Australian Academy of Science

East Asia and Pacific Summer Institutes Program (EAPSI)

2016

Australian Government

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Contents

Introduction

The Australian Academy of Science was delighted to welcome 26 outstanding US graduate students to Australia to participate in the East Asia and Pacific Summer Institutes (EAPSI) program for 2016.

This program has been developed in collaboration with the US National Science Foundation and aims to introduce the students to Australian science and engineering in the context of a research laboratory and to initiate personal relationships that will better enable them to collaborate with their Australian counterparts in the future. The eight-week program began on 7 June 2016.

The Academy acknowledges the importance of research collaboration that goes beyond national borders and academic disciplines, and places great importance in strengthening exchanges that are both competitive and cooperative among talented young researchers.

It was with great pleasure that I read the participants' reports to learn that so many achieved, if not exceeded, their immediate research goals, and initiated strong collaborative links that will provide the foundation for lifetime cooperative research. I was also pleased to learn that several students have expressed interest in returning to Australia to further their research. These graduate students and the Australians with whom they shared their research will play an important role in advancing cooperative research between Australia and the United States in future years.

I would like to extend my gratitude to the National Science Foundation and the Australian Government Department of Education and Training for their continued support in funding this program, and of course to our colleagues at the Australian Embassy in Washington DC. Without their kind assistance and cooperation, this important activity could not be sustained.

The Academy looks forward to continuing this program in 2017 and beyond.

Professor Andrew Holmes AC PresAA FTSE FRS

President
Australian Academy of Science

Orientation program

Tuesday 7 June

Morning	Arrival at Canberra airport
Afternoon	At the Academy's Ian Potter House: • Official opening of EAPSI 2016 • Overview of the Academy and administrative details at Ian Potter House • Presentations: Endeavour Scholarships and Fellowships

Wednesday 8 June

All day	Guided tour of bushland areas in and around Canberra including Mt Ainslie, Red Hill, Tharwa, Tidbinbilla and Hanging Rock. Tour included an overview of Indigenous history and activity in the Canberra region.
Evening	At the Academy's Shine Dome: Lectures: • Mr JP (Justin) Lawrence: *Frogs, fish, and a bucket list: My 2015 EAPSI experience* • Professor Jenny Graves AO FAA: *Weird Australian animals, sex and the future of men*

Thursday 9 June

Morning	Tour of the Aboriginal and Torres Strait Islander Art Gallery at the National Gallery of Australia
Afternoon	Tour of New Parliament House Roof top of New Parliament House for photo opportunity and viewing
Evening	EAPSI participants depart for host cities

Participant: Diana Alatalo, University of Texas, Dallas

Australian research advisor: Dr Donna Geddes

Australian host organisation: University of Western Australia

Title of research proposal: *Investigating the relationship between suction and pressure as applied by an infant during breastfeeding*

Research description:

Successful breastfeeding requires frequent removal of milk from the breasts. Infants use both pressure and suction to remove milk from the breast. Infants are more efficient than hand expression, which utilises only pressure, or mechanical pumps, which utilise only vacuum. The project aimed to utilise the equipment and techniques developed by the Hartmann Human Lactation Research Group in Perth, Australia, to collect clinical data from mother-infant nursing pairs to establish a range of normal values for both pressure and suction in relationship to milk flow as seen in healthy infants nursing at the breast.

Research activities:

A total of 12 participants were successfully recruited for this project. A 3D scan of the breast was taken before and after breastfeeding. A tube filled with water and pressure sensors were attached to the breast and the infant fed at the breast. During the feed, an ultrasound of the infant's mouth on the breast was obtained to visualise the interaction between the breast and the infant's mouth. The infants were weighed before and after feeding to calculate the milk intake. A complete set of data was obtained for six mother-infant dyads. Oral peripheral pressure profiles were obtained for an additional six dyads.

Perspective of research after this program:

a) Focusing specifically on your research project:

This opportunity has helped me see how my project can be improved upon.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

The program provided me the opportunity to see how cultural differences impact research. I was able to make many professional connections that will benefit me as my career progresses.

Australian advisor's remarks:

Diana gained valuable insight into the way in which measurements are attained from breastfeeding infants in our research program. The initial method of measuring pressure applied by the infant on the breast, required manipulation to attain useable measurements. This opportunity to observe that academic theory does not always translate into practice was a valuable one. In addition Diana displayed great problem solving skills as well as perseverance to obtain relevant and utilisable data. She also integrated well into the group thereby extending her knowledge of our broad scope of research.

Participant: Sydney K. Brannoch, Case Western Reserve University

Australian research advisor: Dr Mariella Herberstein

Australian host organisation: Macquarie University

Title of research proposal: *Investigating an unknown sensory structure in eastern leaf-dwelling praying mantises*

Research description:

A group of leaf-dwelling praying mantises (Insecta: Mantodea: Iridopteryigidae), which feature dorsoventrally compressed bodies and large, well-developed wings, feature a novel sensory structure. These mantises are known to rest compressed against the undersides of leaves, a unique ecological niche for praying mantises, while behavior such as prey capture ecology and flight have not been described in the literature. As the sensory structure is present on only this group of mantises, and as they exhibit a unique habitat use, it is hypothesised that the sensory information transduced by the structure is used to modulate specific behaviors associated with their ecological niche. The aims of my EAPSI research were to:

1. collect live praying mantises species that feature the structure
2. record behavioral data (e.g. flight, prey capture, resting posture) related to the ecological niche which the mantises occupy
3. conduct electrophysiological recordings on the structure to determine if the structure responds to external stimuli.

Research activities:

I collected target praying mantis species at field sites in Queensland, Australia by sweeping vegetation and light trapping, thus establishing a colony with which to conduct my research. At Macquarie University, I recorded behavioral data on the specimens for a variety of different environmental conditions (e.g. starved vs sated, in light vs in dark, solo vs with conspecific) using high-speed video equipment, building upon current knowledge of behavior for the target mantis species. Lastly, I conducted electrophysiological recordings on the structure, resulting in a dataset that will be built upon at my home institution at Case Western Reserve University.

Perspective of research after this program:

a) Focusing specifically on your research project:

The research that I conducted at Macquarie University has greatly improved our knowledge of the behaviour and unique sensory structure of the target praying mantis species, thereby providing us with a more thorough dataset from which to continue developing and carrying out more complex behavioural experimentation.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

Receiving the EAPSI grant enabled me to discuss research topics and methods, experimental design, and troubleshooting techniques with leading insect researchers in Australia. This opportunity was crucial for me as a means to develop preliminary data for my doctoral research as well as establishing future collaborators. I am forever grateful for the opportunity to conduct research at

Macquarie University in New South Wales—an experience that might not have been possible without having received the EAPSI grant.

Australian advisor's remarks:

Sydney Brannoch worked in my lab at Macquarie University for 8 weeks during which she conducted physiological and behavioural experiments on Australian praying mantids. This work was designed to complement her taxonomic and systematic work with this group of praying mantids. During her time here at Macquarie University, Sydney was focused, very independent and quickly developed a research network from within and beyond my group. She developed, for the first time, appropriate methods to address her questions and collected relevant data that will help her generate the next set of questions and hypotheses. It was a great pleasure and delight having Sydney in my laboratory and I do hope she will come back for more work on these fascinating animals.

Participant: George A Brusch IV, Arizona State University

Australian research advisor: Professor Rick Shine FAA

Australian host organisation: University of Sydney

Title of research proposal: *Adapting to life with less water: immune function in semi-arid Australia*

Research description:

Current research on immune function in ecological contexts has focused on the theory that immune defenses compete with other physiological functions (e.g. growth, reproduction) for energetic resources, creating associated life-history trade-offs. There remain substantial gaps in our understanding of what resources directly modulate the immune system, with the vast majority of work focusing on energy. Water is a fundamental, non-energetic resource that has received little consideration for its role in possibly modulating immune functions. Water is essential for life and is the main constituent of cells, tissues, and organs. My dissertation research is focused on physiological trade-offs in organisms inhabiting resource-limited environments. I've been working with two different snake species to examine the relationship between hydric state and immune function, an almost entirely unexplored area. My EAPSI research, conducted in the laboratory of Dr Rick Shine of the University of Sydney, broadened the scope of my dissertation research by incorporating both ecological context and conservation implications. In Australia, I took an ecoimmunological approach to assess the distribution potential of the cane toad (*Rhinella marina*), a highly invasive species that has been wreaking havoc on native Australian wildlife since its introduction in 1935. I tested the hypothesis that cane toads at the invasion front in arid regions are adapting a tolerance to water limitations to maintain effective immune function. If true, the expansion of toads may progress well beyond the anticipated boundary based on known species tolerances to aridity. I tested this hypothesis through a combination of lab and field experiments that compared immune function and hydration state between toads from the xeric invasion front and ones from the mesic invasion starting point. The results of these experiments may transform the way we predict distributions of this, and likely other, invasive species. I collected fresh plasma samples from wild animals at four different sites to quantify naturally occurring osmotic state and immune performance. In the laboratory, I experimentally manipulated the hydration state of animals from all sites to determine whether toads from semi-arid portions of Australia will have less suppressed or even enhanced immune function when dehydrated compared to toads found in more mesic areas of Australia where they were first introduced. Participation in the EAPSI fellowship enabled me to improve my dissertation by adding a translational component that will apply my research to conservation efforts in Australia. In addition to my originally proposed research, I also conducted two other experiments. I collected plasma from water pythons (*Liasis fuscus*) throughout the dry season to quantify natural variation in immune performance and hydration state. I also experimentally manipulated water python hydration state for approximately five weeks in the lab to examine trade-offs between increased plasma osmolality and innate immune function. The third project I conducted examined natural variation in osmotic state and immune performance in children's pythons (*Antaresia childreni*) throughout the dry season. I use *A. childreni* for experiments at Arizona State University and being in Australia gave me the chance to collect data on wild caught animals to put my laboratory work in ecological contexts.

Research activities:

I set very lofty goals for the EAPSI program. I realistically did not expect to complete all the data collection over an eight-week period and would have been satisfied with a completed toad project and pilot data on water and children's pythons. Working with world-class researchers at the field station and at CDU inspired me to work tirelessly and successfully complete all of my proposed research objectives. I still have mountains of data to comb through, but I was able to complete three separate research projects, a feat I am very proud of.

Perspective of research after this program:

a) Focusing specifically on your research project:

Data analysis will take quite a bit of time, especially considering I completed three separate projects during the course of the EAPSI program. Within a year I expect to publish two peer-reviewed journal articles and incorporate children's python field data into another paper I've been working on for the past three months.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

The state of career opportunities, especially in the US, can often times be fairly glum. The EAPSI Australia program has boosted my prospects tremendously. Every mentor I've had has stressed the importance of international work and having co-authors from multiple disciplines/international universities. I took every opportunity I could while in Australia this summer and I made life-long connections with multiple world-class researchers. Specifically, the connections I made with Dr Rick Shine, Dr Greg Brown (both University of Sydney) and Dr Keith Christian (Charles Darwin University) will lead to future collaborations. I've already been in talks with Dr Christian about future work together, even a post-doc opportunity, which will only increase my chances of obtaining a competitive job after graduation.

Australian advisor's remarks:

George's visit has been a spectacular success, in terms of interactions between US and Australian researchers as well as in the actual scientific discoveries that have been made. The amount of work that was achieved is quite remarkable, and will form the basis for exciting new insights and high-profile publications. In essence, the visit has been a very great success from the Australian host's perspective.

Participant: Nicholas Buttrick, University of Virginia

Australian research advisor: Dr Takeshi Hamamura

Australian host organisation: Curtin University

Title of research proposal*: An inquiry into the psychological effects of the 1996 Australian Nation Firearms Agreement*

Research description:

In 1996, reacting to a mass-shooting in Port Arthur, Tasmania, in which a gunman killed 35 people and wounded an additional 18, the Australian government passed the National Firearms Agreement (NFA). Among other things (including tightening licensing requirements), the law banned semi-automatic rifles and pump-action shotguns and required that prospective gun owners demonstrate a 'genuine reason' why they needed the weapon, with 'personal protection' no longer a valid cause. As part of a 12-month window to get into compliance with the new law, the Australian government set up a program to buy back any firearms rendered newly illegal. Between October 1 1996 and September 30 1997, the government repurchased over 640,000 guns, reducing the number of privately-held firearms by about 20%, and roughly halving the number of households owning a gun. While much work has been done on the public safety effects of the NFA (researchers have estimated that the law reduced the number of firearm-induced homicides by about 35%, and firearm-induced suicides by about 75%), the psychological effects of the law have been less-well understood. Through experiments with a broad spectrum of Australians, especially including those of age both before and after the NFA was passed, this project will investigate how the law affected attitudes towards firearms and changed the symbolic character of guns and gun ownership, with an eye towards understanding how the widespread presence or absence of weapons alters their cultural meaning.

Research activities:

Collected an initial sample of participants and trained a collaborator to finish the data collection.

Perspective of research after this program:

a) Focusing specifically on your research project:

While getting the project up and running presented more hurdles than originally expected, now that all approvals have been granted and the procedure has been ironed out, I expect that the forthcoming data will be pretty spectacular. But, until it all comes in, there's nothing more concrete that I can say, really.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

I'm supremely hopeful that the work conducted in Australia (and all the ensuing follow-ups) will create enough good science that it will at least not hurt my scientific career (and, if nothing else, demonstrating that I'm at least somewhat fundable seems good). Getting to work with Dr Hamamura was the real benefit to me, however—we're already designing two studies unrelated to the original project, in addition to a series of follow-ups to the main research.

Australian advisor's remarks:

At Curtin, Nick conducted the proposed experiment on psychology of gun ownership. In addition, Nick networked with faculty members and post graduate students in the School of Psychology. He also gave a research seminar to a large research group which was well received.

Participant: Greg Collinge, Washington State University

Australian research advisor: Professor Catherine Stampfl

Australian host organisation: University of Sydney

Title of research proposal: *Modeling the surface of nanoparticles during the conversion of carbon monoxide to transportation fuel*

Research description:

The direct production of fuels and chemical feedstock through the utilisation of renewable sources of carbon is a sustainable, and therefore desirable, means to mitigate the worlds' dependence on oil. A useful and reactive form of carbon is CO, which can be derived from methane or from biomass. By catalytically hydrogenating (reacting with H_2) and oligomerising CO, the FT synthesis provides a well-known and industrially mature means of creating long-chain hydrocarbons which can then be utilised as fuels or chemical feedstocks. However, without a theoretically grounded description of FT, the rational design of optimised and industrially viable catalysts is severely hindered. This theoretical description would be based upon the FT reaction mechanism, but there is no universally accepted mechanism despite nearly 100 years of research. Therefore, in order to probe the likely mechanism of this reaction and provide a theoretically grounded description of it we must understand the nanoscale environment in which it is takes place. This can be accomplished with a detailed and experimentally relevant first-principles phase diagram, constructed via a DFT-parameterised lattice gas (LG) model. The construction of such a phase diagram is the ultimate aim of this project.

Research activities:

Using density functional theory (DFT) via the Vienna *Ab initio* Simulation Package (VASP) as input information, a lattice gas (LG) model of the adsorbed FT reactants, CO and H, on Co(755) will be developed. Cobalt (Co) is chosen since this is the catalyst used in industry for FT synthesis. Combined with Monte Carlo (MC) simulations, the information gleaned from the LG model allows for the discovery of the likely surface configuration of these surface species at industrially relevant reaction conditions through the creation of a first-principles phase diagram. Specifically, a LG model requires the deconvolution of the so-called lateral interactions between different adsorbed surface species into those stemming from the proximity of nearest neighbors, or the existence of 3-body interactions, 4-body interactions, and so on. In so doing, the LG Hamiltonian, or total energy, of the adsorption system can be determined, which can analytically predict the energies of any configuration without the need for further computationally expensive DFT calculations. With the aid of MC simulations, the LG Hamiltonian can be used to sample the configurational space of the surface as a function of both temperature and chemical potentials (relatable to partial pressures), predicting the most probable adsorbate configurations. This can be done by identifying the lateral interactions that potentially contribute to the overall adsorption energy in a moderate number of configurations and then using DFT to actually calculate their adsorption energies. This produces a moderately large system of equations, which can be solved (or regressed upon) to produce the effective lateral interaction energies that were previously identified. New adsorption configurations can then be predicted and calculated to further refine the LG model and to estimate the error in the present iteration. It is generally regarded of supreme importance that the lowest energy configurations also be found in this process. Therefore, when the LG model is sufficiently predictive and all minimum energy configurations have been found, the LG model is considered converged and can be fed into MC simulations to produce the desired first-principles phase diagram. As a method of assessing success, the phase diagram should accurately predict the known 'segregated phase'

configurations for both pure CO and pure H. During the course of the EAPSI fellowship, it was found that the Co(755) surface had more site types than expected, with adsorption energies as well as interaction energies varying as a function of distance from the step. While some variation was expected, the degree to which this impacted our planned model was far greater than anticipated leading to the number of potential cluster interactions increasing by an order of magnitude. The outcome has been the development of a complex and rigorously defined LG model the likes of which has never been attempted before. In order to maintain the rigor and thoroughness that was originally intended, we have modified the intended outcomes slightly. Instead of one paper concentrating on both CO and H on Co(755), the complexity of the model justifies the project's separation into three papers: only CO, only H, and then both species on Co(755). Furthermore, due to this unexpected complexity, we were unable to complete the first model of CO on Co(755) during the 8 weeks allotted by the EAPSI fellowship. The code to do so has been written and a preliminary LG model has been successfully constructed, but further work is required to produce a publication quality paper. We anticipate this will take another six to nine months to accomplish, with all three papers taking potentially two years to fully complete. Collaboration between myself and Professor Stampfl is expected to continue to facilitate the completion of this project.

Perspective of research after this program:

a) Focusing specifically on your research project:

Research will continue on this project into the foreseeable future. This is very exciting as continued collaboration is assured by the necessity of completing the proposed work.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

It is entirely possible that more researchers could be brought onto this project as research and time unfolds. Even without this event, but especially with it, continued international collaboration between the groups of Professor Catherine Stampfl and my PhD advisor, Professor Jean-Sabin McEwen, would be assured well past my own graduation. There is also the prospect of future career opportunities being opened up by our collaboration(s) since close collaboration between multiple participants is an excellent method of extended interview.

Australian advisor's remarks:

It was a pleasure to work with and host Greg in the School of Physics at the University of Sydney. During the visit significant results were obtained on the project including calculation of the total energy of the very many atomic configurations that are required to create the lattice-gas Hamiltonian, as well as the coding and development of algorithms to handle this large amount of data. As Greg describes above, collaborative work will continue into the future on this project and it can be expected that there will be some significant and high impact papers resulting from it. The EAPSI program has afforded the establishment of this new collaboration between Australia and the US and I am grateful for this possibility. Finally, I would like to remark that I was extremely impressed with Greg's productivity during the visit, with each week bringing new and important results.

Participant: Elizabeth Duncan, California State University, Long Beach

Australian research advisor: Dr Jodie Rummer

Australian host organisation: James Cook University

Title of research proposal: *Human impacts on the physiology and behavior of coral reef fishes*

Research description:

My research involved examining the effects of different human impacts (climate change and increased suspended sediments) on coral reef fishes. In addition to warming waters and altered water chemistry due to an increasing concentration of atmospheric CO_2, human activities such as coastal mining and urbanisation have impacted, and will continue to impact, the flora and fauna of the Great Barrier Reef (GBR). For example, decreased ocean pH has been previously shown to alter fish behaviours such as learning, decision making, and discerning predator cues. In addition, the physiological performance of different fish species varies dramatically in response to the same conditions that impaired behaviour, implying that trade-offs exist between behavioural and physiological performance for some species. Further, not only are reef species experiencing warmer temperatures and decreased pH, but nearshore reef inhabitants are additionally experiencing increased concentrations of suspended sediments owed to human activity. The larval and juvenile stages of reef fish may be particularly sensitive to high sediment exposure because these are critical yet sensitive growth stages during which fish can exhibit the most plasticity in response to their local environment to better perform as adults. However, fish also experience the greatest incidence of mortality during the transition from pelagic larval stages to settled juveniles, owing mostly to predation. Previous research has shown that larval reef fish experience decreased overall performance and delayed development in response to increased suspended sediment treatments, further decreasing their chances of survival to adulthood. Ultimately, it is no surprise then that human alterations to the environment are changing fish physiology, behaviour, and species interactions, which subsequently influence the overall structure of marine communities. As many livelihoods rely on a healthy GBR, I worked alongside Dr Jodie Rummer's current graduate students to understand how the behaviour and physiology of reef fish and juvenile sharks might be impacted by human induced alterations to the environment, as well as the implications that these responses might have for the future of the GBR.

Research activities:

During my time at the host campus, James Cook University, I was able to participate in three distinct areas of the lab's research:

1. quantifying the morphological alterations of larval reef fish gill tissue upon exposure to different concentrations of suspended sediment treatments
2. quantifying the critical thermal maximum of winter acclimatised juvenile epaulette sharks, and preliminarily,
3. documenting the impacts of suspended sediments on the behavioural responses of juvenile clown fish to predator cues.

Since my recent background involves the physiological and ecological responses of rocky shore intertidal organisms to climate change, I was able to apply my broad conceptual framework to a new system and learn an abundance of new research techniques and methodologies to answer similar questions in a new environment. All the while I was able to be a productive member of lab for the

winter, helping progress these projects forward in addition to meeting potential research advisors with which to earn my doctorate.

Perspective of research after this program:

a) Focusing specifically on your research project:

It was very exciting for me to be directly involved with the research I've been reading about in the literature for the past several years. Getting hands-on experience, particularly in the field, gave me a whole new perspective into the science itself that I couldn't possibly have gotten from reading the articles alone. To me, this was incredibly valuable because I now have skills that I can take with me to my PhD as I plan to switch my field of study from invertebrates to fish. In addition to gaining a new skill set, I was able to draw from my own thesis research experience to share information and ideas with my peers and offer alternative perspectives on project ideas and challenges. It was very exciting to have these kinds of high-level discussions with the lab!

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

Like many of my fellow EAPSI students are also probably arguing, international collaboration is extremely important—particularly for marine scientists tackling similar problems in different ways (or in my situation, asking similar questions but in different settings). There is so much to gain by understanding another group's reasoning, framework and approach to a question. Stepping away from my well-understood system of the rocky intertidal zone opened my mind to new ways of thinking and allowed for a fresh creative flow that I wouldn't have experienced had I not stepped out of my comfort zone. I feel that the more varied the backgrounds of collaborators are, the more unique experiences we have to draw upon to find new, creative solutions to global problems. In addition, networking for scientists on any scale is invaluable when it comes to searching for grants or job opportunities. Overall, spending this time in Australia has opened a number of doors for me both personally and professionally.

Australian advisor's remarks:

Hosting Elizabeth over the past several months in my laboratory and with my research team has been an absolute joy. Elizabeth has a fantastic attitude and came with an open mind to learn as much as possible, get her hands (and feet) wet, and immerse herself in the research my team is conducting and the techniques and protocols we are using. In addition to learning new techniques, Elizabeth was able to apply her own toolbox of protocols and her knowledge base, but to a completely new system here in the tropics and on the Great Barrier Reef. By working with several of my post-docs, PhD students, and MSc students, Elizabeth also interacted with many different approaches to research and communicating science.

The community and camaraderie aspects of my research team are just as important as the actual experiments, and Elizabeth embraced this and fitted in well. Elizabeth participated in our monthly lab meetings where we not only discuss science, but we engage in professional development, networking and communication activities. In addition, she also was in regular attendance at the Centre of Excellence for Coral Reef Studies weekly seminar and interacted with other researchers and students outside of my immediate team. Finally, before concluding her time with my research team, Elizabeth took the opportunity to meet one-on-one with five other faculty here in the Centre and marine sciences in general to discuss her background, what she did while she was here, and her plans for her academic future/career.

In summary, it was a pleasure to host Elizabeth, and I would be honoured to have her back, as I think she made immense contributions to my team, but I also see her potential as an extremely talented and driven scientist.

Participant: Thom Epps, University of Tennessee

Australian research advisor: Professor Tim Fletcher/Dr Dave McCarthy

Australian host organisation: University of Melbourne/Monash University

Title of research proposal: *Connecting distributed impacts in urban watersheds to in-stream hydrology and water quality observations through refined landscape metrics for optimal stormwater handling*

Research description:

My research seeks to develop methods to better assess impervious surface connectivity in urban watersheds as means to guide distributed installations of green infrastructure within the built environment so that they have the most positive impact on urban stream conditions. The aim of my research as part of the EAPSI program was to apply methods that I have developed to additional watersheds in Melbourne that have received a large amount of attention for water quality improvement. With rich monitoring data already available here, my methods of assessing impervious surface connectivity could be better verified through analysis of this rich dataset.

Research activities:

While finalising computer scripts needed for my methodology, I was able to present my work to researchers at the University of Melbourne and Monash University and get valuable feedback that guided a revision of this while I was in Australia. Because of this setback, I was not able to fully complete my analysis in the time allotted, but I have all of the data that was shared with me and hope to finish this as part of my dissertation and include it in future publication, forging potential lasting collaboration.

Perspective of research after this program:

a) Focusing specifically on your research project:

As part of this program, I received a wealth of valuable feedback from researchers in Australia that pointed me to some very important aspects that I had previously not considered due to a limited scope. By broadening my focus and assessing different watersheds in a completely different environment, city, and country, I feel my work has developed a much stronger basis to justify its application elsewhere.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

Through this program, I was able to make personal connections with researchers whose work I often cite and that has inspired me to pursue the path that I have. We are not just names in citations now, and this has already forged potential future collaboration. I am very grateful to have been given this opportunity to share my work with these respected researchers in Australia!

Participant: C. Adrian Figg, University of Florida

Australian research advisor: Professor Cyrille Boyer

Australian host organisation: University of New South Wales

Title of research proposal: *Degradable synthetic 'nanocantainers' to mimic biology*

Research description:

Biological processes isolate almost every reaction needed to sustain life through micro- or nanoscale compartmentalisation in order to separate incompatible materials. For example, the conversion of food into energy or the fighting of certain diseases both take place between many different biological 'containers'. In comparison, synthetic chemistry is still significantly limited when being used to create 'smart' materials to fight disease. My EAPSI project focused on synthetic polymerisation techniques to encapsulate and compartmentalise biomolecules using differences in polymer compatibility. Our aim of this research was to improve the efficiency of drug delivery, lower a drug's toxicity to healthy cells, and generally improve the 'smart' characteristics of nanomaterials.

Research activities:

The visible-light-mediated polymerisation technique that I had proposed to synthesise my nanomaterials with proved to be incompatible with one of my compounds. Therefore, my time was spent developing a polymerisation technique that would allow for my materials to be used. We were able to find an exciting and novel aqueous system that I defined the conditions for during my last couple weeks at UNSW. I plan to continue collaborating with Dr Boyer while I'm back at UF to both finish this project and synthesise the nanocontainers using the new technique.

Perspective of research after this program:

a) Focusing specifically on your research project:

The EAPSI program was particularly beneficial for this project because Australia has a strong public records infrastructure, making this site an ideal location to begin an examination of the lifecycle of nationally-funded data preservation projects. Findings from this project could inform the development and study of recordkeeping infrastructures in the United States, where recordkeeping systems lack the centralisation and/or standardisation that characterises Australian infrastructure.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

This experience re-iterates my strong belief in international collaboration. I performed undergraduate research abroad, but having this opportunity during my graduate studies was incredible. Being immersed in a different lab and culture tested my professional and personal capabilities and I have made friends and colleagues that will last throughout my career. Australia has a strong polymer chemistry program, and being able to directly interact with leading research groups is something not many students in my field have the opportunity of doing.

Australian advisor's remarks:

This is an excellent program, although it is a bit short (8 weeks). Perhaps, 3-4 additional weeks will be beneficial. Adrian has performed an incredible amount of work and brings his experience from another laboratory and country to my team. This has been extremely useful for my students to exchange idea and expertise with him.

Participant: Benjamin Fish, University of Illinois at Chicago

Australian research advisor: Dr Benjamin Rubinstein

Australian host organisation: University of Melbourne

Title of research proposal: *Creating fast and accurate data mining algorithms that preserve privacy*

Research description:

Previous approaches to big data mining tasks have, among other things, focused on a) achieving useful data mining algorithms that preserve the privacy of individuals or b) achieving fast and accurate algorithms, but not both. This research aimed to find algorithms for big data mining tasks that are simultaneously privacy-preserving, fast, and accurate, to the degree that this is possible.

Research activities:

This project focused on finding sub-linear time algorithms (that is, fast algorithms) that preserve differential privacy of counting queries, a standard task in the field of private algorithms. We showed how to sample from a database and then add noise in order to create privacy for this task, so that malicious users cannot compromise individual's private data.

Perspective of research after this program:

a) Focusing specifically on your research project:

This project has really opened up my eyes about the possibilities of international collaboration. Before this, I really didn't know that this kind of thing was even possible. Now, I am actively looking for similar opportunities in the future.

Participant: Micah Freedman, University of California, Davis

Australian research advisor: Professor Myron Zalucki

Australian host organisation: University of Queensland

Title of research proposal: *Contemporary evolution of monarch butterflies in their introduced Pacific range*

Research description:

Monarch butterflies (*Danaus plexippus*) are best known from their ancestral range in North America but have achieved a nearly global distribution in the past 200 years. In contrast to their North American ancestors, most of these recently established monarch populations are non-migratory, providing the opportunity to study morphological, behavioural, and genetic changes that accompany the shift from migratory to non-migratory status. In Australia, most monarch butterflies form resident populations that breed year-round and do not carry out long-distance migration. For my EAPSI research project, I conducted a growth chamber experiment to determine whether resident Australian monarchs would respond to environmental stimuli known to trigger reproductive diapause, a physiological state associated with migration, in their North American ancestors. I exposed non-migratory monarchs from the Brisbane area to environmental cues (specifically decreasing photoperiod during larval development) normally associated with the induction of migratory behaviour in North American monarch populations. I then measured reproductive development, body size, and wing morphology in newly-emerged adults as a proxy for their migratory status. In addition to this growth chamber experiment, I also visited three major museum collections containing approximately 500 pinned Australian monarch butterflies that were imaged and used for wing morphometric analyses.

Research activities:

My time at the University of Queensland was primarily spent conducting the growth chamber experiment. This entailed collecting wild adult females monarchs from two populations outside of Brisbane and then rearing eggs laid by these adult females under differing photoperiod treatments (constant 12:12 light:dark cycle or decreasing daylength treatment). Caterpillars were fed using milkweed (*Gomphocarpus* spp.) collected in the Brisbane area. After adult butterflies emerged, they were given 7-12 days for reproductive development and were then dissected. Female monarch reproductive development was assessed by counting the number of fully mature and yolked oocytes, while male reproductive development was assessed by recording the mass of the sac containing the testes. Results from this experiment indicate resident Australian monarchs still respond to environmental cues that trigger reproductive diapause in North American monarchs, although these responses are not as strong as those seen in North America and only present in females. These results suggest that even after 150 years of non-migration, monarchs may still retain the underlying genes necessary to resume their migration. In addition to the growth chamber experiment, I visited three museum collections and digitally imaged pinned monarchs. For these monarchs, I used image processing software to generate wing morphometric measurements. These results indicate that the shape and size of monarch forewings may be a function of latitude within Australia, with more southerly populations showing larger and slightly more elongated forewings.

Perspective of research after this program:

a) Focusing specifically on your research project:

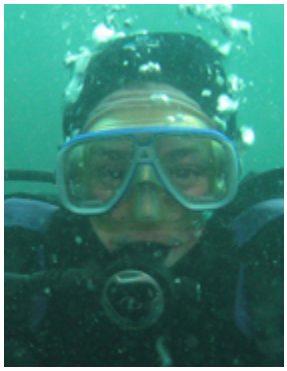
The EAPSI program was hugely beneficial for my research and provided me with valuable data that will serve as a centrepiece in future research proposals. I anticipate at least one scientific paper as a direct result of the data I was able to collect at UQ. Working with Dr Zalucki was and remains incredibly beneficial, as he is one of the world's foremost authorities on monarch butterfly biology and continues to provide me with relevant ideas, suggestions and reading pertaining to this and other projects.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

My time at UQ not only enabled me to cement an important collaboration with Dr Zalucki, but also provided me with data and samples of interest to other collaborators in the US. The experience of performing research internationally will aid in my ability to apply for and receive funding for future projects focusing on monarch butterflies outside of the United States.

Australian advisor's remarks:

It was a pleasure to host Micah. His enthusiasm for the project, dedication, commitment and planning enabled him to undertake experiments that seasoned researchers would have taken much longer to complete. I particularly enjoyed discussing ideas with Micah and look forward to working together with him as a colleague in the future.



Participant: Eliza Heery, University of Washington

Australian research advisor: Professor Emma Johnston

Australian host organisation: University of New South Wales

Title of research proposal: *Comparing food webs on natural and man-made shorelines in Sydney Harbour*

Research description:

The aim of this project was to characterise trophic structure on artificial and natural shorelines in Sydney Harbour. Shoreline habitats in coastal cities are heavily altered by artificial structures such as seawalls and pilings. Previous research from Sydney has indicated that artificial structures support novel assemblages of marine organisms, including different primary consumers and different amounts of macroalgal growth. We sought to identify whether these differences manifest in distinct food web relationships. Using stable isotope analysis, our objective was to compare trophic linkages between seawalls, pilings, and natural rocky shorelines.

Research activities:

From 14-17 June 2016 we collected sediments and rocky intertidal specimens from three habitat types (seawalls, pilings, and rocky shore), each within four sites in Sydney Harbor: Watson's Bay, Bradley's Head, Gore Cove, and Balmain. Sediments were collected via van Veen grab from a research boat operated out of the Sydney Institute for Marine Science. Snorkelers collected rocky intertidal samples by hand at each site. All samples were brought back to the laboratory at the University of New South Wales and frozen.

Though our original objective had been to process both sediment and rocky intertidal samples from all four sites within the eight-week EAPSI program, we quickly realised upon beginning the sediment sorting process that our proposed timeline had been excessively optimistic. The sediment and hard-substrate components of the study were therefore split up into two projects. The project looking at trophic linkages in hard-substrate food webs is to be carried out in collaboration with UNSW PhD student Shinjiro Ushiama and will be ongoing. The project on trophic linkages in sediments was my primary focus for the remainder of the EAPSI program.

We identified six specimens to be used in stable isotope analysis, including three sources of primary production (*Ecklonia* kelp, detrital *Eucalyptus* leaves, and the microphytobenthos in sediments) and three polychaete worms hypothesised to be from different trophic groups (suspension-feeding *Spiochaetopterus*, capitellid detritivores, and predatory lumbrinirids). With the help of a full-time intern, I sorted through 36 sediment samples and extracted all specimens in these categories. Specimens were then freeze dried, ground into a fine powder, and placed in tiny, pre-weighed cups for stable isotope analysis. In total, we produced 171 samples for stable isotope analysis. We have just received initial data from the Bioanalytical Mass Spectrometry Facility at UNSW and are beginning statistical analyses.

In addition to the proposed project, we were able to secure additional funding from the US National Science Foundation IGERT Program on Ocean Change and from Professor Johnston's lab to examine the sediment microbial community next to seawalls, pilings, and natural rocky shores via next generation sequencing. We performed DNA extractions from 24 sediment samples at the Sydney Institute of Marine Science. Extracted samples were sent away for sequencing. Microbial

composition from sequencing will be combined with stable isotope data in our final analysis to evaluate potential differences in assemblage structure at lower trophic levels between seawalls, pilings, and natural rocky shores.

Perspective of research after this program:

a) Focusing specifically on your research project:

Though we had to adapt our strategy in order to achieve all we set out to do, preliminary data appear promising and I am optimistic that they will provide insight into functional relationships on natural versus artificial shorelines. I am grateful to have gained new skills from the EAPSI program (preparing stable isotope samples and conducting DNA extractions), and to have gotten to work with a full-time intern for the duration of my stay in Sydney. I especially learned a lot while trouble-shooting and problem-solving for this project, not only because it required that I gain competency in new methods and areas of study, but also because the collaborative and cooperative environment and the extensive amount of expertise in Professor Johnston's lab meant that I could ask questions and find the right resources more quickly.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

I learned a tremendous amount from my time in Sydney, both personally and professionally, and am returning to my PhD program in the US with new ideas about how I'd like to proceed. Firstly, I am now a firm believer that the use of multiple, modern methodological tools that Professor Johnston's lab employs will be essential if we are to better understand the complex processes that result from marine urbanisation. I hope to direct my future endeavours accordingly, building on the new techniques and skills I gained during EAPSI. Secondly, I've realised it is extremely important to me to seek out collaborative and interactive professional environments for my future work. UNSW was the most welcoming and open science workplace I've found to date and it made each day a joy. Lastly, it is with great determination that I will work to maintain the collaboration formed through EAPSI. The exchange of ideas with Australian colleagues and mentors was wonderfully stimulating and I hope it will lead to further projects that help us understand more about the relationship between humans and marine ecosystems in urban areas.

Australian advisor's remarks:

This research project allowed Eliza to work with and learn first-hand from the Applied Marine Ecology and Ecotoxicology (AMEE) research group at the University of New South Wales. Eliza brought a wealth of experience in the field of urban impacts in marine sedimentary systems from similar large-scale projects in Seattle that are headed by UW. The project has generated interesting data on the changes in sediment food webs and microbial communities associated with the construction of artificial structures that can be used to inform eco-engineering designs in Sydney and Seattle. We think the work will be publishable and that the program that allowed Eliza to join us has been extremely mutually beneficial in the exchange of knowledge and ideas between research programs at Brown University and JCU, and I predict that Eliza's exposure to the results of evolution on the American and Australian continents will further the career of a promising young scientist.

Participant: Cameron Howard, University of California Berkeley

Australian research advisors: Dr Dhriti Bhattacharyya

Australian host organisation: Australian Nuclear Science and Technology Organisation (ANSTO)

Title of research proposal: *Investigating grain boundary strength of a helium implanted engineering alloy using micron-scale tensile testing*

Research description:

To develop a micro-tensile testing method to investigate the grain boundary strength of bulk structural components used in nuclear reactors and implement it on a control sample and a helium implanted sample which serves as simulating the effects of radiation damage by neutrons

Research activities:

- Performing helium implantation on a structural component such that it would have a similar helium concentration to active components for an accurate comparison
- Using the Focused Ion Beam (FIB) to make a batch of specimens in both samples (unirradiated and irradiated) with varying types of grains and grain boundaries and testing them in-situ in the electron microscope to prepare a complete sample matrix for obtaining a better insight into the role of grain boundaries in the mechanical deformation of these alloys

Perspective of research after this program:

a) Focusing specifically on your research project:

We were able to successfully prepare control and irradiated samples and perform the helium implantation in a way which produces similar helium concentrations to the active components. Due to complications with sharing instrument time and sample fabrication, we were not able to complete the full sample matrix and testing. However, the samples will be left at ANSTO for this work to be finished by my collaborators.

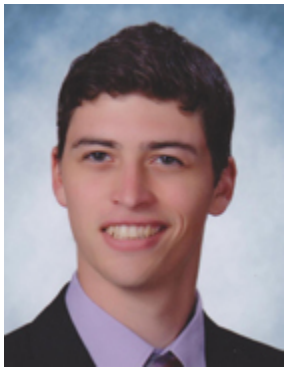
b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

International collaboration is seen on a daily basis at ANSTO. The diverse group of researchers that I work with—from visiting undergraduate students, masters students and permanent staff—is an excellent melting pot. In addition, I was able to interact with AINSE winter school Australian students and share with them my experiences as an international researcher at ANSTO as well as opportunities in the US. Several of my collaborators have lamented the fact that this program isn't longer and hinted at an Endeavour Fellowship.

Australian advisor's remarks:

I would like to mention at the outset that I am very appreciative of this program of international collaboration run by EAPSI in association with NSF and AAS. In regards to this particular research, we have had an extremely valuable collaboration with UC Berkeley, in particular with Cameron Howard, who is working for his PhD degree there. His time here has been fruitful in the application of certain new techniques that we have been developing here at ANSTO, and also in obtaining insight into the deformation mechanism of real-life nuclear structural materials, which had hitherto been unknown at the scale that has been tested here. I agree with Cameron's assessment that this is a very useful

program, which could have been made more productive if the duration of the research period had been longer, e.g. 10-12 weeks instead of 8 weeks. Overall, I believe this to be a very useful program, which can be improved further by increasing the research period as mentioned above. I would also like to commend Cameron's efforts in this research and would like to wish him all the best for his future work. I take this opportunity at this time to thank Professor Peter Hosemann, Cameron's advisor, for sending him to work with us, and hope that we will continue to have a fruitful working relationship in the future.



Participant: Jacob Ivy, Colorado School of Mines

Australian research advisor: Associate Professor John Daniels

Australian host organisation: University of New South Wales

Title of research proposal: *Determining grain size effects on ferroelectric switching speed by time-resolved neutron diffraction measurements*

Research description:

Defects and interfaces in materials can play a wide range of roles with regard to properties. Some defects increase toughness or increase electronic conductivity while others cause premature structural failure or serve as electron traps. In ferroelectric (FE) materials, the roles of some defects are still unclear. Deviations from the ideal lattice, from vacancies to grain boundaries, are often implicated in FEs as nucleation and/or domain wall pinning sites. Nucleation of new domains still lacks a reasonable quantitative description, and descriptions of pinning sites are typically given in terms of abstract energy landscapes. A more fundamental understanding of these phenomena is required to help improve the performance of FEs across multiple applications, such as ferroelectric random access memory or piezoelectrics. The goal of the proposed research was to begin to link the energy barriers currently used to describe domain behaviour to real chemical and/or structural features rather than abstract representations.

Research activities:

Research activities throughout this project ranged from the creation and characterisation of samples to the testing of these samples at the neutron beam line at the Australian Nuclear Science and Technology Organisation (ANSTO) and analysing the resulting data. Barium titanate ceramic samples were made both at the home university and at the host institution of the supported student prior to and during the first six weeks of the EAPSI program. Neutron diffraction experiments were performed at ANSTO during week eight, and data analysis is currently in progress. During the course of the diffraction experiments, due to a range of unforeseen problems, the proposed tests were modified to examine a different phenomenon: the low electronic field domain dynamics of lead zirconate titanate ceramics.

Perspective of research after this program:

a) Focusing specifically on your research project:

The proposed research topic will continue to be examined through further collaboration with the host advisor at the Australian Synchrotron in Melbourne later this year. The synchrotron uses high energy x-rays as the diffracted radiation, as opposed to neutrons, and is capable of much higher rates of data collection. This should result in faster experimental runs, which means a higher degree of flexibility with the trials allowing them to be modified if things go awry.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

This program has served to further impart the importance of collaboration, both domestically and internationally. In the field of electronic ceramics, and science as a whole, one cannot be an expert in all things. The ability to call on others to assist in solving problems is necessary for a scientist to have a long, successful career. This program provides an excellent opportunity to young scholars to begin fabricating their international professional network and to develop the skills necessary to work with people of all backgrounds and cultures.

Australian advisor's remarks:

Jacob's stay at UNSW has been productive and future collaborations between my research group and that of his home research group in the USA are certain. The work done was preliminary to further collaborations on the mechanisms of actuation in electroceramic materials. Planning for further collaborative experiments later in the year is already done, and I expect to visit the students' home institution within the next year.

The administrative support provided by the program was helpful in ensuring a smooth placement here in Sydney (other programs often don't provide such support).

I look forward to working further with the student and his supervisor in the future.

Participant: Scott Jones, Arizona State University

Australian research advisor: Dr Vaughan Clarkson

Australian host organisation: University of Queensland

Title of research proposal: C*omputation of Wishart eigenvalue distributions for multi-channel passive radar detection*

Research description:

The goal for this EAPSI project was to improve computation of the probability distribution of the largest eigenvalue of a complex Wishart matrix. Motivated by problems in passive radar detection, current best implementations overwhelm floating point arithmetic for realistic problem sizes. This project seeks to use techniques from linear algebra, statistics, and approximation theory to reformulate the distribution in a way that will allow floating point computation for realistic problems encountered in radar systems.

Research activities:

While at the University of Queensland, the project first focused on a theoretical understanding of proposed approximation theory based techniques to rewrite the distribution of the largest eigenvalue of a complex Wishart matrix and eliminate large terms causing overflow in problems realistically encountered in passive radar systems, then transitioned to primarily computational experiments to implement and test the derived algorithms to compute CDF's.

The theoretical portion of the work entailed expanding the distribution functions using orthogonal polynomials to eliminate the large terms causing floating point overflows. These reformulated distribution functions were tested and compared to previously known expressions for small problem sizes and Monte Carlo simulations for the large problems of interest to demonstrate their accuracy and feasibility for calculating detection thresholds. Theoretical error bounds and algorithm speed are topics that will be explored via ongoing collaboration over the coming months.

Perspective of research after this program:

a) Focusing specifically on your research project:

I found the research performed during the program was beneficial as I learned a great deal about the current state of the art in multi-channel detection, random matrix theory, and approximation theory. The work progressed well with plans to publish the results and for ongoing collaboration to expand on the project over the coming months.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

The EAPSI program provided an excellent opportunity not afforded to many graduate students, to foster international collaboration at the earliest stage of an academic career. I found it very valuable to work more closely for an extended period with researchers outside my home institution and to receiver exposure to an academic culture that differs from that found in the United States. I have a greater understanding of the importance of international collaboration in science and will strive to make this a priority in my future scientific career.

Australian advisor's remarks:

Scott was a valuable addition to the research team at UQ. It was a pleasure to host him. Scott made excellent progress through the term of his scholarship. A conference paper for peer review in the top international conference in our field is now in the advanced stages of preparation. The paper is being chiefly written by Scott and results directly from the work undertaken while Scott was visiting. I have no doubt that fruitful collaboration will continue into the future, thanks in large part to the opportunities provided by EAPSI.

Participant: Michael Lodge, University of Central Florida

Australian research advisor: Professor Michael Fuhrer

Australian host organisation: Monash University

Title of research proposal: *Phase engineering of tungsten disulfide/quasiparticle interference of a line-nodal Dirac semimetal*

Research description:

Control of matter at the atomic level can enable interfacing of semiconductors and metals with atomically-precise junctions. Fabricating circuit elements in this manner would dramatically increase the efficiency of electronic devices made from such elements by reducing electronic resistance to a minimum. Control over a material at the atomic level can be realised in atomically-thin layers of transition metal dichalcogenides (TMDs), which undergo a structural transformation from a semiconducting phase to a metallic phase upon injection of electrons into the material.

My originally-proposed research was to use scanning tunneling microscopy (STM) and scanning tunneling spectroscopy (STS) to investigate the electronic structure and phase manipulation of atomically-thin layers of the TMD tungsten disulfide. Chiefly, this research aimed to correlate atomic structures with local electronic properties at the metallic-semiconducting interface, and to investigate the creation of such junctions via electron injection into the material from the STM probe.

Device geometry issues and time constraints led me to work on a different project. I investigated the band structure and the selection rules for electronic charge scattering in a topological line-nodal semimetal using STM/STS techniques. In this material, there is a predicted line-like touching of the conduction and valence energy bands that forms a closed, diamond-shaped loop in momentum space. Additionally, the energy of charge carriers in this material is predicted to disperse linearly as a function of momentum, not only in the bulk material where the line nodes are, but also at the surface in certain directions. The exotic quasiparticles hosted by this non-toxic material both at the surface and in the bulk over a wide range of energies make it attractive for experimental study and for the potential fabrication of emerging ‘topotronic’ devices.

Quasiparticle interference (QPI) mapping probes the electrons scattered by defect sites at the crystal surface. By correlating the predicted band structure with the observed electron interference patterns, we can discover selection rules for electron scattering in the material, which governs basic material properties like electrical resistance. Additionally, we can look at the energy-momentum relationship of scattered electrons in the conduction band in order to reconstruct parts of the band structure that are inaccessible to other experimental techniques, like ARPES, and experimentally verify the line-node behavior of electrons.

Research activities:

Day-to-day activity involved sample preparation and data acquisition using the STM. Data acquisition primarily involved first calibrating the spatial and electronic measurements of the microscope, then taking data on the material system of interest. The time-consuming and tedious nature of the measurements motivated the development of custom programming routines to systematise both the collection and processing of the data in order to ensure uniformity of the data collection and

processing conditions across all of our data sets. To this end, we developed LabVIEW routines for systematising data collection and Python scripts to batch process the data.

We acquired QPI data using several operating modes of the STM to determine which one worked best. We reached out to a Dr Hsin Lin at the National University of Singapore to help provide the theoretical framework of our observations. This collaboration is ongoing as we continue to analyse our results. Additionally, I was able to characterise several other physical properties of the material, like the identity of atoms at the surface to determine to cleaving plane and also the thickness of a single layer of the material.

Perspective of research after this program:

a) Focusing specifically on your research project:

Learning the technique of quasiparticle interference mapping to determine electronic information was fascinating, especially as it becomes increasingly important for visualising exotic quasiparticles in newly-realised topological systems. I intend to utilise this method of investigation in my future studies.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

Working in Professor Fuhrer's lab at Monash University highlighted the fact that certain experts are occasionally located on other continents, and that the nature of modern data storage and communication methods remove some of the barriers that might otherwise inhibit collaborations with researchers separated by an ocean. Facile fostering of collaborative efforts is mutually beneficial to both parties, such as in our experimental work combined with the theoretical work of Dr Hsin Lin's group in Singapore.

EAPSI provided valuable experience in proposing research and in grant writing. The insights I gained will help guide me in writing future grant proposals in my academic career.

Australian advisor's remarks:

By mutual agreement, Michael ended up working on a slightly different project than we originally intended. Michael was able to bring with him from Professor Madhab Neupane's lab at UCF some samples of a new line-nodal topological Dirac semimetal, ZrSiS. This presented an exciting opportunity to perform the first scanning tunneling microscopy (STM) and spectroscopy (STS) on this system. Michael worked closely with Dr Bent Weber in my lab to prepare samples and perform STM and STS measurements. He was able to implement a new technique for our lab, quasi-particle interference (QPI) mapping, which studies the patterns of electron waves reflected from defects in a material, inferring both the bandstructure of the material as well as the rules which govern allowed scattering events. Michael took extremely interesting and high-quality data, which we are now analysing. We have begun a new collaboration with Professor Hsin Lin at the National University of Singapore to model the data, and the initial results indicate we have strong evidence for the expected suppression of certain scattering events due to topological protection in this material. We expect a high-impact paper to result from the work.

The EAPSI fellowship thus resulted in strengthening the existing collaboration between my lab and Professor Masa Ishigami's lab at UCF, as well as building new collaborations with Professor Lin, Professor Neupane and Dr Bent Weber (soon to be Assistant Professor at Nanyang Technical University). It was a pleasure hosting Michael Lodge in the lab. He is technically skilled and knowledgeable about condensed matter physics, and he is very easy to get along with and interacted well with the other group members. He has a promising scientific career ahead of him.

Participant: Ryan Loe, The University of Kentucky

Australian research advisor: Dr Jorge Beltramini

Australian host organisation: University of Queensland

Title of research proposal: *Improving and understanding the catalysts used to convert biological oils to diesel fuel*

Research description:

The depletion of fossil fuels and the negative environmental impacts of their consumption are well known problems that require the development of alternative fuels sources. Biodiesel, or fatty acid methyl esters (FAMEs), obtained through transesterification of plant and animal fats is one renewable fuel that has gained significant attention. However, the poor storage stability, cold flow properties and engine compatibility problems with FAMEs keep it from being a drop in fuel replacement to fossil fuels. The drawbacks are attributed to the oxygen content in these fuels: therefore, recent work has been focusing on the deoxygenation of animal and plant fats to produce fuel like hydrocarbons that are completely fungible with fossil fuels. This hydrotreating, elimination of oxygen as water, of lipids is the current commercialised method employed for the conversion of these feeds to renewable hydrocarbon fuels but it requires high hydrogen pressures and problematic sulfided catalysts. Catalytic decarboxylation/decarbonylation (deCOx), elimination of oxygen as carbon dioxide or carbon monoxide, has the potential to be a viable alternative that uses simple supported metal catalysts and is more energy and hydrogen efficient.

Recently, Ni-based catalysts are attracting attention as promising metal formulations for the catalytic deCOx of lipid-based feedstocks to fuel-like hydrocarbons. In previous work, alumina-supported bimetallic Ni-Cu catalysts were developed that outperformed expensive Pd- and Pt-based formulations in deCOx of lipids. Various catalyst support materials, such as carbon, zirconia, titania, silica, and alumina, have been utilised in the catalytic deCOx of lipids. However, the impact of the support morphology has yet to be studied in this application. Support morphology affects the surface area and porosity of the support, both of which have been shown to impact catalytic performance in other processes. Therefore, investigating the synthesis of alumina morphologies was the primary goal of this work. Another point of interest is the catalyst preparation method, where previous work used a wetness impregnation of the active metals onto the support. Preparation methods can result in different active metal particle size and dispersion on the support which impacts the overall catalytic performance. The main objectives of this project were to synthesise alumina supports of different morphologies and synthesis Ni and Ni-Cu catalysts using these supports in two different catalyst synthesis methods, microemulsion and wetness impregnation.

Research activities:

Through the duration of the EAPSI program the main task was synthesising alumina supports. Scaling up the synthesis was problematic, so numerous smaller batches of the supports were made. These were then analysed through nitrogen physisorption, which measures surface area and pore size, followed by transmission electron microscopy to confirm the support morphology. The microemulsion synthesis technique was used to make a supported Ni catalyst on the support morphology as well.

Perspective of research after this program:

a) Focusing specifically on your research project:

My past research had focused on identifying the most promising Ni-based metal formulations for the catalytic deCOx of lipids to fuel like hydrocarbons using commercially available metal oxide supports. The EAPSI program allowed me to work with a nanomaterials group and learn new techniques to synthesise different alumina morphologies. I also learned a new catalyst synthesis method, that being the microemulsion method, which will be interesting to compare with the wetness impregnation method that I have used in the past. These techniques will also be taught to other students at my home institution and will hopefully be applicable on a wider variety of projects.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

The EAPSI program provided a unique experience to conduct research at a foreign institution. Beyond my research goals, the program offered significant opportunities for growth for me personally since I am the only person in my family to have travelled outside of the United States. Through this program, I was able to experience the research and laboratory practices of another country and it provided the opportunity to build international collaborations. The program also emphasised the importance of collaborations to expand the knowledge and skill set of all persons involved. I am thankful for this opportunity as I have gained new skills, collaborators and friends from the EAPSI program that will last long after the programs completion.

Participant: Julie McGettrick, University of Montana

Australian research advisor: Professor Emily Hilder

Australian host organisation: University of South Australia

Title of research proposal: C*haracterisation cationic latex nanoparticles*

Research description:

The goal of my PhD research is to develop an electrokinetic chromatography (EKC) method to separate both anionic and neutral compounds at the same time. EKC uses the instrumentation of capillary electrophoresis and the principles of chromatography to achieve rapid and efficient separations. A pseudostationary phase (PSP) is added to the background electrolyte to interact with neutral analytes and separate them based on their affinity for the PSP. In my research I synthesise cationic latex nanoparticles to use as PSPs by reversible addition-fragmentation chain transfer (RAFT) polymerisation. The goal of my EAPSI research was to learn more about these nanoparticles and try to understand why some perform better as a PSP than others. I brought samples of nanoparticles that I synthesised in Montana and wanted to do transmission electron microscopy (TEM), nuclear magnetic resonance spectroscopy (NMR), and capillary electrophoresis in the critical condition (CE-CC).

Research activities:

I focused my efforts on 10 different nanoparticle samples. I was able to get a nice TEM image for one nanoparticle sample, but other samples either aggregated or burned up in the electron beam. We tried characterising the samples by CE-CC using both pressure mobilisation and non-aqueous CE techniques, but got inconclusive results. Despite this, I will continue to work on optimising the conditions at the University of Montana. The most promising technique was diffusion NMR. Diffusion NMR can be used to calculate particle size, and can resolve multiple populations in a sample. I was able to collaborate with Nathan Williamson to do diffusion NMR experiments at several concentrations and in different solvents. Nathan's Matlab program can then fit the data to a distribution of nanoparticle sizes. We found that biexponential fits best fit the data, which suggest that there are two populations in each sample: larger nanoparticles and something smaller that could be small polymer chains that do not get incorporated into the nanoparticles. I left some of my samples at the University of South Australia so Nathan can continue to investigate them. During my time at UniSA I also had the opportunity to present my research at the Royal Australian Chemical Institute's Analytical and Environmental Division Symposium in Adelaide in July.

Perspective of research after this program:

a) Focusing specifically on your research project:

Most of my research at the University of Montana has been on nanoparticle synthesis or electrokinetic chromatography separations, but we lack the instrumentation and expertise to do polymer characterisation. Being at UniSA gave me access to both of these, and really helped to fill a gap in my knowledge. I was able to talk to many researchers who do nanoparticle characterisation, and I learned a great deal about what will and will not work for my type of samples. It was helpful to be in an environment where materials science is a big focus.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

One of my favourite things about my experience was getting to meet people from around the world. I had the opportunity to meet and talk to experts both in nanoparticle characterisation and separation science, which has expanded my knowledge base and professional network considerably. The opportunity to collaborate with Nathan was beneficial for both of our research projects, and we hope to get two publications out of it.

Australian advisor's remarks:

It was a pleasure to host Julie in the Future Industries Institute (FII) at the University of South Australia. Julie is hardworking and friendly and fitted in as a key member of our research team during her visit. Her work contributed to ARC funded research within my group and she was able to work closely with a Foundation Fellow and PhD student working in the same general area. We hope that this research collaboration will continue and that this will lead to future publications and contribute to ongoing collaboration between the University of South Australia and the University of Montana. I'm particularly pleased that Julie was able to explore new directions for her research by accessing the broad capabilities in FII and that this led to a new collaboration with another research group, which we had not conceived in her application. We would welcome Julie back to South Australia at any time and hope that she enjoyed her time here as much as we enjoyed hosting her visit.

Participant: Amelia Munson, Monash University

Australian research advisor: Associate Professor Bob Wong

Australian host organisation: Monash University

Title of research proposal: *Anti-predator behaviour in response in novel predators using Midas cichlids (*Amphilophus labiatus*)*

Research description:

I initially planned to study anti-predator behaviour in a colour polymorphic fish (Midas cichlid—*Amphilophus labiatus*) to determine whether differences could explain the maintenance of the colour morphs. However due to a number limitations of one of my colour morphs, I refocused my project to study behavioural responses of an introduced prey species (*A. labiatus*) to an introduced predator (barramundi—*Lates calcarifer*).

The project took advantage of an introduced population of Midas cichlid in Hazelwood Pondage (Australia), which historically has reduced predation pressure. Midas cichlid were collected from the pondage prior to the introduction of barramundi, a close relative of a native predator of the Midas cichlid, by the sport fishing group Future Fish Foundation. These fish were used for behavioural assays to examine their response to barramundi and will be compared to a sample of cichlid collected in one year.

1. To examine whether predator naïve fish respond appropriately to introduced predators
2. To asses whether behavioural measures of boldness are consistent across multiple tests
3. To compare behavioural responses of predator naïve fish to fish with predator experience

Research activities (project activities and outcomes):

Each Midas cichlid (n=31) was individually tested twice in a tank with a compartment at either side; once with a barramundi in one compartment and once with both compartments empty. Each test lasted for 20 minutes. Activity level and time spent in the centre and near each side was measured from video recordings of the trial. Analysis is ongoing.

Perspective of research after this program:

a) Focusing specifically on your research project:

This program gave me the opportunity to conduct research on a unique organism at a unique time. While my initial project did not go as planned, I was able to adjust my project to ask new questions about dynamics between predators and prey. I am particularly excited to see how the demographics of the pond change as the barramundi establish themselves and to retest fish once they have had experience with the barramundi for one year.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

This program was incredibly valuable for me in terms of establishing myself as a researcher. The advice and collaborations that I gained from meeting with people in Australia have really solidified my belief that international collaborations have the potential to push science forward. Specifically for me, working with Bob Wong has opened up the potential to collaborate on a grant he has submitted on invasion ecology.

Australian advisor's remarks:

Amelia has been a fantastic ambassador for the program. She worked hard, applied her smarts to the project (including troubleshooting and coming up with effective solutions to resolve issues with her experiments) and integrated herself with the rest of my group. In fact, she very quickly became a valued and much-liked member of my team. In terms of forging collaborative links, it is very much my hope to bring Amelia back out to Australia to extend her research and I have already been in discussions with her PhD supervisor at UC Davis to find ways in which we can continue collaborating. This has been a wonderful experience for me as the host because Amelia has been simply wonderful!

Participant: Megan L. Riley

Australian research advisor: Dr Brendan Choat

Australian host organisation: Western Sydney University

Title of research proposal: *Quantifying interconnecting pore characteristics of leaf water transport conduits in three Australian evergreen tree species using laser and electron-based imaging systems*

Research description:

Our objectives are:

1. to determine size, distribution, density, and location of pits in tracheids and transfusion tracheids
2. image and document physical characteristics of leaf torus-margo structures
3. document intact leaf hydraulic pathways and water status
4. compare pit and torus-margo characteristics to published data for other anatomy (root, bole, and branch) of respective species if available.

The proposed study species were *Callitris rhomboidea*, *Araucaria cunninghamii* and *Pinus radiata*.

Research activities:

Actual species used were *Wollemia nobilis* and *Araucaria bidwillii*. Actual research activities included:

1. embedding leaf samples in resin
2. light microscopy of leaf transects for basic leaf anatomy
3. confocal microscopy to image pit torus structures and transfusion tracheid tissue
4. rehydration kinetics to evaluate leaf water status during desiccation
5. scanning electron microscopy (SEM) of tracheids, transfusion tracheids, and pits within these cells
6. optical viewing using a scanner bed and light microscopy to visualise embolism in leaves of *W. nobilis* and a branch segment of *A. bidwillii*.

Outcomes included imaging in support of objective (1) and the surprising result that neither of our actual study species actual contained torus-margo structures within the leaf tracheids, although previous research has shown they are present in the stem tracheids. Though not included in our original project aim, we successfully demonstrated that the optical view technique can be used on conifer leaves, which has not yet been published.

Perspective of research after this program:

a) Focusing specifically on your research project:

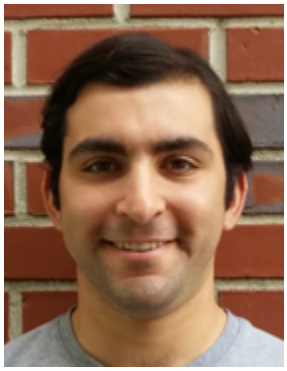
Eight weeks was not sufficient time in regards to completing a project that incorporates new species or new methodologies nor is it enough time to account for unforeseeable issues such as technical difficulties or personnel on sick/holiday/maternal leave. Additionally, we did not anticipate that the first week would be devoted to lab trainings, equipment trainings and required risk assessments before lab/imaging work could commence. However, my research project has produced some unexpected results that will be of interest to plant hydrologists and modelers in plant–leaf water functioning and embolism.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

A successful project can be measured beyond just completing objectives. Developing personal and professional relationships within my field is critical to my continued success and a scientist within my field. International collaborations allow for exchanges of ideas and concepts that transcend institutional and continental boundaries and encourage new and different ways of interpreting existing knowledge and contentious issues.

Australian advisor's remarks:

It was a pleasure to host Megan during her EAPSI fellowship. Although it was not possible to complete all of the objectives of her research project as originally outlined, I believe the primary value of a short international fellowship is making direct contact with researchers in the host country and being exposed to new ideas and techniques. By this measure Megan's fellowship was a great success and it will foster further collaboration between my lab and the lab of Megan's primary supervisor at the University of Idaho.



Participant: Austin Schwartz, Florida State University

Australian research advisor: Professor Glenn King

Australian host organisation: University of Queensland

Title of research proposal: *Synthesis of novel drug delivery molecules for in-vivo tracking and targeting*

Research description:

Venom-derived peptides make fantastic drug candidates as they have a strong structural stability and target selectivity. The goal of my proposed research was to synthesise the venom-derived ion channel inhibitor Margatoxin (MgTx) in an advantageous form such that it can be easily bound to nanoparticles, in turn providing a novel means to target and track the peptide following delivery. This bioconjugate could then later be delivered towards a potential metabolic target found within the olfactory bulb.

Research activities:

My research activities were focused upon recombinant expression of the peptide MgTx in the yeast strain Pichia Pastoris and purification using affinity chromatography and high performance liquid chromatography (HPLC). Although I had difficulties producing MgTx using recombinant expression, I was able to obtain a large quantity through solid phase chemical synthesis. Alternatively, I also produced a similar peptide that has a similar affinity to my target of interest through recombinant expression.

Perspective of research after this program:

a) Focusing specifically on your research project:

Despite having difficulties, my research experience in Australia turned out quite well. I was able to bring home a large amount of materials that will directly aid in the completion of my thesis. I expect to continue the work I did in Australia at home and will definitely maintain the collaboration.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

The EAPSI program was a fantastic experience. Along with my host advisor, I had the opportunity to meet many other researchers with similar ideas and interests who showed enthusiasm towards my research. Having my ideas and opinions validated on the opposite side of the world was truly fulfilling. I will continue to communicate and collaborate with many of those I met in Australia and have no doubt that this experience will benefit my career path.

Australian advisor's remarks:

It was an absolute pleasure having Austin in my lab. He worked extremely hard and is now skilled in production of recombinant proteins via yeast expression. He was additionally exposed to solid-phase peptide synthesis techniques, which proved to be a good alternative for production of his peptide of interest (margotoxin). While he was here, Austin gave an oral presentation of his work to my group (approximately 25 people) which was very well received as we have a mutual interest in intranasal delivery of peptides to the brain. I am certain that Austin's visit will lead to a long-term collaboration between my lab and the lab of his PhD mentor Dr Debi Fadool.

Participant: Jeffrey Simkins, Montana University

Australian research advisor: Professor Michael Johns

Australian host organisation: University of Western Australia

Title of research proposal: *Non-invasive oxygen measurement in a reverse osmosis membrane using fluorine nuclear magnetic resonance*

Research description:

As fresh water becomes scarcer in the coming century, traditional water sources will need to be supplemented to meet demand. This will primarily be accomplished using reverse osmosis (RO) membranes, which extract clean water from saltwater or wastewater, due to their low energy consumption. However, RO membranes are easily degraded by microbial growth, and we have limited ability to detect bacterial-induced damage before the degradation becomes irreversible. The present project will pioneer a new, non-invasive method for identifying bacterial growth on RO membranes using 19F NMR oximetry. The project will demonstrate the feasibility of using fluorinated oxygen reporters to noninvasively quantify oxygen in reverse osmosis membranes, both at high field and earth's field.

Research activities:

1. Modify pulse sequence and data analysis programs on Earth's Field spectrometer to allow for the simultaneous measurement of hydrogen and fluorine spin-lattice relaxation times, among other useful parameters (such as diffusion coefficient).
2. Demonstrate that hexafluorobenzene can be used to quantify oxygen concentration in model RO membrane systems, both at high field and Earth's Field, using a non-biological oxygen scavenger due to project time constraints.
3. Use Pulsed Gradient Spin Echo (PGSE) NMR to characterise droplet sizes of emulsions of hexafluorobenzene in water. These emulsions could be employed to measure oxygen levels in RO membranes.

Perspective of research after this program:

a) Focusing specifically on your research project:

The research fellowship went very well. We were able to collect solid proof-of-concept data in the short period of time allotted and it is likely that my work will form a significant part of a peer-reviewed journal publication. Some aspects of the project had to be altered to meet the time constraints (i.e. we used a non-biological source of oxygen consumption rather than waiting weeks for biofouling to occur), but this was expected and did not limit the value of the research.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

Collaboration with my host advisor and his lab has been invaluable to me. I learned several new lab techniques that I can apply in the future and learned many aspects about the science of emulsion stability, which will be crucial for my research back in the United States and may save me a great amount of time and frustration. My skillset has expanded considerably. I have also had the opportunity to network extensively with members of my host advisor's lab, and I am confident the contacts that I have made will be extremely helpful in my future career prospects (e.g. post-doc/faculty positions). I would love to work with my host advisor in the future.

Australian advisor's remarks:

Jeff was a pleasure to host in our research group. He was bright, focused, enthusiastic, engaged and creative. He actively participated in a number of research projects in our group and is clearly focused on, and very capable of, establishing himself in a research career. In terms of the project objective - the observation of O2 consumption in membrane module - he was able to deliver on it extremely well, despite the relatively short timeframe of his visit. It is very probable that the results will contribute significantly to an international peer-reviewed publication. We also firmed up on research collaboration between my research group and Jeff's research group at Montana State University; establishing two very promising areas of future research—namely B.O.C. measurements using Fluorine NMR and the use of earth's magnetic field NMR to monitor oxygen levels in a convenient and robust manner. Jeff's visit was thus collectively very rewarding. Thank you for funding Jeff to undertake this opportunity from which we all benefitted enormously.

Participant: Katherine Skinner, University of Michigan – Ann Arbor

Australian research advisor: Professor Stefan Williams

Australian host organisation: University of Sydney

Title of research proposal: *Decoding focused plenoptic camera for use in realtime robotics*

applications

Research description:

As opposed to traditional cameras, plenoptic or light field cameras use an array of microlenses between the image sensor and the main lens to capture both intensity and ray direction of incoming light, enabling color and depth measurement from a single passive sensor. The main goal of this research project was to develop methods for decoding a focused plenoptic camera with the requirements that the developed methods are computationally efficient and simple to implement while preserving the total light field structure. Fulfilling these requirements would enable the developed methods to be incorporated into realtime robotics applications for future work.

Research activities:

For this project, I developed and implemented algorithms to decode a focused plenoptic camera, specifically the Raytrix R5 light field camera. I also gathered multiple datasets including one in low light settings and another one underwater in a saltwater sea pool in Sydney. Throughout the program, I collaborated with researchers at the Australian Centre for Field Robotics (ACFR) at University of Sydney, as well as the Australian Centre for Robotic Vision (ACRV) at Queensland University of Technology in Brisbane.

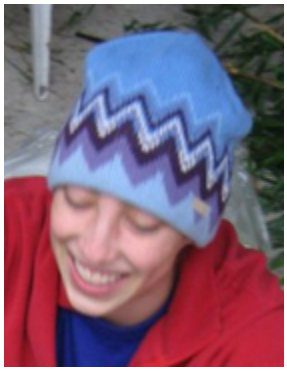
Perspective of research after this program:

a) Focusing specifically on your research project:

Leaving this program, I feel like I have gained a lot of specific and valuable knowledge about working with plenoptic cameras which was made possible by the contacts I made at ACFR and ACRV. I feel like this experience has put me in a great position to make a contribution to my field and I am leaving with even more motivations and questions to answer going into the third year of my PhD program at University of Michigan.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

Moving forward, I will continue to collaborate with researchers I worked with at both ACFR and ACRV. These collaborations will lead to publications in the near future and, hopefully, further opportunities in my future research career.



Participant: Samantha Stutz, University of New Meico

Australian research advisor: Dr Lucas Cernusak

Australian host organisation: James Cook University

Title of research proposal: *CO_2 refixation in four early successional rainforest species.*

Research description:

My proposed research was different from the research I conducted. Please read question 3a for more information.

Tropical rainforests are some of the most productive and diverse biomes on Earth. Tropical plants are adapted to high shade environments and often a small seedling will remain 'dormant', waiting for an opening to access more light and grow. As a result tropical species have several adaptations which help them maximise photosynthesis, 1) leaves with a large surface area for capturing more light and 2) green stems which photosynthesise.

In most plants the main photosynthetic organs are leaves, however, the thin layer of photosynthetic cells found below the bark in branches and stems provide a way for plants to recycle CO2 generated from respiring cells. Refixation has several advantages over leaf photosynthesis: 1) high concentrations of CO2 which reduce rates of the oxygenation reaction (photorespiration) and 2) higher water use efficacy (WUE), the ratio of carbon gained to water loss. While refixation maybe particularly important under conditions of stress such as drought, it is likely important for understory tropical species seeking additional light for photosynthesis. The focus of my study was measuring how woody-tissue photosynthesis varied across species and light-level in four early successional rainforest species. My project was composed of two components: 1) assess how branch photosynthesis varies in four early successional tropical tree species and 2) assess how covering branches with aluminium foil impacts leaf photosynthesis and stomatal conductance.

Problem:

1. How does the rate and contribution of branch refixation change across different light-levels in four early successional tropical tree species?
2. How does branch refixation affects stomatal conductance and leaf photosynthesis?

Objective:

1. Determine how rates of branch refixation change across different light-levels in four early successional tropical rainforest trees. This was accomplished by measuring rates of branch CO2 efflux in the dark and across 5 different light-levels.
2. Determine how branch refixation affects stomatal conductance and leaf photosynthesis in Elaeocarpus angustifolius. This was accomplished by measuring rates of leaf photosynthesis and stomatal conductance before covering branches with aluminium foil for 4 weeks and measuring leaf photosynthesis and stomatal conductance and the CO2 efflux of the covered branches at the end of the 4 weeks.

Research activities:

My research question and target species changed; however, I still measured branch refixation in tropical tree species as originally proposed. Branches were cut and sealed with hot glue before being placed in a closed-loop chamber connected to a CO_2 Picarro which measured the [CO_2] and the ratio

of 12C/13C in the respired CO_2. Total branch CO_2 efflux was measured in the dark followed by measuring CO_2 efflux at 5 light levels. Rates of refixation were similar to previously published values with refixation rates between 50-70%.

The second component of the project consisted of covering branches with aluminium foil for approximately four weeks and measuring leaf photosynthesis and stomatal conductance before and after covering using a portable photosynthesis machine. Stomatal conductance and leaf photosynthesis decreased in branches covered with foil and some branches covered in foil died.

I anticipate my research from the EAPSI program will result in a peer-reviewed article and a presentation at a scientific meeting. In the near future I will be giving a seminar and writing a blog post at my home institution, the University of New Mexico.

Perspective of research after this program:

a) Focusing specifically on your research project:

My proposed research was studying how woody-tissue (branch and stem) photosynthesis differed in trees experiencing drought stress compared to trees not experiencing drought stress at the Daintree Rainforest Observatory (DRO) operated by James Cook University. However, it was not feasible to cut branches from the drought and control plots as I had initially proposed and I was not able to reach the branches from the ground. The original research plan was to measure respiration and refixation on attached branches using a portable gas exchange system coupled to a tuneable diode laser to measure the ratio of 12C/13C in the sample. After discussing with my host we thought the rate of CO_2 efflux from the branch would not allow us to use a small photosynthesis chamber with a portable photosynthesis machine. Additionally the tuneable diode laser had not arrived in Cairns. The proposed research plan changed to using a CO_2 Picarro and using a large drierite tube as a branch chamber. Instead I used excised branches in the drierite chamber connected to the CO_2 Picarro. I decided to focus branch photosynthesis in four early successional species found in the Daintree Rainforest.

Additionally I included a project that was not in my original proposal. This project involved covering canopy branches, using the canopy crane at the DRO, with aluminium foil to see if limiting branch refixation changed stomatal conductance and leaf photosynthesis. I focused on a specific species for this project, Elaeocarpus angustifolius.

My EAPSI project was measuring branch photosynthesis in three early successional species across five light levels, along with the aluminium foil experiment and leaf photosynthesis and stomatal conductance in Elaeocarpus angustifolius.

While the overall goal and objective of my project changed I was still able to accomplish my original goal of measuring branch photosynthesis.

The EAPSI program provided me an opportunity to work in the Daintree Rainforest. The Daintree Rainforest Observatory is one of five forests in the world with a canopy crane. The canopy crane enabled me to do the second part of my EAPSI project, studying how branch refixation affects stomatal conductance. The EAPSI program also allowed me to work with Dr Lucas Cernusak. Dr Cernusak and his post-doc Dr Alex Cheeseman were incredible people to work with. Both patiently answered my many questions and despite being overseas for the first month of the EAPSI program both made sure my project was off to a good start by calling and helping me trouble-shoot. When Dr Cernusak returned to Australia he was still a three-hour drive from where I was located. He still made himself available to answer questions and help when things did not go as planned. My EAPSI project would not have been successful without the help I received from Dr Cernusak and Dr Cheeseman. One instance that meant so much to me and will remain in my memory for a long time was the special trip Dr Cernusak made to the DRO after he returned from Europe. It was special when I received a phone call from Dr Cernusak asking if he could come visit at the DRO 2 days after

he returned from Europe and he drove up 2 days later on a Sunday to look at my set-up and data. Dr Cheeseman was just as incredible. Dr Cheeseman took time from his holiday to help me with R-code (I was having trouble with time in R and did not have reliable enough internet access to trouble-shoot). When Dr Cheeseman returned from Europe he was amazing in procuring a spectrometer that I would be able to measure chlorophyll content in branches with. Drs. Cernusak and Cheeseman went above and beyond in making me feel welcome and in helping me complete my EAPSI project.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

I have previously done research in Australia; however, my EAPSI experience was very different from my previous experience. For EASPI I was located in an isolated location and therefore did not interact with many people. The highlight of my EAPSI study was the week of the Stable Isotopes in Biological Systems (SIBS) workshop. It was an awesome experience to be around isotope scientists, who were mostly plant physiologists like myself. At the SIBS workshop I was able to meet and speak with many of the scientists whose papers I have read. The participants and instructors of the SIBS workshop now live in Australia but were originally from America, the UK, New Zealand, Sir Lanka, Vietnam, China, Germany and Columbia. It was amazing to see such a diverse group of people working together from all over the world. I particularly enjoyed interacting with the graduate students and the post-docs and would like to collaborate with many of the people in the future. My EAPSI experience and the SIBS workshop reminded me of how international Australia is. I have been interested in doing a post-doc in Australia for several years. The EAPSI program coinciding with the SIBS workshop introduced me to many of the researchers I am interested in doing post-docs with. The EAPSI experience further cemented my interest in doing a post-doc in Australia. One thing I found most interesting was seeing how PhD requirements are very different in Australia compared to America. I think the education differences in Australia and America provide different skills and insights which allow people to bring different viewpoints into collaboration. The DRO is an incredibly diverse place to do research; this site has one of five canopy cranes in the entire world, located in one of the most diverse tropical rainforests in the world. Establishing an international collaboration with faculty at James Cook University provide an excellent opportunity to answer important questions regarding climate change and understanding plant diversity.

Australian advisor's remarks:

Samantha performed very admirably in the face of many challenges, from having to work independently, to having to live remotely, to having to troubleshoot complex equipment without immediate support. Samantha worked very hard and the project came together really nicely. The results are worthy of publication in a peer-reviewed journal and I am excited to continue to work with Samantha on that aspect of the project. Overall, I very much enjoyed and appreciated all of my interactions with Samantha, she was a real asset to have in my lab and I feel fortunate to have had the opportunity to work with her. After this experience, I would happily host another EAPSI student.

Participant: Luke Nate Veldt

Australian research advisor: A/Professor Anthony Wirth

Australian host organisation: University of Melbourne

Title of research proposal: *Developing fast and accurate methods for grouping objects in a dataset using inconsistent labels*

Research description:

'Clustering' is the task of taking a dataset of objects and splitting it into different groups of similar objects. We explored special 'low-rank' assumptions about certain datasets and how those assumptions affected the task of 'correlation clustering,' a technique for grouping objects in a dataset based on inconsistent information about which objects are 'similar' or 'dissimilar.' More specifically, we studied cases of correlation clustering where the large dataset of similarity information could be compressed into a much smaller space. We were able to successfully prove that in this case correlation clustering can be solved in reasonable amounts of time.

Research activities:

Our research consisted partially in running numerical experiments on synthetic datasets to observe how 'correlation clustering' worked under our special assumptions. This helped develop our intuition for the problem we were working with. Most of our work was mathematical analysis; we analysed the 'correlation clustering' objective under our low-rank assumptions and used different tools in computational geometry to develop a more efficient method for clustering datasets.

Perspective of research after this program:

a) Focusing specifically on your research project:

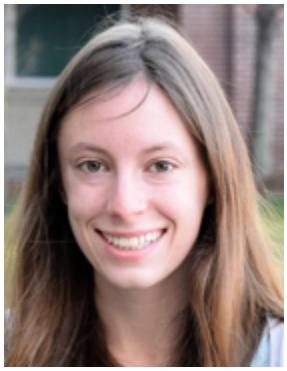
I was very pleased with what we were able to accomplish during the eight weeks of the EAPSI program, and especially excited about further opportunities for research and collaboration in this area. During the EAPSI project I also learned about important connections between my research and areas of math and computer science I previously thought were largely unrelated, which will be valuable to me in future work.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

It was very valuable for me to observe my host advisor and see the interactions between other researchers in the department on a daily basis. I saw firsthand how important collaboration across different universities and even different countries is. I have always known the importance of networking in a research community—this summer simply confirmed for me the benefits that come with taking every opportunity you have to connect and share ideas with different researchers whenever and wherever the opportunity arises.

Australian advisor's remarks:

It was a pleasure to host and to work with Nate Veldt. His keen attention to the problem, polished writing habits, careful mathematical thinking, and general hard work took this research question from an initial idea into a well-understood, connected, and founded branch of theoretical and experimental computer science. Nate's advisor and I were already friends and colleagues. To continue our collaboration, I'm about to visit them at Purdue. I've strongly recommended the EAPSI program to my colleagues at Melbourne.



Participant: Amy Williamson, Georgia Institute of Technology

Australian research advisor: Professor Phil Cummins

Australian host organisation: Australian National University

Title of research proposal: *A better understanding of shallow, subduction zone earthquakes through bayesian analysis: a case study of the 2015 Illapel, Chile earthquake*

Research description:

This project allows for the application of a novel geophysical inversion methodology to a recent and complexly rupturing earthquake. The earthquake in question is the 2015 Illapel, Chile earthquake- one of few recent great (magnitude > 8) earthquakes to occur globally in the past 2 years. The merger of this inversion scheme for the Illapel earthquake is (1) the complex nature of the earthquake and the high quantity of disparate datasets allow for an improvement over the overall inversion scheme by accommodating a joint-inversion and (2) The use of multiple datasets allows for a better resolved spatial and temporal rupture history to be determined for the event. This increases our ability to understand tsunamigenic and shallow earthquakes as well as the societal hazards that they pose.

Research activities:

Focus on this event swayed away from a purely Bayesian analysis and into a higher degree of incorporation of tsunami datasets to fit the goal of understanding shallow slip in tsunamigenic earthquakes. Through this change in methodology, a rigorous analysis of the effects of tsunami data in the shallow source inversion as well as the level of resolvability of this shallow region was conducted. This allowed for the use of new tsunami propagation codes as well as the incorporation of more complex parameters in the tsunami propagation models. The outcome of this was an earthquake source model that addresses some of the questions posed by prior event specific works, such as a phase delay in observed and modelled waveform data.

Perspective of research after this program:

a) Focusing specifically on your research project:

This program greatly aided me in fulfilling my goals toward my research project. Working with Professor Cummins at ANU helped to broaden my understanding of both tsunami inversions as well as general time series inversions while also applying them jointly to static datasets. Because of this program and the work I completed this summer, I have a much better perspective on my own research as well as many new directions that I feel that I can take my work.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

The ability to conduct research abroad in Australia was a wonderful experience that led to a great collaboration. Being able to work closely with a different research group for eight weeks allowed for many of my views and understandings of key concepts in my research to be challenged and discussed. This sort of discourse has been invaluable at this stage in my PhD.

Australian advisor's remarks:

Amy was a great EAPSI intern, very dedicated and focussed on her research. As a result of her sojourn at ANU I think she learned some useful approaches to the joint inversion of earthquake and tsunami data, and she came away with some new tools for investigating the generation of tsunamis

by earthquakes. For my part, I feel she gave me some new perspectives with which to view the problem of earthquake and tsunami source inversion. She was a real pleasure to work with and I hope for the productive collaboration we started to continue into the future.

Participant: Hannah Yokum, Brigham Young University

Australian research advisor: Dr John Morgan

Australian host organisation: La Trobe University

Title of research proposal: *The effects of Aboriginal burnings on contested grassland regions in Victoria, Australia*

Research description:

It is difficult to determine the effect the Aboriginal land use, specifically burning, has on the landscape centuries later. One way to assess if Aboriginal land use type continues today is to look at the conditions when the first Europeans arrived and determine if this is what we would expect based on factors such as climate information, soil type, and precipitation.

Research activities:

We looked at historic images and records from the early European settlement to determine if landscapes that we expect to be forested were replaced by grasslands. We then overlayed these maps with precipitation and climate maps in a geographic information system program. We calculated the average distance from these contested grasslands (areas that are grassy but we expect to be forested) to see if they are found in close proximity to large bodies of water. The idea is that land consistently burned enough to become the landscape now would need to be within walking distance of water for Aborigines to live there.

Perspective of research after this program:

a) Focusing specifically on your research project:

The current landscape is tied strongly to historic land use types. Although no written record makes determining Aboriginal influences more difficult, we can glean ideas from historical documents and the fingerprint of the landscape today.

b) Focusing on research in more general terms (e.g. importance of international collaboration, career opportunities)

International collaboration was so beneficial to me as a young graduate student getting started in the field. Working with other graduate students and professors in Australia helped me contribute things that I have studied extensively while being taught skills from experts in other fields.

Australian advisor's remarks:

During Hannah's time at La Trobe University, she became an integral member of the Plant Ecology Lab. She was involved in PhD data manipulation and analysis, provided training for Lab members interested in using field equipment (spectrometer, gas analyser), provided feedback at Lab meetings and also did primary research examining causes of treelessness. She has a terrific work ethic, is very easy to work with and, above all, is a thorough professional. We hope that she will co-author a paper as a result of her work here and were very sad to see her go.