ridd has previously been on some of these panels, yet conveniently omits them. What can he possibly hope to achieve by setting up yet another panel, other than steering funding away from crucial ongoing research?

In short, as representatives of the Australian Coral Reef Society, we disagree with Dr Ridd's statements about questionable claims. We acknowledge and highlight that science is always under development and new generations of scientists with new tools will review and finetune findings of their predecessors. However, it is an unfortunate fact that the GBR is currently in a bad state, mainly caused by climate change, land use and outbreaks of crown of thorns seastars. The link between former causes and human activities is not disputed by any reasonable scientist, and that human influence also at least contributes to the latter problem is also widely accepted.

Submission written by Selina Ward and Gus Fordyce, and edited by the ACRS Council.

The ACRS requests that Exemption 15 be retained in the proposed new Marine Order 505*

The Australian Coral Reef Society (ACRS) is the oldest organisation in the world dedicated to the study and conservation of coral reefs. Founded in 1922, it now supports and represents over 300 coral reef scientists in Australia who collectively grow our understanding and conservation of coral reef ecosystems through dedicated research. In this capacity, we request that Exemption 15 be retained in the proposed new Marine Order 505 for the benefit of scientific research and educational activities.

Currently, Exemption 15 allows scientists with a recreational boat licence to operate a domestic commercial vessel, less than 7.5 m long, for the purposes of scientific research or education within the Great Barrier Reef (GBR) region, the Torres Strait zone or in defined smooth or partially smooth waters. Exemption 15 has allowed us to conduct cost-effective and wide-ranging research throughout these areas, including the economically and culturally significant GBR. The removal of this exemption in its current form would hinder our ability to conduct quality research that directly informs the preservation of these natural resources that are important to the Australian economy.

As marine scientists, we welcome the streamlining and simplification of maritime safety laws through the proposed new Marine Order. We support the establishment of the Coxswain Class 3 NC for some duties under

Marine Order 505, and agree that a recreational marine driver's licence is sufficient for a Coxswain Class 3 NC certificate. However, we request that Exemption 15 be retained, as written, in order to create stability and efficiency within the regulatory process. Under Marine Order 505, a Coxswain Grade 1 or 2 would be required to conduct the majority of operations completed by researchers, unless Exemption 15 is retained. The undertaking of a Coxswain Grade 1 or 2 is not feasible for researchers due to time and budget constraints.

The expiration of Exemption 15 and current format for Coxswain Class 3 NC represents a significant reduction in our research capacity without a comparable increase in maritime safety. For example, while we support the assessment of medical fitness for the tasks covered by Exemption 15, it is unclear what form this would take in the proposed order. Recreational boat licences do not require a formal assessment; as such we suggest that a self-declaration of medical fitness be more appropriate.

Under the proposed order, Coxswain Class 3 NC would limit operations to 1 nautical mile (nm) from shore. This is a considerable reduction in the area of operations compared to AMSA Exemption 15 where vessels can operate according to their Certificate of Operation. A large portion of reefs in the GBR and Torres Strait zone exist greater than 1nm from shore; therefore, the proposed order would prohibit our access to these

areas and so the breadth of our research output. We request that if Exemption 15 is not retained, then the Coxswain Class 3 NC should be extended to cover operations in all sheltered waters (including partially smooth waters) rather than just smooth waters 1 nm from shore.

Australian researchers are largely associated with universities who implement their own safety regulations in addition to those from AMSA. These are rigorous, involve regular demonstrations of user competency, and are often tailored to hazards or risks specific to particular locations and activities. By applying new changes to AMSA maritime safety laws, the efforts of universities to maximise safety while safeguarding the capacity for quality research will be undermined.

Finally, we emphasise that Australia is a global centre for coral reef research, and as such we attract a large number of international collaborations. The proposed order, which would require researchers to obtain a Coxswain Grade 1 or 2 certificate, runs the risk of reducing the research capacity of visiting scientists by removing the ability to get a time and cost-effective licence for their research activities in Australia. Additionally, a requirement for the assessment of medical fitness as mentioned above is also likely to hinder the research of international visitors. We stress the need to ensure that the proposed requirements have international equivalents to

* Submission originally published on austriancoralreefsociety.org on the 26th of September, 2019

maintain ease of access for international researchers. In addition, international First Aid certificates need to be acceptable.

In summary, the ACRS supports the maintenance of Exemption 15 for the benefit of researchers and the contributions they make towards the nation. We believe the Annual Regulatory costs of less than \$1000 to business and individuals is a gross underestimate of the true impact that the removal of this exemption will have on research. Should AMSA nonetheless continue to pursue the proposed order in its current form, we suggest a longer transitional period to minimise the impact this is likely to have upon Australian coral reef research.

Sincerely,

Dr. Anna Scott



President
Australian Coral Reef Society

*Submission written by Gus
Fordyce, Samantha Goyen, and
Catheline Froehlich, and edited by
the ACRS Council.*



Above: Two researchers at the surface after completing a dive. © Ciemon Caballes
2017 ACRS Photo Competition

The Great Barrier Reef needs evidence-based regulation of farm practices that impact water quality

Submission by the Australian Coral Reef Society to the Senate Rural and Regional Affairs and Transport References Committee (RRAT).

The Australian Coral Reef Society (ACRS) is the world's oldest group of coral reef scientists and conservationists, and the Society has been actively leading coral reef research since 1922. In recent years, the Great Barrier Reef (GBR) and catchment areas have been exposed to extensive habitat degradation and diminishing water quality. Thus, the ACRS strongly supports the request initiated by the Senate for an inquiry and report from the RRAT in regard to the regulation of farm practices that impact water quality in the GBR.

Response to: "a. the existing evidence-base on the impact of farm water runoff on the health of the Great Barrier Reef and catchment areas"

The two largest threats to the GBR are water quality from land-based pollutants and climate change. Urgent and efficient action is necessary to curb the impacts of both threats on the GBR, as many habitats are deteriorating accordingly. It takes several years for management practices to improve the effects of poor water quality on aquatic systems. Without immediate action, water quality will remain in poor condition in the GBR, and will continue to threaten ecosystem

health. Currently, poor water quality is known to increase invasive and harmful species, reduce seagrasses, corals, and algae, disrupt nutrient cycling, fertilization in invertebrates, and hormone production in vertebrates (Au et al., 2001; Bell, 1992; Brodie and Landos, 2019; Bryan et al., 1979; Chislock et al., 2013; Duckworth et al., 2017; Katagi, 2010; Kroon et al., 2017; Saunders et al., 2017; Walczak and Reichert, 2016; Weber et al., 2012).

Climate change and poor water quality from land-based run-off are the highest risk threats to the GBR in the Great Barrier Reef Marine Park Authority's 2019 Outlook Report. Every five years, the report synthesised multiple lines of evidence to produce a 'state of the region' and the changes the GBR has faced since previous reports. The 2019 Outlook Report underlines the need for immediate action on both climate change and water quality in order to reduce anthropogenic impacts and improve the outlook of the GBR. The report emphasizes that sediment and nutrient loads from land-based run-off are the leading problems facing the region, and mentions 'water quality' more than 170 times. Agriculture is the overwhelming contributor to poor conditions of water quality in the GBR, with



cattle and sugarcane industry generating the greatest impact. Additionally, certain areas of the GBR are threatened by high concentrations of pesticides (especially the Mackay-Whitsunday region), which is downstream of a large portion of sugarcane industry. The accumulated threats of sediment and nutrient input, with additional localised input of pesticides, need to be addressed urgently to provide the GBR with an opportunity to recover from its current state.

Every four to five years, a large team of policy makers and expert

* Submission originally published on australiancoralreefsociety.org on the 15th of November, 2019



Above: A lemon damselfish (*Pomacentrus moluccensis*) shelters among coral branches. © Tammy Schuh. 2017 ACRS Photo Competition
Previous page: Mangroves at Lizard Island. © Victor Huertas

scientists prepare a Scientific Consensus Statement in which all recent research is reviewed and discussed at length. These control measures provide an unbiased detailed analysis on the current state of many aspects affecting the natural world. The 2017 Scientific Consensus Statement specifically reviewed the current state of water quality on the GBR and how it has changed since 2013. The statement reviewed many sources of pollutants, and stressed that agricultural diffuse sources are the dominant contributors to land-based pollutants that are affecting the water quality of the GBR. Primary pollutants to the GBR and catchment areas are sediment, nutrients and pesticides, and each pollutant impacts at different scales and locations. For example, one of the highest risk-producing pesticides is diuron, which is a general-use herbicide that is used in many agricultural crops (e.g. fruit, cotton, sugarcane, legumes) to control for a large number of weeds. The highest priority areas for reducing pesticides are Plane, Pioneer and Haughton catchments. Inshore coral reefs are especially vulnerable to land-based run-off, and current impacts, including agricultural practices and past and ongoing catchment development, need to be managed effectively and immediately.

Response to: “d. proposed changes to regulations that would impact on farm productivity and the potential benefits and costs of such proposed regulation”

Review reports, programs, and improvement plans are essential to the continued monitoring and management of water quality and farm practices in the GBR. Combined, the following reports and plans highlight the current state of water quality, emphasize what areas are especially vulnerable, and suggest improvements that are necessary to ameliorate the current trajectory of the GBR:

- Great Barrier Reef Marine Park Authority Outlook Report
- Scientific Consensus Statement
- Great Barrier Reef Marine Park Authority’s Marine Monitoring Program
- Paddock to Reef Integrated Monitoring, Modelling, and Reporting Program
- Reef 2050 Water Quality Improvement Plan 2017-2022
- Reef 2050 Long-Term Sustainability Plan
- 2019 Reef Report Card

Currently, few areas are adopting land management practices that will improve water quality in the GBR. The Reef 2050 plan, which underlines required changes for the improvement of the GBR, emphasizes the following targets by 2025: reduction in anthropogenic end-of-catchment loads of inorganic nitrogen by 60%, particle nutrients by 20%, sediments by 25%, and pesticides to protect 99% of aquatic life. Thus, additional regulations are required to reinforce the reduction of the land-based run-off from farming in many areas. For example, more stringent testing and better applicators of pesticides need to be implemented for chemicals that are currently on the market and for those that are proposed for future use before customer purchase. Impacts of pesticides need to be tested on freshwater, saltwater, and brackish flora and fauna separately in order to understand the scope of impact. Brodie and Landos (2019) evaluate the current ecosystem impacts and management practices of pesticides on the GBR, and propose regulatory and management changes that have the potential to improve the GBR health.

Further management practices should try to limit the spread of land-based run-off from farms and

catchment development. Current regulations need to be reinforced and greater incentives and assistance should be implemented making it easier and economically viable for farmers to adopt landscape remediation and conversion scopes. In doing so, biodiversity will be increased in farmed areas and there will be a reduction in the extent of run-off. In the 2017 Scientific Consensus Statement, current management options are assessed for their effectiveness, and the report finds that improvements are necessary. Social and economic factors need to be more interlaced in assessment protocols, additional support and resources are warranted, and alternative solutions need to be sought out to improve water quality on a large scale. According to the 2019 Great Barrier Reef Marine Park Authority Outlook Report, voluntary arrangements for farmers are inadequate, and new legislations are needed to increase the compliance and uptake of better management practices.

Current initiatives do not meet water quality targets, which reiterates the need for improvements to governance, program design and delivery, and on-ground management and reinforcement. In the 2019 Reef Report Card, sugarcane and cattle grazing were the two largest contributors to water quality, and both have not met targets for best management practices. By 2025, both industries are supposed to meet 90% target of best practices across priority areas. Currently, only 9.8% of sugarcane land exhibit best practices, and only 35.8% for cattle grazing. Since 2016, there has been very limited

progress in meeting these targets by both industries. Immediate changes to initiative regulations need to be undertaken to reach targets for 2025, otherwise water quality will continue to disrupt important processes in the GBR.

Wetland and treatment systems should also be monitored more closely and frequently to confirm that they are able to stop the spreading of land-based run-off to the rivers and oceans. New treatment systems need to be implemented as current practices are unable to control for the outflow of excessive sediment, nutrients and pesticides. In the short-term, these improvements will increase economic input into the management upgrades. However, the initial monetary input will be beneficial economically and socially in the long run because future resources will be unnecessary for removing high loads of inflow in the GBR if we can stop them now. More importantly, habitats in the GBR will have less stressors if water quality improves and will have the potential to recover to previously healthy conditions without the onslaught of continued agricultural diffuse sources.

ACRS would be happy to provide additional information on the above as required.

Sincerely,



Dr. Anna Scott

President
Australian Coral Reef Society

Submission written by Catheline Froehlich and Professor Jon Brodie, and edited by the ACRS Council.

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A rich variety of corals and other reef invertebrates
compete with one another for space.
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