School of Agriculture and Environment

Honours and Masters Research:

Potential projects and supervisors

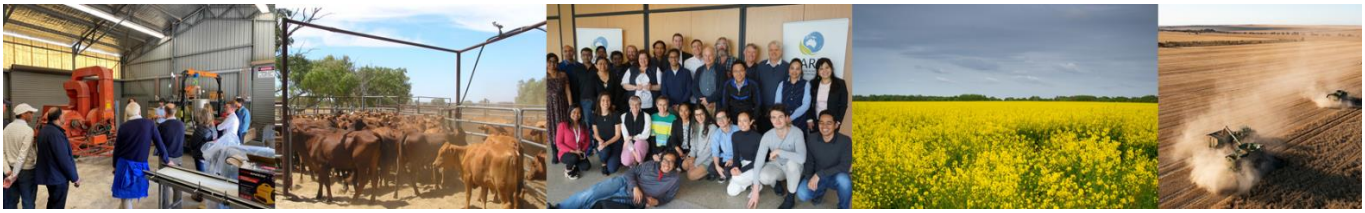
2024

Agricultural Economics
Agricultural Science
Bioinformatics
Biotechnology
Environmental Science

THE UNIVERSITY OF WESTERN AUSTRALIA

Contents

Agricultural Economics



Master of Agricultural Economics degree coordinator – Dr Atakelty Hailu (Atakelty.hailu@uwa.edu.au)

The Master of Agricultural Economics has three 'Specialisation' pathways: Agribusiness, Development and Economics. The table below shows how projects listed by potential supervisors align to these three Specialisations. All listed research opportunities are suitable as Honours projects.

POTENTIAL SUPERVISOR	Agribusiness	Development	Economics
Nanthi Bolan		√	
Michael Burton			√
James Fogarty	√	√	√
Atakelty Hailu	√		√
Ross Kingwell	√		√
Marit Kragt	√		√
Amin Mugera		√	
David Pannell			√
Fay Rola-Rubzen	√	√	√
Steven Schilizzi			√
Ben White			√

- Studies that can be taken using a 'desktop' approach, and thus not requiring field or laboratory work. There is the potential for these studies to be undertaken remotely.

- Studies that involve field sampling such as running field trials or measuring environmental variables or conducting surveys

- Studies that involve research in glass or green houses, animal holding facilities or the laboratory

Dr Nanthi Bolan

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Development

Can biochar improve food security in Timor-Leste? 

Applying biochar to agricultural soils in Timor-Leste provides an opportunity to increase soil health and crop productivity. Field and pot studies have demonstrated that rice hull biochar can be an effective amendment in many Timor-Leste soils. A systematic meta-analysis is now required to understand the underlying soil constraints to crop productivity that biochar is ameliorating in Timor-Leste. This project will suit a student interested in contributing to agricultural development and strengthening their data analysis skills. Primary data from the biochar research undertaken at Timor-Leste, and secondary data from literature covering biochar research in tropical soils will be used in the meta-analysis. Funding ($5,000) is available to support student living expenses. Co-supervisor: James Fogarty.

Prof. Michael Burton

Email: Michael.burton@uwa.edu.au

Economics

Are drinkers confused about what they drink? 

This project will analyze data on consumer choices between wine, beer, and spirits products that have different attribute combinations and test whether consumer choices are consistent with the prediction implicit in standard models of consumer choice. Co-supervisor: James Fogarty.

A new form of food label 

There is a plethora of labels that give consumers information about the unobservable environmental impacts of the goods they consume, in an effort to influence behaviour. This study will evaluate a new, simple, theoretically correct method of conveying this information, and its impact on consumers. Co-supervisor: TBC.

Prof. James Fogarty

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Economics	Agribusiness	Development

Beer, Wine, and Spirits: Do they mix? 

There is a large literature reporting on the way consumers respond to price changes for alcoholic beverages, measured as the own-price elasticity. The relationship between beverage types, measured as a cross price elasticity, has been less studied. The focus of this project will be a study of the global alcohol market literature to test whether beer, wine, and spirits are substitutes, complements, or independent goods. The main method of analysis will be via a meta-regression analysis of the published literature. Co-supervisor: TBC.

Trade policy and the tyranny of distance 

Australian agricultural producers are global leader in terms of production efficiency, and Australia has been a strong advocate of multilateral trade agreements to reduce tariff barriers. The focus of recent trade policy has seen a shift away from multilateral trade agreements towards bilateral trade agreements. This research project will: (i) review trade policy theory; (ii) document tariff changes implemented under multilateral trade agreements and the impact of these changes on the agriculture sector; (iii) provide a critical evaluation of the benefits of Australia's bi-lateral trade agreements for the agricultural sector and assess the potential benefits of the Comprehensive and Progressive Agreement for Trans-Pacific Partnership. Potential co-supervisor: Ross Kingwell.

Industry levies for agricultural production 

In Australia, compulsory levies are charged to growers to fund biosecurity, generic marketing functions, and industry research and development. This research project will (i) review the different funding arrangements implemented across agricultural industries in Australia to fund these functions, (ii) evaluate different models of service delivery, using criteria such as efficiency and equity and (iii) make recommendations for best practice industry levy schemes. Potential co-supervisor: Ben White.

Banned Drinkers Register 

To limit harmful alcohol consumption, the Government of Western Australia has implemented a banned drinker register. Anyone on the register is restricted from purchasing takeaway alcohol. This policy has also been implemented in the Northern Territory. The government has commissioned an evaluation of the policy effectiveness. There is an opportunity to participate in many different elements of the project, where a structured program of work from literature review to primary data collection and analysis, and final dissertation drafting of results. Co-supervisor: TBC.

Distance education for improved productivity in the agriculture sector 

In the past decade there have been substantive changes in the way higher education is delivered, and these changes provide opportunities to provide education services to Agricultural Science and Agribusiness students in new ways. This research project will (i) review the education literature to identify best practice approaches for on-line education, (ii) survey institutions delivering Agricultural Science and Agribusiness education via online platforms and understand the business model of these institutions and (iii) develop a financial model that can identify the breakeven point for operating an online Agricultural Sciences and Agribusiness education program. Potential co-supervisors: Amin Mugera, Dominique Blache.

Weather and fine wine: Cabernet Sauvignon for the Yarra Valley and Margaret River 

This project will use a regression model to explain observed wine quality through analysis of weather variables during the grape growing season. The project involves the creation of a database of fine wine sale price data collected from an auction house. The final sale price of the wines will then be regressed on weather data collected from the Bureau of Meteorology to determine the role of weather variables in determining wine quality. Separate models will be estimated for the Yarra Valley and Margaret River. Potential co-supervisor: Chunbo Ma.

Potato market deregulation and the spud shed 

To ensure supply and mitigate against price fluctuations the Western Australian ware potato market was regulated during the Second World War, and production regulations remained in place until 2016. This research project will: (i) provide a historical review of potato market regulation; (ii) estimate the consumer welfare loss due to market regulation; and (iii) describe the change in the industry structure post deregulation. Potential co-supervisor: Ben White.

The Demand for Meat: a meta-analysis approach 

The consumer response to price changes in the market for meat has been studied extensively. This project involves: (i) discussing the existing published literature on the price elasticity and income elasticity for meat as a whole and specific meat products; and (ii) undertaking a quantitative analysis of the existing literature, starting with Australia. You will collect information from existing studies and undertake a systematic review of the published information using a meta-analysis method. Depending on the size of the literature identified it may be possible to extend the analysis to other countries. Potential co-supervisor: Michael Burton.

Counting calories: A meta-analysis of posting calorie content information 

Requiring fast-food chain restaurants to post information on the energy content of the food they serve is an increasingly common requirement. Many studies have investigated the effect of calorie posting. This project involves: (i) reviewing the issue of obesity and the relationship to fast food consumption; and (ii) conducting a structured review and meta-analysis of the existing literature on the effect of calorie posting. A major part of the project will be to collate and review the existing literature. Potential co-supervisor: Michael Burton.

A/Prof. Atakelty Hailu

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Economics	Agribusiness

Profitability and productivity analysis 

Did you ever wonder why some firms or farms do better than others? Why they have lower prices, lower costs or better revenues? Or why some tend to improve their performance faster than others? Well, you might be able to generate good answers to the questions using productivity and efficiency analysis. The focus industry could be mining, agriculture, manufacturing, utilities or other service industries. The analysis could be at a local or aggregate level (State or National). Methods that are relevant include data envelopment analysis (DEA) and econometric methods such as stochastic frontier analysis (SFA). Co-supervisors: Amin Mugera, Michael Burton, Fay Rola-Rubzen.

Bio-economic modelling of optimal farm management practices 

What do farms consider when they make decisions about what to grow and how? How do they modify their activities to take advantage of changes in market prices or environmental policies? Would farms alter their behaviour to take advantage of initiatives that pay for greenhouse gas emission reduction? How do predictions from models compare with actual farm management decisions? This project is suitable for a student who is keen to survey farmers to investigate the degree to which farm management practices are rational and conform to assumptions made in economic modelling. You will use an existing whole-farm economic model and interview farmers to test critically and improve the assumptions and data underpinning the economic model. Co-supervisor: Ross Kingwell, Steven Schilizzi, Marit Kragt.

Prof. Ross Kingwell

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Agribusiness	Economics

Impact of Australian grain market de-regulation on sales of noodle wheat to Japan 

The demise of the Australian Wheat Board (AWB) enabled many grain traders to sell noodle wheat into Japan through its monopsonist MAFF tender system. The student would use a bilateral monopoly model to describe the trade environment under the AWB but then also show the aftermath of grain trade de-regulation in Australia. How has the demand for and supply of Australian noodle wheat been affected by de-regulation? Co-supervisor: TBC.

Diversification of farm businesses in Australia 

One of the farm business defences towards market, price and production risk is enterprise diversification. How diversified are farm businesses in Australia. Has their degree of diversification changed over time? Are there notable regional differences in farm diversification? The student can draw on ABARES AgSurf data to help answer these questions. Co-supervisor: TBC.

The impact of climate variability on farm profitability 

Does climate variability reduce farm profitability? What might be the implications of greater climate variability at different locations in WA's agricultural region? Using simulation models of land use sequences and climate volatility at various locations, this project will examine how climate variability affects farm profit and the ability of different farms to invest in productivity-improving innovation. Co-supervisor: TBC.

Dr Marit Kragt

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Economics	Agribusiness

Farmer behaviour and technology adoption - a systematic review 

There is an increasing interest in the potential of behavioural economics to 'nudge' people's behaviour. In this project, you will conduct a systematic review of the literature on how behavioural science has been used to study farmers' adoption of technological innovations. You will study current lines of research (what innovations have been studied, what behavioural science methods are used, what are some common findings) and identify potential for future research. You will learn to develop a systematic literature review protocol and become familiar with reporting standards for systematic reviews and meta-analyses. Co-supervisor: Fay Rola-Rubzen.

Innovation ecosystems for sustainable farming systems 

Innovation ecosystems are central to the development of novel sustainable technologies or practices in the agricultural sector. Despite their vital role, there is no clear picture of agricultural innovation ecosystems in Australia. You will conduct a comprehensive analysis of web-based and literature sources, together with key stakeholder interviews, to map the innovation ecosystem for Australian agriculture. You will conduct a network analysis and assess key players at important stages of innovation (conception, development, implementation,

and evaluation). This research will generate recommendations to improve agricultural innovation in Australia. Co-supervisor: Professor Byron Keating (QUT).

Consumer preferences for sustainable agriculture
The WA government is providing strong support for so-called 'regenerative' farming practices to restore soil health, mitigate climate change, and reduce the environmental impacts of agricultural production. To finance changes in farming practices, advocates often argue that consumers will need to pay higher prices for their foods. In this project, you will conduct a market survey of 'regenerative' products in Western Australia. This would involve an analysis of the prices for 'regenerative' products in the market and a non-market valuation survey of consumer preferences. Co-supervisor: Chi Nguyen.

A Natural Capital Accounting framework for regenerative farming
So-called 'regenerative' farming is being advocated around the world to restore soil health, mitigate climate change, and increase farming profits. However, there is very little research on the profitability and natural capital impacts of regenerative farming. This study will use in-depth interviews and collect data from farmers in WA to evaluate whether regenerative practices have resulted in increased profits and natural capital on regenerative farming properties. As a desktop study, this research could conduct a meta-analysis of the global literature to critically evaluate changes in natural capital; or an in-depth financial review of 'regenerative' against 'conventional' farming benchmarks. Co-supervisor: Fiona Dempster, Megan Ryan.

Agricultural business models for circular economy solutions
There is a need to increase the circularity of our food production systems, through the re-use of supply chain waste products (e.g., manures, food wastes, crop residues). Implementation of sustainable ways to use circular opportunities requires the development of novel business models. Such business models need to be based on the opportunities that circular supply chains offer, but should also consider potential regulatory, social, and environmental risks. In this project you will conduct a literature review of potential circular solutions for Australian agriculture. The review will classify the main opportunities and risks associated with novel, value-added, circular opportunities, and provide advice for developing sustainable business models. Co-supervisor: Sasha Jenkins.

A Natural Capital Accounting framework for regenerative farming
So-called 'regenerative' farming is being advocated around the world to restore soil health, mitigate climate change, and increase farming profits. However, there is very little research on the impacts of regenerative farming on environmental goods and services. This study will use in-depth interviews and collect data from farmers in WA to evaluate whether regenerative practices have resulted in increased natural capital on regenerative farming properties. As a desktop study, this research would conduct a meta-analysis of the global literature to critically evaluate changes in natural capital. Co-supervisors: Fiona Dempster, Megan Ryan.

What drives farmers' adoption of climate change abatement- a meta regression analysis
The agricultural sector contributes around 14% of Australia's greenhouse gas emissions. Agriculture is a notoriously difficult sector to abate emissions, because if its heterogeneity in industries, climates, and number of operators involved. In this project, you will collect information from existing studies that have explained the adoption of climate change mitigation practices by farmers. A meta-regression analysis on the data collected will determine what factors drive adoption. You will learn how to conduct a systematic literature search and meta-regression analysis techniques. An affinity with statistics is required. Co-supervisor: Chunbo Ma or James Fogarty.

Dr Amin Mugera

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Development

Research in international development 

Research projects in development economics field emphasize the economics of agricultural growth and development with a focus on the analysis of food and nutrition security, poverty and vulnerability to poverty, farm household efficiency and productivity, marketing policy, and performance of food systems in developing countries. Given the geographical diversity of students in our course, those research projects are tailored to the specific research interest of the student subject to availability of data and financial resources where necessary. Often, the projects involve analysis of large survey dataset available in the public domain - such as the World Bank Living Standard Survey - using econometric techniques to address specific issues in international development. Co-supervisor: TBC.

Examples of past projects:

- Lifting the productive efficiency of smallholder maize producers in Tanzania: A meta-frontier analysis of conventional and minimum tillage
- Determinants and benefits of sustainable intensification practices (SIPs) among smallholder producers in Tanzania
- Does Contract Farming Improve Productive Efficiency? Evidence from Ginger Farming in Nepal
- Investing in pivot irrigation can be economically feasible for beef production in the Pilbara if high-quality pastures are produced
- Determinants of Child Malnutrition in Punjab, Pakistan: A Cross-sectional Study
- Impact of Food-based interventions on Child Nutrition Outcomes: Empirical Study of Northern Ghana
- Effect of Household Headship Gender on Food Security and Child Nutrition in Northern Ghana
- Vulnerability to Poverty in Nepal

Prof. David Pannell

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Economics

Prioritizing agricultural research projects 

There are many more potential agricultural research projects than there is funding for, so it is important to do a good job of prioritizing which projects receive funding. This project focuses on the maths and the economics of that prioritization. Using data from real research projects, and working in collaboration with US-based researchers, we will investigate the performance of difference mathematical systems for prioritizing projects. Co-supervisor: Phil Pardey (University of Minnesota).

A/Prof. Fay Rola-Rubzen

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Development	Economics	Agribusiness

A systematic literature review of risk management practices by broadacre farmers
Agriculture is fraught with risks; thus, farmers' risk management practices are crucial to farm business success. In this study, you will examine how farmers manage farm-related risks; what tools they employ to consider risk and make strategic decisions to manage risks; and investigate the use of formal tools (e.g., use of probabilistic decision-making models) vs. heuristics and "gut feeling", employing a systematic literature review approach. Co-supervisor: Fiona Dempster, Marit Kragt or Ben White.

Effects of climate-smart agriculture on household nutrition: A systematic review of literature
Following the increasing use of climate-smart agriculture technologies as a strategic response to address climate change, many studies have examined their impacts. Most of these studies have focused on CSA impacts on production, productivity and income. One area that has received less attention is its impact on household nutrition. This study will conduct a systematic literature review of CSA's impacts on food and household nutrition. Co-supervisor: TBC.

Can conservation agriculture-based sustainable intensification improve the resilience of smallholder farmers?
Many researchers claim improved sustainability and resilience as advantages of CASI. However, few studies have tested this claim empirically. Using survey data from a research project, this study will examine the impacts of CASI on farmers' resilience. You will develop a resilience index and examine whether CASI adopters are more resilient than non-adopters and whether adoption of CASI leads to improved resilience. Co-supervisor: TBC.

Constraints facing smallholder farmers in developing countries from participating in high-value agribusiness value chains: A systematic literature review
Market access is important for farmers in developing countries for them to fully benefit from agricultural development. However, smallholder farmers often find it difficult to access high value markets. In this project, you will review literature on the production and marketing constraints that prevent smallholders from accessing high value markets. This will involve conducting a systematic literature review. Co-supervisor: TBC.

The economics of conservation agriculture in South Asia
Farmers in the Indo-Gangetic Plains of South Asia are faced with many challenges, some exacerbated by climate change. An intervention to improve farmers' resilience is conservation agriculture (CA). However, there are also risks and economic considerations involved in CA. This project will look at the economics of CA using field-level data of farmers in the Eastern Gangetic Plains South Asia. Co-supervisor: TBC.

Are CASI farmers more technically efficient than non-CASI farmers?
Using scarce resource efficiently is critical in achieving food security. This is especially important in South Asia, home to one of the largest concentrations of poor people in the world. The type of farming systems and technologies adopted also have a bearing on the efficiency of farmers. This study will examine the technical efficiency of farmers using Conservation Agriculture-based Sustainable intensification (CASI) technologies compared to those using conventional tillage (CT) using stochastic production frontier analysis. The findings will provide important policy recommendations on sustainable production in the region. Co-supervisor: TBC.

Sources of technical (in)efficiency of farmers in South Asia

Farmers are constantly striving to improve their productivity and profitability. In South Asia, farmers have adopted various farming practices geared towards improving productivity. However, many farmers are still producing below the optimal level. In this study, you will use existing survey data to analyze farmers' technical efficiency and identify sources of technical inefficiency using stochastic frontier production analysis (SFA) or data envelop analysis (DEA). Co-supervisor: TBC.

Improving Service Provision for CASI Technologies in developing countries

One of the bottlenecks faced by farmers in developing countries in the adoption of innovative technologies is the lack of availability of these technologies (e.g., zero till (ZT) machines, seeders/ seeding machines) in their area. Despite the increasing interest of farmers in ZT machines, service providers do not seem interested in providing this machinery. In this project, you will analyze the reasons for the lacklustre response of service providers in supplying ZT machines. You will also examine their willingness to supply ZT machines. Co-supervisor: TBC.

Do farmers' perception of climate change risk influence the adoption of Conservation agriculture-based sustainable technologies?

This study will examine whether farmers' perception of climate change risks influences their adoption behaviour towards the use of conservation agriculture-based sustainable intensification (CASI) using survey data collected from a random sample of farmers in the Indo-Gangetic Plains in South Asia. There will be an opportunity to develop an adoption decision-making framework and analyze the data using logit models. Co-supervisor: TBC.

Behavioural factors influencing adoption of conservation agriculture-based sustainable intensification technologies in South Asia

Decisions to adopt new technology are influenced by economic and non-economic factors such as social, cultural, psychological, and other behavioural factors. In this study, you will examine the role of behavioural factors in technology adoption using existing survey data from a research project. Co-supervisor: TBC.

Behavioural factors influencing adoption of climate-smart technologies: A systematic literature review

Decisions to adopt new technology are influenced by economic and non-economic factors such as social, cultural, psychological, and other behavioural factors. In this study, you will review the literature on the role of behavioural factors in the adoption of climate smart agriculture technologies using a systematic literature review approach. Co-supervisor: TBC.

Climate change coping strategies of men and women in agricultural households: A systematic literature review

Climate change is causing havoc in agricultural systems around the world. Climate change does not affect women and men in the same way because of their different roles at in the household, the farm and the community. Hence their coping mechanisms also differ. In this project, you will review the literature on the differential strategies used by men and women farmers to cope with climate change using a systematic literature review approach. Co-supervisor: TBC.

Adoption of ICT in agricultural extension in Asia: A systematic review of literature

The lack of agricultural extension workers and wide coverage per extension worker mean that many farmers in Asia do not receive important agricultural information. With the advent of big data and increased affordability of mobile phones, ICT-based agricultural extension may provide some solution to this problem. This study will

involve a review of literature on examining farmers' adoption of mobile phone based agricultural extension using a systematic literature review. Co-supervisor: TBC.

Effects of climate-smart agriculture on household nutrition: A systematic review of literature 

Following the increasing use of climate-smart agriculture technologies as a strategic response to address climate change, many studies have examined their impacts. Most of these studies have focused on CSA impacts on production, productivity and income. One area that has received less attention is its impact on household nutrition. This study will conduct a systematic literature review of CSA's impacts on food and household nutrition. Co-supervisor: TBC.

Can conservation agriculture-based sustainable intensification improve the resilience of smallholder farmers? 

Many researchers claim improved sustainability and resilience as advantages of CASI. However, few studies have actually empirically tested this claim. Using survey data from a research project, this study will examine the impacts of CASI on farmers' resilience. You will develop a resilience index and examine whether CASI adopters are more resilient than non-adopters and whether adoption of CASI leads to improved resilience. Co-supervisor: TBC.

A systematic literature review of risk management practices by broadacre farmers 

Agriculture is fraught with risks; thus, farmers' risk management practices are crucial to farm business success. In this study, you will examine how farmers manage farm-related risks; what tools they employ to consider risk and make strategic decisions to manage risks; and investigate the use of formal tools (e.g., use of probabilistic decision-making models) vs. heuristics and "gut feeling", employing a systematic literature review approach. Co-supervisor: Fiona Dempster, Marit Kragt or Ben White.

Prof. Steven Schilizzi

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Economics

How do local social norms affect adoption by farmers of environmentally friendly practices? 

A new ARC-Discovery project started late-2022 that includes this topic, mostly aimed at farming communities, in Australia or elsewhere. The question can take on several different forms. Social norms can be injunctive (one should) or descriptive (what most others do); they can also be identity-based (I'm a farmer and a farmer does this, not that). One may consider the role of social norms by themselves, or one may consider how they might interact with financial incentives (e.g., PES: payments for environmental services), which may be positively or negatively. One may also consider if social norms can be 'activated' by public authorities to 'nudge' communities into adopting a socially beneficial practice, e.g., to cooperate for establishing wildlife corridors across private properties. It is a fascinating new area that cuts through several disciplines. Co‐supervisors: Chi Nguyen.

Are competitive tenders a good policy tool for achieving environmental outcomes? 

This topic will not start from scratch but can build on existing analyses from an ARC project. It will involve either statistical analysis or experimental work, or both. The student may choose from several possible questions. This project is an opportunity for the student to learn firsthand from the ARC project leader how to run economic

experiments, by designing then running a simple experiment (in our BEL Lab). Co‐supervisors: Chi Nguyen, Sayed Iftekhar (Griffith Univ), Ben White.

Is insurance an effective tool for landholders for providing environmental services to the community?

This question was investigated by a PhD student in connection with an ARC project from a theoretical point of view, leaving much room for asking whether the answers found would really be observed in reality. This project would focus on designing and running a simple experiment and/or carrying out a survey in an agricultural community. Co-supervisor: Toto Olita (Curtin) or Ben White.

Equity and fairness for disaster relief in developing countries

The point of departure could be the housing reconstruction program in Pakistan after the disastrous 2010 floods, but the problem could be adapted to other countries for other types of disasters. The focus would be on trade‐offs between economic efficiency and social equity, which often create the most difficult decisions for disaster managers to make. Co-supervisors: Chi Nguyen.

Carbon footprint labelling for sustainable (climate-friendly) food choices 

This project will adopt a behavioural economics approach and techniques aiming to evaluate the effectiveness of carbon footprint labelling programs in Australia (e.g., The Carbon Reduction Label and NCOS), so as to encourage sustainable food choices. The project will develop a commonly recognized footprint label to better drive sustainable food choices and test novel behavioural policy interventions to increase customers' willingness to pay for carbon footprint labels. Co-supervisors: Chi Nguyen and Atakelty Hailu.

Australian farmers' willingness to adopt regenerative agricultural practices

This project aims to identify the factors driving farmers' willingness to adopt regenerative agricultural practices with a focus on social motives, and to explore the effectiveness of 'nudges' in promoting behavioral changes among farmers. Co-supervisors: Chi Nguyen and David Pannell.

Results-based payments for the provision of environmental services on private farmland

Results-based payments means that farmers are paid for the environmental outcomes they generate rather than for implementing predefined land management practices that are more environmentally friendly. This has been advocated as a cost-effective payment mechanism for the provision of environmental services. In this project, you (Masters/Honours) will conduct a systematic review on the performance of results-based payment schemes and identify the factors that affect their performance. Co-supervisor: Chi Nguyen.

Forestry micro-finance credit programs for sustainable rural development

This project will examine the effectiveness of forestry micro-finance credit programs for sustainable rural development in developing countries. It will provide evidence-based contractual design for promoting landholders' willingness to adopt agroforestry practices, which combine trees and crops in an ecologically and agronomically optimized way. Co-supervisors: Chi Nguyen and Ram Pandit

Applying the new 5K framework to agricultural or rural problems in development countries

Trying to solve agricultural or rural problems in developing countries can be a real challenge, and international organizations like the World Bank & the FAO, national governments, and many NGOs are facing these challenges every day. A major difficulty lies in linking together various aspects of a problem that involve economic, social, technical, and political aspects. No single academic discipline can yet link all these aspects together. A new framework labelled '5K' (for 5 forms of capital) has been created to help tackle this challenge, and it is already

raising interest outside academia (Vietnam Ministry of Agriculture, World Bank). A student choosing a topic in this area could directly link with an existing World Bank (or other) project, via one of our Adjunct Professors who is actively involved in the field. Co-supervisors: Ram Pandit, Fay Rola-Rubzen, Julian Roche.

A/Prof. Ben White

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Economics

Behaviour change for regional biosecurity 

How do we design community surveillance and management systems that encourage smallholders to manage pests? Rural Australia is over-run with exotic pests: feral pigs, foxes, cats, fruit flies and numerous weeds. The big challenge for organizations like the Peel Harvey Biosecurity Group is to persuade people to report pest problems and act collectively to manage the pest. This paper will involve working with the biosecurity group to survey landholders and test alternative strategies to get people to manage pest. We will use fruit fly as the case study pest. Co-supervisor: Jonelle Cleland (Peel Harvey Biosecurity Group).

Where there is no muck there is money: value of dung beetles in farming systems 

Introduced dung beetles do a dirty job in that they bury livestock manure, but they are highly valued in terms of increasing soil fertility and suppressing blow flies. This Masters or Honours project will estimate the value of dung beetles in farming systems in the Northern Wheatbelt. Funding to support the project will be available through a Meat and Livestock Australia project. Co-supervisor: Fiona Dempster.

The economics of beneficial insects for pollination 

This study will explore the value of honey bees to a number of pollinator dependent industries possibly avocados. Managed honey bees are good pollinators, but so are feral honey bees and some native insects. This Masters or Honours project will be linked to the Honey Bee products Cooperative Research Centre. Co-supervisor: Liz Barbour.

How do farmers select cereal varieties? What determines the rate of adoption and dis-adoption of cereal varieties? 

This project would involve developing a questionnaire to assess how farmers select "portfolios" of varieties to plant on their farms based on variety attributes that include yield, grain quality, disease resistance and frost tolerance. The project would focus on how farmers trade-off risk and return in making variety selections. Co-supervisor: Fiona Dempster.

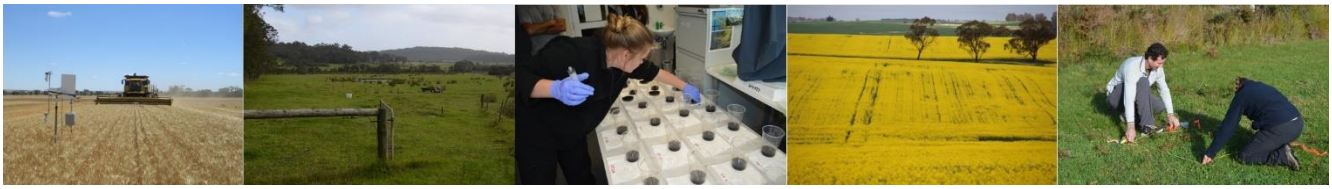
The Aliens are coming! How should Western Australia prepare? 

The Russian wheat aphid is a potentially devastating cereal pest of wheat and barley in Australia. It established in South Australia in 2016 and this was the first incursion into Australia. This project will involve an economic analysis of how the WA cereal industry should respond in terms of resistant varieties and pesticides. Co-supervisor: Fiona Dempster.

How do poor households reduce exposure to risk 

This study will use panel data from Vietnam (possibly another country if data is available) to test hypotheses about the strategies households use to avoid exposure to weather and natural disaster risk. For instance do they reallocate labour out of agriculture into other employment or businesses? Co-supervisor: Amin Mugera.

Agricultural Science



Master of Agricultural Science degree coordinator – Prof. Martin Barbetti (Martin.barbetti@uwa.edu.au)

The Master of Agricultural Science has four 'Specialization' pathways. The coordinators of each of these Specializations are as follows:

Agricultural Technology – Dr Ken Flower (Ken.flower@uwa.edu.au)
Crop and Livestock Farming Systems – Prof. Megan Ryan (Megan.ryan@uwa.edu.au)
Genetics and Breeding – Dr Judith Lichtenzveig (Judith.lichtenzveig@uwa.edu.au)
Soil Science and Plant Nutrition – Dr Zed Rengel (Zed.rengel@uwa.edu.au)

The table below shows how projects listed by potential supervisors align to these four Specializations. All listed research opportunities are suitable as Honours projects.

POTENTIAL SUPERVISOR	Agricultural Technology	Crop and Livestock Farming Systems	Genetics and Breeding	Soil Science and Plant Nutrition
Michael Ashworth	√	√		
Martin Barbetti		√		
Louise Barton		√		√
Dominique Blache		√		
Nanthi Bolan				√
Roberto Busi		√		
Nik Callow		√		
Yinglong Chen		√	√	
Michael Considine		√	√	
Wallace Cowling			√	
Sasha Jenkins				√
Marit Kragt		√		
Judith Lichtenzveig		√	√	
Bede Mickan				√
Caitlin Moore		√		√
Phillip Nichols			√	
Zed Rengel		√		√
Megan Ryan		√		
Kadambot Siddique		√	√	

POTENTIAL SUPERVISOR	Agricultural Technology	Crop and Livestock Farming Systems	Genetics and Breeding	Soil Science and Plant Nutrition
Erik Veneklaas		√	√	
Phil Vercoe	√	√		
Ben White		√		

- Studies that can be taken using a 'desktop' approach, and thus not requiring field or laboratory work. There is the potential for these studies to be undertaken remotely.

- Studies that involve field sampling such as running field trials or measuring environmental variables or conducting surveys.

- Studies that involve research in glass or green houses, animal holding facilities or the laboratory.

Dr Mike Ashworth

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Agricultural Technology	Crop & Livestock Farming Systems

Remote sensing crops for weed competitiveness

The normalized difference vegetation index (NDVI) is widely used in agriculture and environmental research and the industry as a measure of plant health. It utilizes the reflectance from a leaf's surface of near infra-red and red light waves of sunlight to estimate an index. Canopeo is a mobile app that helps to estimate green canopy cover, it's potential use for environmental and agricultural use as a surrogate for NDVI is huge but it has not been widely studied. The agronomy team at the Australian Herbicide Resistance Initiative has been collecting field data over two years where a significant correlation was found (R^2=0.77). The prospective student will carry out laboratory experiments to determine whether it is possible to create a regression model which allows to predict NDVI from Canopeo measurements. Co-supervisor: TBC.

Effectiveness of the time of the spray topping/crop topping and alternatives to glyphosate/paraquat

Spray-topping of annual weed species during the reproductive growth stages is commonly done to prevent the formation of viable seeds. This late-stage intervention weed management approach is used to stop the target weeds from setting seed without negatively impacting the ability of the crop or the pasture species to produce seed. Spray topping/crop topping is widely used in Australian cropping systems in canola and pasture, however weeds are adapting their reproductive timing to evade spray-topping applications. This project will investigate whether we can effectively spray-top early flowering time brome grass populations without compromising crop and pasture grain and seed production. Co-supervisor: TBC.

Prof. Martin Barbetti

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Crop & Livestock Farming Systems

Identifying and understanding novel host resistances in Brassica crops (e.g., canola, mustard)
The Plant Pathology group at UWA currently is a world leading group in terms of diseases of oilseed Brassica crops and has strong international linkages to leading research programs on Brassicas both nationally and internationally (India, China, France, the United Kingdom and Poland). We have developed a diverse and extensive Brassica germplasm collection that can be exploited for many new host resistances to major diseases and our research includes studies to understand the operational mechanism of different and novel host resistances. Co-supervisor: Ming Pei You.

Identifying and understanding novel host resistances in crop and forage legumes (e.g., faba bean, lentils, clovers, medics, lucerne)
The Plant Pathology group at UWA currently has long been a world leading group in terms of diseases of forage legumes and more recently on crop legumes. For forage legumes these include both those which have been (e.g. subterranean clover, annual medic) or are being developed (many new annual and perennial species). We have strong international linkages to leading research programs on forage legumes both nationally (State Departments of Agriculture and private consultants across WA, Victoria, NSW, SA) and internationally (France, China, Italy). On crop legumes we have strong overseas linkages with the International Center for Agricultural Research in the Dry Areas (ICARDA) in Morocco and Tunisia and with the Ethiopian Institute of Agricultural Research in Ethiopia. We have a diverse and extensive subterranean clover, faba bean and lentil germplasm collections that can be exploited for many new host resistances to major diseases and our research includes studies to understand the operational mechanism of different and novel host resistances and how the environment influences the expression of host resistance. Co-supervisor: Ming Pei You.

A/Prof. Louise Barton

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Crop & Livestock Farming Systems | Soil Science & Plant Nutrition

Fertilizer recommendations for grain legumes in Western Australia
Despite the various positive benefits of including legume crops in cereal-based systems and crop diversification, lack of knowledge of critical nutrient levels to maximize profitability and high fertilizer prices are obstructing growers from integrating legumes into their cropping systems. In this project, you will conduct small pot glasshouse experiments as part of a larger GRDC funded project lead by industry researcher Living Farm to produce fertilizer response curves that will be used to inform small plot and large-scale trial treatments in following years. This project is an opportunity for you to collaborate with leading researchers, engage with prominent industry representatives and contribute to research that will directly aid WA agronomists and growers. The project budget includes a $5000 student scholarship. Co-supervisors: Prof. Zed Rengel (UWA) and Kathryn Fleay (Living Farm).

Dr Dominique Blache

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Crop & Livestock Farming Systems

Is there a clock in the sheep stomach? Or chronobiology and rumen function
Circadian rhythms refer to endogenous biological processes that fluctuate over a 24-hour period. The microbial population present in the rumen is naturally exposed to circadian rhythms of temperature. Amazingly, so far all in-vitro study of rumen physiology have been done at constant temperature. You will explore the role of circadian rhythms of temperature in the rumen on the activity and survival of the microbial population. Co-supervisors: Phil Vercoe, Shane Maloney.

Early life stress and subsequent stress resilience and emotionality in pigs
There is a substantial body of evidence in laboratory species, particularly non-human primates and rodents, that stress affects adult vulnerability to stressors. This project investigates how stress resilience acquired in early life will be mediated by long term changes in the activity of the pig's brain serotonergic and noradrenergic systems and stress axis. Co-supervisor: Alan Tilbrook (Uni of Queensland).

The gut-brain axis in sheep
The gut microbiome is a collection of microorganisms that live in the digestive tract, and it has been shown to play an important role in metabolism, immune function, and other physiological processes. While the rumen microbial population digests plant material that the ruminants cannot digest on their own, and so is essential to the survival and function of those ruminants, the rumen microbiome could have another role to play in the determination of temperament, with follow-on effects for the welfare of animals in our production systems. Co-supervisor: Luoyang Ding.

Prof. Nanthi Bolan

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Soil Science & Plant Nutrition

Can biochar improve food security in Timor-Leste?
Applying biochar to agricultural soils in Timor-Leste provides an opportunity to increase soil health and crop productivity. Field and pot studies have demonstrated that rice hull biochar can be an effective amendment in many Timor-Leste soils. A systematic meta-analysis is now required to understand the underlying soil constraints to crop productivity that biochar is ameliorating in Timor-Leste. This project will suit a student interested in contributing to agricultural development and strengthening their data analysis skills. Primary data from the biochar research undertaken at Timor-Leste, and secondary data from literature covering biochar research in tropical soils will be used in the meta-analysis. Funding ($5,000) is available to support student living expenses. Co-supervisors: James Fogarty.

Bentonite to improve moisture and nutrient retention of arable sandy soils of Australia

In Australia, around 7.5 million ha of sandy soils under agricultural production are mostly located in South Australia and Western Australia. Sandy soils are generally more vulnerable to climate change than other soil types. The major constraints of sandy soils for agricultural production include: (i) poor buffering capacity, leading to susceptibility to changes in soil properties; (ii) low organic matter content and soil biological activity; (iii) high permeability and leaching of nutrients; (iv) low soil water storage and thus restricted root development; and (iv) water repellence which restricts the infiltration of rainfall into topsoil. Application of clay-based amendments has been shown to improve health and productivity of sandy soils. A large volume of high quality bentonite clay is mined in Western Australia which is having excellent moisture and nutrient retention characteristics. The overall aim of the project is to examine the moisture and nutrient retention and release characteristics of bentonite clay composite products in various soil types. The plant availability of bentonite-retained moisture and nutrients will be examined using various arable crops. Co-supervisor: Kadambot Siddique.

Food waste derived soil amendments to enhance carbon sequestration and nutrient use efficiency of sandy soils

In Australia, around 7.5 million ha of sandy soils under agricultural production are mostly located in South Australia and Western Australia. Sandy soils are generally more vulnerable to climate change than other soil types. The major constraints of sandy soils for agricultural production include: (i) poor buffering capacity and susceptibility to changes in soil properties; (ii) low organic matter content and soil biological activity; (iii) high permeability and leaching of nutrients; (iv) low soil water storage and restricted root development; and (iv) water repellence which restricts the infiltration of rainfall into topsoil. Large volumes of food wastes (~ 7.6 million tonnes/yr) are generated in Australia, most of which are disposed to landfills. The use of food wastes in agriculture has dual benefits for the waste-producing sectors and primary producers by providing a primary avenue for safe and beneficial recycling of these resource materials as an alternative source of carbon and nutrients, and soil conditioners. This project aims to test the value of some of food waste derived soil amendments such as compost, anaerobic digestate, dehydrates, biochars and frass to enhance carbon sequestration, and nutrient and water use efficiency to augment climate resilience of sandy soils. Co-supervisor: Kadambot Siddique.

Dr Roberto Busi

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Crop & Livestock Farming Systems

Levels of resistance to key herbicide modes of action in Australia

This project aims to reveal the level of herbicide resistance in wild radish samples and/or annual ryegrass collected from across Western Australia, submitted to UWA at the end of 2023. The student will perform dose-response studies with a range of herbicide modes of action to quantify the current levels of resistance and cross-resistance and the relative efficacy of standalone herbicides vs. mixtures in key weed species. Project can start in mid March 2024. The work can be presented at regional and national conferences and published in a peer-reviewed journal. This would best suit a candidate student with an interest in pursuing an academic career or working with a chemical company. This project will be done entirely at the UWA campus. Co-supervisor: Danica Goggin (AHRI).

Effective management of herbicide resistance in annual ryegrass in the field 

This project aims to reveal the effectiveness of herbicide resistance management by using crop rotation, herbicide rotation and herbicide mixtures in populations of annual ryegrass collected from across Australia and grown in a wheat-canola rotation at the experimental field station of Shenton Park. Project starts in May 2024 and ends December 2024. The work will be suitable for presentation at regional and national conferences and publication in a peer-reviewed journal. This would best suit a candidate student with an interest in pursuing an academic career. This project has a field work component which will be very valuable to the student. Student can expand experimental activity with dose-response analysis at the UWA campus. Co-supervisor: Danica Goggin (AHRI). Project availability: May 2024 – December 2024.

Characterization of dual glyphosate and paraquat resistance in annual ryegrass 

This project aims to reveal the level of herbicide resistance in annual ryegrass samples collected in 2023 in Western Australia that display glyphosate and paraquat resistance. The student will perform dose-response studies with paraquat and glyphosate to quantify the levels of resistance and cross-resistance and the relative efficacy of standalone herbicides vs. mixtures. Project can start at any time. The work can be presented at regional and national conferences and published in a peer-reviewed journal. This would best suit a candidate student with an interest in pursuing an academic career or working with a chemical company. This project will be done entirely at the UWA campus. Co-supervisor: Danica Goggin (AHRI).

A/Prof. Nik Callow

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Crop & Livestock Farming Systems	Agricultural Technology

Drought and Water Security in SWWA 

This project looks at landscape-level drought risk in the SWWA agricultural region. This region is undergoing significant change in climate and rainfall, which is impacting on-farm water supplies. Through SWWA, there are "have's" and "have-nots" in terms of access to the integrated water supply network, and those who are entirely reliant on on-farm water supplies. This project will focus on the patterns of water security in relation to supply and climate options and the adoption of runoff enhancement technologies. Co-supervisors: Matt Hipsey, Sally Thompson.

Impacts of hydrological connectivity on valley-floor salinity  

Interventions to improve flow connectivity have been implemented at locations across the Western Australian Wheatbelt. These have reduced surface water ponding, with the aim of disconnecting fresher surface water from salinity in the soil profile. This project will use cloud satellite computing platforms (Google Earth Engine) to explore the changes in the patterns of salinity impacting vegetation health adjacent to the intervention structures. Lakes Toolibin and Bryde will be a focus. While predominantly desktop, there is an opportunity for fieldwork to be incorporated. Co-supervisor: Matt Hipsey.

Dr Yinglong Chen

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Crop & Livestock Farming Systems	Genetics and Breeding	Soil Science & Plant Nutrition

Crop root system architecture and rhizosphere interactions for improving nutrient acquisition efficiency and adaptation to environmental stress

The rhizosphere of crop root system is a place for complex plant-soil-microbe interactions. Nutrient availability in soil affects plant growth and productivity, Phosphate (Pi) is one of the important limiting nutrients for crop growth and production with dominant roles in metabolism. Plant acquisition of soil Pi and other nutrients largely depends on vigorous root proliferation (root system architecture) to accelerate soil exploration, and on chemical (root exudate) and biological (microbiome) modifications of the rhizosphere to enhance Pi bioavailability. The rhizosphere microbiome (such as arbuscular mycorrhizal fungi) plays a vital role in Pi mineralization and is crucial for plant health. In Western Australia, food crops often encounter more than one abiotic stress, simultaneously. These projects explore recently developed non-destructive phenotyping, imaging, isotope, metabolism and modelling techniques to track rhizosphere interactions and nutrient dynamics from macroscale to nanoscale levels for improving crop nutrient use efficiency, and adaptation to abiotic stress and crop production. Multiple projects available. Co-supervisor: TBC.

Linking phenotyping with genotyping to discover novel genes and QTLs regulating important root architecture traits in soybean germplasm

Soybean [Glycine max (L.) Merr.], with its high protein and oil contents as well as nitrogen-fixing ability, is an important component in climate-smart agriculture. With the intensification of climate change, soybean, as a representative grain legume, also serves as one of the many saviours in low-emission agriculture. Root system architecture (RSA) determines plant health and crop productions. Understanding of phenotypic and genetic diversity in RSA traits and the underpinning mechanisms in stress response in the world soybean collections is not well understood. Over 70,000 cultivated and 20,000 wild soybean accessions are maintained by different seed banks worldwide. Since the release of the first soybean reference genome in 2010, genomic research has been expanding, contributing greatly to the molecular breeding of soybean benefiting from advances in genome sequencing technologies. Despite the importance of root traits, studies on plant domestication have been focused on the aerial part rather than in roots. Although some studies suggest the importance of shoot traits on root development, genes and quantitative trait loci (QTLs) regulating RSA traits and underpinning mechanisms in root response to abiotic stress, and the role of shoot-related traits in shaping root traits in soybean has not been reported. This project aims to characterise RSA traits in soybean collections and to discover genes and quantitative trait loci (QTLs) regulating RSA traits and adaptation to abiotic stress by linking root phenotyping with genotyping approaches. The project will generate important information on soybean RSA and regulating genes for improved resource use and stress adaptation and provide training of young researchers and strengthen international collaborations. Co-supervisor: TBC.

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Crop & Livestock Farming Systems	Genetics and Breeding

Genetic analysis of ascorbate and glutathione functions in grapevine

Ascorbate and glutathione are the major soluble antioxidants, and play key roles in plant development and stress response. A wealth of knowledge has resulted from the study of their functions in annual plants, however this knowledge may not translate to perennial life cycles, including all major fruit and nut crops. This project will develop and study transgenic lines of grapevine with reduced levels of ascorbate and glutathione, together with the function of the grapevine homologues by heterologous complementation in Arabidopsis. Co-supervisor: TBC.

Role of oxygen and reactive oxygen species in controlling branching and flowering

Oxygen is more than a mere substrate for respiration. All energy reactions involve oxidation and reduction (redox), meaning that cascades of redox metabolites are required to ensure substrates are regenerated. As a result, oxygen, redox metabolites and reactive oxygen species (ROS) acts as cellular signals that trigger adaptive responses to environmental change. We have identified genetic mutants in *Arabidopsis* that are affected in plant shape, particularly branching or flowering. In this project you will learn how to accurately phenotype plant development and begin to explore the molecular and metabolic cascades in further detail. Co-supervisor: TBC.

Which climate cues regulate dormancy and viability in grapevine?

Grapevine is highly climate sensitive. In temperate regions it displays a deciduous habit, whereas in subtropical and tropical climates it tends towards evergreen. Managing production however relies on orderly and predictable growth. There are enormous opportunities to expand production in northern regions and to contribute to adaptation under climate change in existing production areas. We can guide you towards a range of projects involving field physiology (from Manjimup to Broome), microscopy and histology and/or lab-based biochemistry and molecular biology. Co-supervisor: TBC.

Reserves as signals in perennial plant phenology and development

Perennial plants are distinguished by the presence of tissues and organs that serve as reserve pools of carbon and nitrogen and usually by episodic annual growth cycles. One or two vegetative cycles in temperature trees and shrubs but as many as four in subtropical and tropical trees and shrubs. This project seeks develop analytical tools to dissect the partitioning of metabolisable carbon through the annual cycle(s) of growth and to follow the path of their flow – symplast/apoplast. We seek then to apply that to explore their role in periodicity –stasis – acclimatization – growth and of biomass partitioning: reproductive organs to vegetative organs. Co-supervisor: TBC.

Production systems innovation to improve table grape production in the sub-tropics

We are part of a team working to improve productivity and incidentally water use efficiency in subtropical horticulture emphasizing grape production. Flower initiation is severely limited by current production systems which are based on a single annual cycle of growth with many attendant problems. Changing the production cycle may assist in resolving problems associated with low flower initiation, high bud necrosis and extreme levels

of carbon reserves. It will also contribute to our general understanding of the limits warm climates impose on productivity of temperate crop plants. Co-supervisor: TBC.

Prof. Wallace Cowling

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Genetics and Breeding

Plant breeding – speeding up and gearing up for the future

Our group works on accelerating plant breeding to meet future global food demands while adapting crops to changing climates. We seek to improve crop yield, disease resistance, heat and drought tolerance, and adaptation. We do this in a holistic way taking into account all the traits that future crops will need. We work with a wide range of experts inside and outside of UWA to achieve these goals.

Projects co-supervised by Dr Li Li and Emer Prof Brian Kinghorn (University of New England):

- Accelerating crop breeding for future food production based on pedigree and genomic selection and optimized mating designs
- Breeding with genetic diversity in elite crop breeding programs
- The genetic basis of heterosis (hybrid vigour)

Projects co-supervised by Dr Sheng Chen (UWA Institute of Agriculture):

- Improving heat and drought stress tolerance in Brassica crops
- Understanding the physiological, genetic and molecular mechanism of abiotic stress tolerance

Projects co-supervised by Prof Guijun Yan (UWA School of Agriculture and Environment):

- Genetic dissection of agronomically important traits and pre-breeding of wheat

Projects co-supervised by Adj. A/Prof. Matthew Nelson (CSIRO):

Harnessing genetic diversity in wild Brassica species for canola improvement. This project will involve a combination of desk-based (identifying the most promising wild relatives for canola improvement), field work (evaluating wild relatives) and glasshouse work (crossing canola with its wild relatives).

- Discovering new flowering time genes in crops
- Identifying domestication genes in narrow-leafed lupin (*Lupinus angustifolius*)

Projects co-supervised by Prof Jacqueline Batley (UWA School of Biological Sciences):

- Understanding the molecular basis of disease resistance and susceptibility

Projects co-supervised by Prof. Martin Barbetti (UWA School of Agriculture and Environment):

- Resistance to Sclerotinia stem rot in canola

Dr Sasha Jenkins

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Soil Science & Plant Nutrition

Assessing the impact of soil amendments on methane uptake in dryland soils

Climate change is a serious threat to agricultural productivity and global food security. However, livestock industries such as dairies are a major contributor of methane (CH_4) emissions. Soils can be either sources and sinks of CH_4 depending on the balance between methane-producing (methanogenenic) and methane-consuming (methanotrophic) activities. Recent studies have suggested that the dryland soils of Western Australia are sinks for CH_4 but the mechanisms and controls involved are not fully understood. Several factors, including soil pH, redox potential, temperature, soil organic matter and moisture content influence soil CH_4 fluxes. This project provides an excellent opportunity for candidates interested in exploring the impact of different soil amendments (lime, clay, compost) on greenhouse gas emissions (methane, nitrous oxide and carbon dioxide), soil chemistry and nutrient dynamics in soil under laboratory conditions. There is the option to study the microbes involved in GHG production using quantitative PCR or sequencing. All students will gain experience in data and statistical analysis using R Studio. Importantly, this project fosters an environment for learning and collaboration within a diverse and passionate research group. Co-supervisors: Sun Kumar Gurung, Pankaj Singh.

Mitigating abiotic stress tolerance in wheat through application of novel organo-mineral fertilizers

Australia is a major wheat-producing country but production has been limited by water shortage. In the rain-fed drylands, drought is a significant stressor with a major impact on plant growth and development leading to significant grain yield losses. Increasing wheat productivity in arid and semi-arid areas is critical to providing food security for future generations. Organo-mineral fertilizers are gaining increasing attention as a sustainable, alternative to synthetic fertilizers that mitigate the impact of drought. These novel fertilizers have the potential to maintain plant productivity and soil functioning under water stress by adjusting the soil moisture content, plant water status and soil health. This project aims to investigate the use of organo-mineral fertilizer to alleviate the impact of water stress on wheat plants. There are several opportunities in this study. Students can study (i) plant resistance and resilience to abiotic stresses by analyzing plant productivity, plant nutrition, plant non-structural carbohydrates and plant functional traits, (ii) utilize molecular methods to analyze gene expression or (iii) investigate the development of novel organo-mineral fertilizer products as alternative fertilisers or soil conditioners. For the latter projects, candidates will focus on assessing the impact of organo-mineral fertilizers on one of the following: soil fertility and soil structure, soil microbial community diversity and nutrient cycling, broader aspects of plant-soil-microbe interactions and ecosystem functions or soil resilience and resistance to abiotic stress. For Master of Bioinformatic or Biotechnology students there are further opportunities to develop specific bioinformatic workflows for amplicon sequencing and shotgun metagenomic sequences and to overcome the limitation of large eukaryotic genomes such as fungi. All candidates will be taught data analysis and statistical analysis using R. Most importantly, these projects are part of larger industry-based research project across Australia. Students will be part of a friendly multi-disciplinary research group and given the opportunity to build a larger network within academia, government and industry. Co-supervisors: Sun Kumar Gurung, Pankaj Singh.

Black Soldier Fly castings as a high quality fertilizer product

This project is part of a larger, interdisciplinary and industry funded project that is developing novel ways to process agricultural waste using Black Soldier Fly (BSF) larvae. The BSF larvae convert waste into high quality fertilizer (casting residues or frass) and/or protein for animal feed (larvae). Adoption of BSF technology and its products has potential to increase productivity and profitability on farms by reducing input costs and generating alternative revenue streams. However, the BSF fertilizer products cannot be used as a fertilizer in Australia until he environmental, agronomic and economic value of this product is fully evaluated. As part of the project, you will conduct a glasshouse pot trial study to determine whether BSF larvae castings could be used as fertilizers. You will measure crop nutrition, growth and yield responses to BSF larvae residues and frass applied to soil as a fertiliser. Co-supervisors: Megan Ryan, Kadambot Siddique.

Quantifying the leaching potential of applying Black Soldier Fly castings residue (a novel fertiliser product) to soils

This project is part of a larger, interdisciplinary and industry funded project that is developing novel ways to process agricultural waste using Black Soldier Fly (BSF) larvae. The BSF larvae convert waste into high quality fertiliser (casting residues or frass) and/or protein for animal feed (larvae). Adoption of BSF technology and its products has potential to increase productivity and profitability on farms by reducing input costs and generating alternative revenue streams. However, the BSF fertiliser products have a high ammonium content which could result in nitrogen (N) loss following its application to land via leaching. As part of the project, you will conduct a glasshouse pot trial study to determine the leaching potential of BSF larvae castings when it is applied to a soil as a fertiliser. You will measure leaching behaviour of N and other nutrient (elements/heavy metals) as well as crop nutrition, growth and yield responses to BSF larvae residues and frass applied to soil as a fertiliser. Co-supervisors: Megan Ryan, Talitha Santini.

How do we measure soil quality?

Soil microorganisms play a central role in maintaining soil health and quality through their activities that include recycling nutrients, nitrogen fixation, disease suppression, pollutant mitigation, improved soil structure and degradation of organic matter. Thus, they determine the form and availability of nutrients that are essential for plant growth and subsequently impact on grain productivity. To continue to improve the sustainability, quality and productivity of agricultural grains, producers need monitoring tools that directly measure soil biology enabling them to adopt the best management practices to enhance crop performance. Consequently, there is a pressing need to identify a set of biological indicators that can be used to assess the quality of Australian soils; this project will develop these bio-indicators. Co-supervisor: TBC.

Dr Marit Kragt

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Crop & Livestock Farming Systems

What drives farmers' adoption of climate change abatement- a meta regression analysis

The agricultural sector contributes around 14% of Australia's greenhouse gas emissions. Agriculture is a notoriously difficult sector to abate emissions, because if its heterogeneity in industries, climates, and number of operators involved. In this project, you will collect information from existing studies that have explained the adoption of climate change mitigation practices by farmers. A meta-regression analysis on the data collected will determine what factors drive adoption. You will learn how to conduct a systematic literature search and

meta-regression analysis techniques. An affinity with statistics is required. Co-supervisor: Chunbo Ma or James Fogarty.

Stacking technologies for climate change mitigation in agriculture - a systematic review 

The agricultural sector contributes around 14% of Australia's greenhouse gas emissions. No single abatement practice will be able to completely mitigate emissions from agriculture. Hence combinations of technologies need to be implemented to achieve Australia's greenhouse gas reduction objectives. In this project, you will review existing studies that have considered the impacts of combining ('stacking') technologies on farm and determine whether effects are summative, increasing or decreasing in marginal returns. Co-supervisor: Phil Vercoe.

Accessibility in teaching and learning of agriculture and environment 

Universal Design for Learning (UDL) is a framework to improve teaching and learning practices and enhance accessibility for all people. In this project, you will conduct a global review of teaching and learning practices in agriculture or environment. Following systematic review guidelines, you will identify strengths and weaknesses in current practice. This project will give you a sound understanding of UDL principles and Web Content Accessibility Guidelines. Co-supervisor: Natasha Pauli.

Farmer behaviour and technology adoption - a systematic review 

There is an increasing interest in the potential of behavioural economics to 'nudge' people's behaviour. In this project, you will conduct a systematic review of the literature on how behavioural science has been used to study farmers' adoption of technological innovations. You will study current lines of research (what innovations have been studied, what behavioural science methods are used, what are some common findings) and identify potential for future research. You will learn to develop a systematic literature review protocol and become familiar with reporting standards for systematic reviews and meta-analyses. Co-supervisor: Fay Rola-Rubzen.

Innovation ecosystems for sustainable farming systems 

Innovation ecosystems are central to the development of novel sustainable technologies or practices in the agricultural sector. Despite their vital role, there is no clear picture of agricultural innovation ecosystems in Australia. You will conduct a comprehensive analysis of web-based and literature sources, together with key stakeholder interviews, to map the innovation ecosystem for Australian agriculture. You will conduct a network analysis and assess key players at important stages of innovation (conception, development, implementation, and evaluation). This research will generate recommendations to improve agricultural innovation in Australia. Co-supervisor: Professor Byron Keating (QUT).

Consumer preferences for sustainable agriculture 

The WA government is providing strong support for so-called 'regenerative' farming practices as a way to restore soil health, mitigate climate change, and reduce the environmental impacts of agricultural production. To finance changes in farming practices, advocates often argue that consumers will need to pay higher prices for their foods. In this project, you will conduct a market survey of 'regenerative' products in Western Australia. This would involve an analysis of the prices for 'regenerative' products in the market and a non-market valuation survey of consumer preferences. Co-supervisor: Chi Nguyen.

A Natural Capital Accounting framework for regenerative farming 

So-called 'regenerative' farming is being advocated around the world as a way to restore soil health, mitigate climate change, and increase farming profits. However, there is very little research on the profitability and natural capital impacts of regenerative farming. This study will use in-depth interviews and collect data from

farmers in WA to evaluate whether regenerative practices have resulted in increased profits and natural capital on regenerative farming properties. As a desktop study, this research could conduct a meta-analysis of the global literature to critically evaluate changes in natural capital; or an in-depth financial review of 'regenerative' against 'conventional' farming benchmarks. Co-supervisor: Fiona Dempster, Megan Ryan.

Dr Judith Lichtenzveig

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Crop & Livestock Farming Systems	Genetics and Breeding

Plant response to deep sowing in chickpea and lentil (multiple projects available) 

Are you looking forward to getting your boots dirty while applying modern scientific concepts and techniques? Dr Rich's trials have uncovered promising aspects of deep sowing of profitable pulses of immediate impact to agricultural practices in the medium to low rainfall region of the Central and Eastern Wheat belt of WA. You are welcome to join us and choose your project's focus: root physiology, plant-water/nutrient interactions, and genetics underlying the response to deep sowing. Co-supervisor: Sarah Rich (CSIRO, Farming Systems).

Chickpea domestication and evolution (multiple projects available) 

Crop domestication and evolution is a fascinating story interlocking plants, country and humans. Your project can take one of multiple directions in investigating the crop's evolution and its impact on current cropping practices (e.g. seed dormancy, pod shattering). For this purpose, you will have access to (i) a recent collection of wild Cicer specimens, evolutionary snapshots of ancestral relatives of chickpea, (ii) inter-specific offspring populations and high-density genetic maps, (iii) large DNA sequence databases for chickpea and other Cicer in the public domain, and (iv) the infrastructure to conduct common garden experiments. Co-supervisors: Janine Croser, Maria Pazos Navarro, Robert Symes.

Gene flow between Cicer species 

Chickpea and a close wild relative species, *Cicer echinospermum*, vary in their genome structure. However, the extent of such variation is unknown. Genome structure variation is a major impediment to gene flow and a leading drive to speciation in both animals and plants. In addition to being of interest to fundamental evolution studies, gene flow is of importance in conservation of plant diversity in a changing climate. This project includes aspects of cytogenetics, linkage mapping, and genomics; it is also conducive to the generation and analysis of new DNA sequencing data. Co-supervisors: Janine Croser, Maria Pazos Navarro.

Genomics of pulse crops' reproductive phenology 

Today a large amount of genomic data is available to the public; the challenge is producing relevant syntheses. In this project, you will take a candidate gene approach to evaluate gene diversity within and between cultivated and wild legume species. The choice of which genes to target is yours and will follow a thorough literature review. We are particularly interested in reproductive phenology of legumes. A pre-requisite to undertaking this project is participation at a bioinformatics course (e.g. SCIE4002_SEM-2). Co-supervisor: Drs Maria Pazos Navarro, Robert Syme.

Quantitative genetics of chickpea's reproductive phenology 

Despite the large box of molecular tools (including whole-genome sequences) available to legume crops, linking genotypes to phenotypes remains a challenge. We are adopting high-throughput phenotyping techniques to bridge the genotype-phenotype gap to improve chickpea. Your project will include running common garden experiments under control conditions and/or in the field, using genome-wide genetic markers, producing high-density genetic linkage maps and quantitative trait loci (QTLs) analyses. This project will facilitate developing proficiency in R (programming language). Co-supervisors: Janine Croser, Maria Pazos Navarro.

Genomics of pea response to necrotrophic pathogens 

Ascochyta blight of field pea is caused by at least four Didymellaceae species, *Didymella pinodes, D. pinodella, Ascochyta pisi* and *Phoma koolunga*. Genome sequences are available for field pea and the causal agents of ascochyta blight. Your project will undertake transcriptomics analysis of plant-pathogen interactions to discover key networks in plant resistance and fungal pathogenicity. A pre-requisite to undertaking this project is articipation at a bioinformatics course (e.g. SCIE4002_SEM-2). Co-supervisors: Robert Syme, Chala Turo.

Phylogenomics of the Didymellaceae 

Speciation of plant-pathogenic fungi is fundamentally and economically important yet the process remains poorly understood. This project aims to identify genomic signatures of selection underlying speciation and host specialisation in an important fungal family of plant pathogens, the Didymellaceae. This project is an opportunity for you to sequence and analyse the most important Didymellaceae species compromising your country's key crop. A pre-requisite to undertaking this project is participation at a bioinformatics course (e.g. SCIE4002_SEM-2). Co-supervisor: Dr Robert Syme.

Legume response to symbionts and pathogens under shade 

In this project, shade is defined by the red to far-red ratio in light spectra to isolate it from other associated factors such as temperature and humidity. Plant response to shade involve a phyto-hormonal environment with molecular shared by the plant response to disease. To dissect genetic factors affecting these responses and their interaction you will conduct experiments under control conditions in a given legume-microbe symbiotic/ pathogenic interaction. Co-supervisor: Janine Croser.

Dr Bede Mickan

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Soil Science & Plant Nutrition

Optimizing waste management: an economic assessment of food-waste derived digestate from Australia's leading anaerobic digestion facility 

In this cutting-edge project, you will collaborate closely with industry experts to conduct a comprehensive cost-benefit analysis of managing digestate, the liquid by-product resulting from anaerobic digestion, which is a pivotal factor influencing the widespread adoption of this technology in Australia. Your work will bridge the gap between academia and industry, providing invaluable hands-on experience as you partner with UWA academics specializing in environmental economics and waste valorization. Anaerobic digestion technology plays a crucial role in generating biogas and managing organic waste. However, the challenge lies in effectively managing the digestate produced during this process. Your role will entail conducting a detailed economic assessment of food-

waste derived digestate at Australia's largest anaerobic digestion facility. By evaluating the cost-benefit dynamics, you will uncover opportunities to optimize waste management practices, paving the way for sustainable and efficient resource utilization. Co-supervisors: Michael Burton, Troy Franks (Richgro).

Growing greener: An innovative solution for the horticulture industry's carbon shortage

The horticulture, retail garden, and landscape sectors are facing a shortage of carbon materials for their potting media due to the decline of timber mills in the region. The reduced availability of carbon materials from the timber industry has resulted in a need for alternative sources of carbon for potting media. This project aims to explore and evaluate alternative carbon sources for sustainable potting media. The study will be carried out in close collaboration with a national garden products company, with the goal of developing a new, sustainable potting media solution for the horticulture sector. The experiment will involve conducting plant growth trials (plant nutrition, soil chemistry, soil biology) using the newly developed potting media (and fertilizer) and comparing the results with those of traditional potting media. The research will aid in providing valuable information on the feasibility of alternative carbon sources for potting media, and the results will be used to develop recommendations for the horticulture sector. This project will contribute to the sustainability of the horticulture industry by reducing its dependence on unsustainable sources of carbon and promoting the use of alternative sources. Co-supervisor: Megan Ryan.

Enhancing plant growth and soil health through the development of organo-mineral fertilizer: a study on the effects on soil chemistry, soil biology, and the potential for promoting a circular economy

The experiment will involve combining various organic waste materials with a synthetic, organo-mineral fertilizer and evaluating their effect on plant growth, soil chemistry, and soil biological processes. The research will determine the most effective combination of organic waste and synthetic fertilizers, and the results will be used to develop a sustainable organo-mineral fertilizer. This research project will make a significant contribution to the development of a circular economy by promoting the reuse of organic waste materials and reducing the reliance on synthetic fertilizers. The results of this study will provide valuable information for the fertilizer industry, and the newly developed organo-mineral fertilizer will have the potential to be commercialized for use in the horticulture and agriculture sectors. Ultimately, this project will help to create a more sustainable and environmentally friendly future by promoting the use of alternative, sustainable fertilizer options. Co-supervisor: Megan Ryan.

Dr Caitlin Moore

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Crop & Livestock Farming Systems	Soil Science & Plant Nutrition

Microclimate modification under solar panels and it potential for plant growth

As we progress towards a cleaner energy future, large scale renewable energy installations such as solar farms will increase across the landscape. Adding solar panels to the landscape has been shown to modify the microclimate beneath the panels, which can improve conditions for plant growth. This project will investigate how the microclimate is altered under a solar farm in WA, with the aim to understand whether the land beneath can be used for native or agricultural plant growth. Potential co-supervisor: Sally Thompson (engineering), Pieter Poot (School of Biological Sciences).

Carbon and water cycle dynamics across the diverse climate cropping region of southwest WA

Solving the challenge of feeding the world while dealing with environmental change requires in-depth knowledge of how crop productivity and water use responds to the climate. Climate change is already negatively impacting Australia's A$28 billion cropping sector (2019/20 financial year), with hotter and drier growing season conditions linked to stalled wheat production since 1990. The frequency and intensity of extreme heat and drought events are projected to rise in the future, with the hardest hit region of south-western Australia likely to experience yield decline up to 49 %. A way to measure crop productivity and its response to climate in real-time is via the eddy covariance technique, colloquially referred to as flux towers. This project will investigate how carbon and water cycling differ between two distinct growing regions in southwest WA. the project may involve fieldwork to regional areas of WA. Potential co-supervisor: Jason Beringer.

Implementing improved vineyard floor management for premium grape production in a warm and dry Mediterranean climate

The table and wine grape industries contribute $800 million to the Western Australian economy, but vineyards are at risk from drought and heat stress that rapidly degrade fruit quality and decrease fruit premiums. Vineyard irrigation requirements increase under drought and rising heat conditions to accommodate extra water demand by the vines. A major challenge facing grape growers is their ability to use water to moderate vineyard resilience to heat stress and drought due to reductions in their irrigation licences. Implementing a cover crop between irrigated grapevines in the growing season can reduce soil water evaporation, heat reflectance into grapevine canopies, soil erosion and nutrient leaching, and help control invasive weed proliferation. However, bare soils persist in some vineyards where lack of adoption is due to industry perception that cover crops compete for grapevine essential water resources. This project aims to demonstrate how winter cover crops can be dried into 'green mulch' in summer as a vineyard water management strategy. Potential co-supervisors: Nik Callow, Colin Gordon (DPIRD).

A/Prof. Phillip Nichols

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Genetics and Breeding	Crop & Livestock Farming Systems

Diversity within ssp. *brachycalycinum* subterranean clovers collected from the Mediterranean region

Subterranean clover (*Trifolium subterraneum*) is the most important annual pasture legume in southern Australia and a large collection of wild populations from its native habitat in the Mediterranean region has been assembled. It consists of three subspecies, *subterraneum*, *yanninicum* and *brachycalycinum*. To date, little genetic improvement has been conducted on ssp. *brachycalycinum* and there appear to be significant opportunities to develop more productive and better-adapted cultivars. This project will involve examining important traits among wild populations to determine their potential as parents for crossing. Particular traits of interest include biomass in winter and spring, flowering time, seed yield and hardseededness, but other traits could also be examined. Variety differences can also be related to characteristics of their sites of collection. This work will be conducted at the Shenton Park Field Station, as part of the Annual Legume Breeding Australia (ALBA) pasture legume breeding and selection program. The project will suit anyone wishing to gain skills in evaluation of genetic diversity for agronomic traits. Project availability: Semesters 1 or 2, 2024. Potential co-supervisors: Megan Ryan, Maria Pazos-Navarro and Judith Lichtenzveig.

Red-legged earth mite resistance in subterranean clover

The red-legged earth mite (RLEM; *Halotydeus destructor*) is an important pest of subterranean clover (*Trifolium subterraneum*) and other pasture legumes, particularly at the seedling stage. Prior selection programs have identified sources of resistance to RLEM in subterranean clover and crossing programs have been conducted to select resistant progeny. This project will be conducted as part of the Annual Legume Breeding Australia (ALBA) Joint Venture between UWA and DLF Seeds and will screen for RLEM resistance among advanced breeding lines and cultivars of subterranean clover (and potentially other species) to aid cultivar selection. The project will suit anyone wishing to gain skills in entomology and pest resistance screening. Project availability: Semester 1, 2024. Potential co-supervisors: Megan Ryan, Maria Pazos-Navarro, Judith Lichtenzveig.

Leaf disease resistance in subterranean clover

Several leaf diseases can affect subterranean clover (*Trifolium subterraneum*), reducing biomass production and persistence. Key pathogens include clover scorch (*Kabatiella caulivora*) and leaf rust (*Uromyces trifolii-repentis*). This project will be conducted as part of the Annual Legume Breeding Australia (ALBA) Joint Venture between UWA and DLF Seeds and will evaluate resistance among advanced subterranean clover breeding lines and cultivars to aid cultivar selection. The project will suit anyone wishing to gain skills in plant pathology and disease resistance screening. Project availability: Semester 1, 2024. Potential co-supervisors: Martin Barbetti, Megan Ryan and Ming Pei You.

Hardseededness in annual pasture legumes (multiple projects available)

Hardseededness and the timing of its breakdown over the summer-autumn period is an important seed dormancy trait for persistence of annual pasture legumes. The Annual Legume Breeding Australia (ALBA) program is a Joint Venture between UWA and the pasture seeds company DLF Seeds aimed at developing new annual pasture legume cultivars for southern Australia and internationally. Species being examined include subterranean clover (*Trifolium subterraneum*), Persian clover (*T. resupinatum*), arrowleaf clover (*T. vesiculosum*) and balansa clover (*T. michelianum*). This project will examine hardseededness and the timing of its breakdown among advanced breeding lines in these species to aid cultivar selection. This project will suit anyone wishing to gain skills in germination, dormancy and seed studies. Project availability: Commencing summer 2023. Potential co-supervisors: Megan Ryan, Maria Pazos-Navarro, Judith Lichtenzveig.

Population improvement of Persian, balansa and arrowleaf clovers (multiple projects available)

Persian clover (*Trifolium resupinatum* var. *majus*) balansa clover (*T. michelianum*) and arrowleaf clover (*T. vesiculsoum*) are vigorous, out-crossing fodder species. Breeding programs for these species have involved recurrent selection for seed size, seedling vigour, high biomass in winter and spring and late flowering. This project will examine the genetic gains following two generations of recurrent selection in these species, in comparison with the original parents and other cultivars. This work will be conducted at the Shenton Park Field Station, as part of the Annual Legume Breeding Australia (ALBA) Joint Venture between UWA and DLF Seeds. This project will suit anyone wishing to develop skills in measurement of phenotypic traits and genetic analyses. Project availability: Semester 1, 2024. Potential co-supervisors: Megan Ryan, Judith Lichtenzveig and Maria Pazos-Navarro.

Developing improved subterranean clover seed harvesting methods

A key feature for the success of subterranean clover (*Trifolium subterraneum*) as a pasture plant is its ability to bury its seed-bearing burrs. However, this trait is a major disadvantage for commercial seed production. Current seed harvesting methods involve cultivating dry soil in summer to loosen up the burrs, which are then removed from the soil by specially designed vacuum harvesters. However, this process is very slow and energy inefficient,

resulting in relatively high seed prices, and also causes significant soil erosion. The UWA Engineering and Pasture Science groups are currently investigating more efficient and sustainable seed harvesting systems as part of an AgriFutures Australia-funded project. This student project will examine plant traits associated with seed burial and harvestability in subterranean clover to identify those that enable easier harvesting. This project will suit anyone wishing to develop skills in trait measurements and seed science and their application for development of improved harvesting machinery. Project availability: Semester 1, 2024. Potential co-supervisors: Megan Ryan, Andrew Guzzomi, Wesley Moss.

Prof. Zed Rengel

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Crop & Livestock Farming Systems	Soil Science & Plant Nutrition

Effects of glyphosate drifts on non-resistant canola and wheat crops

Glyphosate-resistant canola is grown in proximity of non-resistant crops. Given that glyphosate is now applied in-crop to resistant varieties, there is potential of drift to nonresistant varieties. Work in 2015 showed that such drift (2-3% of the weed-kill rate) can damage root and shoot growth and micronutrient uptake of non-resistant canola and wheat varieties. This work can be extended by testing the alleviating effects of micronutrient sprays before glyphosate drift occurring. Co-supervisor: TBC.

Plant physiology of nutrient uptake and transport (multiple projects)

Multiple projects on offer including (i)Transport pathways of root- and leaf-supplied micronutrients into developing cereal or legume grains; (ii) Fertilizer placement and nutrient uptake by various crops; (iii) Modelling 3D root growth nutrient uptake and determining optimal fertilization; (iv) P nutrition and root exudation by various crops and genotypes and (v) Characterise N-use efficiency of selected wheat and barley genotypes, specifically looking at potential mechanisms underlying differential efficiency (eg. root growth, stem carbohydrates, N remobilisation from leaves into developing grain, etc). Co-supervisor: TBC.

Biology and chemistry of rhizosphere

Projects on offer include (i) Role of root exudates in acquisition of micronutrients and phosphorus and (ii) Isolating bacteria and fungi capable of increasing availability of phosphorus in the rhizosphere. Co-supervisor: TBC.

Exploring the effects of a carbon supply on performance of feremycorrhizal symbiosis in wheat (*Triticum aestivum*)

Feremycorrhiza (FM) is a beneficial plant-fungus symbiosis. Due to lack of root colonization in the FM symbiosis, host plants presumably feed the fungus by exuding sugars or other organic compounds into the rhizosphere (main fungal habitat). This project will (i) characterize the effects of different carbon sources (including glucose and sucrose) on growth of wheat inoculated with the FM fungus, and (ii) determine whether soil sugar application influences the P nutritional benefits provided by the FM fungus via monitoring P nutrition of plants, soil pH, and carboxylates exudation. Co-supervisor: Khalil Kariman.

Exploring the role of native leaf fungal endophytes on heat stress tolerance in wheat (*Triticum aestivum*)

Endophytes are microbial endosymbionts that colonise different plant organs without causing any visible symptoms. Endophyte-plant associations are driven by environmental constraints e.g. hot climates would potentially favour the evolution/selection of plants adapted to forming connections with beneficial endophytes. This research project will (i) isolate fungal endophytes from leaves of several Australian native plants growing in high temperature environments and (ii) determine the effects of foliar application of fungal endophytes or their exudates on heat tolerance of wheat grown in a glasshouse. Co-supervisor: Khalil Kariman.

Characterising the functional mechanisms of sand-binding roots in the Australian native plant *Lyginia imberbis*

Sand-binding roots (SBR) are found in certain plant species including the Australian native plant *Lyginia imberbis* (Restionaceae). Improved plant nutrition and drought tolerance have been proposed as some of the potential benefits provided by SBR. This project will (i) explore the potential nutritional function of SBR in L. imberbis seedlings growing under nutrient deficiency/sufficiency conditions; via monitoring their morphology, amount of sand bound to roots (as a mineral nutrient source), and carboxylate exudations, and (ii) determine whether soil microbes are involved in SBR formation. Co-supervisor: Khalil Kariman.

Long-term effects of gypsum, lime and dolomite on topsoil and subsoil acidity

This project would utilize a long-term CSBP trial in Bonnie Rock. CSBP would support the project financially, and their staff would be involved in supervision. The project would involve (i) Root growth and distribution assessment in the field, (ii) Soil properties measurements and (iii) Modelling based on multi-year grain yield data. Co-supervisor: TBC.

The potential for ameliorating subsoil acidity with gypsum

For this project you will (i) Identify the levels, species and activity of aluminium found in subsoils across the Wheatbelt and relate this back to potential limitations to crop growth, and (ii) Test for potential responsiveness to gypsum based on pH changes and sorption of gypsum using the method of Sumner (1993). Does this test apply to WA Wheatbelt soils? Assess changes in aluminium and pH levels associated with sites where gypsum has been applied to overcome subsoil activity. Co-supervisor: TBC.

Role of Mg in alleviating Al toxicity and soil acidity

CSBP would support the project financially, and their staff would be involved in supervision. A range of Mg sources and rates will be tested in layered soil profiles (topsoil/subsoil) and/or nutrient solution with various levels of acidity and Al toxicity stresses. Wheat would be a preferred crop, but other choices are available depending on interest. Co-supervisor: TBC.

Prof. Megan Ryan

Email: Megan.ryan@uwa.edu.au

Crop & Livestock Farming Systems

Novel subterranean clover seed harvesting technologies
In this project you will work with a multidisciplinary team to look at the impact of alternative seed harvesting technologies on seed characteristics and seedling growth of subterranean clover. Co-supervisors: Phil Nichols, Andrew Guzzomi, Wesley Moss.

Annual Legume Breeding Australia
Are there benefits from pasture legume diversity for productivity? Does plant diversity enhance diversity of mycorrhizal fungi? Co-supervisor: Phil Nichols.

Oestrogenic pastures
Old cultivars of subterranean clover high in phytoestrogens are abundant in many WA pastures. In this project you will track cultivar abundance and levels of phytoestrogens over winter and spring. You will examine whether high phytoestrogens confer ecological advantages. Co-supervisor: TBC.

Prof. Kadambot Siddique

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Crop & Livestock Farming Systems | Genetics and Breeding

Improving phosphorus acquisition and utilization in chickpea with diverse genetic background
Phosphorus (P) is an essential nutrient required for plant growth and development. It is important to improve P efficiency in agriculture by understanding phosphorus acquisition and utilization strategies in crop species. Chickpea is the second most important grain legume globally, and is the largest pulse crop in Australia, which is supplying about one third of India's pulses import. A world mini-core collection of over 250 chickpea accessions and over 150 wild Cicer germplasm with diverse genetic background is available in our group. We are interested in investigating root morphological and physiological characteristics associated with improved P acquisition, mechanisms encoding high photosynthetic P-use efficiency, identification of germplasm with low seed P level, and others. Co-supervisors: Jiayin Pang, Hans Lambers.

How do root architecture traits improve resource-use efficiency and adaptation to edaphic stress?
Recently we have characterized root architecture trait variabilities in legume (e.g. narrow-leaf lupin, chickpea and soybean) and cereal crops (e.g. wheat, barley, maize) using a novel semi-hydroponic system. The root system is the main organ for water and nutrient uptake from the soil and thus determines plant growth and productivity. Food crops are facing a number of edaphic/environmental stresses in Australia and around the world, such as low soil water availability, low soil fertility (particularly P and N), salinity and compaction. Genotypic variation in response to stress exists in many crop species. The proposed project/s will evaluate how differences in root system architecture respond differently to edaphic stresses for enhanced adaptations.

Multiple projects are available to test crop species (narrow-leaf lupin, chickpea, soybean, wheat, barley and castor bean) and different stresses (drought, low P/N, salinity, acidity and soil compaction). Co-supervisors: Yinglong Chen, Jairo Palta.

Genomics and phenomics of deep rooting systems for increased water-use efficiency

The genetic improvement portfolio at DPIRD, WA aims to incorporate and discover new traits to tackle abiotic stress tolerance. We have realized deeper root systems in wheat helps tackle various abiotic stress. The focus of this project will be to combine genomic and phenomic data associated to rooting systems in diverse wheat panel to identify genomic regions and candidate genes. Co-supervisor: Roopali Bhoite.

Genetic investigations and physiology of phosphorus (P) uptake in acidic soil conditions

Phosphorus (P) is the second most frequently limiting major nutrient for plants; it is essential because of its critical role in energy metabolism and biosynthesis of nucleic acid and membranes. Acidification and alkalinization in the rhizosphere can affect soil P availability. Organic acids exuded from roots can benefit the P nutrition of plants and protect roots by detoxifying Al in the rhizosphere. The study will aim to identify potential donors having ability to exudate organic acid and better uptake P uptake. Co-supervisor: Roopali Bhoite (roopali.bhoite@dpird.wa.gov.au).

Genomics and phenomics of deep rooting systems for increased water-use efficiency

Genetic improvement portfolio at DPIRD, WA aims to incorporate and discover new traits to tackle abiotic stress tolerance. We have realized deeper root systems in wheat helps tackle various abiotic stress. Our focus here will be to combine genomic and phenomic data associated to rooting systems in diverse wheat panel to identify genomic regions and candidate genes. Co-supervisor: TBC.

Pre-harvest sprouting tolerance in wheat: Single-cell multi-omics analysis to determine proteins, metabolites, and DNA variants associated with tolerance

Pre-harvest sprouting is a common quality constraint of wheat that can result in downgrading of grain quality in Australia. Investigating single-cell RNA will precisely identify the targets for genetic enhancement for pre-harvest sprouting tolerance. Co-supervisor: Roopali Bhoite (roopali.bhoite@dpird.wa.gov.au).

Genetics and genomics of long coleoptile wheats – strategy to improve abiotic stress tolerance in wheat amidst climate change

Long coleoptile wheats allow deeper sowing which provides an opportunity to access subsoil moisture for germination. With the climate change and prevailing dry-land farming system, long coleoptile is a much sought-after trait. Investigating genetics, genomics and mechanisms for long coleoptile will help develop climate-resilient wheats. Co-supervisor: Roopali Bhoite (roopali.bhoite@dpird.wa.gov.au).

Genetics and genomics of Glufosinate (BASTA®) tolerance in wheat

Glufosinate is a broad-spectrum herbicide used to control weeds in more than 100 crops. It promotes residual weed control and crop rotation in Australian farming systems. The pre-breeding knowledge of Glufosinate tolerance will be helpful to develop tolerance cultivars. Co-supervisor: Roopali Bhoite (roopali.bhoite@dpird.wa.gov.au).

Detection of new genes for yellow spot, nodorum blotch and/or powdery mildew resistance in wheat

The Cereal Pathology and Genetics team at the Department of Primary Industries and Regional Development (DPIRD) has established research, development and extension activities across several national and international projects leading to significant advances in genetic enhancement of disease resistance in wheat. Our program focuses on enhancing resistance to foliar diseases of wheat through the development of genetic knowledge, genetic resources, breeding tools and selection methodologies. We currently have doubled haploid mapping populations which can be exploited to detect resistance genes to multiple diseases. This is an exciting opportunity to work in an enjoyable team environment and be part of developing cutting edge technology in enhancing disease resistance to various foliar diseases of wheat. Co-supervisor: Manisha Shankar (manisha.shankar@dpird.wa.gov.au).

Prof. Erik Veneklaas

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Crop & Livestock Farming Systems	Genetics and Breeding

Water and CO_2 transport in relation to stomatal distribution

Most plant species have stomata on the lower side of the leaf only. In crop species there is a large variation in stomatal distribution: one side only (hypostomaty), or equally distributed on both sides (amphistomaty). This project will assess the (dis)advantages of having stomata on both leaf sides, rather than on one side, and determine how these traits relate to the leaf's specific micro-climate. This knowledge will provide novel insights into the functional diversity of plants, direct plant breeding targets and contribute to the fundamental understanding of plant transpiration and photosynthesis, two processes that determine crop yield and water-use efficiency. Co-supervisor: Paul Drake.

Plant water relations in challenging climates and soils

The Western Australian climates and soils present many challenges to a favourable plant water status, and plant growth is often limited by water availability. Understanding the concept of water availability requires insights into soil properties (hydraulics, texture, gravel/rocks, salinity, hardpans etc.) root architecture (depth, branching, root diameters, hydraulics etc.), biomass partitioning, shoot hydraulics, leaf area, stomatal control etc. We are interested in root-soil, leaf atmosphere and overall plant hydraulic research to increase our insight into drought tolerance and water limitation of growth. Projects may vary in focus, e.g. phenotyping a range of genotypes for several traits; detailed analysis of root distribution and water uptake pathways in different soils; the effect of rock/gravel on plant-soil water relations, etc. Co-supervisor: Matthias Leopold.

Salinity and flooding tolerance of samphires

Samphires are stem-succulent halophytes, i.e. plants that live in saline environments. Western Australia has many species in this group, some of which are edible. The species vary in distribution, presumably due to ecological gradients of salinity, inundation regimes and water availability. This project, supported by DBCA, involves experimental research in a controlled environment to assess tolerance to salinity and inundation in a selected group of samphire species. Co-supervisor: Kosala Ranathunge/Sergey Shabala.

Prof. Phil Vercoe

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Crop & Livestock Farming Systems

Reducing methane emission from sheep and cattle

Mitigating methane emissions from sheep and cattle through manipulating the feed base, exploring the antimethanogenic properties of plant secondary compounds in Australian native plants, and genetic selection. This work includes plants, feed additives and grazing management practices that are relevant to the northern WA beef industry (northern and southern rangelands, fodder from pivot irrigation) as well as southern sheep and beef systems and is part of the approach to addressing the goal of the red meat industry to be carbon neutral by 2050. Potential co-supervisors: Zoey Durmic, Peter Hutton, Dean Revell.

Genetic resistance of sheep to gastro-intestinal worms - reducing our reliance on drugs

In ruminant livestock, gastro-intestinal worms (helminths) reduce productivity, and can cause diarrhoea (or 'scouring'). In Merino sheep, this leads to faecal contamination around the anus (or 'breech') that attracts blowflies, leading to flystrike. Globally, worms are becoming resistant to anthelminthic drugs. Breeding worm-resistant sheep is very effective, but a significant proportion of the worm-resistant sheep scour. We need to identify the components of the immune system that are affected by worm infection and by genetic selection for worm resistance so we can simultaneously select for resistance to both worms and diarrhoea. Co-supervisor: Graeme Martin.

A/Prof. Ben White

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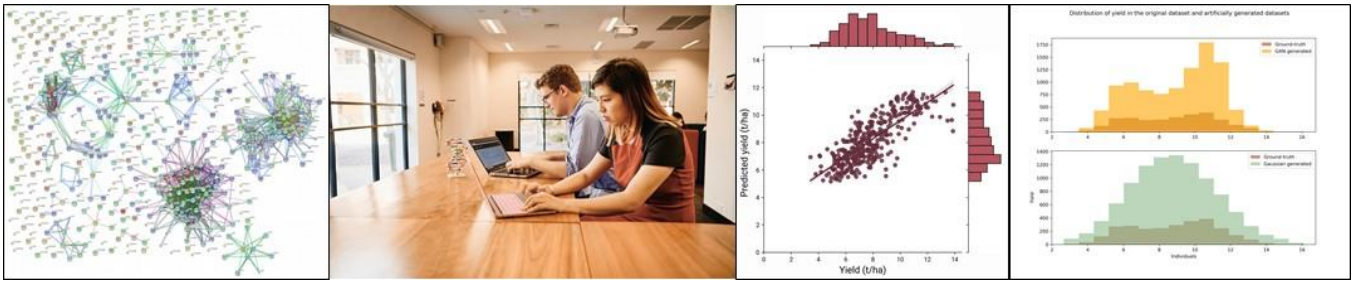
Crop & Livestock Farming Systems

Behaviour change for regional biosecurity

How do we design community surveillance and management systems that encourage smallholders to manage pests? Rural Australia is over-run with exotic pests: feral pigs, foxes, cats, fruit flies and numerous weeds. The big challenge for organizations like the Peel Harvey Biosecurity Group is to persuade people to report pest problems and act collectively to manage the pest. This paper will involve working with the biosecurity group to survey landholders and test alternative strategies to get people to manage pest. We will use fruit fly as the case study pest. Co-supervisor: Jonelle Cleland (Peel Harvey Biosecurity Group).

Bioinformatics



Master of Bioinformatics degree coordinator - Prof. Dave Edwards (Dave.edwards@uwa.edu.au)

The table below lists potential supervisors who are offering projects focused on bioinformatics.

POTENTIAL SUPERVISOR	Area of research
Jonathan Chee	
Heng Chooi	Genome mining of fungi and bacteria for bioactive metabolite discovery
Mark Cruickshank	Cancer genomics
Dave Edwards	Plant genomics, evolution and crop improvement
Rich Edwards	Genome assembly, evolution, and marine genomics
Aleksandra Filipovska	Systems biology, synthetic biology, machine learning
Patrick Finnegan	Dynamics of mitochondrial and chloroplast biogenesis
Timo Lassmann	Precision health
Zhaoyu Li	Cancer genomics for the identification of epigenetic biomarkers to predict cancer risks
Ryan Lister	High-throughput and single cell transcriptome and epigenome analyses in plant and animal systems in the context of organism development, biomedicine, stress, and synthetic biology
David Martino	Clinical epigenetics
Nina McCarthy	Genomics of psychiatric disorders
Mark Nicol	Human microbial ecosystems and microbiome analysis
Ian Small	RNA biology in organelle gene expression

- Studies that can be taken using a 'desktop' approach, and thus not requiring field or laboratory work. These studies can be undertaken remotely.

In addition to specific projects listed below, there are a diverse range potential projects for applied bioinformatics students across biomedicine, agriculture and environmental research. Many of these projects are also suitable for students enrolled in the Master of Biotechnology program. Areas span genomics, image analysis, epidemiology and machine learning and can often be adapted to the interests of the student. For a list of current potential project supervisors and their speciality, please contact Dave.Edwards@uwa.edu.au.

Dr Jonathan Chee

Email: Jonathan.chee@uwa.edu.au

Identifying antigen receptors that predict immunotherapy outcomes

Adaptive immunity is predicated on specificity. Immune (T/B) cells respond specifically to target antigens, such as cancer, viral of self-protein. Immune specificity is attributed to the antigen receptors of T/B cells. To generate a repertoire of immune cells capable of responding to different insults, our immune system generates a diverse set (10^6-10^8) of T cell clones that each possess a unique antigen receptor. High-throughput sequencing allows us to study millions of these antigen receptors in parallel. We have sequenced antigen receptors of T cells in different disease models. This project will utilize bioinformatics tool to investigate if there are features of antigen receptor sequences that predict cancer therapy outcomes, or organ pathology in autoimmune disease. Co-supervised by Dr Jesse Armitage (jesse.armitage@telethonkids.org.au.).

Dr Heng Chooi

Email: Heng.chooi@uwa.edu.au

Genome mining of fungi and bacteria for bioactive metabolites

Fungi and bacteria produce bioactive small molecules known as secondary metabolites, which have been the source of human medicines (e.g. antibiotics and anticancers). The surge of microbial genomic information in recent years revealed that fungi and bacteria encode for secondary metabolite biosynthetic potential that far surpasses the chemical diversity that we have previously appreciated via traditional culturing approach. This presents immense opportunities for genome-based discovery of novel chemical entities as pharmaceuticals and agrochemicals. We are building in-house genomics database of Australian microbes to support such discovery. Different bioinformatics strategies are being developed to mine the microbial genomes for biosynthetic gene clusters and prioritising them for discovery. While synthetic biology tools are being developed to translate the candidate biosynthetic gene clusters to bioactive metabolites. There are projects available in this area.

Dr Mark Cruickshank

Email: Mark.cruickshank@uwa.edu.au

Identification of leukaemia drug response biomarkers and mechanisms of action

Cancer cells often show aberrant signalling and epigenetic modifications. These features are promising targets for new anti-cancer agents. This project involves analysing genome sequencing, transcriptomic and epigenomic data from a panel of human leukaemia cell lines together with drug response data. The project will utilise a range of analytical tools to identify features predictive of drug sensitivity and resistance. These biomarkers will be explored in pan-cancer datasets. The mechanisms of action for novel therapies will also be evaluated.

Prof. Dave Edwards

Email: Dave.edwards@uwa.edu.au

Plant genomics
The Edwards group are leaders in plant genomics and pangenomics (understanding the gene content of a species rather than an individual). We continue to develop pangenomes for a range of species of agricultural, environmental, and evolutionary interest. The Edwards group at UWA is a dedicated computational biology group, asking biological questions using big data and high-performance computing. Projects range from genome and pangenome assembly, annotation and comparison, population analysis, trait association, evolutionary studies and crop improvement, predominantly using wild plant and crop species. Candidates will receive training in the use of high-performance computing in biology. Please contact Dave Edwards to discuss specific opportunities.

Machine learning applications
We have several potential projects developing machine learning methods for plant data including plant recognition, trait association and genomic analysis. The group has previously developed and applied methods to predict accurate gene models, associate traits with the underlying genomic variation and identify weeds in crops. The Edwards group at UWA is a dedicated computational biology group, asking biological questions using big data and high-performance computing. Candidates will receive training in the use of high-performance computing in biology. Please contact Dave Edwards to discuss specific opportunities.

Decoding the impact: bridging missense variants and protein structures for functional assessment (in collaboration with Mark Derbyshire (Curtin University)).
This project will primarily focus on the model plant *Arabidopsis thaliana*, using the extensive publicly available data for this species. The project will assess the impacts of missense variants on protein structure and thermodynamic stability in plant pathogens to understand the impacts of missense variants on plant proteins at the whole genome scale. Phenotypic data will then be used to assess whether the predicted impacts of missense variants on protein structural properties can be used to prioritise genomic loci for breeding.

Probing the past: understanding effector evolution through structural phylogenetics (in collaboration with Mark Derbyshire (Curtin University)).
Pathogen proteins called ‘effectors’ play important roles in manipulating host defences during infection. This project will use computational structural biology and structural phylogenetics to understand the evolutionary origin of and evolutionary relationships between known effector families. The project will aim to distinguish between different evolutionary scenarios such as de novo gene birth, horizontal transfer and vertical inheritance from a distant common ancestor.

Prof. Rich Edwards

Email: Rich.edwards@uwa.edu.au

Marine vertebrate reference genomes and comparative genomics
The Minderoo OceanOmics Centre at UWA is a multidisciplinary team of fish biologists, bioinformaticians and ecologists, using genomics to address pressing challenges in marine conservation. The Ocean Genomes Laboratory is equipped with the latest high-throughput sequencing technology and computational biology facilities. In collaboration with global partners, we are generating a comprehensive library of high-quality marine vertebrate reference genome assemblies. Projects are available throughout the process of assembling, annotating, curating and interpreting reference genomes. These include developing automated workflows, advancing methods for assembly curation through comparative genomics, developing data visualising/sharing dashboards, and detailed curation of individual reference genomes. Candidates from a range of biological or computational backgrounds are welcome. Co-supervisor: Dave Edwards or other SBS academic dependent on project.

Environmental DNA for better ocean health conservation
Oceans are suffering from human-made pressures such as overfishing and climate change. Monitoring of fish populations relies on expert surveys and underwater cameras (BRUVs), approaches which do not scale well across marine park areas (MPAs). Environmental DNA (eDNA) sampled from ocean water offers a chance to improve scalability of ocean health assessments. A wide range of projects are also available in collaboration with Minderoo scientists working with the Minderoo OceanOmics Centre at UWA. Projects include (1) Analysis, comparison, and interpretation of eDNA data from expeditions to Australian MPAs, (2) Implementing analysis workflows to streamline and automate large scale processing of eDNA data and (3) Implementing novel ML or AI approaches to analyse eDNA data. Candidates will learn how to work with multiple types of biological data and experience working in a cross-disciplinary team composed of fish biologists, bioinformaticians and ecologists. Co-supervisor: Renae Hovey or other SBS academic dependent on project; Philipp Bayer (Minderoo).

Prof. Aleksandra Filipovska

Email: aleksandra.filipovska@uwa.edu.au

Systems biology evaluation of gene therapy and 3D imaging for diagnosis of metabolic disorders
We have developed tools that can specifically target genetic mutations to revert them from a mutated to normal condition. We will use and develop specific bioinformatic analyses to identify and evaluate the effectiveness of our gene therapy approaches. In addition, like urban planning of cities, the structure and organisation of cellular components is critical for their function and cell health. We will investigate the topological properties of complex surfaces and solids within dynamic environments to model pathological changes in cells. The project aims to design, validate and implement an unsupervised machine learning system to differentiate diverse molecular changes in models of diseases.

Assoc. Prof. Patrick Finnegan

Email: Patrick.Finnegan@uwa.edu.au

Genomics of chloroplast and mitochondrial biogenesis during leaf greening in a phosphorus-efficient plant
This project will use existing RNAseq datasets to determine the dynamics of mitochondrial and chloroplast biogenesis across leaf development in the highly phosphorus-efficient plant *Hakea prostrata* (Proteaceae). This plant displays delayed leaf greening. In the family Proteaceae, which also includes banksias and grevilleas, delayed leaf greening is a strategy that economically spreads the use of scarce nutrients over time, unlike crop plants that tend to invest high amounts of nutrients all at once. We have recently found that during leaf development, transcripts encoding cytosolic and mitochondrial ribosomal subunits in *H. prostrata* decline in abundance, while transcripts for chloroplast transcripts increase in abundance. The relative timing of these events differs substantially from model plants like *Arabidopsis* that do not have delayed leaf greening and economises on the use of the essential nutrients phosphorus and nitrogen. We hypothesize that the developmental timing of other aspects of chloroplast and mitochondrial biogenesis also differ substantially from model plants, which may provide insights in how to better manage nutrient use, and therefore fertiliser use, in crop plants.

Assoc. Prof. Timo Lassmann

Email: Timo.lassmann@telethonkids.org.au

Precision health approaches to tackle rare and undiagnosed diseases
Rare diseases collectively affect >1 person in every 17, about ~1.3 million Australians, including 500,000 children. 80% of rare diseases have a genetic causation or association. Approximately 30% of patients wait more than 5 years to receive a diagnosis, while a similar number see more than 6 doctors before receiving a diagnosis; half of these patients had at least one incorrect diagnosis. In one Australian state, the associated hospital admissions costs alone of fewer than 500 of the estimated 10,000 rare diseases extrapolated to more than $4 billion p.a. nationally. Improved approaches to diagnosing rare genetic diseases have enormous potential to reduce suffering and deliver efficiencies and health system savings. We have established a combined computational and laboratory research group to end the diagnostic odyssey experienced by patients suffering from rare diseases and their families. A wide range of projects are available including (1) Re-purposing of public single cell data in the context of variant interpretation, (2) Analysis and interpretation of bulk RNAseq and single cell data from experiments validating the function of patient variants, (3) Implementing single cell analysis workflows to streamline and automate large scale data processing in the context of rare diseases including cancers and (4) Reproducible data management and analysis using datalad. Candidates will learn how to work with multiple types of biological data and experience working in a cross-disciplinary team composed of clinicians, laboratory and computational scientists.

Dr Zhaoyu Li

Email: Zhaoyu.li@uwa.edu.au

Epigenetic signatures of environmental toxins
Epigenetic signals bridge environmental risk factors with cellular gene expression and could be used as the cellular response and readout of environmental risks. This project aims to identify risk-specific epigenetic signatures of environmental toxins by analysing epigenomic data of histone modification from ChIP-Seq and gene expression data from RNA-Seq.

Cancer-specific non-coding variants
The majority of genetic variants appear at the non-coding regions of the human genome. The functions of these non-coding variants are still not fully understood. Transcription factors have unique binding sites and binding motifs in the genome. Most of transcription factor binding sites are at the non-coding regions. This project aims to address the function of non-coding variants that affect the binding of transcription factors by analysing the genetic variant data from whole genome sequencing and genome-wide location data of transcription factor binding sites from ChIP-Seq.

Dr David Martino

Email: David.Martino@telethonkids.org.au

The clinical epigenetics team is engaged in understanding the links between child health and the molecular hallmarks of epigenetic control. Our mission is to improve the health and well-being of children through epigenetic research. We have several projects below.

Developing clinical diagnostics for neurodevelopmental disorders
Foetal alcohol spectrum disorder (FASD) has life-long consequences for affected individuals and their families. It's a public health issue of international significance that is entirely preventable. Early diagnosis is the key to treating affected children early, to minimize harm and maximise their quality of life. The problem is we have no clinical markers for FASD, meaning diagnosis and treatment only occurs once the severely damaging effects of neurotoxicity are evident. Using methylation data from mice exposed in utero to alcohol, and human methylation data sets from patients with FASD, we are identifying episignatures that define FASD syndrome. You will work with DNA methylation data sets and apply machine learning and regression techniques to develop markers with diagnostic utility.

Precision medicine approaches for allergic disease
Peanut allergy is a severe and life-threatening disorder of the immune system. Oral immunotherapy is on the cusp of becoming a mainstream treatment for sufferers. Oral immunotherapy trials (OIT) show variable efficacy with some children experiencing toxicity, and it's very difficult to predict which patients respond well, which don't, and who will have a bad reaction to treatment. This project will mine single cell data sets from patients undergoing immunotherapy to identify epigenetic changes that predict patient outcomes. Validation will occur using existing bulk data sets and new single cell data sets to develop epi-signatures of patient outcome.

Dr Nina McCarthy

Email: Nina.mccarthy@uwa.edu.au

Understanding the biology of psychiatric disorders
Using genomic tools to better understand the biology of psychiatric disorders. These projects will involve using bioinformatic and statistical methods to analyse human genomic data in large studies of psychiatric disorders such as schizophrenia.

Dr Mark Nicol

Email: Mark.nicol@uwa.edu.au

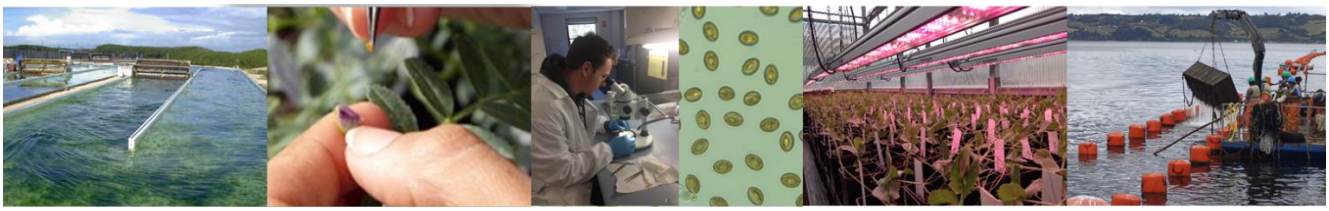
Human microbial ecosystems and microbiome analysis
Project description: Our group explores the role of the human microbiome in early life on health outcomes. In particular, we study the respiratory, human milk, skin and gut microbiota in relationship to outcomes such as pneumonia, asthma, allergic skin conditions and neonatal sepsis. We also take an ecological approach to understanding how interactions between bacteria drive ecosystem composition. We use a range of data sources, including 16S amplicon sequencing, whole metagenome sequencing, whole bacterial genome sequencing and targeted bacterial and viral detection. Analysis is frequently complex, including longitudinal, case-control and network analysis. I am happy to discuss specific opportunities with enthusiastic and dedicated students.

Prof Ian Small

Email: Ian.small@uwa.edu.au

RNA biology in organelle gene expression
Our group studies RNA processing in mitochondria and chloroplasts, ranging from the study of the structure, function and evolution of natural proteins in a wide range of organisms to the design of synthetic proteins for use in synbio control circuits or treating genetic diseases. Bioinformatics projects include the analysis of RNA processing events using RNA-seq data, target prediction for RNA-binding proteins and genome annotation/comparative genomics.

Biotechnology



The table below shows which supervisors have projects listed under two ('AQUAtech' and 'Environmental & Agricultural Biotechnology') of the four 'Specializations' that are offered within the Master of Biotechnology. There is a separate research project booklet produced by the School of Molecular Sciences that lists projects in the other two 'Specializations' (Biochemistry & Molecular Biology and Genetics & Genomics). Students may select a project appropriate to their interests from either booklet.

POTENTIAL SUPERVISOR	AQUAtech	Biochemistry & Molecular Biology	Environmental & Agricultural Biotechnology	Genetics & Genomics
Rob Atkin			√	
Dave Edwards			√	
Theo Evans			√	
Deirdre Gleeson	√		√	
Sasha Jenkins			√	
Parwinder Kaur			√	
Judith Lichtenzveig			√	
Talitha Santini	√		√	

- Studies that can be taken using a 'desktop' approach, and thus not requiring field or laboratory work. These studies can be undertaken remotely.

- Studies that involve field sampling of biota and/or field measurement of environmental parameters.

- Studies that involve research in glass or green houses, animal holding facilities or the laboratory

Prof. Rob Atkin

Email: Rob.atkin@uwa.edu.au

Environmental & Agricultural Biotechnology

Could plastic eating insects help save our environment? 

Polystyrene is a non-biodegradable persistent plastic that is accumulating at alarming rates on land and in rivers, lakes and oceans. Australia's government is committed to a 70% reduction of plastic pollution by 2020. To address this, UWA together with Woodside Energy Ltd are investigating the use of insect technology as a means of converting polystyrene waste into high value protein products. Preliminary studies suggest that larvae of yellow mealworms *(Tenebrio molitor*), superworms (*Zophobas atratus*), and wax moths (*Galleriinae species*) are capable of degrading polystyrene and polyethylene via enzymatic processes in the gut, either incorporating these into the biomass of the insect or converting them into insect castings (frass). However, the full extent of their capacity to degrade plastic and feasibility of adopting intensive insect farming for plastic removal is still unknown. Students should pick one plastic-eating insect farming related project to focus on. Potential projects include (i) ***Economic evaluation of plastic-eating insect farming including mealworm, wax moth, superworms or other plastic-eating insects.*** Students will evaluate the potential markets for the plastic-eating insect farm by-products - insect larvae (protein, glycerol and oil) and insect castings or frass (fertiliser, soil improvers). This could include: evaluating the price of other products and market shares; determination of what features would make the protein, oil, glycerol, fertiliser and soil improver more desirable and identify any gaps in the market that the products could fill; (ii) ***Lab experiment comparing the various plastic eating insects, and viability as digestors of different plastic types.*** Students will investigate the ability of insects to degrade polystyrene and other plastics (i.e. polyethylene) and explore the factors influencing larval rearing on plastics (e.g. temperature, larval density and dietary factors) and conversion rates to insect biomass (larvae) and insect castings (frass); (iii) ***Evaluation of the microbiome of the mealworm/waxmoth/superworm*** – what is known, what are the knowledge gaps? Can we selectively breed insects and/or gut microbiome to increase conversion rates? Co-supervisor: Georg Fritz.

Prof. Dave Edwards

Email: Dave.edwards@uwa.edu.au

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A/Prof. Theo Evans

Email: Theo.evans@uwa.edu.au

Environmental & Agricultural Biotechnology

Evaluating dung beetles 

By burying cattle dung, dung beetles can enrich our soils and protect us from pest species. 50 years ago one of the most famous biocontrol experiments in the world began with the release of exotic dung beetles into Australia to bury cattle dung. They were an immediate success, reducing dung in fields, and nuisance bush fly populations. However, the ecosystem services were not quantified in either ecological or economic terms, or over large temporal or spatial scales. Furthermore, the success is patchy, as dung beetle populations vary across Australia, likely due to a combination of differing ecophysiological requirements, dispersal and farm management. Available projects include (i) Ecological functions of dung beetles: effects on soils and plant growth; (ii) Interspecific interactions between dung eating animals, including beetles, flies, worms, termites, and nematodes; (iii) Economic value of dung beetle ecosystem services; (iv) Effects of farm management, such as tillage and drenches, on dung beetles and (v) Population genetics of widespread vs restricted congeneric dung beetles. Co-supervised by TBC.

A/Prof. Deirdre Gleeson

Email: Deidre.gleeson@uwa.edu.au

AQUAtech	Environmental & Agricultural Biotechnology

Biodiversity of living, non-marine, thrombolites of Western Australia 

Microbialites are biosedimentary structures formed by the interaction of microorganisms with their environment. Living microbialites, including stromatolites and thrombolites, are found in just a few select locations worldwide. This project will investigate the microbial populations present in the thrombolites at Lake Clifton in the Peel-Yalgorup region to determine if they are still living and investigate how they might be affected by climate change. The project will involve sampling of thrombolites and lake water at Lake Clifton and the use of DNA and RNA based tools to assess the microbes and functions that maintain the thrombolites. Co-supervised by Gavan McGrath (DBCA); Rick James (Peel Harvey Catchment Council).

Environmental DNA as a monitoring tool for surface water management 

As part of the license conditions for a mine in Western Australia, the Department of Water and Environmental Regulation (DWER) recommend the incorporation of ecological measurements into existing surface water management (SWM) programs, operated by the mine. The SWM plan has suggested that lithium is a contaminant of particular interest, the impacts of which should be investigated further. To achieve this, a UWA team has carried out surveys at sites both upstream and downstream from the mine and, as part of these

surveys, fish were sampled using baited fish traps. The current project proposes to investigate the use of e-DNA to determine whether the range of fish species in streams upstream from the mine differs from those downstream, and to compare the e-DNA results to the more traditional fish trap surveys.
Co-supervisor: Prof Peter Cook.

The contribution of elemental sulfur in decreasing pH in sodic soils – relationship with microbial communities

Dispersive or sodic soils are common in the south-west agricultural area of Western Australia where they occur mainly as duplex or gradational profiles. A dispersive soil is a structurally unstable soil. When the soil gets wet the individual sand, silt and clay particles collapse and separate into the water instead of remaining bound together in aggregates. The floating clay particles then clog the soils pores causing slow water infiltration. When the soil dries the separated clay particles act like cement and cause the soil to become hard, crusty and poorly structured. These soils contain so much sodium that it interferes with the soils 'normal' behaviour causing this dispersion. In the Australian context, sodic soils are defined as having an exchangeable sodium percentage (ESP) greater than 6 %. Sodic soils usually have an elevated pH (pH > 8.5) which may be treated with a direct (gypsum) or indirect (elemental sulphur) calcium source to remove excess exchangeable Na+ from the soil. In prior pot trials using WA sodic soils elemental sulphur has been shown to be effective in lowering soil pH and had a positive effect on both the chemical and physical properties of the soil (Mulvany and Barrett-Lennard). This project aims to investigate the effect of differing rates of elemental sulfur and different forms of organic matter amendment on the biological properties of soil, specifically microbial populations. This project will focus on microbial community relationships and will assess microbial community response to sulfur amendment in sodic soils via quantitative PCR. The project will suit a student with an interest in laboratory experimental research, soil biology and microbiology. Co-supervisors: Ed Barrett-Lennard (DPIRD staff - Ed.barrett-lennard@dpird.wa.gov.au); David Hall (DPIRD Staff).

The microbiome of gabbro and granophyre rock surfaces in the Burrup peninsula (WA)

The Burrup Peninsula in north-west Western Australia is home to one of the most substantial collections of rock engravings, or petroglyphs, in the world. These petroglyphs are carved through the dark coloured patina, commonly referred to as rock varnish, into the weathering rind of the local parent rock (gabbro andgGranophyre). It is generally considered to be a hostile environment for microorganisms due to extreme environmental conditions including low nutrient availability, lack of water, exposure to extreme ultraviolet radiation and intense seasonal and diurnal temperature fluctuations. Despite these environmental extremes, microorganisms have been found on and in the patina or rock varnish. This project will characterize the microbiome of the patina (rock varnish) on granophyre and gabbro surfaces and will investigate potential environmental perturbations to these microbial communities. The project will suit a student with an interest in field work and with strong molecular microbial ecology skills and/or bioinformatic skills. Co-supervisor: Eliot Hanrio (eliot.hanrio@research.uwa.edu.au).

Dr Sasha Jenkins

Email: Sasha.jenkins@uwa.edu.au

Environmental & Agricultural Biotechnology

Assessing the impact of soil amendments on methane uptake in dryland soils

Climate change is a serious threat to agricultural productivity and global food security. However, livestock industries such as dairies are a major contributor of methane (CH_4) emissions. Soils can be either sources and sinks of CH_4 depending on the balance between methane-producing (methanogenenic) and methane-consuming (methanotrophic) activities. Recent studies have suggested that the dryland soils of Western Australia are sinks for CH_4 but the mechanisms and controls involved are not fully understood. Several factors, including soil pH, redox potential, temperature, soil organic matter and moisture content influence soil CH_4 fluxes. This project provides an excellent opportunity for candidates interested in exploring the impact of different soil amendments (lime, clay, compost) on greenhouse gas emissions (methane, nitrous oxide and carbon dioxide), soil chemistry and nutrient dynamics in soil under laboratory conditions. There is the option to study the microbes involved in GHG production using quantitative PCR or sequencing. All students will gain experience in data and statistical analysis using R Studio. Importantly, this project fosters an environment for learning and collaboration within a diverse and passionate research group. Co-supervisors: Sun Kumar Gurung, Pankaj Singh.

Mitigating abiotic stress tolerance in wheat through application of novel organo-mineral fertilizers

Australia is a major wheat-producing country but production has been limited by water shortage. In the rain-fed drylands, drought is a significant stressor with a major impact on plant growth and development leading to significant grain yield losses. Increasing wheat productivity in arid and semi-arid areas is critical to providing food security for future generations. Organo-mineral fertilizers are gaining increasing attention as a sustainable, alternative to synthetic fertilizers that mitigate the impact of drought. These novel fertilizers have the potential to maintain plant productivity and soil functioning under water stress by adjusting the soil moisture content, plant water status and soil health. This project aims to investigate the use of organo-mineral fertilizer to alleviate the impact of water stress on wheat plants. There are several opportunities in this study. Students can study (i) plant resistance and resilience to abiotic stresses by analyzing plant productivity, plant nutrition, plant non-structural carbohydrates and plant functional traits, (ii) utilize molecular methods to analyze gene expression or (iii) investigate the development of novel organo-mineral fertilizer products as alternative fertilisers or soil conditioners. For the latter projects, candidates will focus on assessing the impact of organo-mineral fertilizers on one of the following: soil fertility and soil structure, soil microbial community diversity and nutrient cycling, broader aspects of plant-soil-microbe interactions and ecosystem functions or soil resilience and resistance to abiotic stress. For Master of Bioinformatic or Biotechnology students there are further opportunities to develop specific bioinformatic workflows for amplicon sequencing and shotgun metagenomic sequences and to overcome the limitation of large eukaryotic genomes such as fungi. All candidates will be taught data analysis and statistical analysis using R. Most importantly, these projects are part of larger industry-based research project across Australia. Students will be part of a friendly multi-disciplinary research group and given the opportunity to build a larger network within academia, government and industry. Co-supervisors: Sun Kumar Gurung, Pankaj Singh.

Black Soldier Fly castings as a high quality fertilizer product

This project is part of a larger, interdisciplinary and industry-funded project that is developing novel ways to process agricultural waste using Black Soldier Fly (BSF) larvae. The BSF larvae convert waste into high quality fertilizer (BSF casting residues or frass) and/or protein for animal feed (BSF larvae). Adoption of BSF technology

and its products has potential to increase productivity and profitability on farms by reducing input costs and generating alternative revenue streams. However, the BSF fertilizer products cannot be used as a fertilizer in Australia until the environmental, agronomic and economic value of this product is fully evaluated. For this project you will conduct a glasshouse pot trial study to determine whether BSF larvae castings could be used as fertilizers. You will measure crop nutrition, growth and yield responses to BSF larvae residues and frass applied to soil as a fertilizer. Additionally, you will use a variety of molecular tools to determine how the soil microbial communities and their function respond to frass applications. Co-supervised by Deirdre Gleeson, Kadambot Siddique.

Quantifying the leaching potential of applying Black Soldier Fly castings residue (a novel fertiliser product) to soils

This project is part of a larger, interdisciplinary and industry-funded project that is developing novel ways to process agricultural waste using Black Soldier Fly (BSF) larvae. The BSF larvae convert waste into high quality fertilizer (BSF casting residues or frass) and/or protein for animal feed (BSF larvae). Adoption of BSF technology and its products has potential to increase productivity and profitability on farms by reducing input costs and generating alternative revenue streams. However, the BSF fertilizer products have a high ammonium content which could result in nitrogen (N) loss following its application to land via leaching. For this project, you will conduct a glasshouse pot trial study to determine the leaching potential of BSF larvae castings when it is applied to a soil as a fertilizer. You will measure leaching behaviour of N and other nutrients (elements/heavy metals) as well as crop nutrition, growth and yield responses to BSF larvae residues and frass applied to soil as a fertilizer. Additionally, you will use a variety of molecular tools to determine how the microbes involved in N cycling are impacted by frass applications. Co-supervised by Deirdre Gleeson, Talitha Santini.

Bioenergy: Converting household waste into biogas

In Western Australia the preferred disposal method for municipal solid waste (MSW) is landfill. However, this is not necessarily the most effective means of disposing of such waste and there is growing interest in finding alternative uses that solve both waste excesses and energy shortages. One option is to convert MSW into biogas (methane) and compost via a process called anaerobic digestion. The biogas can then be used to provide renewable energy by the generation of electricity. However, anaerobic digestion is a complex process performed by microbes and consequently the ecology, prevailing environmental conditions and mechanisms involved remain poorly understood. This project will develop more efficient anaerobic digestion by investigating the relationship between microbial degradation, environmental parameters and biogas production during the anaerobic digestion of MSW. Co-supervised by TBC.

Converting piggery waste into biogas

Currently most pig farmers put their pig waste into large ponds where the waste is gradually broken down by microbes within the pond. However, these microbes release both odours and methane that upset local residents and contribute to global warming. One solution is to cover these ponds with an impermeable cover resulting in reduced gas emissions since the methane is retained under the cover. Although, the prospect of covered ponds is attractive, initial start-up costs are high. This could be overcome by capturing the methane under the cover and using it to off-set start-up costs by providing on-farm heating or electricity. However, methane recovery from covered ponds is not very efficient, and covers on the ponds could alter the waste degradation process and reduce biogas yield. Our research aims to increase biogas production from covered ponds by optimizing the waste degradation process through different management practices and provide advice on interventions required to prevent pond failure. Co-supervised by TBC.

Flies as alternative pollinators

Flies can be just as efficient as honeybees in transferring pollen for various crops. However, the key issue is that flies often aren't as abundant as honeybees and other insects. This project will look at ways of increasing their abundance we can have flies which are just as efficient as honeybees at pollinating on all sorts of crops. Co-supervised by Dr David Cook (DPIRD).

A/Prof. Parwinder Kaur

Email: Parwinder.kaur@uwa.edu.au

Environmental & Agricultural Biotechnology

Exploration of alternative synthetic production platforms for bio-synthetic pathways using microbial cell factories

An increasing world population augmented with fast industrialization has significantly increased global energy consumption per capita. This increasing energy demand is usually met using conventional, non- renewable energy sources such as fossil fuels, associated with environmental degradation and health issues. Many studies have estimated that the demand for energy is going to escalate 50% by 2030, demonstrating the urgent need for non-conventional, renewable and sustainable energy resources. The demand for pharmaceutical proteins and other high value products is being fulfilled by industrial biotechnology by employing yeast, mammals and insects. Concepts and technologies provided by synthetic biology and biotechnology are inspiring and encouraging researchers to re-imagine bio-based materials. Multiple projects available. Co-supervised by Dr Shane Stone.

DNA Zoo - Understanding Evolution

With the climate emergency exacerbating natural disasters, as evidenced by the Australian wildfires having killed >1 billion animals, we have a very short time to document and support our unique biodiversity. Living on an island continent, Australian biota have evolved in isolation, which has given rise to Australia's unique biodiversity. All three lineages of mammals are found on the continent including monotremes (egg-laying), marsupials (pouched) and eutherians (placental). Monotremes were the earliest diverging mammalian lineage and it is estimated marsupials and eutherians diverged ~150mya. Marsupials have a unique biology, giving birth to extremely under-developed young and having a complex lactation system. Genomic studies of marsupials are limited compared to eutherians. However, given their phylogenetic position and unusual biological features, genomic studies of marsupials will provide important insights into mammalian evolution, disease and development. Co-supervised by Prof Michael Wise.

Dr Judith Lichtenzveig

Email: Judith.lichtenzveig@uwa.edu.au

Environmental & Agricultural Biotechnology

Adaptation and secondary metabolites gene-clusters of the Didymellaceae 

Adaptation of plant-pathogenic fungi is fundamentally and economically important yet the process remains poorly understood. This project aims to evaluate the role of secondary metabolites (SM) in adaptation at the pathogenic and resting phase (i.e. in between infection cycles) of species in an important fungal family of plant pathogens, the Didymellaceae. One way to go about it is identifying signature of selective sweeps in SM gene clusters. A pre-requisite to undertaking this project is participation at a bioinformatics course (e.g. SCIE4002_SEM-2). If taken face-to-face, the project offers an opportunity to gain experience in molecular biology. Co-supervisors: Drs Robert Syme and Heng Chooi.

Fungal effectors of disease in legumes 

Ascochyta blight pathogens (ABP) of legumes are necrotrophs, which over-summer on stubble and spread via rain-splashed spores in autumn-winter, form a close phylogenetic group, and probably all secrete effectors (i.e. small molecules which determine the disease outcome). Preliminary observations based on comparative genome analyses, transcription profiling and biochemical analyses of fungal cultures support the hypothesis that the ABP secrete multiple effectors. Your task will be to identify and characterize effectors and evaluate them as selection tools for resistance breeding, deploying bioinformatics and molecular biology skills. Co-supervisor: Dr Robert Syme.

Dr Talitha Santini

Email: Talitha.santini@uwa.edu.au

AQUAtech | Environmental & Agricultural Biotechnology

Bioremediation of tailings and wastewaters 

Microbially-driven approaches for remediation of tailings, mineral processing wastes, and contaminated waters provide novel pathways to address the challenging chemical and physical properties of these materials. Use a variety of methods including laboratory or glasshouse leaching columns, laboratory experiments, and geochemical, microbial, and physical laboratory analysis methods, this project will test microbially-driven approaches for remediation of tailings or leachates. Specific remediation targets may include pH neutralization, metals removal, nutrient fixation, and/or structure development or dust suppression, for a range of different tailings and wastewaters/leachates. Potential co-supervisor: Sasha Jenkins.

In situ remediation of bauxite residue 

In situ remediation is increasingly being adopted in mine closure and rehabilitation plans. Bauxite residue, produced from alumina refining, is a globally significant tailings stream, with 120 MT produced worldwide annually. In situ remediation of bauxite residue may use a combination of inorganic and organic amendments, and biological approaches to transform it into a medium that is chemically, physically, and biologically suitable

for plant growth. This project will optimize the combination of amendments and approaches applied to bauxite residue to achieve sustainable in situ remediation to support a variety of post-mine closure land uses. The project involves field sampling and analysis, and/or laboratory trials. Potential co-supervisor: Sasha Jenkins.

Enabling reuse of tailings through in situ remediation 

In situ remediation is an increasingly popular approach for tailings rehabilitation and closure. The coupled abiotic-microbial strategies developed for rapid in situ remediation of tailings also opens the door for development of a new reuse pathway for tailings. Large scale utilization of tailings as a soil product requires transformation of its properties to meet specified targets demanded by potential consumers. Focusing on bauxite residue, this project will identify the opportunities for remediation and reuse as a soil product in agricultural activities around several pilot refinery sites globally. The project involves market analysis and consideration of bauxite residue properties and evidence for efficacy of various amendments to transform residue properties to achieve desired targets for the soil product. Potential co-supervisors Michael Burton, Marit Kragt.

Hitching a ride: contributions of dust deposition to nutrient accumulation and microbial community succession in tailings 

Dust is a poorly quantified but widely acknowledged source of biological nutrients and potential source of microbial inoculants in natural environments. This role of dust has been almost entirely overlooked in mining environments. Recent laboratory experimental work by Santini et al (2018) demonstrated that dust is a significant source of microbial inoculants in tailings and suggested that limited dust inputs likely underpin the delayed microbial community succession observed in tailings when compared to natural primary successional environments. This project will use field samples from dust traps to identify and quantify dust sources, total dust inputs, microbial community biomass, and dust nutrient content in a tailings site and adjacent non-mining site, and will evaluate microbial community functions to better explain the delayed succession and limited function that is commonly observed in tailings. Potential co-supervisor: Sasha Jenkins.

Blended waste caps for sustainable closure of tailings facilities 

Blended waste caps, using tailings mixed with other waste materials present on site to create both an impermeable (capillary break) layer and a plant growth (soil) layer, are a new approach to tailings management that offers opportunities to eliminate risks and costs associated with capping and in situ remediation approaches (capillary rise, expense/effort of importing capping materials and amendments, etc.). This project will identify the optimal blend of wastes available onsite at an alumina refinery to create a plant growth medium capable of supporting plant growth. Subsequent stages of the project will involve running flume trials to optimize water balance between the plant growth layer and capillary break layer. Potential co-supervisors: Matt Hipsey.

Environmental Science

Master of Environmental Science degree coordinator – Dr Natasha Pauli (Natasha.pauli@uwa.edu.au)

The Master of Environmental Science has six 'Specialization' pathways, the coordinators of which are as follows:

Catchments and Water – Dr Paul Close (Paul.close@uwa.edu.au)
Environmental Economics – A/Prof. Ben White (Benedict.white@uwa.edu.au)
Environmental Management – Dr Natasha Pauli (Natasha.pauli@uwa.edu.au)
Environmental Rehabilitation – Dr Andrew Rate (Andrew.rate@uwa.edu.au)
Marine and Coastal Management – Dr Sharyn Hickey (Sharyn.hickey@uwa.edu.au)
Sensing and Spatial Data Science – Dr Bryan Boruff (Bryan.boruff@uwa.edu.au)

The table below shows how projects listed by potential supervisors align to these six Specializations. All projects are suitable as Honours projects.

POTENTIAL SUPERVISOR	Catchments and Water	Environmental Economics	Environmental Management	Environmental Rehabilitation	Marine and Coastal	Sensing and Spatial Data Science
Roberta Bencini			√	√		
Jason Beringer	√					√
Michael Burton		√			√	
Nik Callow	√		√			√
Paul Close	√		√			
Barbara Cook	√		√	√	√	
James Fogarty		√			√	
Deirdre Gleeson	√					
Atakelty Hailu	√	√			√	
Sharyn Hickey					√	√
Matthew Hipsey	√			√	√	√
Steve Hopper			√			
Sasha Jenkins	√		√			
Marit Kragt		√	√	√		
Mathias Leopold	√		√		√	√
Caitlin Moore						√
Amin Mugera		√				
Ram Pandit	√	√	√	√		
David Pannell		√				
Natasha Pauli	√		√		√	
Andrew Rate	√		√		√	

POTENTIAL SUPERVISOR	Catchments and Water	Environmental Economics	Environmental Management	Environmental Rehabilitation	Marine and Coastal	Sensing and Spatial Data Science
Zed Rengel	√		√			
Abbie Rogers		√				
Talitha Santini				√		
Steven Schilizzi		√				
Peter Speldewinde	√		√	√		
Kate Sprogis					√	
Ben White		√				

- Studies that can be taken using a 'desktop' approach, and thus not requiring field or laboratory work. These studies can be undertaken remotely.

- Studies that involve field sampling of biota and/or field measurement of environmental parameters or conducting surveys.

- Studies that involve research in glass or green houses, animal holding facilities or the laboratory

A/Prof. Roberta Bencini

Email: Roberta.bencini@uwa.edu.au

Environmental Rehabilitation	Environmental Management

Translocation of the ash-grey mouse (*Pseudomys albocinereus*) from Cataby to Woodland Reserve, Whiteman Park

The project will involve the translocation of this native mouse from a mine site in Cataby to Whiteman's Park Woodland reserve. Animals will be sourced from the mine site by pitfall trapping and moved to Whiteman Park where there will be follow up monitoring via camera trapping and radio tracking to see how the animals are establishing in the new environment. Statistical analysis of results and submission of a report to the Park at completion of the study is required, as well as a presentation to stakeholders. Whiteman Park will assist with covering the costs of all consumables, support with report writing and field assistance, including any necessary training. Co-supervisors: Mike Bamford (Bamford consulting), Chris Rafferty (Whiteman Park).

Does behaviour affect survival of dispersing western ringtail possums?

The ngwayir or western ringtail possum (*Pseudocheirus occidentalis*) is a critically endangered arboreal marsupial endemic to southwest Australia. Little is known about survival rates of the species in the wild, especially during the dispersal phase. This project will investigate the personality of dispersing juvenile western ringtail possums and their survival rates at Locke Nature Reserve in Abbey (near Busselton). The student will be capturing, personality testing, radio collaring, and monitoring two cohorts of subadult possums, one in autumn and one in spring. Each cohort will be monitored for four months. The project aims to assist the recovery efforts for the species. Co-supervisor: Sara Corsetti.

Prof. Jason Beringer

Email: Jason.beringer@uwa.edu.au

Catchments and Water	Sensing and Spatial Data Science

Land-use change in the wheatbelt 

The Western Australian Wheatbelt includes a vast 15.4 million hectares of agricultural land with remnant native forest woodland that together are significant for cropping and grazing, and for their wilderness value but most native vegetation has been cleared. This UWA project investigates how land-use change from native woodlands to agricultural systems modifies the fluxes of water, carbon and heat with the atmosphere. The aims of this project will be accomplished through contrasting the water and carbon balance of a paired flux tower observations at Boyagin Nature Reserve and the UWA Future Farm. Potential co-supervisor: Caitlin Moore.

Water use of understorey and overstorey trees in a Wandoo woodland 

Extensive land use clearing for agriculture has left only small patches of remnant native Wandoo woodland that has significant value for providing ecosystem service but is under threat from environmental change. This UWA project investigates the seasonal water use of the Wandoo forest at the TERN Supersite at Boyagin Nature Reserve and drivers of ecosystem water use in a changing climate. The aims of this project will be accomplished through examining the water use of both the whole ecosystem and the understorey in a changing climate using flux tower observations. Potential co-supervisor: Caitlin Moore.

Remote sensing of plant productivity and stress 

New satellites are measuring plant productivity from space using Solar-induced chlorophyll fluorescence (SIF). This has begun to be measured in recent years using satellite remote sensing yet it has not yet been fully exploited but it is the focus of upcoming space missions. We have recently deployed infrastructure to measure the SIF signal from three ecosystems at tower masts at TERN Supersites in WA (Boyagin, GWW and GinGin). Your project would examine this brand-new data to interpret how SIF relates to photosynthesis and stress across a given ecosystem and compare that with satellite remotely sensed data. Potential co-supervisor: Caitlin Moore.

Laser scanning to characterize ecosystems structure 

Vegetation structure and leaf area are crucial drivers of ecosystem production (carbon uptake) and water use. Currently at ecosystem monitoring sites across Australia, that are part of TERN, they measure leaf area annually but there is a great need to measure this much more frequently. We have recently deployed infrastructure to measure the canopy using laser scanners that are deployed and scan every day at three ecosystems at tower masts at TERN Supersites in WA (Boyagin, GWW and GinGin). Your project would examine this brand-new laser data to interpret how to determine canopy structure and leaf area and compare that with on ground measurements to validate the approach. Potential co-supervisor: Caitlin Moore.

A/Prof. Michael Burton

Email: Michael.burton@uwa.edu.au

Environmental Economics	Marine and Coastal Management

How big is the value of a little penguin? 

Little penguins are the smallest penguin species. Their largest breeding colony in Western Australia is just off the shore of Rockingham, in the Perth metropolitan region. They face many threats given their co-location with a major human population base, including marine and coastal developments, predation, watercraft strikes, and pressures from eco-tourism. To balance the benefits and costs of coastal activities with the benefits and costs of conserving little penguins, decision makers need to identify what the value of the penguin colony is. This project will involve developing a non-market valuation survey to estimate how much people are willing to pay to protect little penguins through improved management outcomes. Co-supervisors: Abbie Rogers, Belinda Cannell.

The existence value of traditional crafts 

There is a 'Red List' of endangered species. What might come as a surprise is that there is a Red List of endangered crafts. These are traditional crafts, the practice of which are at risk of dying out. In the same way that one can identify values for the existence of species (which may be independent of ever actually interacting with them), this project will investigate whether there are existence values for the preservation of crafts, independent of whether one actually wants to purchase the products. If interested in this project, contact me early, as it will require some coordination with partners in the UK. Co-supervisor: TBC.

Urban biodiversity and water conservation: A study of verges in Perth 

Governments often attempt to influence citizens' behaviour to help achieve environmental goals. Local governments in Perth have been encouraging property owners to plant native gardens on their verges to save water and support urban biodiversity using a range of different policies and programs. This project will examine what types of people have planted native gardens on their verges, what motivates people to plant them, and how policies that differ between local governments might influence the adoption of native verge gardens. While we have already collected survey data for this project, there is potential to collect further quantitative and/or qualitative data if necessary. Co-supervisors: Claire Doll and Curtis Rollins.

A/Prof. Nik Callow

Email: Nik.callow@uwa.edu.au

Catchments and Water	Environmental Management	Sensing and Spatial Data Science

Do farm dams with trees save or use more water? 

This field-based project will work with partners as part of the WaterSmart Dams project and an established field site. This site is a large farm dam near Kojonup, with vegetation growing in the dam. The vegetation uses and transpires water that is lost form the dam, but the vegetation also reduces evaporation losses as winds speeds are lower. This project will use drones and field instrumentation to collect data and answer the question: "Do farm dams with trees save or use more water?" Co-supervisors: Caitlin Moore, Bonny Stutsel and Sally Thompson.

Making dams work again!

This field-based project will work with partners as part of the WaterSmart Dams project and established field sites through the WA Wheatbelt to investigate different technologies to make farm dams collect and store more water under a changing climate. Farming operations rely on farm dams for water, but many no longer securely store water since the rainfall intensity as shifted as a result of climate change and farming systems now more efficiently use water and result in less runoff. There will be opportunities to work with regional partners including growers and grower groups, Grower Group Alliance, DPIRD and others as part of this project, including regional fieldwork. Co-supervisor: Bonny Stutsel

Does stopping valley-floor waterlogging reduce salinity?

Interventions around 15-20 years ago were constructed combat waterlogging and improve the flow of water in valleys that were prone to salinity in the Western Australian Wheatbelt. The original project validation data suggested that these reduced surface water ponding, and improved water quality by reducing salinity. This project will use cloud satellite computing platforms (Google Earth Engine) and/or drones to assess the changes in the patterns of salinity and vegetation health adjacent to the intervention structures. Lakes Toolibin and Bryde will be a focus. While predominantly desktop, there is an opportunity for fieldwork to be incorporated. Co-supervisor: Matt Hipsey.

What controls the distribution of snow depth in the Australian Alps?

Runoff from the Australia Alps sustains the Snowy Mountains Hydroelectric Scheme, inflows to the Murray-Darling system and environmental flows to alpine and downstream ecosystems. Records of snow depth are only collected in a very limited number of locations, and do not necessarily accurately record the actual distribution of snow and stored water through the Australia Alps. This project will combine satellite and drone data of snow depth to look at factors such as vegetation and terrain sheltering, and assimilate ground observation and satellite data on snow presence/absence to improve estimates of stored snow and water in the seasonal alpine snowpack. Co-supervisor: Dr Shane Bilish (Snowy Hydro Limited), Prof Lopez-Moreno (Spain)

Dr Paul Close

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Catchments and Water	Environmental Management

Student opportunities for research projects in the Dieback Unearthed State NRM Project

Dieback, caused by the invasive pathogen *Phytophthora cinnamomi*, impacts 40% of southwest WA flora species and is a Key Threatening Process impacting WA's biodiversity and threatened species. The disease is primarily spread by human activity, but little is known about public understanding of Dieback, effective communication, and affecting positive behaviour change to protect threatened socioecological assets. The biodiverse Fitzgerald River National Park and associated UNESCO listed Fitzgerald Biosphere is one of the last remaining areas to be relatively free of Dieback. However, with increasing tourism and commercial operations in the area, this status is at risk. The Dieback Working Group (DWG) is sponsoring multiple project opportunities, based at the UWA Albany Campus. These projects focus on improving management and communications relating to Dieback in the Fitzgerald Biosphere. Areas of focus include: gathering baseline data on current understandings of Dieback and biosecurity hygiene; understanding behaviour in response to current communication tactics; and quantifying the effects of novel interventions to trigger positive behaviour change in key audiences. Through this project you will gain access to skills and expertise from leading Dieback professionals, sponsorship to attend and present

results at the annual Dieback Information Group Conference, connections with local partners including the Binalup Aboriginal Corporation, DBCA, and DPIRD, and research-related financial support. Students with an interest in integrating social science principles with positive environmental outcomes are encouraged to apply. Co-supervisors: Barbara Cook, Giles Hardy (Murdoch University).

Backyard ponds: who lives there?

Providing garden water sources (e.g., ponds, bird baths) has become a popular and strongly promoted form of wildlife-friendly gardening, yet evidence of their use by wildlife is scarce and limited to a few taxa and water source types. Water within the residential landscape may particularly benefit conservation, as urban wetlands, lakes and rivers are often only seasonally available to wildlife, have been strongly altered from their natural state, and the landscape-scale connectivity among them has been reduced by urban land use change. In contrast, water sources in gardens are often permanently watered, can be numerous and implemented by a substantial proportion of residents. This project aims to assess the potential value of residential garden water for aquatic biodiversity using field surveys of aquatic biota, and characteristics of garden water sources. Co-supervisors: Bronte Van Helden, Barbara Cook.

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Biodiverse Dams: can fire dams supplement natural freshwater refugia in a drying climate?

Western Australia is experiencing a period of significant climate warming and drying which is impacting on the ecological value of remaining freshwater refuge habitats. Preliminary surveys from southwestern Australia demonstrate that some fire dams, depending on their location and habitat characteristics support native fish and crayfish. It is possible that these novel water resources also support a variety of other wildlife such as birds, frogs and mammals. This project will undertake field surveys of existing fire dams in the southern forests region of western Australia, to determine characteristics of fire dams that influence their potential value in supporting native wildlife. Research projects can focus on one or more wildlife groups including fish, invertebrates, birds and mammals. Co-supervisor: Steve Beatty (Murdoch University).

Influence of climate change on fish life cycles

A study of a freshwater fish that occurs near Albany showed that these animals are capable of shifting the timing of reproduction to match suitable environmental conditions. Over the past 20 years, a period of significant drying, these fish delayed spawning and migration to match stream discharge. There are numerous opportunities for projects aimed at further exploring whether flexibility in life history characteristics in aquatic fauna offers some resilience to changes in climate. Co-supervisor: Barbara Cook.

Environmental influence of mussel growth

Long-lived species experience variations in environmental conditions over temporal scales ranging from decades to days. In some animals, bone-like structures formed over the animal's entire life contain structure that provide information on age and growth rates. Where historical environmental data exists, these structures can provide detailed information on an animal's response to a chronology of environmental change. This project will use growth structure in the shells of freshwater mussels (*Westralunio carteri*) to investigate environmental influence on growth over the life of animals that span a period of major change in climate. Co-supervisor: Barbara Cook.

Has salinization decreased mussel population connectivity?

Freshwater mussels are an important functional component of freshwater ecosystems. The only representative of this group in southwestern Australia (*Westralunio carteri*) is threatened by secondary salinization. Freshwater tributaries in salt affected catchments provide refugia for mussels, yet the distribution of these refugia disconnects mussel populations. This project will assess the degree of genetic structuring occurring among mussel populations in remnant tributaries. Co-supervisor: Barbara Cook.

Mussel habitat preference

An understanding of the habitat requirements for imperiled species can inform conservation and restoration activities. Current knowledge of southwestern Australia's only freshwater mussel (*Westralunio carteri*) is limited, and derived from field survey of habitats where mussels are most abundant. Whether mussels actively select these habitats, or passively accumulate there during periods of high river flow is unclear. This project will investigate the movement capabilities of a freshwater mussel, assess their capacity to actively 'select' spatially distributed microhabitats and identify those habitats likely to support the species. Co-supervisor: Barbara Cook.

What eats mussels?

Freshwater mussels can be highly abundant and exceed the combined biomass of all other benthic aquatic fauna by orders of magnitude. It is possible, where abundances are high, that they contribute substantially to the diet of terrestrial-based predators such as water rats. In turn, they may contribute to broader ecosystem processes by contributing aquatic sourced energy to riparian/terrestrial food webs. This project will use camera traps to identify predators and stable isotope analysis to investigate their contribution to energy flux and /food webs. Co-supervisor: Peter Speldewinde.

Can wildlife friendly gardening provide conservation outcomes in modified urban habitats

There is a growing body of evidence that shows wildlife can persist in modified urban habitats and that a variety of local and landscape features influence their presence. Some of these features, such as the presence of water, suitable habitat and the absence of introduced predators, could be manipulated in residential gardens to promote wildlife presence and therefore contribute conservation outcomes. This project will investigate whether wildlife friendly gardening can influence the presence of wildlife in gardens using field-based wildlife surveys in residential gardens. Co-supervisors: Bronte Van Helden, Barbara Cook.

Wildlife conservation outside reserves but inside the city limits

There is growing evidence that urban landscapes could offer substantial opportunities for wildlife conservation. The distribution of many species, both common and threatened, overlap urban areas; wildlife can occur not only in the network of reserves, but also in a diverse array of other, highly modified habitats. This project will investigate the potential conservation value of highly modified habitats such as street verges, cemeteries, parks and gardens using wildlife surveys to determine the presence and/or abundance of a variety of taxa. Co-supervisors: Barbara Cook, Peter Speldewinde, Bronte Van Helden.

City slickers or stressed relics: is urban wildlife healthy?

The transition of natural landscapes to highly modified 'urbanscapes' is accelerating globally. While many native species appear to be able to persist within urbanized landscapes, little is known about more subtle impacts of landscape change on animal stress and health. This project will investigate whether animals in urbanized habitats display compromised health using a variety of possible indicators including parasite loads and stress hormone levels. Co-supervisors: Barbara Cook, Bronte Van Helden.

Dr Barbara Cook

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Catchments and Water	Environmental Management	Environmental Rehabilitation
Marine and Coastal Management		

Optimizing the use of AI models for processing images from wildlife camera traps

To be able to cost-effectively monitor biodiversity at the scale needed in Australia, automation of processes will become essential. Despite the existence of some 'stand out' examples of using automated processes such as the monitoring of fauna in fire damaged landscapes in eastern Australia using remote cameras, adoption across other parts of Australia of automated workflows for camera trapping has been poor. Many regions lack adequate training image data sets to ensure that AI models are accurate, and potential users vary in terms of their access to technology. Following targeted collection of training image data sets, this project will test the performance of selected AI models for detection of terrestrial fauna in southwestern Australia. Co-supervisor: Peter Speldewinde.

Student opportunities for research projects in the Dieback Unearthed State NRM Project

Dieback, caused by the invasive pathogen *Phytophthora cinnamomi*, impacts 40% of southwest WA flora species and is a Key Threatening Process impacting WA's biodiversity and threatened species. The disease is primarily spread by human activity, but little is known about public understanding of Dieback, effective communication, and affecting positive behaviour change to protect threatened socioecological assets. The biodiverse Fitzgerald River National Park and associated UNESCO listed Fitzgerald Biosphere is one of the last remaining areas to be relatively free of Dieback. However, with increasing tourism and commercial operations in the area, this status is at risk. The Dieback Working Group (DWG) is sponsoring multiple project opportunities, based at the UWA Albany Campus. These projects focus on improving management and communications relating to Dieback in the Fitzgerald Biosphere. Areas of focus include: gathering baseline data on current understandings of Dieback and biosecurity hygiene; understanding behaviour in response to current communication tactics; and quantifying the effects of novel interventions to trigger positive behaviour change in key audiences. Through this project you will gain access to skills and expertise from leading Dieback professionals, sponsorship to attend and present results at the annual Dieback Information Group Conference, connections with local partners including the Binalup Aboriginal Corporation, DBCA, and DPIRD, and research-related financial support. Students with an interest in integrating social science principles with positive environmental outcomes are encouraged to apply. Co-supervisors: Paul Close, Giles Hardy (Murdoch University).

Stock watering (troughs/ dams) refuges

Many waterways and wetlands in the Wheatbelt of Western Australia have become salinized due to past land clearing, leading to the loss of many freshwater species. Freshwater troughs and dams used for livestock are 'islands' of suitable habitat surrounded by inhospitable environments and are likely to be the only refuges remaining for obligate freshwater species. This project will investigate the distribution of aquatic invertebrates in stock watering troughs and dams in the light of habitat size and degree of isolation. Co-supervisor: Paul Close.

Sensitivity of aquatic macroinvertebrates to acidity

Extensive networks of deep drains have been built in Western Australia to reduce the effects of dryland salinity on agricultural lands. Most of these drains discharge highly saline and acidic waters into natural river and wetland systems, with little consideration given to environmental impacts. Using existing data, this project will

investigate pH tolerances of aquatic biota to identify threshold levels associated with significant changes in biodiversity composition in Wheatbelt streams. Co-supervisor: Paul Close.

Assessing the effectiveness of revegetation projects

There has been significant investment in the revegetation of cleared land aimed at increasing the extent of native vegetation in Australia. Although the degree to which this service has been delivered is well reported, a lack of follow-up to determine the effectiveness of these plantings makes it difficult to (i) quantify success, (ii) identify failure and ways to improve the implementation of plantings to rectify this, and (iii) apply what has been learnt from individual sites to other areas. In this research, you will evaluate the response of selected taxa such as mammals, birds or invertebrates to restored vegetation patches of differing ages, type and size in southwestern Australia. Co-supervisor: Paul Close.

Measuring participation in outdoor recreation

According to the Australian Bureau of Statistics, bushwalking and cycling are the most popular forms of exercise and recreation. However, unlike traditional, club-based competitive sports, outdoor recreation is generally undertaken outside of organized groups, making it difficult to develop a fine-grained understanding of participation rates and trends. This project will develop a detailed picture of participation in outdoor recreation in Albany by surveying people recreating on hiking and cycling trails. It will determine what kinds of activities people are involved in, whether they are involved in clubs, how they improve their skills, what trails they use, and what types of infrastructure or support they need. Co-supervisor: Natasha Pauli.

Impact of phosphite spraying on invertebrate communities

Phosphite is a biodegradable fungicide that has been used to slow down the spread of Phytophthora dieback in southwestern Australia. To date, the focus of aerial spraying of phosphite has been on protecting critically endangered and endangered plants such as *Dryandra montana*, *Leucopogon gnaphilioides* and *Andersonia axilliflora* in the Stirling Ranges and *Lambertia echinata* ssp. *echinata* in ironstone shrubland near Busselton. Of concern is the impact that this control measure might be having on native flora and fauna. This project will assess the impact of this phosphite spraying on benthic invertebrate communities. Co-supervisor: Peter Speldewinde.

Understanding market demand for mountain biking

Interest in mountain biking is a growing rapidly around the world. Despite this interest, we know little about who mountain bikers are and what types of trail experiences they are interested in. This project will develop a detailed profile of mountain biking in Western Australia. Who participates in MTB? Where do they ride? What style of riding do they prefer? What grades of trail do they ride (green, blue, black)? How often do they ride? What are the demographics of these riders? This project will use surveys to collect information from MTB riders in several locations in Perth and the Southwest, including Albany and sites such as Margaret River and Kalamunda. Co-supervisor: Natasha Pauli.

Developing protocols for assisted migration of threatened flora

In recent years, numerous threatened flora translocations have been undertaken in the South Coast region whereby flora species have been introduced to novel habitat due to difficulty finding suitable natural habitat free from threats within the species' known range. In addition, future translocations are likely to focus more on 'assisted migration' to potentially higher rainfall habitat in the face of a drying climate, this is also likely to be outside the known historical range and habitat for the species. This project will develop protocols for future assisted migrations taking into consideration species biotic and abiotic requirements, using a selection of South Coast Threatened Flora as case studies. Co-supervisor: Sarah Barrett (DBCA).

The effect of Phytophthora dieback on species richness and vegetation structure 

The Stirling Range has unique plant communities with high levels of plant endemism. Many of these communities are poorly documented and are highly threatened by the introduced root pathogen *Phytophthora cinnamomi*. This project will investigate the changes brought about by Phytophthora dieback and document the plant biodiversity before it is irrevocably altered. The project will document floristics, species richness and plant structure in a healthy plant community compared with the same habitat infested by dieback, with a focus on the Proteaceae-dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of Western Australia. Co-supervisors: Sarah Barrett (DBCA), Steve Hopper.

The role of inter-fire recruitment in maintaining populations of long-unburnt obligate seeding species 

Fire is an integral part of the Australian landscape and plays a significant role in plant community dynamics and regeneration. Obligate seeding (serotinous), woody species typically release seed with the passing of a fire which subsequently germinates. However, many serotinous species are capable of low levels of recruitment between fire. It is unclear for many Kwongan plant communities whether inter-fire recruitment is sufficient to prevent local extinction of serotinous obligate seeders due to senescence. This project will investigate the role of inter-fire recruitment on plant community dynamics in long-unburnt vegetation on the South Coast. Co-supervisors: Sarah Barrett (DBCA), Steve Hopper.

Pollination biology of the critically endangered *Banksia montana* 

The critically endangered Stirling Range endemic *Banksia montana* is known from eight mature individuals in the wild but has been successfully translocated to a seed orchard south of the Stirling Range. However, little is known of the pollination biology of this species. This project will identify pollinators and will investigate their behaviour and visitation rates in ex-situ populations. The study will determine whether pollination or other factors are limiting reproductive success and whether the species is self-compatible. Co-supervisors: Sarah Barrett (DBCA), Peter Speldewinde.

A/Prof. James Fogarty

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Environmental Economics	Marine and Coastal Management

Mining exploration incentives: a systematic review 

Mining exploration is associated with externality issues that result in those undertaking exploration investment not receiving all the benefit of their investment. This situation has led to government providing subsidies for mineral exploration. This project will: (i) review the case for the theoretical evidence for providing exploration subsidies and (ii) conduct a systematic review and meta-analysis of the existing literature on the return to government of mining exploration subsidies. Co-supervisor: Chunbo Ma.

Waste management in Western Australia 

Local governments across Western Australia have implemented a range of different waste management technologies and waste collection systems. This research will: (i) describe the different waste management systems used in Western Australia; (ii) use ANOVA models to examine the waste diversion performance of different technology and collection systems; and (iii) use regression analysis to estimate the price elasticity of demand for waste services. Co-supervisor: TBC.

Fisheries management issues

The Western Australian government is responsible the overall management of coastal fisheries, which are common property resources. The management input of the government involves the issue of cost recovery from the beneficiaries of that management, which are generally taken to include both fishing operators and the broader community. Current policy for determining the contribution of industry in each managed fishery requires information on the Gross Value of Product (GVP) from the fishery. This research project will: (i) review fisheries management policy and approaches across Australia; (ii) identify any practical issues with current approaches to collecting charges from industry; (iii) evaluate the impact of alternate cost recovery options. Co-supervisor: Chunbo Ma.

Dr Deirdre Gleeson

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Catchments and Water	Environmental Rehabilitation

Biodiversity of living, non-marine, thrombolites of Western Australia

Microbialites are biosedimentary structures formed by the interaction of microorganisms with their environment. Living microbialites, including stromatolites and thrombolites, are found in just a few select locations worldwide. This project will investigate the microbial populations present in the thrombolites at Lake Clifton in the Peel-Yalgorup region to determine if they are still living, and investigate how they might be affected by climate change. The project will involve sampling of thrombolites and lake water at Lake Clifton and the use of DNA and RNA based tools to assess the microbes and functions that maintain the thrombolites. Co-supervisors: Gavan McGrath (DBCA); Rick James (Peel Harvey Catchment Council).

The contribution of elemental sulfur in decreasing pH in sodic soils – relationship with microbial communities

Dispersive or sodic soils are common in the south-west agricultural area of Western Australia where they occur mainly as duplex or gradational profiles. A dispersive soil is a structurally unstable soil. When the soil gets wet the individual sand, silt and clay particles collapse and separate into the water instead of remaining bound together in aggregates. The floating clay particles then clog the soils pores causing slow water infiltration. When the soil dries the separated clay particles act like cement and cause the soil to become hard, crusty and poorly structured. These soils contain so much sodium that it interferes with the soils 'normal' behaviour causing this dispersion. In the Australian context, sodic soils are defined as having an exchangeable sodium percentage (ESP) greater than 6 %. Sodic soils usually have an elevated pH (pH > 8.5) which may be treated with a direct (gypsum) or indirect (elemental sulphur) calcium source to remove excess exchangeable Na+ from the soil. In prior pot trials using WA sodic soils elemental sulphur has been shown to be effective in lowering soil pH and had a positive effect on both the chemical and physical properties of the soil (Mulvany and Barrett-Lennard). This project aims to investigate the effect of differing rates of elemental sulfur and different forms of organic matter amendment on the biological properties of soil, specifically microbial populations. This project will focus on microbial community relationships and will assess microbial community response to sulfur amendment in sodic soils via quantitative PCR. The project will suit a student with an interest in laboratory experimental research, soil biology and microbiology. Co-supervisors: Ed Barrett-Lennard (DPIRD; Ed.barrett-lennard@dpird.wa.gov.au); David Hall (DPIRD).

A/Prof. Atakelty Hailu

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Environmental Economics	Catchments and Water	Marine and Coastal Management

Designing better auctions for water buybacks 

Water markets and auctions are being used to reallocate water and restore environmental flows. Although the sums involved can be huge, the thinking behind the markets or auctions used can be too simple. In this project, you will use computational models (agent-based models) to analyze how alternative and more flexible auction types (e.g. similar to those used in financial markets) can be developed to allocate water more efficiently and to improve budgetary performance. Co-supervisor: Steven Schilizzi.

Analyzing the value and management of recreational fishing 

The management of recreational fishing is a source of controversy in many jurisdictions. Those who are interested in conservation argue that governments are not doing enough to protect fish and fishing sites. Angling communities, on the other hand, argue that recreational fishers are more responsible than conservationists suggest, and that their activities generate significant economic and social benefits. Governments try to balance the interests of these two groups but need good research-based evidence. In this project, you would use either secondary or primary data to develop models of recreational site choice and use those models, possibly together with ecological or fish stock models, to analyze different management strategies in terms of their economic, social and ecological benefits. Co-supervisors: Abbie Rogers, Michael Burton.

Dr Sharyn Hickey

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Marine and Coastal Management	Sensing and Spatial Data Science

Wrack on my beach 

Macroalgae and seagrass are important habitat on the WA coast. However, seasonally and with weather events can accumulate on beaches as wrack. This wrack plays an important role in the environment including nutrient cycling, providing food and habitat amongst others. This project will utilize drones and high-resolution aerial and satellite imagery to track the spatial and temporal variance in wrack location and size on WA beaches. It will look at location of the wrack on the beach and in relation to its role in greenhouse gas emissions. This project could involve field, computer and lab work, and could be adapted to be undertaken remotely. Co-supervisor: Stanley Mastrantonis.

ICOLLs and anthropogenic influence 

Intermittently closed and open lakes and lagoons are a dominant landform on the southeast Australian coastline. This study will explore changes in natural and anthropogenic openings as a result of climatic changes, and urbanization. It will explore this in relation to the ICOLL flora and fauna biodiversity. Co-supervisor: TBC.

Remotely monitoring mangroves 

Mangroves provide an opportunity for climate change mitigation and adaptation through their ability to store and sequester large quantities of carbon, and protect the coast from wave and storm surge, while sustaining

fisheries through the provision of habitat. This project will utilise spatial modelling, cloud processing, and remote sensing techniques to develop a West Australian assessment of mangrove condition. There is potential for fieldwork opportunities. Co-supervisor: TBC.

Healthy Wetlands
The relationship between green space (e.g., parks), as well as coastal areas is widely documented, however there is limited understanding on mental and physical health associated with wetlands, and in particular restored wetlands. This project would look at spatial and temporal changes in wetlands, as well as surveying people about their use of wetlands. Co-supervisor: Sarah Foster (RMIT).

Downscaling of remotely sensed Sea Surface Temperature (SST) with deep learning
Increasing sea surface temperatures and the severity of marine heatwaves threaten marine ecosystems globally. Current thermal sensors can provide data at frequent intervals but at coarse spatial scales or infrequently at fine spatial scales. Thus, a fusion between these data products will be useful to monitor changing SST at appropriate spatiotemporal scales. This project will use existing SST data from MODIS AQUA, Landsat 5-8 and in-situ logger data to downscale SST in space and time using deep convolutional neural networks. Co-supervisor: Dr Stanley Mastrantonis.

A/Prof. Matthew Hipsey

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Catchments and Water	Sensing and Spatial Data Science

Climate change impacts on wetland ecosystems
The drying trend in south-western Western Australia has caused a loss of suitability of critical wetlands that support the requirements of the critically endangered Western Swamp Tortoise. In this project you will explore the future suitability of wetlands in different regions of the south-west using a lake modelling tool and climate change forecasts, in order to find suitable sites for translocation of captive animals. Co-supervisor: TBC.

Ecosystem metabolism of urban wetlands
The metabolism of aquatic ecosystems (defined as the balance between photosynthesis and respiration) varies at the system scale in response to changes in hydrology, nutrients and other factors. This project will look at how changes in metabolism influences water quality and the implications for warming lakes in a changing climate. The project will involve using in situ sensors and modelling of a wetland on the Swan Coastal Plain (Lake Monger or Lake Yellagonga). Co-supervisor: TBC.

Swan-Canning real-time water quality reporting system
In this project the candidate will work on the development of an automated workflow for synthesis of real-time water quality data being collected in the Swan Canning estuary system, and work on developing real-time predictions of hydrology and water quality. Novel outputs for reporting estuary condition will be developed, related to estuary metabolism, nutrient cycling and harmful algal bloom risk. Co-supervisor: TBC.

Prof. Steve Hopper

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Environmental Management

Ethnobiology studies with Noongar people
A series of projects is on offer, tailored to your skills and interests exploring Traditional Ecological Knowledge (TEK) with Elders on the South Coast and or at Dryandra near Narrogin. The aim is to capture TEK through oral history interviews on country, and test hypotheses derived from such investigations before elders pass on. Culturally important plants, animals and ways of caring for country are the focus. Co-supervisor: Alison Lullfitz, Noongar Elder Lynette Knapp.

Bloodroot phylogeny and the peat swamp endemic Haemodorum sandifordeae ms
This project involves understanding where in the phylogeny of SW *Haemodorum* species does the peat swamp endemic *H. sandifordeae* lie. It is hypothesized that the new species may be a relictual south coast endemic, as it is the only species in the genus known to inhabit the margins of peat swamps. Co-supervisor: Margaret Byrne and Rachel Binks (DBCA).

Investigating the origins of undescribed hilltop endemics in Eucalyptus series Tetrapterae in the Fitzgerald River National Park and elsewhere through DNA studies
It is suspected that several hilltop endemics in *Eucalyptus* series Tetrapterae may warrant formal description as new taxa. This project involves collecting material in the field, undertaking morphological/morphometric population-level studies and comparing results with DNA sequencing. Co-supervisors: Margaret Byrne and Rachel Binks (DBCA).

Correlates of rarity and endangerment among species of Conostylis (Haemodoraceae)
Preliminary data suggest that threatened species of *Conostylis* have variable chromosome numbers, low ovule numbers, poor seed set and possibly novel pollination systems. This project will examine such parameters among endangered *Conostylis* species and common congeners. Co-supervisors: Margaret Byrne and Rachel Binks (DBCA).

Floristic surveys of Walpole Wilderness peat swamps and assessing their endangerment
There is an urgent need to document the range of flora found in peat swamps across the Walpole Wilderness region to tie in with large scale geomorphological, hydrological and fauna surveys under Noongar Elder guidance. Collectively, this research will better inform conservation strategies and help identify the rarest and most threatened floristic peat communities. DNA studies of key threatened species may be undertaken to document population level patterns of divergence and hybridization. Co-supervisors: Margaret Byrne and Rachel Binks (DBCA).

Dr Sasha Jenkins

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Catchments and Water	Environmental Management

Assessing the impact of soil amendments on methane uptake in dryland soils

Climate change is a serious threat to agricultural productivity and global food security. However, livestock industries such as dairies are a major contributor of methane (CH_4) emissions. Soils can be either sources and sinks of CH_4 depending on the balance between methane-producing (methanogenenic) and methane-consuming (methanotrophic) activities. Recent studies have suggested that the dryland soils of Western Australia are sinks for CH_4 but the mechanisms and controls involved are not fully understood. Several factors, including soil pH, redox potential, temperature, soil organic matter and moisture content influence soil CH_4 fluxes. This project provides an excellent opportunity for candidates interested in exploring the impact of different soil amendments (lime, clay, compost) on greenhouse gas emissions (methane, nitrous oxide and carbon dioxide), soil chemistry and nutrient dynamics in soil under laboratory conditions. There is the option to study the microbes involved in GHG production using quantitative PCR or sequencing. All students will gain experience in data and statistical analysis using R Studio. Importantly, this project fosters an environment for learning and collaboration within a diverse and passionate research group. Co-supervisors: Sun Kumar Gurung, Pankaj Singh.

Mitigating abiotic stress tolerance in wheat through application of novel organo-mineral fertilizers

Australia is a major wheat-producing country but production has been limited by water shortage. In the rain-fed drylands, drought is a significant stressor with a major impact on plant growth and development leading to significant grain yield losses. Increasing wheat productivity in arid and semi-arid areas is critical to providing food security for future generations. Organo-mineral fertilizers are gaining increasing attention as a sustainable, alternative to synthetic fertilizers that mitigate the impact of drought. These novel fertilizers have the potential to maintain plant productivity and soil functioning under water stress by adjusting the soil moisture content, plant water status and soil health. This project aims to investigate the use of organo-mineral fertilizer to alleviate the impact of water stress on wheat plants. There are several opportunities in this study. Students can study (i) plant resistance and resilience to abiotic stresses by analyzing plant productivity, plant nutrition, plant non-structural carbohydrates and plant functional traits, (ii) utilize molecular methods to analyze gene expression or (iii) investigate the development of novel organo-mineral fertilizer products as alternative fertilisers or soil conditioners. For the latter projects, candidates will focus on assessing the impact of organo-mineral fertilizers on one of the following: soil fertility and soil structure, soil microbial community diversity and nutrient cycling, broader aspects of plant-soil-microbe interactions and ecosystem functions or soil resilience and resistance to abiotic stress. For Master of Bioinformatic or Biotechnology students there are further opportunities to develop specific bioinformatic workflows for amplicon sequencing and shotgun metagenomic sequences and to overcome the limitation of large eukaryotic genomes such as fungi. All candidates will be taught data analysis and statistical analysis using R. Most importantly, these projects are part of larger industry-based research project across Australia. Students will be part of a friendly multi-disciplinary research group and given the opportunity to build a larger network within academia, government and industry. Co-supervisors: Sun Kumar Gurung, Pankaj Singh.

Recycling waste as organic fertilisers: Are they safe?

Many organic fertilizers are derived from waste products that may contain contaminants or undesirable elements resulting in adverse environmental impacts. Manure is often directly spread onto agricultural land

without treatment and there are growing concerns over this practice with respect to pathogens and nutrient contamination of surface and groundwater, Greenhouse Gas (GHG) emissions, salinity and phyto-toxicity. This project will quantify the environmental risks associated with the re-use of different waste byproducts, with specific focus on (i) pathogen survival (ii) salinity & toxicity (iii) N and P leaching to surface and groundwater's and (iv) GHG emissions. Co-supervisor: TBC.

Recycling waste as organic fertilisers: Do they enhance soil quality?

It has been claimed that organic farming enhances soil health & quality in terms of biodiversity, nutrient cycling, organic matter content, soil structure & stability, water holding capacity and disease suppression. However, the true extent to which organic management 'enhances' nutrient cycling and other soil functions remains largely unexplored. This project will quantify whether soil quality is 'enhanced' in soils subject to organic waste inputs. It will initially investigate how organic management impacts on soil biology by developing biological indicators. These bio-indicators in combination with other conventional indicators will then be used to assess whether soil quality is being gained, maintained or has been lost in soils receiving organic waste. Co-supervisor: TBC.

Converting piggery waste into biogas

Currently most pig farmers put their pig waste into large ponds where the waste is gradually broken down by microbes within the pond. However, these microbes release both odours and methane that upset local residents and contribute to global warming. One solution is to cover these ponds with an impermeable cover resulting in reduced gas emissions since the methane is retained under the cover. Although, the prospect of covered ponds is attractive, initial start-up costs are high. This could be overcome by capturing the methane under the cover and using it to off-set start-up costs by providing on-farm heating or electricity. However, methane recovery from covered ponds is not very efficient, and covers on the ponds could alter the waste degradation process and reduce biogas yield. Our research aims to increase biogas production from covered ponds by optimizing the waste degradation process through different management practices and provide advice on interventions required to prevent pond failure. Co-supervisor: TBC.

Bioenergy: Converting household waste into biogas

In Western Australia the preferred disposal method for municipal solid waste (MSW) is landfill. However, this is not necessarily the most effective means of disposing of such waste and there is growing interest in finding alternative uses that solve both waste excesses and energy shortages. One option is to convert MSW into biogas (methane) and compost via a process called anaerobic digestion. The biogas can then be used to provide renewable energy by the generation of electricity. However, anaerobic digestion is a complex process performed by microbes and consequently the ecology, prevailing environmental conditions and mechanisms involved remain poorly understood. This project will develop more efficient anaerobic digestion by investigating the relationship between microbial degradation, environmental parameters and biogas production during the anaerobic digestion of MSW. Co-supervisor: TBC.

Dr Marit Kragt

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Environmental Economics	Environmental Management	Environmental Rehabilitation

Accessibility in teaching and learning of agriculture and environment 

Universal Design for Learning (UDL) is a framework to improve teaching and learning practices and enhance accessibility for all people. In this project, you will conduct a global review of teaching and learning practices in agriculture or environment. Following systematic review guidelines, you will identify strengths and weaknesses in current practice. This project will give you a sound understanding of UDL principles and Web Content Accessibility Guidelines. Co-supervisor: Natasha Pauli.

Community preferences for biodiversity offsets in mine site rehabilitation 

Biodiversity offsets are often used to offset ecosystem impacts of mining practices. In this project, a talented study will investigate community preferences for biodiversity offsets for mine site rehabilitation. You will identify what types of offsets are currently used in mining approvals and mine closure plans, and analyse a choice experiment data-set to evaluate what type of offsets are preferred by community members. Strong econometric skills are required and you will contribute to a scientific publication. Co-supervisor: Prof. Ben White.

Consumer preferences for sustainable agriculture 

The WA government is providing strong support for so-called 'regenerative' farming practices as a way to restore soil health, mitigate climate change, and reduce the environmental impacts of agricultural production. To finance changes in farming practices, advocates often argue that consumers will need to pay higher prices for their foods. In this project, you will conduct a market survey of 'regenerative' products in Western Australia. This would involve an analysis of the prices for 'regenerative' products in the market and a non-market valuation survey of consumer preferences. Co-supervisor: Chi Nguyen.

A Natural Capital Accounting framework for regenerative farming 

So-called 'regenerative' farming is being advocated around the world as a way to restore soil health, mitigate climate change, and increase farming profits. However, there is very little research on the profitability and natural capital impacts of regenerative farming. This study will use in-depth interviews and collect data from farmers in WA to evaluate whether regenerative practices have resulted in increased profits and natural capital on regenerative farming properties. As a desktop study, this research could conduct a meta-analysis of the global literature to critically evaluate changes in natural capital; or an in-depth financial review of 'regenerative' against 'conventional' farming benchmarks. Co-supervisor: Fiona Dempster, Megan Ryan.

A/Prof. Mathias Leopold

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Catchments and Water	Environmental Management	Marine and Coastal Management
Sensing and Spatial Data Science		

Using geophysics and remote sensing to map relict and current boodie warrens at Matuwa National Park
Boodies (*Bettongia lesueur*) are medium-sized (~1 kg), Australian marsupials that forage for underground food resources, creating numerous, shallow digs in the process. In 2010 Boodies were reintroduced to the Matuwa National Park (160km NE of Wiluna) now jointly managed by DBCA and the Tarlka Matuwa Piarku Aboriginal Corporation. Hundreds of potential relict warrens have been noted on satellite imagery in calcrete areas and reintroduced Boodies have dug new warrens in the red sand plains inside a predator-free, fenced reserve. The magnitude and complexity of below-ground warren structures is not yet known. This research project will assess the potential for geophysics techniques to characterize the extent and connectivity of warrens and to assess potential differences between the current sandy and relict calcrete warren structures. The project is jointly supported by DBCA and UWA. Funding for travel and accommodation is available. Co-supervisor: Gavan McGrath.

The geoarchaeology of Middle Gidley Island, Murujuga
This project aims to provide the first assessment of archaeological lithic scatter and post-depositional soil processes at Middle Gidley Island, Murujuga (Dampier Archipelago) in northwest, Western Australia. Murujuga is renowned for archaeological and cultural significance, as one of the world's largest rock art provinces and is National Heritage Listed. A range of earth surface and soil zone processes will be assessed to understand the formation of this significant site. Co-supervisors: Jo McDonald (School of Social Sciences), Mick O'Leary (School of Earth Sciences), Caroline Mather (School of Social Sciences).

How does soil depth regulate forest health and resilience?
Forestcheck is a long-term ecological monitoring program run by the Department of Biodiversity Conservation and Attractions that examines forest ecosystem responses to harvesting. With the end to native forestry in 2024 these sites are key to continued monitoring of forest health and to inform future forest management. Forestcheck consists of 65 plots, each 200 m x 200 m across which are spread across the entire Jarrah and Karri forests. Soil depth looks to be a key factor influencing how Jarrah forest responds to drought. This study will characterize the subsurface of a subset of Forestcheck sites using geophysics. We are seeking a student willing to undertake fieldwork with DBCA staff to use electrical resistivity to image the subsurface structure of a selection of sites. By using historical metrics in the FC database related to forest health such as growth, post fire responses, drought impact and recovery, this study will evaluate how soil depth regulates some of these ecological processes. Co-supervisor: Gavan McGrath (DBCA).

Swan River and Urban Interactions with a Fringing Wetland
The Department of Biodiversity Conservation and Attractions (DBCA) is undertaking a 2-year study of the hydrology and water quality of Ashfield Flats Reserve in Bassendean. The aims of the project are to assess the hydrological processes governing the wetland water balance as well as the geochemical factors contributing to heavy metal, nutrient and pH impacts from urban drains and groundwater. Student projects available include (i) the acquisition of near-surface geophysics and drilling, for the development of a conceptual hydrogeological model; (ii) experiments and monitoring to identify Swan River – Wetland interactions and Urban drain – wetland

interactions; and (iii) experiments and field sampling to assess the geochemistry of urban runoff/sediments to untangle why pH drops when flows increase. Co-supervisor: Gavan McGrath (DBCA).

Environmental geophysics to study soils in the context of agriculture and environmental science
Soil plays an important role in agriculture and/or environmental science. A number of novel and innovative techniques allow the 3D mapping of various soil properties via environmental geophysical methods. There are a number of projects available for students who are specifically interested in developing and applying these methods to map and assess soils and their properties and constraints. Co-supervisor: Andrew Rate.

Ecohydrology of trees
Many trees in the Perth metropolitan area were continuously stressed over the past decades and many of the older trees such as Banksia or Norfolk Pine trees died in the recent past. Water stress was identified as a key factor. Understanding and monitoring the pathways of water uptake from the soil zone into the tree is the key aim for this project. A combination of different methods such as dendrometers, sap flow meters, environmental geophysics and soil studies is required. Co-supervisor: Erik Veneklaas or Paul Drake.

Landscape evolution and early Aboriginal occupation of the archipelago west of Dampier, WA
Timing of early Aboriginal occupation along the west coast of Western Australia is still under discussion, with known camp sites dating back about 30,000-40,000 years ago. Holocene sea level rise has altered the coast lines at the area west of Dampier and consequently multiple Islands have formed., setting challenging conditions for the interpretation and reconstruction of these oldest camp sites. This project explores the landscape-ecological conditions during the time of early occupation on Enderby and Rosemary Island in collaboration with UWA Archaeologists. Multiple soil and sediment samples have been collected in the past and these await analysis and interpretation. Additionally, shallow geophysical data are available to process and incorporate into a landscape model. Co-supervisor: TBC.

Palaeosols as a valuable source for ancient microbial communities
Investigation of buried soils (Palaeosols) on the coast of WA (Hamelin Bay) and their comparison with the modern soil. Work includes fieldtrip with mapping and sampling of soils (2 days), characterisation of physical and chemical soil parameters (particle size distr., C/N, pH EC etc.,). Additionally, the microbial community composition (16S rRNA next generation sequencing) and biomass (quantitative PCR) of the different soil horizons will be analysed. Co-supervisor: TBC.

Dr Caitlin Moore

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Catchments and Water	Environmental Management	Marine and Coastal Management
Sensing and Spatial Data Science		

Connecting light interception with ecosystem productivity
The structure of ecosystems is a core determinant of light interception through the plant canopy, which drives productivity of that system. As part of Australia's Terrestrial Ecosystem Research Network (TERN), light monitoring equipment has been installed in three key WA ecosystems to understand light interception dynamics in more detail. This project will involve investigating these dynamics in detail and linking light interception with

other metrics of ecosystem productivity. It may also involve fieldwork in regional and remote parts of WA. Potential co-supervisor: Jason Beringer

Microclimate modification under solar panels and it potential for plant growth

As we progress towards a cleaner energy future, large scale renewable energy installations such as solar farms will increase across the landscape. Adding solar panels to the landscape has been shown to modify the microclimate beneath the panels, which can improve conditions for plant growth. This project will investigate how the microclimate is altered under a solar farm in WA, with the aim to understand whether the land beneath can be used for native or agricultural plant growth. Potential co-supervisor: Sally Thompson (engineering), Pieter Poot (Biological Science).

Carbon and water cycle dynamics across the diverse climate cropping region of southwest WA

Solving the challenge of feeding the world while dealing with environmental change requires in-depth knowledge of how crop productivity and water use responds to the climate. Climate change is already negatively impacting Australia's A$28 billion cropping sector (2019/20 financial year), with hotter and drier growing season conditions linked to stalled wheat production since 1990. The frequency and intensity of extreme heat and drought events are projected to rise in the future, with the hardest hit region of south-western Australia likely to experience yield decline up to 49 %. A way to measure crop productivity and its response to climate in real-time is via the eddy covariance technique, colloquially referred to as flux towers. This project will investigate how carbon and water cycling differ between two distinct growing regions in southwest WA. the project may involve fieldwork to regional areas of WA. Potential co-supervisors: Jason Beringer.

Dr Ram Pandit

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Catchments and Water	Environmental Economics	Environmental Management
Environmental Rehabilitation		

Effectiveness of wetland restoration

Wetland degradation is a serious environmental issue in Australia. A range of actions have been taken to restore degraded wetlands. It is not always clear that whether these actions are effective from economic, social, and ecological perspectives. This project aims to evaluate the effectiveness of such actions in restoring identified wetlands (case studies) based on an Effectiveness Analysis Framework. The project involves stakeholder consultation, developing and implementing questionnaire to understand public perception and preferences. Co-supervisor: Michael Burton.

Maximizing synergies between biodiversity conservation and climate change mitigation practices in urban areas

Biodiversity conservation and climate change mitigation are two important environmental challenges we are facing. Addressing these challenges simultaneously is important but at the same time actions and policies directed to address these challenges should be complementary to each other than antagonistic (strong trade-off). This project aims to explore climate change sensitive biodiversity conservation policies and practices in urban areas with case studies from Perth. This will involve developing a framework and assessing existing policies and practices using the framework to learn about what sort of practices to promote and what not. Co - supervisor: Ben White.

Biodiversity offsets in practice: challenges and mitigating strategies 

Biodiversity offsets have increasingly been used as a policy tool to balance economic development and biodiversity conservation. The effectiveness of this tool in achieving intended outcomes is contested for a variety of reasons, including how offsets have dealt with like-for-like, ecological equivalency, uncertainty and risks in offsets plans. Effectiveness of offset plans remains unclear. Understanding of the performance of the offset plan is important to design effective offsets in the future. This project looks at the offset process from planning to generating outcomes and highlights challenges and mitigating strategies at various stages of the offset process. Co-supervisor: Marit Kragt.

Development Infrastructure and biodiversity offsets: Lessons from Jandakot Airport development 

Infrastructure development such as airport affect natural environment, sometimes threatened species or matters of national significance. Jandakot airport redevelopment impacted the habitat of Carnaby's Black Cockatoo. To compensate for impacts, biodiversity offset was planned and implemented. However, it is unclear what level of costs was allocated to offset project and how much success the offset project had. In other words, how cost effective the offset project was remains unclear. This project aims to evaluate the offset outcomes from this offset project and explore cost effective options to enhance effectiveness of offsets applicable to infrastructure development projects. Co-supervisor: Ben White.

Housing development and biodiversity offsetting: Lessons from Perth 

Growth of Perth city impacts its surrounding natural environment in many ways. New housing development to accommodate increased city population directly impacts the habitat of threatened species. Examining a particular housing development project and associated offset plans, this project aims to examine the cost-effectiveness of offsets plans in generating environmental outcomes due to the impact of housing development. In particular, it aims to examine whether mitigation hierarchy had been applied and properly documented in relation to the project and the outcome of the offset implementation. Co-supervisor: White.

Does COVID-19 shifted our use and views of public open spaces/urban forests in metropolitan areas 

COVID-19 has forcefully changed our behaviour and possibly the way we value natural environment. Local parks, urban forests and public open spaces have been the places of attractions for individuals. Has COVID-19 shifted the use and views of these spaces? It is important to know public preferences on what else and how should we manage urban green spaces. Such information would help to design nature-based solutions to address health or environmental problems by city councils. This project will investigate urban greening strategies of selected city councils in Perth (Cockburn and Sterling) for such purposes. Co-supervisor: Michael Burton.

Prof. David Pannell

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Environmental Economics

Benefit-Cost Analysis of agricultural research projects 

Agencies that fund agricultural research need to be able to evaluate the performance of projects that have been completed, and to assess the potential performance of projects that might be funded in future. The main approach used for doing this is Benefit-Cost Analysis. There is a wealth of literature and many examples available, but there is always a demand for more analyses to be done. It's a skill in high demand. Co-supervisor: TBC.

Benefit-Cost Analysis of environmental projects

The success of different environmental projects is quite variable. Conducting Benefit-Cost Analysis of existing or potential projects can help environmental managers to make better decisions about how they should allocate their resources. In this project, we would work closely with an environmental agency to apply Benefit-Cost Analysis to a particular project or set of projects of interest to them. Co-supervisor: TBC.

Adoption pathways analysis

UWA PhD student Oscar Montes developed a new approach to tracking how a new innovation or technology in agriculture spreads through the farming community. (9. Montes de Oca Munguia, O., Pannell, D.J., Llewellyn, R. and Stahlmann-Brown, P. (2021). Adoption pathway analysis: Representing the dynamics and diversity of adoption for agricultural practices, Agricultural Systems 191, 103173.) He has applied the approach in New Zealand, but it has not yet been applied in Australia. In this project we would work with DPIRD to understand the adoption of a particular agricultural practice. Co-supervisor: TBC.

High fertilizer prices

In the first half of 2022, fertilizer prices are at record high levels, which is a concern for farmers. This project would pull together evidence about the reasons for these high prices and provide a clear explanation for the overall causes and would study the strategies available to grain farmers to adapt to high fertilizer prices. Co-supervisor: TBC.

Dr Natasha Pauli

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Catchments and Water	Environmental Management

Do the unique colours and textures of native plant foliage influence the urban heat island effect?

A team of researchers from UWA and the University of Arizona are researching how plant foliage colour impacts both the ambient environment, and human perceptions of whether plants provide a cooling impact. Join us to be part of this unique interdisciplinary research project with researchers from UWA and University of Arizona, and use high-precision environmental sensors to investigate variation in microclimate, soil moisture and foliage spectral reflectance (i.e. colour) during key periods of water and heat stress in demonstration plantings and comparison substrates. Co-supervisors: Caitlin Moore, Ignatieva (School of Design).

Do perceptions of how 'green' and 'cool' a plant is influence garden and streetscape design?

A team of researchers from UWA and the University of Arizona are researching how plant foliage colour impacts both the ambient environment, and human perceptions of whether plants provide a cooling impact. Join us to be part of this unique interdisciplinary research project with researchers from UWA and University of Arizona and use surveys and interviews to understand the key drivers of community perceptions of native Australian plants with a variety of xerophytic adaptations in colour, form and texture. The student can also be involved in constructing a typology of plant form, colour, texture and biomass that could be used in further research. Co-supervisor: Maria Ignatieva (School of Design).

Reconciliation and urban green space management

The Swan-Canning River (Derbal Yerrigan-Djarlgarro Beeliar) and the surrounding wetlands that persist in the Swan Coastal Plain are nowadays some of our most precious urban green spaces. Not surprisingly, they are also

places of immense significance to First Nations people. A change of attitudes from local governments since the 1960s has seen a growing appreciation for these environments for their recreational and wellbeing value, with many being cared for and restored by local volunteer groups. This project aims to explore the social-cultural-governance aspects framing stewardship of local waterways and remnant bushland by local community groups, and how those aspects can hinder or foster Reconciliation, ie, the meaningful, respectful and inclusive collaboration with Traditional Custodians to care for Country and urban places that are loved by all. This is a project that can be approached from many different angles, and will include collaborations with different people, from within and outside academia, as appropriate. Principal supervisor: Dr Cristina Ramalho (School of Biological Sciences) and co-supervisor Natasha Pauli.

Social-ecological systems research

Please contact Natasha Pauli if you are interested in developing a research project centering around social-ecological systems research. Co-supervisors: TBC.

Dr Andrew Rate

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Catchments and Water	Environmental Management

Environmental geochemistry desktop projects

Several sources of data exist in the public domain, for example: the WA Department of Water's WiR database; WA Department of Mines and Petroleum's Data and Software Centre; and multiple international (USA, European) data repositories. Many of these datasets are a rich and in cases under-utilized source of geochemical, spatial, and temporal data. Depending on your interest, your project could involve using one or more of these databases to deduce environmental chemical processes and environmental effects. Potential co-supervisors: Gavan McGrath (DBCA), Steve Appleyard (DWER), Patrice de Caritat (Geoscience Australia).

Magnetic particles in street dusts and soils as pollution proxies

The magnetic properties of many urban soils, sediments and related materials may represent a simple and cost-effective screening technology since parameters like magnetic susceptibility or the content of ferromagnetic particles are known to be correlated with pollutant indices. This project would assess the relationships between magnetic properties and pollutant (e.g. potentially toxic trace element) contents in soils, sediments and street dusts from metropolitan Perth, Western Australia. Potential co-supervisors: Allan McKinley (MCS), Matthias Leopold.

Tracking urban microplastics

Urban environments are a major source of microplastics to natural waters, and eventually marine environments, via runoff from impervious surfaces and transport in stormwater, and we already know that urban land use exerts control on microplastic counts (see doi.org/10.1016/j.marpolbul.2021.112362 and doi.org/10.3390/land11101815). Materials such as street dusts may act as temporary storage for urban microplastics on their journey. This project would examine various urban waters and/or street dusts and related materials to further understand urban environments as microplastic sources. Potential co-supervisors: Hua Li (CMCA), Emielda Yusiharni.

Prof. Zed Rengel

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Catchments and Water	Environmental Management

Using constructed wetlands for purification of wastewater and stormwater 

This project will (i) Identify WA wetland species suitable for accumulation of nutrients from wastewater, (ii) optimize conditions for biofiltration of stormwater using constructed wetlands and (iii) characterize interactions between heavy metals (e.g. cadmium) and organic contamination (e.g. hydrocarbons) in constructed wetlands purifying wastewater. Co-supervisor: TBC.

Dr Abbie Rogers

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Environmental Economics

The economic benefits of artificial surf reefs 

Installation of an artificial surf reef is being considered in the City of Bunbury. A range of questions could be explored to help inform whether this project would be worthwhile. Data could be collected from non-market valuation surveys to understand the surfing community's willingness to pay for such a reef, and whether installation of a reef in Bunbury would increase visitation to the region. Non-market and other market-based benefits and costs could then be integrated into a benefit-cost analysis to identify whether the reef installation is economically viable. There will be opportunities to spend time in the field and working with local government and community organizations. Co-supervisors: Michael Burton, Ana Manero Ruiz.

Do non-market values change the outcome of prioritising natural hazard mitigation? 

Natural hazard managers need to be able to prioritise mitigation actions to reduce the impact of bushfire, flood and other hazard events, so that they get the best bang for their buck. Benefit-cost analyses can be used to weigh up the economic costs and benefits of different mitigation programs, including non-market costs and benefits. This project will explore the efficiency of different natural hazard mitigation programs depending on whether non-market values are included in benefit-cost analyses. Co-supervisor: Veronique Florec.

The Great Southern Reef: is it more valuable than the Great Barrier Reef? 

Kelp forests are a key ecosystem in Australia's temperate waters. The Great Southern Reef, an interconnected system of kelp forests, spans roughly from Kalbarri in WA around to the northern border of NSW, and is likely to contribute significantly to our economy through tourism and provision of fish habitat for commercial and recreational fisheries. This project aims to estimate the value of ecosystem services provided by Australian kelp forests through analysis of available data. Co-supervisors: Michael Burton, Karen Filbee-Dexter.

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Environmental Rehabilitation

Bioremediation of tailings and wastewaters

Microbially-driven approaches for remediation of tailings, mineral processing wastes, and contaminated waters provide novel pathways to address the challenging chemical and physical properties of these materials. Use a variety of methods including laboratory or glasshouse leaching columns, laboratory experiments, and geochemical, microbial, and physical laboratory analysis methods, this project will test microbially-driven approaches for remediation of tailings or leachates. Specific remediation targets may include pH neutralization, metals removal, nutrient fixation, and/or structure development or dust suppression, for a range of different tailings and wastewaters/leachates. Potential co-supervisor: Dr Sasha Jenkins.

In situ remediation of bauxite residue

In situ remediation is increasingly being adopted in mine closure and rehabilitation plans. Bauxite residue, produced from alumina refining, is a globally significant tailings stream, with 120 MT produced worldwide annually. In situ remediation of bauxite residue may use a combination of inorganic and organic amendments, and biological approaches to transform it into a medium that is chemically, physically, and biologically suitable for plant growth. This project will optimise the combination of amendments and approaches applied to bauxite residue to achieve sustainable in situ remediation to support a variety of post-mine closure land uses. The project involves field sampling and analysis, and/or laboratory trials. Potential co-supervisor: Sasha Jenkins.

Modelling water balance and salt export during tailings rehabilitation

In situ remediation is an increasingly popular approach for tailings rehabilitation and closure, the end goal being the transformation of tailings into a suitable plant growth medium. Geochemical and physical data collected from field trials can be used to model the progress of rehabilitation fronts and changes in leachate chemistry, demonstrating to regulators and other stakeholders that the trajectory of the tailings system is on track to achieve remediation and closure goals. This project will use chemical and physical data collected from field trials of in situ remediation in bauxite residue to model water movement and mineral dissolution/ precipitation processes, and predict future behaviour of the tailings as it continues its transformation into soil. Modelling programs (HYDRUS1D, PHREEQC, and/or MIN3P) and provided field trial data will be used. Potential co-supervisors: Matt Hipsey, Andrew Rate.

Enabling reuse of tailings through in situ remediation

In situ remediation is an increasingly popular approach for tailings rehabilitation and closure. The coupled abiotic-microbial strategies developed for rapid in situ remediation of tailings also opens the door for development of a new reuse pathway for tailings. Large scale utilization of tailings as a soil product requires transformation of its properties to meet specified targets demanded by potential consumers. Focusing on bauxite residue, this project will identify the opportunities for remediation and reuse as a soil product in agricultural activities around several pilot refinery sites globally. The project involves market analysis and consideration of bauxite residue properties and evidence for efficacy of various amendments to transform residue properties to achieve desired targets for the soil product. Potential co-supervisor: Michael Burton.

Hitching a ride: contributions of dust deposition to nutrient accumulation and microbial community succession in tailings 

Dust is a poorly quantified but widely acknowledged source of biological nutrients and potential source of microbial inoculants in natural environments. This role of dust has been almost entirely overlooked in mining environments. Recent laboratory experimental work by Santini et al (2018) demonstrated that dust is a significant source of microbial inoculants in tailings and suggested that limited dust inputs likely underpin the delayed microbial community succession observed in tailings when compared to natural primary successional environments. This project will use field samples from dust traps to identify and quantify dust sources, total dust inputs, microbial community biomass, and dust nutrient content in a tailings site and adjacent non-mining site and will evaluate microbial community functions to better explain the delayed succession and limited function that is commonly observed in tailings. Potential co-supervisor: Sasha Jenkins.

Blended waste caps for sustainable closure of tailings facilities 

Blended waste caps, using tailings mixed with other waste materials present on site to create both an impermeable (capillary break) layer and a plant growth (soil) layer, are a new approach to tailings management that offers opportunities to eliminate risks and costs associated with capping and in situ remediation approaches (capillary rise, expense/effort of importing capping materials and amendments, etc.). This project will identify the optimal blend of wastes available onsite at an alumina refinery to create a plant growth medium capable of supporting plant growth. Subsequent stages of the project will involve running flume trials to optimize water balance between the plant growth layer and capillary break layer. Potential co-supervisor: Matt Hipsey.

Pulse or drip? Irrigation intensity in leaching salts from mine wastes

After processing, mine wastes and tailings materials can contain substantial amounts of salt in both pore water and as sparingly soluble minerals. The slow dissolution of these minerals poses problems for long-term management as salinity is maintained during rainfall leaching. Supplementing rainfall leaching with irrigation is one method of accelerating salt removal, but it is unclear whether rapid, pulsed flow or slow, continuous leaching removes more salt per pore volume of water or unit of time. This project will use laboratory leaching columns and geochemical and physical laboratory analysis methods to identify whether continuous, slow leaching or episodic, intense leaching is more effective at removing salts from pore water and solid phases in tailings. Potential co-supervisors: Matt Hipsey, Andrew Rate.

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Environmental Economics

The switch to electric vehicles - in Perth, WA, Australia or elsewhere 

Electric vehicles are the future, we are told, but there are still only a few around. Why? Cars, buses, trucks, trains may also have different electrical futures - What are they? Do conditions differ between cities and countryside? How do they link with PV panels on rooftops? What are people's perceptions and how much do they value this switch? Who is influential in what is (not) happening? These and other questions have become a hot topic that can be explored using economic analysis, surveys or even lab experiments. Co-supervisor: Chunbo Ma.

Transitioning to renewable energies

This can be a survey-based or modelling-based study regarding the economic viability of renewable energy sources, and which policies can be most effective for their adoption. Students can investigate the effect of taxes, buyback rates, cost-sharing and subsidies. In particular, comparisons between renewable and non-renewable options can be examined. Co-supervisor: Chunbo Ma.

What factors can encourage economic agents to reduce, reuse and recycle waste, in particular (but not only) plastic waste?

This is a 'hot topic' which is being addressed by a PhD student in ARE. A Masters or Honours project could complement some of the work done for the PhD project and in collaboration with it. The methodology will include aspects from behavioural economics. However, the project does not need to focus on plastic, or on WA. Co-supervisor: Sasha Jenkins, Chi Nguyen.

How can a specific tech project contribute to the Circular Economy?

Waste management and recycling has become a big priority, and there are many start-up companies initiating new tech projects with new processes and products. However, there is only a vague notion of how they might contribute to a "circular economy" (CE). There is a need for some clear thinking to help specific projects know how much they can contribute, which should also increase their chances of success. UWA is bidding for a new Plastic Waste CRC, providing context to this work, but it does not need to be focused on plastic. This is a fast-growing area, both in academia and in industry. Co-supervisor: Sasha Jenkins, Chi Nguyen.

Solving the equity-efficiency trade-off in paying for environmental services

Ecosystem or environmental services (ES), such as biodiversity or carbon sequestration, do not carry a market price, yet have value to society. Underpaying yields too little ES; overpaying wastes tax-payers' money. Competitive tenders can provide a market-mechanism solution which, though efficient, raise strong community concerns about their fairness - this can lead to reduced participation, which destroys the sought-after efficiency. The project would involve designing and running a lab experiment to address an aspect of this important question. Co-supervisor: Chi Nguyen.

The power of environmental norms in combating marine plastic pollution

Environmental norms (particularly anti-plastic norms) have proven to be effective in mitigating marine plastic pollution. However, policy interventions for boosting the emergence of anti-plastic norms have not received sufficient attention. This project will examine the effectiveness of alternative policy interventions aiming to generate anti-plastic social norms and to accelerate progress towards a social tipping point when enough people reduce their use of plastics. Co-supervisors: Chi Nguyen and Fay Rola-Rubzen.

Results-based payments for the provision of environmental services by private landholders

Results-based payments means that landholders are paid for the environmental outcomes they generate rather than for implementing predefined land management practices that are more environmentally friendly. This has been advocated as a cost-effective payment mechanism for the provision of environmental services. In this project, you (Masters/Honours) will conduct a systematic review on the performance of results-based payment schemes and identify the factors that affect their performance. Co-supervisor: Chi Nguyen.

Applying the new 5K framework to environmental problems in development countries

Trying to solve environmental problems in developing countries can be a real challenge, and international organizations like the World Bank, national governments, and many NGOs are facing these challenges every day. A major difficulty lies in linking together various aspects of a problem that involve economic, social, technical,

and political aspects. No single academic discipline can yet link all these aspects together. A new framework labelled '5K' (for 5 forms of capital) has been created to help tackle this challenge, and it is already raising interest outside academia (Vietnam Ministry, World Bank). A student choosing a topic in this area could directly link with an existing World Bank (or other) project, via one of our Adjunct Professors who is actively involved in the field. Co-supervisors: Ram Pandit, Fay Rola-Rubzen, Julian Roche.

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Catchments and Water	Environmental Management	Environmental Rehabilitation

Changes in small mammal fauna in relation to landuse changes in Sumatra

The landscape in Indonesia has undergone massive changes (and is still happening) in land-use. This change in land-use can have potential impacts on mammal fauna. This study will examine the impacts of land-use on the small-medium mammal species diversity and abundance in small scale rubber plantation, small scale oil palm plantations, large scale oil palm plantations, small subsistence farms and native vegetation. The study will use motion triggered cameras to detect fauna in the different land-uses. Co Supervisor: Dr Rizaldi (Universiti Andalas (Sumatra).

How does urban lifestyle impact on parasite loads in native mammals

Increasing urbanization opens up a range of new and unusual habitats for native mammals, as well as exposing them to a range of different stresses and domestic animals. This study will use faecal samples to measure the parasite burden of a range of native mammals, with the aim of comparing the diversity and abundance of parasites in native mammals living in urban environments with those living in natural environments. Co-supervisor: Paul Close.

Ross River virus and livestock watering points

Ross river virus is a debilitating disease spread mainly by the *Aedes camptorhynchus* mosquito. This mosquito is highly tolerant to saline conditions and dominates saline landscapes, as other mosquito species (and their predators) are unable to survive in these conditions. This project will examine if livestock watering points provide habitat for other species of mosquito that would otherwise not be present in the salinized environment. Co-supervisor: Barbara Cook.

Who watches the watchers? What are motion triggered wildlife cameras missing?

Motion triggered cameras are now a common method of sampling and monitoring native fauna and feral species (e.g. Comer et al. 2018). These cameras may be baited or unbaited. The issue is that cameras only face in one direction and have a limited field of view and fauna may not being detected due to this limitation. This study will utilize motion triggered cameras to attempt to quantify the proportion of detections using standard techniques in relation to what could be detected when the area surrounding the camera trap is monitored. Co-supervisor: Sarah Comer (DBCA).

Are native wildlife eating plastic?

Waste disposal sites are often situated in places where small to medium sized native fauna have access. Much of the waste disposal consists of plastic. So the question to be asked is how much plastic do the native animals

in the area consume and how far does this plastic contamination extend from the waste site? Co-supervisor: Harriet Paterson.

Landuse change and zoonotic disease vectors

A recent publication (Mendoza et al. 2019) highlighted how land use change can increase the abundance of zoonotic reservoirs (particularly rodents). The 2019 meta-analysis was based on studies in tropical ecosystems. This study will test the hypothesis that land use change will increase the abundance of rodent hosts of zoonotic diseases in temperate ecosystems. The study could also examine the impact of restoration on rodent communities. The study will involve small mammal trapping in the Great Southern region of Western Australia. Co-supervisor: Barbara Cook.

Impact of infrastructure construction on native wildlife

The city of Albany has a major infrastructure development planned in the form of a ring road to carry heavy vehicles to and from the port. This new major road will pass through sections of remnant bushland. This presents the potential for multiple projects (depending on the stage of development) on the impact of the existing road, the construction phase and completed road on fauna. The project can also focus on fauna use of specially constructed tunnels and overhead bridges designed to allow transit of animals. Co-supervisors: Paul Close, Barbara Cook**.**

Using historical photos to track environmental changes in urban landscapes

Since European colonization, Australia's landscape has undergone dramatic change. In many long-established regional towns, there exists a historical photographic record of the changes to the surrounding landscapes. This project will utilize these historical photos to test whether they are effective as a tool for documenting environmental change. Co-supervisor: Barbara Cook.

Making use of digital technologies for monitoring fauna and flora

As digital technologies advance, these tools have become more affordable and feasible to use for monitoring biodiversity. For example, they can be used to enhance animal welfare when using traps. Using sensors and data loggers, this project will measure environmental conditions in fauna traps with and without animals present to assess conditions faced by these animals during capture. Co-supervisor: Sarah Comer (DBCA).

Rewilding to optimize human and ecosystem health in regional Western Australia

Many introduced species such as rats, mice and foxes can thrive in urban environments. These species can potentially carry zoonotic diseases. Many native animal species such as bush rats, possums and bandicoots can also thrive in urban environments. This study will examine disease burden in native and introduced species, in both urban and wild settings to determine if introduced species pose a higher disease risk in urban areas than native species. Co-supervisors: Paul Close, Angus Cook (School of Population Health).

What is driving plastic pollution dispersal in Oyster Harbour?

Plastics get everywhere, but why are they where they are? There are two potential projects. The first is looking at the short-term drivers of plastics movement within Oyster Harbour. The project would look at plastics in the water column to determine what factors (such as wind, tide etc.) drive the movement of plastics in the harbour, and ask the question do different types of plastic behave differently? The second project is looking at the long-term deposition of plastics in the harbour. The project would look at plastics in sediment samples to determine where plastics are depositing and to ask the question whether different types of plastics deposit in different areas. Co-supervisor: Dr Harriet Paterson.

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Marine and Coastal Management

Whale energetics and behaviour 

Southern right whales are a baleen whale species that are migratory to our Australian coastlines. Whilst on the coast, mother-calf pairs give birth and nurse their young. During the breeding/calving season, the mother does not feed and her energy is invested into the growth of her calf. The calf grows an astonishing 3 cm in length per day from the mother's rich milk. This project will assess the energetics and behaviour of mother-calf pairs whilst on the breeding ground. Co-supervisors: Barbara Cook, Fredrik Christiansen (Aarhus University).

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Environmental Economics

Behaviour change for regional biosecurity 

How do we design community surveillance and management systems that encourage smallholders to manage pests? Rural Australia is over-run with exotic pests: feral pigs, foxes, cats, fruit flies and numerous weeds. The big challenge for organizations like the Peel Harvey Biosecurity Group is to persuade people to report pest problems and act collectively to manage the pest. This paper will involve working with the biosecurity group to survey landholders and test alternative strategies to get people to manage pest. We will use fruit fly as the case study pest. Co-supervisor: Jonelle Cleland (Peel Harvey Biosecurity Group).

The economics of the new Department of Mines Fidelity Fund 

The Department of Mines, Industry Regulation and Safety (DMIRS) introduced an environmental charge on mines to cover rehabilitation costs. This has replaced environmental bonds, but it is unclear how mining firms responded in terms of the rate and quality of rehabilitation. The study will develop a model of how rehabilitation responds to the policy and the link between firm financial performance and environmental performance. Co-supervisor: TBC.

The economics of beneficial honeybees 

This study will explore the value of honeybees to a number of pollinator depended industries possibly avocados and cherries. Managed honeybees are good pollinators, but so are feral honeybees and some native insects. This Masters or Honours project will be linked to the Honey Bee products Cooperative Research Centre. Co-supervisor: Liz Barbour.