

Report



Australian Museum Lizard Island Research Station

2018

Lizard Island Research Station 2018 Report

LIRS Directors

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Lizard Island Research Station

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The Lizard Island Research Station acknowledges the traditional owners of Jiigurru, the Dinggaal people, on whose land the research station is situated.

The Lizard Island Research Station respects elders past and present, and welcomes all who visit the research station.



Welcome



In 2018 we marked 45 years since the Lizard Island Research Station (LIRS) was established, supporting thousands of visiting scientists to undertake world-leading research into the Great Barrier Reef. Former AM Director, Frank Talbot's vision for a world class research centre continues to be clear and bold.

As we look back at almost five decades of the LIRS, we know that coral reefs support more than a quarter of all marine life and yet in the last 30 years nearly half of the world's shallow water corals have been lost (*WWF 2018 Living Planet Report*).

At the 2019 World Economic Forum, world-renowned naturalist and broadcaster Sir David Attenborough called for a global plan to tackle climate change. "Right now, we are facing a man-made disaster of a global scale," the 92-year-old Attenborough said. "What we do now and in the next few years will profoundly affect the next few thousand years."

During this time of unprecedented change, the work of research stations such as LIRS has never been more critical. Successive years of coral bleaching in 2016 and 2017 alongside abnormally high water temperatures sounded another warning bell on the impacts of climate change. In 2018 there was a glimmer of hope with no further coral bleaching observed and evidence of recovery among some of the corals.

These positive signs underscore the need for greater research, increased awareness and positive action on climate change to ensure the Reef can continue to recover. In 2019 the AM will be doing just that.

As always, my continued thanks to our dedicated LIRS co-directors Anne Hoggett and Lyle Vail who have operated this important research outpost for the last 28 years. They are champions in the world of coral reef preservation.

Thank you also to the Lizard Island Reef Research Foundation (LIRRF), led by Chair Kate Hayward, for their investment in the work of the LIRS, and to the visiting researchers, volunteers, donors, Australian Museum Research Institute staff and AM Trust for your support of the LIRS.

Kim McKay AO
Director & CEO, Australian Museum



2018 was the 40th year the Foundation has supported the Australian Museum's Lizard Island Research Station (LIRS). It's a significant birthday and timely to acknowledge the work of so many people who, over four decades, have helped shape this world-renowned research facility. This includes our members and all donors, whose generosity continues to be key, our former Trustees who have helped steer its development, the support of LIRS's parent, the Australian Museum and its dedicated staff, the collaborative institutions, and not least of all the talented marine scientists.

I'd particularly like to recognize the ongoing work and guidance of LIRS co-directors Anne Hoggett and Lyle Vail. Their report, which follows, highlights the significance for science of being able to draw on historic data. Some of these data sets to which they refer, researched and collected at LIRS over the past 45 years, are now playing a crucial role in helping scientists better understand the threats facing our coral reefs – and the communities that depend on them. Never has it been so vital for this important research to continue, and continue to be funded.

On behalf of my fellow Trustees, a heartfelt thank you to David Shannon who late last year stood down as LIRRF's Chair after six years at the helm. David has made an enormous contribution to the Foundation, dedicating his time, energy and considerable skills. I'm pleased to report that David has agreed to stay on as a Trustee, and will continue to play a very important role in communicating to our supporters, in non-scientific terms, some of the research being undertaken at LIRS. We hope you enjoy these science stories as we continue to share them over the coming year. They are all so important in informing our public of the workings of the Station.

Kate Hayward
Chair, Lizard Island Reef Research Foundation

2018 in review



"Wow – so many new little corals!" is a common comment from returning researchers in 2018. This is particularly encouraging because for the first time since 2013, the Lizard Island area did not suffer a major summertime disaster this year.

By contrast, reefs in the area were devastated by severe cyclones in 2014 and 2015 and by extensive coral bleaching in 2016 and 2017. Australian Museum Lizard Island Research Station (LIRS) staff and visitors alike were enormously relieved when the summer of 2017/18 passed without any further destruction. While the ongoing recovery of corals is very heartening, it's important not to underestimate the future consequences of climate change on coral reefs.

Well-established, long-term research stations provide unique opportunities for assessing environmental change. As one of the premier research stations globally, LIRS has facilitated many important studies that provide invaluable historical data that can be used for comparison now and into the future.

One of these historical data sets allows us to determine changes in reef metabolic performance over a time-span of 43 years – and counting. In 1975, researchers measured "net community calcification" at Lizard Island. This is the rate at which calcium carbonate is accreted or dissolved on a reef and it's an important measure of reef health. Repeating this landmark study in 2008 and 2009 at the same place and time of year, other researchers found this metric had declined by 27-49%, which they attributed to ocean acidification. This year, other teams are repeating these measurements thanks to support from the Lizard Island Reef Research Foundation and others. Analysis of that data will show whether the declining trend has continued. The researchers plan to repeat their work in future which will extend the significance of this important data set.

Another long-term study has recorded coral community structure annually since 2008 in a way that is comparable to studies in the same area in the 1990s. This project has produced one of the highest resolution, long-term data sets of coral communities ever put together in the world. Initially, more than 40,000 corals were mapped on one large reef flat in the Lizard Island lagoon enabling minute changes, to within millimetre precision, to be tracked in the coral community over time. In 2014, the team took advantage of the cyclone disturbance to expand their mapping program to 21 sites around the island. This has continued annually and is planned to continue into the future, subject to funding. They have documented the extent to which the two cyclones and the two bleaching events have profoundly changed Lizard Island coral communities (publication 49, page 21). For example, coverage by *Acropora*, which includes plate and staghorn corals, declined by 95% from 1995 to 2017 with most of the decline following the cyclone and bleaching events.

The longest data set of all has been provided by the Dingaal people, the traditional owners of Jiigurru (Lizard Island). Their rich cultural heritage extending over thousands of years is evident on the island in shell middens and stone arrangements. For the past several years,

archaeologists have collaborated with the Dingaal people to investigate the use of Lizard Island by its traditional owners. This research is now a major focus of the recently-established ARC Centre of Excellence for Australian Biodiversity and Heritage (CABAH). Up to 50 specialists are currently analysing a wealth of archaeological material. Due to the high level of preservation of artefacts such as mollusc shells and fish bones, the archaeologists should be able to determine if there have been changes to the composition of the local marine communities over thousands of years. The Australian Museum and CABAH are in discussion about ways to highlight and promote these important archaeological discoveries.

Scientific research remains the primary focus of LIRS but it is also important to educate people about coral reefs. Accordingly, LIRS also facilitates educational visits by student groups and access for documentary film makers. *Blue Planet II* is a BBC series on marine life narrated by Sir David Attenborough. It was first broadcast in Australia in 2018 and Lizard Island features in four of the seven episodes. One of the Lizard Island stars is Percy (the persistent), a tuskfish who collects clams with its teeth and takes them to a specific coral head where it breaks open the shells to eat the animal inside. After filming in 2015, Percy's coral "anvil" bleached in 2016 but we are pleased to report that it has recovered and Percy is still there. *Blue Planet II* has been viewed by hundreds of millions of people around the world, has won numerous awards and has been instrumental in educating vast numbers of people about the importance of protecting coral reefs and other marine environments.

Continued support for these and similar projects is vital. Not only do they provide relevant data to measure change reliably, they also inform and inspire the public about reef issues. Both aspects are crucial as reefs around the world are facing serious environmental challenges. In partnership with the LIRRF, LIRS is achieving both goals.

Lyle Vail AM and Anne Hoggett AM
Directors, Lizard Island Research Station

Opposite Growth of new corals in some areas is astounding and larger branching corals provide habitat for small fish.



An aerial photograph of a coastal area. The top right shows a rocky shoreline with sparse, dry vegetation. The water is a vibrant turquoise color, and a large, dark green coral reef is visible in the lower right quadrant. The text 'Fellowships and grants' is overlaid in white on the left side of the image.

Fellowships and grants

The Fellowships program provides funding for field-intensive research at LIRS by PhD students and recent postdocs. The program is fully supported by the Lizard Island Reef Foundation and its donors.

Details of the conditions and selection criteria for these highly sought-after Fellowships can be found in the Lizard Island Research Station section of the Australian Museum's website. Applications close in August or September each year for funding that becomes available in March of the following year.

Fellowships

Seven new fellowship recipients will commence work in 2019: four PhD students and three early-career scientists. Outlines of their projects can be found below. As well, funding continues into 2019 for six fellows who are in the second or third year of their award.



Jessica Bellworthy

2019 Raymond E. Purves Foundation
Doctoral Fellow, Bar Ilan University, Israel

How do local thermal regimes and reproductive timings impact coral planulae plasticity?

During the famous annual coral spawning, many types of corals broadcast eggs and sperm into the water. Eggs that become fertilised develop into larvae that drift for weeks before settling permanently onto the bottom, far from their parents. However, other types of corals spawn larvae that are well-developed and do not move far from their parent colony. Both types of coral are important reef-builders and their very different life-histories mean that they respond differently to environmental stresses.

Jessica is investigating the ability of corals to adapt to rapidly increasing temperatures as is happening through climate change. She is focussing on the larvae-bearing type of corals to assess how parental condition affects survivorship of larvae: does a healthier parent produce more robust offspring? Her work to date has been conducted in the Gulf of Aqaba, where normal sea temperatures are much higher than on the Great Barrier Reef. She has found that larvae there have extremely high tolerance to temperature but it is affected by the resources provided by the parent. At Lizard Island, she will determine the temperature tolerances of coral larvae and assess whether investment in larvae is compromised when parent corals have been under stress such as severe bleaching.



Catheline Froelich

2019 Zoltan Florian Marine Biology
Doctoral Fellow, University of Wollongong

Investigating the advantages of sociality in challenging environments using coral-dwelling gobies

Coral-dwelling gobies are small fishes that form mutually beneficial relationships with their coral hosts. At Lizard Island, coral gobies of many species are common and they have been the subject of much research. Different species have different levels of sociality. Following the coral bleaching and cyclonic events in recent years, we know that populations of both corals and their goby inhabitants were drastically reduced at Lizard Island. However, according to evolutionary theory, differing social structures (social versus asocial) may result in some species being more resilient than others in such challenging environments.

Catheline will evaluate how sociality affects the outcome for coral-gobies after extreme environmental events. She will record the long-term recovery and population structure of social and asocial species following the cyclones and bleaching, building on knowledge from before those events. She will also determine whether there is any link between genetic and social system diversity before and after bleaching events, and compare habitat preference, dispersal ability, and competition between social and asocial species to determine the mechanisms underlying variability in recovery rates. This project will evaluate evolutionary theory while simultaneously predicting the recovery of coral-gobies following stochastic climatic events.



Tim Gordon

2019 Ian Potter Doctoral Fellow
University of Exeter, UK

Investigating soundscape restoration as a novel management tool for degraded coral reefs

Tim has already completed three field seasons at Lizard Island investigating the importance of sound in reef fish ecology. He and his co-workers have shown that degraded Lizard Island reefs (following cyclones and bleaching) are quieter and less complex acoustically than in their pre-degraded state, and this reduces their attractiveness to settlement-stage fishes. This leads to fewer new fishes settling onto the reef and that may compromise reef resilience.

In 2019, Tim will investigate this feedback loop to determine which of the multiple changes in degraded reef soundscapes are predictive of reduced attractiveness to fish. Listening to reefs through passive acoustic monitoring is a promising tool for reef management, and altering the reef soundscape could enhance reef recovery by making degraded reefs more attractive to fishes. Tim’s work will pinpoint which characteristics of the reef soundscape are important to fishes and hence improve these tools.



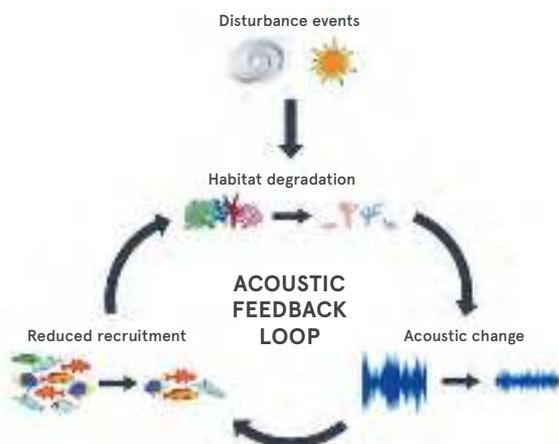
Kelly Hannan

2019 Lizard Island Doctoral Fellow
James Cook University

Mechanisms underpinning maintained or enhanced performance of coral reef fishes under future climate change conditions

How will coral reef fishes cope as temperature and acidity of the oceans increase as forecast over the next 100 years? Under high CO₂ conditions (i.e. more acidic water), it has recently been found that coral reef fishes actually become “athletes” – they can use oxygen more effectively – and the physiological mechanism for that process has been identified in non-coral-reef fishes. But those studies did not take into account elevated temperature which will occur at the same time in the real-world situation, and it remains unknown whether the mechanism holds true for coral reef fishes which are on a different branch of the evolutionary tree.

Kelly’s research aims to fill those gaps in knowledge. She will do that by testing the swimming performance of fishes in a series of experiments in the LIRS aquarium.



Above Graphic by Tim Gordon, adapted from publication 30 in this report.





Dr Bridie Allan

John and Laurine Proud Postdoctoral Fellow, University of Otago, New Zealand

Microplastics in the marine environment and their implications for behaviour, physiology and oxidative damage in coral reef fish

Plastic is accumulating in the environment because so much of it is produced, it is readily discarded and it degrades very slowly. Plastics are often mistaken for a food source by animals. This can lead to internal damage through abrasion, ulcers and digestive congestion resulting in a loss in body condition. There is also the threat of exposure to highly toxic chemicals that are used during the manufacturing of plastics. Microplastics (pieces less than 5 mm) in the marine environment are increasingly being seen as a worldwide scourge but there has been little research on their impact in coral reef environments.

Microplastics in the sea are rapidly colonized by microbial communities including bacteria and algae. The build-up of complex biofilms has been shown to increase the palatability of microplastics to some invertebrate species, although this is yet to be shown in fish. Therefore, understanding the links between microplastics and naturally produced biofilms is important for understanding the attractiveness of microplastics as a potential food source to marine organisms.

Bridie's investigations at LIRS will involve field and aquarium components to determine some of the effects of microplastic pollution on the behaviour and physiology of coral reef fishes. It will enable us to better understand the potentially toxic effects of microplastic pollution on the health of coral reef fishes and it could have implications for future guidelines governing the release of such contaminants into aquatic environments.



Dr Rohan Brooker

2019 Isobel Bennett Marine Biology Postdoctoral Fellow, Deakin University

The ecological role of camouflage on coral reefs under current and future conditions

Predation is the major cause of mortality for most species on Earth so it is important to understand how predators and prey interact, how predation influences ecological communities, and how environmental changes impact predator-prey dynamics. Sensory environments of animals are changing due to human-induced disturbances including climate change. This could alter the ability of prey to learn, identify, detect, and respond to predation risk or reduce the effectiveness of mechanisms that mediate these interactions. Camouflage is one of the best-known mechanisms that species use to avoid predators or to capture prey.

Recent evidence suggests that camouflage likely plays a highly important role within coral reef ecosystems. For instance, many of the gaudy colour patterns of reef fishes are known to have an underlying cryptic function, and camouflage has been implicated in the colour patterns of both predators and prey. While the majority of camouflage research has examined visual mechanisms, non-visual senses also play a key role in predator-prey interactions and it appears that some coral reef animals have evolved non-visual camouflage. Rohan recently published the first evidence of chemical camouflage in a reef animal, discovering that the coral-feeding filefish chemically resembles the coral it feeds on. To a predator, the fish smells like a coral, not a fish.

Rohan's research at Lizard Island will use field and laboratory experiments to determine how some coral reef animals use both visual and non-visual camouflage, and how habitat degradation impacts camouflage-mediated predator-prey interactions.

Left Corals at Lizard Island's Cobia Hole are well on the way to recovery and the site attracts a huge variety of fishes.



Dr Darko Cotoras

2019 Lizard Island Reef Research Foundation Fellow, California Academy of Sciences

Exploring the arachnid diversity of the Lizard Island group, Great Barrier Reef (GBR)

Islands of the Great Barrier Reef are a complex system of terrestrial habitats that are understudied in comparison to their surrounding marine environment. The complexity is due to the different geological histories, ages, sizes, disturbance histories, and degrees of isolation of these islands and is likely reflected in their faunas.

The spider fauna is a key and understudied component of the biodiversity of islands on the GBR. Arachnids are a diverse group with almost 100,000 described species worldwide and many more to be discovered. These animals have a double role as predators and prey in ecosystems. They are among the first colonizers on islands and are well known for their high degree of endemism on islands.

Darko has conducted field research on spiders in many parts of the world. He will spend a month at LIRS in 2019 undertaking collections of spiders at Lizard Island and on neighbouring islands. Initial sample processing will be done at LIRS and detailed sorting and identification will be carried out at the Australian Museum.

Darko plans to eventually sample spiders from other GBR islands, especially from islands on the southern and central sections of the Reef. In addition to publishing his results in the scientific literature he will also contribute to the Lizard Island Field Guide.

Opposite The diversity of life on coral reefs is astounding. Left to right and top to bottom: a pair of nudibranchs, *Phyllidia elegans*; encrusting coral; sea fan detail; a variety of soft corals and feather stars; extensive tract of the coral *Heliopora coerulea*.

COTS Control Grants

Outbreaks of coral-eating Crown-of-Thorns Starfish (COTS) cause massive loss of coral cover in many locations, including the Great Barrier Reef. Given the numerous challenges facing coral reefs, managing predation by COTS is one step we can take to help protect corals. An Ian Potter Foundation 50th Anniversary Commemorative Grant was awarded to the LIRRF in 2014 to help find ways to do that.

Eighteen grants have been awarded to investigate the following major topics involving COTS: 1) larval behaviour, 2) behaviour of juveniles and adults, 3) control by injection, 4) control by predators, and 5) development of early warning systems. Research undertaken in 2018 and funded for 2019 includes:

- 2018 Maria Byrne (University of Sydney) and Jonathan Allen (College of William & Mary, USA)**
Assessing the causes and prevalence of cloning in larval Crown-of-Thorns Seastars: implications for estimating and modelling dispersal potential
- 2018 Frederieke Kroon (Australian Institute of Marine Science)**
Informing COTS control through understanding COTS predation pressure by fish and fisheries species
- 2018 Maria Byrne (University of Sydney) and Karen Chan (Hong Kong University of Science and Technology)**
Swimming behaviours of larval Crown-of-Thorns-Seastars: implications for distribution and dispersal modelling
- 2019 Jennifer Wilmes (ARC Centre of Excellence for Coral Reef Studies, James Cook University)**
Temporal and spatial variation in settlement and post-settlement survivorship of *Acanthaster cf. solaris*
- 2019 Vanessa Messmer (ARC Centre of Excellence for Coral Reef Studies, James Cook University)**
Early detection of Crown-of-Thorns starfish recruitment using settlement traps and genetic analyses
- 2019 Jason Doyle (Australian Institute of Marine Science)**
Further develop COTS environmental DNA (eDNA) tools with a view to operationalizing as part of an early-warning system
- 2019 Morgan Pratchett and Andrew Hoey (ARC Centre of Excellence for Coral Reef Studies, James Cook University)**
Distribution, abundance and reproductive behaviour of non-outbreak populations of *Acanthaster cf. solaris*



Lizard Island Reef Research Foundation

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The late Sir John Proud

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 Dr Des Griffin AM
 Mr Raymond Kirby AO
 Mrs Jacqueline Loomis
 The Ian Potter Foundation
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 Mrs Greer Banyer²
 Dr Penny Berents
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 Ms Belinda Gibson¹
 Dr Ronnie Harding¹

Mr Chris Joscelyne
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 Mr Graham Sherry OAM
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¹ Resigned in 2018

² New Trustee in 2018

SCIENCE COMMITTEE

Dr Penny Berents (Chair)
 Mr Charlie Shuetrim AM
 Dr Rebecca Johnson
 Dr Lyle Vail AM
 Dr Anne Hoggett AM
 Prof Lynne Madden

We thank Australian Museum staff Dr Shane Ahyong and Dr Mandy Reid who act as Dr Rebecca Johnson's delegates on the fellowships selection committee.

The Lizard Island Reef Research Foundation is an independent trust established in 1978 to conduct and support scientific research at LIRS and elsewhere on the Great Barrier Reef.

Go to lirrf.org for information about the Foundation and the research it supports and to make a donation to its worthy causes. All donations of \$2 or more are tax deductible in Australia.

Members donate \$1,000 or more in a 12 month period and Friends give a lower amount. Life Members donate at least \$100,000 which may be spread over several years. Our wonderful Members in 2018 are listed on page 24.

40th Anniversary

The LIRRF celebrated 40 years of supporting coral reef research in 2018. In that period, it has raised \$11.3 million for that purpose, most of it in the last 15 years. This includes \$5 million for the 30th Anniversary Development Program which completely revitalised all LIRS infrastructure between 2005 and 2011. The fellowships and grants program started in 1984 with a single fellowship per year. Now it provides seven or more new fellowships every year and produces a substantial body of research. To date, this program has supported 70 doctoral fellowships worth \$952,746 and 57 post-doctoral research grants worth \$919,545.

By enabling LIRS to provide excellent facilities for science and education, and by supporting research directly through the fellowships and grants program, the LIRRF has made an enormous contribution to coral reef research over the past 40 years. And it continues to do so thanks to many committed donors and a strong Board that is looking to the future.

Board changes

David Shannon stepped down from the Chair this year after six years in that position. The Foundation has gone from strength to strength under his leadership. Having taken over when LIRS had just completed a major physical upgrade, David's goals were to rejuvenate the donor base, expand direct funding for coral reef science, and to communicate the

Opposite New Chair of the Lizard Island Reef Research Foundation Kate Hayward with outgoing Chair David Shannon.

science better to a non-scientific audience. The fellowships and grants program burgeoned during his tenure and he initiated the Foundation's website, lirrf.org. We are grateful that David remains a trustee. He has taken on the unofficial role of Chief Explainer, writing engagingly and accessibly about LIRS research and sharing the wonder of coral reefs.

We warmly welcome Kate Hayward as the new Chair. Kate has been a trustee since 2016 but has been involved with the LIRRF for many years prior. Her mother, Alison Hayward, was a trustee for many years before retiring in 2006. Kate's business background coupled with her knowledge of the station's purpose and its requirements make her ideal for the role. We are extremely grateful that she took on this challenge and we look forward to working more closely with her.

Ronnie Harding and Belinda Gibson retired from the board this year after joining it in 2003 and 2013, respectively. We thank them both for their contributions and wise counsel.

New Trustees this year are Greer Banyer and Geoff Shuetrim. Greer has a degree in marine science and her involvement with LIRS goes back to 2000 when she spent months on the island assisting with research as a student. Now a government research and policy analyst, Greer brings substantial relevant experience to the LIRRF board. Geoff is an economist and nature lover who also has long involvement with LIRS and the LIRRF. Initially this was through his father, long-time trustee Charlie Shuetrim, and more recently as the inspired and talented developer of the Lizard Island Field Guide website and associated mobile applications. We welcome these engaged and active trustees to the board.

Projects and equipment funded by LIRRF in 2018

In the 2018 financial year, the LIRRF contributed a total of \$514,432:

- \$203,672 for research through its fellowships and grants program
- \$251,671 for capital equipment to support research at LIRS, including final payments for the John Gough Cyclone Shelter that was constructed in 2017
- \$59,089 for research operations

Events

The LIRRF held several events in Sydney and Melbourne for its friends, members and guests during the year.

On 10 April 2018 at the Australian Museum, we showed part of the ABC TV *Catalyst* documentary – *Can we save the Reef?* This was followed by a panel discussion involving scientists instrumental in making the documentary, Professor Emma Johnson AO and Associate Professor Jody Webster, with LIRS Director Dr Anne Hoggett AM. The venue was booked to capacity with over 120 people attending. The formal session was followed by informal discussion with light food and drinks in the Museum's fascinating *Wild Planet* area.



On the following evening, Mr Sam Hayward hosted a dinner for Members and guests at the Melbourne Club. The *Catalyst* excerpt was screened and this was followed with short talks by LIRS Director Dr Anne Hoggett AM and Professor Madeleine van Oppen whose research involving adaptation/acclimatisation by corals to climate change was featured in the documentary.

In December, Trustee James Kirby and Claire Wivell Plater generously hosted a special function at their lovely home in Sydney for Trustees and guests to thank outgoing Chair David Shannon for his excellent leadership in that role.

Lizard Island Resort

The luxurious Lizard Island Resort provides an exceptional base from which to experience the Great Barrier Reef. Owned and operated by Delaware North, the Resort is a long-term supporter of the Research Station and the Foundation. Members and Friends of the LIRRF can benefit from two generous Resort offers:

1. Win a three-night stay at the Resort for two people

Donors of \$100 or more in the financial year to 30 June 2019 will be included in a draw for this wonderful prize that includes return transfers by light aircraft from Cairns, accommodation, meals, beverages and more. Conditions apply – see lirrf.org.

2. A 20% discount for LIRRF Members at the Resort

Current LIRRF Members (i.e. those who have made a donation of \$1,000 or more in the last 12 months) qualify for a 20% discount on any stay of 3 or more nights at the Resort, except in the last week of October and in the Christmas-New Year period. See lirrf.org for information about making a booking.

Donations can be made through lirrf.org. All donations of \$2 or more are tax deductible in Australia.

When you are on the island, please be sure to visit the Research Station to see how your donation is being put to good use. For more information about the Resort, visit lizardisland.com.

For the record



Lizard Island Field Guide

More than 2,500 local species are now illustrated in the Lizard Island Field Guide. This includes about 700 of the 1500 known fish species in this area, 250 corals, 500 molluscs, 200 echinoderms, 100 birds and 200 land plants.

One would expect the rate of increase to slow now that most of the common and easily-identified species have been entered. Amazingly, growth has continued at the same high rate as last year, with one new species being added per day on average – and it shows no sign of slowing. Researchers and other island visitors are contributing increasing numbers of photos with relevant data, showing good public engagement with the project and its relevance to visiting scientists.

The online guide (<http://lifg.australianmuseum.net.au/Hierarchy.html>) is updated continuously and free mobile applications for both major platforms are updated about twice each year. Thanks to the LIRRF for providing the funds to maintain these sites, to Geoff Shuetrim and the Gaia Guide Association for developing them, to Marianne Pearce who has entered much of the background data, and to the many contributors. Anne Hoggett oversees the quality and development of content.

Above left Tiny reef fishes such as this goby, *Eviota melasma*, are important in coral reef food chains. **Above right** Green Turtles (*Chelonia mydas*) are common on the seagrass beds in front of LIRS.

Staff

Dr Lyle Vail AM and Dr Anne Hoggett AM completed 28 years as joint Directors in August 2018.

Marianne Dwyer and John Williamson completed their third year as maintenance staff in March 2018.

Snow Amos, Kerry Sackett and Bruce Stewart back-filled when Marianne and John were on leave. Renie Amos also helped enormously as a volunteer during that period.

Internships

The **undergraduate internship program** continued this year thanks to support from the Lizard Island Reef Research Foundation. Selected through a competitive process, Olivia Rose of Deakin University spent about a month at LIRS in early 2018. She had the opportunity to learn many technical skills and gain valuable experience by assisting with various research projects.

The **postgraduate student internship program** also continued. It provides extended access to field and aquarium facilities for PhD students who assist LIRS staff for 12 hours per week in lieu of bench fees for at least three months. Kelly Hannan of James Cook University was the postgraduate intern this year.

Volunteers

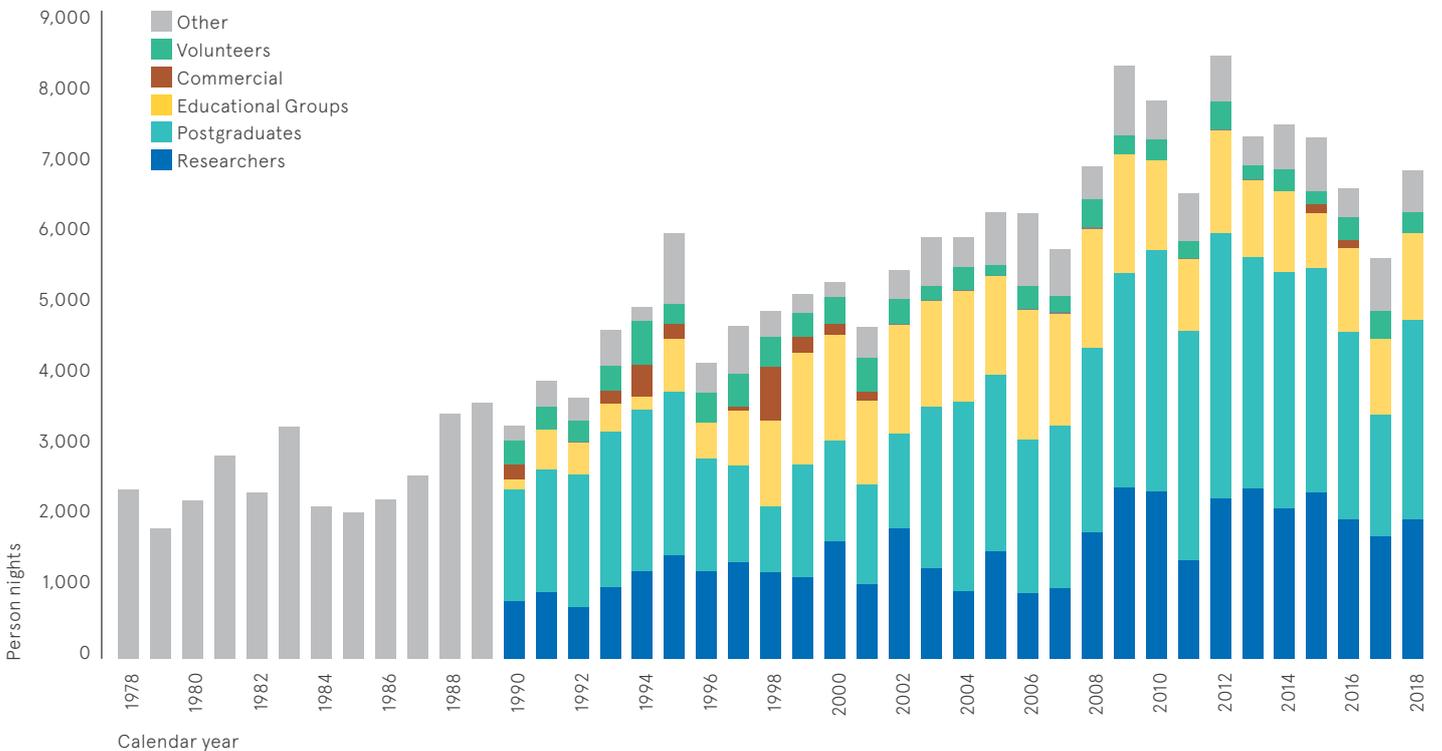
LIRS relies upon volunteers to help with its maintenance. Our special thanks and acknowledgement in 2018 to “regulars” Renie Amos, Lois Wilson, Terry Ford and Sue Lawrence, and to new volunteers Aimee Brownlow, Cassidy Drayton, Charlie Maling and Zohar Yannai.

Usage

Since attaining the current level of visitor housing in 2009, the optimum level of usage of LIRS is 7,000 person days per year. Usage suffered a marked decline from this level in 2016 and 2017. It is pleasing to see the return to near-optimal usage in 2018 (6,704 person nights).

Bench fees

Per person per night, Including GST	2018	2019
Researcher	\$145.00	\$148.50
Researcher’s assistant	\$129.00	\$132.00
Postgrad student (own project)	\$56.00	\$57.50
Postgrad’s assistant	\$51.00	\$52.50
School or university group	\$92.00	\$94.50
Media	\$217.50	\$223.00
Commercial	\$272.00	\$279.00



Visitors in 2018

Institutions

Australian

- 1 ARC Centre of Excellence for Coral Reef Studies
- 2 Australian National University
- 3 Curtin University
- 4 Griffith University
- 5 James Cook University
- 6 Macquarie University
- 7 Monash University
- 7a Queensland Museum
- 8 Queensland University of Technology
- 9 Southern Cross University
- 10 University of Adelaide
- 11 University of New England
- 12 University of Queensland
- 13 University of Sydney
- 14 University of Tasmania
- 15 University of Wollongong

International

- 16 Arkansas State University (USA)
- 17 California State University Northridge (USA)
- 18 Cambridge University (UK)
- 19 Carnegie Institution (USA)
- 20 College of William and Mary (USA)
- 21 Hong Kong University of Science and Technology
- 22 Monterey Bay Aquarium Research Institute (USA)
- 23 National Cheng Kung University Tainan (Taiwan)
- 24 School for International Training (USA)
- 25 Scripps Institution of Oceanography (USA)
- 26 Simon Fraser University (Canada)
- 27 Sussex University (UK)
- 28 Università Politecnica della Marche (Italy)
- 29 University of Auckland (NZ)
- 30 University of Bristol (UK)
- 31 University of Exeter (UK)
- 32 University of Hawaii (USA)
- 33 University of Neuchâtel (Switzerland)
- 34 University of Otago (NZ)
- 35 University of Oxford (UK)
- 36 University of Saskatchewan (Canada)
- 37 University of St Andrews (UK)

Scientists from 38 institutions in 9 countries conducted 98 research projects at Lizard Island in 2018 comprising 68 senior scientists or postdocs, 38 PhD candidates, 10 MSc candidates and 6 undergraduate research students. The researchers are listed here with their project titles and institutional affiliations.

Above Broadclub Cuttlefish, *Sepia latimanus*

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Senior scientists and postdocs

Bridie Allan³⁴, **Mark McCormick**^{1,5},
Maud Ferrari³⁶, **Doug Chivers**³⁶,
Gerrit Nanninga¹⁸

Impacts of microplastics on coral reef fish survival

Cassandra Thompson as field leader for Kristen Anderson^{1,5}

Recovery of coral growth rates and reef carbonate budget after severe bleaching events at Lizard Island

David Bellwood^{1,5}

Photographic assessment of fish-coral associations

Michael Bok³⁰

Unusual vision on the reef

Redouan Bshary³³

Cooperative and cognitive aspects of cleaning symbiosis

Redouan Bshary³³

Testing for the existence of general intelligence in cleaner wrasse

Theresa Burt de Perera³⁵

Video tracking of the navigational routes of *Rhinecanthus aculeatus*

Maria Byrne¹³, **Karen Chan**²¹, **Jonathan Allen**²⁰ and PhD student **Dione Deaker**¹⁵

Biology of Crown-of-Thorns Starfish larvae

Lucille Chapuis³¹, **Stephen Simpson**³¹

Effect of boat noise on vocalisation of *Pomacentrus ambionensis* and surrounding soundscape

Fabio Cortesi¹², **Justin Marshall**¹²

Triggerfish colour vision

Fabio Cortesi¹²

Visual ecology of anemonefish

Scott Cutmore¹²

Trematodes of Great Barrier Reef fishes

Tyler Cyronak²⁵, **Ken Caldeira**¹⁹,
Manoela Romano¹⁹, **Kennedy Wolfe**¹²,
Bradley Eyre⁹, **Yuichiro Takeshita**²²

Alyssa Griffin²⁵

Measuring reef metabolism using autosamplers on the reef flat

Jennifer Donelson^{1,5}

Behavioural thermoregulation of coral reef fish

Matthew Dunbabin⁸

AUVs for Crown-of-Thorns Starfish control program

Christopher Goatley¹¹, **Simon Brandl**²⁶

Ecology of small fishes on coral reefs

Miriam Henze¹²

Colour processing in stomatopods – how do stomatopods see colour?

Andrew Hoey^{1,5}

Differential resilience of coral- and macroalgae-dominated reefs

Andrew Hoey^{1,5}

Post-bleaching recovery of coral populations

Scott Ling¹⁴

Rates of herbivory and carnivory on reefs

Joshua Madin³², **Maria Dornelas**³⁷

Reefs through time

Justin Marshall¹², **Tsyrr Huei Chiou**²³

Stomatopod vision

Mark McCormick^{1,5}, **Maud Ferrari**³⁶,
Doug Chivers³⁶

The effect of habitat degradation on reef fish

Mark McCormick^{1,5}, **Jamie McWilliam**³

Effects of habitat on fishes' body conditions

Mark McCormick^{1,5}

Monitoring of fish and corals around Lizard Island

Sebastien Mouchet³¹

Animal perception of UV scattered by natural photonic structures

Sophie Nedelec³¹

Impacts of motorboat noise on coral reef fish reproduction and survival

Cait Newport³⁵

Video tracking of the navigational routes of *Rhinecanthus aculeatus*

Daniela Pica²⁸

Stylasterid corals at Lizard Island

Chiara Pisapia¹⁷, **Steve Doo**¹⁷,

Robert Carpenter¹⁷

Assessing recovery of Lizard Island reef community structure and function following multiple successive stress events

Megan Porter³²

Studies of unusual marine eyes – fan worms and mantis shrimp

Samuel Powell¹²

Measuring the underwater polarisation light field

Samuel Powell¹²

Using the underwater light field for navigation

Michael Rasheed⁵, **Paul York**⁵

Seagrass and herbivore interactions

Laura Richardson³¹

Assessing differential impacts and recovery of distinct coral habitats and associated fish assemblages to mass coral bleaching events

Michael Salter³¹, **Chris Perry**³¹

Short-term preservation potential of carbonate sediments produced by fish

Anna Scott⁹

Finding Nemo's personalities

Uli Siebeck¹²

Visual learning in reef fish

Paul Sikkel¹⁶, **Lexa Grutter**¹²,

Will Feeny¹²

The role of micropredators and cleaning behaviour in coral reef fish communities

Graham Taylor³⁵

Video tracking of the navigational routes of *Rhinecanthus aculeatus*

Gergely Torda^{1,5}

Population genomics of coral recovery at Lizard Island following the 2016 bleaching

Noa Truskanov³³

Social learning in the Bluestreak Cleaner Wrasse

Sean Ulm⁵, **Ian McNiven**⁷, **Robert Bultitude**⁵, **Ariana Lambrides**⁵,
Christian Reepmeyer⁵, **Matt Harris**⁵,
Brit Asmussen^{7a}, **Simon Haberle**²,
Feli Hopf², **Kelsey Lowe**¹² and **Laura Weyrich**¹⁰ with PhD students **Lauren Linnenlucke**⁵ and **Nathan Woolford**⁵,
terrain scanners **Chris Little**⁴ and **Benjamin Connolly**, historian **Billy Griffith** and filmmaker **Martin Potter**
Lizard Island Archaeological Project

Marian Wong¹⁵

Social structure of coral-dwelling gobies in response to climate change



Postgraduate research students

Melisande Aellen³³

Testing for the existence of general intelligence in cleaner wrasse (PhD)

Ellie Bergstrom⁴

Carbon physiological strategies of crustose coralline algae with potential for acclimation/adaptation to ocean acidification and warming (PhD)

Nader Boutros¹³

Spatial surveys of reef fish and their habitat (PhD)

Viviana Brambilla³⁷

Coral reefs and niche construction: quantifying patterns (PhD)

Katherine Chapman³⁰

The effect of short-term boat noise on egg care behaviours in *Pomacentrus amboinensis* (MSc)

Adam Downie^{1,5}

How do coral reef fish develop into athletes? (PhD)

Alexia Dubuc⁵

Impact of dissolved oxygen on fish assemblages (PhD)

Luisa Fontoura⁶

The structure of reef fish assemblage after severe coral bleaching on the Great Barrier Reef (PhD)

Kate Fraser¹⁴

Spatial and habitat variability in epifaunal assemblages (PhD)

Tim Gordon³¹

Acoustic preferences of settlement-stage fishes (PhD)

Alexia Graba-Landry^{1,5}

The effect of increasing temperature on fish-seaweed interactions on coral reefs (PhD)

Alyssa Griffin²⁵

CISME (Coral In Situ Metabolism) incubation of healthy and unhealthy corals (PhD)

Kelly Hannan^{1,5}

Physiological effects of elevated pCO₂ on fishes employing different swimming modes (PhD)

Oscar Hartman Davies³⁵

How does knowledge produced at LIRS inform a wider network of knowledge production about the reef and the environmental problems facing it? (Masters)

Siobhan Heatwole¹⁵

The evolution and variability of social behaviour in anemonefishes (PhD)

Maureen Ho⁴

Determining functional relationships of trait responses to temperature gradient on various macroalgal species in the Great Barrier Reef (PhD)

Victoria Hrebien⁹

Isoprene emission from tropical benthic habitats (seagrass and coral reef sediments) (PhD)

Victor Huertas^{1,5}

Trends in parrotfish predation on massive *Porites* (PhD)

Emily Husband³¹

Mapping and modelling changes in coral reef structural complexity (MSc)

Zoe Loffler⁵

Canopy-forming macroalgae on coral reefs: dynamics and herbivory (PhD)

Clarisse Louvard¹²

Life cycles of hemiuroids infecting pelagic fishes; taxonomy and systematics of the Bivesiculidae (PhD)

Caitlin Maling¹³

Fish song (poetry) (PhD)

Kieran McCloskey³¹

Effects of motorboat disturbance on dyadic relationships and nest defence against egg predation in *Pomacentrus amboinensis* (PhD)

Mardi McNeil⁸

Role of *Halimeda* algal bioherms in provision of benthic habitat (PhD)

Jamie McWilliam³

Mapping boat noise around Lizard Island (PhD)

Heather Middleton¹²

Pheromone utilisation by elasmobranchs (PhD)

Renato Morais Araujo^{1,5}

Habitat degradation effects on reef fish productivity (PhD)

Pauline Narvaez^{1,5}

Cleaner fish as vectors of parasitic disease (PhD)

Noora Nevala²⁷

Hyperspectral imaging underwater (PhD)

Georgina Nicholson²⁹ with supervisor Kendall Clements²⁹

Diet and bioerosion in Indo-Pacific parrotfishes (MSc)

Matthew Nicholson¹⁶

Ectoparasite consumption by diurnal non-cleaner coral reef fishes (PhD)

Simon Niklaus³³

Does punishment trigger fear conditioning in cleaner wrasse? (MSc)

Tessa Page⁴

The capacity for crustose coralline algae to acclimate to changing oceans (PhD)

Sophie Porta³³

Social learning in adult cleaner wrasses (MSc)

Vivien Rothenberger¹²

How the ability to see red influences food detection: visual ecology in damselfishes (MSc)

Marina Santana⁵

Assessing the ecological risks of plastic pollution to coral reef environment (PhD)

Virginie Staubli³³

Public information in the marine cleaning mutualism (MSc)

Amy Streets¹²

Neural connectivity in the stomatopod lamina (PhD)

Robert Streit^{1,5}

Heterogeneity of feeding by herbivorous fishes (PhD)

Sterling Tebbett⁵

Mediation of fish functions by sediment (PhD)

Valerio Tettamanti¹²

Seeing on the reef: the visual ecology of *Naso brevirostris* (MSc)

Damaris Torres-Pulliza⁶

Scaling up metrics of habitat complexity from coral colonies to space

Zegni Triki³³

Underlying neural mechanisms of cleaner wrasse sophisticated cognition (PhD)

Laura Velasquez^{1,5}

Effects of vessel noise on the behavior and physiology of reef fishes and their potential habituation (PhD)

Hong Vo¹²

Visual process in the lateral protocerebrum in the mantis shrimp (PhD)

Nicholas Wee¹²

Monorchids of Great Barrier Reef fishes (PhD)

Hannah Wolstenholme⁵

Habitat degradation and its influence on the life history of *Pomacentrus moluccensis* (MSc)

Rachael Woods⁶

Cyclone mapping project - coral recruitment on mapped sites (PhD)

Undergraduate research students

Olivia Antczak²⁴

Butterflyfishes on a degraded reef: species richness, abundance, recruitment and feeding behaviours at Lizard Island.

Danielle Barnes²⁴

Fish community structure surrounding *Pomacentrus amboinensis* nests with and without eggs

Alexander Carlson²⁴

The effects of seawater temperature on the photosynthetic ability of crustose coralline algae

Alea Laidlaw²⁴

Photosynthetic maxima of crustose coralline algae

Caroline Phelps²⁴

Growing pains: physiological and aerobic requirements of metamorphosis in coral reef fish

Haley Rivers²⁴

A comparison of the composition of juvenile and adult scleractinian coral populations after major disturbance at Lizard Island

Education groups

Australian Museum Members

Led by Penny Berents

Ascham School

Led by Ann Brownlee, Anthony Gilchrist and Reef Ecotours staff

Barker College

Led by Tim Binet, Sarah Cormio and Justin Varjavandi

Geelong College Preparatory School

Four groups led by Tim Colbert, Julie-Anne Hussey, Yannick Lairs, Lucy Pring, Benjamin Robbins, Marita Seaton, Ian Sheppard, Paula Wilson and Reef Ecotours staff

RMIT University

Led by Jeff Shimeta, Nathan Bott, and David Heathcote

School for International Training

Led by Tony Cummings, David Sellars and Vanessa Messmer

Other visitors

Australian Museum**AMRI**

Director Rebecca Johnson and staff Alexandra Nuttall

AM Trustees

Sara Watts and Shauna Jarrett with Greg Pearce and AM staff Jacinta Spurrett and Amanda Webster

AM staff recognition award winner

Laura McBride

Lizard Island Reef Research Foundation

Chair Kate Hayward with Trustees Greer Banyer, Chris Joscelyne, James Kirby and Lynne Madden, former Trustee Alison Hayward, and family members

Trustee Rob Purves with associates

Anna and Tony Le Deux

Undergraduate intern

Olivia Rose, Deakin University

Reconnaissance for future project

Alexander Fordyce, University of Newcastle

Media

ABC TV 7.30 Report, Peter Greste and crew

National Library

Gregg Borschmann

First aid training

Charlie Makray and Julie Armour

Australian Institute of Marine Science

GBROOS maintenance team

Contractors

Jammic Gas (replace appliances)
Bryant (cyclone shelter construction)

Opposite Students scoring coral colours for the CoralWatch program.

Publications



In 2018, 107 publications based on work carried out at LIRS were received into the collection as listed below. There are now more than 2,280 LIRS publications.

1. Abreu, M.S., J.P.M. Messias, A.C.V.V. Giacomini and M.C. Soares, 2018.

Estradiol shapes mutualistic behaviour of female cleaner fish (*Labroides dimidiatus* Valenciennes, 1839): potential implications of environmental disturbance. *Ecotoxicology and Environmental Safety*, 157: 244–248.

2. Alvarez-Campos, P., G. Giribet, G. San Martín, G.W. Rouse and A. Riesgo, 2017.

Straightening the striped chaos: systematics and evolution of *Trypanosyllis* and the case of its pseudocryptic type species *Trypanosyllis krohnii* (Annelida, Syllidae). *Zoological Journal of the Linnean Society*, 179: 492–540.

3. Álvarez-Campos, P., S. Taboada, G. San Martín, C. Leiva and A. Riesgo, 2018.

Phylogenetic relationships and evolution of reproductive modes within flattened syllids (Annelida: Syllidae) with the description of a new genus and six new species. *Invertebrate Systematics*, 32: 224–251.

4. Alvarez-Noriega, M., A.H. Baird, M. Dornelas, J.S. Madin and S.R. Connolly, 2018.

Negligible effect of competition on coral colony growth. *Ecology*, 99(6): 1347–1356.

5. Alvarez-Noriega, M., A.H. Baird, T.C.L. Bridge, M. Dornelas, L. Fontoura, O. Pizarro, K. Precoda, D. Torres-Pulliza, R.M. Woods, K. Zawada and J.S. Madin, 2018.

Contrasting patterns of changes in abundance following a bleaching event between juvenile and adult scleractinian corals. *Coral Reefs*, 37: 527–532.

6. An, J., M. Zhang and G. Paulay, 2018.

New records of *Tylokepon* with the description of a new species (Epicaridea, Bopyridae, Keponinae). *Zookeys*, 790: 77–85.

7. Baird, A.H., M. Álvarez-Noriega, V.R. Cumbo, S.R. Connolly, M. Dornelas and J.S. Madin, 2018.

Effects of tropical storms on the demography of reef corals. *Marine Ecology Progress Series*, 606: 29–38.

8. Barnett, L.J. and T.L. Miller, 2018.

Phenotypic plasticity of six unusual cercariae in nassariid gastropods and their relationships to the Acanthocolpidae and Brachycladiidae (Digenea). *Parasitology International*, 67: 225–232.

9. Bellwood, D.R., S.B. Tebbett, O. Bellwood, M. Mihalitsis, R.A. Morais, R.P. Streit and C.J. Fulton, 2017.

The role of the reef flat in coral reef trophodynamics: past, present, and future. *Ecology and Evolution*, 8: 4108–4119.

10. Binning, S.A., D.G. Roche, A.S. Grutter, S. Colosio, D. Sun, J. Miest and R. Bshary, 2018.

Cleaner wrasse indirectly affect the cognitive performance of a damselfish through ectoparasite removal. *Proceedings of the Royal Society B*, 285: 20172447.

11. Bok, M.J., N.W. Roberts and T.W. Cronin, 2018.

Behavioural evidence for polychromatic ultraviolet sensitivity in mantis shrimp. *Proceedings of the Royal Society B*, 285: 20181384.

12. Bostrom-Einarsson, L., M.C. Bonin, S. Moon and S. Firth, 2018.

Environmental impact monitoring of household vinegar-injections to cull crown-of-thorns starfish, *Acanthaster* spp. *Ocean and Coastal Management*, 155: 83–89.

13. Bray, R.A., S.C. Cutmore and T.H. Cribb, 2018.

Lepotrema Ozaki, 1932 (Lepocreadiidae: Digenea) from Indo-Pacific fishes, with the description of eight new species, characterised by morphometric and molecular features. *Systematic Parasitology*, 95: 693–741.

14. Carrier, T.J., K. Wolfe, K. Lopez, M. Gall, D.A. Janies, M. Byrne and A.M. Reitzel, 2018.

Diet-induced shifts in the crown-of-thorns (*Acanthaster* sp.) larval microbiome. *Marine Biology*, 165: 157–164.

15. Chase, T.J., M. S. Pratchett, G.E. Frank and M.O. Hoogenboom, 2018.

Coral-dwelling fish moderate bleaching susceptibility of coral hosts. *PLoS ONE* 13(12): e0208545.

16. Chase, T.J., J.P. Nowicki and D.J. Coker, 2018.

Diurnal foraging of a wild coral-reef fish *Paraperca australis* in relation to late-summer temperatures. *Journal of Fish Biology*, 93: 153–158.

17. Chegoonian, A.M., M. Mokhtarzade and M.J. Valadan Zoj, 2017.

A comprehensive evaluation of classification algorithms for coral reef habitat mapping: challenges related to quantity, quality, and impurity of training samples. *International Journal of Remote Sensing*, 38: 4224–4243.

18. Constant, J., 2018.

Revision of the Eurybrachidae XIV. The Australian genera *Olonia* Stål, 1862 and *Stalobrachys* gen. nov. (Hemiptera: Fulgoromorpha). *European Journal of Taxonomy*, 486: 1–97.

19. Cutmore, S.C., R.A. Bray and T.H. Cribb, 2018.

Two new species of *Bacciger* Nicoll, 1914 (Trematoda: Faustulidae) in species of *Herklotsichthys* Whitley (Clupeidae) from Queensland waters. *Systematic Parasitology*, 95: 645–654.

20. Daneliya, M., W.W. Price and R.W. Heard, 2018.

Revision of the *Siriella* brevicaudata species group (Crustacea: Mysida: Mysidae) from the West Indo-Pacific. *European Journal of Taxonomy*, 426: 1–80.

21. Doo, S.S., 2017.

Understanding the functional role of large benthic foraminifera on coral reefs in a changing climate. PhD thesis, University of Sydney.

Erratum: The opening paragraph of this section in the 2017 Report was unchanged from the year before. It should have stated: "In 2017, 125 publications based on work carried out at LIRS were received into the collection as listed below. There are now more than 2,175 LIRS publications."

Left Coral and damselfishes in the Lizard Island lagoon.



Left Reef crest corals are recovering after cyclones and bleaching. Bottom right Potato Cod (*Epinephelus tukula*) at Cod Hole, a world-famous dive site near Lizard Island.

- 22. Dornelas, M. J.S. Madin, A.H. Baird and S.R. Connolly, 2017.** Allometric growth in reef-building corals. *Proceedings of the Royal Society B*, 284: 20170053.
- 23. Ern, R., J.L. Johansen, J.L. Rummer and A.J. Esbaugh, 2017.** Effects of hypoxia and ocean acidification on the upper thermal niche boundaries of coral reef fishes. *Biology Letters*, 13: 20170135.
- 24. Erséus, C., I. Envall, P. De Wit and L.M. Gustavsson, 2017.** Molecular data reveal a tropical freshwater origin of Naidinae (Annelida, Clitellata, Naididae). *Molecular Phylogenetics and Evolution*, 115: 115-127.
- 25. Ferrari, M.C.O., M.I. McCormick, M.G. Meekan, S.D. Simpson, S.L. Nedelec and D.P. Chivers, 2018.** School is out on noisy reefs: the effect of boat noise on predator learning and survival of juvenile coral reef fishes. *Proceedings of the Royal Society B*, 285: 20180033.
- 26. Ferrari, M.C.O., M.I. McCormick, B.J.M. Allan, R.B. Choi, R.A. Ramasamy and D.P. Chivers, 2015.** The effects of background risk on behavioural lateralization in a coral reef fish. *Functional Ecology*, 29: 1553-1559.
- 27. Fitzpatrick, A., I.J. McNiven, J. Specht and S. Ulm, 2018.** Stylistic analysis of stone arrangements supports regional cultural interactions along the northern Great Barrier Reef, Queensland. *Australian Archaeology*, doi.org/10.1080/03122417.2018.1507807.
- 28. Gingsins, S., F. Marcadier, S. Wismer, O. Krattinger, F. Quattrini, R. Bshary and S.A. Binning, 2018.** The performance of cleaner wrasse, *Labroides dimidiatus*, in a reversal learning task varies across experimental paradigms. *PeerJ*, 6: e4745; DOI 10.7717/peerj.4745.
- 29. Goatley, C.H.R., S. Wroe, S.B. Tebbett and D.R. Bellwood, 2018.** An evaluation of a double-tailed deformity in a coral-reef surgeonfish *Acanthurus nigrofuscus* (Acanthuridae) using micro-computed tomography. *Journal of Fish Biology*, 92: 1645-1650.
- 30. Gordon, T.A.C., H.R. Harding, K.E. Wong, N.D. Merchant, M.G. Meekan, M.I. McCormick, A.N. Radford and S.D. Simpson, 2018.** Habitat degradation negatively affects auditory settlement behavior of coral reef fishes. *Proceedings of the National Academy of Science*, 115(20): 5193-5198.
- 31. Graham, N.A.J., S.K. Wilson, P. Carr, A.S. Hoey, S. Jennings and M.A. MacNeil, 2018.** Seabirds enhance coral reef productivity and functioning in the absence of invasive rats. *Nature*, 559: 250-253.
- 32. Green, N.F. H.H. Urquhart, C.P. van den Berg, N.J. Marshall and K.L. Cheney, 2018.** Pattern edges improve predator learning of aposematic signals. *Behavioral Ecology*, 29(6): 1481-1486.
- 33. Hallett, S.L., C. Erseus, P.J. O'Donoghue and R.J.G. Lester, 2001.** Parasite fauna of Australian marine oligochaetes. *Memoirs of the Queensland Museum*, 46(2): 555-576.
- 34. Hedley, T.D., C. Roelfsema, V. Brando, C. Giardino, T. Kutser, S. Phinn, P.J. Mumby, O. Barrilero, J. Laporte and B. Koetz, 2018.** Coral reef applications of Sentinel-2: Coverage, characteristics, bathymetry and benthic mapping with comparison to Landsat 8. *Remote Sensing of Environment*, 216: 598-614.
- 35. Hemingson, C.R. and D.R. Bellwood, 2018.** Biogeographic patterns in major marine realms: function not taxonomy unites fish assemblages in reef, seagrass and mangrove systems. *Ecography*, 41: 174-182.
- 36. Hempson, T.N., N.A.J. Graham, M.A. MacNeil, A.S. Hoey and G.R. Almany, 2018.** Mesopredator trophodynamics on thermally stressed coral reefs. *Coral Reefs*, 37: 135-144.
- 37. Hing, M.L., O.S. Klanten, M. Downton, K.R. Brown and M.Y.L. Wong, 2018.** Repeated cyclone events reveal potential causes of sociality in coral-dwelling *Gobiodon* fishes. *PLoS ONE* 13(9): e0202407.
- 38. Holmes, T., 2009.** Processes and mechanisms of predatory interactions on newly settled reef fish. PhD thesis, James Cook University.
- 39. Horká, I., S. De Grave, C.H.J.M. Fransen, A. Petrušek and Z. Duriš, 2018.** Multiple origins and strong phenotypic convergence in fish-cleaning palaemonid shrimp lineages. *Molecular Phylogenetics and Evolution*, 124: 71-81.

- 40. Huston, D.C., S.C. Cutmore and T.H. Cribb, 2018.** *Trigonocephalotrema* (Digenea: Haplosporididae), a new genus for trematodes parasitising fishes of two Indo-West Pacific acanthurid genera. *Invertebrate Systematics*, 32: 759–773.
- 41. Jain-Schlaepfer, S., E. Fakan, J.L. Rummer, S.D. Simpson and M.I. McCormick, 2018.** Impact of motorboats on fish embryos depends on engine type. *Conservation Physiology*, 6: 10.1093/conphys/coy014.
- 42. Jenkins, B.W., 2018.** Revision of the genus *Pugillaria* Iredale, 1924 (Mollusca: Panpulmonata: Siphonariidae). *Molluscan Research*, 38(4): 274–286.
- 43. Johansen, J.L., B.J.M. Allan, J.L. Rummer and A.J. Esbaugh, 2017.** Oil exposure disrupts early life-history stages of coral reef fishes via behavioural impairments. *Nature, Ecology and Evolution*, DOI: 10.1038/s41559-017-0232-5.
- 44. Komyakova, V., G.P. Jones and P.L. Munday, 2018.** Strong effects of coral species on the diversity and structure of reef fish communities: A multi-scale analysis. *PLoS ONE*, 13(8): e0202206.
- 45. Kroon, F.J., C.E. Motti, L.H. Jensen and K.L.E. Berry, 2018.** Classification of marine microdebris: A review and case study on fish from the Great Barrier Reef, Australia. *Scientific Reports*, 8: 16422.
- 46. Leck, C. and E.K. Biggs, 2008.** Comparison of sources and nature of the tropical aerosol with the summer high Arctic aerosol. *Tellus*, 60B: 118–126.
- 47. Löffler, Z., A. Graba-Landry, J.T. Kidgell, E.C. McClure, M.S. Pratchett and A.S. Hoey, 2018.** Holdfasts of *Sargassum swartzii* are resistant to herbivory and resilient to damage. *Coral Reefs*, 37: 1075–1084.
- 48. Lonnstedt, O., M.C.O. Ferrari and D.P. Chivers, 2018.** Correction to ‘Lionfish predators use flared fin displays to initiate cooperative hunting’. *Biology Letters*, 14: 20170716.
- 49. Madin, J.S., A.H. Baird, T.C.L. Bridge, S.R. Connolly, K.J.A. Zawada and M. Dornelas, 2018.** Cumulative effects of cyclones and bleaching on coral cover and species richness at Lizard Island. *Marine Ecology Progress Series*, 604: 263–268.
- 50. Martin, S.B., D. Ribu, S.C. Cutmore and T.H. Cribb, 2018.** *Opistholobetes* (Digenea: Opecoelidae) in Australian tetraodontiform fishes. *Systematic Parasitology*, 95: 743–781.
- 51. Martin, S.B., S.C. Cutmore and T.H. Cribb, 2018.** Revision of *Podocotyloides* Yamaguti, 1934 (Digenea: Opecoelidae), resurrection of *Pedunculacetabulum* Yamaguti, 1934 and the naming of a cryptic opecoelid species. *Systematic Parasitology*, 95: 1–31.
- 52. McCormick, M.I., B.J.M. Allan, H. and S.D. Simpson, 2018.** Boat noise impacts risk assessment in a coral reef fish but effects depend on engine type. *Scientific Reports*, 8: 3847.
- 53. McCormick, M.I., E. Fakan and B.J.M. Allan, 2018.** Behavioural measures determine survivorship within the hierarchy of whole-organism phenotypic traits. *Functional Ecology*, 32: 958–969.
- 54. McCormick, M.I., S.-A. Watson, S.D. Simpson and B.J.M. Allan, 2018.** Effect of elevated CO₂ and small boat noise on the kinematics of predator-prey interactions. *Proceedings of the Royal Society B*, 285: 20172650.
- 55. McWilliam, J.N., 2018.** Coral reef soundscapes: the use of passive acoustic monitoring for long-term ecological survey. PhD thesis, Curtin University.
- 56. Meekan, M.G., 1992.** The influence of pre- and post-settlement processes on the population dynamics of coral reef damselfishes. PhD thesis, Griffith University.
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