
Centre for
Sustainable
Tropical Fisheries
& Aquaculture
Fisheries and Aquaculture
Food security through knowledge
JAMES COOK
UNIVERSITY
AUSTRALIA

Centre for
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Tropical Fisheries
& Aquaculture

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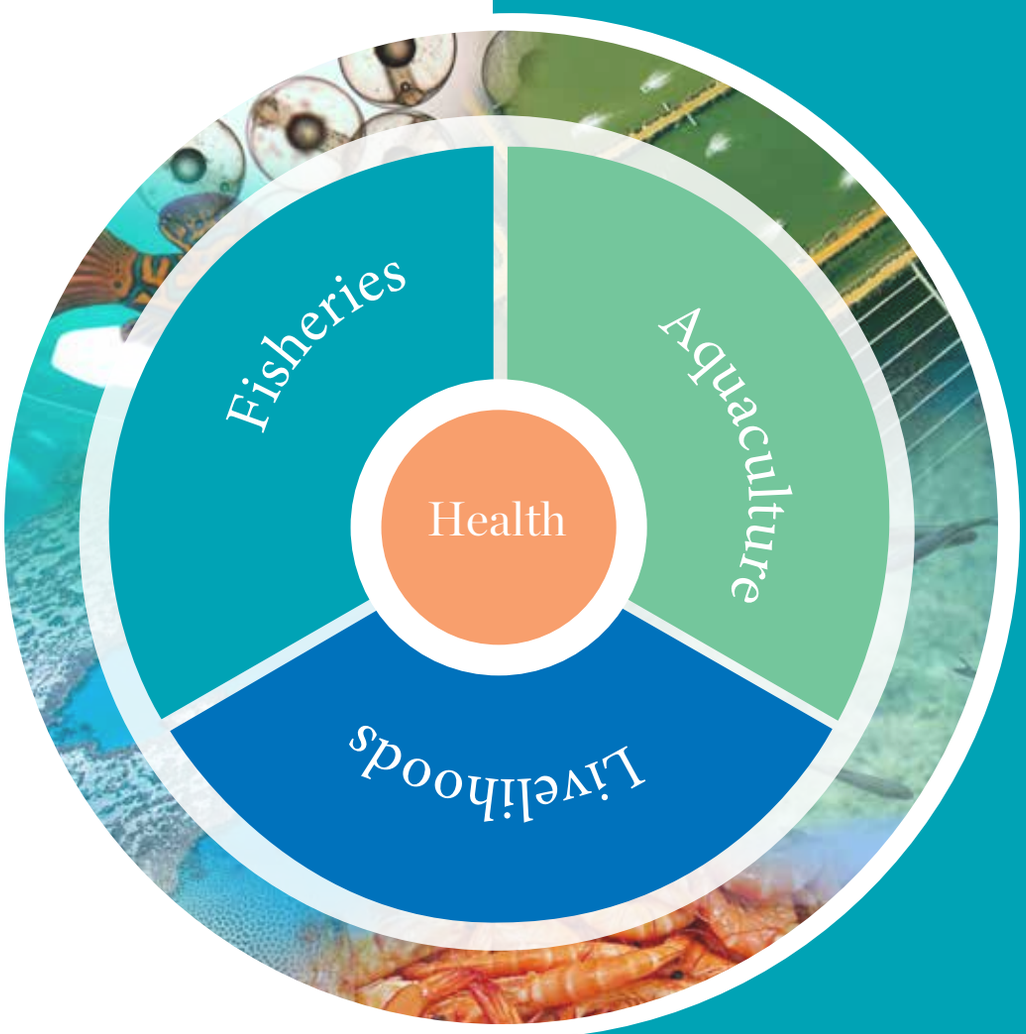
Tropical Fisheries and Aquaculture JCU

James Cook University is the premier provider for sustainable tropical fisheries and aquaculture research globally. Our team provides world class, multidisciplinary, solutions-focussed research for local, state, federal and international resources managers, both in government and the private sector.

Get in touch today to discuss your research needs.

Jan Strugnell,
Director



Contents

Aquaculture & Fisheries at JCU

Tropical regions of the world face unprecedented challenges due to population growth and an associated demand for high-quality seafood. This population expansion will continue to pressure wild fisheries resources and dictate ever higher efficiencies from aquaculture production.

Capitalising on its location, James Cook University (JCU) specialises in the sustainable exploitation of tropical aquatic species and is Australia's leading university in Tropical Fisheries Science including Aquaculture. JCU is dedicated to creating a brighter future for life in the tropics world-wide, through graduates and discoveries that make a difference. Our research activities in aquaculture and fisheries are ensuring this goal.

The university offers a teaching and industry-outcome R&D portfolio delivered by internationally renowned experts. With a comprehensive undergraduate offering in aquaculture and fisheries sciences, through to graduate coursework and higher degree research options, JCU trains the next global leaders in aquatic food production. Through the Centre for Sustainable Tropical Fisheries and Aquaculture (CSTFA), JCU also partners with industry, NGOs, and government to tackle grand challenges associated with sustainable production of seafood. Our research is world- class, as evidenced by the Excellence in Research for Australia evaluations, where JCU was the highest ranked Australian university receiving rankings of research "well above" and "above" world average".

Research Strengths

Our research into tropical aquaculture is renowned for being innovative and high quality, with James Cook University's Fisheries Science (incorporating aquaculture) being recognized as the highest standard possible receiving a 5-star Excellence in Research Australia 2018 rating – well above world standard. Many of our research-graduate alumni have gone on to become global aquaculture leaders further spreading our impact.

By the numbers:

43
Professional and Tehcnical Staff

92
Postgraduate Students

362
total publications from 2016 - 2019

806
collaborating authors from 2016 - 2019

34
Research Collaborators

37
Collaborating Countries

$6.3M
Competitive research grant income

$15.2M
Total funding income

Tropical Aquaculture

Research Capacity

James Cook University through the Centre for Sustainable Tropical Fisheries and Aquaculture (CSTFA) has internationally recognized expertise in industry relevant, outcome driven research and development for a multitude of globally important farmed tropical species, including well-established aquaculture species such as barramundi, marine shrimp, pearl oysters, tilapia, sea cucumbers, Macrobrachium prawn and macro/microalgae. The aquaculture team at James Cook University are also specialists for the culture of emerging species, including tropical abalone, blacklip rock oysters, spiny lobsters, freshwater crayfish, mudcrab, blue swimmer crab, Australian native freshwater prawn (Cherabin), marine ornamental crustaceans and copepods.

With research teams in both Australia and Singapore, James Cook University is perfectly positioned to continue to significantly contribute towards sustainable and productive aquaculture development in tropical zones of the world.

James Cook University is also home to the Australian Research Council (ARC) Research Hub for Advanced Prawn Breeding. This research hub brings together world-leading animal geneticists, research and service providers to gather genomic resources, commercial phenotypic data and apply cutting-edge genetic and genomic selection methodologies, leading to the most advanced and industry transformative improvement program for any marine shrimp species globally.

Research and Development

Researchers from the CSTFA have experience and expertise in all biological and industry aspects of tropical aquaculture, including hatchery and nursery techniques, aquatic animal health, nutrition and feed development, bioremediation, sustainable livelihoods, seafood quality and human health, reproductive control and domestication, and the application of advanced selective breeding techniques. Recent examples of leading and industry-impactful research includes:

- development and implementation of genomic-based breeding programs for barramundi, pearl oysters and marine shrimp (Pacific white shrimp, black tiger shrimp)
- biosecurity audits for Australian shrimp farms
- identification and prevalence of commercially important pathogens
- situational analysis of northern Australian aquaculture
- feed development using plant-based and alternative protein sources
- bioremediation of waste nutrients using macroalgae
- influence of microbial communities for health and productivity of marine shrimp

Industry Engagement

The majority of R&D conducted by researchers within the CSTFA are linked with commercial aquaculture companies, industry associations and/or government. Examples of recent partners in research include Mainstream Aquaculture, Australian Prawn Farmers Association, Australian Barramundi Farmers Association, Australian Abalone Growers Association, Seafarms Ltd, Australian Genome Research Facility, CSIRO, Qld Dept of Agriculture and Fisheries, MBD, North Qld Redclaw Farmers Association, Barramundi Asia, Coral Coast Barramundi, Australian Prawn Farms, Australian Centre for International Agricultural Research (ACIAR), Marianvale Cod, Ellies Pearls, Cygnet Bay Pearls, The Product Makers, Ridley's Agrifood, Adisseo, and Biomar.

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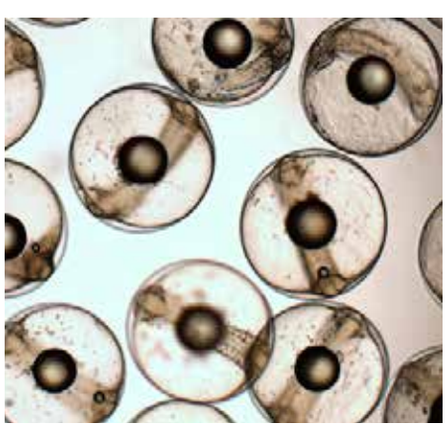

Facilities

The aquaculture department at James Cook University comprises one of the largest aquaculture research groups in Australia which has access on-campus to world-class infrastructure specifically designed to conduct industry research and train the next group of aquaculture professionals. Infra-structure include a state -of-the-art aquaria (1.4 million litres, 8 independent systems, 21 environmentally controlled laboratories, a commercial barramundi hatchery, 24 hr parameter monitoring and manipulation), complemented with fully-equipped molecular genetic, biochemical, and analytical laboratories, along with a commercial genotyping and NATA accredited pathogen testing facility, semi-commercial experimental feed extruder, and extensive macroalgae culture tanks.

Genetics

Research Capacity

James Cook University is internationally renowned for their work in aquaculture genetics and hosts the largest research team in the southern hemisphere. This team is focused on developing the knowledge and tools required by the aquaculture industry to understand genetic processes affecting culture success and in the conduct of efficient selective breeding programs. With over 15 year's expertise delivering services to the global aquaculture industry, James Cook University has been instrumental in the design and conduct of breeding programs for many important tropical species, including barramundi, marine shrimps, pearl oysters and freshwater crayfish. The university also has a comprehensive teaching program in genetics and biotechnology as applied to aquaculture.

Research and Development

James Cook University is a global leader in the area of aquaculture genetics and provides a full complement of expertise relevant to genetic improvement of aquatic organisms, including development of molecular markers for new species, DNA pedigreeing, environmental DNA (eDNA) genetic audits of broodstock, estimation of genetic parameters for commercial traits, molecular early prediction of growth performance, transcriptomic, nutrigenomic, advanced genomic applications, breeding program design and genomic selection approaches. The team has the capability to start fresh with new species, or to integrate current knowledge to aid industry in their aspirations to breed faster growing and disease tolerance strains.

Industry Engagement

The aquaculture genetics team works directly with the aquaculture industry to develop the tools and knowledge required for them to commence selective breeding programs. As examples of some of these partnerships we currently work with global companies involved in breeding programs for marine shrimp (Global Gen Inc, Seafarms Ltd), barramundi (Mainstream Aquaculture), tilapia (Worldfish), redclaw crayfish (NQFA), pearl oyster (Atlas South Sea Pearl) and abalone. There is a particular focus on improvement of important aquaculture species in Australia and Asia.

Facilities

James Cook University has a fully-equipped, modern genetics laboratory, including an Illumina Mi-Seq sequencer, flow cytometers, robotics, quantitative PCR and high throughput PCR capabilities. Given its strengths in quantitative statistics and genomics, it also has the high-performance computing capability necessary to link phenotypes with the genome and develop genomic selection algorithms. JCU also has the largest tertiary aquaculture aquaria research infrastructure in Australia for the conduct of genetic related experiments and training.

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Nutrition

Research Capacity

James Cook University is a global leader in aquaculture nutrition, physiology and post-harvest technology. The Nutrition, Physiology and Post-Harvest Technology Group has been influential in developing and implementing applied solutions across these fields for several important tropical species, including barramundi, grouper, tilapia, freshwater crayfish, tiger prawn and sea cucumbers. The university also boasts a world-leading comprehensive teaching program in aquaculture physiology, nutrition, and propagation, with specific applications to commercial aquaculture and hands-on training in up-to- date relevant production techniques.

Research and Development

We combine whole animal studies with relevance to commercial culture conditions; this includes work on both new and well-established aquaculture species, particularly marine and freshwater finfish. The group is recognised as being at the forefront of R&D in these respective areas and provides a full complement of expertise, including methods for determining nutritional requirements of species, evaluating the use of sustainable plant based ingredients to replace marine ingredients as well as of novel and functional dietary ingredients to improve intestinal health, molecular characterisation of the physiological response to dietary and environmental changes, resolving the drivers of egg and larval quality, and measurement of metabolism and energetics in aquaculture species.

Industry Engagement

The Aquaculture Nutrition Team is heavily engaged with aquaculture industries in Australia and internationally through research partnerships and training based on-campus and on-farms. As examples of some of these partnerships we currently, or have recently worked with barramundi (Australian Barramundi Farmers Association, Ridley Aquafeeds, Skretting, Coral Coast Fisheries), redclaw crayfish (Australian Redclaw Farmers Association, Rural Industries Research and Development Corporation), tilapia (Australian Centre for International Agricultural Research; Secretariat of the Pacific Community), grouper (US Soybean Export Council), and sea cucumbers (Australian Institute of Marine Science, Australian Centre for International Agricultural Research). Although the group works with a wide variety of species and countries, it has a particular focus on important, or developing aquaculture species in tropical Australia and Asia.

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Aquatic Animal Health

Research Capacity

James Cook University Aquatic animal health expertise ranges from viral and bacterial pathogens of fish and crustaceans, through to metazoan parasites of fish. Research conducted by JCU researchers enables fisheries, aquaculture and government stakeholders, to make informed decisions in regards to stock structure, disease management and import regulations. This marriage of pure and applied research has led to the development of unique and strong partnerships between industry, academia and government agencies. With access to many expert researchers in genetics, nutrition, biotechnology and bioinformatics, the Aquatic Animal health team is well resourced to adopt a multidisciplinary approach to disease management in Tropical Aquaculture species.

Research and Development

Aquatic health specialists undertake sponsored and contract R&D and partner closely with industry to develop solutions that assess and lower disease risk. Projects recently conducted involving industry include assessment of prawn samples to determine the presence of pathogens in wild and aquaculture raised stocks. Research is also focused on the management of viral infections of finfish including Ranavirus and Betanodavirus. Another major R&D capability is in the *Vibrio harveyi* clade of bacteria and their virulence determinants including the role of bacteriophages.

Facilities

The Aquatic Animal health has access to Australia's largest tertiary aquarium research infrastructure at JCU if required to undertake larger-scale industry-relevant R&D. JCU has developed a National Association of Testing Authorities (NATA) accredited pathogen detection laboratory, JCU AquaPATH, with capability for shrimp and finfish viral and bacterial pathogens, and offers R&D and commercial testing services to industry.

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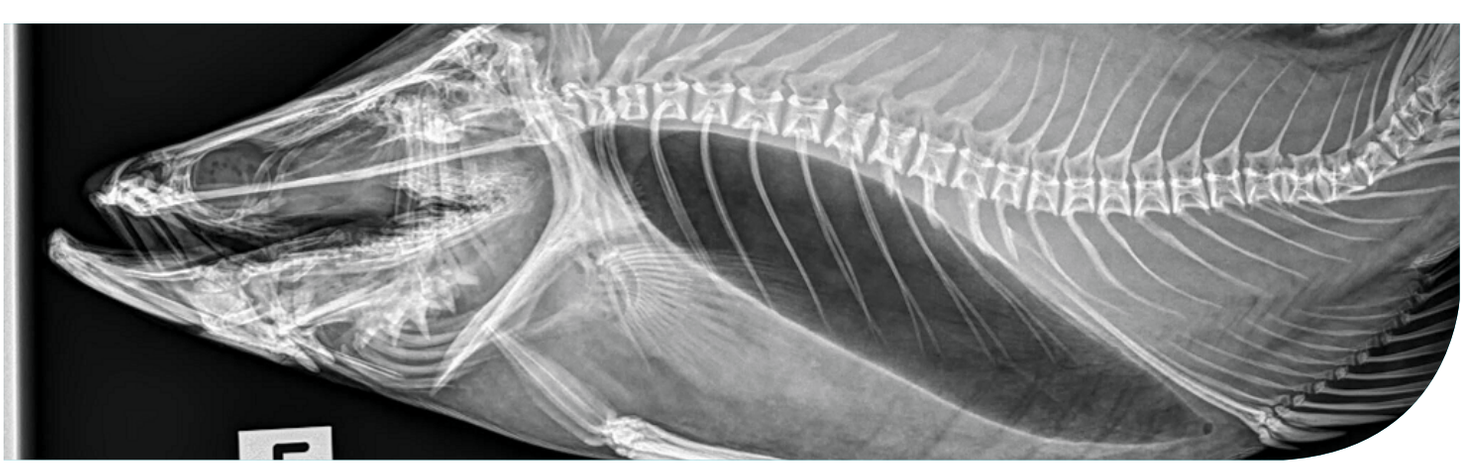

JCU AquaPATH

"JCU Aquapath has provided important services that assist us in managing biosecurity. Working with a high quality local science provider like JCU is a significant benefit to our business"

Dallas Donovan,
Chief Operating Officer
Seafarms

JCU AquaPATH is a NATA accredited laboratory located at the Townsville campus.

The AquaPath team is committed to the university strategic intent to create a brighter future for life in the tropics world-wide. JCU AquaPATHs role within this intent is to investigate ways to reduce losses due to disease in aquaculture production systems.

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Seafood and Health

Research Capacity

James Cook University is globally recognized for its research strength on seafood consumption and subsequent reactions with the human health system. The molecular investigation of seafood has influenced the development of novel and improved diagnostics and detection systems for specific seafood proteins, including barramundi, salmon, tuna, basa, cod, crabs, oyster and five prawn species from the Asia-Pacific region. Furthermore, the health effects of purified components are investigated in whole animal models to develop nutraceuticals for improved health in consumer as well as important aquaculture species. The university also boasts a world-leading comprehensive teaching program in molecular biology and immunology with specific application in food allergy, toxicology and development of therapeutics

Research and Development

The MARL (Molecular Research Laboratory) at JCU is among the world leaders in research and development in health products derived from aquatic organisms, including marine and freshwater fish, invertebrates and marine algae. The group is well recognized for the isolation, purification and biophysical charactersation of proteins and polysaccharides from aquatic organisms. Genomic, transcriptomic and advanced proteomic approaches allow the complete sequencing of proteins, analysis and comparison with international databanks. We have purified and characterized over 20 novel protein from fish, including barra, basa, salmon, tuna, mackerel and cod, as well as different shellfish species (e.g. prawn, oyster, abalone, squid). These proteins are utilized for improved diagnosis of sensitization among consumer and processor of seafood. We combine whole animal studies to study the influence of purified components on the health of seafood consumer, including positive regulation of diseases such as IBD, colitis and food allergy. In addition, the impact on improved disease resistance is investigated in important aquaculture species including Tiger prawn and barramundi.

The group leads several international research programs with universities and hospitals in the Asia-Pacific Region including Vietnam, Indonesia, Thailand, China as well as partners in Austria, Norway, Saudi Arabia and South Africa. International students are trained in the field of molecular biology and advanced proteomics of over 100 seafood species.

Industry Engagement

MARL at JCU works closely with different research and industry partners in Australia and internationally through active partnerships. Close collaboration with pharma and biotech companies in the US, UK, Sweden and Germany has resulted in novel diagnostics and treatments for a range of inflammatory diseases. The detection of seafood proteins in processed food for human consumption is required by international food legislation and is investigated for the Australian setting in collaboration with the NMI (National Measurement Institute). To improve the working conditions for processing seafood, the group collaborates with research institutes in South Africa, Newfoundland, Greenland, Denmark and Norway, to detect exposure to airborne fish, crab and parasite proteins.

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Macroalgae Research

Research Capacity

James Cook University is internationally renowned for its innovative industry and outcome driven research and development in macroalgae. The integrated production and application of macroalgae has been a focus of research at James Cook University, with the institution responsible for development of the core knowledge base leading to the productive and profitable aquaculture of freshwater and marine macroalgae(seaweed).

Research and Development

James Cook University has been a world leader in the research and development of macroalgae for more than 15 years and over this period has been a leading international source of high-quality research for the integrated production of macroalgae for the bioremediation of wastewaters. The institution is a recognised leader in biology, chemistry and production research, including the use of biomass in products ranging from human food and food ingredients (phycocolloids) through to nutraceuticals, animal feeds, fertilisers, biochar and bioenergy.

Industry Engagement

James Cook University is heavily engaged with the aquaculture and wastewater treatment industries in Australia and internationally through direct partnerships and research and training based on-campus and on-farms. The exemplar of this industry engagement is with Pacific Biotechnologies, a long-term partnership with substantial and ongoing collaboration in the development and implementation of the bioremediation of wastewaters, and the profitable use of the end-product biomass. Some collaborative multidisciplinary project work has been done also with CSIRO. In addition, the macroalgal team has a world-class international presence in the South Pacific and SE Asia.

Facilities

Research on macroalgae is centred around a purpose-built modern, world-class research and development facility on-campus. The facility is specifically designed for industry research and development and includes pilot-scale commercial production for marine and freshwater macroalgae.

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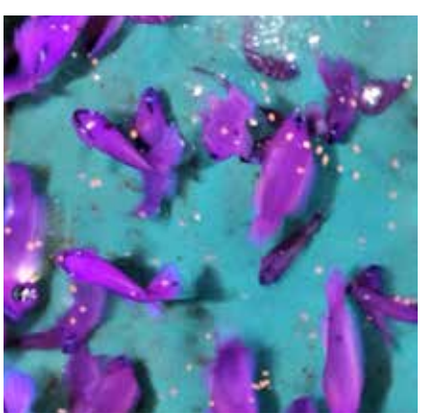

Marine Ornamentals

Research Capacity

The aquarium trade is a multi-billion dollar industry worldwide, and it is growing at a rapid pace. However, unlike freshwater ornamentals, of which 98% are captive bred, it is estimated that currently over 95% of marine ornamental s are collected directly from the wild, mainly from coral reefs, a practice that negatively impacts biodiversity of the fragile reef ecosystems. Moreover, in developing countries where the bulk of marine ornamentals are sourced, the collection is often done via reef damaging methods, e.g. using explosives and cyanide, which contributes to reef destruction.

In order to be sustainable, highly sought-after marine aquarium species must be bred in captivity to supply the trade and to further expand the industry. The Marine Ornamentals Captive Breeding Group are developing captive breeding techniques for a range of popular marine ornamentals, including crustaceans and fish. The Group have so far successfully bred more than 30 species, several of which are world firsts, and work on multiple other species is ongoing.

Research and Development

The aquaculture department at JCU is a world-leader for the research and development of captive breeding techniques for various marine ornamental fish and crustaceans, as well as intensive culture methods for tropical copepods, the key prey for larviculture of many marine ornamentals. The data and knowledge generated through R&D are being used to improve the economic and environmental sustainability of the multi-billion dollar marine ornamental trade industry while fostering an emerging marine ornamental aquaculture industry.

Facilities Overview

The Marine Ornamentals Captive Breeding Group utilizes both outdoor and indoor purpose-built modern research and development aquarium facilities on-campus, including several large dedicated temperature and environmental controlled saltwater recirculation systems. These systems are specifically designed for conducting experiments to improve culture techniques for marine ornamentals focusing on key aspects such as achieving captive spawning of broodstock and improving reproductive output and larval quality, optimisation of larval feeding regime, nutrition and culture conditions, as well as designing species-specific culture systems to enhance breeding success and culture productivity.

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Fisheries Science

Research Capacity

James Cook University is a world leader in Fisheries Science. JCU staff and students work closely with the fishing industry and management agencies to provide relevant science-based advice on improving the management of fisheries in the tropical world.

Research and Development

JCU is a global leader in fisheries research, especially in relation to tropical systems such as coral reefs. Research is conducted not only in Australia, but through much of Southeast Asia and globally; and is designed to inform improved management. Research includes biology of fished species, ecosystem effects of fishing, fisheries assessment, stock assessment, ecological risk assessment and socio-economic assessment and monitoring. JCU's research strength is recognised by its ranking as Well Above World Standard in the recent Excellence in Research for Australia exercise.

Industry Engagement

JCU researchers work closely with commercial, recreational, charter and indigenous fishers, and provide advice on management of fished resources to relevant management agencies locally, nationally and internationally. JCU staff hold key positions on national and international advisory panels and management bodies actively advising policy and management. JCU's location provides for close links with world leading marine and fisheries research and management agencies, and with fishing industry groups.

Facilities

High calibre facilities including field (Orpheus Island Research Station, research vessels), laboratory and computing infrastructure support our research.

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Sharks and Rays

Research Capacity

James Cook University is globally recognised for its research strength in sharks and rays, being the top ranked university for publications in the last five years. In addition, JCU staff are listed within the top ten shark and ray researchers worldwide (Google Scholar).

Research and Development

Research is especially designed to inform the management and conservation of sharks and rays at local, national and international scales. This includes work on the spatial ecology of sharks, stock structure and connectivity, population status, life history, fisheries interactions and post-release effects, and novel survey techniques.

Industry Engagement

JCU researchers work closely with commercial, recreational and indigenous fishers, and provides advice on management and conservation of sharks to relevant management agencies locally, nationally and internationally. JCU staff hold key positions on national and international advisory panels and management bodies such as the IUCN Shark Specialist Group and government reference groups, actively advising policy and management.

Facilities

JCU has world class facilities that allows the study of sharks and rays in the field, including the Orpheus Island Research Station. Access to field and laboratory infrastructure for telemetry, life history, genetics and stable isotope studies is available.

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Human Dimensions

Research Capacity

James Cook University is internationally recognised for its strength in interdisciplinary research that improves the lives of people living in the tropics through the effective management and conservation of coastal and marine environments. The sustainable use and production of aquatic resources can only occur if emerging biophysical and technological knowledge is effectively translated into management action. Resilient, adaptive, and receptive societies are essential for achieving this goal. Understanding the broader social context, including how people perceive, value, and use aquatic resources is therefore key to ensuring sustainability through the effective uptake of new science and technology.

Research and Development

The CSTFA human dimensions team collaborate closely with staff from other themes to implement interdisciplinary research aimed at improving the lives of people through effective management and conservation of coastal and marine resources. Topics include the sustainability of fishers, producers, industries and communities involved in aquatic food production; how to deal with change in fisheries and aquaculture to ensure aquatic food security; and identification of adaptation strategies in coastal communities. Research projects span Australia, Melanesia, Southeast Asia and South America.

Industry Engagement

Staff on the human dimensions team work directly with individuals, communities, and decision-making bodies to provide targeted advice and research to support use, management and conservation needs. These include commercial, recreational, charter and indigenous fishers both nationally and internationally, and key agencies such as the Great Barrier Reef Marine Park Authority of Australia, Queensland's Department of Agriculture and Fisheries, the National Fisheries Authority of Papua New Guinea, and the Galapagos Science Centre in Ecuador. JCU human dimensions staff hold key positions on national and international advisory panels such as the World Commission on Protected Areas and the International Council for the Exploration of the Seas' Study Group on the Socio-economic Dimensions of Aquaculture.

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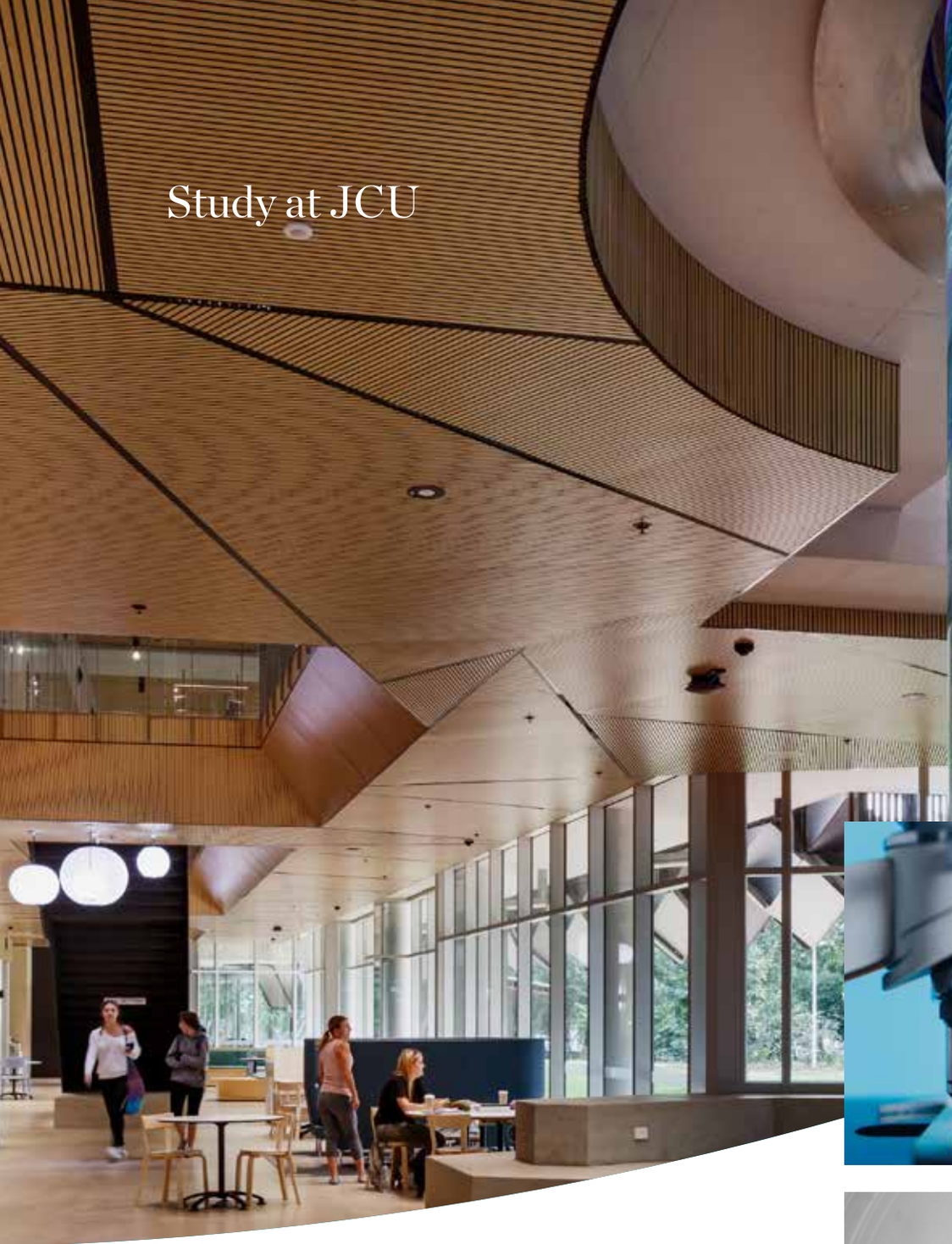
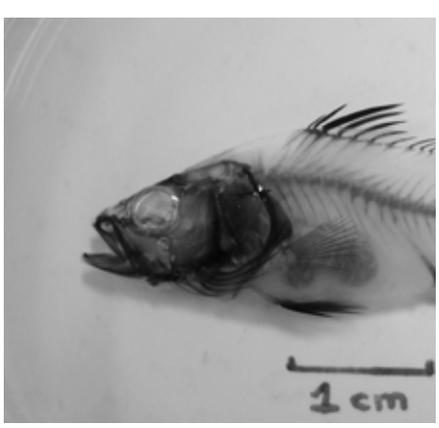
Study at JCU



Aquaculture Science and Technology

Increased global demand has driven a rapid expansion of aquaculture food and resource production. James Cook University is proud to be internationally recognized as a world-leader in industry-focused tropical Aquaculture teaching and research. Studying Aquaculture at JCU strategically positions students with knowledge, scientific reasoning, hands on experience and the ability to develop strong industry leadership skills into the future



Courses

At JCU, the Aquaculture Science and Technology degree is built on a multi-disciplinary "whole process" program that is tailored to a wide range of careers and industries. Key areas covered include:

- Animal breeding and genetic improvement
- Nutrition and aqua-feeds
- Aquatic animal health
- Hatchery techniques
- Aquatic species stock assessments
- Emerging aquaculture species & industries
- International aquaculture best practices
- Sustainable aquaculture practices and technologies
- Understanding aquatic animal physiology
- Marine sensor technologies and applications
- Understanding production value chain
- Sampling and experimental design
- Quantitative methods in science

The JCU Aquaculture Science and Technology course is a hand-on science program that utilizes state-of-the art on-site teaching and research infrastructure. The Marine and Aquaculture Research Facility supports 23 research laboratories and allows researchers and students to rear and maintain a wide variety of aquatic organisms including; fin-fish, crustaceans, mollusc, ornamental marine species, echinoderms, live feeds production species, algae and coral under fully controlled conditions. Furthermore, as part of the aquaculture program, students directly engage with leading aquaculture companies to obtain a first-hand perspective of the industry and future opportunities. These direct industry links provide valuable networking opportunities for students.

Access to leading research

JCU has a long-standing reputation and capacity to successfully apply research and training to address sustainable global food security issues. More specifically, both the research and training programs are closely linked with industry topics of high relevance to ensure translation of knowledge to real-world industry outcomes. Research and training reflects the full aquaculture value chain incorporating knowledge acquisition, building human capital, resource development and translational activities to support industry development. With more than 50 world-leading staff and graduate research students across designated aquaculture research centers (Centre for Sustainable Troptical Fisheries and Aquaculture CSTFA), there is significant capability to address growing global needs

For further information vist:

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Townsville Campus

Study Period 1 & 2

3 years full-time

Notes

Notes

This publication was designed by Melissa Joyce for the Centre for Sustainable Tropical Fisheries and Aquaculture. This publication is intended as a general introduction to Fishereis and Aquaculture at JCU. Information is correct at the time of printing. Prospective domestic students and all international applicants should contact the University to confirm admission requirements and the availability of courses. The University reserves the right to alter any admission requirement or degree included in this publication without prior notice. CRICOS Provider Code 00117J


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