

A graphic consisting of several horizontal, wavy lines in a rainbow color gradient (blue, purple, pink, red, orange, yellow, green) that flow from the left side of the image towards the right, where they meet the text.

SEASIM

The National Sea Simulator



Australian Government



AUSTRALIAN INSTITUTE
OF MARINE SCIENCE

INTRODUCTION

The National Sea Simulator (SeaSim) is the most advanced research aquarium in the world. Built upon leading-edge technology, SeaSim provides scientists with unprecedented opportunities for extending their experimental capabilities, contributing to a transformation in tropical marine research.

SeaSim provides the potential to unlock invaluable insights into how our marine systems may look in the future. It facilitates multi-disciplinary, collaborative research in high priority areas such as climate change, ocean acidification, water quality, pest management and intervention, and coastal and industrial development impacts. This is achieved through not only accurately replicating marine conditions such as temperature, light and salinity, but also by dynamically manipulating these parameters to model future scenarios.

SeaSim is operated by the Australian Institute of Marine Science (AIMS), Australia's tropical marine research agency, at its Cape Ferguson headquarters, near Townsville. Its combined proximity to the Great Barrier Reef (GBR), access to dedicated research vessels and world-class laboratory and analytical facilities, SeaSim presents a compelling package for marine researchers around the globe.



WHAT IS THE SEASIM?

The National Sea Simulator is a world-leading experimental aquarium facility revolutionising marine science research.

By integrating technology drawn from the industrial processing sector and large-scale commercial aquaria, SeaSim can:

1. Precisely control complex combinations of environmental variables to accurately simulate both naturally-occurring and human-influenced water conditions;
2. Undertake long duration, multi-organism experiments (particularly with corals, sponges and seagrasses) in large-scale tanks (mesocosm-style) with precise control over seawater and ambient conditions; and
3. Increase knowledge rates through the development of model marine organisms, with the current focus on corals and coral reproduction.

Innovative design infrastructure and key technologies set SeaSim apart from other marine research aquariums; the most up-to-date specifications are provided on the AIMS website: <http://www.aims.gov.au/national-sea-simulator/capabilities>.

There are a number of differently configured areas within the SeaSim suited to a variety of different experimental systems.

Controlled Environment Rooms facilitate shorter duration experiments in highly replicated small tanks. Researchers are able to carry out complex, large multi-factorial experiments to determine the individual, combined and cumulative effects of various factors (e.g. temperature, $p\text{CO}_2$, turbidity, nutrients, and contaminants) on tropical marine ecosystems and organisms.





Open Plan – Indoor Spaces support the development of larger “mesocosm” style systems where complex communities of organisms can be set up to conduct long term, multi-generational studies under controlled conditions - critical in understanding the ways in which marine organisms interact, cope with and adapt to a changing environment.

Open Plan – Outdoor Spaces allow for large experimental systems under natural lighting conditions creating more representative experimental replications of local and regional (agricultural, coastal and industrial) development impacts on the marine environment, and provide opportunities to study how marine organisms respond to these impacts in combination with rising sea temperatures and ocean acidification.

SeaSim’s sophisticated capabilities are bolstered by its location and dedicated staff.

- Access to a wide range of facilities that complement and support research at SeaSim, including: specialised laboratories, data management facilities, engineering workshops, extensive microscopy facilities, and a modern fleet of research vessels.
- Adjacent to the Great Barrier Reef, the SeaSim operates a state-of-the-art seawater processing plant that can deliver over 3 million litres of seawater daily and provide filtration to 0.04 μm . This ensures that the facility is supplied with high-quality water all year round to enable long-term, multi-species studies on coral reef organisms with a high-degree of control.
- Highly qualified and motivated staff assist with all aspects of SeaSim operations including design, set-up and support of experimental systems, provision of consistent high-quality seawater, and development of sophisticated controls systems.
- Experimental parameters are closely monitored by an automated central control system 24/7/365. After hours, skilled technical staff are on-call to provide prompt alarm response if needed, ensuring continuous integrity of study conditions.

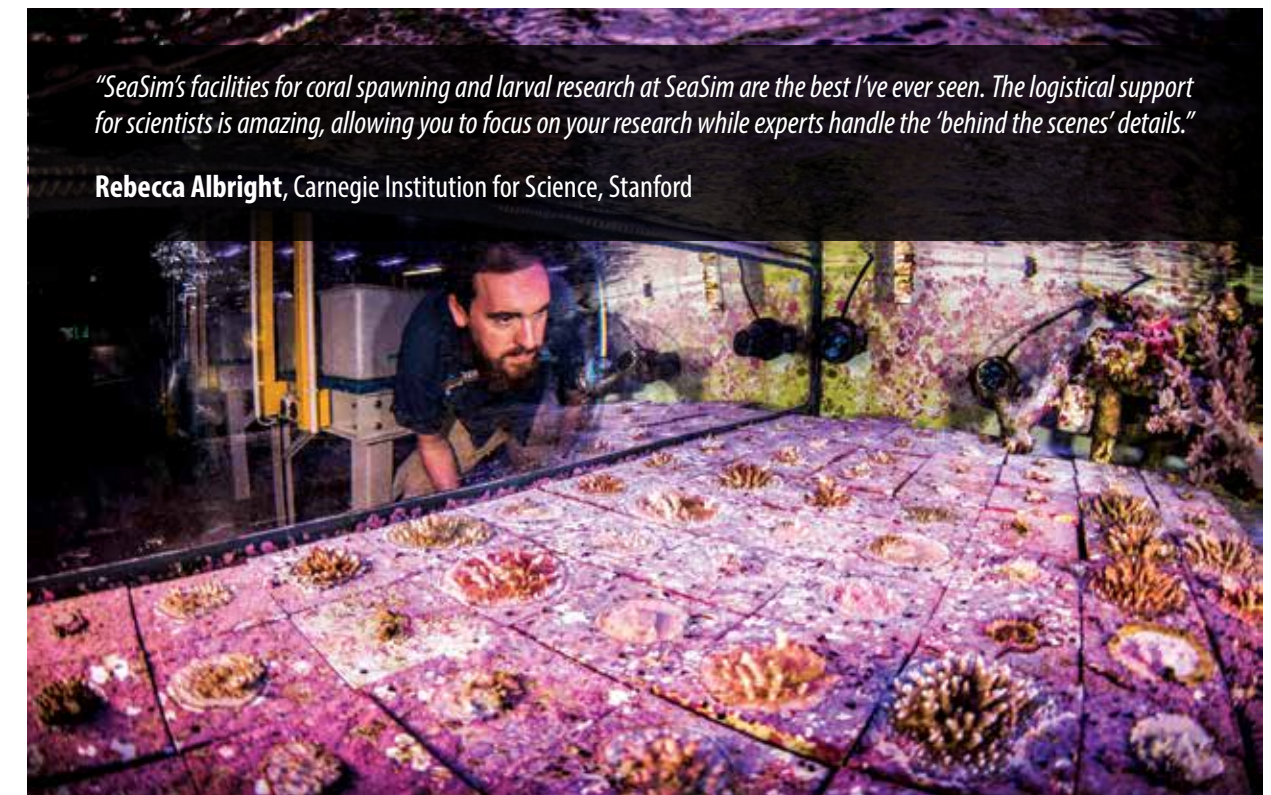


AIMS RESEARCH AT SEASIM

SeaSim provides a platform for research into the cumulative impacts of global, regional and local pressures on tropical marine ecosystems. Current research priorities include:

Climate change

Using precisely controlled and well-replicated conditions afforded by the SeaSim, it is possible to determine the responses of many reef species to cumulative impacts of climate change as well as local stressors. This allows researchers to recognise resilience and vulnerability across the GBR.



"SeaSim's facilities for coral spawning and larval research at SeaSim are the best I've ever seen. The logistical support for scientists is amazing, allowing you to focus on your research while experts handle the 'behind the scenes' details."

Rebecca Albright, Carnegie Institution for Science, Stanford



OCEAN ACIDIFICATION

SeaSim is being used to investigate the response of many organisms to changes in pH and temperature, and the potential compounding effects of water quality. A key question that SeaSim will allow us to address is how coral reef communities, not just individual species, are likely to cope with a rapidly changing marine environment.



"SeaSim is playing a valuable role in improving our knowledge about impacts such as climate change and poor water quality from catchment runoff which are key threats to the Great Barrier Reef."

The strategic assessment of the Great Barrier Reef we have been undertaking for the Australian Government is showing us where there are knowledge gaps — for example, the effects of cumulative impacts on the health of the Reef. Research that would normally take years to undertake in the field can be completed much more quickly in SeaSim, adding to our knowledge and ability to respond to impacts with appropriate management actions."

Russell Reichelt, Chairman, Great Barrier Reef Marine Park Authority





WATER QUALITY

The health of tropical marine environments is strongly dependant on water quality. Using SeaSim facilities, researchers are examining the response of a wide range of organisms to multiple pressures such as salinity, turbidity, sedimentation and contaminants to help determine resilience at both organism and ecosystem levels.

COASTAL AND INDUSTRY DEVELOPMENT

Like many around the world, Australia's tropical coastline is becoming increasingly developed.

AIMS is making advances in knowledge of coastal systems in tropical Australia using environmental monitoring, laboratory testing (including SeaSim), and application of models and other decision-making tools.

Utilising SeaSim, researchers are determining thresholds of a variety of tropical marine organisms to the cumulative effects of agricultural land practices and urbanisation within the GBR catchment.

The construction of ports for the resource sector in tropical Australia carries environmental risk. Using field monitoring and controlled laboratory conditions, such as those offered by SeaSim, researchers can determine the short and long-term effects on key organisms, such as corals and sponges, to better manage these activities. SeaSim is being used in particular to better understand the effects of dredging on marine organisms.

"One of the issues facing Australia is to understand the impacts of human activities on the marine environment, and SeaSim gives a very good opportunity to do some cause-effect studies around contaminants, toxins and dredging impacts in a simulated environment."

Dr. Luke Smith, Environment Manager, Woodside Energy Ltd

CROWN-OF-THORNS STARFISH

SeaSim is being used to investigate the causes of, and ways to control crown-of-thorns (*Acanthaster planci*) outbreaks.

AIMS researchers are using SeaSim to investigate the drivers behind outbreaks, particularly the larval development phase, and the response of both phytoplankton and larvae to different nutrient regimes.

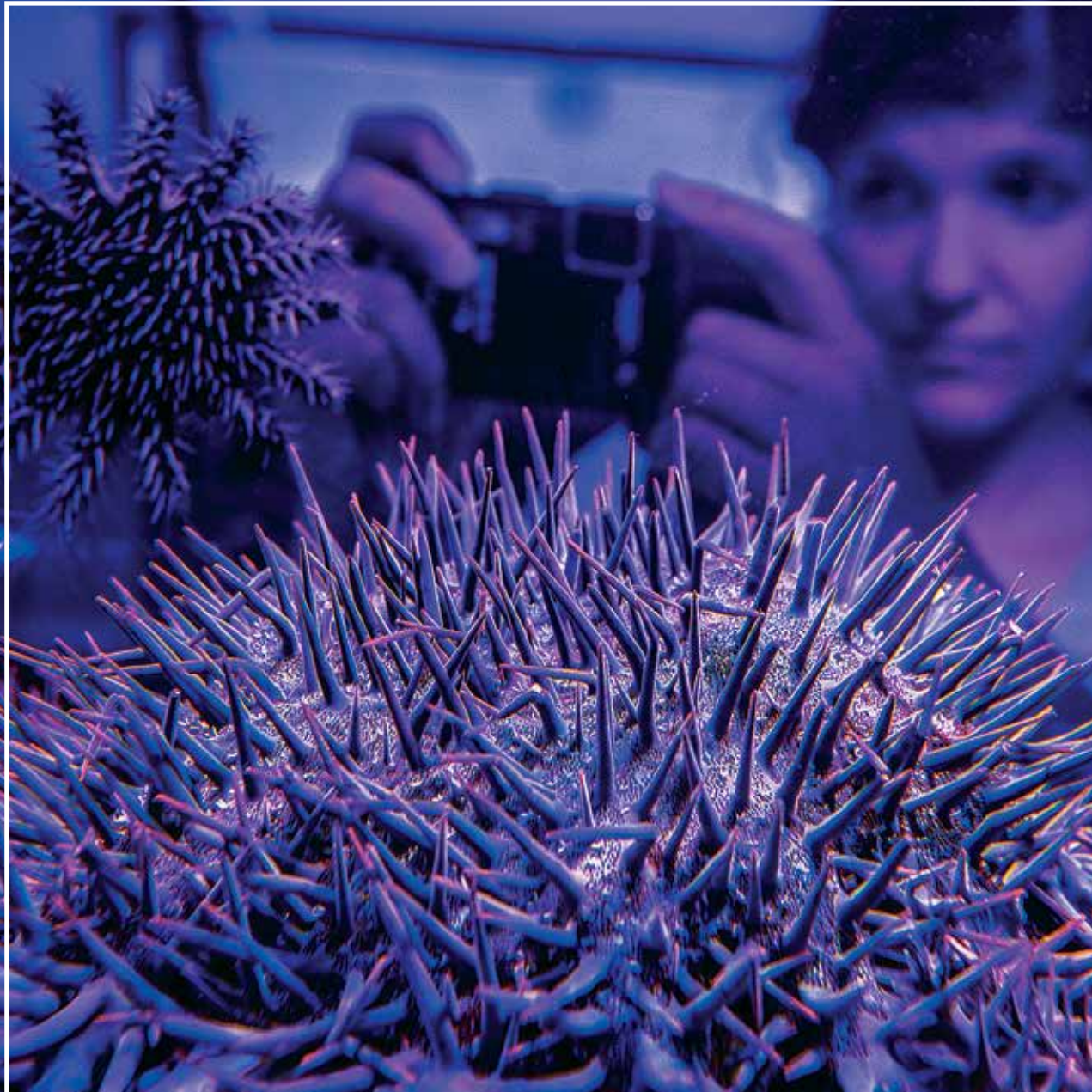
Adopting pest management strategies from terrestrial systems, SeaSim will facilitate research into the use of chemoreceptors to manipulate crown-of-thorns behaviour - to both deter, as well as attract them to designated areas.

HOW ARE MARINE RESEARCHERS USING SEASIM?

The SeaSim is a resource for marine researchers everywhere. Already a wide range of experiments have been conducted in the SeaSim, many of them led by AIMS researchers in collaboration with researchers from around Australia and the rest of the world.

Tropical marine research projects ranging from water quality impacts on marine ecosystems, to novel 'assisted evolution' of corals to enhance stress resistance are supported by SeaSim's technical capabilities and ideal location.

With a number of high profile experiments focused on larval stages of corals, the SeaSim's unique capacity to replicate reef-like conditions supports a ready stock of coral larvae.



MASS CORAL SPAWNING

Once a year on the Great Barrier Reef, corals of multiple species synchronise their release of sperm and eggs over several days, usually after the October/November full moon.

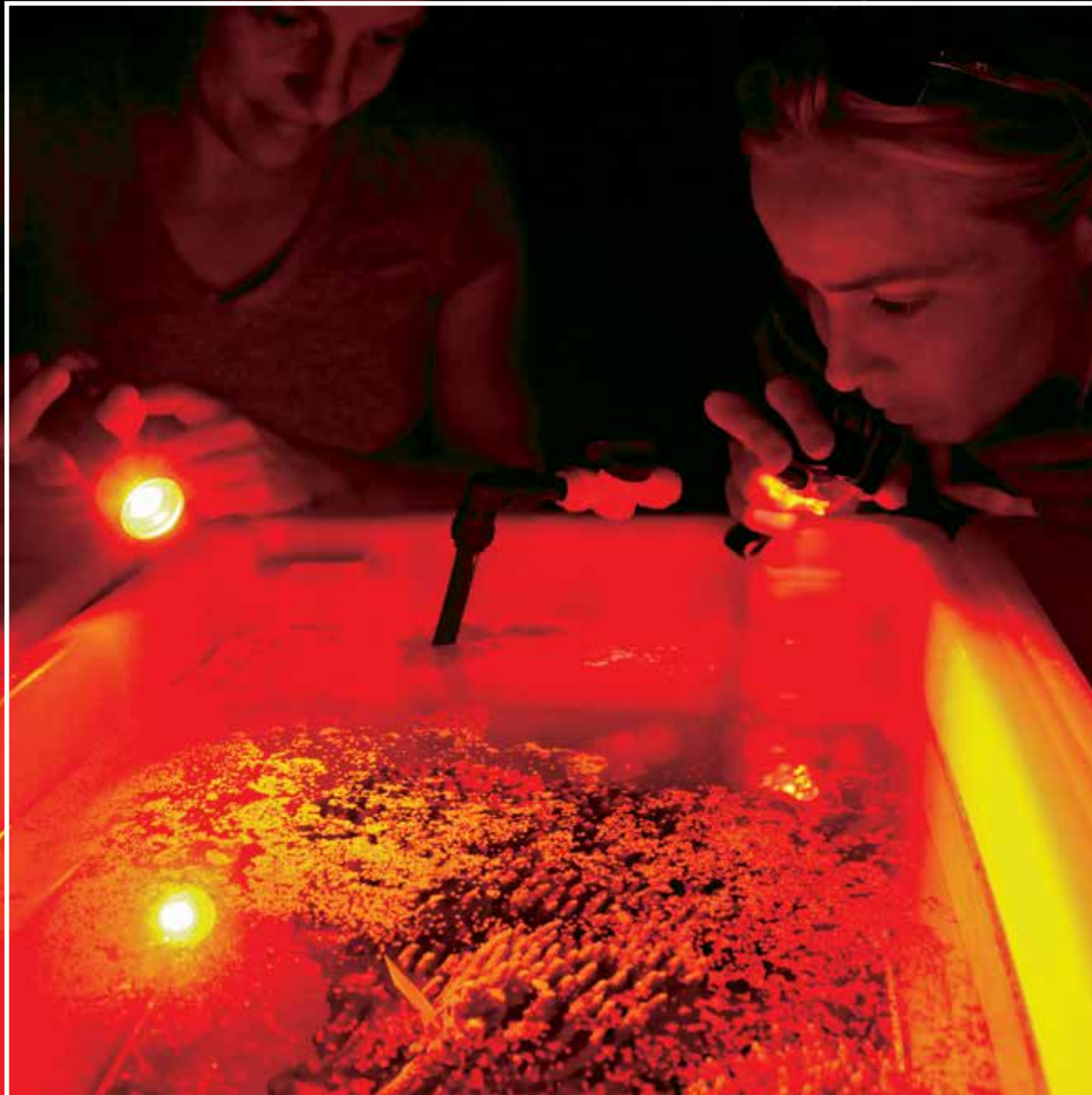
It is during this very narrow window of opportunity, lasting only days, that researchers can study how broadcast-spawning corals reproduce, and collect samples of coral larvae for study.

With large areas dedicated to mimicking natural spawning conditions and a sophisticated larval rearing facility, the National Sea Simulator maximises researcher's efforts during this critical annual event and supports a range of early-life history projects, including:

Coral Adaptation University of Texas researchers are working with AIMS to examine the potential for corals to adapt to increased temperatures, acidification, bacterial loads, and the physiological and genetic mechanisms by which these processes occur.

Assisted Evolution In collaboration with Hawaii Institute of Marine Biology, University of Melbourne, Swinburne University of Technology, and ARC Centre of Excellence for Coral Reef Studies, AIMS researchers are exploring 'assisted evolution' in corals—to naturally enhance certain traits such as stress resistance and growth rate.

Dredging Sediments The Western Australian Marine Science Institute, University of Western Australia and AIMS are collaborating on a study to determine how sediments released from dredging can affect early life history stages of coral.



ABOUT AIMS: AUSTRALIA'S TROPICAL MARINE RESEARCH AGENCY

SeaSim has a critical role in enabling AIMS to deliver on its mission and vision for tropical marine research in Australia.

Our mission

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

Our vision

- A healthy and resilient Great Barrier Reef.
- Sustainable coastal ecosystems and industries across northern Australia.
- Environmentally sustainable offshore oil and gas development.

Underpinned by:

- Integrated observing systems and robust long-term monitoring of key components of Australia's tropical coastal and marine ecosystems.
- Strategic and applied research into major gaps in our understanding of the impacts of natural and human pressures on these ecosystems.
- Effective environmental risk assessment and decision tools that drive efficiency gains in evidence-based regulatory regimes and marine industry development.
- Publicly available data and information bases.
- International research collaborations enhancing Australia's role in supporting regional blue economies.





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ACCESSING SEASIM

For information on how to access the SeaSim facility for research purposes, contact:

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**AIMS: Australia's tropical
marine research agency.**

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