AUSTRALIAN MUSEUM
LIZARD ISLAND
RESEARCH STATION

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2016 Report

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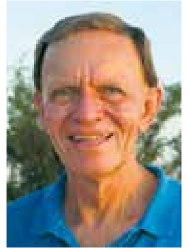
LIRS Directors
Dr Lyle Vail AM and Dr Anne Hoggett AM

Lizard Island Research Station
PMB 37
Cairns QLD 4892
Australia
t + 61 (0)7 4060 3977
e lizard@austmus.gov.au
australianmuseum.net.au/lizard-island-research-station

Australian Museum Research Institute
Dr Rebecca Johnson, Director
t + 61 (0)2 9320 6237
e Rebecca.Johnson@austmus.gov.au

Cover: Anemones bleach too. Clownfish *Amphiprion percula* among the bleached tentacles of anemone *Heteractis magnifica*.

WELCOME



Sir David Attenborough conducted some of his earliest scuba dives on coral reefs at Lizard Island in the 1950s. He visited again in 2014 to film *David Attenborough's Great Barrier Reef*. At the end of the series, he warns, "The Great Barrier Reef is in grave danger. The twin perils brought by climate change – an increase in the temperature of the ocean and in its acidity – threaten its very existence." His words were prescient.

Extensive coral bleaching in 2016 eclipsed the destruction caused by category 4 cyclones in each of 2014 and 2015. The cyclones stripped all but the most robust corals from the perimeter of the island group but large stands of delicate branching corals survived in the lagoon. By contrast, no area was protected from the bleaching. It killed corals down to at least 20 metres depth. The Lizard Island reefs now look very different to how they were only three years ago.

The bleaching at Lizard Island was part of a global event of unprecedented scale. On the Great Barrier Reef, the area most severely affected is the formerly-pristine northern third, where an average of 67% of shallow-water corals died according to a large-scale survey by the ARC Centre of Excellence for Coral Reef Studies. Lizard Island is in the most badly-hit area and we estimate that at least 90% of the iconic acroporid corals died. This report shows the event as it unfolded at Lizard Island.

Mass bleaching is caused by higher-than-normal water temperature that accumulates over time and it is directly attributable to global warming. Such events are likely to become more frequent in the future. There is much we can learn to predict future impacts and perhaps ameliorate them. LIRS researchers are taking advantage of the gigantic, system-wide upheaval to gain knowledge that could not be achieved experimentally on such a scale. All of next year's Fellowship awards have been directed to that purpose.

Lizard Island's reefs still have plenty of fish, turtles, giant clams and large colonies of some types of corals. And we are greatly heartened by the enormous number of tiny colonies of acroporid corals that survived the bleaching. They just need time and the right conditions to grow. We know what 'the right conditions' are – providing them is the stumbling block. It's not too late to halt and reverse the decline of coral reefs but time is running out.

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

This year the Australian Museum (AM) celebrates its 190th anniversary, while the AM's Lizard Island Research Station (LIRS) on the Great Barrier Reef celebrates 44 years of operation. That's an extraordinary achievement and each year has contributed significantly to our understanding of the biodiversity of the Reef and its environs.

During the past four decades, LIRS has provided the facilities for thousands of visiting scientists to undertake world-leading research into the Reef and its marine life, helping the world to better understand, manage and conserve one of Australia's treasured ecosystems.

When reflecting on the past year, it is hard to overlook the challenges that face the Great Barrier Reef today. In the summer months of early 2016, the coral around Lizard Island was impacted by a severe case of coral bleaching, caused by an increase to water temperature – an impact of climate change. This event in turn saw a reduction in the level of coral spawn seen later in the same year.

Despite this impact, the area around Lizard Island continues to be unique not only in its beauty, but also in its scientific significance. There is hope for recovery too – a number of tiny coral colonies (> 5 cm diameter) survived the bleaching, and they're growing fast. If they manage to survive for a few years, they'll eventually be able to spawn.

As always, our co-directors of LIRS, Anne Hogget and Lyle Vail, are to be commended for their continuing to work on the frontline of Reef science. They have supported visiting researchers in their work at LIRS, while continuing to monitor and report on the state of coral in the region. They have operated this important scientific outpost for 26 years, and we thank them for their continued dedicated and extraordinary service.

Of course, significant credit is also due to the Lizard Island Reef Research Foundation (LIRRF), led by David Shannon, for the ongoing investment in the operation of LIRS and the research conducted there.

The AM's LIRS has an increasing and critical role to play in the future of the Great Barrier Reef – now more than ever. Without the generosity and support of the LIRRF Trust and donors, the Station simply could not operate. Thank you to all those involved, our staff, volunteers, visiting researchers, donors and the LIRRF and AM Trust for their support.

Kim McKay AO,
Australian Museum Exectutive Director and CEO

2016 MASS BLEACHING

Unprecedented coral bleaching killed a huge proportion of corals in the northern Great Barrier Reef following elevated temperatures in early 2016. These pages show what happened at Lizard Island.

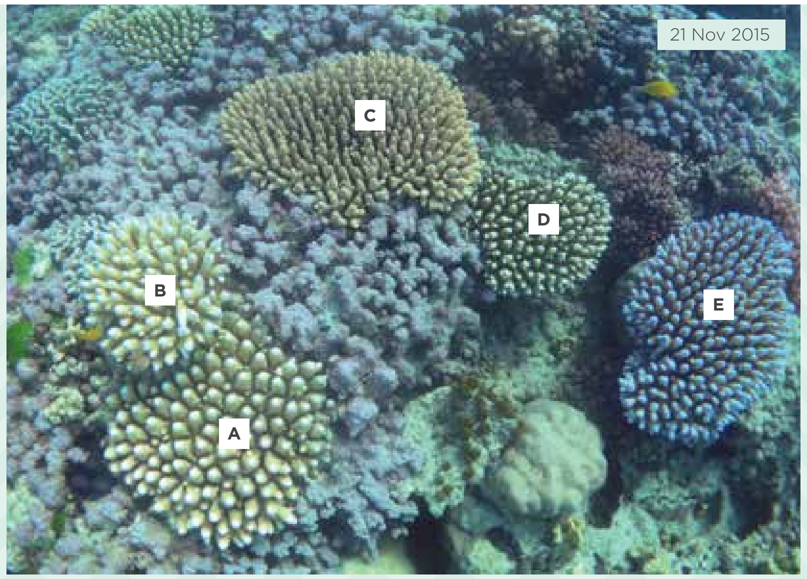
What is coral bleaching?

The coral animal, called a polyp, uses chemicals from seawater to build its characteristic skeleton. Coral skeletons *en masse* create coral reefs. Polyps need food to live and grow. They can capture food particles from the water with their tentacles but there is not enough food in clear coral reef waters to provide the energy needed to create reefs. Reef-building depends on a vital relationship between the coral animal and minute plant-like cells called zooxanthellae.

Zooxanthellae gain shelter by living within the bodies of the coral animals. There they photosynthesise, using sunlight to produce carbohydrates and oxygen. Corals rely on the food provided and in normal circumstances the extra oxygen is not a problem. But when environmental conditions stray from a narrow range, zooxanthellae produce too much highly reactive oxygen ('free radicals'). Corals have evolved to protect themselves from damage in such circumstances by ejecting zooxanthellae. This is termed 'bleaching' because zooxanthellae give corals much of their colour, and when the zooxanthellae are gone, you can see the white skeleton through the now-transparent living polyps.

Bleaching corals often go through a brief 'fluorescing' stage where they look very colourful before turning completely white. Why? A healthy coral is mostly brown with tinges of brighter colours. Zooxanthellae cause the brown colour; the corals themselves produce the pinks, blues and greens. These pigments act as sunscreens to protect the coral from too much light which would cause zooxanthellae to work overtime and produce too much oxygen. When zooxanthellae are expelled, the other colours appear more vibrant because they are not muted by the tiny brown particles. Making sunscreens takes a lot of energy and corals can't continue to do it for long when they're getting less food than usual with their zooxanthellae gone.

A bleached coral is still alive but it's sick and starving. If the environmental stress is removed, corals can regain zooxanthellae from seawater or from a few remnant cells in their bodies. In such cases, the corals will likely recover – although they won't grow as quickly or spawn as much that year as they would if they had not bleached. But if the environmental stress persists for too long, the coral will die and its skeleton will quickly be covered with algae.



These images show the same corals in the Lizard Island lagoon as they progress from healthy to dead due to bleaching. The five marked colonies are all *Acropora* species, which were the hardest hit by the bleaching event.

TOP LEFT: All colonies are healthy in late spring.

TOP RIGHT: By mid-February, colonies A and B are beginning to bleach. Colonies C, D and E are not yet bleaching.

ABOVE LEFT: A month later, colonies A and B are completely bleached but still alive. The other three are beginning to bleach. Colony E is fluorescing.

ABOVE RIGHT: Three weeks after that, colonies A and B have died and are covered in a thin layer of algae. Colonies C, D and E are completely bleached with colony E still fluorescing.

LEFT: By late April, all five colonies are dead. A and B are covered with a thicker layer of algae than the other three because they died earlier. Colony E has the least algae so it was probably the last to die.

OPPOSITE: A researcher photographs a coral that is still partly alive but bleached (white) and partly dead from the effects of bleaching (brown, covered with algae).

What causes mass coral bleaching?

On a local scale, corals can bleach in response to a range of adverse environmental conditions including warmer water, cooler water, freshwater input, exposure to air, and too much light. However, there is only one trigger for mass coral bleaching that occurs over a large geographic area: elevated sea temperature.

Mass coral bleaching is a very recent phenomenon. The first event on a global scale occurred in 1998 and other large-scale events have occurred since, including 2002 on the GBR and 2005 in the Caribbean. The 2016 event on the GBR is considered to be part of the third global event.

Mass bleaching can be predicted accurately from calculations of heat build-up in the oceans over time using satellite records of sea surface temperature. One degree above the long-term average sustained for one week is termed 1 degree heating week (DHW). Corals start to bleach at 4 DHW and mass bleaching occurs from 8 DHW. Mass coral bleaching is predicted to occur with increasing frequency as the oceans continue to warm due to the enhanced greenhouse effect of carbon dioxide in the atmosphere.

Will the Lizard Island reefs recover?

Coral reefs can recover from terrible damage remarkably quickly – as long as conditions are right. They need clean, clear water in the right temperature range. They also need healthy populations of animals that eat algae to keep their greatest competitor in check. Local actions can be taken to promote most of those things but global action is needed to rein in global warming.

Even after the devastation of the past few years at Lizard Island, the kernel of recovery is present: thousands of tiny colonies of many coral species survived. In the absence of more disasters, the reef will look much better than it does now within a few years because those colonies will have grown and others are likely to have settled. But will they have those years? The pace of global warming has not slowed and the frequency of bleaching is likely to increase.

ABOVE LEFT: Fluorescing and bleaching corals in the Lizard Island lagoon early in the bleaching event.

ABOVE RIGHT: Like corals, anemones and some other reef animals have zooxanthellae and they can bleach. This anemone is fluorescing before turning completely white.

LEFT: This bleached *Acropora* colony is still alive and providing habitat for juvenile reef fishes.

What does research tell us about the prospects?

Research over the past decade or so at LIRS has shown that degradation of corals has many knock-on effects. We know that living coral is important as habitat for many reef animals such as fishes, crabs and worms. They use live coral as food and for shelter, a base from which they can forage, reproduce and evade predators. This implies that without corals, this enormously diverse ecosystem would collapse and become something quite different. There are many unanswered questions. Research funded for 2017 through the Fellowships program – outlined in the next section – will address some of them.

LEFT, TOP TO BOTTOM:
Bleached and distintegrating soft corals at low tide in the Lizard Island lagoon.

Hard corals that died during the bleaching are covered with algae.

By winter 2016, soft corals were regenerating in some places from remnant pieces of much larger colonies that had disintegrated.

Many tiny hard coral colonies survived the bleaching and are growing fast.

ABOVE: Surviving corals can overgrow skeletons of dead ones.

BELOW: Filming the bleaching event in the Lizard Island lagoon.

FELLOWSHIPS

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 Research Foundation and its donors. All of this year's awards will be used to learn from the recent environmental disasters in the Lizard Island area.

Details of the conditions and selection criteria can be found in the Lizard Island Research Station section of the Australian Museum's web site. Applications close in August or September each year for funding that becomes available in March of the following year. Below can be found scientific and technical detail describing each of the projects funded by LIRRF in 2016 for work commencing in 2017

Damaris Torres-Pulliza
2017 Ian Potter Doctoral Fellow
Macquarie University

> Monitoring habitat complexity from space: a multi-scale approach for quantifying ecological change on coral reefs

Structural complexity is a feature of healthy reefs – think of enormous areas of branching and table corals. Degraded reefs are structurally flatter – think of reefs smashed by cyclones or where corals die through bleaching, disease or predation and then their skeletons break down. We need information about reef complexity to understand the ability of reefs to cope with such disturbances, but it is impractical to measure it directly at the required large scale. Remote sensing is the only way to do it effectively. Damaris will evaluate remote sensing data and techniques to quantify the structural complexity of coral reefs from space.

Through her research team, Damaris has access to detailed data of coral populations at 21 sites around the Lizard Island Group. The time series encompasses cyclones in 2014 and 2015 and the mass coral bleaching in 2016. She will continue six-monthly monitoring of these sites for two years. She will quantify fine-scale changes in structural complexity and species composition at particular sites. Damaris will also use multiple satellite imagery products to determine if structural complexity metrics measured locally can be effectively reproduced remotely at scales relevant to regional monitoring and management programs.

Alexia Graba-Landry
2017 Lizard Island Doctoral Fellow
ARC Centre of Excellence for Coral Reef Studies,
James Cook University

> Algae-fish interactions in a changing ocean

Environmental temperature governs the rates of biochemical and physiological processes in coral reef plants and animals. Sea temperature is increasing due to global warming and this will affect the performance, distribution, community composition, and predator/prey relationships of reef organisms. Many studies have investigated the effects of temperature on individual species. Alexia's will be one of few to consider how changing temperature will impact the interactions between predators and prey. She will focus on a crucial interaction on coral reefs: the consumption of algae by herbivorous fishes.

Herbivorous fishes have an important ecological role on coral reefs: controlling the potential overgrowth of corals by seaweed. How do rates of production and consumption of algae vary with current seasonal changes in temperature? How will predicted increases in sea temperature affect that? What will a change in the metabolism of individual species do to affect the outcome? Alexia will combine field and aquarium experiments to answer these questions.

Renato Morais Araujo
2017 Lizard Island Doctoral Fellow
James Cook University

> Cyclone damage and massive bleaching effects over reef fish productivity, biomass and assemblage composition

Reef fishes are affected by loss of stuctural complexity through disturbances such as cyclones and mass coral bleaching. Loss of coral can result in declines in the number of reef fish species, their genetic diversity, abundance and biomass. Its effect on fish productivity, however, remains understudied. Productivity is the rate at which fish produce biomass. Change in productivity might be more relevant than change in biomass to understand recovery from disturbances.

Renato will explore how reef damage caused by cyclones and mass coral bleaching between 2014 and 2016 have affected fish productivity and biomass. He will sample the same sites and habitats at Lizard Island as a published study that was conducted in 2003, prior to any recent major disturbance. This will show how fish biomass, productivity and species composition have changed in the last 14 years. He will determine how fish productivity varies between sites and characterise the effect of structural complexity in fish productivity from both living and dead substrate components. Ongoing changes in fish assemblages and structural complexity will also be documented, providing a detailed picture of the effects of disturbances on coral reef fishes and their capacity for recovery.

Dr Thomas DeCarlo
2017 John and Laurine Proud Postdoctoral Fellow
University of Western Australia

> Are corals acclimating to warming on the Great Barrier Reef? Reconstructing temperature and coral bleaching histories on Lizard Island

Warming sea temperatures are having devastating impacts on coral reefs. Even a small temperature increase – less than one degree – if sustained over weeks, can cause corals to die as was seen on a large scale on the Great Barrier Reef in 2016. Since the mid-20^{th} century, sea surface temperature (SST) has increased faster on the GBR than most other coral reefs. The trend is expected to continue, with climate simulations implying that bleaching will occur annually on the GBR by the end of this century.

However, there are few records of SST from the GBR prior to the 1960s. This makes it difficult to determine the sensitivity of GBR corals to historical ocean warming, a factor that is critically important in forecasting their response to 21^{st} century climate change. What is the threshold of thermal stress that has induced bleaching in the past, and has this threshold changed over time? Thomas aims to answer that question by producing a reconstruction of accurate SSTs and determining how corals have responded to past SST changes.

Like trees, corals produce annual bands that can be counted to reveal age of the organism. They can also record environmental changes, including temperature, but there are greater technical challenges to reading the coral record. New insights and technology developed by Thomas and colleagues enable that rich data source to be tapped. At Lizard Island, Thomas will take cores from colonies of the massive coral *Porites* that may be hundreds of years old. From these, he will reconstruct past temperature variability and correlate it with coral growth and bleaching events. Even mass bleaching events in the past should be distinguishable through anomalous high-density "stress bands" that have been shown to correlate with community-level bleaching. Crucially, he will also be able to test whether the threshold temperatures for bleaching and/or reduced growth rates are changing, and answer a critical question – are corals acclimating to rising SST?

FAR LEFT: The complex habitat of healthy coral reefs supports enormous diversity of life.

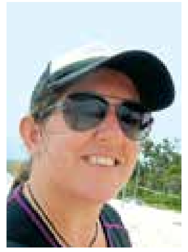
LEFT: Like trees, long-lived corals can provide a window on the past.

Dr Gergely Torda
2017 Yulgilbar Foundation Fellow
ARC Centre of Excellence for Coral Reef Studies and James Cook University

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

There are well-grounded concerns that the species composition of coral reefs is changing due to differential responses of corals to disturbances such as cyclones and mass bleaching. Future reefs may look and function very differently to current reefs. With major disturbances occurring with increasing frequency under climate change, a key question is: can corals adapt genetically or acclimatise via non-genetic mechanisms to recurring stressors?

We know little about the rate of adaptation in coral populations, hindering accurate predictions of the future composition of coral communities and the communities they support. The 2016 bleaching event caused huge death of corals in the northern third of the Great Barrier Reef and it provides an opportunity to determine rates of adaptation in corals. In collaboration with others, Greg will: analyse patterns of benthic community changes as a function of severe disturbances; assess rates of recruitment of coral species on reefs in the Lizard Island region; and explore genomic changes in populations of selected coral species before and after the major selection sweep caused by the 2016 bleaching event.



Dr Zoe Richards
2017 Lizard Island Reef Research Foundation Fellow
Curtin University

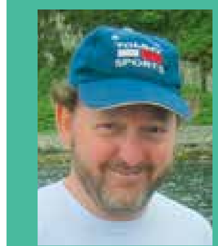
Dr Daniela Ceccarelli
2017 Isobel Bennett Marine Biology Fellow
Consultant, Magnetic Island, Qld

> Monitoring the effects of repeated disturbances on corals and fishes

Cyclones in 2014 and 2015 and severe coral bleaching in 2016 have taken their toll on the coral reefs around Lizard Island. Zoe, a coral taxonomist, and Dani, a fish researcher, have detailed data on coral and fish communities around Lizard Island from 2011, before these impacts. They were awarded 2015 Fellowships to resurvey the same sites after the first cyclone and they have been awarded 2017 Fellowships to do it again following the second cyclone and the bleaching event.

Their survey in 2015 found no significant overall reduction in the total density, biomass and species richness of reef fishes from 2011, but for individual fish families and fish species, these metrics changed in complex and unpredictable ways. This confirms the need for species-level analyses to capture the consequences of disturbance events on coral reefs. Comparison of 2011 and 2015 coral data has not been published yet. With the third survey planned for early 2017, this data set will provide a valuable baseline that will be useful for much future research at LIRS.

Profile of a former fellow



Dr Bryce Beukers-Stewart
Bryce is a marine ecologist and fisheries biologist whose work has ranged from temperate coasts to tropical coral reefs and the deep-sea. After completing his bachelor degree in Melbourne, Bryce did his PhD at James Cook University and was awarded the 1996 Lizard Island Doctoral Fellowship. At Lizard Island, he studied interactions between fish-eating fishes and their prey. Bryce is now a lecturer and researcher at the University of York, UK.

Throughout his career, the central thread of Bryce's research has been to gain an increased understanding of the factors regulating marine populations and communities so they can be utilised sustainably. His work on deep-sea fishes was among the first to demonstrate their extreme longevity, and his Lizard Island work provided new evidence for mechanisms of fish community regulation by predators. Since moving to the UK after his PhD, Bryce's focus has been on how to improve the management of fisheries through the use of predictive recruitment models, marine protected areas and stock enhancement. Most recently, he has been heavily involved with advising the UK government, fishing industry and seafood sector on how to ensure sustainable management of fisheries after the UK leaves the European Union.

COTS Control Grants

Crown-of-Thorns Starfish (COTS) occur naturally on coral reefs throughout the Indo-Pacific. The species is notorious. Adult COTS eat the living parts of corals and COTS populations are prone to boom and bust. This can result in extensive death of corals during outbreaks. With all the other challenges that reefs are facing – such as bleaching, sedimentation, overgrowth by algae, increased cyclone damage – managing COTS predation is a step we can take to protect corals. An Ian Potter Foundation Commemorative grant to the Lizard Island Reef Research Foundation is enabling research aimed at mitigating the effects of COTS outbreaks on corals and of preventing or minimising new ones.

Grants awarded so far:

2015 **Lisa Bostrom-Einarsson**[1]
Using a common household product to control COTS outbreaks

2015 **Maria Byrne**[9], **Jonathan Allen** (College of William and Mary, USA) and **Symon Dworjanyn**[6]
The lifespan and behavioural repertoire of COTS larvae, responses to haloclines, food patches, temperature and predator cues

2015 **Zara-Louise Cowan**[1,4]
Mechanisms of evading predation by early life-history stages of COTS

2015 **Vanessa Messmer**[1,4] and **Morgan Pratchett**[1,4]
The role of predation in controlling COTS: do overfishing and biodiversity loss exacerbate outbreaks?

2015 **Morgan Pratchett**[1,4] and **Ciemon Caballes**[1,4]
Key biological information for strategic control of COTS outbreaks: reproduction and dispersal

2016 **Morgan Pratchett**[1,4]
Fine-scale movement and diurnal changes in detectibility of COTS

2016 **Morgan Pratchett**[1,4] and **Vanessa Messmer**[1,4]
Settlement collectors as an early warning system for outbreaks of COTS

2016 **Sven Uthicke**[2]
Testing environmental DNA as a new monitoring tool for early detection of COTS outbreaks

The key to institutional affiliations is on page 15.

Results from two of the earliest projects have been published. They have discovered:

- Vinegar and citric acid effectively kill COTS when injected and there is no impact on other reef organisms. These cheap and readily-available chemicals make manual control of COTS an effective option in remote and developing nations for the first time (Publication 14).
- Damselfishes are effective predators of COTS larvae, despite the larvae containing unpalatable chemicals that were thought to protect them. Such predation may explain the low numbers of COTS on reefs that are not experiencing a COTS outbreak (Publication 24).
- COTS larvae can detect the presence of bottom-dwelling predators such as worms and crabs and will settle elsewhere if possible, and benthic predators can significantly reduce the number of COTS that settle successfully. This vulnerability points to the importance of benthic predators influencing patterns of settlement of COTS (Publication 25).

Other research completed in 2015 and 2016 is being prepared for publication. Additional grants for 2017 will be announced soon and another round will be available for 2018.

LIZARD ISLAND REEF RESEARCH FOUNDATION

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.

Projects and equipment funded by LIRRF in 2016

- The LIRS Fellowships and Grants programs as outlined in previous sections
- Developing plans for a cyclone shelter to be constructed in 2017
- Replacement of outboard motors
- Lizard Island Field Guide and associated mobile applications (page 12)
- Social media engagement through an intern based at the Australian Museum and the website lirrf.org, thanks to David and Daniela Shannon
- Satellite tags to record long-distance movements of marlin, thanks to the Teakle Foundation.

Board changes

Fiona Playfair retired from the Board this year after 10 years service. She played an especially important role in arranging the Annual Sydney Dinner for LIRRF Members and Friends.

We welcome Kate Hayward and James Kirby as new Trustees. Both have a long family history of involvement with LIRS and the LIRRF.

lirrf.org

The Foundation's website, lirrf.org, is the place to go to make a secure online donation, find out more about why it is important do so, and read posts on science and scientists funded through LIRRF. You can also subscribe to receive occasional email updates. Donors of $100 or more will be included in the draw to win a three-night stay at the Lizard Island Resort.

Chris Carbonaro, a LIRRF-funded intern based at the Australian Museum in 2016, made regular contributions to the site and publicised it on social media. That internship program is now complete.

Members and Friends

LIRRF Members donate $1000 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. Donations of $2 or more are tax deductible in Australia. Please see page 24 for this year's Members.

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 2017 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 three 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 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.

Events

The Foundation hosted three events for Members and guests during 2016 to thank them for their continuing support and to provide updates on the Reef and Lizard Island science .

19 April – David Attenborough's Great Barrier Reef Virtual Reality Dive Experience at the Australian Museum. A visit to the Reef with a scientist-guide is by far the best way of understanding why Lizard Island science is so vitally important. The GBR-VRD experience was truly the next best thing to actually being there.

11 May – Melbourne Dinner. The guest scientist was Dr Jodie Rummer. She presented her research on the athletic performance of fish and how it is likely to be affected by climate change and higher concentrations of carbon dioxide in sea water.

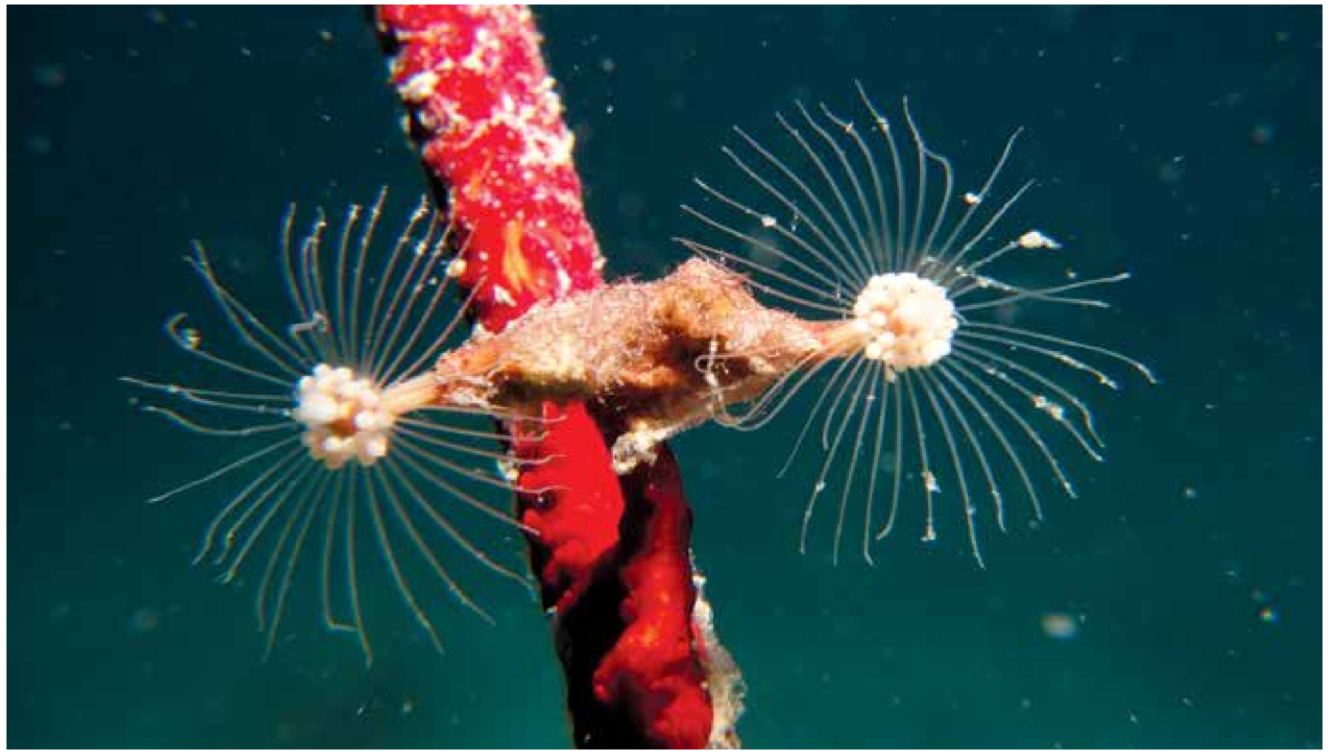
10 August – Sydney Dinner. Dr Rummer repeated her Melbourne presentation at this event, held in the Australian Museum's Wild Planet and Atrium areas. Guests also had the opportunity to see Janet Laurence's installation art – *Resuscitation for the Reef.*

LIRRF Visitors to LIRS

- David and Daniela Shannon
- Kate Hayward and Jonathon McKeown
- Heather Power
- Helen Wellings
- Wayne and Jane Peters and family
- Tom Healy (Ian Potter Foundation) and Jan Gill
- Rob Purves and Bronwyn Darlington
- Lynne Madden and Peter Sainsbury
- Bill and Annette Blinco
- Mike and Lou Hamshere

TOP LEFT: Light traps are used to catch larval fishes for many kinds of research. Here Dr Bridie Allan prepares traps for deployment.

TOP RIGHT: PhD student Emily Lester and assistant Ellen D'Cruz at work in the aquarium.



FOR THE RECORD

Lizard Island Field Guide (LIFG)

This online guide to the life of the Lizard Island area developed enormously during the year. It now includes more than 1,800 species with photographs, up from 1,280 at the end of 2015, and the total number of species known from the area has grown from about 6,500 to almost 6,800.

The Guide is a collaborative effort. Financial support is provided by the LIRRF and a grant from the Ian Potter Foundation. Geoff Shuetrim (Gaia Guide Association) develops and maintains the three platforms; Anne Hoggett (LIRS) oversees the quality and development of content; scientific experts provide or confirm identifications of photographed animals and plants; interested people contribute photos and observations; and LIRS interns, contractors and staff enter data, capturing records of species collected and observed by researchers on site and of subsequent published records.

The Guide is at lifg.australianmuseum.net.au and free mobile applications are available for Apple and Android platforms.

Staff

Lyle Vail and Anne Hoggett completed 26 years as joint Directors in August 2016.

Marianne Dwyer and John Williamson started their second year as maintenance staff in March 2016.

Former staff members Lance and Marianne Pearce and Bruce Stewart all returned during 2016 to assist when permanent staff were on leave. Kerry Sackett was also a temporary staff member during one of those periods.

Postgraduate Student Interns

Samantha Aird of James Cook University was the only intern during 2016, starting in September. She provided excellent support for LIRS staff while undertaking archaeological research for her PhD.

The internship program provides extended access to field and aquarium facilities for postgraduate students who assist LIRS staff for 12 hours each week for at least three months in lieu of bench fees. Interns must have a project that can be done effectively without an assistant. Interested postgraduate students who fit that profile are invited to contact LIRS at any time to discuss.

Volunteers

LIRS would not be the place it is without volunteers who help with maintenance. This year, we thank: Bella Blanche, Angela Brkic, Nikolas Eckert, Claudia Fraser, Claudia Glazener, Laura Hampton, Roger Kanitz, Sue Lawrence, Robin Lonsdale, Jo Moulton, Alisa Pietzker, Veronika Schyra, and Meryl Simpson.

Special thanks go to four people who have been volunteering every year for many years: Renie and Snow Amos, Lois Wilson and Terry Ford. We are also grateful to Charlie Makray (First Response Australia), who provides first aid training for all LIRS staff, tailored to our needs, on a voluntary basis each year.

OPPOSITE: Extraordinary reef life: two hydroid polyps growing on a wire coral.

ABOVE LEFT: Anemones and anemonefishes are common at Lizard Island.

ABOVE RIGHT: PhD student Sam Powell studies uses of polarised light underwater.

RIGHT: PhD student Alexia Graba-Landry running an experiment in the aquarium.

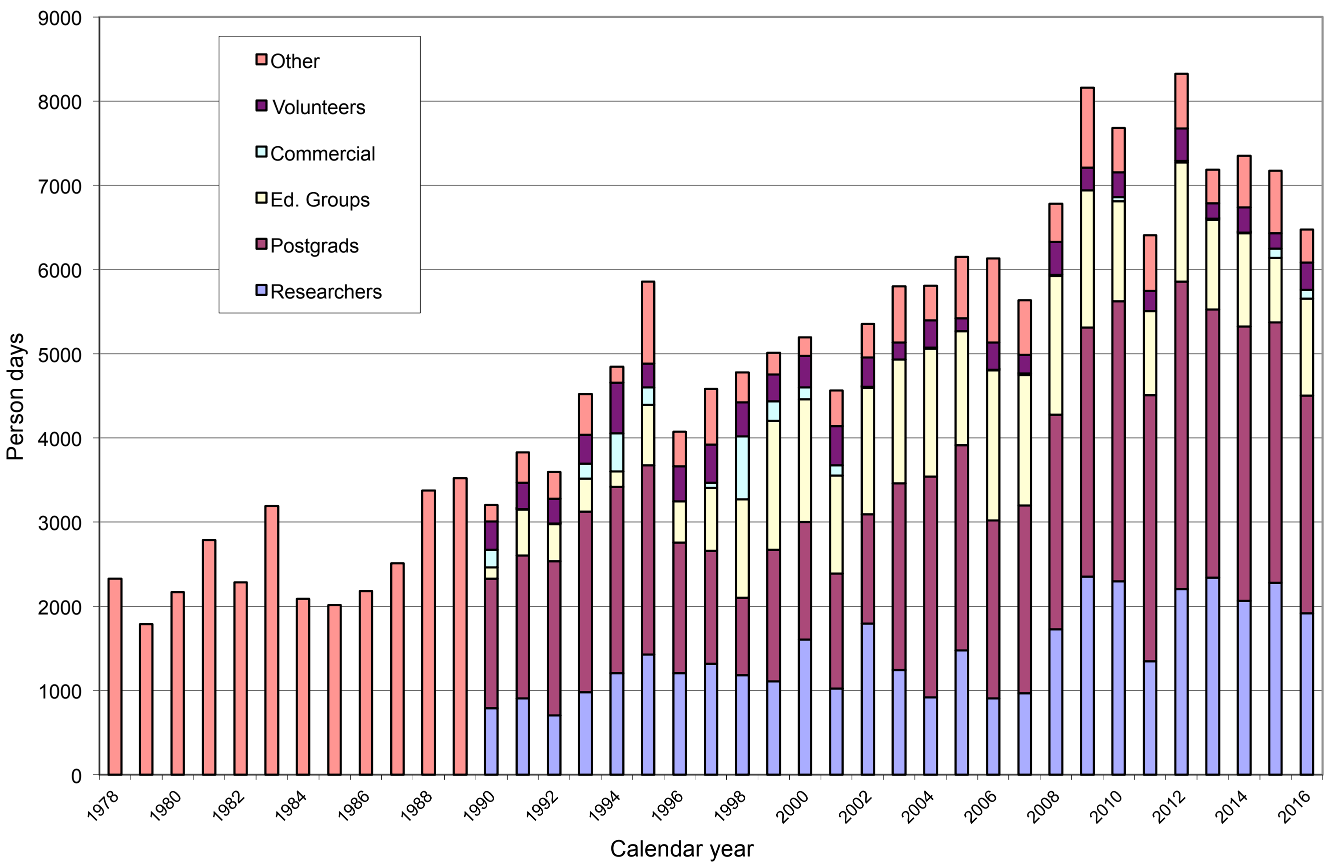
Bench Fees

Per person per night, including GST	2016	2017
Researcher	$139.00	$142.00
Researcher's assistant	$124.00	$126.50
Postgrad student (own project)	$54.00	$55.00
Postgrad's assistant	$49.00	$50.00
School or university group	$88.00	$90.00

Tours

LIRS welcomes island visitors to learn about the work of the Station by joining a tour. Resort guests can book tours through the Resort. Other island visitors can join a tour on Mondays at 10am between May and November. Even within that period, tours are not run every week so we advise people to contact LIRS to check. At other times, visitors are welcome to call into the Station to view the Sir John Proud Aquarium and courtyard displays but guided tours are not available.

Usage



VISITORS

Scientists from 38 institutions in 10 countries conducted 106 research projects at Lizard Island in 2016 comprising: 74 senior scientists or postdocs, 38 PhD candidates, 6 MSc candidates, 3 Honours candidates and 6 undergraduate research students. The researchers are listed here with their project titles and institutional affiliations.

Institutions

Australian

1. ARC Centre of Excellence for Coral Reef Studies
2. Australian Institute of Marine Science
3. Curtin University
4. James Cook University
5. Macquarie University
6. Southern Cross University
7. University of Hobart
8. University of Queensland
9. University of Sydney
10. University of Technology Sydney
11. University of Western Australia
12. University of Wollongong

International

13. Arkansas State University (USA)
14. Auckland University of Technology (NZ)
15. Bermuda Institute of Ocean Sciences (Bermuda)
16. Boston University (USA)
17. California State University Northridge (USA)
18. Cornell University (USA)
19. Lund University (Sweden)
20. Norwegian University of Science and Technology (Norway)
21. Queens University (Canada)
22. School for International Training (USA)
23. Uppsala University (Sweden)
24. University College London (UK)
25. University of Auckland (NZ)
26. University of Basel (Switzerland)
27. University of Bristol (UK)
28. University of Connecticut Avery Point (USA)
29. University of Exeter (UK)
30. University of Hawaii (USA)
31. University of Lisbon (Portugal)
32. University of Maryland Baltimore County (USA)
33. University of Massachusetts Boston (USA)
34. University of Neuchatel (Switzerland)
35. University of St Andrews (UK)
36. University of Oslo (Norway)
37. University of Victoria (Canada)
38. Washington University St Louis (USA)

Senior scientists and postdocs

Bridie Allan[4]
Impacts of bleaching on coral reef fish

Bridie Allan[4]
Alexandra Grutter[8]
Paul Sikkel[13]
Effect of parasite infection on escape performance of coral reef fish

Trond Amundsen[20]
Coral bleaching effect on fishes

Esther Angert[18]
Francine Arrago[18]
Ahmed Gaballa[18]
David Sannino[18]
Exploring circadian cycles in intestinal Firmicutes (Bacteria)

Sandra Binning[34]
Dominique Roche[34]
1) Cooperation, conflict and cognition in marine cleaning mutualisms
2) A comparison of direct vs indirect metabolic rate measurements in coral reef fishes

Michael Bok[19]
Megan Porter[30]
Maria Capa[20]
Looking with gills: the evolution and function of fan worm radiolar eyes

Katie Chartrand Miller[4]
Alysha Sozou[4]
Seagrass monitoring

Howard Choat[4]
Kendall Clements[25]
Lindsey White[14]
Paul Caiger[25]
Nutritional ecology of herbivorous fishes

Wen-Sung Chung[8]
Justin Marshall[8]
Colour vision and communication in the marine environment

Fabio Cortesi[8]
Karen Cheney[8]
Surgeonfish visual system and adaptation

Tom Cronin[32]
Chan Lin[32]
Neuroanatomy of stomatopod larvae

Fanny de Busserolles[8]
Karen Cheney[8]
Visual adaptations in coral reef fishes

Maria Dornelas[35]
Stefan Williams[9]
Mia Hoogenboom[1,4]
Automated underwater vehicle survey of Trimodal Reef, Lizard Island

Renata Ferrari Legorreta[9]
Will Figuera[9]
Quantification of reef 3D structure

Rebecca Fox[10]
Understanding the movements of marine fishes for management

Rebecca Fox[10]
Jennifer Donelson[1,4]
Exploring the nexus between physiology and behaviour in a warming world

Alexandra Grutter[8]
Ecology of gnathiid isopods on coral reefs

Eric Hochberg[15]
Robert Carpenter[17]
Yvonne Sawall[15]
Rodrigo Garcia[33]
Brandon Russell[28]
Chiara Pisapia[17]
Coral Reef Airborne Laboratory

Andrew Hoey[1,4]
1) Post-bleaching survival of corals
2) Northern GBR bleaching surveys

Sjannie Lefevre Nilsson[36]
Goran Nilsson[36]
Physiological responses to hypoxia of the Humpback Conch

Joshua Madin[5]
Biodiversity and habitat complexity consequences of physical disturbance

Joshua Madin[5]
Maria Dornelas[35]
Oscar Pizzaro[9]
Mia Hoogenboom[1,4]
Cyclone and bleaching coral recovery

Justin Marshall[8]
Miriam Henze[8]
Surgeonfish vision

Justin Marshall[8]
Hanne Thoen[8]
Triggerfish vision

Mark McCormick[1,4]
1) Long-term monitoring of fish communities
2) The effect of habitat degradation on reef fish
3) Influence of ship sound on fish assemblages

Phil Munday[1,4]
Sue-Ann Watson[1,4]
Behavioural effects of high CO_2 on fishes

Cathie Page as field leader for **Bette Willis**[1,4]
Ecological significance of coral disease on the Great Barrier Reef

Chiara Pisapia[4]
Does chronic partial mortality effect susceptibility to bleaching?

Megan Porter[30]
1) UV vision in stomatopods
2) Opsin expression patterns in larval stomatopods

Morgan Pratchett[1,4]
Andrew Hoey[1,4]
Reproductive behaviour of Crown-of-Thorns Starfish

Nichola Raihani[24]
Strategic behaviour in marine cleaning mutualism

Rui Rosa[31]
Trial by combat: intraspecific competition in an acidified ocean

Jodie Rummer[1,4]
Stress and physiological performance in coral reef fishes

Michael Salter[29]
Rod Wilson[29]
Intestinal carbonate production by fish

Uli Siebeck[8]
Visual learning and cognition in reef fish

Paul Sikkel[13]
Derek Sun[8]
Alexandra Grutter[8]
The role of micropredators and cleaning behaviour in coral reef fish communities

Stephen Simpson[29]
Impact of bleaching on Lizard Island soundscapes

Sara Stieb[8]
Vision in reef fish and stomatopods

Robert Streit as field leader for **David Bellwood**[1,4]
Photographic assessment of fish-coral associations

Luke Strotz[5]
Jane Williamson[5]
Michael Gillings[5]
Foraminifera diversity of the Great Barrier Reef

Derek Sun[8]
The role of parasites and cleaning behaviour in coral reef fish communities

Josefin Sundin[23]
Timothy Clark[7]
Ben Speers-Roche[8]
Dominique Roche[34]
Sandra Binning[34]
Effects of climate change on the physiology and behaviour of coral reef fishes

John Taylor[37]
Light sensitivity and camouflage in flounders

Gergely Torda[1,4]
1) Rapid adaptation to thermal stress in corals
2) Intracolonial phenotypic variability in corals

Sven Uthicke[2]
Testing eDNA as a new monitoring tool for early detection of Crown-of-Thorns Starfish outbreaks

Sue-Ann Watson[1,4]
Giant clam responses to the 2016 bleaching event

Marian Wong[12]
Peter Buston[16]
Social networks in fish societies: a new approach to quantifying patterns, causes and consequences of group dynamics

Postgraduate research students

Samantha Aird[4]
Long-term Aboriginal resource use on the Great Barrier Reef (PhD)

Randall Barry[4]
Effect of coral degradation on chemical alarm cue response in coral fishes (Hons)

Rebecca Branconi[16]
An investigation of social networks: a new approach to quantifying pattern, causes and consequences of group dynamics (PhD)

Tory Chase[1,4]
Dynamic coral mutualisms: A case study of the effects of coral-associated fish on coral health (PhD)

Peter David[5]
Quantifying damage to coral colonies by waterbourne debris during hydrodynamic disturbances (MSc)

Lorraine Delisle[34]
Understanding inter-individual variation in cooperation levels by the bluestreak cleaner wrasse, *Labroides dimidiatus* (MSc)

Jacob Eurich[1,4]
Territorial fish habitat use (PhD)

Tim Gordon[29]
The influence of bleaching on auditory preferences of coral reef fish (PhD)

Alexia Graba-Landry[1,4]
Algae-fish interactions in a changing ocean (PhD)

Naomi Green[8]
Contextual learning of complex colour patterns by Picasso Triggerfish (PhD)

Harry Harding[27]
Impacts of motorboat noise on coral reef fish (PhD)

Martin Hing[12]
Evolution of sociality in habitat-specialist coral reef fishes (PhD)

Daniel Huston[8]
Systematics and life cycles of digenetic trematodes infecting herbivorous marine fishes (PhD)

Sofia Jain-Schlaepfer[4]
Effect of vessel noise on coral reef fish (PhD)

Saskia Jurriaans[1,4]
Thermal performance of scleractinian corals (PhD)

Joanna Khan[4]
Shelter use and spatial ecology of large reef fishes: a telemetry study (Hons)

Emily Lester[11]
Fear in fish: quantifying risk effects behaviour in coral reef fish (PhD)

Elena Levorato[34]
Does brain size reflect cognitive abilities in cleaner wrasse? (MSc)

Zoe Loffler[1,4]
The effect of canopy-forming macroalgae on reef processes (PhD)

Emmanuel Marquez-Legorreta[8]
Visual learning in a changing world (PhD)

Storm Martin[8]
Taxonomy, host-specificity and biogeography of Trematoda: Opecoelidae (PhD)

Eva McClure[1,4]
Redundant or resilient: the impact of cyclones and bleaching on GBR marine reserves and herbivorous fish communities (PhD)

Ashly McMahon[6]
Groundwater nutrient dynamics: metabolism at Lizard Island, a 20-year perspective (PhD)

William McNeely[34]
Behavioural effects of gnathiid isopods ectoparasites on their fish hosts (MSc)

Jamie McWilliam[3]
The pulse of a coral reef: using acoustic survey as a tool for monitoring coral reef ecosystems in a changing climate (PhD)

Renato Morais Araujo[4]
Distribution and feeding behaviour of planktivorous fishes (PhD)

Pauline Narvaez[13]
Ecology of 'ticks of the sea' on coral reefs (PhD)

Michael Natt[4]
Reef degradation and its impacts on kleptoparasitism (MSc)

Tiffany Nay[1,4]
Thermal stress response in fish (PhD)

Maria del Mar Palacios[1,4]
Controlling mesopredators: importance of intraguild behavioural interactions in trophic cascades (PhD)

Jose Paula[31]
Mutual change: Bio-ecological responses of marine cleaning mutualisms to climate change (PhD)

Samuel Powell[38]
Using polarisation of background lighting for navigation (PhD)

Laura Richardson[1,4]
Herbivory and algal production post severe coral bleaching (PhD)

Marina Richardson[8]
Behaviour and abundance of a fish blood-sucking isopod before and after a coral bleaching event on the Great Barrier Reef (MSc)

Fabrizia Ronco[26]
Comparative visual evolution between Australian reef fishes and African cichlid fishes (PhD)

Molly Scott[1,4]
Behavioural thermoregulation in coral trout (PhD)

Robert Streit[4]
Spatial ecology in fish herbivory on coral reefs: movement ecology of large herbivores (PhD)

Sterling Tebbett[4]
Sediment mediated suppression of herbivory and detritivory on coral reefs (Hons)

Rachel Templin[8]
Polarisation vision in stomatopod crustaceans (PhD)

Damaris Torres-Pulliza[5]
A multi-scale approach for quantifying habitat complexity of coral reef from space (PhD)

Zegni Triki[34]
Linking cognition and brain physiology to marine cleaning mutualism (PhD)

Cedric Van Den Berg[8]
Colour pattern changes in benthic marine invertebrates (PhD)

David Vaughan[4]
Investigating unexplored ecological aspects of cleaner shrimps (PhD)

Megan Welch[4]
Sensitivity heritability under elevated CO_2 in a coral reef fish (PhD)

Rachael Woods[5]
Factors limiting coral larvae settlement in temperate waters (PhD)

Rob Yarlett[29]
Quantifying parrotfish carbonate cycling and predicting impacts of environmental change (PhD)

Russell Yong Qi Yung[8]
Aporocotylidae of tetraodontiform fishes (PhD)

Undergraduate research students

Malia Cedar[22]
A zooarchaeological study of *Tridacna maxima*: size comparisons of Holocene and modern populations at Lizard Island, Great Barrier Reef, Australia

Catherine Mitchell[21]
Effect of cleaner presence on algal farmer fish territory size, using 3D imagery

Caroline Rosinski[22]
Effect of ocean acidification on visual discrimination in reef fish

Elena Smith[22]
Macroalgal feeding selectivity of small herbivorous fishes and their functional role on the reef

Josh Temes[22]
Collection and analysis of marine rubbish on and around Lizard Island

Katy Wong[22]
Condition-dependent vulnerability to marine anthropogenic noise in damselfish

Dr Megan Porter collects stomatopods for her research.

Student groups

Ascham School
Led by Anne Brownlee, Nicola Freyne and Reef Ecotours staff

Barker College
Led by Tim Binet, Sarah Cormio and Scott Graham

Canberra Girls Grammar School
Led by Robyn Woinarski, Kylie Hughes and Reef Ecotours staff

Geelong College Preparatory School
Led by Benjamin Robbins, Marita Seaton and Reef Ecotours staff

RMIT University
Led by Jeff Shimeta, Gale Spring and Nathan Bott

School for International Training
Led by Tony Cummings, Vanessa Messmer and David Sellars

Other visitors

LIRRF
David and Daniela Shannon
Kate Hayward
Jonathon McKeown
Heather Power
Helen Wellings
Wayne and Jane Peters and family
Rob Purves and Bronwyn Darlington
Lynne Madden and Peter Sainsbury

The Ian Potter Foundation
Tom Healy and Jan Gill

ABC TV Catalyst
Mark Horstman and team

BBC Natural History Unit
Yoland Bosiger and team

BBC Science
Hywel Griffith and Matthew Leiper

Channel One (USA)
Keith Kocincsky and Anubhav Bhardwaj

Exposure Labs
Jeff Orlovsky and team

Independent documentary
Stafford and Isabelle Bettridge

Kyodo News
Iori Sagisawa and Yuichiro Inokuchi

The Ocean Agency
Christophe Bailhache and team

Photojournalism
Gary Braasch and Joan Rothlein

Artist
Laura Jones

Anthropocence art project
Emma Lindsay

Australian Institute of Marine Science – GBROOS
Scott Gardner and team

Great Barrier Reef Marine Park Authority
Julia Chandler

French Consul-General
Nicolas Croizer

PUBLICATIONS

In 2016, 102 publications based on work carried out at LIRS were received into the collection as listed below. There are now more than 2,050 LIRS publications.

1. Aguado, M.T., C. Grande, M. Gerth, C. Bleidornc and C. Noreña, 2016. Characterisation of the complete mitochondrial genomes from Polycladida (Platyhelminthes) using next-generation sequencing. *Gene, 575:* 199-205.

2. Ahmadian, R., I. Burghardt and U.L. Shepherd, 2016. Embryonic development of the solar-powered nudibranch *Phyllodesmium lizardensis* (Gastropoda: Nudibranchia). *Molluscan Research, 36(4):* 285-289.

3. Allan, B.J.M., 2015. The effects of climate change on predator-prey interactions in coral reef fish. PhD thesis, James Cook University.

4. Álvarez-Noriega, M., A.H. Baird, 2, M. Dornelas, J.S. Madin, V.R. Cumbo, and S.R. Connolly, 2016. Fecundity and the demographic strategies of coral morphologies. *Ecology, 97(12):* 3485-3493.

5. Babcock, R.C., D.A. Milton and M.S. Pratchett, 2016. Relationships between size and reproductive output in the Crown-of-Thorns Starfish. *Marine Biology, 163:* 234, doi 10.1007/s00227-016-3009-5.

6. Bellwood, D.R., C.H.R. Goatley, J.A. Khan and S.B. Tebbett, 2016. Site fidelity and homing in juvenile rabbitfishes (Siganidae). *Coral Reefs 35:* 1151-1155.

7. Binning, S.A. and D.G. Roche, 2015. Water flow and fin shape polymorphism in coral reef fishes. *Ecology, 96(3):* 828-839.

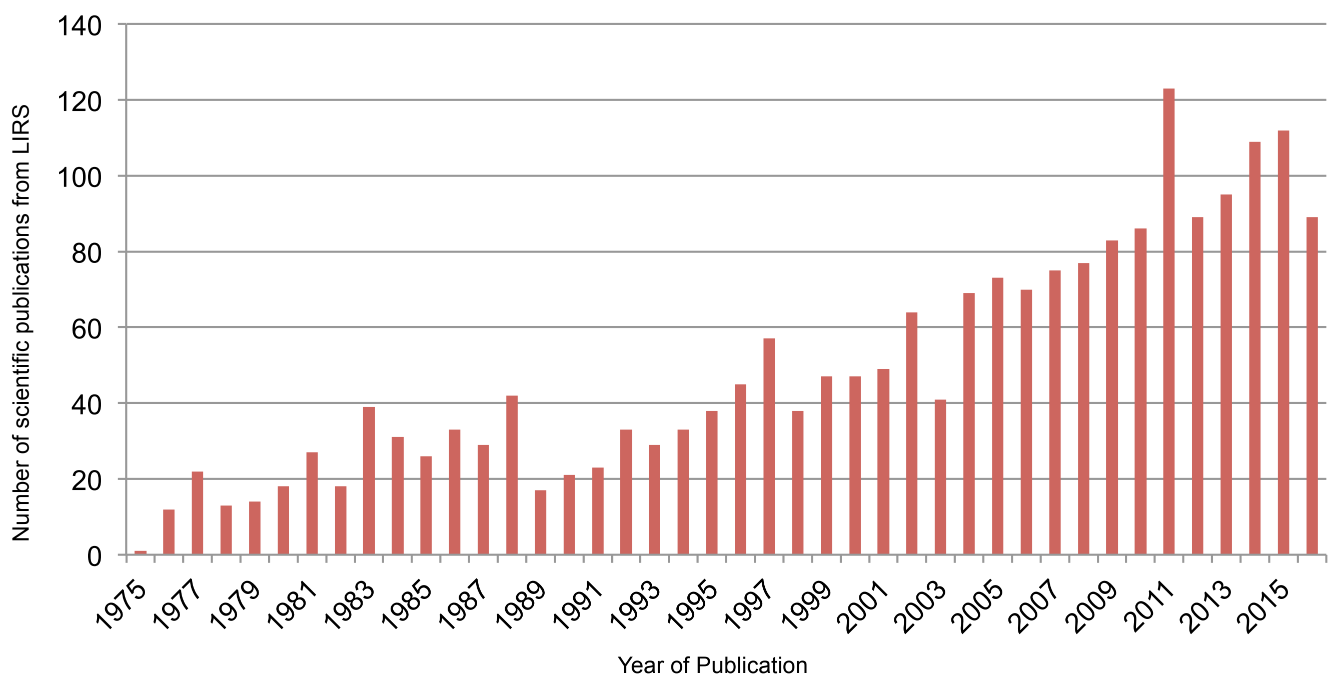
8. Bogdanov, A., C. Hertzer, S. Kehraus, S. Nietzer, S. Rohde, P.J. Schupp, H. Wägele and G.M. König, 2015. Defensive diterpene from the aeolidoidean *Phyllodesmium longicirrum. Journal of Natural Products, 79:* 611–615.

9. Bok, M.J., M. Capa and D.-E. Nilsson, 2016. Here, there and everywhere: the radiolar eyes of fan worms (Annelida, Sabellidae). *Integrative and Comparative Biology,* doi:10.1093/icb/icw089.

10. Brandl, S.J. and D.R. Bellwood, 2014. Individual-based analyses reveal limited functional overlap in a coral reef fish community. *Journal of Animal Ecology, 83:* 661-670.

11. Brandl, S.J. and D.R. Bellwood, 2016. Microtopographic refuges shape consumer-producer dynamics by mediating consumer functional diversity. *Oecologia, 182:* 203-217.

12. Brandl, S.J., M.J. Emslie and D.M. Ceccarelli, 2016. Habitat degradation increases functional originality in highly diverse coral reef fish assemblages. *Ecosphere, 7(11):* e01557.



The annual scientific output from LIRS continues to increase as shown above.
The apparent dip in 2016 is an artefact – papers published very late in 2016 are not yet in the LIRS collection.

13. Braun, C., R. Reef and U.E. Siebeck, 2016. Ultraviolet absorbing compounds provide a rapid response mechanism for UV protection in some reef fish. *Journal of Photochemistry and Photobiology B, 160:* 400-407.

14. Buck, A.C.E., N.M. Gardiner and L. Boström-Einarsson, 2016. Citric acid injections: an accessible and efficient method for controlling outbreaks of the Crown-of-Thorns Starfish, *Acanthaster cf. solaris. Diversity, 8:* 28, doi:10.3390/d8040028.

15. Capa, M. and A. Murray, 2016. Combined morphological and molecular data unveils relationships of *Pseudobranchiomma* (Sabellidae, Annelida) and reveals higher diversity of this intriguing group of fan worms in Australia, including potentially introduced species. *ZooKeys, 622: 1-36.*

16. Casey, J.M., A.H. Baird, S.J. Brandl, M.O. Hoogenboom, J.R. Rizzari, A.J. Frisch, C.E. Mirbach and S.R. Connolly, 2016. A test of trophic cascade theory: fish and benthic assemblages across a predator density gradient on coral reefs. *Oecologia,* doi 10.1007/s00442-016-3753-8.

17. Ceccarelli, D.M., M.J. Emslie and Z.T. Richards, 2016. Post-disturbance stability of fish assemblages measured at coarse taxonomic resolution masks change at finer scales. *PLOS One,* doi 10.1371/journal.pone.0156232.

18. Champ, C.M., M. Vorobyev and N.J. Marshall, 2016. Colour thresholds in a coral reef fish. *Royal Society Open Science, 3:* 160399.

19. Cheney, K.L., A. White, I.W. Mudianta, A.E. Winters, M. Quezada, R.J. Capon, E. Mollo and M.J. Garson, 2016. Choose your weaponry: selective storage of a single toxic compound, Latrunculin A, by closely related nudibranch molluscs. *PLoS One, 11(1):* e0145134.

20. Chivers D.P., M.I. McCormick, B.J.M. Allan and M.C.O. Ferrari, 2016. Risk assessment and predator learning in a changing world: understanding the impacts of coral reef degradation. *Scientific Reports, 6:* 32542.

21. Chivers, D.J., M.I. McCormick, B.J.M. Allan, M.D. Mitchell, E.J. Goncalves, R. Bryshun and M.C.O. Ferrari, 2016. At odds with the group: changes in lateralisation and escape performance reveal conformity and conflict in fish schools. *Proceedings of the Royal Society B, 283:* 20161127.

22. Clements, K.D., D.P. German, J. Piche, A. Tribollet and J.H. Choat, 2016. Integrating ecological roles and trophic diversification on coral reefs: multiple lines of evidence identify parrotfishes as microphages. *Biological Journal of the Linnean Society.*

23. Cortesi, F., Z. Musilová, S.M. Stieb, N.S. Hart, U.E. Siebeck, K.L. Cheney, W. Salzburger and N.J. Marshall, 2016. From crypsis to mimicry: changes in colour and the configuration of the visual system during ontogenetic habitat transitions in a coral reef fish. *Journal of Experimental Biology, 219:* 2545-2558.

24. Cowan, Z.-L., S.A. Dworjanyn, C. F. Caballes and M.S. Pratchett, 2016. Predation on Crown-of-Thorns Starfish larvae by damselfishes. *Coral Reefs,* DOI 10.1007/s00338-016-1491-3.

25. Cowan, Z.-L., S.A. Dworjanyn, C.F. Caballes and M. Pratchett, 2016. Benthic predators influence microhabitat preferences and settlement success of Crown-of-Thorns Starfish (*Acanthaster cf. solaris*). *Diversity, 8: 27*, doi:10.3390/d8040027.

26. Cutmore S.C., B.K. Diggles and T.H. Cribb, 2016. *Transversotrema* Witenberg, 1944 (Trematoda: Transversotrematidae) from inshore fishes of Australia: description of a new species and significant range extensions for three congeners. *Systematic Parasitology, 93:* 639-652.

27. Daly, I.M., M.J. How, J.C. Partridge, S.E. Temple, N.J. Marshall, T.W. Cronin and N.W. Roberts, 2016. Dynamic polarisation vision in mantis shrimps. *Nature Communications, 7:* 12140.

28. Diaz-Pulido, G., C. Cornwall, P. Gartrell, C. Hurd and D.V. Tran, 2016. Strategies of dissolved inorganic carbon use in macroalgae across a gradient of terrestrial influence: implications for the Great Barrier Reef in the context of ocean acidification. *Coral Reefs*, doi 10.1007/s00338-016-1481-5.

29. Dougherty, L., 2016. Flashing in the 'Disco' Clam *Ctenoides ales* (Finlay, 1927): mechanisms and behavioural function. PhD thesis, University of California Berkeley.

30. Feller, K.D. and T.W. Cronin, 2016. Spectral absorption of visual pigments in stomatopod larval photoreceptors. *Journal of Comparative Physiology A*, 202: 215-223.

31. Fitzpatrick, A., 2015. Stone arrangements in the Lizard Island Group: a study of indigenous seascapes in Northeastern Australia. Honours thesis, James Cook University.

32. Frisch, A.J., M. Ireland, J.R. Rizzari, O.M. Lonnstedt, K.A. Magnenat, C.E. Mirbach and J.-P.A. Hobbs, 2016. Reassessing the trophic role of reef sharks as apex predators on coral reefs. *Coral Reefs, 35:* 459-472.

33. Gagnon, Y.L., R.M. Templin, M.J. How and N.J. Marshall, 2015. Circularly polarised light as a communication signal in mantis shrimps. *Current Biology, 25:* 3074-3078.

34. Galassi, D.M.P., N.L. Bruce, B. Fiasca and M.-J. Dole-Olivier, 2016. A new family Lepidocharontidae with description of *Lepidocharon* gen. n., from the Great Barrier Reef, Australia, and redefinition of the Microparasellidae (Isopoda, Asellota). *ZooKeys, 594:* 11-50.

35. Gardiner, N.M., 2010. Habitat specialisation, niche overlap and site fidelity in a vulnerable family of coral reef fishes – the cardinalfish (Apogonidae). PhD thesis, James Cook University.

36. Geange, S.W., D.E. Poulos, A.C. Stier and M.I. McCormick, 2016. The relative influence of abundance and priority effects on colonisation success in a coral-reef fish. *Coral Reefs*, doi 10.1007/s00338-016-1503-3.

37. Gingins, S., 2016. What makes a cleaner a cleaner? PhD thesis, University of Neuchatel.

38. Gingins, S. and R. Bshary, 2016. The cleaner wrasse outperforms other labrids in ecologically relevant contexts, but not in spatial discrimination. *Animal Behaviour, 115:* 145-155.

Commensal shrimp *Periclimenes brevicarpalis* living with an anemone.

A Goldlined Sweetlips, *Plectorhinchus chrysotaenia*

39. Goatley, C.H.R., A. González-Cabello and D.R. Bellwood, 2016. Reef-scale partitioning of cryptobenthic fish assemblages across the Great Barrier Reef, Australia. *Marine Ecology Progress Series,* 544: 271–280.

40. Habary, A., J.L . Johansen, T.J. Nay, J.F. Steffensen and J.L. Rummer, 2016. Adapt, move or die – how will tropical coral reef fishes cope with ocean warming? *Global Change Biology,* doi 10.1111/gcb.13488.

41. Hall, A. and M. Kingsford, 2016. Predators exacerbate competitive interactions and dominance hierarchies between two coral reef fishes. *PLoS One,* doi 10.1371/journal.pone.0151778.

42. Hall, A.E. and T.D. Clark, 2016. Seeing is believing: metabolism provides insight into threat perception for a prey species of coral reef fish. *Animal Behaviour, 115:* 117-126.

43. Heuer, R.M., M.J. Welch, J.L. Rummer, P.L. Munday and M. Grosell, 2016. Altered brain ion gradients following compensation for elevated CO_2 are linked to behavioural alterations in a coral reef fish. *Scientific Reports, 6:* 33216.

44. Hoese, D.F. and Y. Obika, 1988. A new gobiid fish, *Fusigobius signipinnis*, from the western tropical Pacific. *Japanese Journal of Ichthyology, 35(3):* 282-288.

45. Horka, I, C.H.J.M. Fransen and Z. Duri, 2016. Two new species of shrimp of the Indo-West Pacific genus *Hamodactylus* Holthuis, 1952 (Crustacea: Decapoda: Palaemonidae). *European Journal of Taxonomy 188:* 1-26.

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The reefs cooked during calm, clear days in February 2016.

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