WESTERN SYDNEY
UNIVERSITY

Hawkesbury Institute
for the Environment

Success Showcase

Autumn 2016

WELCOME

Welcome to the Autumn Success Showcase, our first for 2016.

One of our major areas of focus is nurturing emerging academic and scientific talent, and it is immensely pleasing to see so many up and coming scientists achieving success through grants, awards, prizes and in their research.

Through development of professional skills, fostering of essential networks and collaborations, and providing opportunities for experiences through conferences, workshops and events, HIE is about building graduates that are ready for a world experiencing rapid change.

We trust you will enjoy our Autumn Showcase.

Prof Ian Anderson,
Director

Prof Mark Tjoelker presents the new Horticulture Innovation Australia project on identifying tree stock quality metrics to the Nursery and Garden Industry Industry conference in Adelaide.

HAPPENINGS

A LIFELONG INVESTMENT IN BETTER TREES

All over the world, planners and architects are taking much more notice of the need for trees and plantings in urban areas to add value, create welcoming neighbourhoods and to offset the urban heat island effect that can make cities so hot.

HIE's first project by tender is to establish metrics to answer the question "what makes a quality landscape tree?" The origin of this question comes from the release of a new standard for landscape trees in Australia, a move welcomed by the nursery and landscape communities of Australia. However, this new standard relies on incomplete data that is yet to fully recognise the different climatic regimes around Australia, or a full range of trees from native to exotic, fast and slow-growing and heat or drought-tolerant.

HIE is working closely with the industry to use field testing and industry engagement measures so that the outcomes adequately reflect the growing practices and climates of a wide range of tree types and species. At the recent Nursery and Garden Industry Conference in Adelaide, Prof Mark Tjoelker and our new postdoctoral fellow (and HIE graduate) Court Campany outlined plans for the measurement of landscape trees in nurseries around Australia.

By David Thompson

HAPPENINGS

THE PARRAMATTA STORY CONTINUES IN THE WHOLE TREE CHAMBERS' NEXT EXPERIMENT

We have selected Parramatta red gum (*Eucalyptus parramattensis*) for study in our next climate warming experiment at the Whole Tree Chambers. This species is a red gum (related to *E. tereticornis*, the Forest Red Gum) and has a rather narrow geographic distribution, being endemic to the Sydney basin. We have implemented a warming experiment in which trees will be grown in ambient and elevated (+3°C above ambient) temperature conditions at our research site (the Hawkesbury Forest Experiment).

Warming of 3°C will push the species outside of its current-day "climate envelope," providing an opportunity to examine how eucalypts with narrow geographic range limits might respond to future climate warming. Will the species be able to physiologically adjust to warmer conditions or will the increased summer heat result in increased stress and reduced growth?

These are pressing questions to answer in light of the fact that many of Australia's eucalypts inhabit rather narrow climate zones.

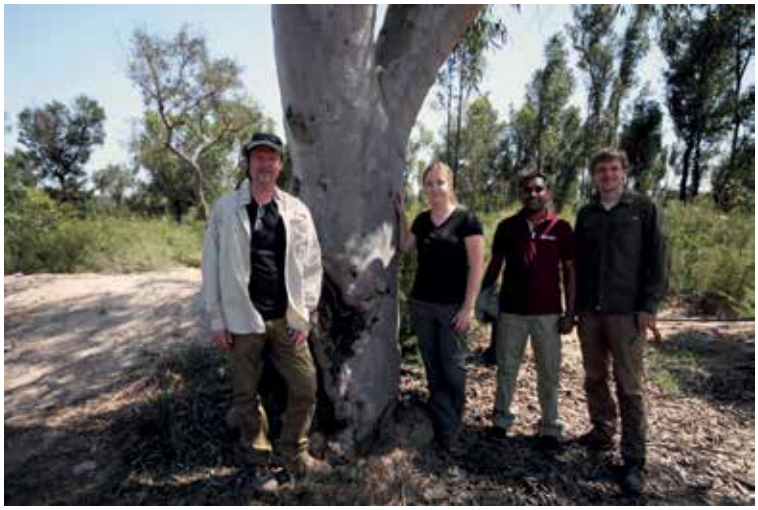
We grew our trees from seed and transplanted seedlings into 25 L pots in our 12 tree chambers (six at each temperature treatment). Just before Christmas we selected and planted one tree into the soil in each chamber. We are regularly measuring tree height and diameter growth (each fortnight).

The trees have now grown tall enough (> 2 m) that we will be able to seal the suspended floors soon (in the next several weeks) and begin automatically collecting whole-tree photosynthesis and transpiration data to complement our planned leaf level measurements.

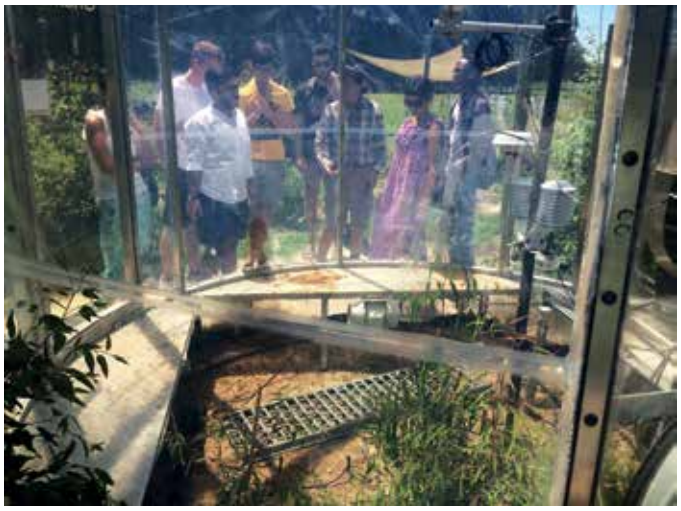
The research is sponsored in part by our ongoing ARC Discovery Project Grant.

Read more about the Whole Tree Chambers at **http://bit.ly/1SmU2pp**.

By Prof Mark Tjoelker



Professor Mark Tjoelker, Angelica Varhammar, Dushan Kumarathunge and Dr John Drake at a stand of *Eucalyptus parramattensis* near Richmond



Guests from New York University at the new plantings inside the Whole Tree Chambers

HAPPENINGS

SCIENCE POLICY: THE UNITED STATES WAY WITH PROFESSOR SYLVESTER GATES

As his second term in office draws to a close, President Barack Obama is receiving substantial praise and acclaim for driving progress in renewable energy, culminating in the landmark agreements reached at the Paris Climate Conference. President Obama's legacy will be one of substantial investment in advancing renewable energy technologies to the point where wind and solar technologies have become economically-viable and grow to an industry worth over $200 billion.

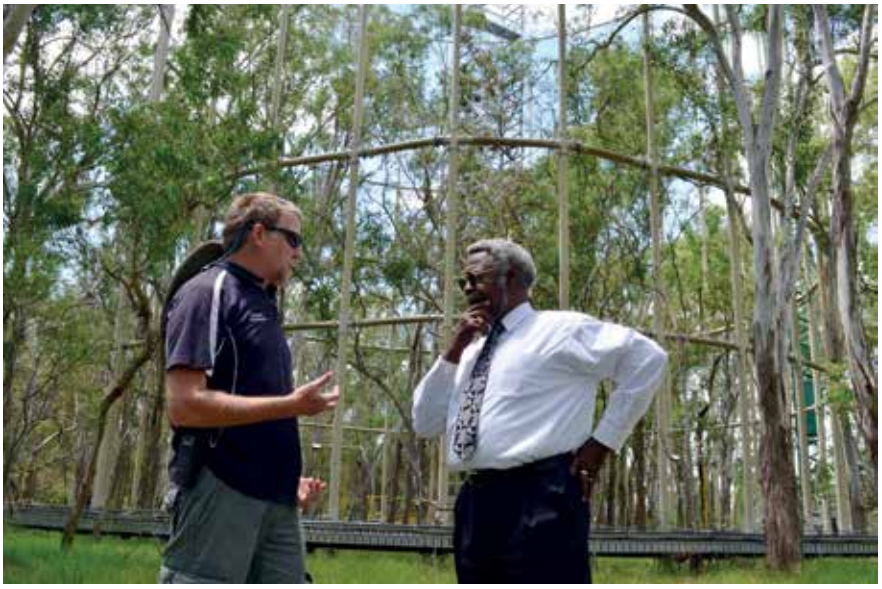
These decisions are made with the advice of the United States President's Council of Advisors on Science and Technology, a panel of 18 leading experts in science drawn from across the United States. Meeting every quarter, it is the role of these scientists to provide detailed advice on a wide range of topics, with background, context and recommendations to the President. One of these advisors is Professor Sylvester James Gates, a Professor of Physics at the University of Maryland and a University of Maryland Regents Professor.

Professor Gates joined us at HIE for a tour of our field facilities and a highly engaging public lecture on the journey of shaping United States science and technology policies. More than just an insight into how policy is shaped, Professor Gates provided an entertaining and personal tour of the sometimes complex and controversial mechanisms to implement policies in one of the world's largest economies.

We greatly appreciate the support of the Office of the DVC (R&D) and the School of Science and Health for supporting this visit by Professor Gates to share his experiences.

Read more at **http://bit.ly/EucFACE-Results**

By David Thompson



RESEARCH

PLANTS AND POISONS: UNDERSTANDING AUSTRALIA'S TOXIC PLANTS

Dr Ben Moore is an ecologist at HIE and interested in the interactions between plants and animals, chemical ecology and the causes and consequences of variation in plant chemistry. Dr Moore recently contributed to The Conversations' *Deadly Australia* series with an article outlining Australia's poisonous plant inhabitants.

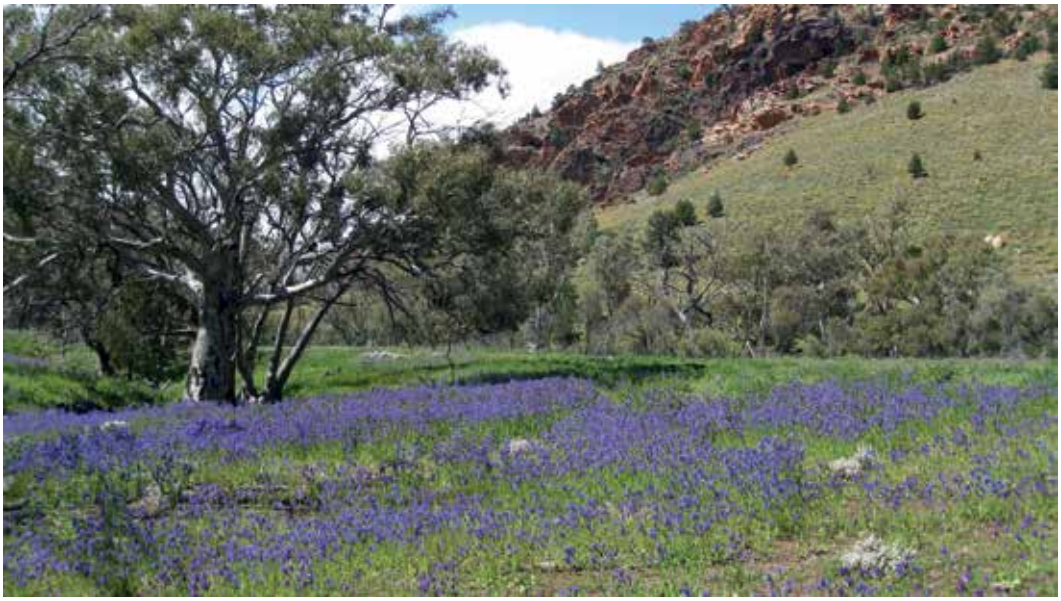
The good news for our tourism industry seems to be that our dangerous plants and animals are not much a deterrent to their arrival, which is a good thing because it turns out Australian plants have a range of toxic properties too.

Whether a plant is 'poisonous' is about the level of toxic chemicals it contains and how much of that toxin is consumed by an animal, or person. Over millions of years, plants have evolved toxins, defences and devices that they use to protect themselves, ranging from physical deterrents such as thorns and spikes to small hairs that inject poisons into the skin, and chemical defences that animals learn to avoid. There was even recent media coverage about the potential danger from Australian honey where bees have visited toxic plants such as Paterson's Curse and the accumulated toxins in the pollen end up in the honey – thankfully, this was quickly dismissed as being a very low risk scenario.

In Dr Moore's research, he is interested in the ways in which plants produce chemicals to support their role in the environment and to enable them to cope with being eaten (herbivory) or under changing climatic conditions. In his ARC Discovery project '*Get Tough, Get Toxic Or Get A Bodyguard*', Dr Moore's research seeks to understand how grasses defend themselves from root-chewing beetle larvae by using chemical, physical or 'bodyguard' defence mechanisms. Because grasses cannot run away, these methods allow them to repel the organisms that might otherwise eat them and understanding these mechanisms could help us develop methods that reduce the use of pesticides against beetle larvae under the soil.

Visit: **http://bit.ly/AusToxin**

By David Thompson. Article on The Conversation by Dr Ben Moore.



Paterson's Curse (Image credit: Flickr/Stephan Ridgeway). (Invasive weeds such as Paterson's Curse (*Echium plantagineum*) defend themselves with toxins that damage the liver and these toxins can even make their way in small amounts into honey via the pollen).

A DRYING CLIMATE IS NOT GREAT NEWS FOR SOIL MICROBES

Recent research published in the Proceedings of the National Academy of Sciences and in Nature Communications revealed the impacts that increasing aridity imposes on microbes in soils. As climates become warmer and drier, the abundance and diversity of these microbial communities reduces, largely as a result of the lower water and carbon content of these soils as they become drier.

Soil microbes provide a wide range of functions in the environment and our own wellbeing is closely tied to the health of soils – everything from providing clean water, fresh food, clean air and much more.

In this research, researchers around the world drew on data collected from every continent except Antarctica to examine soil samples from more than 80 locations. By using advanced genetic sequencing technologies, researchers were able to determine the quantities and types of microbes present in the soils and how increasingly arid conditions changes the composition of microbial communities.

"This kind of research is enormously important", says Dr Manuel Delgado-Baquerizo, one of the authors from HIE.

"We are essentially comparing how the climate change models used by scientists around the world to predict the impacts of global climate change actually compare with the real-world behaviour of soils as they become more arid. Given that we expect the area of dryland ecosystems to expand by 10% before the year 2100 and that these drylands are home to nearly 38% of the world's human population, any changes will pose significant challenges to many people and many environments."

Read the story at **http://bit.ly/AridSoil**

By David Thompson

Image: Drought-affected wheat

RESEARCH AND VISIT

I KNOW WHAT YOU DID LAST WINTER

Doing nothing can have important benefits. Many animals spend the temperate winter season in a state of dormancy. In mammals, seasonal dormancy (hibernation) is facilitated by employing periods of deep torpor, when metabolic energy expenditure is reduced to a trickle. Torpor, in combination with pre-winter fattening or food storage, permits even mouse-sized hibernators to forego all external foraging activity for a large proportion of the year.

We found that mean annual temperature is negatively associated with hibernation duration and annual survival rate in hibernating rodents (but not in a representative sample of non-hibernating rodents). A straight-forward explanation is the known positive effect of dormancy on survival (i.e. in colder climates, a greater proportion of the year is spent in the relative safety of hibernation).

Seasonal dormancy has a positive effect on annual survival even in mammals.

Read More: **http://bit.ly/HIEbernate**

By Dr Chris Turbill

Survival rates of hibernating rodents, such as the edible dormouse (*Glis glis*) – a common rodent of European forests, are higher at colder locations where they hibernate for a greater proportion of the year. Photographer and copyright owner: Dr Claudia Bieber

DOES ELEVATED CARBON DIOXIDE MAKE TREES GROW MORE LEAVES?

Global prediction models for the effects of rising atmospheric carbon dioxide predict in many cases that trees will take advantage of the additional CO_2 and produce more leaves. This response is considered an important element of the response to rising CO_2 and could enable more carbon to be drawn out of the air into forest ecosystems. These predictions are typically based on international forest ecosystems in regions of higher rainfall and better soils than Australia.

EucFACE is designed to answer the Australian questions of rising CO_2. Our soils are much lower in nutrients than those in international FACE experiments and our rainfall is variable, with very wet and very dry periods.

Did the availability of extra CO_2 at EucFACE have any impact on the overall leaf area of the trees' canopies in EucFACE's first three years? Based on data collected by Dr Remko Duursma and colleagues from HIE, the major determinant of the leaf growth was rainfall, and not CO_2.

Over the last three years, we have experienced very wet as well as very dry conditions where soil moisture levels declined to just a few percent. It is widely known that Australia has highly variable rainfall patterns and scientists predict that this variability will increase in coming decades.

When conditions are favourable the trees respond by producing plenty of new growth, and when conditions dry out the trees reduce their leaf area. The timing of these processes is closely aligned with rainfall patterns.

Read more: **http://bit.ly/LeafyTree**

By David Thompson and Dr Remko Duursma

This Photosynthetically Active Radiation (PAR) sensor measures light intensity below the canopy. These are combined with sensors above the canopy to estimate how much shading is occurring, which correlates with the amount of leaf area. The sensors log data every minute of every day and there are over 40 million readings. Image credit: Dr Remko Duursma

EUCFACE TOUR WITH NEW YORK UNIVERSITY'S SUMMER SCHOOL

HIE hosted a tour with students from New York University's Abu Dhabi campus, here on tour as part of a summer course in environmental change. We hosted fourteen keen students from Africa, the United States, Europe and Asia.

With a tour of EucFACE and the Whole Tree Chambers, the students could see active climate change research in action.

> "Thank you for the tour – really I should say 'experience!"
> Professor Tyler Volk,
> New York University

GRANTS

DR KRISTINE CROUS AWARDED ARC DISCOVERY EARLY CAREER RESEARCHER AWARD

How will Australian rainforest species cope with climate warming?

This is the question posed in Dr Crous' successful DECRA application that sees her continue her research following her postdoctoral fellowship at HIE.

The response of rainforest species to climate warming is one of the largest uncertainties in the future terrestrial carbon cycle. This work aims to give us a predictive capacity for the temperature sensitivity of unique rainforest species.

The multi-faceted nature of this proposal, combining observational and experimental approaches, will maximise our understanding of how, and how much, rainforest tree species will adjust to warmer temperatures.

Given the large contribution of rainforests to carbon storage and uptake from the atmosphere, outcomes of this project will benefit species conservation strategies in the face of climate change and improve our capacity to safeguard our unique rainforest flora from future climate risk.

Words provided by Dr Kristine Crous.

DR KRISTINE CROUS AWARDED AUSTRALIAN ACADEMY OF SCIENCE JG RUSSELL AWARD

Following her DECRA announcement, Dr Kristine Crous was then awarded the annual JG Russell Award from the Australian Academy of Science.

The J G Russell Award is aimed at financially helping talented younger researchers in the basic sciences as a token of the community's regard for them. It recognises the costs involved in experimental research, and can be used towards the costs of equipment, maintenance, and travel.

Read about Dr Crous' research:
http://bit.ly/Crous

AWARDS

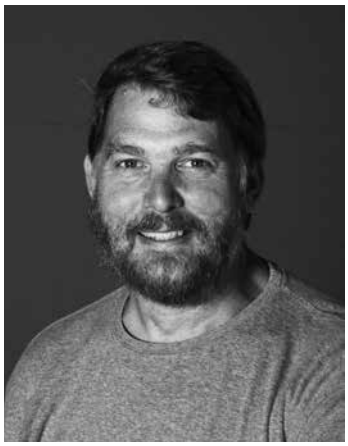
SUPERB OUTCOMES FOR HIE IN THE 2015 ARC DISCOVERY ROUND

The results of 2015's ARC Discovery round have been enormously successful for HIE and demonstrate the continued success of collaborations and partnerships in pressing areas of environmental and scientific concern.

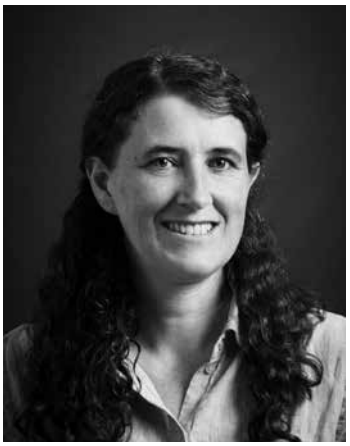
Our grants round includes:

→ **Will trees get enough nitrogen to sustain productivity in elevated CO2?**
In this research, we are answering questions around the role and cycling of nitrogen in Australian ecosystems under rising carbon dioxide, one of the areas where there is a major gap in our knowledge relating to an essential plant nutrient.

→ **To grow or to store: Do plants hedge their bets?**
Australia's woody plant ecosystems represent an important economic, social and environmental resource, but are under threat from extreme events such as severe drought. By providing new and fundamental insights into how trees grow and survive, this project will enhance our ability to predict the tolerance thresholds of Australia's forest and woodland ecosystems in the face of future environmental change.


Prof David Ellsworth


Dr Yolima Carrillo


Prof Belinda Medlyn

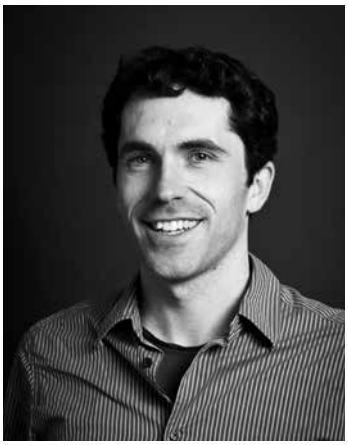

Assoc Prof Oula Ghannoum (second from left)


Dr Remko Duursma

→ **Characterising controls of carbon flow from trees into mycorrhizal fungi**
This project will identify the genetic traits correlated to enhanced carbon capture by ectomycorrhizal fungi during mutualistic symbiosis with host trees. The outcomes of this project will benefit the forestry and bio-energy sectors by identifying different isolates of mutualistic fungi that can be paired with eucalypt hosts to maximise carbon sequestration and forest productivity.

Prof Ian Anderson

→ **Closing the carbon cycle: an ecological understanding of wood decay**
Awarded through UNSW in collaboration with Dr Jeff Powell – The project aims to understand the controls on the return of carbon to the atmosphere within forests, especially focusing on this problem from a microbial perspective. Microbial dynamics and wood decay are crucially important for the global carbon cycle.



Dr Jeff Powell

Dr Jonathan Plett

DR KELLY HAMONTS' SWEET SUCCESS

Dr Kelly Hamonts has been successful in receiving travel funding of $4,500 from Sugar Research Australia. These funds will support Kelly's attendance at the American Phytopathological Society's annual meeting in Tampa, Florida, USA, from July 30–3 August 2016.

Dr Hamonts will present an overview of her research conducted for the SRA project: "A novel polyphasic framework to resolve the Yellow Canopy Syndrome paradox" at this conference.

Yellow Canopy Syndrome is a condition that affects Australia's sugarcane crops and results in progressive and widespread yellowing of leaves and reductions in yield. Scientists are trying to determine its cause which is currently unknown.

STUDENT SUCCESSES

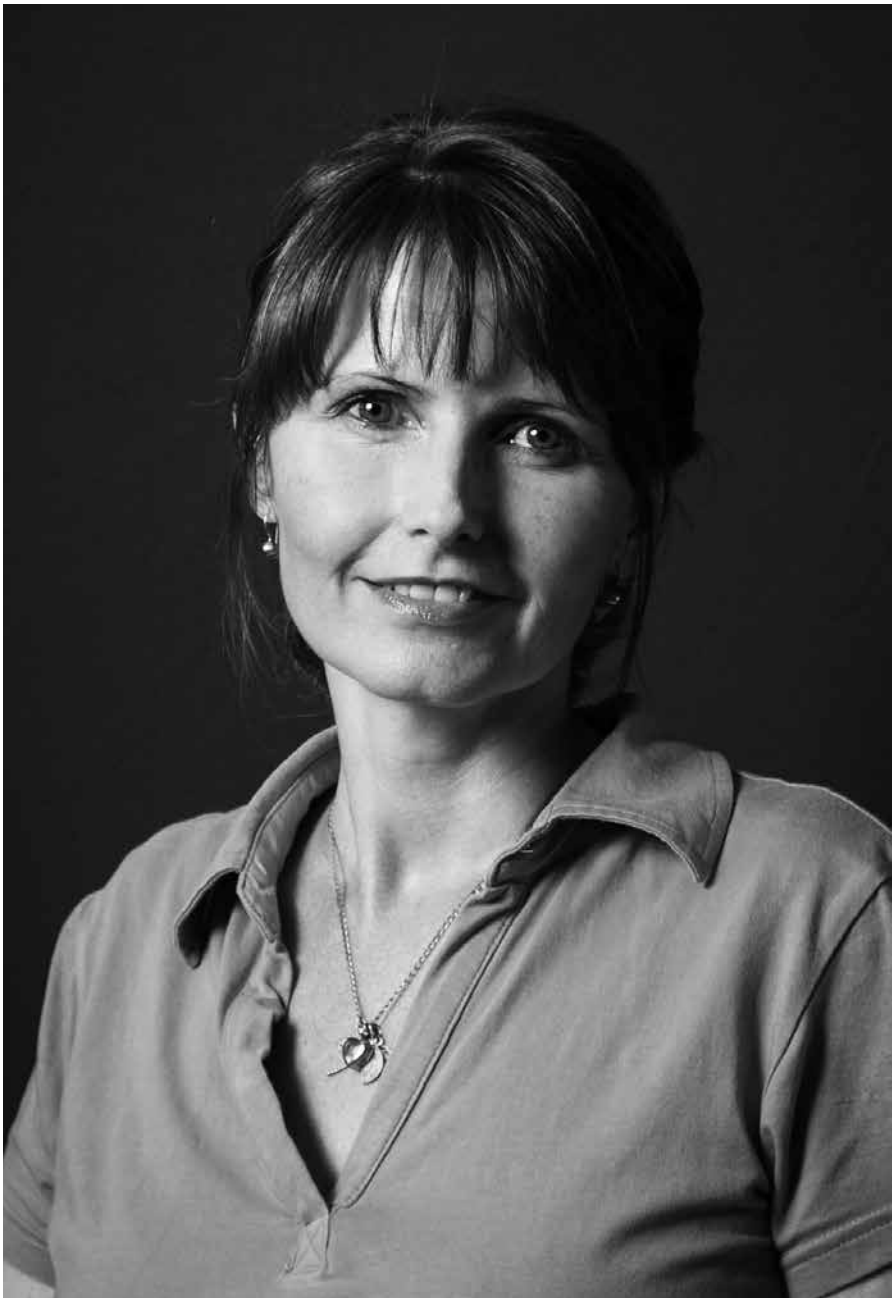
HDR STUDENT KYLIE BRICE EXPANDING PROFESSIONAL NETWORKS

Kylie was commended for her research into the problem of relocating koalas when they become too numerous, which has occurred in recent years in Victoria and other regions.

Relocation of koalas nearly always results in significant mortality, with mortality rates of approximately 36% in the first twelve months. We believe that mortality is due to the inability of relocated koalas to adapt to the change of diet, as their gut microbes are unable to process the plant defensive chemicals found in the new habitat's Eucalypts. Eucalypts produce a range of defensive compounds and it is thought that the koalas' ability to digest these is dependent on specific gut bacteria.

This project aims to quantify the bacterial community in koalas' digestive system through qPCR using DNA extracted from the faeces of 33 Cape Otway koalas. The results will be used to develop inoculants that can be administered to translocating koalas to provide them with the appropriate range of gut microbes that would enable them to digest Eucalypts in new regions and increase their survival rates.

By David Thompson and Kylie Brice



STUDENT SUCCESSES

HDR STUDENT DANIELLE CREEK AWARDED THE INAUGURAL HAWKESBURY APPEAL PRIZE

The Hawkesbury Appeal Prize is a very special award that reflects more than one hundred years of science excellence at the Hawkesbury campus. Supporters include John B Fairfax, the Hawkesbury Lunch 2015 and George Bennett. The Prize is offered for the first time in 2015 to postgraduate students based at the Hawkesbury Institute for the Environment.

My Research Journey: "Living with drought: adaptive responses of Eucalyptus species to water deficit"

By Danielle Creek

The arid and semi-arid inland regions of "outback" Australia have inspired and helped define Australia's identity. Despite the harshness of climate, characterised by periods of extreme drought and occasional flooding, the area boasts extraordinary biodiversity and is able to support vast woodlands and forests on the edge of the desert interior.

However, the current transition in Australia to a hotter and drier climate, with more frequent and extreme drought (CSIRO 2015), presents a major risk to these ecologically and culturally important ecosystems. Drought-induced tree mortality is an emerging global phenomenon with mounting evidence that increasing temperatures and reduced rainfall associated with climate change are responsible for this acceleration of large scale forest die-back we are seeing across the globe (Breshears et al. 2005; Allen et al. 2010).

These dieback events have profound effects on the biodiversity and ecosystem function with flow on effects to carbon, nutrient and hydrological cycles. Locally, we are already seeing widespread tree dieback events in parts of Outback Australia including large areas of the iconic River Red Gum (Eucalyptus camaldulensis) in the Murray-Darling Basin as well as Savannah Eucalypts of Northern Queensland and the Northern Territory.

However, despite the many exciting advances in drought research over the recent years, our understanding of how climate drives plant hydraulic and other associated functional traits to confer adaptive drought tolerance, especially within an Australian context, is still limited. My research at the Hawkesbury Institute for the Environment aims to assess the vulnerability of key semi-arid eucalypts to long-term drought and identify physiological mechanisms important to drought resistance and subsequent recovery.

> "My research will help to fill in some of the knowledge gaps surrounding physiological mechanisms responsible for drought-induced tree death..."

I utilise a range of experimental approaches including detailed glasshouse and controlled environment studies at Western Sydney University to simulate drought events in order to characterise key plant physiological traits that determine species' drought tolerance as well as undertake field based research across semi-arid Australia to identify arid eucalypt species vulnerable to die-back events. With most of south-eastern Australia, including the Western Sydney region, facing more frequent and severe drought events under future climate scenarios, widespread tree dieback will not be isolated to the interior of Australia.

My research will help to fill in some of the knowledge gaps surrounding physiological mechanisms responsible for drought-induced tree death. This in turn will enable us to better predict how the future climate will affect tree species distributions and drive changes in vegetation structure and ecosystem function not only for trees of inland Australia but also other eucalypt species across Australia.

My research also adds to expanding body of international literature investigating this alarming phenomenon of widespread tree mortality across the world. Most immediately, my research will benefit Australian land managers by providing crucial information about the risks of drought mortality that may impact biodiversity and conservation values across Australia's Outback.

STUDENT STORIES

NICOLA HANRAHAN - THE PHYSIOLOGICAL AND BEHAVIOURAL ECOLOGY OF THE GHOST BAT: IMPLICATION FOR CONSERVATION AND MANAGEMENT.

My research centres around the acoustic ecology of the ghost bat (*Macroderma gigas*), an iconic microbat endemic to northern Australia. This highly social bat has a repertoire of vocalisations but the function of these is unknown.

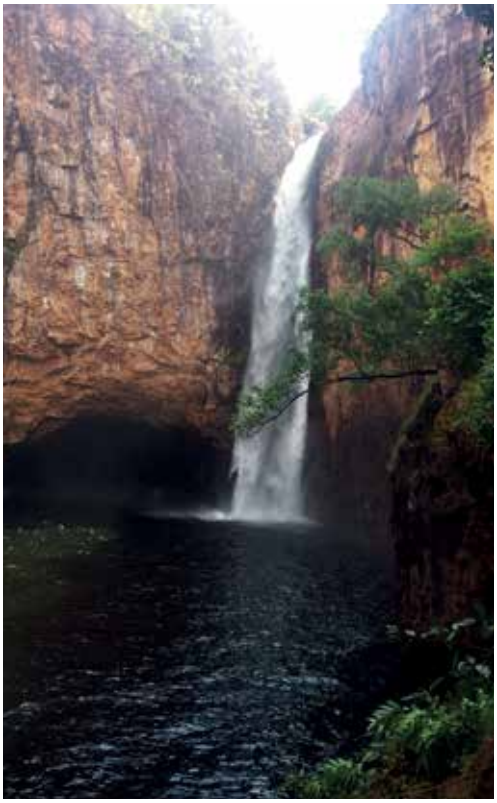
The calls or songs of bats have been shown to hold a wealth of information on social structure and colony interaction including mating behavior, parent-young interactions, cooperation and even to determine an individual and their gender and age group by the structure of their call.

I plan to break down and compare the structure of these songs to uncover the information being shared through call analysis of wild colonies and behavioural experiments on captive populations using innovative low disturbance playback and recording devices.

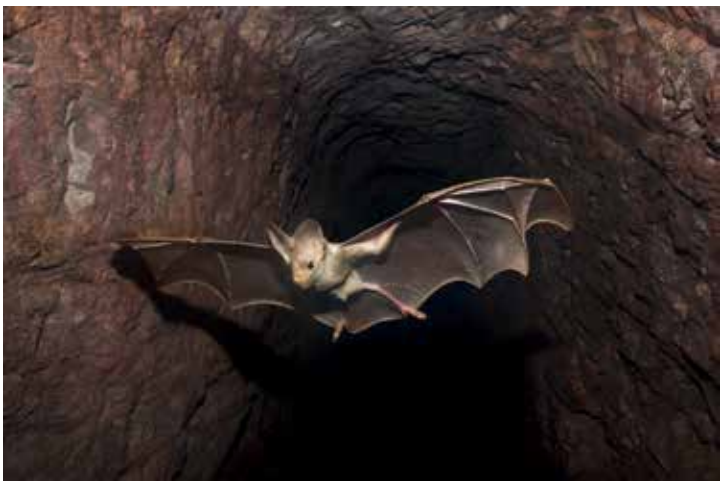
My field work will take me to the amazing Top End of the Northern Territory and across the beautiful landscapes of Litchfield National Park and Arnhem Land.

Unravelling the vocalisations of this species will tell us a lot about ghost bat social organization allowing the development of passive monitoring techniques for future ecological studies of this vulnerable bat.

By Nicola Hanrahan

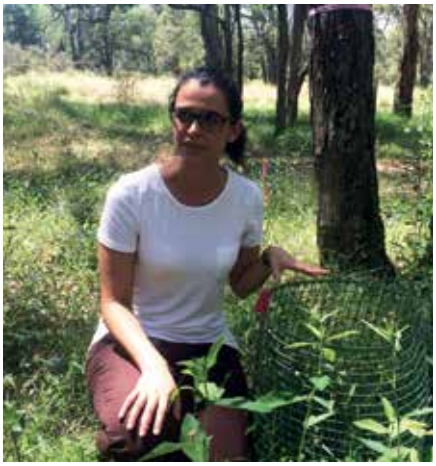


Waterfall at Litchfield National Park.
The ghost bats live in the cave on the left



Ghost Bat

STUDENT STORIES



Laura Castaneda Gomez

MECHANISMS BY WHICH THE N AVAILABILITY FOR PLANTS CHANGES UNDER ELEVATED CO2 CONDITIONS

"I am originally from Colombia. I have been here at the Hawkesbury Institute for nearly one year now.

My research project is at the EucFACE site and I am aiming to understand the differential role of Arbuscular Mycorrhizae and Ectomycorrhizal fungi on soil organic matter decomposition and the impact that future elevated carbon dioxide levels will have on this process and soil carbon storage.

This is a very beautiful and interesting place to do research..."

Tatiana Mondragon Cortes

SUNSET AT EUCFACE

As I finished my work for the day, I was entranced by an artist's sky over the EucFACE climate change experiment. The sun was angled perfectly and radiated its beams through the clouds and the cranes.

BOBBY MISSAGHIAN'S SUMMER OF SIEF

Undergraduate student Bobby Missaghian joined our internship program in Autumn 2015, working with Prof David Tissue, Dr Brendan Choat and Prof Belinda Medlyn on the Science and Industry Endowment Fund Project 'Forests for the future: making the most of a high CO2 world'.

Nearly twelve months later, Bobby has continued working on this project and recently, we asked him for his thoughts on what it has been like to experience a real-world science project.

What attracted you to HIE, Bobby?

"I wanted an opportunity to gain knowledge, technical experience and also get a feel for life as a researcher, and the Hawkesbury Institute for the Environment provides excellent winter and summer programs to achieve this."

What have you found most valuable over the last year?

"I learned a lot of technical skills as a result of this program, and I learnt the way research is undertaken in the real world. I also had the opportunity to meet a lot of good people that work with HIE.

In the winter program, learning some of the more meticulous technical skills proved to be a challenge at first, as did the use of some of the equipment I had never used before."

Would you recommend the internship program to other students?

"I would advise other students to apply for the HIE programs, particularly if they are thinking about doing a Masters of Research and pursuing a life in research. It is valuable experience and it will also give you the opportunity to meet people who are very knowledgeable and respected in their field of expertise. "

By Bobby Missaghian

"My project is about selecting trees that will cope with future climate extremes of heat and drought. These are big issues in Australia and around the world. It is rewarding to think that I am part of the solution."

Contact information
Telephone: +61 2 4570 1125
hieinfo@westernsydney.edu.au
westernsydney.edu.au/hie

Western Sydney University
Locked Bag 1797
Penrith NSW 2751 Australia

WESTERNSYDNEY.EDU.AU