Title of Project: Advanced imaging of microplastics in tropical marine environments

Names of supervisors:

Name	Affiliation (AIMS or JCU)
Cherie Motti	AIMS
Frederieke Kroon	AIMS
George Vamvounis	JCU
Lynne van Herwerden	JCU
Danielle Martin	Australian Synchrotron

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Brief description of the project

Marine debris, including microplastics, has been identified as a contaminant of major concern to the Great Barrier Reef. This PhD project will join a multi-disciplinary team to address the need to understand the effects of microplastics in Northern Australia's marine life. The team is now looking for a PhD student to develop new methodology to examine these persistent marine contaminants in tropical marine environments, with the view to (1) identify the location of these marine pollutants and (2) prepare a model based on degradation kinetics to determine when a plastic is toxic to aquatic life.

The proposed objectives of the project are to:

- Prepare new "labelled" plastics using JCU's expertise in polymer science that are engineered for advanced imaging techniques
- Perform the uptake of these engineered microplastics using the sea simulator (AIMS)
- Develop new non-invasive imaging techniques at the Australian Synchrotron
- Use the information obtained to prepare a predictive toxicity model

The project will contribute to an improved understanding of:

- the nature of microplastic toxicity in tropical marine environments, including the relative importance of microplastic sizes and shapes;
- the development of new state-of-the-art tools to characterise microplastics in tropical marine environments; and
- predictive toxicity models for microplastics

Key words: Marine debris, microplastics, particle, fibre, imaging, chemistry

This project would suit someone who: is interested in emerging contaminants in tropical marine environments. While microplastics have been identified as a global concern, methods of detection and quantitation are rudimentary at best. This project would suit a student interested in polymer chemistry and chemical analyses and who has the capability to undertake controlled laboratory experiments (with marine organisms) with the potential for application in the field. Laboratory work would include polymer synthesis and manipulation (size and shape), chemical characterisation and various types of microscopy and chemical imaging. SeaSim work would include exposure studies of key organisms to these microplastics, the data from which would be incorporated into a statistical model to explain the interaction(s).

Title of Project: Can adaptation help corals cope with climate change?

Names of supervisors:

Name	Affiliation (AIMS or JCU)
Line Bay	AIMS
Madeleine van Oppen	AIMS
bioinformaticist / statistician	AIMS/JCU
David Bourne	JCU

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Brief description of the project

As environmental pressures increase on the GBR due to climate change, ocean acidification and local disturbances, the ability of reef organisms to increase their tolerance through acclimatization and adaptation becomes increasingly critical. Predictive models suggest that a 1.5^0C increase in temperature tolerance for corals will be sufficient to limit the immediate impacts of climate change, however, at present insufficient evidence is available to assess whether this will be possible for most species, nor the mechanisms by which this may occur.

The aim of this project is to understand genetic adaptation and trans-generational epigenetic acclimatisation in a number of critical coral traits (including coral settlement, juvenile growth and survival) under temperature and pCO_2 scenarios projected to occur by mid and end of this century. The project will capitalise on the Evolution21 experimental system in SeaSim, which allows multi-generational, multi-factorial experiments to be carried out on a range of taxa simultaneously. Hence, ecological and evolutionary interactions among taxa, such as the exchange of microbial symbionts, competition for space and resources and functional and behavioural changes leading to evolutionary innovations can be examined in a controlled, simulated reef environment. The candidate will work as part of a multidisciplinary research group and focus on coral reproduction, larval and juvenile performance and fitness under climate change scenarios, as well as on unravelling the underlying genetic and epigenetic mechanisms of the observed phenotypes. The candidate is expected to have some experience in experimental, physiological, molecular, bioinformatic or statistical analyses and a willingness to develop these skills further. The project will be primarily experimental and laboratory based but field opportunities exist and can be developed further. The candidate will execute experiments, undertake laboratory, and biostatistical analyses, and modelling, prepare publications and research thesis.

Key words: Evolution, Climate Change, Coral, Settlement, Fitness

This project would suit someone who: has a background in one of quantitative genetics / molecular biology /reef ecology/coral biology. Prior experience in experimental work with corals and their offspring and quantitative genetic analysis would be desirable.

Title of Project: Cumulative impacts of water quality and climate change (SST warming and ocean acidification) on important reef species

Names of supervisors:

Name	Affiliation (AIMS or JCU)
Sven Uthicke	AIMS
Andrew Negri	AIMS
Mia Hoogenboom	JCU

Contact: Sven Uthicke <s.uthicke@aims.gov.au>

Brief description of the project

Cumulative impacts of climate change and water quality on the GBR is of major scientific and management concern. The candidate will work across several calcifying reef taxa (e.g. corals, *Halimeda* algae, CCA, foraminifera) and study their response to water quality stressors, mainly sediments, light reduction and pesticides. The aim is to apply multiple levels of the water quality stressors across three different 'near future' climate scenarios. These data will be used in a multi-disciplinary team to model climate-adjusted thresholds for various stressors and contribute to risk and exposure maps.

Key words: Coral Reefs, calcifying organisms, climate change, ocean acidification, sediments, pesticides

This project would suit someone who: is passionate about marine science and is committed to using science to improve management of the Great Barrier Reef. This project will be primarily lab-based with some opportunities for field-work and sample collection. Students with good knowledge of ecology, ecotoxicological tools and statistics would be preferred.

Title of Project: Ecology of an important coral predator: eDNA as a novel tool to investigate different life-history stages of Crown of Thorns Seastars (*Acanthaster planci*)

Names of supervisors:

Name	**Affiliation (AIMS or JCU)**
Sven Uthicke	AIMS
Morgan Pratchett	JCU

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Brief description of the project

Crown of Thorns Seastars (CoTS) are important coral predators. On the Great Barrier Reef, CoTS outbreaks may have been responsible for over 40% of the recent coral cover decline. The reasons for these outbreaks are still under debate, possible explanations range from bottom-up ('nutrient limitation hypothesis') to top-down hypothesis ('predator removal hypothesis'). At least to some degree, the confusion about the causes is due to a lack of knowledge on the ecology of CoTS, especially of early life history stages: Planktonic larval stages are hard to distinguish from other echinoderm species and post settlement juveniles are cryptic. Our team has recently developed molecular probes which allow detection and quantification of larval stages, and potentially also juveniles. These 'eDNA' tools open new alleys to investigate the ecology of larvae and juveniles of CoTS, such as temporal and (large and fine scale) spatial distribution.

Key words: reef-degradation, crown-of thorns-seastar, molecular tools, eDNA, echinoderms

This project would suit someone who: We seek a highly motivated student with both genetic laboratory and ecological skills who is interested in using these tools along with the development of further methods to shed more light on the ecology of CoTS and contribute to new management solutions.

Title of Project: Effects of petroleum hydrocarbons on corals and other key tropical species

Names of supervisors:

Name	Affiliation (AIMS or JCU)
Andrew Negri	AIMS
Joost van Dam	AIMS
Michael Oelgemoeller	JCU

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Brief description of the project

Coral reefs face risks from petroleum hydrocarbons due to accidental spills during oil and gas extraction and shipping accidents. This project will develop and apply state of the art toxicity tests for hydrocarbons and dispersants to coral reef species in the National Sea Simulator. Tests will also examine the cumulative effects of hydrocarbons with other reef-relevant pressures such as thermal stress and UV. The results will be integrated with spill models to improve risk assessments and responses.

Key words: Pollution, oil, dispersant, coral, reef, toxicity, bleaching

This project would suit someone who: Is versatile and into multidisciplinary science with real world applications. Good in the field, aquarium, laboratory and not scared of some chemistry and statistics. There is also the potential to apply these results in risk models.

Title of Project: Impacts of microplastics on tropical marine organisms and ecosystems

Names of supervisors:

Name	Affiliation (AIMS or JCU)
Frederieke Kroon	AIMS
Cherie Motti	AIMS
Lynne van Herwerden	JCU
Mia Hoogenboom	JCU

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Brief description of the project

Marine debris, including microplastics, has been identified as a contaminant of major concern to the Great Barrier Reef. This PhD project will join a team that has been examining the presence, abundance and composition of microplastics in Northern Australia. The team is now looking for a PhD student to examine the potential acute and chronic effects on tropical marine organisms and ecosystems, with a view to inform the development of environmental risk assessments for marine debris.

The proposed objectives of the project are to:
• Assess the bio-availability and uptake of microplastics in tropical marine organisms (e.g. filter-feeders);
• Assess the bio-accumulation of microplastics in tropical marine ecosystems, including into species for human consumption;, and
• Develop tropical species sensitivity distributions for exposure to microplastics.

The project will contribute to an improved understanding of
• The (toxicological) impacts of primary and secondary microplastics on tropical marine organisms for environmental risk assessments; and
• The bio-accumulation of microplastics into the tropical marine foodweb, including into marine species for human consumption.

Key words: Microplastic, particle, fibre, bio-availability, bio-accumulation, ecotoxicology

This project would suit someone who: is interested in emerging contaminants in tropical marine environments. Microplastics have been identified as an issue of global concern, however, information on their potential impacts and risks is uncertain. This project would suit a student who has the (interest and capability to develop) skills to conduct both field work in the marine environment and controlled laboratory experiments with marine organisms. For field work this would include boating and diving skills, while for laboratory work this would include aquarium husbandry, various types of microscopy and photography, and attention to detail.

Title of Project: Machine learning approach to restoration, prediction and quality control of oceanographic data from IMOS Moorings.

Names of supervisors:

Name	Affiliation (AIMS or JCU)
Paul Rigby	AIMS
Oleg Makarynskyy	AIMS
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Brief description of the project

Reliable data on the state of the ocean and coastal areas are in growing demand. For the past 10 years, the Australian National Mooring Network, as part of the Integrated Marine Observing System (IMOS) has measured physical and biological parameters at over 50 sites in Australian coastal waters [1].

The resulting data collection consists of a huge amount of time series information across many variables. Processing these data sets currently requires a significant amount of human-in-the-loop overheads for quality control and data processing. Furthermore, on occasion field instrumentation will fail due to the adverse ambient conditions and/or faulty manufacturing. The presence of gaps in data records may render the period of observation unsuitable for many practical purposes e.g. where a continuous record is required for numerical model validation or calibration.

It has been demonstrated in a range of recent studies that meshless data–based methods of time series interpolation and expansion, which include stochastic models as well as artificial intelligence approaches such as genetic algorithms, fuzzy logics, artificial neural networks (ANNs) [2-4], may be beneficially used to estimate met-ocean parameters. Other recent studies have demonstrated that a Bayesian network can be trained to conduct quality control of real time measurements from IMOS oceanographic sensors [5].

This project provides a candidate the opportunity to investigate a machine learning approach to increasing the value of oceanographic data. The full collection of IMOS Moorings data will be available for use in developing and training algorithms. Much of this data has already been flagged by heuristic quality control routines, and manually annotated by domain experts.

This PhD project will contribute to the following tasks:

- Analyse and understand the relationships between different oceanographic, water quality and ecosystem parameters in the tropics
- Develop an approach and implement an artificial intelligence technique to the task of data gap interpolation;
- Develop a forecasting methodology for extrapolating data on different timescales.
- Investigate a machine learning approach to automate the quality control process of oceanographic data by flagging anomalies and outliers

The candidate is expected to possess and be willing to further develop high-level quantitative analysis and machine learning techniques to progress this project.

[1] http://imos.org.au/nationalmooringnetwork.html
[2] Makarynskyy, O., Makarynska, D., Kuhn, M., Featherstone, W. E., 2005. Using artificial neural networks to estimate sea level in continental and island coastal environments. Hydrodynamics IV: Theory and Applications, L.Cheng and K.Yeow (eds.), Taylor & Francis Group, London, 451-457.
[3] Makarynskyy, O., Makarynska, D., Rusu, E., Gavrilov, A., 2005. Filling gaps in wave records with artificial neural networks. Maritime Transportation and Exploitation of Ocean and Coastal Resources, C.Guedes Soares, Y.Garbatov and N.Fonseca (eds.), Taylor & Francis Group, London, 1085-1091.
[4] Makarynskyy, O., 2005. Artificial neural networks for wave tracking, retrieval and prediction, Pacific Oceanography, 3 (1), 21-30.
[5] Smith, D.; Timms, G.; De Souza, P.; D'Este, C. A Bayesian Framework for the Automated Online Assessment of Sensor Data Quality. *Sensors* **2012**, *12*, 9476-9501.

Key words: Machine Learning, automated quality control, algorithm development, IMOS data, artificial intelligence, statistics, interpolation, prediction

This project would suit someone who: The PhD project proposal will be developed around analysis of IMOS oceanographic and water quality parameters. The candidate is expected to possess and be willing to further develop high-level quantitative analysis and machine learning techniques to progress this project. Demonstrated strong skills in programming and data science will be required. The candidate should have an interest in understanding and working with large collections of oceanographic data. Some previous exposure to oceanography would be highly regarded.

Title of Project: The Role of Microorganisms in the Transgenerational Acclimatisation of Reef Species

Names of supervisors:

Name	Affiliation (AIMS or JCU)
Nicole Webster	AIMS
David Bourne	JCU

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Brief description of the project

Recent experimental and field studies have highlighted how some reef organisms such as corals and sponges can rapidly alter their microbial symbionts in response to future climate change conditions. However, whether these symbiotic shifts influence the ability of the host to acclimatise/adapt to new environmental conditions is still uncertain. Favourable symbiotic shifts that enhance the scope for growth or infer environmental tolerance to the host may be passed to subsequent generations, ultimately enabling long term acclimatisation of these organisms to climate change conditions. This PhD project will attempt to understand how changes in the composition and function of microbial symbionts contribute to the acclimatisation/adaptation of a range of reef species including corals, sponges, foraminifera and echinoderms. The experimental research will be conducted in a recently established reef mesocosm system at the Australian Institute of Marine Science SeaSimulator. Understanding how microorganisms contribute to the acclimatisation / adaptation of the host will be essential for reliably predicting the consequences of global change.

Key words: Microbial Symbiosis, Reef, Adaptation, Transgenerational Acclimatisation, Experimental Mesocosm Research

This project would suit someone who: has a background in one of microbial ecology / molecular science /quantitative ecology/computational biology. Prior experience in analysing the composition or function of complex microbial communities would be desirable. Quantitative bioinformatics analyses will be critical to achieving the project's primary objective of identifying the contribution of microorganisms to host acclimation and adaptation.

Title of Project: Transgenerational effects to climate change in seagrasses

Names of supervisors:

Name	Affiliation (AIMS or JCU)
Sven Uthicke	AIMS
Catherine Collier	JCU

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Brief description of the project

Seagrasses are often regarded as winners of climate change because they increase productivity under ocean acidification in the short-term and they are relatively heat tolerant. There is now a need to test if acclimation to changed conditions in one generation can be transferred to the next generation and lead to evolution. A long term, multi-generational mesocosm experiment has recently started at AIMS with many collaborators to test this. We seek a student who is interested in conducting molecular studies (e.g. epigenetics, microbial epiphytes, population genomics), physiological measurements (e.g. primary production) and life history measures (sexual reproduction, seed germination) of seagrasses following long-term exposure to climate change simulations.

Key words: Coral Reefs, Seagrasses, Molecular, Acclimation/adaptation, transgenerational plasticity

This project would suit someone who: A student who is passionate about marine science and is committed to using science to improve management of the Great Barrier Reef. This project will be primarily lab-based with limited field-work for sample collection. Ideally, the student will have some experience with molecular biology techniques such as DNA/RNA extraction or physiological measurements. Furthermore, the student should have solid quantitative skills needed for genetic data analysis