Lizard Island Research Station

Report 2022

AUSTRALIAN MUSEUM

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Lizard Island Research Station
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Published May 2023

Portait photographs on pages 1 and 6-11 were provided by the subjects. All other photographs by Lyle Vail or Anne Hoggett unless otherwise indicated.

Design and production:
Australian Museum Design Studio

Printed on 100% recycled paper

ISSN 0729-0942

Kim McKay AO
Director & CEO, Australian Museum

At the Australian Museum, our vision is to be a leading voice for the richness of life, the Earth and culture in Australia and the Pacific. We do this through our award-winning exhibitions and public programs and also through our world-leading science at the Australian Museum Research Institute, which includes the vital research about coral reefs happening at the Lizard Island Research Station (LIRS).

I hope you will be inspired by the 2022 report from LIRS co-directors Anne Hoggett and Lyle Vail in the pages to come. This year saw LIRS return to pre-COVID activity and the inaugural Lizard Island Coral Reef Study Tour, which was postponed several times due to COVID-19. Funded by the Lizard Island Reef Research Foundation (LIRRF), 13 specially selected students and two teachers from NSW were guided by marine scientists to learn about coral reefs and marine research. I look forward to seeing this program continue, helping inspire the next generation about the importance of protecting coral reefs.

At the AM, we're always thinking of ways we can promote awareness of the great work happening at LIRS. In 2022, the LIRRF held a dinner at the AM to highlight the important research being undertaken at LIRS, including a talk by Prof. Morgan Pratchett on the Crown-of-Thorns Starfish (CoTS) and steps to control these outbreaks and protect corals. In May, the AM hosts the 2023 Talbot Oration, which will feature a keynote address from LIRS co-director Anne Hoggett in recognition of the 50th anniversary of LIRS.

I would like to thank our dedicated LIRS co-directors Lyle Vail AM and Anne Hoggett AM for another year leading the great work on LIRS. I would also like to thank the Australian Museum Research Institute staff and the AM Trust for their continued support of the AM's LIRS. And a heart felt thank you to Professor Frank Talbot AM, a former Director of the Australian Museum, for having the vision to found LIRS 50 years ago.

Of course, none of the vital work on LIRS would be possible without the unwavering efforts to support the work of LIRS by the LIRRF, led by Chair Kate Hayward. In closing, a massive thank you to the donors who make LIRS' work to preserve our precious marine environments, and inspire the next generation, possible.

Kate Hayward
Chair, Lizard Island Reef Research Foundation

Coral reefs are such an important part of our ocean habitats. Understanding how they function, the life and biodiversity they support, and protecting it all, is becoming increasingly critical. Which is why we're happy to report that research activity and productivity at the Lizard Island Research Station resembled normal as the 2022 year closed.

In the pages that follow, Station co-directors Anne Hoggett and Lyle Vail detail the array of projects supported at the Station over the past 12 months. With borders open, over 75 different research projects were undertaken in 2022. It's inspiring to know that these projects were conducted by scientists from 34 institutions, from 6 different countries. Collaboration is important for scientific research and the benefits from having scientists interacting and sharing ideas in their workplace, *in situ* on the Great Barrier Reef, cannot be overstated. Other highlights for the year include the award of 8 new Fellowships for research to be started in 2023, ongoing field work for Critical Research Grants, the successful running of the first Coral Reef Study tour for NSW public school students and teachers, as well as ongoing maintenance and upgrade of Station facilities.

The Foundation supports all these projects. In the 2022 financial year, the LIRRF contributed over $370,000 in financial support, three quarters of which was directed to research, the remainder to maintaining Station facilities. Such support could not happen without the generosity of all our donors. Some families have supported the Foundation consistently since its founding, over four decades ago. We also have a growing base of new supporters. My fellow Trustees and I are exceptionally grateful to you all.

2023 will be a particularly notable year for the Station, marking the 50th year since its founding in 1973. We look forward to highlighting many of the achievements made over those 5 decades, including some of the important scientific work undertaken there, as well as focussing on how we can best support the Station in coming decades.

2022 in review

What a difference the lifting of COVID travel restrictions has made! Research and educational usage of LIRS roared back to pre-COVID levels soon after reliable travel became possible with the opening of the Queensland border in December 2021 and the Australian border in February 2022. After two years of dismal occupancy and a short lag-time while researchers made their travel arrangements, usage began to approach average monthly occupancy in April and May, and then far exceeded it for the rest of the year.

At the end of 2022, there is still a lot of pent-up demand from researchers and 2023 is already heavily booked. Numerous projects that had been planned for 2020 are now going ahead: some started in 2022 and others will start in 2023. Of course, PhD student projects can't cope with such delays and, sadly, several overseas students who intended to do their field work at LIRS had to make other plans.

The Lizard Island fellowships program has returned to normal and is again open to applicants worldwide. As outlined in this report, eight new fellowships and a new critical research grant were awarded this year.

The inaugural Lizard Island Coral Reef Study Tour finally took place in April 2022 after a pandemic-related delay of two years. Amazingly, 15 of the 18 people who were selected in 2019 for the fully funded trip were still able to participate this year. The trip was a great success (page 14) and it paves the way for future trips that will include paid and funded places, making the resources and opportunities available to a wide group of secondary students.

Reefs around Lizard Island bleached for the third year in a row in early 2022. Like the events in 2020 and 2021, it was widespread but did not proceed to large-scale death of corals because the weather changed before too much heat stress accumulated and most corals recovered. For the first time, this year, bleaching also occurred early in summer, during November and December 2022, due to unseasonal warm conditions. Fortunately, significant cooling conditions arrived in late 2022. Overall, the recovery of local reefs continues following the devastation caused by cyclones and mass coral bleaching in 2014-2017. Although the recovery of corals is patchy, the percentage of coral cover in many places is now very high.

Eighty scientific publications were added to the list of LIRS contributions during 2022, including 11 PhD theses. Growth of the online Lizard Island Field Guide (lifg.australianmuseum.net.au) slowed this year, probably because it now contains most of the common and easily photographed species in the area. It now includes photos, date/location data and other information for 3,410 species.

LIRS opened in 1973 and therefore celebrates its 50th anniversary in 2023. Beginning as a series of tents along the beach and a couple of modest buildings, it has developed into a world-class coral reef field station. To celebrate this significant milestone, the AM and LIRRF have numerous events planned in 2023. LIRS would not have achieved its world-renowned status without the generous support of the LIRRF and its donors.

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

Fellowships and grants

The Lizard Island fellowships and grants program provides funding for field-intensive research at LIRS. It is fully supported by the Lizard Island Reef Foundation (LIRRF) and its donors.

New fellowships are awarded each year to support broad categories of research by PhD students and recent postdocs. Grants are awarded periodically to support more tightly targeted research. The program is now back on track after major disruptions over the past two years due to COVID-19.

In 2022, we awarded four doctoral and four postdoctoral fellowships and one critical research grant. Donors who support specific awards are listed below. We sincerely thank them for their generous support.

- Lizard Island Reef Research Foundation members and friends
- The Ian Potter Foundation
- The Charles Warman Foundation
- The Gough Family
- The Hermon Slade Raiatea Foundation
- The Maple-Brown Family Foundation
- The estate of Sir John and Lady Proud
- The estate of Chris Joscelyne
- Ian Darling AO and Min Darling
- Sally White OAM
- The Raymond E. Purves Foundation
- The Sapphire Project

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

Fellowships

The scope of projects supported by Fellowships is intentionally broad to enable applicants to seek support for research within their areas of interest and existing commitments. They are highly competitive and produce excellent research while making an important contribution to research training.
The program is unique for its scope and longevity and for the rare support it offers for field work by early career scientists. Since the program's inception in 1984, the LIRRF has supported 122 Fellowships totalling about $1.5 million.

The value of our Fellowships will increase substantially from 2023 to reflect the growing requirement by Australian universities for diving by their scientists and students to take place in teams of at least three people. Until recently, it was common to dive at LIRS in two-person teams. The new requirement increases the cost of field work, and the new value of our Fellowships reflects that.

Eight new fellows will commence their field work in 2023: four PhD students and four recent post-docs. Outlines of their projects can be found on pages 6 – 11.

Grants

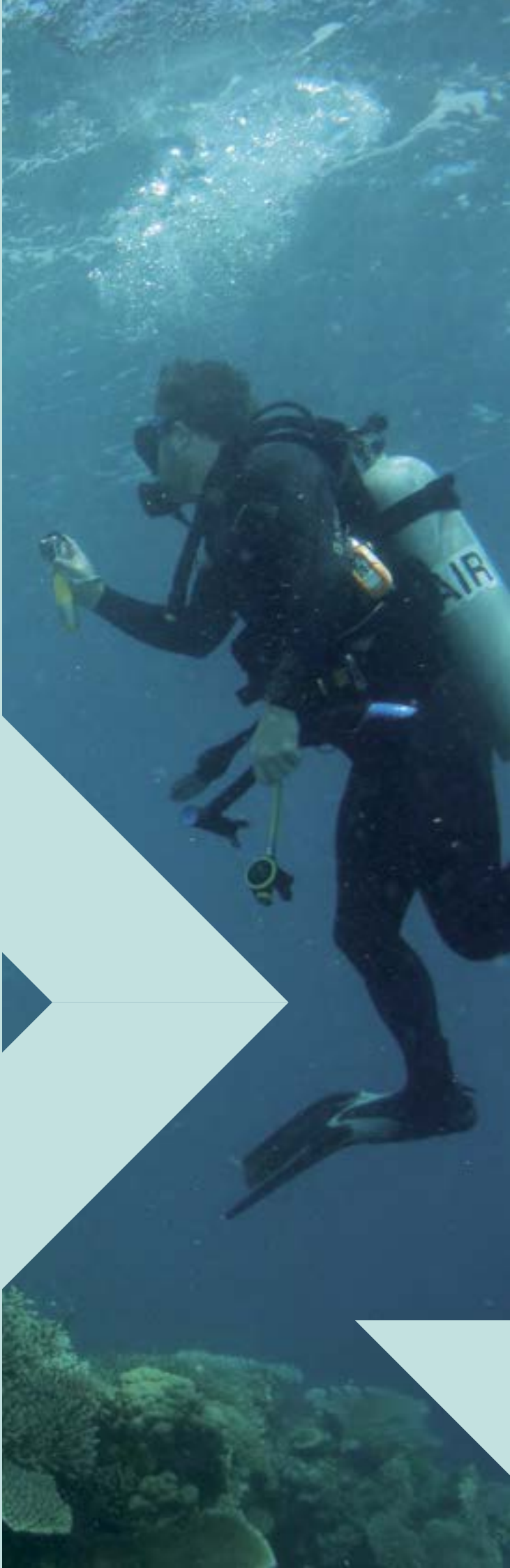
Since its establishment in 2012, the Lizard Island Grants program has supported research within several themes, including sustainable fishing, Crown-of-Thorns Starfish, and plastic pollution. Recently, the program has crystallised into a single theme with broad scope - critical research.

Critical Research Grants support coral reef research that is important on a broad scale and has a time-critical element. Unlike the fellowships program, grants are not limited to a particular research demographic - applicants can be at any level within the research community. They are offered irregularly depending on need and the funding available. These grants are supported by specific donors and the LIRRF generally. One new Critical Research Grant was awarded in 2022 for 2023 (page 11), supported by funding from Sally White, Ian and Min Darling and The Sapphire Project.

In 2022, field work was carried out for two Critical Research Grants awarded earlier:

Prof. Maria Dornelas (University of St. Andrews) and Assoc. Prof. Joshua Madin (University of Hawaii) were awarded the 2020 Critical Research Grant for a long-term study: *Understanding coral reef recovery from extreme disturbances using 3D maps*. This 3-year grant is funded by the Charles Warman Foundation. Due to the importance and demonstrated success of this long-term project, this year Maria was awarded a European Research Grant of €2 million to continue it. The EU funding will enable the team to continue to collect valuable comparative data at Lizard Island at a crucial time for coral reefs. The team is developing ecological theory using the Lizard Island dataset to both test predictions and inform theory development.

Prof. Andrew Baird (James Cook University), Dr Tom Bridge and Dr Peter Cowman (Museum of Tropical Queensland) and Assoc. Prof. Joshua Madin (University of Hawaii) were awarded the 2022 Critical Research Grant for the project: *Taxonomy of the reef-building corals at Lizard Island*. This grant is funded by Sally White and Ian and Min Darling. Coral taxonomy is in flux as molecular techniques are increasingly used to help distinguish species. It is important to gather specimens for molecular analysis now, at a time of massive change on coral reefs, while the current diversity of species exists. The team collected samples from hundreds of coral species at Lizard Island during 2022 and molecular analysis is currently underway. They will contribute to a worldwide reassessment of coral taxonomy.



Juan Carlos Azofeifa Solano

2023 Purves Foundation Doctoral Fellowship

Curtin University

Decoding coral reef soundscapes of Lizard Island

The use of reef soundscape is emerging as a means of studying and restoring coral reefs, with the advantage of it being non-invasive, cost-effective, and automatable. Coral reefs are noisy environments, and their "song" is comprised by a cacophony of sounds including waves, wind, fishes, snapping shrimps, and other marine species. Listening to the reef's song provides clues on population and ecological dynamics, and usually reflects the reef's conditions, as healthy reefs produce louder and more diverse sounds than degraded reefs. Recently, the playback of healthy reef songs is being used to enhance the attraction of fish and invertebrate larvae to appropriate habitats in coral reef restoration projects.

LIRS has a history of supporting soundscape research and Juan's research will add to this significant body of work. As part of his research, Juan plans to build a series of coral rubble patches in the middle of shallow sandy lagoons at Lizard Island where fishes' calls will be isolated from other reef noises enabling good-quality recordings of calls which can be linked to species and behaviours. He will explore the production of distress calls in reef fish that are in the presence of an artificial model predator. In addition, he will explore the sound production of planktivorous nocturnal and diurnal fishes around Lizard Island as they are abundant and major contributors to reef soundscapes. Results from his research will contribute to a better understanding of the significance of coral reef soundscapes.

Abigail Shaughnessy

2023 Gough Family Doctoral Fellowship

University of Queensland

Colour vision plasticity of coral reef fish in a changing world

The visual environment underwater is far more variable than on land. For instance, as one dives deeper, you will notice that colours such as red begin to disappear. Fish living on coral reefs experience frequent changes to their light environment as conditions change naturally over different seasons and depth, or due to human influences such as sediment run-off. With environmental disturbances increasing, it is important to understand the extent and limits of visual plasticity of fishes under natural and disturbed conditions.

Abigail's research will be the first of its kind to reveal in detail how the molecular plasticity of the visual system functions in coral reef fish. Specifically, her project aims to determine (1) the extent of plasticity in colour vision systems of some reef fishes when exposed to natural environmental changes i.e., seasons; (2) the limitations of their colour vision plasticity when experiencing anthropogenic changes i.e., high turbidity events; and (3) whether changes at a molecular level have a functional impact on the behavioural response of reef fishes.

Outcomes of this project will expand our understanding of the visual capabilities of coral reef fish and the specific strategies they have evolved to survive. Investigating short-term plasticity in reef fishes will provide insight into their adaptive scope and whether they may be able to mitigate the impacts of increasing environmental change. This knowledge can then inform management strategies, for example, reef restoration efforts may profit from taking the sensory ecology of its inhabitants into consideration.

Devynn Wulstein

2023 Lizard Island
Doctoral Fellowship

University of Hawaii, USA

Self thinning in coral assemblages as they recover from disturbance

Corals are susceptible to disturbances like thermal bleaching and cyclones that change the size structure of their populations. During recovery, population density and mean individual size increases. In terrestrial systems, a scaling-law relationship has been shown where population density decreases as mean individual size increases, termed "self-thinning." Self-thinning becomes prevalent as sessile organisms become more crowded, directly impacting the survival of individuals within the population. As disturbances are likely to become more frequent and severe, and active restoration approaches more common, understanding the dynamics between coral population density and mortality as communities recover becomes increasingly important for maintaining coral reef functions.

This project utilizes 21 long-term coral monitoring sites encircling Lizard Island that were established by Devynn's PhD supervisor Joshua Madin and his collaborator Maria Dornelas (page 5), and which have been tracked and annotated to species level each year since 2016. Devynn plans to investigate how competition between corals affects reef recovery dynamics. Competition between corals is only evident during periods of high coral cover or high population density where individuals are close enough to one another and resources become limited. Specifically, she will study the relationship between the average size of coral colonies and the number of colonies on the reefs (the self-thinning theory) and quantify the dynamics of pair-wise coral competition interactions to better define the succession and recovery stages of these 21 reefs. Results from her work will help inform future restoration efforts and increase our understanding of the dynamics that drive coral reef recovery.

Above: Example of competition between coral colonies showing scarring where the two colonies meet.

Casey Bowden

2023 Ian Potter Foundation Doctoral Fellowship

James Cook University

Water flow ecology: How reef structure and water flow shape the world of fishes

Water is the medium in which fishes move, feed, reproduce, and live their lives. Because it is all around them, it must play a critical role in shaping how fishes live. On coral reefs, we know that fishes are important for the health of the reef. But may we be overlooking a critical aspect of their interaction with their environment - water.

Most studies that measure water and its flow patterns, do so on global, continental, or regional scales; not at the fish-sized scale of metres to centimetres. However, it is these small on-reef scales that are relevant to fishes. Reefs are complex, jagged places. As such, water flow is constantly modified by the 3-dimensional shape of the reef. Therefore, it is critical to consider this complex shape and the flow of water together. How do they create the environment in which fishes live?

To understand how fishes use different flow conditions within their environment, we first need to understand what these conditions are and where they are likely to occur. Casey's research will study and measure how water flow is affected by the 3-dimensional structure of coral reefs. She will then use these results to assess if and how fish behaviour is influenced by the range of flow speeds in their habitat. Her research will gather three sets of data: fish behaviour, coral reef structure, and water flow at a fish-sized scale. This will provide a detailed view of how fishes use their whole environment including the medium in which they live, water.

Dr Alejandre Siqueria

2023 Chris Joscelyne Postdoctoral Fellowship

James Cook University

The evolution of a critical ecosystem function for the future of coral reefs

Coral reefs are highly productive ecosystems at the forefront of anthropogenic impacts. This productivity is underpinned by one of the major components of coral reef ecosystems: fishes. Modern coral-dominated reef systems are largely a product of the last 60 million years, when fishes and corals displayed marked functional changes. Among these changes, the rise of herbivorous fishes is arguably one of the most important in shaping modern-day productivity patterns. Specifically, herbivorous fishes play essential roles on coral reefs – mediating the competitive balance between corals and algae – and they act as key agents in ecosystem processes like sediment dynamics that are critical for reef recovery after disturbance.

Surgeonfishes (family Acanthuridae) have recently been demonstrated to play a central role in the removal of sediments on coral reefs. Degraded reefs are predicted to accumulate more sediments into the future, which may hinder their potential for natural recovery. Surgeonfishes may be one of the key fish groups needed for reef recovery through their enhanced capacity for removing sediments bound within algal turfs.

Alejandre's project will take advantage of the vast diversity of surgeonfish species that occur at Lizard Island. A main goal is to quantify the process of sediment removal and transportation across functional groups of surgeonfishes. This project will provide: 1) novel information about the functional roles of surgeonfishes on coral reefs, especially related to reef recovery; and 2) fundamental knowledge about surgeonfish evolution and ecosystem functions. By revealing the functions of surgeonfishes, this project will provide better insights into processes that shaped coral reefs over evolutionary time and it will contribute knowledge for understanding how they can best recover from impacts in the future.

Dr Amanda Pettersen

2023 John and Laurine Proud Fellowship

Sydney Institute of Marine Science

Investigating the metabolic ecology of Crown-of-Thorns Starfish larvae

Anthropogenic activity is causing unprecedented environmental change, and organisms are developing in environments which may be very different to those in which they evolved. The effects of warming waters and increased nutrient availability from major flood and runoff events are exposing organisms inhabiting coral reefs to novel selection pressures. One potential "winner" from this environmental change is the Crown-of-Thorns Starfish (CoTS), *Acanthaster* cf. *solaris*. This coral-eating sea star currently poses a significant threat to the resilience of coral reefs which are increasingly vulnerable to climate change impacts. A high proportion of recent coral loss is attributable to outbreaks of CoTS and irruptions in CoTS larvae have been linked to elevated nutrients while warmer temperatures are expected to increase developmental rates.

Despite increased knowledge of the distribution and abundance of adult CoTS, questions regarding the mechanisms by which temperature and food availability affect recruitment and survival remain to be addressed. Amanda's research will measure the relative rates of energy acquisition (feeding), energy expenditure (metabolism), and energy allocation towards fitness-enhancing processes of development and growth. Investigating the metabolic ecology of larval CoTS will improve our understanding of the interplay between food availability and temperature on their survival, and therefore the demography of CoTS in response to future environmental change. An understanding of the mechanisms by which larval stages of CoTS can grow and survive under environmental change will i) Identify potential vulnerabilities to target, and ii) predict future abundance and distribution of CoTS on coral reefs under different management strategies.

Dr Michelle Achlatis

2023 Maple-Brown Family Foundation Fellowship

University of Amsterdam, Netherlands

Nutrient sharing between photosynthetic symbionts and their sponge host: implications for coral reef productivity across oceans

Life on Earth has evolved ingenious ways to satisfy its daily nutritional needs. Often, these require macro- and micro-organisms to team up, forming intimate collaborations that are very successful in nutrient-poor environments like coral reefs. Photosymbiosis, a partnership between animal hosts and microbes fueled by sunlight, is famous in corals, but it is even more diverse and complex in sponges.

Inside sponges, symbiotic microbes harvest sunlight and produce sugars but how much sugar do they share with their host sponge? Michelle's research in the Caribbean illustrated how symbiont and sponge cells communicate, how much nutrition they exchanged, and why the resulting productivity matters for the complex food webs that sustain tropical coral reefs. Funding from the Maple-Brown Family Foundation Fellowship will enable Michelle to study nutritional sharing in a foliose sponge (*Phyllospongia foliascens*) that is abundant at Lizard Island. Specifically, results from her research will determine whether the photosynthetic sugars are used to build sponge biomass, which can then be consumed by other members of the coral reef food web.

Phyllospongia foliascens

Dr Nina Schiettekatte

2023 Isobel Bennett Marine Biology Fellowship

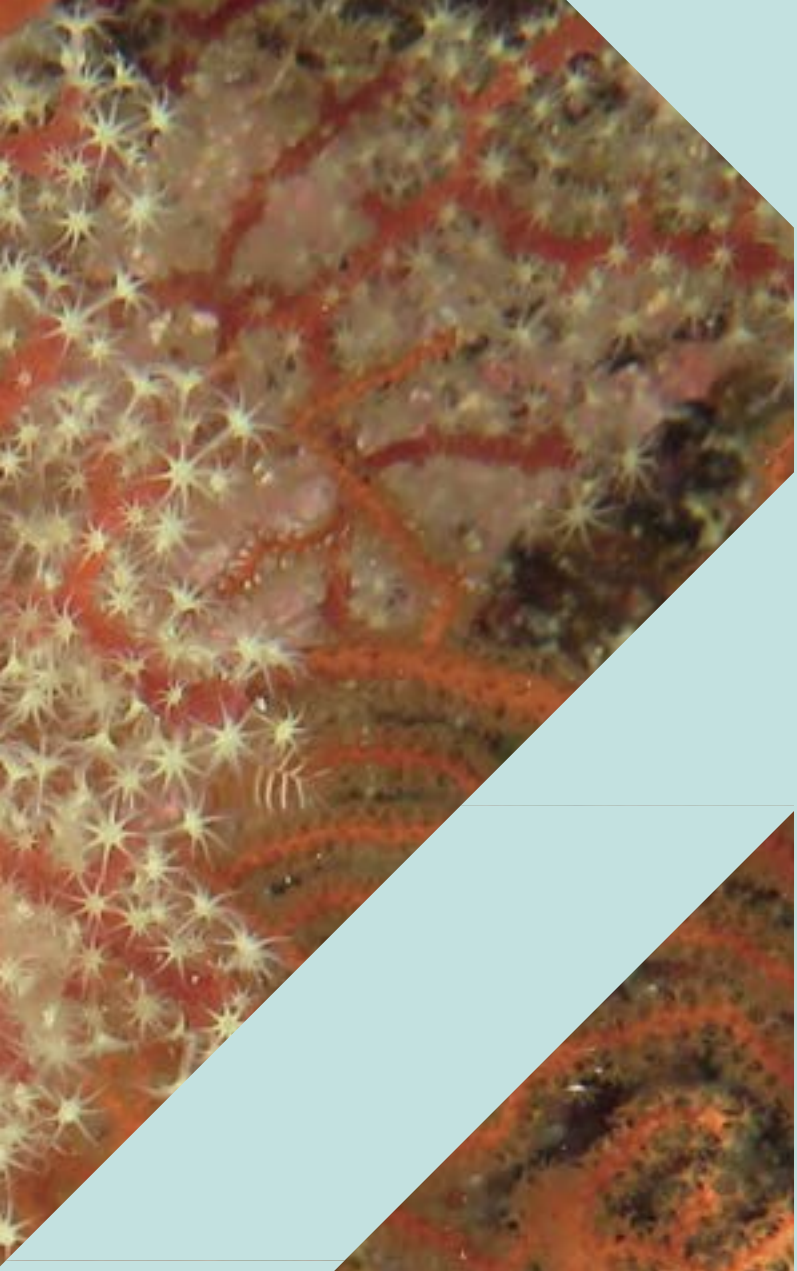
University of Hawaii, USA

Linking structural complexity with biodiversity and ecosystem functions

Coral reefs increasingly experience events of mass coral mortality, triggering a transition into modern reefs characterized by a decreased diversity and structural complexity. The physical habitat structure of a coral reef provides the possibility for species to accumulate and interact. Corals help construct the 3D profile of the reef. Mobile animals such as fish and invertebrates use the 3D environment to hide and search for food. More complex reefs provide a larger area for mobile animals to occupy. Moreover, the shape of a reef profile may affect the types of species that can live there. For example, a large bommie with an overhang provides the ideal resting spot in the shade for a nocturnal fish (picture below), while a branching coral with many small nooks may be ideal for smaller species to hide in when a predator comes by

Coral reef fishes play a crucial role in mediating key ecosystem functions such as nutrient cycling, biomass production, and herbivory. As coral reef habitats become less complex, we expect fish communities to shift. The challenge is to understand how exactly the changing structural complexity of coral reefs affects the diversity and functioning of these fish communities.

Nina will use existing reef sites around Lizard Island, part of a long-term monitoring program established by Prof. Maria Dornelas and Assoc. Prof. Joshua Madin (page 5), to link structural complexity, biodiversity, and fish-mediated functions. The 3D profiles of reef plots will allow for the estimation of structural complexity measures such as fractal dimension and rugosity. She will combine these measurements with fish observations and bioenergetic modelling to directly link structural complexity, biodiversity, and fish-mediated functions.



Prof. Morgan Pratchett

2023 Critical Research Grant
ARC Centre of Excellence
for Coral Reef Studies

James Cook University

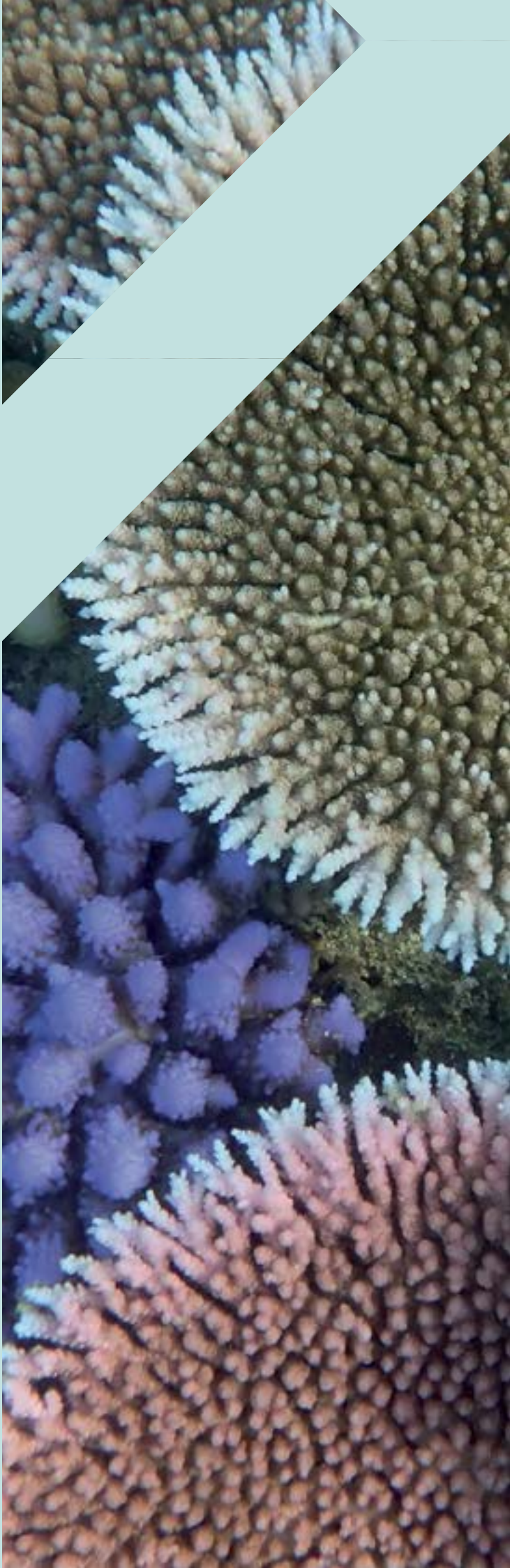
Spatiotemporal variation in settlement rates of Crown-of-Thorns Starfish on Australia's Great Barrier Reef: critical research to underpin understanding and management of impending population irruptions

Recent and extensive research into putative causes of population irruptions (or outbreaks) of Crown-of-Thorns Starfish (CoTS) on Australia's Great Barrier Reef (GBR) has focused on reefs within the broadly designated initiation area, either within the vicinity of Lizard Island region (around 14° of latitude) or at reefs in the Cairns region. However, during population irruptions in the early 1990s, it was noted that elevated densities of adult CoTS were apparent in the far northern GBR (around 12° of latitude) up to two years before population irruptions were detected at reefs in the Lizard Island region. It is possible therefore, that the proliferation of CoTS at reefs in the Lizard Island region represents the secondary accumulation of larvae spawned by burgeoning or expansive populations on reefs to the north.

The purpose of Morgan's research is to quantify spatiotemporal variation in settlement rates of CoTS in the lead up to renewed population irruptions on the GBR. Attention will focus on reefs within the putative initiation area and on reefs in the far northern GBR. This is the first attempt to measure and compare settlement rates of CoTS over a broad cross-section of reefs in the northern GBR. It has the potential, once and for all, to show where population irruptions originate, which is needed to underpin transformative management to prevent (or contain) renewed population irruptions.

This project is time sensitive since renewed population irruptions are predicted around 2025. It capitalises on recent advances in studying CoTS, such that this project would not have been possible before now. For instance, it will use newly developed, but proven, methods to quantify larval settlement of CoTS. It will also use the latest genetic techniques (specifically, droplet digital polymerase chain reaction based on specific mtDNA primers for CoTS) to not only detect, but quantify the approximate number of larval CoTS that settle into settlement traps. This project is focused on providing critical information to further improve the ecological underpinning, and ultimate effectiveness, of CoTS management on the GBR.

Lizard Island Reef Research Foundation (LIRRF)



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[1] Died in January 2022
[2] Retired during 2022

We thank Australian Museum staff Dr Shane Ahyong and Dr Joey DiBattista for being part of the Selection Committee in 2022 for LIRRF Fellowships and Grants, joining Science Committee members Penny Berents, Kris Helgen, Anne Hoggett and Lyle Vail (Chair of 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 donate 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 gift a lower amount. Life Members donate at least $100,000 which may be spread over several years. LIRS would not be the place that it is without the support of the LIRRF. Members in 2022 are listed on page 28.

Projects and equipment funded by LIRRF in 2022

In the 2022 financial year, the LIRRF contributed a total of $373,408 in support of research and education.

- **$232,963** for research and education through its fellowships and grants program and for the Coral Reef Study Tour.
- **$89,934** for capital works and equipment to support research at LIRS: final payment for solar power upgrade, replacement of main electrical switchboard, and replacement of outboard motors.
- **$50,511** for other research operations.

Board changes

David Shannon retired from the Board last year (2021) after 16 years as a Trustee including six years as Chair from 2012 to 2018. He has made extraordinary contributions of time and funds throughout his tenure. David and his wife Daniela Shannon are Life Members and remain involved with LIRRF activities.

David Armstrong, Rod Kefford AM and Helen Wellings resigned as LIRRF Trustees during 2022. David and Rod served as Australian Museum Trust representatives and their terms as AM Trustees have ended. All were long-term LIRRF Trustees and made important contributions during their terms. David, Rod and Helen brought unique skills to the LIRRF board with their extensive backgrounds in finance, education and journalism, respectively. We thank them for their dedicated service.

Former long-term Chair and Trustee, Ken Coles AM, died peacefully at age 95 on 18 January 2022 with his wife Rowena Danziger AM by his side. His many achievements are outlined in a tribute by fellow Trustee Charlie Shuetrim at: lirrf.org/a-tribute-to-ken-coles-am.

Coral Reef Study Tour

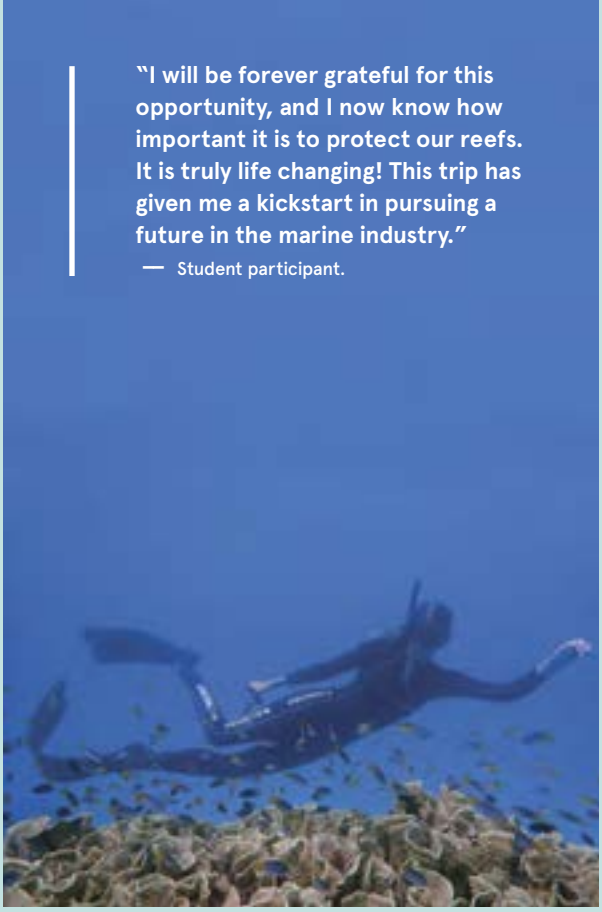
The inaugural Lizard Island Coral Reef Study Tour took place in April 2022, two years later than planned due to COVID-19 restrictions. It was fully funded by the Lizard Island Reef Research Foundation. The program makes the fantastic resources at LIRS accessible for secondary school education to a much broader group than is possible through school-based programs. It is a live-in educational experience for students and teachers of Year 11 Biology in NSW.

Back in 2019, sixteen high achieving students of Biology at NSW government schools and two Biology teachers had been selected in a competitive process for the 9-night educational trip to LIRS. Unfortunately, several of those students couldn't attend in 2022 due to other commitments. However, of the eighteen people selected in 2019, fifteen were able to take part: two teachers and thirteen students. The immersive, live-in educational experience about coral reefs was a great success.

The program was conceived and organized by Anne Hoggett with on-site course content and field excursions delivered by Dr Andy Lewis and Dr Cristiana Damiano (Coral Sea Foundation). The trip was fully funded by three generous donors to the LIRRF: the James N. Kirby Foundation, the Corella Fund, and the Coles Danziger Foundation. We sincerely thank them for their support which provided such a unique educational experience. Due to the success of this program, another Coral Reef Study Tour is planned for October 2023.

> **"This experience has changed me as a teacher. It has lit a spark under me that now, more than ever, I will continue to use to inspire and engage the next generation."** — Teacher participant.

> **"I will be forever grateful for this opportunity, and I now know how important it is to protect our reefs. It is truly life changing! This trip has given me a kickstart in pursuing a future in the marine industry."**
> — Student participant.



Above: Participants spent many hours in the water, learning about coral reefs. Photo Andy Lewis.

Below: Participants and leaders of the 2022 Lizard Island Coral Reef Study Tour.

Solar power upgrade

Modelling for the solar power upgrade carried out in 2021 predicted that solar would provide at least 95% of the station's electrical needs over a year. It has been in action for more than a year now and we are happy to report that the prediction is accurate. Before solar power, LIRS used about 45,000 litres of diesel annually for generating electricity compared to about 2,000 litres after the upgrade. This vital infrastructure upgrade was funded by the Minderoo Foundation, and by LIRRF donors the Charles Warman Foundation, Angela Rossi & Tim Whitbread, Ian Learmonth & Julia Pincus. Continuing to reduce our environmental impact, the next step is to change from gas to electricity for cooking. That will involve higher-capacity underground wiring and additional battery storage, and planning is underway.

The Sapphire Project

The Sapphire Project was founded in the US by Susan Rockefeller to promote sustainability and ocean conservation. The inaugural Australian Sapphire Dinner was held on World Oceans Day 2022 in Sydney. Its purpose was to raise awareness of the benefits humankind derives from the ocean and to generate philanthropic support for ocean conservation with a focus on the Great Barrier Reef. LIRS was selected as one of several organizations to benefit from funds raised, receiving $243,200. These funds will support important initiatives at LIRS such as the Fellowship and Grants Program and for acquiring essential equipment. We sincerely thank members of the Sapphire Committee for their considerable fundraising efforts and for supporting research at LIRS.

Donations

LIRRF operates with very low overhead costs, and it provides a highly efficient channel for donations to support science on the Reef. LIRS would not exist and could not continue without donor support. Various options for donating are available online at: lirrf.org/donate. All donations of $2 or more are tax deductible in Australia.

Events

Following two years without any large face-to-face events due to the pandemic, 2022 saw their return. At these events, we highlighted the important research being done at LIRS and how donations by supporters are utilised.

Dinners were held at the Melbourne Club and at the Australian Museum's Hintze Hall on 10 and 11 October 2022, respectively, with 226 people attending in total. Prof. Morgan Pratchett (James Cook University) was the main speaker at both, along with LIRS Director Anne Hoggett who highlighted recent activities at the station. Morgan is an expert on the Crown-of-Thorns Starfish (CoTS) and the audiences were enthralled to learn about the biology of this notorious coral-eating starfish and the steps being undertaken to help protect corals by controlling CoTS outbreaks. We thank LIRRF Chair Kate Hayward and Trustee Anna Le Deux for organizing these well attended and informative dinners.

Lizard Island Resort

The luxurious Lizard Island Resort provides an exceptional base from which to experience the Great Barrier Reef. Delaware North, operator of the Resort, is a long-term supporter of LIRS and of LIRRF.

Each year Delaware North donates to LIRRF a generous three-night stay at the Resort for two people that includes return transfers by light aircraft from Cairns, accommodation, meals, beverages and more. This wonderful package is used to raise funds.

In addition, current LIRRF Members (i.e., those who have donated $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.

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.

Above: Prof. Morgan Pratchett speaking at the Australian Museum. Photo: Annie Post.

For the record

Reef health

It has been nearly seven years since the mass coral bleaching event of 2016 caused massive death of corals in the vicinity of Lizard Island and elsewhere on the Great Barrier Reef. Since then, recovery of corals has been fantastic in some areas but not in others – particularly the lagoon, which still shows little sign of regrowth. Since 2016, only two years (2018 and 2019) have passed without noticeable heat stress to corals. In each of the years 2020, 2021 and 2022 there was widespread bleaching in late summer. Fortunately, it didn't progress to mass death of corals because the weather changed to cloudy and rainy before too much heat stress had accumulated. There have now been five thermal bleaching events in this area over the past seven years. Generally, accumulated heat stress in corals first becomes observable in mid to late summer - January or February. Alarmingly, for the first time we observed minor bleaching of corals in early summer - November and December 2022 - after a prolonged period of hot, calm weather. Fortunately, the sea temperature cooled in late December 2022 and early 2023 due to rain and heavy cloud cover.

Above: Coral spawning occurred as expected in 2022, with the event split between two months. Because the full moon occurred quite early each month in late 2022, there was major spawning after the full moon in both November and December.

Volunteers

The volunteer program was strongly curtailed in 2020 and 2021 due to the pandemic and we were glad to be able to accept more volunteers in 2022. Our wonderful volunteers in 2022 were: Renie and Snow Amos, Trish Cornish, Teresa Hackney, Lucy Mychael, Lance Pearce, Helen and Tim Roper, and Jack Voulgaris.

Volunteers come from all walks of life and from all over the world. Many come just once while others make repeat visits. Renie and Snow Amos are 'hard-core' volunteers who have provided their valuable services every year for decades. All volunteers bring a wide array of skills and undertake a diverse range of essential maintenance jobs without which LIRS would not be the place that it is.

Above right: Renie and Snow Amos continue to give so much to LIRS.

COVID-19

LIRS returned to vibrant life in mid-2022 after more than two years of COVID-19 disruptions. There is considerable pent-up demand for space which will take at least a year to clear.

Five people developed COVID-19 at LIRS during 2022, within a day or two of arrival on the island. This was despite precautions in place until late in the year requiring everyone to be fully vaccinated and to return a negative rapid antigen test in the 24 hours before arrival. Fortunately, none of the cases were serious and it didn't spread to other visitors. LIRS follows Queensland Government health directions that are current at the time for management of COVID-19.

Staff

Dr Lyle Vail AM and Dr Anne Hoggett AM completed 32 years as joint Directors in August 2022.

Arthur Davie and Ruth Carr have completed almost two years as Maintenance Officer and Accommodation Officer, respectively.

Long-term former staff member Marianne Pearce was employed during May 2022 to assist Anne while Lyle was off the island. Her husband Lance Pearce, also LIRS staff for 24 years up to 2012, assisted as a volunteer at that time.

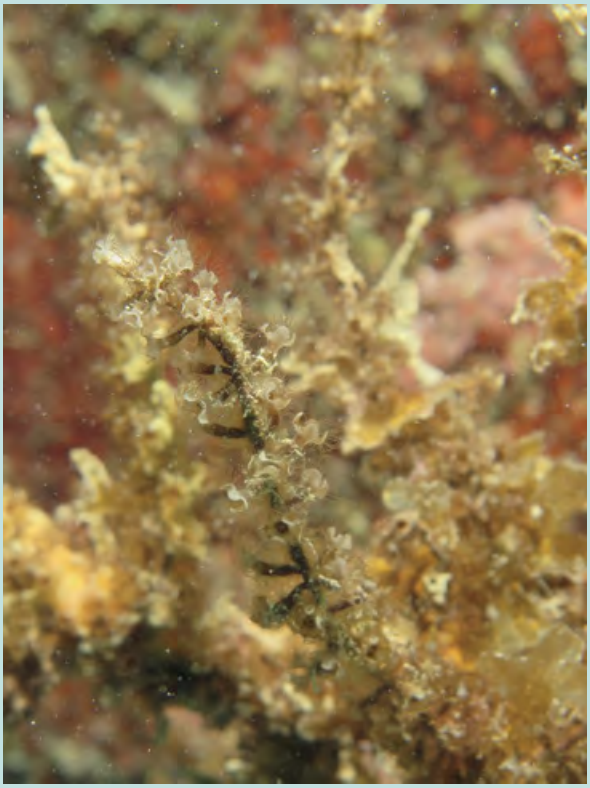
GBROOS

The Great Barrier Reef Ocean Observing System is a federally funded environmental monitoring system. It was slated for decommissioning in 2022 after only about 10 years operation due to lack of funding. The Australian Institute of Marine Science, which operates the system, decided to direct internal funds to support a considerably reduced network, in recognition of the importance of the data for management of the Reef. Lizard Island will be retained as one of the sites. Configuration of the modified system at Lizard Island will comprise the weather station at Bird Island and one or two underwater sites recording sea temperature at various depths. Near real-time access to the data will be much reduced compared to the original system but this is an acceptable trade-off to not having the data at all. We thank AIMS for retaining the Lizard Island site.

Lizard Island Field Guide

The Lizard Island Field Guide (LIFG) is an online guide to the life of Lizard Island, terrestrial and marine. At year's end, it included 3410 species with photographs and much other information - an increase of 110 during the year. The background database of species recorded from the area (excluding known synonyms) rose by the same number, to 7910.

The LIFG website: **lifg.australianmuseum.net.au** is updated continuously. However, the free mobile applications which allow for use of the guide offline are currently unavailable while undergoing major redevelopment. We thank the LIRRF for its ongoing support for this initiative.



Above: One of the more unusual entries into LIFG in 2022. This is a colony of the bottom-dwelling form of a scyphozoan (jellyfish), *Nausithoe*.

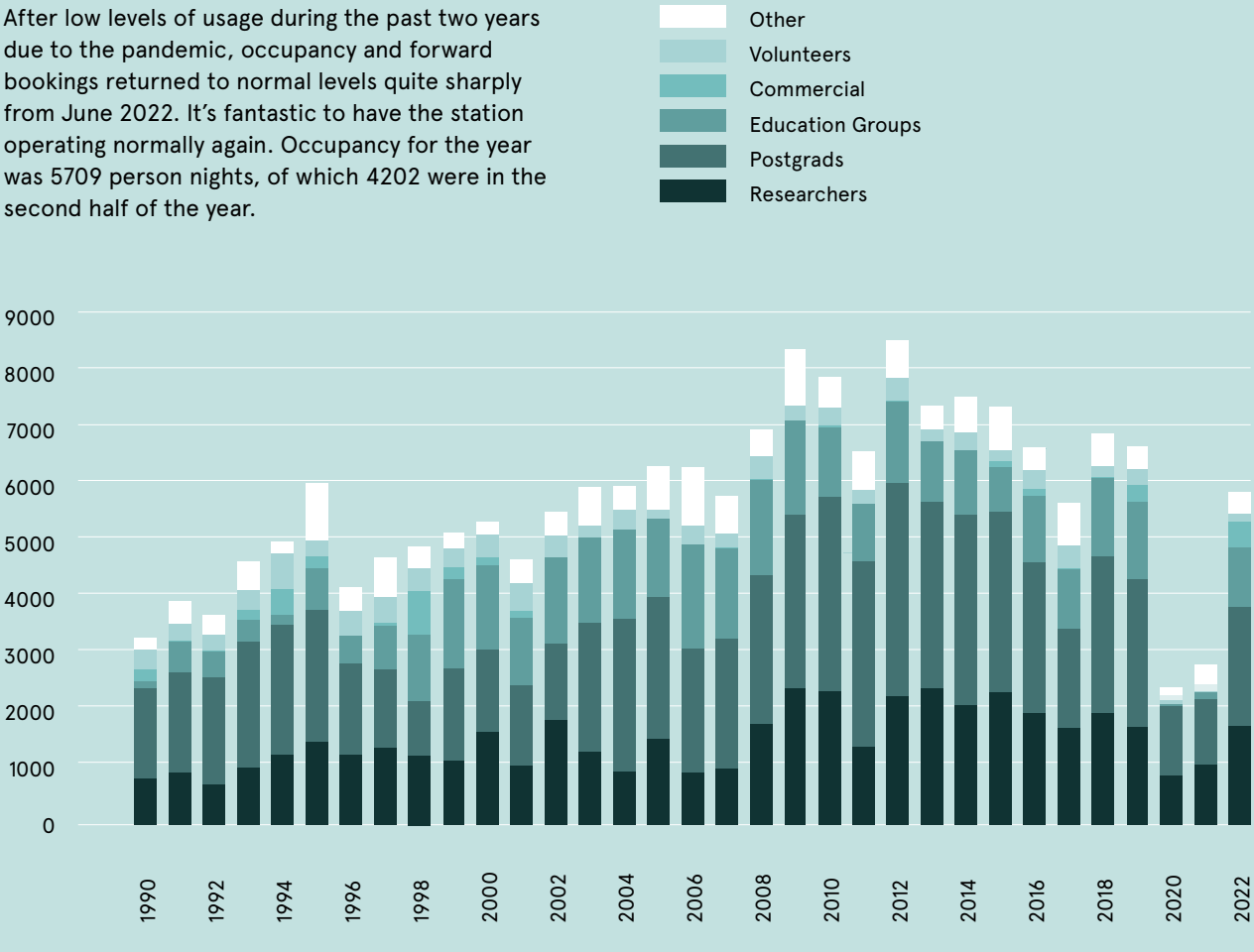
Bench fees

Per person per night, including GST	2022	2023
Researcher	$154.00	$158.00
Researcher's assistant	$138.00	$142.00
Postgrad student (own project)	$59.50	$61.00
Postgrad's assistant	$54.50	$56.00
School or university group	$98.00	$101.00
Media	$231.00	$238.00
Commercial	$289.00	$298.00

Above: *Paguritta*, a coral-dwelling hermit crab.

Usage

After low levels of usage during the past two years due to the pandemic, occupancy and forward bookings returned to normal levels quite sharply from June 2022. It's fantastic to have the station operating normally again. Occupancy for the year was 5709 person nights, of which 4202 were in the second half of the year.



Visitors in 2022

Scientists from 34 institutions in six countries conducted 75 research projects in 2022, comprising 55 senior scientists or postdocs, 30 PhD candidates, 6 MSc candidates, 2 Honours candidates, and 8 undergraduate research students. The researchers are listed here with project titles and institutional affiliations.

All visits by people based at institutions outside of Australia took place after March 2022 due to COVID-19 travel restrictions.

Institutions

Australian

1. Australian Institute of Marine Science
2. Australian Museum
3. CSIRO
4. Curtin University
5. Deakin University
6. Great Barrier Reef Marine Park Authority
7. Griffith University
8. James Cook University
9. Minderoo Foundation
10. Monash University
11. Murdoch University
12. Queensland University of Technology
13. Southern Cross University
14. University of New England
15. University of Queensland
16. University of Sydney
17. University of Tasmania
18. University of Western Australia
19. University of Wollongong

International

20. King Abdullah University of Science and Technology, Saudi Arabia
21. Mars, USA
22. Nova Southeastern University, USA
23. School for International Training, USA
24. Università degli Studi di Milano-Bicocca, Italy
25. University of Bristol, UK
26. University of Exeter, UK
27. University of Fribourg, Switzerland
28. University of Geneva, Switzerland
29. University of Hawaii, USA
30. University of Oxford, UK
31. University of Miami, USA
32. University of Neuchatel, Switzerland
33. University of St. Andrews, UK
34. University of Texas Austin, USA

Senior scientists and postdoctoral researchers

Andrew Baird[8]
Taxonomy of the reef-building corals of Lizard Island

Daniela Basso[20]
Survey of benthic communities

David Bellwood[8]
The evolution of viruses in cryptobenthic fishes

Rohan Brooker[1], **Mark Meekan**[1], **Miles Parsons**[1], **Steve Simpson**[25], **Sophie Nedelec**[26] **and others**
Reef Song: an ecosystem-based approach to enhancing reef recovery and resilience

Neal Cantin[1]
Bleaching processes

Jordan Casey[34]
Environmental DNA as a monitoring tool for cryptobenthic reef fishes

Wen-Sung Chung[15]
Cephalopod visual and neurobiology

Fabio Cortesi[15]
Anemonefish hotels: restoring Nemo's home and its community for the future

Maria Dornelas[33], **Joshua Madin**[29], **Viviana Brambilla**[33], **Oscar Pizarro**[16], **Heather Doig**[16], **Wilhelm Marais**[16], **Jackson Shields**[16] **and others**
Understanding coral reef recovery from extreme disturbances using 3D maps

Matthew Dunbabin[12]
CoralBots for benthos classification, impact, and restoration assessment

Will Feeney[7]
Mutualisms in a changing world: does the presence of cleaner wrasses confer resilience to coral reef ecosystems?

Christopher Goatley[14] and **Simon Brandl**[34]
Function, biodiversity, and distribution of Australia's smallest vertebrates

Peter Harrison[13], **Marine Guoezo**[13], **Damian Thompson**[3], **Georges Roff**[3], **Rachel Pears**[6] **and others**
Moving Corals Reef Restoration and Adaptation Program - coral larval restoration

Jean-Paul Hobbs[15]
Long-term monitoring of anemonefish and their host anemones

Andrew Hoey[8]
Resilience of coral-dominated and habitats to multiple disturbances

Ariana Lambrides[8]
Understanding long-term indigenous uses of the Great Barrier Reef: re-excavating the Freshwater Bay midden, Lizard Island

John Majoris[34], **Joey DiBattista**[2] **and Amanda Hay**[2]
Connecting larval and adult cryptobenthic fish communities around Lizard Island

Justin Marshall[15]
Colour vision and communication

Eva McClure[8]
Effects of recurrent disturbances on coral reefs across the continental shelf

Matheus Mello Athayde[15]
Responses of a "tough" coral found at the GBR to future warming and acidification scenarios at different reefs: can it give hope for this highly biodiverse marine ecosystem?

Chiara Pisapia[20] **and Steve Doo**[20]
Assessing recovery of Lizard Island Reef community structure and function following multiple successive stress events

Morgan Pratchett[8] **and Will Figueira**[16]
In situ feeding rates of Crown-of-Thorns Starfish and fate of prey corals

Morgan Pratchett[8] **and Simon Ling**[17]
Quantifying predation rates on Crown-of-Thorns Starfish relative to fisheries management zones and corresponding differences in abundance of putative predators

Kate Quigley[9], **Micaela Domisse**[9], **Alicia McArdle**[21] **and Eric Fisher**[21]
Reconnaissance for future rehabilitation project

Elias Samankassou[28]
Collection and investigation of *Porites* fragments

Nina Schiettekatte[29]
Linking structural complexity with biodiversity and ecosystem functions

Silvia Spezzaferri[27]
Understanding coral thermal bleaching thresholds during past interglacial extremes: Insight into thermal stresses dynamics on tropical coral reef ecosystems

Sean Ulm[8], **Ian McNiven**[10], **Martin Potter**[5] **with Traditional Owner representatives Louis Charlie, Kenneth McLean, Donald Baru, Niall Cobus and Esmond Cobus**
Lizard Island archaeological project

Sven Uthicke[1] **and Jason Doyle**[1]
Operationalising and implementing eDNA monitoring of Crown-of-Thorns Starfish on the Great Barrier Reef

Research students

Jeron Atlas[23]
Comparative analysis of human influences on Green Sea Turtles *(Chelonia mydas)* behaviours and distribution amongst exposed Lizard Island reefs (Undergraduate)

Monica Bacchus[22]
Effect of habitat degradation on group size preference in a coral reef fish (MSc)

Makeely Blandford[8]
The influence of habitat degradation and fragmentation on coral reef fish communities (PhD)

Colin Breen[23]
An analysis of the health and fecundity of Crown-of-Thorns Starfish populations on shallow reefs around Lizard Island using demographics, coral cover, and gonad analysis (Undergraduate)

Joanna Buckee[11]
The influence of water level variability in driving coral cover on shallow coral reefs (PhD)

Adriano Cantelmi[23]
An investigation on benthic and seascape drivers of reef fish assemblages in isolated reef patches found across Lizard Island (Undergraduate)

Leira Centeno[22]
Coral size following disturbance events in Mermaid Cove, Lizard Island, Australia (MSc)

Cher Chow[33]
Reef diversity and function (PhD)

Kyra Jean Cipolla[34]
Effects of reef structural complexity on reef fish biodiversity and behavior (MSc)

Joshua Connelly[8]
Investigating constructed seascapes in the Lizard Island Group (PhD)

Jordyn Cotton[22]
Carbon system dynamics of Lizard Island ecosystems (MSc)

Evie Croxford[25]
Sound preferences in recruiting coral reef fishes (PhD)

Yasmin Emery[32]
The impact of intra- and interspecific fish densities on brain morphology (PhD)

Eric Fakan[8]
Impact of habitat quality on the survival and fitness of coral reef fishes (PhD)

Catheline Froehlich[19]
Investigating the advantages of sociality in challenging environments using coral-dwelling gobies (PhD)

Garrett Fundakowski[33]
Tracking 3D size and shape changes in stony corals (PhD)

Alan Gojanovic[18]
Breaking the bottleneck: enhancing larval fish survival (PhD)

Georgia Hammersley[30]
Sexual healing: IVF and making coral futures on the Great Barrier Reef (MSc)

Michael Hood[22]
The daily carbon cycle in reefs and mangroves at Lizard Island, Great Barrier Reef (MSc)

Macee Hussey[23]
How does the benthic community composition affect fish communities? (Undergraduate)

Tyson Jones[17]
Traits of detectability: towards unbiased density estimates of reef fishes (PhD)

Christina Langley[13]
Culturing wild coral symbionts (PhD)

Claire Moad[15]
Determining the visual acuity of reef fishes using optomotor response (PhD)

Adrien Montillier[28]
Taxonomic investigation on benthic foraminifera (PhD)

Juliano Morais[8]
Coral recovery dynamics on post-bleach coral reefs (PhD)

Serena (Ya) Mou[12]
Reconfigurable robots for scaling reef restoration (PhD)

Clelia Mula[18]
Macroalgae as nursery habitat for coral reef fishes (PhD)

Matthew Nicholson[31]
Ectoparasite consumption by diurnal fishes (PhD)

Gioele Pappalardo[28]
Assessment of the Foraminifera in Reef Assessment and Monitoring Index (FI) and the Sediment Constituents Index (SI) at Lizard Island (PhD)

Letizia Pessina[32] **with supervisor Redouan Bshary**[32]
Life history of cleaner fishes (PhD)

Tim Quimpo
Changing nature of reef fish herbivory with depth: from shallow to mesophotic coral ecosystems (PhD)

Isobel Ryan[15]
Influence of habitat quality on the habitat preferences of anemonefishes (Hons)

Carl Santiago[15]
Is the availability of host anemones regulating cohabitation in clownfish? (PhD)

Alice Schacher[15]
Luminance discrimination in *Haptosquilla trispinosa* (Hons)

Isabel Schireson[23]
Does the abundance and diversity of Crown-of-Thorns Starfish predators impact the abundance and health of Crown-of-Thorns Starfish on reefs surrounding Lizard Island? (Undergraduate)

Madison Schumm[34]
Behaviour and cognitive ability of *Eviota* species (PhD)

Abigail Shaughnessy[15]
Seasonal visual function in Pomacentridae (PhD)

Kristine Shaw[23]
The effect of habitat degradation on the abundance and social organisation of coral dwelling gobies (Undergraduate)

Juan Carlos Azofeifa Solano[4]
Decoding coral reef soundscapes of Lizard Island (PhD)

Sterling Tebbett[8]
An assessment of coral recovery after repetitive coral bleaching events (PhD)

Valerio Tettamanti[15]
Development of the visual system and colouration in damselfishes (PhD)

Rick Usami[23]
Investigation on the prevalence and distribution patterns of disease on massive *Porites* (Undergraduate)

Ching Wen (Judy) Wang[15]
Spectral and polarisation processing in the stomatopod visual system (PhD)

Chelsea Waters[13]
Developing and scaling deployment, settlement and monitoring of wild cultured larvae for reef restoration (PhD)

Lucy Woodke[23]
How often do juvenile cleaner wrasse get chased compared to adults? (Undergraduate)

Devynn Wulstein[29]
Self-thinning in coral assemblages as they recover from disturbance (PhD)

Education groups

Ascham School

- Led by Andy Lewis, Johanna Leonhardt and Tara Prenzlau and teachers Jennifer Arapakis, Azlifa Shareef and Sarah Wilson

Barker College

- Led by Tim Binet, Sarah Cormio and Katherine Haigh

Emmanuel Anglican College

- Led by Justine Jacobs, Daniela Payne, Paul Pryor and Mason Brenton

Lizard Island Coral Reef Study Tour

- Led by Andy Lewis and Cristiana Damiano

Nova Southeastern University

- Led by Lauren Nadler and Tyler Cyronak with guest lecturers Bradley Eyre, Morgan Pratchett and Charlie Veron

RMIT University

- Led by Jeff Shimeta, Nathan Bott, David Heathcote and Kathryn Hassell

School for International Training

- Led by Tony Cummings, Vanessa Messmer and David Sellars

Other visitors

Lizard Island Reef Research Foundation

- Kate Hayward with Etienne Beaumont, Edgar Downes, Lynnie Downes, Sarah Gough, Sam Hayward, Penelope McKeown and Karen Panton
- Kate Hayward with Claire Armstrong, Chris Bundey, Pip Bundey, Libby Owen Edmunds, Tim Owen Edmunds and John Sharpe
- Greer, Jay, Eve and Erin Banyer
- Jane and Jol Valentine

Coral Sea Foundation

- Coral Sea Foundation citizen scientists recording coral recovery, led by Andy Lewis

Non-researching scientific visitors

- Terry Hughes (formerly James Cook University and Centre of Excellence for Coral Reef Studies) with Mary Jo Boyle and Paddy Hughes
- Jeff Leis (formerly Australian Museum), Dianne Bray (Museums Victoria) and Martin Gomon (Museums Victoria)

Media

- Documentary filming by Sealight Productions, Adam Geiger and large crew
- Underwater mapping by Phoria, Trent Clews de Castella, Joseph Purdam and Matan Yuval
- Southern Cross University media team filming coral larvae seeding project, Sharlene King and Danny McShane
- Documentary filming by Ronde Media, Max Bourke, Tim Hawkins, Terrence Meehan and Ben Abbatangelo
- Sydney Morning Herald story about LIRS, journalist Laura Chung and photographer Brook Mitchell
- Documenting the work of Queensland Parks and Wildlife Service, Andrew Denzin and Gus Burrows
- Documentary filming by Willi Bieri, Switzerland

Australian Institute of Marine Science

- GBROOS maintenance team: Scott Gardner and Brett Hodgetts

First aid training

- Charlie Makray and Julie Armour

Queensland Parks and Wildlife Service

- National Park maintenance: Paul Anderson, Chris Billett, Fyscher Darcy, Hamish Gibson, Kylie Goodall, Alex Gorham, Brody Gray, Lee Hess, Alex Hoffmann, Nic Inskeep, Joel McClune, Daniel Miller, Olivia Slip, Michael Solinas and Hamon Williams

Contractors

- Allan Ross, microscope maintenance
- Jason Hanlon, Edge Marine, install new outboards

Below: LIRRF Chair Kate Hayward and Libby Owen Edmunds prepare to go snorkelling.

Right: Swiss PhD student Letizia Pessina will spend more than a year at LIRS studying the life history of cleaner fishes in the field.

Publications

In 2022, 80 publications based on work carried out at LIRS were received into the collection as listed below. There are now more than 2,630 LIRS publications.

1. Aellen, M., J.M. Burkart and R. Bshary, 2022. No evidence for general intelligence in a fish. *Ethology, 128:* 424–436.

2. Anyosa, S., J. Eidsvik and O. Pizarro, 2023. Adaptive spatial designs minimizing the integrated Bernoulli variance in spatial logistic regression models - with an application to benthic habitat mapping. *Computational Statistics and Data Analysis, 179:* 107643.

3. Arjunwadkar, C.J., S.B. Tebbett, D.R. Bellwood, D.G. Bourne and H.A. Smith, 2022. Algal turf structure and composition vary with particulate loads on coral reefs. *Marine Pollution Bulletin, 181:* 113903.

4. Bacchus, M.D., 2022. Impacts on fast-start performance: how do group size and habitat degradation alter the escape behavior of a schooling coral reef fish? Master's thesis, Nova Southeastern University.

5. Berenshtein, I., R. Faillettaz, J.-O. Irisson, M. Kiflawi, U.E. Siebeck, J.M. Leis and C.B. Paris, 2022. Evidence for a consistent use of external cues by marine fish larvae for orientation. *Communications Biology, 5(1):* 1307.

6. Bergstrom, E., 2021. Carbon physiological strategies across dominant Great Barrier Reef crustose coralline algae in the context of evolutionary history and global change. PhD thesis, Griffith University.

7. Bergstrom, E., J. Lahnstein, H. Collins, T.M. Page, V. Bulone and G. Diaz-Pulido, 2022. Cell wall organic matrix composition and biomineralization across reef-building coralline algae under global change. *Journal of Phycology, 2022, doi:* 10.1111/jpy.13290.

8. Bowden, C.L., R.P. Streit, D.R. Bellwood and S.B. Tebbett, 2022. A 3D perspective on sediment turnover and feeding selectivity in blennies. *Marine Pollution Bulletin, 180:* 113799.

9. Boxshall, G.A., 2022. A new parasitic copepod (Copepoda; Cyclopoida; Chondracanthidae) from two pomacentrid fishes caught on the Great Barrier Reef, Queensland, Australia. *Systematic Parasitology, 99:* 601-610.

10. Brambilla, V., 2021. Exploring patterns of coral ecological niche construction in coral reef ecosystems. PhD thesis, University of St Andrews.

11. Bray, R.A., S.C. Cutmore and T.H. Cribb, 2022. A paradigm for the recognition of cryptic trematode species in tropical Indo-west Pacific fishes: the problematic genus *Preptetos* (Trematoda: Lepocreadiidae). *International Journal for Parasitology, 52:* 169-203.

12. Caballes, F.C., V. Messmer, M.L. Raymundo and M.S. Pratchett, 2022. Prevalence and severity of sublethal injuries in Crown-of-Thorns Starfish relative to marine reserves in the Great Barrier Reef. *Aquatic Conservation: Marine and Freshwater Ecosystems, 32:* 993-1004.

13. Cheney, K.L., J. Hudson, F. de Busserolles, M. Luehrmann, A. Shaughnessy, C. van den Berg, N.F. Green, N.J. Marshall and F. Cortesi, 2022. Seeing Picasso: an investigation into the visual system of the triggerfish *Rhinecanthus aculeatus. Journal of Experimental Biology, 225:* jeb243907.

14. Chung, W.-S., N.D. Kurniawan and N. Justin Marshall, 2022. Comparative brain structure and visual processing in octopus from different habitats. *Current Biology, 32:* 1–14.

15. Collins, W.P., D.R. Bellwood and R.A. Morais, 2022. The role of nocturnal fishes on coral reefs: A quantitative functional evaluation. Ecology and Evolution, 12: e9249.

16. Corner, R.D., T.H. Cribb and S.C. Cutmore, 2022. Vermetid gastropods as key intermediate hosts for a lineage of marine turtle blood flukes (Digenea: Spirorchiidae), with evidence of transmission at a turtle rookery. *International Journal for Parasitology, 52(4):* 225-241.

17. Courtney, T.A., T. Cyronak, A.J. Griffin and A.J. Anderson, 2021. Implications of salinity normalization of seawater total alkalinity in coral reef metabolism studies. *PLoS One, 16(12):* e026210.

18. Cribb T.H., R.A. Bray, J-L. Justine, J. Reimer, P. Sasal, S. Shirakashi and S.C. Cutmore, 2022. A world of taxonomic pain: cryptic species, inexplicable host-specificity, and host-induced morphological variation among species of *Bivesicula* Yamaguti, 1934 (Trematoda: Bivesiculidae) from Indo-Pacific Holocentridae, Muraenidae and Serranidae. *Parasitology, 149:* 831–853.

19. Cronin, T.W., M.L. Porter, M.J. Bok, R.L. Caldwell and J. Marshall, 2022. Colour vision in stomatopod crustaceans. *Philosophical Transactions of the Royal Society B3, 77:* 20210278.

20. Cutmore S.C and T.H. Cribb, 2022. New collections of blood flukes (Aporocotylidae) from fishes of the tropical Indo-west Pacific, including a new genus, two new species and molecular evidence that *Elaphrobates chaetodontis* (Yamaguti, 1970) is widespread in the region. *Parasitology International, 88:* 102565.

21. Deaker, D.J. and M. Byrne, 2022. Crown-of-Thorns Starfish life-history traits contribute to outbreaks, a continuing concern for coral reefs. *Emerging Topics in Life Sciences, 6:* 67-79.

22. Doropoulos, C. and G. Roff, 2022. Coloring coral larvae allows tracking of local dispersal and settlement. *PLoS Biology, 20(12):* e3001907.

23. Duong, B., S.C. Cutmore., T.H. Cribb, K.A. Pitt, N.Q.-X. Wee and R.A. Bray, 2022. A new species, new host records and life cycle data for lepocreadiids (Digenea) of pomacentrid fishes from the Great Barrier Reef, Australia. *Systematic Parasitology, 99:* 375-397.

24. Fisher, R., J.M. Leis, J.D. Hogan, D.R. Bellwood, S.K. Wilson and S.D. Job, 2022. Tropical larval and juvenile fish critical swimming speed (U-crit) and morphology data. *Scientific Data, 9:* 45.

25. Fogg, L.G., F. Cortesi, D. Lecchini, C. Gache, N.J. Marshall, and F. de Busserolles, 2022. Development of dim-light vision in the nocturnal reef fish family Holocentridae. I: Retinal gene expression. *Journal of Experimental Biology, 225:* jeb244513.

26. Fogg, L.G., F. Cortesi, C. Gache, D. Lecchini, N.J. Marshall and F. de Busserolles, 2022. Developing and adult reef fish show rapid light induced plasticity in their visual system. *Molecular Ecology, 32:* 167–181.

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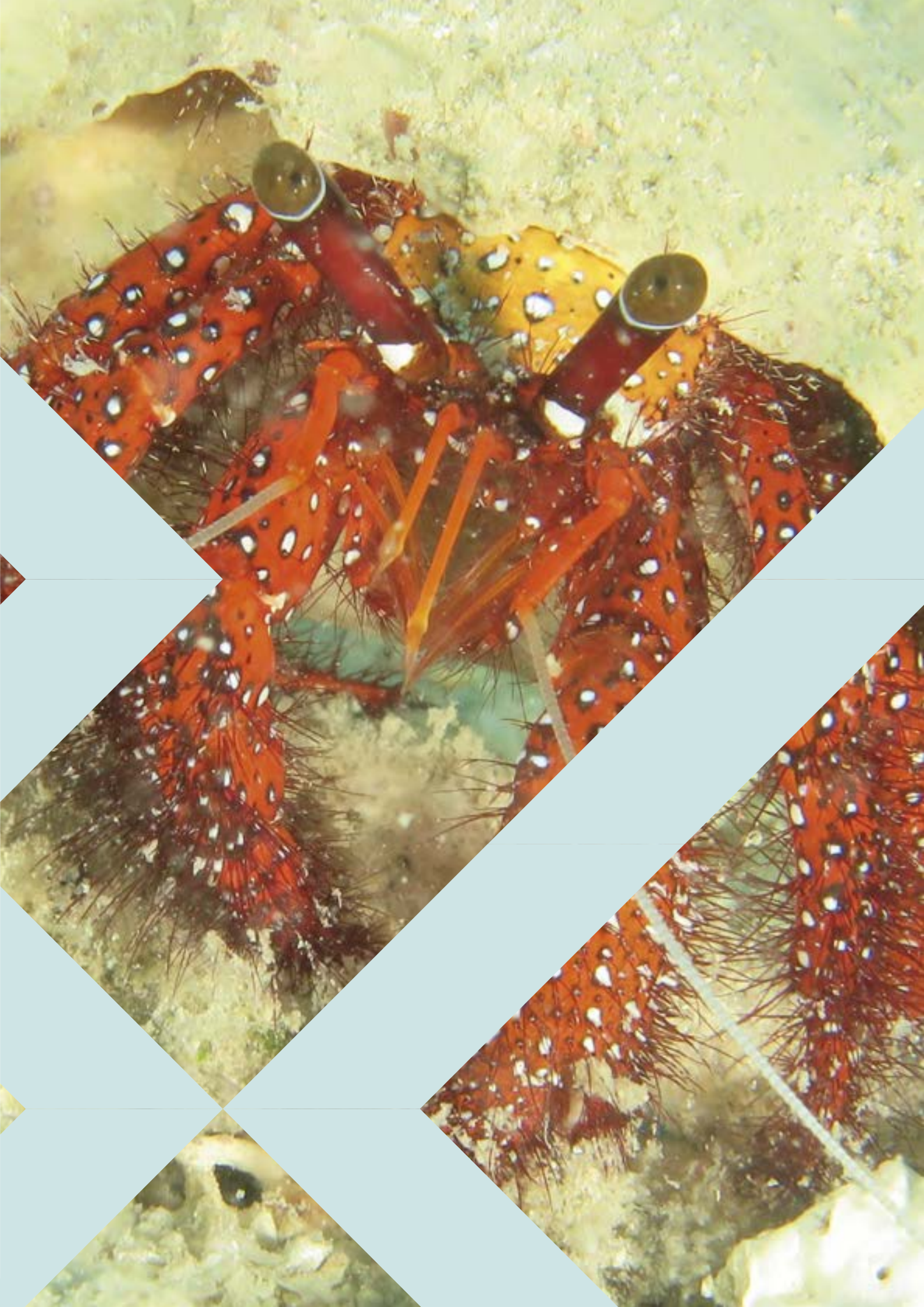

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