List of available Honours projects, last updated Nov 2023

The next page provides a list of BScHonours projects currently available. There may be more available by contacting specific staff members in our departments (also staff members that have not advertised a project in this document). The table of contents on the next pages gives the specific project titles, which can be found on the corresponding page. To search for all projects in a specific discipline use CTRL-F to search for one of the following terms:

- ☐ Aquaculture Science and Technology
- ☐ Biomedical Sciences and Molecular Biology
- ☐ Chemistry
- ☐ Data Science
- ☐ Earth Science
- ☐ Ecology, Conservation, Plant Sciences and Zoology
- ☐ Environmental Science and Management
- ☐ Geology
- ☐ Marine Biology
- ☐ Marine Science
- ☐ Mathematical Science
- ☐ Physics
- ☐ Physical Sciences
- ☐ Statistical Sciences

Table of Contents

Discipline: Aquaculture Science and Technology

Discipline: Marine Biology

Effects of environmental change on the juvenile stage of tropical rock lobster, Panulirus ornatus

Summary of Project:

Tropical rock lobster form an important part of commercial and recreation fisheries on the east coast of Australia and it is an emerging species for aquaculture development. Yet, little is known about the ideal ocean conditions that promote growth and survival during various life stages, and especially how future climate change may impact this species. This project will investigate the independent and interacting effects of ocean warming, acidification (both pH and alkalinity changes) and salinity during the early juvenile stages of development. A wide range of skills and techniques will be developed during this project including respirometry, animal husbandry, titrations, image analysis software, as well as system maintenance and design. Knowledge from this research will be useful for both fisheries management and aquaculture development.

Location: Townsville

Townsville, possible for part-time students

Advisor(s) : Primary: Assoc Prof Jennifer Donelson (JCU)

Co-supervisor: Assoc Prof Jennifer Blair (Ornatas)

Co-supervisor: Sandra Infante Villamil (Ornatas)

Would suit a student who:

Has an interest in ecology, climate change, aquatic sciences and/or aquaculture. Preferred: Subjects in aquaculture and aquatic physiology. Experience in live animal husbandry a benefit but not required

Preferred start date

Feb 2024

Discipline: Aquaculture Science and Technology

Cost effective genotyping for selective breeding through imputation

Summary of Project:

Genotyping is a significant expense in any genetic selective breeding application. Strategic selection and design of genotyping platform is integral to delivering enough genotypic information to implement selective breeding in aquaculture. This study will explore recent developments in imputation strategies using a variety of genotyping platforms and SNP marker densities to cost-effectively maximise the information returned per genotype.

Townsville, possible for part-time students

Advisor(s) :

Prof Dean Jerry (https://research.jcu.edu.au/portfolio/dean.jerry/)

Dr. Dave Jones https://research.jcu.edu.au/portfolio/david.jones3/)

Would suit a student who:

Interested in genetics and selective breeding within aquaculture species. Basic genetics and genotyping knowledge desirable.

Preferred start date

February (SP1), or September (SP9).

Discipline: Aquaculture Science and Technology

Global population genomics of barramundi (Lates calcarifer) based on high-resolution single nucleotide polymorphisms

Summary of Project:

Barramundi is an important aquaculture, fishery and recreational species that has a natural distribution throughout northern Australia, PNG, southeast Asia, India and Sri Lanka. Genetic studies have highlighted that this species is genetically structured, with major genetic stocks present. This study will use genome-wide SNP markers to further examine the genetic sub-structure of barramundi at unprecedented resolution in Australia and Southeast Asia in order to understand the evolution of this species and to identify genetic stocks for conservation and aquaculture management.

Townsville, possible for part-time students

Advisor(s) : Prof Dean Jerry

https://research.jcu.edu.au/portfolio/dean.jerry/

Would suit a student who:

Interested in genetics and use of genomics to understand the evolution and genetic interconnectivity of fish species. Requires knowledge of basic genetics, population genetics knowledge desirable.

Preferred start date Feb 2024

Discipline: Aquaculture Science and Technology

Assessment of antibacterial activity in mucosal immunity in cultured fish species.

Summary of Project:

Mucosal immunity is the major front line immune defence of fish against invasion by waterbourne bacterial pathogens. Many fish species have been described to express antibacterial activity in skin mucous however for many tropical marine species such activity has not been described despite a biological precedent for presence. This project will investigate establish assays to measure antibacterial activity in skin mucous. Antibacterial activity against different fish bacterial pathogens will be measured and potentially characterised. The study will provide fundamental research to support future work to investigate approaches to influence mucosal immunity in aquaculture species including but not limited to climate change, nutrition, genetic selection and microbiome studies.

Townsville, possible for part-time students

Advisor(s) : Kelly Condon, Dean Jerry and Andreas Lopata

https://research.jcu.edu.au/portfolio/dean.jerry/

https://research.jcu.edu.au/portfolio/andreas.lopata/

https://research.jcu.edu.au/portfolio/kelly.condon/

Would suit a student who:

Students should possess knowledge in the fields of aquaculture or microbiology or protein analysis. This project will suit a student that has an interest in developing technical laboratory skills and an improved understanding in fish health, fish aquaculture or marine microbiology.

Preferred start date: February (SP1), or September (SP9).

Discipline: Aquaculture Science and Technology

Influence of rearing conditions on antibacterial activity in mucosal immunity in cultured fish species.

Summary of Project:

Mucosal immunity is the major front line immune defence of fish against invasion by waterbourne bacterial pathogens. Many fish species have been described to express antibacterial activity in skin mucous however the impact of rearing conditions in aquaculture such as temperature, pH, salinity and exposure to ammonium on mucosal activity are undetermined. Antibacterial activity in the mucous of barramundi or groupers to different fish bacterial pathogens will be measured and potentially characterised. The study will provide fundamental research to support future work to investigate approaches to influence mucosal immunity in aquaculture species including but not limited to climate change, nutrition, genetic selection and microbiome studies.

Townsville, possible for part-time students

Advisor(s) : Kelly Condon, Dean Jerry and Andreas Lopata

https://research.jcu.edu.au/portfolio/dean.jerry/

https://research.jcu.edu.au/portfolio/andreas.lopata/

https://research.jcu.edu.au/portfolio/kelly.condon/

Would suit a student who:

This project will suit a student that has an interest in developing technical laboratory skills and an improved understanding in fish health, fish aquaculture or marine microbiology. Students should possess knowledge in the fields of aquaculture or microbiology or protein analysis.

Preferred start date February (SP1), or September (SP9).

Discipline: Aquaculture Science and Technology

Development of antibacterial activity in mucosal immunity with age in juvenile marine aquaculture fish species.

Summary of Project:

Mucosal immunity is the major front line immune defence of fish against invasion by waterbourne bacterial pathogens. Many fish species have been described to express antibacterial activity in skin mucous however the age of onset of mucosal immunity within important aquaculture species (barramundi, giant groupers) has not been established. This study will investigate the age of onset and changes in the activity of mucosal antibacterial action in fish skin mucous with age. The research is fundamental to support future work to investigate approaches to influence mucosal immunity in aquaculture species including but not limited to climate change, nutrition, genetic selection and microbiome studies.

Townsville, possible for part-time students

Advisor(s) : Kelly Condon, Dean Jerry and Andreas Lopata

https://research.jcu.edu.au/portfolio/dean.jerry/

https://research.jcu.edu.au/portfolio/andreas.lopata/

https://research.jcu.edu.au/portfolio/kelly.condon/

Would suit a student who:

This project will suit a student that has an interest in developing technical laboratory skills and an improved understanding in fish health, fish aquaculture or marine microbiology. Students should possess knowledge in the fields of aquaculture or microbiology or protein analysis.

Preferred start date February (SP1), or September (SP9).

Discipline: Aquaculture Science and Technology

Discipline: Biomedical Sciences and Molecular Biology

Sex change in fish – Assessment of the biomarker Vitellogenin in cultured fish species

Summary of Project:
Sex control is the most important factors for the commercialisation and efficient propagation of fish species. Without the ability to regulate sexual differentiation, maturation, and reproduction, there is little control over breeding processes. Sex determination and differentiation in fish is an evolutionarily diverse and highly plastic developmental process which leads to great challenges when trying to develop a general understanding of sex in fish. Sex is not only determined through genetic factors but also by the environment.
Barramundi fish change sex from male to female only after 4 or more years, and this is a major challenge for the growing aquaculture industry in Australia. Determining the sex of barramundi is not possible through visual observations, but can be achieved through measurement of biomarkers. Vitellogenins (VTGs) are large phospholipoproteins that serve as a source of lipid and protein egg yolk nutrients in many vertebrates and fish. They are produced in the liver, usually in response to female hormones, but can also be detected in some males. The VTGs seem to differ between fish species but specific antibodies can be used to distinguish and quantify VTG in fish.
This study will investigate the presence and quantity of the biomarker VTG in blood and skin mucus of barramundi during different developmental stages. Specific antibodies will be generated against purified VTG and used in different biochemical and immunological assays to determine sex change. This study will provide fundamental information about the modulation of this central biomarker of sex change in fish.

Townsville, possible for part-time students

Advisor(s):, Andreas Lopata, Kelly Condon, Jarrod Guppy, Dean Jerry
https://research.jcu.edu.au/portfolio/andreas.lopata/
https://research.jcu.edu.au/portfolio/kelly.condon/
https://research.jcu.edu.au/portfolio/jarrod.guppy/
https://research.jcu.edu.au/portfolio/dean.jerry/

Would suit a student who:

This project will suit a student that has an interest in developing technical laboratory skills and an improved understanding in animal and human health. Students should possess knowledge in the fields of protein or DNA analysis or biomedical sciences or aquaculture.

Preferred start date February (SP1), or September (SP9).

Discipline: Biomedical Sciences and Molecular Biology

Discipline: Aquaculture Science and Technology

Effect of different growing conditions on the protein profile of farmed Black Soldier Flies – Impact on animal and human health

Summary of Project:

The world's increasing population will eventually lead to a shortage in our mainstream food supply. To supplement the global dietary needs, various alternative and innovative solutions have been identified in the past decade, including edible insects due to their high-nutritional values. Furthermore, there is a growing demand of mass-rearing of insects for animal feed which has gained worldwide attention due to their rapid biomass generation. Substituting soybean and fishmeal protein components in animal feed with insect biomass is a promising solution to the problem of increased demand on animal feed in aquaculture.

This study will investigate the impact of different diet and developmental stages on the complete proteome composition in Black soldier flies using a combination of gene and protein technologies. This research is fundamental to support the benefits of a circular economy through bioconversion of organic waste into healthy food products for animals and human.

Townsville, possible for part-time students

Advisor(s):, Andreas Lopata, Kyall Zenger, Shay Karnaneedi, Kelly Condon, Dean Jerry

https://research.jcu.edu.au/portfolio/andreas.lopata/

https://research.jcu.edu.au/portfolio/kyall.zenger/

https://research.jcu.edu.au/portfolio/kelly.condon/

https://research.jcu.edu.au/portfolio/dean.jerry/

Would suit a student who:

This project will suit a student that has an interest in developing technical laboratory skills and an improved understanding in animal and human health. Students should possess knowledge in the fields of protein or DNA analysis or biomedical sciences or aquaculture.

Preferred start date: February (SP1), or September (SP9).

Discipline: Chemistry

Discipline: Physical sciences

Electrochemical Sensors for Aquatic Analysis

Summary of Project:

Portable electrochemical sensors with high performance and low cost are increasingly necessary for aquatic analysis to protect freshwater and marine ecosystems. This project aims to innovatively design electrochemical sensors for detection of substances of environmental and biological importance. JCU Electrochemistry & Sensors Lab has excellent facilities for preparation and characterisation of sensing materials, as well as testing analytical performance of electrochemical sensing devices. The tasks of this project include development of electrochemical sensors, optimisation of their analytical performance and exploration of their applications in water quality monitoring.

Townsville, possible for part-time students

Advisor(s) : Yang Liu

Would suit a student who:

has interest and background in analytical chemistry, electrochemistry or water quality monitoring. Requires completing subject CH2103

Preferred start date February (SP1), or September (SP9).

Discipline: Chemistry

Discipline: Physical sciences

Plasma Electrocatalysis for Degradation of Microplastics

Summary of Project:

Millions of tonnes of plastic waste are estimated to enter the oceans annually. In marine environment, plastic breaks up into smaller particles, e.g., an estimated 13% to 32% of the total weight of buoyant plastics in the oceans consists of microplastic particles of 0.3–5 mm in size, which have been reported to affect the health of our marine ecosystem mainly due to microplastic intake by marine organisms (Figure 1a). Currently, removal of microplastics from seawater is of great challenge due to the lack of effective and environmentally friendly techniques.

Plasma electrocatalysis has attracted increasing attention in recent years due to their high potential in environmental remediation. This project aims to understand the physical and chemical properties of plasma-liquid interfaces that involve a variety of energetic photons, ions and electrons, and to explore the applications of this technique in degradation of microplastics.

The tasks of this project include:

1. Prepare microplastics with known composition and size.
2. Optimise the plasma-liquid system for degradation of microplastics.
3. Characterise the microplastics before and after degradation using electron microscope, gel permeation chromatography, FT-IR, and correlating these results with carbon analysis of the plasma and liquid phases.

Townsville, possible for part-time students

Advisor(s) : Yang Liu

Would suit a student who:

has interest and background in physical chemistry, electrochemistry or environmental remediation.

Requires completing subject CH2103

Preferred start date February (SP1), or September (SP9).

Discipline: Data Science

Discipline: Ecology, Conservation, Plant Sciences and Zoology

Discipline: Marine Science

Discipline: Mathematical Sciences

Discipline: Physics

Developing topological models for reef conservation

Summary of Project: What factors drive changes to reef biodiversity at local (small) scales? How important is the spatial distribution of species? How do local changes influence the biodiversity and resilience of the whole reef system? What does this mean for reef management policies?

Could abstract mathematics provide insights into such questions? Topology and geometry are the areas of maths concerned with shape. In particular, many tools of topology have been developed to study the interplay between local and global features of a system.
This year, a team at Oxford, Berkeley and Cambridge – building on the work of Mumby-Hastings-Edwards 2007 -- have published a new spatio-temporal model to investigate the effects of species distribution on reef resilience. This model uses *persistent* and *zig-zag homology*, methods from the fast-growing field of *topological data analysis (TDA)*, that study the shape of data by analysing features that persist under continuous transformations (like evolution through time).
Together with reef scientists and mathematicians, you will investigate how this new TDA model may be adapted to a variety of situations. You will consider questions like: how do boundary effects influence the model? How can we incorporate physical processes such as currents driven by tides, wind and large scale oceanic currents ? Over what scales could the model be used? The project is just one of many possible investigations into new applications of the mathematics of shapes -- and their boundaries, configurations and connectivity -- in reef ecology. Does this area of research excite your curiosity? Please get in touch!

Townsville, part-time project is open for discussion

Advisor(s): Dr Sophie Raynor and Dr Severine Choukroun

Would suit a student who:

i) likes abstract maths but is also interested in the "real world" **and/or**
ii) has a (marine) physics background and is happy to learn new maths **and/or**
iii) enjoys theoretical/methodological aspects of data science.
iv) you will be designing new scientific methods so this will require a curious, creative, and problem-solving mindset!

You should have a suitable undergrad major (e.g. maths, physics, marine science, data science).

Preferred start date February 2024 (SP1). Later is also possible.

Discipline: Data Science

Mitigate Biases and Promote Fairness in Language Models

Summary of Project:

Biases in pretrained language models have been a significant concern in the field of natural language processing. Existing studies have shown that these models can perpetuate gender language processing. Existing studies have shown that these models can perpetuate gender biases, political biases, and fairness-related harms in their generated text. However, researchers are actively addressing these issues and proposing novel approaches to promote fairness and mitigate biases. Methods like GEnder Equality Prompt (GEEP) and FairPrism aim to improve gender fairness and measure and mitigate fairness-related harms, respectively. These advancements demonstrate the commitment to creating pretrained language models that are more inclusive, unbiased, and aligned with the values of a diverse society. Depending on interest, in this project the student(s), our aim is to make creating/modify models to achieve improved performance. Students are expected to build on top of previous state-of the-art methods under the guidance of the supervision team (you will not feel that you are alone in this project) and establish better performance using deep learning and natural language processing. You will be provided with a code and datasets.

Cairns and/or Townsville, not possible for part-time students

Advisor(s): Usman Naseem

Would suit a student who:

The student(s) should have a basic understanding of data science and deep learning or have equivalent experiences.

Preferred start date

February 2024

Discipline: Data Science

Using Advanced deep learning methods for biomedical and health Informatics and conversation

Summary of Project:

The biomedical and healthcare sciences have become data-intensive fields, with a strong need for sophisticated data mining methods to extract knowledge from the available information. Both biomedical and healthcare data contain several challenges in data analysis, including high dimensionality, highly distributed data as well as data sources, class imbalance, and low numbers of samples. Recently, advanced machine learning methods have shown promising results in biomedical and healthcare applications. Therefore, there is a need to explore novel learning methods, optimization, and inference techniques for processing biomedical and healthcare data to get performance closer to clinical diagnosis. Advances in machine learning can be used to develop sophisticated and novel applications in the healthcare domains.

Depending on interest, in this project, the student(s) will apply state-of-the-art (SOTA) CV and NLP in various multimodal (both text and image) tasks such as Medical Visual question answering (VOA), Medical dialogue generation, medical report generation/ Image captioning tasks etc. In this project(s), our aim is to make creating/modify models to achieve an improved performance. you will not feel that you are alone in this project.

Cairns and/or Townsville, not possible for part-time students

Advisor(s): Usman Naseem

Would suit a student who:

The student(s) should have a basic understanding of data science and deep learning or have equivalent experiences.

Preferred start date

February 2024

Discipline: Data Science

Fake news detection

Summary of Project:

Fake news is false or misleading information presented as news in social media. Social media can be a double-edged sword for society, either bringing convenience to exchanging ideas or unexpectedly circulating fake news with high potential hazards to society. Therefore, it has become crucially important and attracted increasingly more public attention to effectively detect fake news on social media. For content-based fake news detection models, it is necessary to investigate the supports and evidence to detect from the multi-modality content, e.g., images and texts, of news. Students are expected to build on top of previous state-of-the-art methods under the guidance of the supervision team and establish better performance using deep learning.

Cairns and/or Townsville, not possible for part-time students

Advisor(s): Usman Naseem

Would suit a student who:

The student(s) should have a basic understanding of data science and deep learning or have equivalent experiences.

Preferred start date

February 2024

Discipline: Data Science

Identification of personal health experiences on social media using deep learning

Summary of Project:

Public health surveillance from social media relies on being able to separate what people say about their own health from other discussions that use the same keywords for other reasons. Many applied studies in the area have failed to take this into account, leading to biased results that could overrepresent the importance of certain health issues by location or over time and lead to poor quality decision-making about policy or resource allocation.

The key idea of the project is to identify the user posts where the user talks about their health and conditions using disease or symptom words. In this project, you are expected to use recent deep learning and natural language-based methods to improve the classification performance under the guidance of the supervision team. You will be provided with a code and datasets.

Cairns and/or Townsville, not possible for part-time students

Advisor(s): Usman Naseem

Would suit a student who:

The student(s) should have a basic understanding of data science and deep learning or have equivalent experiences.

Preferred start date

February 2024

Discipline: Data Science

Detecting and Understanding Memes on social media

Summary of Project:

Social media has enabled individuals to freely share content online. While this was a hugely positive development as it enabled free speech, it was also accompanied by the spread of harm and hostility. Hate speech, offensive language, abusive language, propaganda, cyberbullying, cyber aggression, and other kinds of harmful content have become prominent online. Such content can target users, communities (e.g., minority groups), individuals, and companies. Social media have defined various categories of harmful content that they do not allow on their platforms, and various categorizations of such content have also come from the research community. Social media content is often multimodal, combining text, images, and/or videos. In recent years, Internet memes have emerged as a prevalent type of content shared on social media. A meme is "a group of digital items sharing common characteristics of content, form, or stance, which were created by associating them and were circulated, imitated, or transformed via the Internet by many users". Memes typically consist of images containing some text. The design used in memes is typically humorous, but they are often harmful. Students are expected to build on top of previous state-of-the-art methods under the guidance of the supervision team and establish better performance using deep learning and natural language processing.

Cairns and/or Townsville, not possible for part-time students

Advisor(s): Usman Naseem

Would suit a student who:

The student(s) should have a basic understanding of data science and deep learning or have equivalent experiences.

Preferred start date

February 2024

Discipline: Data Science

Early detection of Mental health issues using social media

Summary of Project:

Mental health is a critical issue in modern society, and mental disorders could sometimes turn to suicidal ideation without adequate treatment. Early detection of mental disorders and suicidal ideation from social content provides a potential way for effective social intervention. The key idea of the project is to leverage the user-generated data on social media to create a usable decision support system that aids in the detection of mental health issues. The implication of this work is to improve public health surveillance using social media data.

Students are expected to build on top of previous state-of-the-art methods under the guidance of the supervision team (you will not feel that you are alone in this project) and establish better performance using deep learning and natural language processing. You will be provided with a code and datasets.

Cairns and/or Townsville, not possible for part-time students

Advisor(s) : Usman Naseem

Would suit a student who:

The student(s) should have a basic understanding of data science and deep learning or have equivalent experiences.

Preferred start date

February 2024

Discipline: Data Science

Identifying Offensive online contents

Summary of Project:

Social media has become one of the main channels for people to access and consume news, due to the rapidness and low cost of news dissemination on it. However, such properties of social of social media also make it a hotbed of hate speech, misinformation, and fact checking, bringing negative impacts on both individuals and society. Therefore, detecting fake news has become a crucial problem attracting tremendous research effort. Depending on interest, in this project the student(s), our aim is to make creating/modify models to achieve improved performance. Students are expected to build on top of previous state-of the-art methods under the guidance of the supervision team (you will not feel that you are alone in this project) and establish better performance using deep learning and natural language processing.

Cairns and/or Townsville, not possible for part-time students

Advisor(s): Usman Naseem

Would suit a student who:

The student(s) should have a basic understanding of data science and deep learning or have equivalent experiences.

Preferred start date

February 2024

Discipline: Data Science

Identifying Toxic Behavior in Online Gaming

Summary of Project:

The problem of toxic behavior in online games and the gaming industry has become increasingly serious. The toxic language used in in-game chat differs significantly from other online platforms like social media or online news. This is mainly due to the shorter length of messages, as players tend to type in-game chat while playing, while longer messages are typically seen in pre- or post-game discussions. Considering this unique nature of in-game chat, it is crucial to understand the slot-level (word token) context in order to detect toxic language. In this project students are expected to collect a new dataset and establish the baselines using existing methods.

Cairns and/or Townsville, not possible for part-time students

Advisor(s): Usman Naseem

Would suit a student who:

The student(s) should have a basic understanding of data science and deep learning or have equivalent experiences.

Preferred start date

February 2024

Discipline: Earth Science

Discipline: Ecology, Conservation, Plant Sciences and Zoology

Discipline: Environmental Sciences and Management

Using plants and rock dust to permanently remove carbon dioxide from the atmosphere

Summary of Project:

This project involves studying plant and soil processes to optimise CO_2 removal via enhanced weathering, in the field and/or laboratory. To mitigate climate change we need not only to reduce CO_2 emissions but also to remove CO_2 from the atmosphere and lock the carbon away. Enhanced weathering is rapidly gaining attention as a way of doing that, but there are still important unknowns about how effective it will be. It involves adding basalt rock dust to agricultural soil, which rejuvenates the soil and should also remove CO_2 during weathering. This might be particularly effective in tropical climates and soils. However, many plant, microbial, soil chemical, hydrological and management processes need to align. This project will focus on one of the key questions and can be tailored to suit your interests and background. You will be part of a JCU team running field trials and laboratory analyses, and we are part of the international Leverhulme Centre for Climate Change Mitigation.

Cairns, possible for part-time students

Advisor(s) : Dr Paul Nelson

Would suit a student who:

has an interest in plants, climate change mitigation, sustainable agriculture, chemistry, lab work or field work; i.e. there are a variety of potential projects. Drivers license would be handy but not necessary. It would be best if you have studied 'EA2007/EA3207 Soil Properties and Processes'

Preferred start date February (SP1), or September (SP9).

Discipline: Ecology, Conservation, Plant Sciences and Zoology

Parental care in a changing environment

Parental care in a changing environment

Summary of Project:

Everyone needs a helping hand most when times are tough. Indeed, it has been argued that the distribution and evolution of social species -that live in groups and cooperate- have evolved in harsh environmental conditions, allowing for successful reproduction and survival in environments where pairs alone cannot succeed. This implies that social behaviour may moderate the impact of climate change.

In cooperative breeding groups, the presence and number of helpers that assist the breeding pair in raising young can positively impact reproductive success through various mechanisms. Larger groups provide more food to offspring, which is crucial for their growth and survival, particularly in environments where food availability is limited. Helpers also alleviate the workload of the breeding pair, leading to better reproductive outcomes. In this project you can analyse recordings of nestling provisioning behaviour of the cooperatively breeding red-winged fairy-wren (*Malurus elegans*) collected from the field. Depending on your interest topics of research can include:

-how birds adapt their parental care in response to changing weather conditions

-whether larger groups can buffer effects of adverse weather conditions

-the fitness consequences of changes in behaviour

Cairns or Townsville (either), possible for part-time students

Advisor(s) : Lyanne Brouwer (https://research.jcu.edu.au/portfolio/lyanne.brouwer)

Would suit a student who:

Has an interest in behavioural, evolutionary, and global change ecology. The project will require data collection through watching and scoring behavioural observations from video recordings, and subsequent analysis of the data.

Preferred start date

February (SP1), or September (SP9).

Discipline: Ecology, Conservation, Plant Sciences and Zoology

Bird Acoustics and Environmental Conditions

Summary of Project:

In my lab, we are using the large sound database generated by the Australian Acoustic Observatory, an Australia-wide network of recorders to determine the calling patterns of vocal animals (mammals, birds, amphibians and insects). We are looking for students to focus on particular taxa and help examine geographic or site specific calling patterns, in relation to environmental conditions. This may include rare or threatened species, or common migratory species, for example. Students interested in analysing data returned from citizen science platforms would also be welcome.

Cairns or Townsville (either), possible for part-time students

Advisor(s) : Lin Schwarzkopf https://research.jcu.edu.au/portfolio/lin.schwarzkopf/

Would suit a student who:

e.g. has an interest in ecology, sound or calling, and analysing large datasets

Preferred start date: February (SP1), or September (SP9).

Discipline: Ecology, Conservation, Plant Sciences and Zoology

Bird Acoustics and Environmental Change

Summary of Project:

We are conducting studies on the impact of drying on vertebrate biodiversity surrounding waterbodies. We will be sampling biodiversity extensively at 16 waterbodies in outback Queensland. We will be collecting acoustic, camera trap and standard active searching and trapping studies at a range of water bodies as they dry out over the dry seasons. We are intending to describe patterns of change to obtain data to predict wildlife responses to future climate change. You will help with trapping and recording data, and analyse a subset of the data for your honours project.

Cairns or Townsville (either), possible for part-time students

Advisor(s) : Lin Schwarzkopf https://research.jcu.edu.au/portfolio/lin.schwarzkopf/

Would suit a student who:

Has an interest in field ecology, and analysing large datasets. You must have a driver's licence and be willing to work in hot conditions in the field.

Preferred start date : February (SP1), or September (SP9).

Discipline: Ecology, Conservation, Plant Sciences and Zoology

Discipline: Data Science

What causes the extinction risk of biodiversity to deteriorate or improve? A global analysis of birds, mammals, corals or amphibians

Summary of Project

Humans influence the environment in such a strong way that many species are going extinct, or are in such low numbers that they become endangered. Conservation actions and mitigation of threats help to slow down ongoing increases in extinction risk, and ultimately the aim is to become Nature positive and turn the tide. At the other side of the equation, some changes in the environment (e.g. climate change) are still accelerating and may cause extinction risks to worsen over time. Currently, we have a poor understanding of what are the main determinants of extinction risks in animals.

This project aims to study changes in the threat status of species using the IUCN red list data. The IUCN for each species summarizes all the existing scientific evidence into a red list threat status of whether a species is non-threatened, threatened, extinct in the wild, or various gradual steps in between. The red list is updated every so many years for each species due to new scientific evidence. In this project, we will develop a new mult-state transition model to quantify the rates of changes in red list threat status over time for all the world's species in a specific group (birds, mammals, corals or amphibians). To understand the causes of these changes, we will next identify which factors (type of species, habitat, type of threats, type and amount of conservation action) can explain why some species improve while other deteriorate. This project will thus help identify the main drivers of ongoing reductions in extinction risks of the world's animals, as well as the factors that lead to success and contribute to a nature positive world.

Cairns and/or Townsville, not possible for part-time students

Advisor/s: Martijn van de Pol https://research.jcu.edu.au/portfolio/martijn.vandepol/

Would suit an applicant who

Has an interest in ecology, global change and conservation or statistics. For ecologists an affinity with statistics and/or modelling is desirable, for data science students an affinity with ecology is desirable. The project can be adapted to be more focusses on statistical methods or on biodiversity consequences.

Preferred start date February (SP1), or September (SP9).

Discipline: Ecology, Conservation, Plant Sciences and Zoology

Discipline: Mathematical Sciences

Cassowary extinction risk

Summary of Project:

Southern cassowary is the iconic species of Northern Queensland, and Australia's largest birds. These birds are an important species in this region because they disperse large seeds of fruits throughout the rainforest. Cassowaries are also an endangered species, and a national species action plan sets out key goals to improve the population viability of this species. However, to be able to determine evidence-based and efficient conservation actions, we first need to be able to determine what the current extinction risk is before we can start assessing what the best way is to improve the population viability of this species. In this project you will collate from the literature all the information on the demography of this species and integrate this into a population model to determine the population viability of this species. Once the model is built there are additional opportunities to determine what conservation actions would best help to increase the population size and viability of this species.

Cairns or Townsville (either), possible for part-time students

Advisor(s) : Martijn van de Pol https://research.jcu.edu.au/portfolio/martijn.vandepol/

Would suit a student who:

e.g. has an interest in ecology and has some basic experience with ecological/mathematical/computer modelling (e.g. done BS5260 or MA3211).

Preferred start date: February (SP1), or September (SP9).

Discipline: Ecology, Conservation, Plant Sciences and Zoology

Discipline: Mathematical Sciences

Discipline: Data/Statistical Sciences

Various projects at the interface of Ecology, mathematical and statistical modelling

Summary of Project:

Our research is at the interface of ecology (coastal and terrestrial), mathematical and statistical modelling. Therefore, I am happy to discuss projects to suit students that are interested in one or more of these fields. Topics we are currently working on are:

- Meta-analysis of species differences among wildlife to human disturbance.
- Developing an early warning system for conservation management in arid boom-bust systems (bilbies),
- Statistical tools for robust climate change biology
- Population dynamical responses to climate change on a continental scale.
- Demographic models of the evolution of cooperation.
- The impact of sea level rise on shorebirds – a global analysis.

Cairns or Townsville (either), possible for part-time students

Advisor(s) : Martijn van de Pol https://research.jcu.edu.au/portfolio/martijn.vandepol/

Would suit a student who:

e.g. has a background in statistics or mathematics with an interest in ecology, or an ecologist / marine biologist with in interest in quantitative methods

Preferred start date: February (SP1), or September (SP9).

Discipline: Ecology, Conservation, Plant Sciences and Zoology

Diet choice in a changing world

Summary of Project:

Some shorebirds are like Darwin's famous finches: by looking at their bill one can determine what they eat. In oystercatchers, some birds become shellfish specialists and have blunt bills, while other birds are worm specialists and have pointy bills. The abundance of worms and shellfish has changed dramatically over time, either due to shellfisheries or global warming causing cold-loving prey species to decline. Little is known how wildlife can track and adapt to such rapid changes in the environment. In this project you can analyse a dataset of more than 35 years on bill shapes, food stocks and climate change to determine how shorebird's diet specialization responds to a changing environment. Depending on your interest, your Honours project could focus on for example:

- How birds have adapted their diet specialization over the past decades
- How it will change under future climate change scenarios
- Whether the male and female in a pair avoid competition over food by choosing opposite specializations
- How diet specialization develops from an early age and whether it is inherited from their parents, or depends on their natal habitat.

Cairns or Townsville (either), possible for part-time students

Advisor(s) : Martijn van de Pol https://research.jcu.edu.au/portfolio/martijn.vandepol/

Lyanne Brouwer https://research.jcu.edu.au/portfolio/lyanne.brouwer/

Would suit a student who:

This project is at the interface of behavioural, evolutionary, functional and global change ecology. Some experience with statistics (particularly regression models) is useful.

Preferred start date: February (SP1), or September (SP9).

Discipline: Ecology, Conservation, Plant Sciences and Zoology

Discipline: Environmental Sciences and Management

Ecology and evolution of tropical invasive plants

Summary of Project:

Several projects available, from more theoretical to fully applied, suitable to different interests and backgrounds. Invasive plants pose a major environmental problem that requires applied scientific solutions. However, they are also optimal model systems to study key ecological concepts, providing with unique insights into the evolutionary processes unfolding during colonization and adaptation to newly colonised areas. Projects are available to study direct management approaches, but also to test ecological theories about plant-animal interactions, biogeography, ecology, ecophysiology, reproductive biology, and others.

The Australian Tropical Herbarium (ATH) is located at James Cook University's Cairns campus. Its location in the Wet Tropics, proximity to the Great Barrier Reef, and a variety of diverse habitats, species, and communities, locates it ideally for the development of research on invasive plant biogeography, reproductive ecology, seed biology, plant physiology and chemistry, and plant-animal interactions. The ATH has a dedicated biosecurity group with funding to support several Honours, MSc, and PhD projects to selected candidates. Informal inquiries are welcome, and personal areas of interest will be considered for the planning of projects that fit within the group's expertise.

Cairns, possible for part-time students

Advisor(s) : Daniel Montesinos https://research.jcu.edu.au/portfolio/daniel.montesinos/

Would suit a student who:

Has a background on ecology, botany, biology, or similar, and a motivated, curious mind, willing to study plant evolutionary ecology in the context of biogeography and invasions.

Preferred start date : February (SP1), or September (SP9).

Discipline: Environmental Sciences and Management

Discipline: Ecology, Conservation, Plant Sciences and Zoology

Exploring recruitment of soil fauna in sugar cane farming systems

Summary of Project:

Understanding the recruitment and retention of beneficial soil fauna in sugarcane farming systems will be vital as the industry moves toward regimes of less cultivation. Post-harvest green cane trash blanketing, where the unused components of sugar cane plants are spread over the ground, has become popular over the past 30 years but has not led to predicted increases in soil carbon content. This is possibly because the green cane trash blanket is fully decomposed on the soil surface and not incorporated into the soil profile by the activities of soil invertebrates. The lack of organic matter incorporation into the soil by soil invertebrates is presumably due to cultivation which is usually carried out every 4-6 years. This may be destroying the soil invertebrate ecosystem and thereby reducing the capacity of soil fauna incorporate organic matter and other functions during a typical cane rotation. In addition, the use of insecticides in the sugar cane system may further effect non-target soil fauna and also reduce the rate of trash incorporation deep into the soil.

This project will seek to understand the effects of cultivation on the soil fauna, and the conditions that are required for the recruitment of soil invertebrates into cane farming systems. Whilst there is flexibility in how this project is approached, an initial starting point would be to use a space-for-time experiment to investigate the responses of soil invertebrates from 1 to 6 years post-cultivation. This could include additional contrasts such as variation in insecticide use, farm context (such as the surrounding vegetation matrix), and edge effects.

Cairns, possible for part-time students

Advisor(s) :
Peter Yeeles: https://research.jcu.edu.au/portfolio/peter.yeeles/
Paul Nelson: https://research.jcu.edu.au/portfolio/paul.nelson/

Would suit a student who: has an interest in terrestrial invertebrates, soil science and agriculture. Driving license required , and a willingness to perform fieldwork in sugar cane systems.

Preferred start date: February 2024

Discipline: Environmental Sciences and Management

Flow monitoring using video cameras

Summary of Project:

The aim of the project is to do flow measurements for an urban drain in Saltwater Creek (Cairns) using innovative camera technology. The student will be trialing out new technology and working with hydrographers from QLD Government. The work involves fieldwork, image analysis and comparison of results with traditional measurement techniques.

Location: Cairns, full-time student only

Advisor(s) : HanShe Lim

https://research.jcu.edu.au/portfolio/hanshe.lim/

Would suit a student who:

Students who are interested in learning new technology and applying it to environmental measurements, don't mind getting wet and preferably can get to saltwater creek relatively easily on their own at quick notice. Student will preferably need to have their own car and have the flexibility to drive to the site during or soon after rainfall events to measure different flow conditions experienced at the drain.

Preferred start date : February (SP1), or September (SP9).

Discipline: Environmental Sciences and Management

Understanding groundwater contributions to a wetland in a nutrient rich agricultural environment

Summary of Project:

The project aims at understanding groundwater flows through a small wetland in South Johnstone using tracers and radon. The field activities include collecting water samples and helping with radon measurements.

Cairns, possible for part-time students

Advisor(s) : HanShe Lim

https://research.jcu.edu.au/portfolio/hanshe.lim/

Would suit a student who:

Suit a student with interest in fieldwork and environmental processes/pollution. Requires drivers license, taken subjects EA2006/5016 and/or EA3007/5018.

Preferred start date February 2024

Discipline: Marine Biology

Age, size at maturity and sexual development in *Acanthochromis polyacanthus* across the species range on the Great Barrier Reef.

Summary of Project:

Demographic patterns of life-history traits in animal populations can be used to assess the status and allow targeted conservation actions. Variations in traits like growth, maturation, reproductive output, and life span can occur both within and between populations due to environmental conditions. For example, warming water temperature associated with latitude tends to accelerate life histories, with faster growth, earlier maturation, and smaller asymptotic lengths. Shifts within a population through time can give indications of how a population is responding to environmental change, however, this requires a baseline understanding of life-history traits across populations. This project will complete a detailed assessment of sexual maturation in wild samples of the spiny chromis damselfish, *Acanthochromis polyacanthus*. These data will be combined with body size and population growth rates to understand the demographic patterns of this species from specific sites. Because we also have captive reared *A. polyacanthus* of know ages in tanks we can observe the time of first spawning. A component of the study, therefore, would be to compare estimates of maturation time from histological slides with observations from tanks.

Townsville, possible for part-time students

Advisor(s) : Mike Kingsford & Jennifer Donelson

https://research.jcu.edu.au/portfolio/michael.kingsford/

https://research.jcu.edu.au/portfolio/jennifer.donelson/

Would suit a student who:

involves aquarium based lab work, no fieldwork. Samples already collected under appropriate permits.

Preferred start date February (SP1), or September (SP9).

Discipline: Marine Biology

Population genomics of the deadly jellyfish *Chironex fleckeri*

Summary of Project:

Chironex fleckeri, commonly known as 'box jellyfish' or 'stingers' are a major threat to swimmers along the coast of Queensland over the summer months. A detailed knowledge of the ecology of this species is required to minimise the risk of envenomation to humans. Historically though, there has been little knowledge of where box jellyfish from a region come from, and more broadly whether populations widely exchange genes. In short, is there no population genetic structure, or is restricted gene flow indicative that jellyfish found in a geographic area are endemic and represent local recruitment. We have found spatial variation in the phenotypes of jellyfish and their elemental chemistry. Furthermore, jellyfish have behaviours, including swimming and obstacle avoidance, that help them remain in localised areas. More recently, we have used environmental DNA to demonstrate how localised populations can be. The gap in our knowledge is understanding the level of connectivity among local populations. This project will use high resolution and genome -wide Single Nucleotide polymorphisms (SNPs) to determine the genetic interconnectivity of box jellyfish populations in order to understand how broadly jellyfish may migrate, and/or levels of local recruitment that has resulted in different genetic stocks being present. If you have an interest in expanding your skills in genetics this could be the project for you?

Townsville, possible for part-time students

Advisor(s) : Mike Kingsford & Dean Jerry

https://research.jcu.edu.au/portfolio/michael.kingsford/

https://research.jcu.edu.au/portfolio/dean.jerry/

Would suit a student who:

Basic genetics – population genetics an advantage

Preferred start date February (SP1), or September (SP9).

Discipline: Mathematical sciences

A graphical calculus for compact closed categories

Summary of Project:

Category theory is often called the mathematics of mathematics because it looks at structural similarities between different areas of maths (and applications). It considers (mathematical) *objects*, and relationships between them, encoded by *morphisms.* In some contexts, graphs provide a useful tool for studying the combinatorics of certain types of categories.

Compact closed categories are used to describe systems that are equipped with a strict notion of *duality*. For example there is a compact closed category of finite dimensional vector spaces and linear transformations. Compact closed categories (and variations thereof) are frequently used in (quantum) physics.

Categories have a directed structure described by inputs and outputs of morphisms. In particular, the graphs used to study categories are directed. However, the duality encoded by compact closed categories suggests that there is a sense in which the direction of their morphisms doesn't matter.

The aim of this project is to build up a system (a category!) of undirected graphs that can be used to study compact closed categories. This would provide a so-called *operadic* description of compact closed categories, which should lead to new connections with other areas of mathematics.

Whilst this project is very similar to work that I have already done (on *modular operads* and *circuit algebras*), there is a subtle combinatorial challenge involved in building the graphs for compact closed categories. The main aim of the project is to solve this problem.

This is just one of several abstract mathematical projects available. If you are interested, please get in touch!

Townsville, part-time option is negotiable

Advisor(s): Dr Sophie Raynor

Would suit a student who:

Likes figuring out difficult puzzles. Requires A suitable undergrad major (e.g. maths, physics). Familiarity with formal proofs and some abstract algebra would be useful. Other than that, there are no specific requirements. But you will need a curious, creative, and problem-solving mindset! Please get in touch if you are interested in this, or similar, projects.

Preferred start date

February 2024 (SP1). Later is also possible.

Discipline: Data Science
Discipline: Marine Science
Discipline: Mathematical Sciences

New mathematical techniques in coral classification

Summary of Project

There are various subprojects available as part of a wider programme that aims to find new mathematical tools to investigate how the morphology (shapes) of corals reflect their systematic and evolutionary relationships.

In recent decades, advances in molecular phylogenetic methods have thrown traditional coral taxonomy – based solely on morphology (shape) of the coral skeleton - into disarray: evolutionary relationships revealed through molecular phylogenetic analysis (comparison of coral genetic codes) are not congruent with those inferred using the traditional morphological methods. Consequently, we are currently unable to identify species in the field or using Museum collections.

So far, research into morphological descriptors that are compatible with molecular structure has used quite crude methods (simply measuring distances between certain structural markers). Can topology and geometry – the areas of mathematics concerned with shape – help overcome this problem?

This project will aim to use novel mathematical tools to identify morphological characters that are phylogenetically informative; i.e., that reflect species boundaries and evolutionary relationships revealed by through molecular phylogenetics. There are diverse research opportunities for honours and HDR students. Potential projects may use a variety of techniques from maths, data science, and physics to study coral morphology. See, e.g. the advertised project on topological data analysis and staghorn corals. If you have a background in maths, physics, data science, marine biology (or related) and would like to work together with coral scientists and mathematicians to investigate new mathematical applications in marine science, please get in touch to discuss possible projects!

Townsville, part-time option is negotiable

Advisor(s): Dr Sophie Raynor and Dr Tom Bridge

Would suit a student who:
The techniques involved in this project are highly transferable so this would suit anyone who

i) likes abstract maths but is also interested in the "real world" **and/or**
ii) enjoys theoretical/methodological aspects of physics or data science **and/or**
iii) is fascinated by coral and willing to learn some new maths.
iv) likes designing new methods and has a curious, creative, and problem-solving mindset!

Preferred start date: February 20224, later also possible

Discipline: Data Science
Discipline: Marine Science
Discipline: Mathematical Sciences

Using topological data analysis to find morphological descriptors for staghorn corals

Summary of Project This project aims to develolop new mathematical tools to investigate how the shapes of staghorn corals reflect their evolutionary relationships.

Recent advances in molecular phylogenetic methods have thrown traditional coral taxonomy – based solely on morphology (shape) of the coral skeleton - into disarray. Consequently, we are currently unable to identify species in the field or using Museum collections. So far, research into morphological descriptors that are compatible with molecular structure has used quite crude methods (simply measuring distances between structural markers).

This project is part of a wider programme that asks whether topology and geometry -- the mathematics of shape -- can provide sophisticated and statistically reliable tools to identify morphological characters that are phylogenetically informative.

Topological data analysis (TDA) is a growing research field which applies topological theory to explore the shape of data. Recently, neuroscience researchers at the Blue Brain Project (EPFL, Switzerland) have used TDA to develop the first effective tool for classifying certain neurons, according to their tree-like structure. You will work together with coral scientists and mathematicians to adapt this technique for the study of staghorn (or 'tree-shaped') corals. The goal is to find precise markers to aid understanding of the relationships between coral morphology and molecular phylogenetics, e.g. by accurately distinguishing genetically distinct corals.

This is one subproject in a wider programme investigating new mathematical techniques in reef science. If you have a background in maths, physics, data science, marine biology (or related) and think you may be interested, please get in touch!

Townsville, part-time option is negotiable

Advisor(s): Dr Sophie Raynor and Dr Tom Bridge

Would suit a student who:

The techniques involved in this project are highly transferable so this would suit anyone who

i) likes abstract maths but is also interested in the "real world" **and/or**
ii) enjoys theoretical/methodological aspects of data science **and/or**
iii) is fascinated by coral and willing to learn some new maths.
iv) likes designing new methods and has a curious, creative, and problem-solving mindset!

Preferred start date February 20224, later also possible