AIMS

Australia's tropical marine research agency

In Focus

2023 – 2024

Australian Government

Australian Institute of Marine Science

Mission

To provide the research and knowledge of Australia's tropical marine estate required to support growth in its sustainable use, effective environmental management and protection of its unique ecosystems.

Values

Care for ourselves and others in all that we do

Together we create impact

Treat everyone with dignity, value diversity, support others

Energy that inspires excellence

Always transparent, ethical and objective

Vision and creativity to solve big challenges

Minimise our footprint

Cover photo by Andre Rerekura – Whaleshark liver ultrasound research

Indigenous artwork design by Wemba Wemba artist David Flagg

Locations and assets

- Sensor networks
- AIMS monitoring sites
- Long-term ocean moorings (IMOS)
- Weather stations
- Location of major activities
- Location of office and laboratory facilities
- Location of office facilities

2023/2024

In Brief

Australian Government | Australian Institute of Marine Science

An eye on our tropical oceans: long-term biodiversity and water quality monitoring

LTMP

Running for 39 years, our Long-term Monitoring Program for the Great Barrier Reef (GBR) is the world's longest record of change in coral reefs - tracking coral and fish populations, crown-of-thorns starfish outbreaks, and the effects of cyclones and coral bleaching. This data is an essential resource to guide decision-making for government, industry and the science community.

Marine Monitoring Program (MMP)

AIMS continues to implement the MMP in collaboration with the GBR Marine Park Authority. Our team records water quality in inshore waters and the cover of hard and soft corals, macroalgae and coral recruitment on 30 inshore reefs. We provide the data to support the Reef report card, and we undertake monitoring to inform several regional report cards including Mackay and Gladstone regions.

Marine science solutions: Reef restoration initiatives

RRAP: Reef Restoration and Adaptation Program

RRAP brings together the best in marine STEM to develop large scale reef interventions for the Great Barrier Reef that are cost-effective, practical, safe and acceptable.

ACRRI: Australian Coral Reef Resilience Initiative

ACRRI uses an ecosystems approach to simultaneously research underwater acoustics to help rebuild fish populations, and develop coral seeding technologies for more resilient reefs.

Blue technology: innovation in marine science

ReefWorks

ReefWorks is Australia's tropical marine technology test range, enabling Australian innovators to trial new marine technologies, autonomous systems and sensors in the real-world tropical environment. Twenty-three activities were conducted in 2023/24 supported by about $1.13M external investment.

ReefCloud

ReefCloud is a collaborative platform using automated data management and artificial intelligence to optimise coral reef monitoring - empowering scientists, governments, and communities to protect and restore coral reefs on a global scale.

ReefScan

A suite of technology-based solutions for coral researchers and environmental managers to conduct in-field marine observations.

TROPICAL NORTHERN AUSTRALIA FIELD OPERATIONS

40,713 NAUTICAL MILES STEAMED

5,253 NUMBER OF DIVES

258 COLLABORATORS ON FIELD TRIPS

1,686 SCIENCE FIELD DAYS INCLUDING CHARTERS

13,423 RESEARCHER FIELD DAYS

Indigenous Partnerships Program

Our Indigenous Partnerships Program weaves AIMS science with the rights, responsibilities and knowledge of sea Country Traditional Owners across northern Australia.

We work together to

- Seek free prior informed consent for AIMS' research activities on Country;
- Deliver new knowledge in areas prioritised by Traditional Owners;
- Build training and employment pathways;
- Co-design and co-deliver partnership projects.

SCIENCE OUTPUT

154 PEER REVIEWED JOURNAL ARTICLES*

56% WITH INTERNATIONAL CO-AUTHORSHIP

42% WITH NATIONAL CO-AUTHORSHIP

*Data from Scival, at July 2024

ENVIRONMENTAL PERFORMANCE

↑ **92%** INCREASE IN RECYCLING*

↓ **28%** REDUCTION IN CARBON EMISSIONS ACROSS OUR OPERATIONS^

↓ **28%** REDUCTION IN SOLID WASTE TO LANDFILL

*from baseline year
^Scope 1 and 2 emissions

SCIENCE IMPACT

>5x RETURN ON GOVERNMENT INVESTMENT

>$200m ECONOMIC RETURN ESTIMATE

NATIONAL SEA SIMULATOR

$42.7m OVER 3 YEARS

NATIONAL FACILITY EXPANSION IS ONGOING THROUGH 23/24.

NEAR DOUBLING OF EXPERIMENTAL SPACE AND SIGNIFICANT INCREASE IN SEAWATER PROCESSING.

SAFETY PERFORMANCE

INJURY SEVERITY RATE

14% BETTER THAN TARGET

TOTAL RECORDABLE INJURY FREQUENCY RATE (TRIFR)

12

4 OVER TARGET (8)

POLICY IMPACTS

22% OF OUTPUTS CITED BY POLICY ACROSS

27 COUNTRIES

*2019-2023 data, Scival

FINANCES

$99.9m APPROPRIATIONS

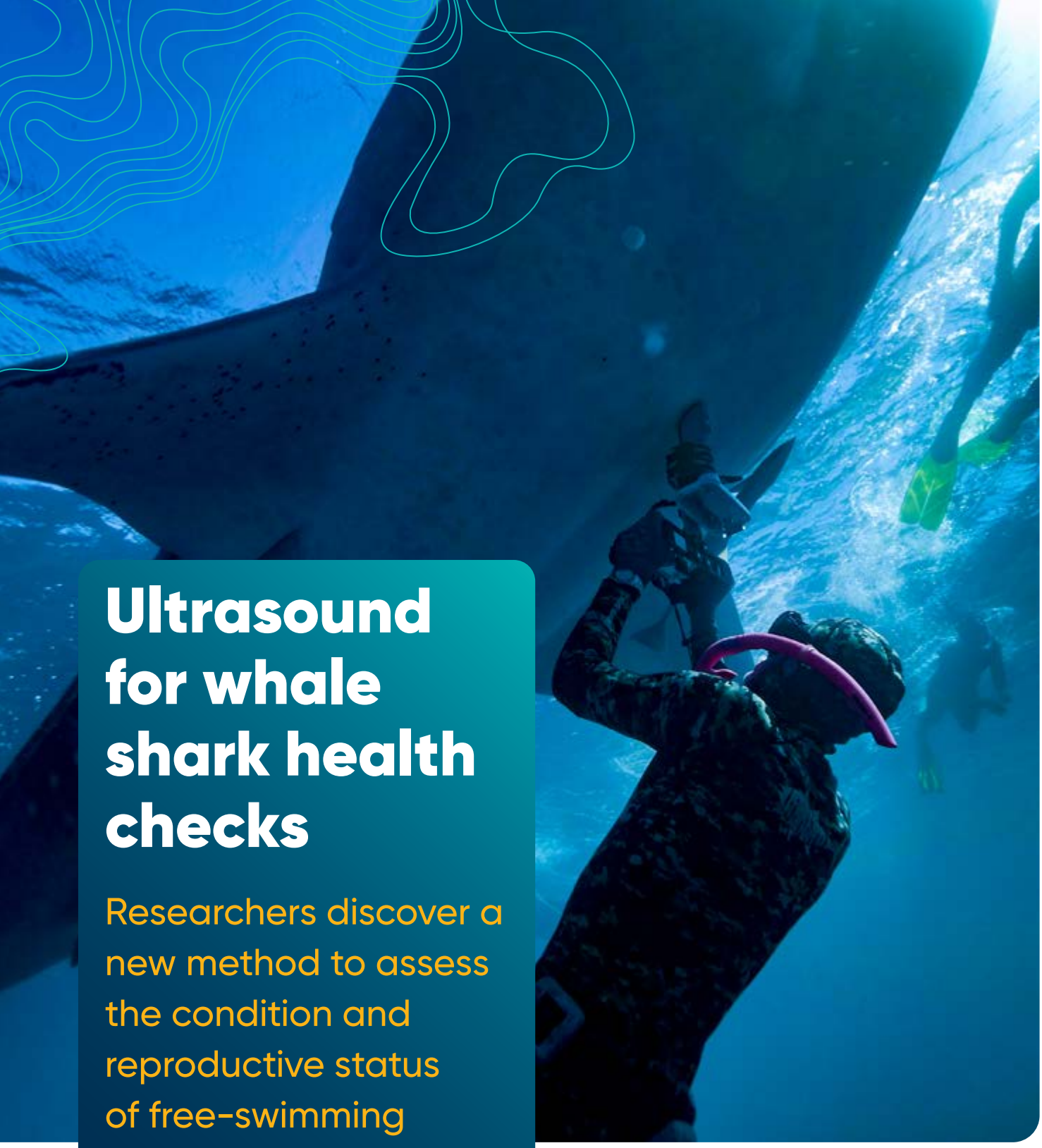
$65.3m EXTERNAL REVENUE

$137m TOTAL EXPENSES

INDIGENOUS ARTWORK DESIGN BY WEMBA WEMBA ARTIST DAVID FLAGG

The National Sea Simulator has just finished expanding to double the size, increasing its capacity to manage large-scale coral rearing facilities.

Photo: Chris Brunner



Ultrasound for whale shark health checks

Researchers discover a new method to assess the condition and reproductive status of free-swimming whale sharks

Whale sharks are large filter feeders, which makes them vulnerable to consuming plastics and man-made chemicals in the water. Efforts to monitor the health of endangered whale shark populations have led to new research opportunities using hand-held underwater ultrasound technology.

To better understand what whale sharks eat, researchers have been collecting tiny shrimp-like parasites called copepods from the whale sharks' lips and the edges of their fins. The chemical composition of the copepods is an indicator of what whale sharks are eating and of an individual animal's health.

In the process of collecting the copepods, researchers found the animals would slow down and hang vertically in the water as the parasites were scraped off. While the whale sharks were in this position, researchers were able to use a handheld

Photos: Andre Rerekura

underwater ultrasound to capture images of the animals' internal organs to help assess their condition and reproductive status.

Ultrasounds of the heart found that whale sharks have a slow heart rate of just 12 to 16 beats per minute. Researchers also mapped the location of other internal organs, particularly the liver, where oil is stored to keep the whale shark buoyant.

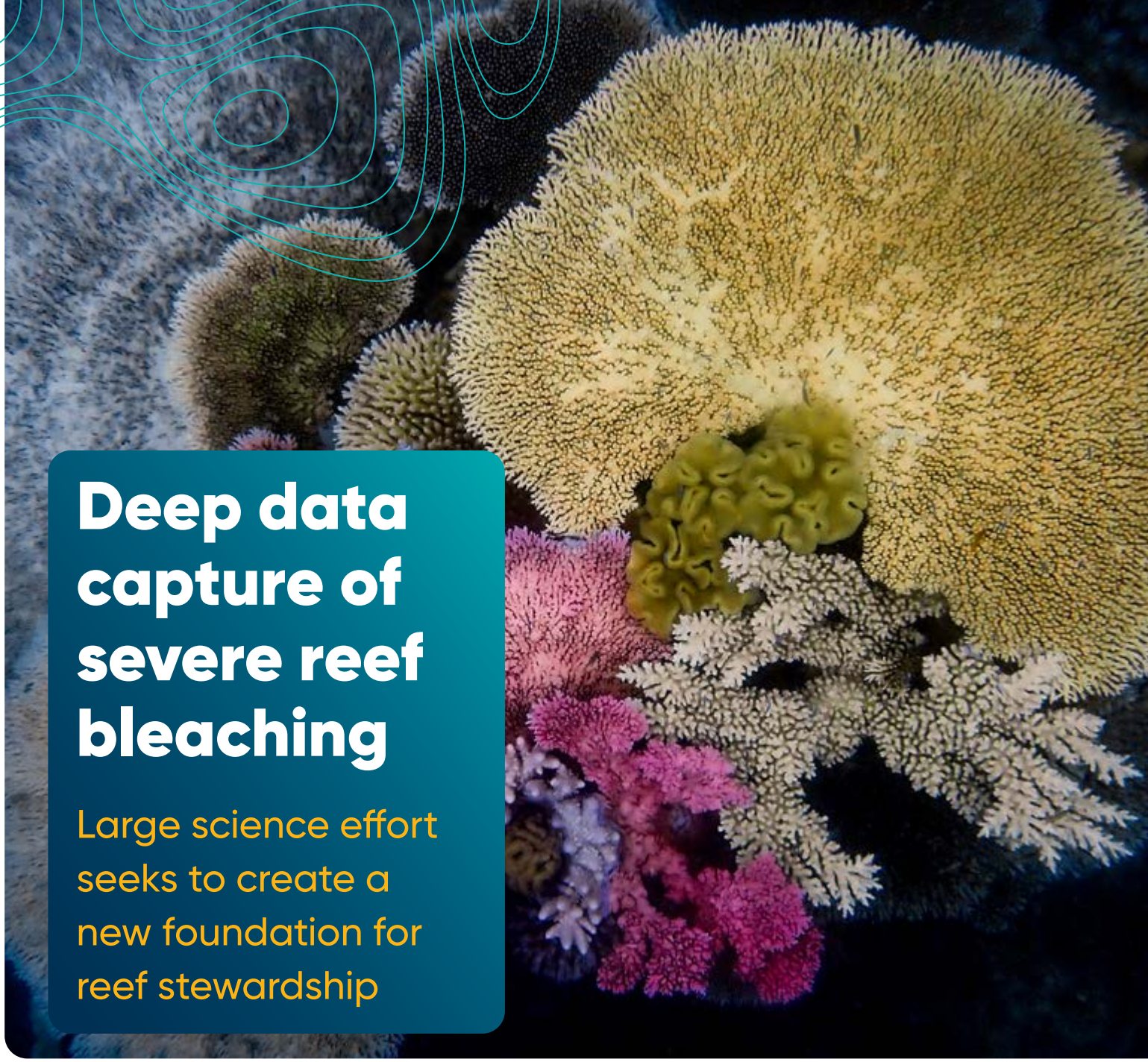
Ultrasounds of the back of the shark identified skin thickness and muscle bundles. They also showed the layer of hard denticles that feels like sandpaper at the skin surface, and the layer of connective tissue up to 20cm deep below it. Whale shark skin is among the thickest of any animal, and the study showed that whale sharks that were in poor condition had thinner skins.

The ultrasound research builds on the 20-year whale shark monitoring program at Ningaloo Reef run by Australian Institute of Marine Science (AIMS) and the University of Western Australia's Oceans Institute to help conserve the species. As scuba diving around whale sharks is not permitted at Ningaloo and touching whale sharks is illegal, the research has been conducted with animal ethics approval and sampling permits granted by the Western Australian Department of Biodiversity, Conservation and Attractions.

The ultrasound research has been conducted and funded by AIMS and supported by Santos. Collaborators include The University of Western Australia, WA's Mira Mar Veterinary Hospital, Okinawa Churaumi Aquarium in Japan, and Georgia Aquarium in the US.

AIMS researchers work in tandem to collect copepods from the mouth of the whale shark, which places the fish in a good position for a liver ultrasound.

Photo: Andre Rerekura



Deep data capture of severe reef bleaching

Large science effort seeks to create a new foundation for reef stewardship

The 2024 Great Barrier Reef bleaching event was among the most extensive and serious on record. It was also subject to the largest ever survey of bleaching undertaken by AIMS.

Observations of coral bleaching were captured from aerial surveys of 1000 reefs across the entire length of the Great Barrier Reef using helicopters and fixed-wing airplanes. The aerial survey area ranged from Torres Strait in the north to the Capricorn-Bunker group in the south. Around half of the reefs experienced record levels of heat stress during 2024, with ocean temperatures peaking at 2.5°C above the historical summer maximum.

Aerial surveys documented the extent and prevalence of the bleaching. Overall, coral bleaching was observed on 73 per cent of surveyed reefs within the Marine Park and 6 per cent in the Torres Strait.

Beneath the surface, over 40 scientists carried out in-water surveys to assess bleaching severity and coral mortality within reef communities, after summer heat stress reached its peak.

The team worked from AIMS' research vessels and chartered vessels. Those surveys were undertaken during the peak of coral bleaching and included tens of thousands of individual corals. These in-water studies are now set to provide information on:

- heat stress variation among different corals, including genetic analysis of corals showing more resilience to coral bleaching
- the prevalence and severity of bleaching in different habitats and depths
- data on coral death and follow-on impacts to reef communities.

Photo: Greta Zampa

The team also ran research projects from the point where heat was building on the reef (February-March), through to when it peaked. The objective was to understand the ecological and evolutionary impacts of more frequent mass bleaching events, and to develop new tools for reef restoration.

Additionally, follow-up surveys were conducted to better understand the long-term effects on coral death, susceptibility to disease, reproduction, growth, recovery and resilience.

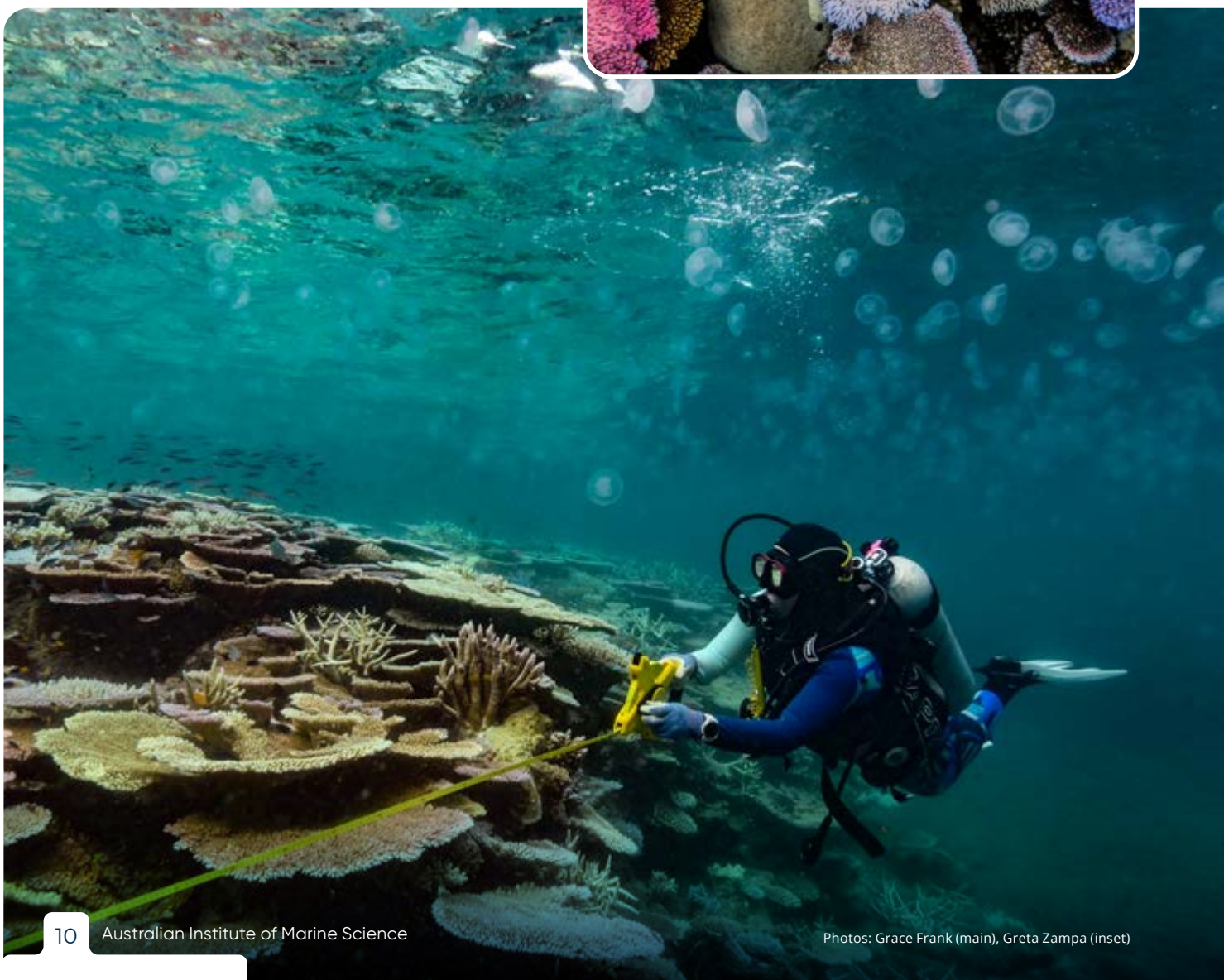
Those insights into reef ecology are also strengthened by combining data from AIMS' routine monitoring surveys, including the Long-Term Monitoring Program (LTMP) and the ongoing EcoRRAP surveys.

Analytical methods are boosted through innovations, such as computational models driven by artificial intelligence (AI) to speed up coral bleaching and species identification in survey imagery data.

The aim is to acquire a better understanding of the overarching dynamics of coral bleaching events and the impact of climate change. This will play a pivotal role in building foundational knowledge and in the development of end-to-end solutions to address reef restoration needs. In the future these could include solutions such as large-scale coral aquaculture and adaptation of coral species to tolerate higher temperatures.

More information about the bleaching event is available in the *Reef Snapshot 2023–24* report.

The project was conducted in partnership with the Great Barrier Reef Marine Park Authority.



Photos: Grace Frank (main), Greta Zampa (inset)

Extreme bleaching levels in shallow waters at North Direction Island in the Northern Great Barrier Reef (March 2024).

Photo: Neal E Cantin

Throwing light on coastal fish nursery habitats

Indigenous Ranger groups learn skills to map and monitor fish stocks

The Integrated Reef Fish Monitoring Program was a two-year collaborative project between Ranger groups, government agencies and universities to promote reliable long-term monitoring data of fish populations in sea Country by Traditional Owner Rangers.

Scientists and Traditional Owner-led Ranger groups have co-designed an integrated reef fish monitoring project in the central Great Barrier Reef (GBR), between the Family Islands group and the coastal city of Townsville.

MinggaMingga, Yunbenun and Girringun Land and Sea Rangers have gained fish monitoring skills to help assess the status of fish populations in their sea Country in the central GBR.

The research contributed to filling knowledge gaps about how reef fish use coastal nursery seascape habitats. The underwater video surveys targeted important commercial and recreational species such as nannygai and red emperor, as well as the overall abundance and diversity of a number of fish species.

Photos: Gus Burrowes

Underwater video camera systems were placed on the sea floor in various near-shore locations. After retrieval, the footage is analysed by specialists, who identify the fish species, and record their size and relative abundance.

The monitoring will increase the communities' knowledge of their traditional coastal habitats and allow our research teams to establish a reference point that will help detect future changes in the fish populations abundance, particularly early life history stages such as juvenile fishes. This is valuable information for managers, fisheries and Traditional Owners to help assess the health of fish stocks in specific locations.

The project was part of the Reef Trust Great Barrier Reef Integrated Monitoring and Reporting Program, led by AIMS. It is a collaborative project between AIMS, TropWATER: JCU's Centre for Tropical Water and Aquatic Ecosystem Research, Marine Data Tech, University of the Sunshine Coast, Traditional Owners from Girringun Aboriginal Corporation, Manbarra and Wulgurukaba, and with input from Department of Agriculture and Fisheries (Queensland) and the Great Barrier Reef Marine Park Authority.

The monitoring and reporting program was funded by a partnership between the Australian Government's Reef Trust and the Great Barrier Reef Foundation.

At Orpheus Island, Traditional Owner rangers and scientists are using underwater video surveys to monitor reef fish populations and coastal habitats. This collaboration strengthens sea Country management and supports future conservation efforts.

Photo: Gus Burrowes

ReefSeed: A breakthrough in coral reef restoration capability

Global role for AIMS' innovative portable coral aquaculture system

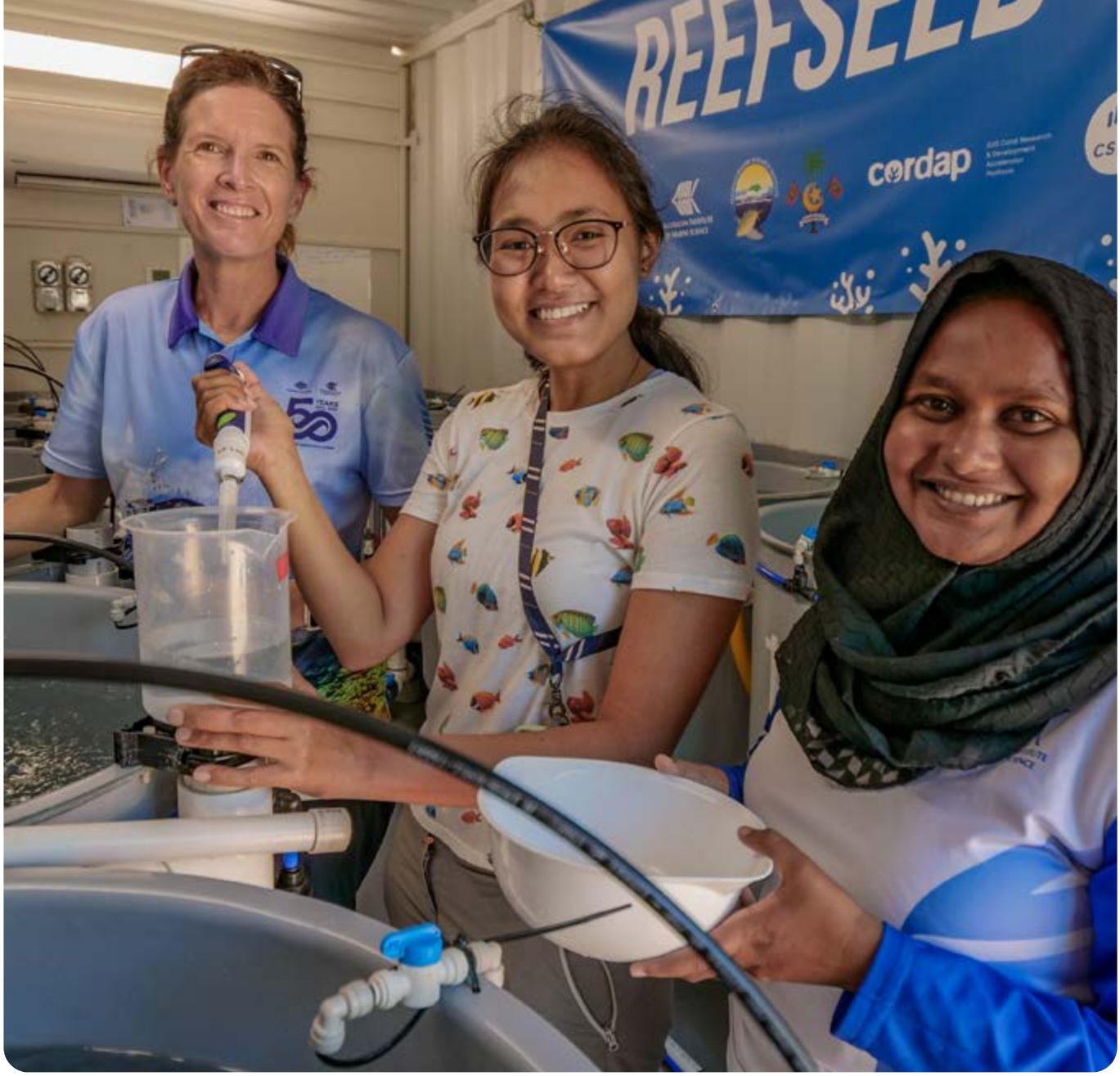
In recent years, AIMS has developed innovative technologies to mass produce healthy coral larvae needed to help restore damaged reefs. Two such developments, the Autospawner and ReefSeed, are now being used for the first time internationally.

The Autospawner facilitates the fertilisation of large numbers of coral eggs with minimal labour. This makes it more efficient to produce millions of coral larvae, as part of AIMS' collaboration in the Reef Restoration and Adaptation Program (RRAP).

The Autospawner, which is being further developed for use by international collaborators, has now been incorporated into the ReefSeed system. ReefSeed is a first-of-its-kind portable and self-contained coral aquaculture system that includes both power and life-support capabilities. It is designed to be taken to remote areas to produce millions of coral larvae for reef restoration.

Compared to manual spawning methods, ReefSeed is designed to maximise fertilisation success and larval production, reducing labour costs for restoration efforts at scale.

Photos: Marie Roman



The mobile coral spawning and rearing unit maintains water filtration and temperature controls using an independent power source. It draws water from the ocean to support a multiphase coral rearing process, which involves:

- spawning of adult corals collected from local reefs;
- automated egg and sperm capture, and egg fertilisation;
- development and rearing of coral larvae; and
- settlement and development of coral larvae into coral polyps. Coral seeding devices are then assembled to hold the young corals for deployment onto specifically chosen reefs.

The AIMS team designed and built ReefSeed in time to test it during the Great Barrier Reef's synchronised mass spawning in October 2024. This spawning event was of particular concern as it followed extensive bleaching events during summer and damage caused by cyclones and floods.

Collaborating scientists from the Maldives Marine Research Institute (MMRI) were trained to use the ReefSeed system at AIMS in 2024, and the whole team is working together again on location in the Maldives for the coral spawning event in March 2025.

The Maldives deployment effort spearheads efforts to scale up the production of healthy young corals for reef restoration around the world, even in the most challenging environments.

The ReefSeed project was developed by AIMS in partnership with MMRI and CSIRO, using funding from the G20 Coral Research and Development Accelerator Program (CORDAP).

ReefSeed is a portable large-scale coral aquaculture system designed by researchers at AIMS, CSIRO, and the MMRI. The automated system can be packed in two containers and used in remote areas, with international researchers receiving hands-on training from AIMS experts.

Photo: Marie Roman

Starfish control backed by long-term Reef data

The challenge

Crown-of-thorns starfish (also known as COTS) are a major driver of coral loss throughout the Indo Pacific, including the Great Barrier Reef. The native starfish eat living hard coral and when in large numbers, can decimate reef-building coral communities. Four waves of starfish outbreaks have been recorded on the Great Barrier Reef since the 1960s.

Targeted suppression of COTS outbreaks via manual culling is one management action that can protect coral across entire reefs and regions. On the Great Barrier Reef, this activity is implemented through the Reef Authority's COTS Control Program.

The Control Program originally targeted small-scale, high-value tourism sites during the third outbreak (1992-2009) on the Reef. From 2012, during the fourth outbreak, the Program evolved with a strategic 'scaled up' approach to supress starfish numbers and protect coral at the regional level.

A robust assessment of Control Program performance required an extensive region-wide data set across many reefs from before and after the Program's renewed activities commenced.

The approach

AIMS' Long-Term Monitoring Program (LTMP), begun in 1986, routinely monitors the condition and status of reefs along the length and breadth of the Great Barrier Reef. It is the most comprehensive and extensive record of a reef ecosystem in the world.

The LTMP records of crown-of-thorns starfish numbers and hard coral cover were the ideal source of data to test the efficacy of the Control Program. The evaluation (Matthews et al, 2024) used 20 years of data from 207 reefs, across seven regions on the Great Barrier Reef, to compare outcomes from the third starfish outbreak wave (before 2012), and the fourth outbreak wave (after 2012 when current strategic control activities commenced). Different levels of control effort and timeliness were also assessed.

The impact

AIMS' large scale, long term, routine information demonstrated that the improved COTS Control Program was an effective tool to protect corals at regional scales.

Starfish densities in some regions were reduced by up to six times with timely and adequate control efforts compared to the previous outbreak. This level of effort also coincided with region-wide coral cover increases of up to 44% despite other disturbances occurring. The previous outbreak saw coral cover declines of up to 37%. Even reefs which received reduced control effort were afforded some protection from the Control Program. On these reefs, the rate of coral loss was more than halved from the previous outbreak.

The results indicate that the COTS Control Program may contribute to delaying the wave of outbreak progression to adjoining sectors by reducing starfish larval supply.

AIMS' LTMP was the ideal data source for a spatially extensive and robust evaluation of the Control Program, providing certainty around its efficacy value as a resilience-based management tool. The COTS Control Program is a core priority of the Reef 2050 Plan and supported by a $161.4 million investment (2022 -2030) from the Australian Government.

The COTS Control Program is delivered by the Great Barrier Reef Marine Park Authority in partnership with the Reef and Rainforest Research Centre and supporting government agencies, industry partners and contractors.

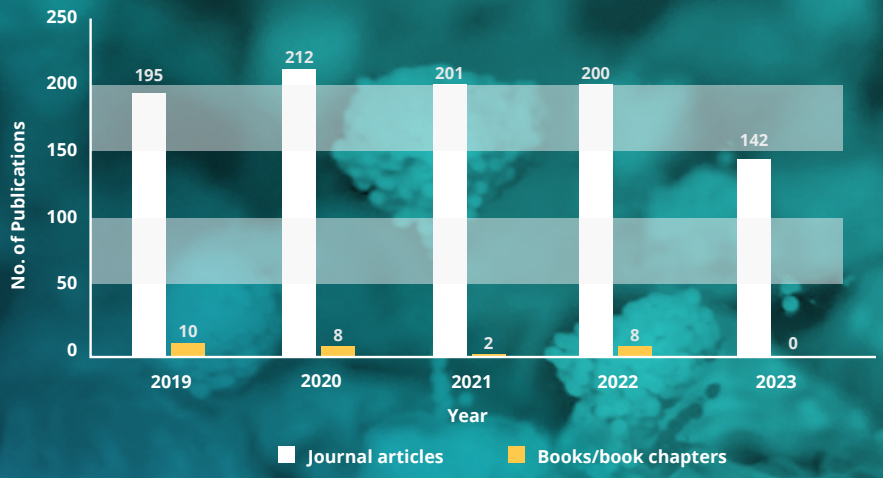
20 YEARS
OF COTS DATA
FROM 207 REEFS

UP TO
6 X LESS
CORAL-EATING STARFISH

UP TO
44% INCREASE
IN REGION-WIDE
CORAL COVER

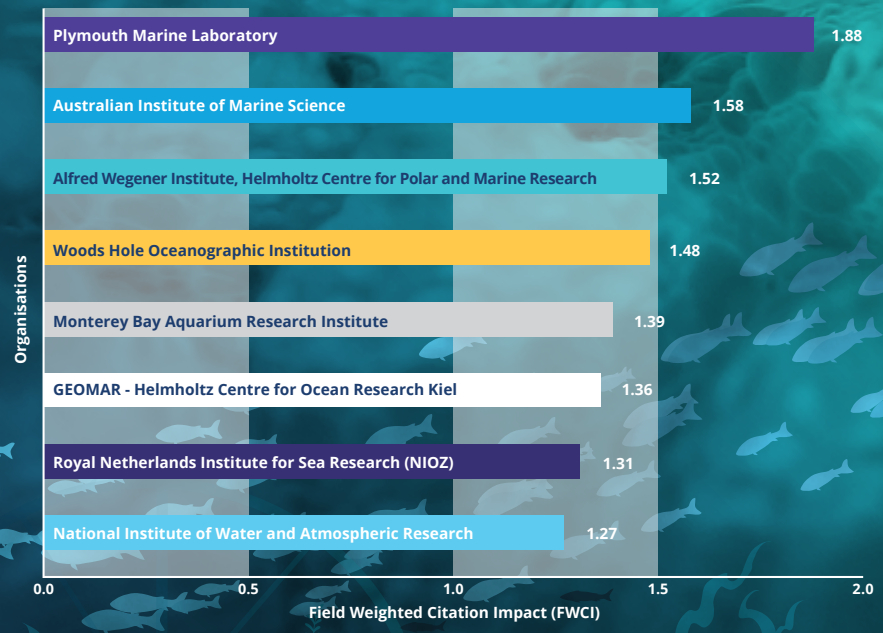
CERTAINTY AROUND
$161.4M
INVESTMENT

Research performance



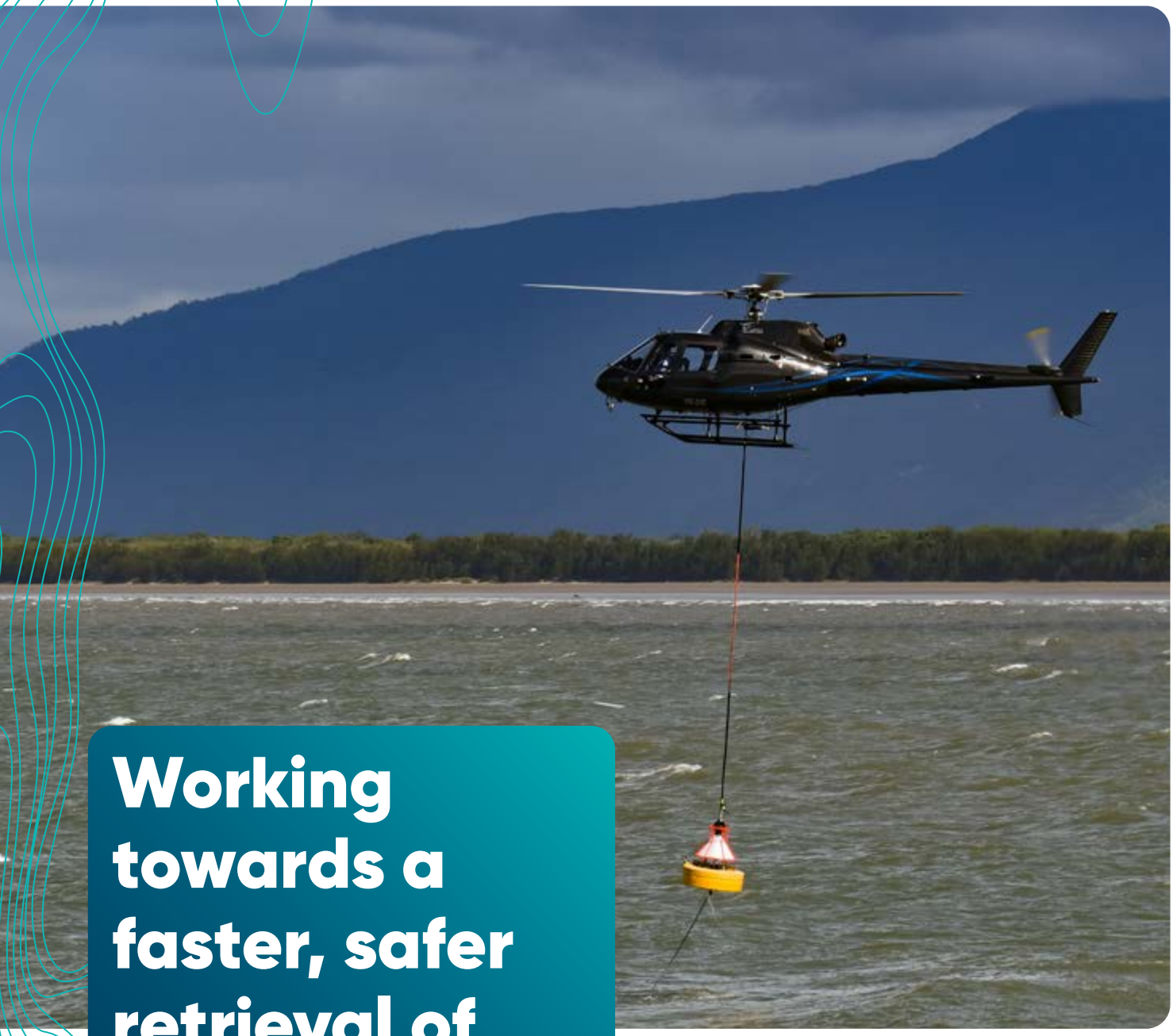
Number of AIMS publications by type, 2019 to 2023

The main types of publications produced by our research staff are peer-reviewed journal articles and reviews, books and book chapters, followed by client reports (not shown).



Citation impact ranking

Top 8 marine science organisations as indicated by the Field Weighted Citation Impact (FWCI) factor, where a FWCI equal to 1.00 is the world average. Graph shows a 5-year average. (Comparison of Field Weighted Citation Impact (FWCI), 2023, SciVal).



Working towards a faster, safer retrieval of marine assets

Modified cargo lift automates deployment and recovery of research buoys

Retrieving valuable marine assets such as ocean monitoring buoys from rough seas or remote locations can be a logistical and physical challenge for helicopter operators and on-water support crews.

In collaboration with Townsville Helicopters, AIMS has successfully modified a land-based autonomous cargo handling system for use at sea.

Townsville Helicopters tested the modified Talon Auto-Loc Cargo Hook System, which can attach to marine assets without the need for a sea-based support crew to manually attach lines for deployment or retrieval.

The system has two parts: a hook assembly attached under a helicopter, and a target component attached to the asset. The hook and target components automatically lock together without manual assistance.

Photos: Jo Hurford

Townsville Helicopters first tested the Talon system on land, then on still water, and finally at sea in rough conditions. This trial identified that the target component on the buoy can be knocked out of position, causing the auto-lock mechanism to fail.

AIMS staff modified the buoy by incorporating a rigid target assembly to ensure consistent auto-locking.

The third trial phase, at sea, was conducted in 2024 at the AIMS ReefWorks tropical marine technology test range, an AIMS facility supported by the Queensland Government.

The helicopter smoothly deployed, then retrieved, a modified 375kg AIMS mooring (buoy, chain and anchor) from the waters of the inshore test range and delivered it onto the wharf. This was achieved without the assistance of land or sea-based personnel, during adverse weather with strong winds and rough seas.

AIMS maintains a significant amount of sea-based infrastructure across tropical Australia including buoys, moorings and uncrewed systems. The development of this autonomous system for marine conditions is expected to provide marine organisations such as AIMS with alternative, safe methods to deploy and recover moorings and autonomous systems.

It will increase the efficiency of operations and, in urgent situations such as preparing for incoming cyclones, can help retrieve assets more rapidly.

The AIMS research vessel, RV Cape Ferguson, located on the east coast, assists researchers in testing a new automated reef monitoring platform at the Davies Reef test range.

Photos: Marie Roman

Monitoring turtle nests to better protect turtles from climate change

Collaborating with NT rangers to build skills and collect data for effective sea Country management

Climate change poses a significant threat to marine turtle populations, especially during egg incubation. The sex of hatchlings is determined by temperature; warmer temperatures tend to produce more females. Consequently, if temperatures are too high during incubation, the ratio of male to female turtles becomes imbalanced. Extreme temperatures can also affect egg survival and impact hatchling body size and performance.

Researchers from AIMS and Charles Darwin University have been working with Aboriginal Land and Sea Rangers over the past two years across the Northern Territory. The project seeks to establish baseline data on turtle nest environments at key nesting sites for green, olive ridley and hawksbill turtles throughout the region, focusing on variables such as temperature and humidity.

The project has two main components: the first step involves a desktop spatial risk assessment to identify

Photo: Michele Thums

high-risk hotspots related to temperature, inundation or cumulative risks to hatching success. The desktop analysis is complemented by field studies aimed at collecting data on nest temperatures and hatching rates, while also training rangers in vital research and monitoring techniques, including:

- deployment of temperature and humidity loggers in nests and on nesting beaches
- measurements of beach slope angles in nesting habitats to evaluate vulnerability to sea-level rise.

Through this research, we aim to enhance the scientific monitoring skills of rangers in the Sea Country areas where AIMS conducts research. This capacity-building effort will empower rangers to better comprehend the ecological processes impacting marine turtles, thus strengthening partnerships with the various supporting agencies involved.

The scientific outcomes of this project include understanding of the risk of climate change (increasing temperature and sea level rise) at nesting sites for listed threatened marine turtle species from three key genetic stocks in Northern Australia, and how these factors influence hatching success.

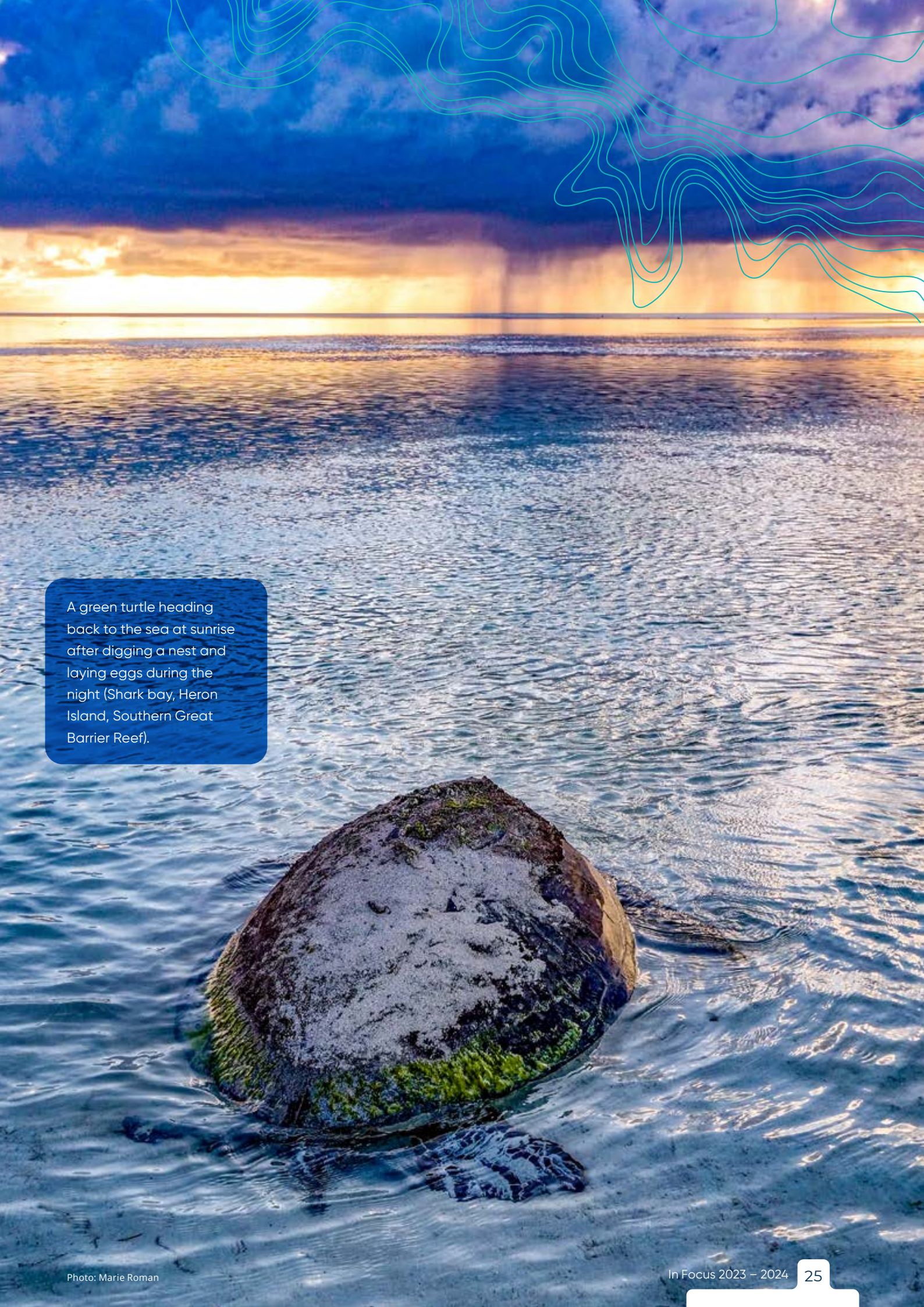
Additionally, we will enhance our understanding of hatchling sex ratios in nests and determine the temperature thresholds affecting egg survival.

These outcomes will provide robust data to guide decisions around potential management strategies at turtle nesting sites.

In March we will convene a knowledge-sharing workshop to discuss results and co-design feasible mitigation measures with representatives from each Ranger Group. This event will also serve to strengthen partnerships among government agencies, researchers and Rangers.

This project is funded by the Australian Government Department of Climate Change, Energy, Environment and Water, and led by a research partnership through Charles Darwin University and AIMS in collaboration with the Anindilyakwa Land and Sea Rangers, the Crocodile Island Rangers, Dhimurru Aboriginal Corporation, the Ii-Anthawirriyarra Sea Ranger Unit and Parks and Wildlife Commission, Northern Territory Government.

Photo: Joan Costa



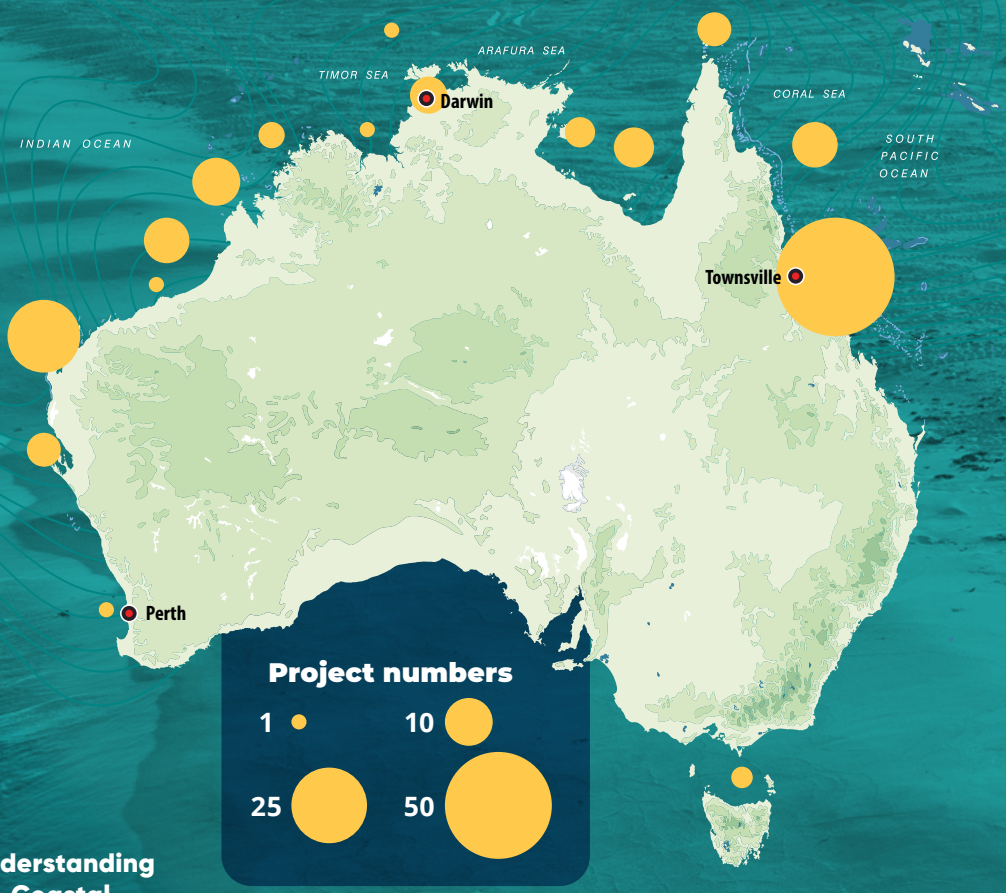
A green turtle heading back to the sea at sunrise after digging a nest and laying eggs during the night (Shark bay, Heron Island, Southern Great Barrier Reef).

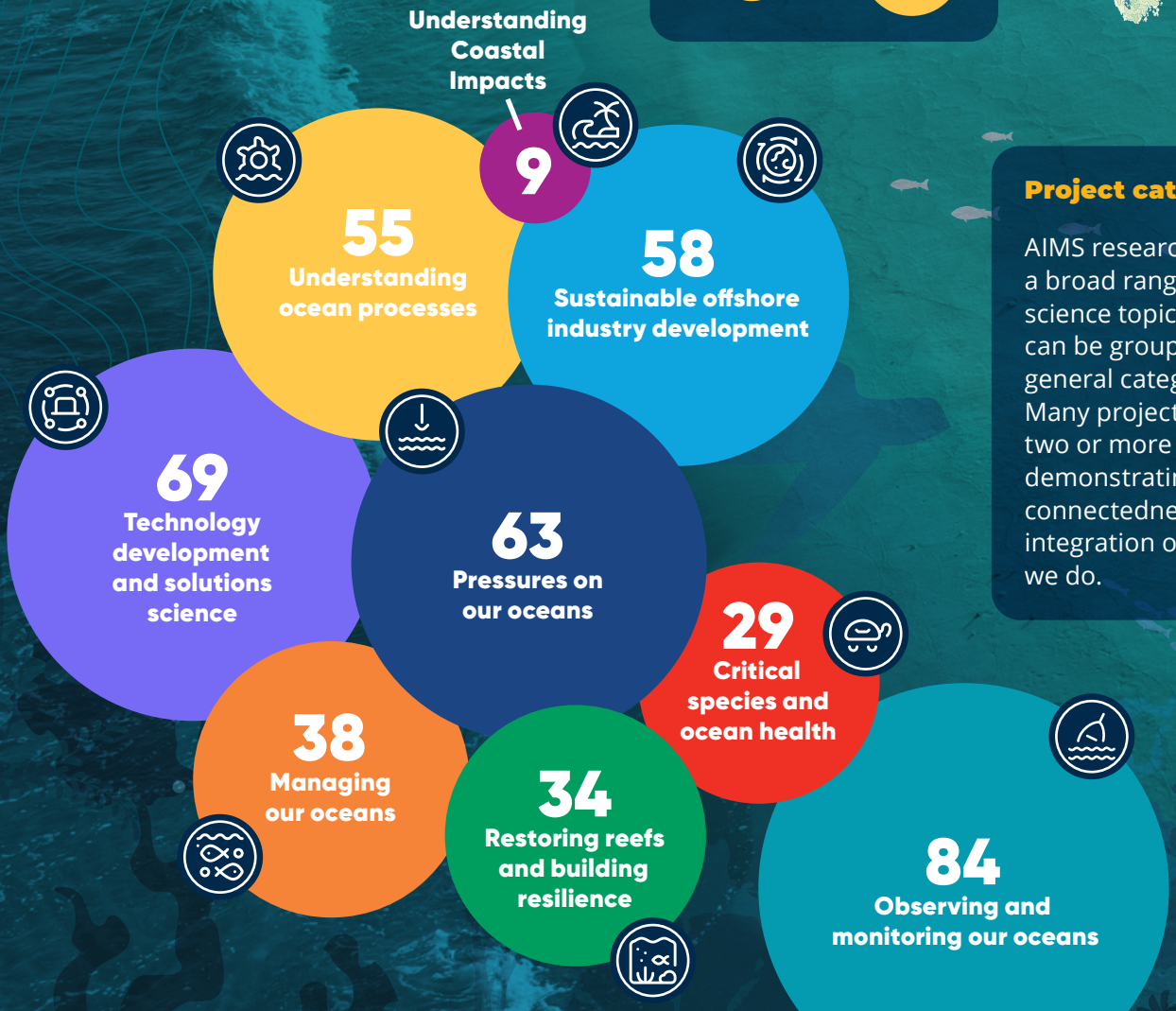
Photo: Marie Roman

Project scopes

Project geography

AIMS researchers worked on 114 projects, conducting research across Australia's tropical locations. Many of the projects cover multiple locations, as shown by the graphic.





Project categories

AIMS research covers a broad range of science topics that can be grouped into general categories. Many projects cover two or more categories, demonstrating the connectedness and integration of all that we do.

AIMS' National Sea Simulator is pioneering new coral restoration techniques to fast-track reef recovery. Using the automated AutoSpawner system, researchers are producing millions of coral larvae, which are nurtured and transplanted onto reefs to enhance survival and growth.

Photo: Jose Montalvo-Proano

World-first mass coral seeding trial

Scientists deliver 100,000 baby corals to advance reef restoration

In what is thought to be the largest single coral reef restoration research trial, AIMS scientists distributed 100,000 baby corals to the Great Barrier Reef in late 2023, as part of the Reef Restoration and Adaptation Program (RRAP).

The trial represents a major scaling up of coral conservation aquaculture and restoration methods. It brings together teams of scientists, engineers and technicians from a range of organisations to help the Great Barrier Reef survive climate change.

Using AIMS' National Sea Simulator (SeaSim), the teams have developed novel coral production and distribution approaches to fast-track the recovery of reefs affected by disturbances such as coral bleaching.

In particular, the new AIMS-designed AutoSpawner technology has boosted the number of coral larvae produced in the SeaSim facility, becoming a completely automated system that increases the efficiency of the coral aquaculture process during the annual mass coral spawning period. This has reduced reliance on human handling and labour and

Photo: Marie Roman

improved efficiencies. AIMS had four auto-spawners in operation during last year's spawning event, with each one capable of producing up to 7m larvae in one night.

The larvae then proceed to fix themselves onto special tiles and reared into baby corals over the course of a few days or weeks, before being placed into special AIMS-designed ceramic devices, which are used to seed reefs with new live coral.

Each device can hold 15 to 30 young corals, but not all will survive and grow to full maturity. This process has increased larval survival significantly above natural rates by providing added protection for the growing juveniles.

In 2023, 10,000 devices were delivered onto several reefs through the RRAP, some carefully placed into plots by divers and others were freely deployed from a small vessel. Researchers are monitoring the devices to compare how the young corals fare in both deployment scenarios.

Techniques to optimise the environment and health of these young corals are being explored, such as harnessing natural cues that encourage larvae to settle quickly and grow on preferred surfaces. Scientists have also applied non-toxic foul release coating on these deployment devices to reduce competition from algae and protect the young during their first year of life on a reef.

Coral aquaculture activities in the National Sea Simulator at AIMS are being conducted in collaboration with Southern Cross University, Taronga Conservation Society, The University of Queensland, James Cook University, Griffith University and Queensland University of Technology.

RRAP is funded by the partnership between the Australian Government's Reef Trust and the Great Barrier Reef Foundation.

Photos: Jose Montalvo-Proano (main), Marie Roman (inset)

Water Usage

Water usage was 41.7 megalitres (ML) for 2023-2024, a reduction of 12.4 ML from the previous year.

Recycling & Waste

This year we have achieved a reduction in solid waste to landfill of 43 tonnes compared with 2018-19. This represents a 28 per cent reduction from the 2018-19 base year. In 2023-24 we recycled 33.93 tonnes of paper, cardboard and plastic products. This is a 60 per cent increase on the previous year.

Energy Usage

Our total energy usage across the sites that we operate was 6623 MW for 2023-24. This represents a 6 per cent reduction in usage at our Cape Ferguson Facilities and a 12 per cent reduction at our facility in Darwin. We also generated 1335 MW from our solar PV systems, avoiding 1088 T of emissions.

Radiation Safety

During the year, AIMS continued to hold a source licence issued by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA).

This licence is subject to conditions including quarterly reporting, maintaining a source inventory and complying with relevant regulations, codes and standards.

Gene Technology

Two proposals for dealings involving genetically modified organisms (GMOs) were assessed by the AIMS Biosafety Committee this year.

AIMS has two active dealings with GMOs. Both projects are Notifiable Low Risk Dealings (NLRDs).

Marine radiation risk from oil and gas infrastructure probed

AIMS researchers measure environmental toxicity levels to guide decommissioning decisions

A new AIMS project is examining the environmental toxicity of radioactive materials that naturally accrue in offshore oil and gas infrastructure over time.

The aim is to understand at what level these materials become toxic to marine sediment organisms. Insights gained can then assist operators and regulators decide how best to decommission offshore infrastructure to minimise environmental risks and meet international obligations.

Of concern are the radioactive elements that occur naturally at low levels in soils, rocks, the seabed, and oil and gas basins. As oil and gas is extracted, these elements can accumulate in infrastructure, such as pipelines, and form Naturally Occurring Radioactive Material (NORM). Over time, concentrations can build to exceed those found in nature.

Photo: Marie Roman

If infrastructure is left in the ocean following decommissioning, NORM may eventually leach into seawater and be released into ocean floor sediment. However, there is currently a knowledge gap around NORM impacts on marine organisms.

Using facilities at the National Sea Simulator within AIMS' Townsville headquarters, researchers are running first-of-its-kind NORM experiments. The AIMS team is dosing marine sediments collected at the AIMS jetty and beach with specific amounts of NORM. The potential toxicity of different radiation doses is then examined in four marine organisms: sea anemone, snail, starfish and a type of sea floor single-cell organism called foraminifers.

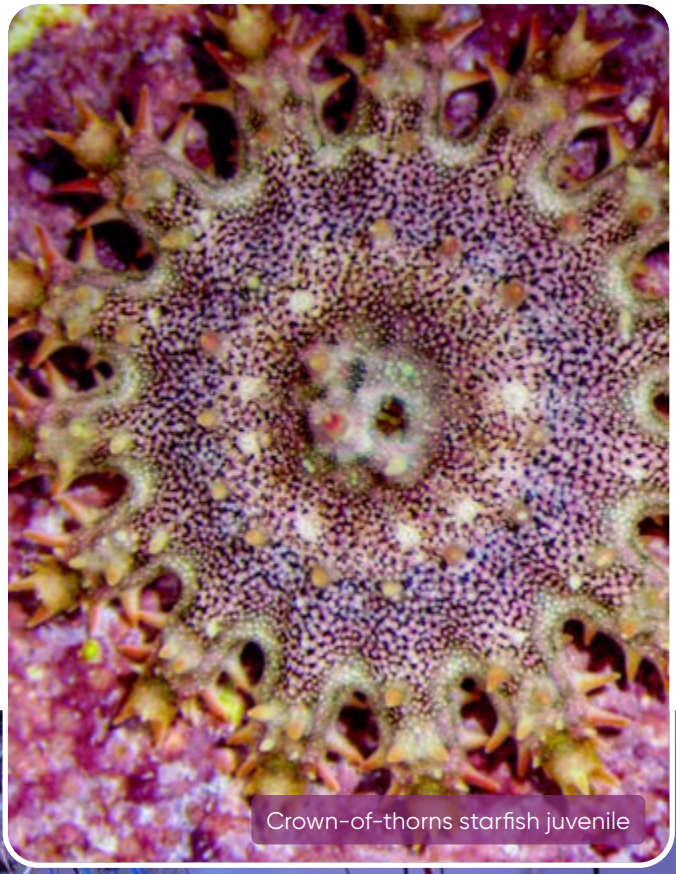
The team is also extracting environmental DNA (eDNA), which is genetic material that is sampled from a variety of sources across an environment (such as seawater) rather than directly sampled from an individual organism. As a technique, it permits the monitoring of ecosystems and the study of biodiversity.

The eDNA in the AIMS project is being extracted from sediments to understand the impact on bacterial biodiversity of the various NORM doses over a four-week experiment.

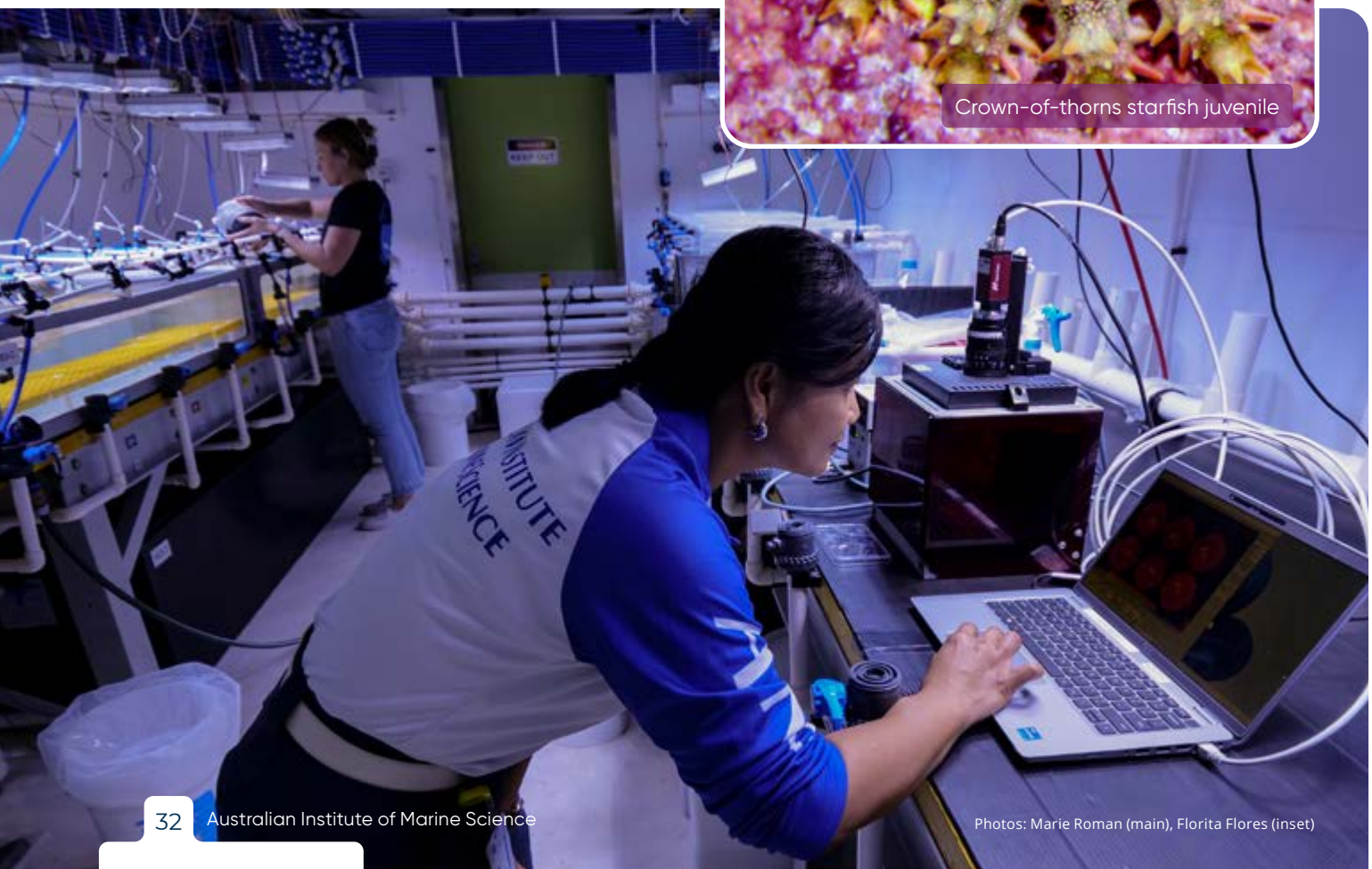
AIMS scientists are also investigating other aspects of decommissioning. This includes the habitat value of offshore structures and whether they can help maintain populations of marine species.

Taken together, the experiments stand to optimise environmental outcomes when decisions are being made about whether to remove decommissioned offshore infrastructure.

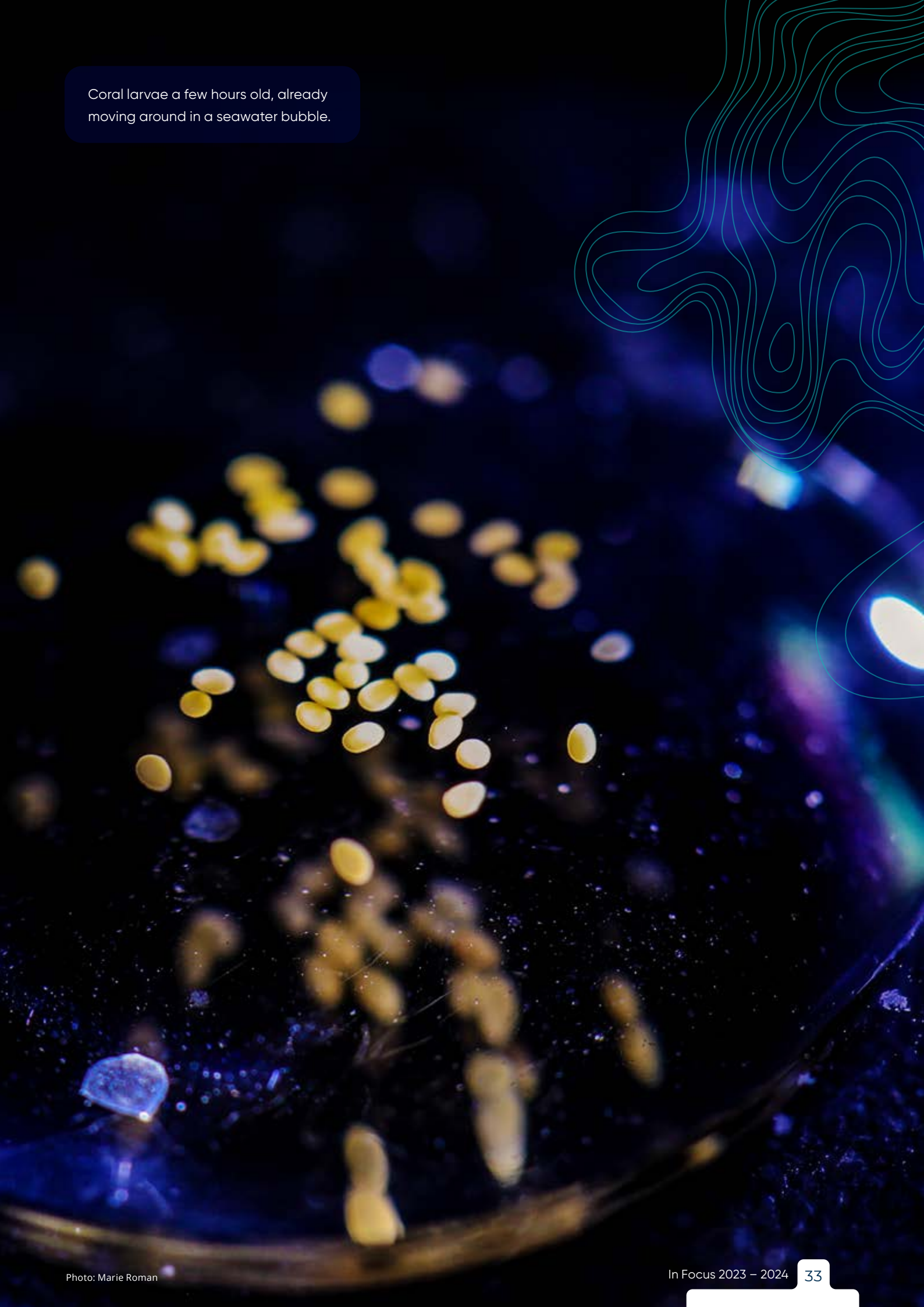
This project is a collaboration between AIMS and Australia's Nuclear Science and Technology Organisation (ANSTO).



Crown-of-thorns starfish juvenile



Photos: Marie Roman (main), Florita Flores (inset)



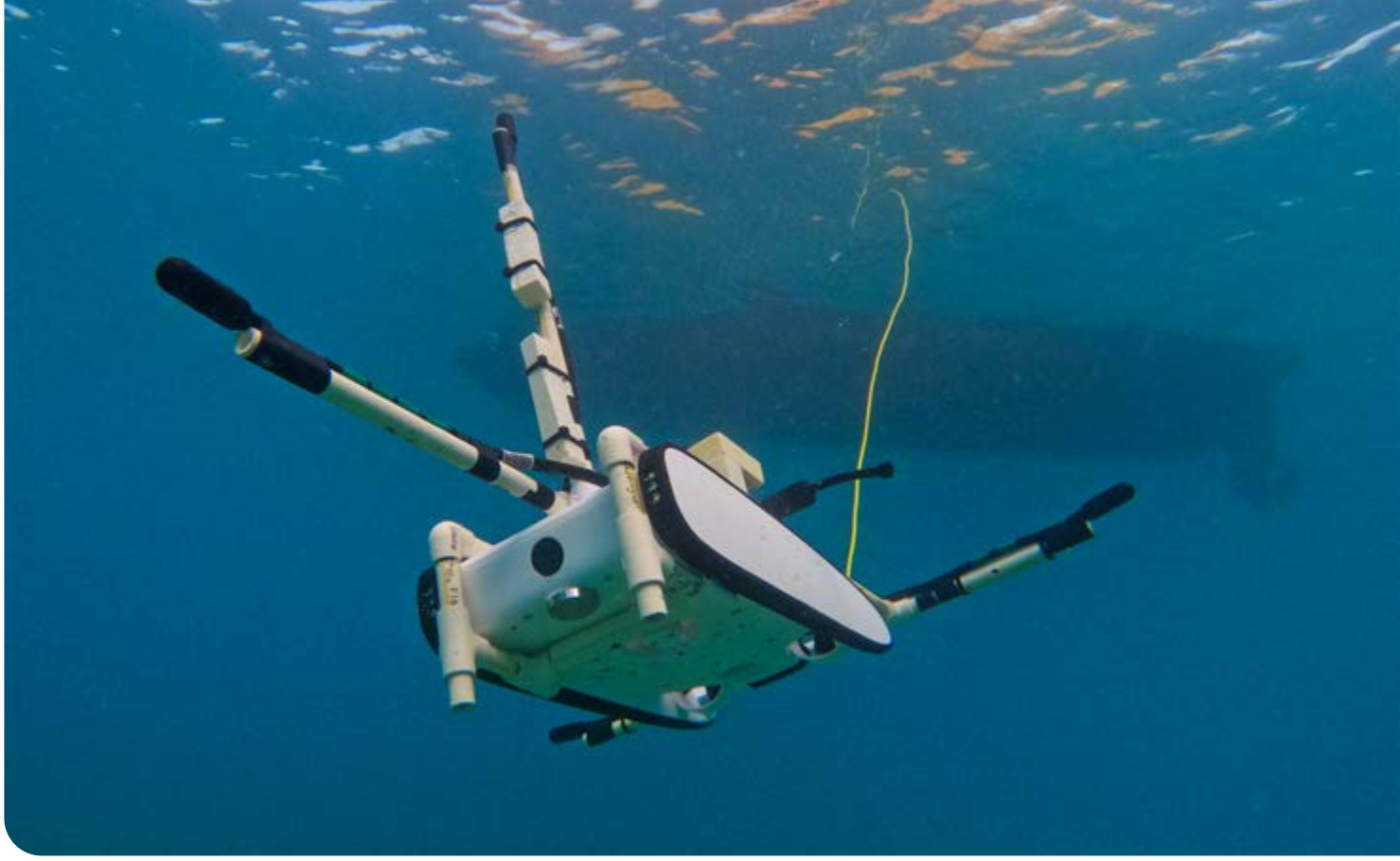
Coral larvae a few hours old, already moving around in a seawater bubble.

Photo: Marie Roman

Reef Song: can sound lure young fish to improve the resilience of coral reefs?

'Whole-of-system' approach to reef restoration looks at the interaction of sound with fish and coral health

Photo: Gemma Molinaro



As global temperatures rise, marine heatwaves are occurring more frequently, and cyclones are becoming more intense. This leaves coral reefs with less time to recover between damaging events.

Reef Song is an innovative AIMS research initiative that could help reefs by either attracting or restocking young larval fish, which may help to speed up coral growth during the critical recovery windows.

This whole-of-system approach is the first known research of its kind, taking place at Ningaloo Reef and the Great Barrier Reef.

Corals provide fish with food and habitat, while fish provide corals with cleaning services that clear the way for baby corals to settle. Fish poo also fertilises corals, boosting their growth.

Previous AIMS research has suggested that fish larvae are attracted to reefs with loud healthy coral reef sounds. When fish, crabs, shrimps and other invertebrates forage, hunt, feed, groom and mate on a reef, they create a distinct melody made up of pops, grunts, crackles and croaks – orchestrating a coral reef's signature sound.

But as reefs lose structure and diversity during disturbances, they lose the unique reef harmonies that attract young fish.

Reef Song researchers hope to confirm whether fish can be attracted to reefs and remain for periods that are long enough to assist coral development, or whether directly adding fish to the community is a more efficient way to speed coral growth to maturity.

The five-year Reef Song project was launched in 2021, initially establishing 60 experimental patch reefs at Ningaloo Reef off Western Australia's north-west coast. Another 60 patch reefs were established at Lizard Island in Queensland in 2023. These constructed patch reefs are a collection of coral rubble and live fragments of two key species.

Underwater speakers play the sound of healthy reefs at select patch reefs to attract fish, while other sites are directly stocked with juvenile and adult fish collected from adjacent areas.

Ongoing monitoring includes a technique called photogrammetry to measure coral growth on the patch reefs, fish surveys and restocking of reefs with fish larvae if needed. Recordings of sounds on patch reefs and nearby natural reefs are helping scientists to identify the sources of different sounds.

AIMS researchers have been joined by collaborators from Exeter and Bristol universities in the United Kingdom, Curtin University and The University of Western Australia, and the National Oceanic and Atmospheric Administration (NOAA) from the United States.

Reef Song is jointly funded by AIMS and BHP. It is part of the $27m Australian Coral Reef Resilience Initiative (ACRRI).

Photo: Jo Hurford

AIMS' Reef Song project is exploring how reef sounds and fish stocking can accelerate coral recovery. Using underwater speakers and fish reintroductions, researchers aim to restore reef ecosystems and boost coral growth after climate-driven disturbances.

Photo: Jo Hurford

Decoding the dynamics of enigmatic ocean currents

Ocean sensors and satellites to better predict currents off the North West Shelf

Sensors have been deployed north of Broome in the Browse Basin, Western Australia, to better predict ocean current dynamics, which can help inform conservation projects, as well as manage operational challenges for offshore industries or search and rescue missions.

These measurements, along with water sampling and satellite imagery, will help close knowledge gaps about swirling eddies, underwater waves and how the ocean responds to tropical cyclones.

The sensors were deployed from the AIMS Research Vessel *Solander* and can measure ocean properties from the surface to the sea floor.

Several moorings were deployed in the study area for six weeks to measure temperature, salinity and ocean currents throughout the water column. Other instruments measured fine-scale water features and turbulence with very delicate probes.

Photo: Andrew Zulberti

The deployment coincided with the detailed mapping of the Browse Basin using the SWOT satellite (Surface Water and Ocean Topography) deployed by NASA/CNES (Centre National D'Etudes Spatiales) during its fast-sampling phase.

The combined dataset will be incorporated into ocean computer models to improve our understanding of strong currents, which can range from hundreds of metres to hundreds of kilometres and can last from hours to days.

Currently available forecasts cannot predict these transient ocean processes, as they have not been measured or mapped in fine enough detail to inform offshore operators.

The immediate goal is to develop predictive models to guide decision-making by those working in the Browse Basin to help offshore operators achieve high operational and environmental safety standards.

In the years ahead, the team will analyse data and develop products that can be translated into further tools for industry.

The project was conducted in partnership with the University of Western Australia through the Australian Research Council (ARC) Research Hub for Transforming energy Infrastructure through Digital Engineering (TIDE). TIDE was established in 2021 through funding provided by the ARC, several major industry partners, UWA and the University of Wollongong.

Photos: Simon Spagnol

This healthy bubble coral (*Plerogyra sp.*) uses its water-filled bubbles to regulate light exposure during the day. At night, the bubbles deflate, allowing feeding tentacles to emerge and capture prey.

Photo: LTMP

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Photo by Giacomo D'Orlando