



Annual report 2014



Contents

WELCOME FROM THE HEAD OF DEPARTMENT	3	OUTREACH ACTIVITIES	42
HISTORY OF THE DEPARTMENT OF BIOLOGICAL SCIENCES	4	EXTERNAL BOARDS AND SERVICES	44
GOVERNANCE	5	RESEARCH CENTRES AND FACILITIES	46
DEPARTMENT OF BIOLOGICAL SCIENCES STAFF	6	Genes to Geoscience Research Centre	46
LEARNING AND TEACHING	8	Climate Futures Research Centre	46
Undergraduate Offerings	8	The NSW Adaptation Research Hub – Biodiversity Node	46
Master of Marine Science and Management	10	Ecosystem Modelling and Scaling Infrastructure Facility (eMAST)	47
Biodiversity Conservation Programs	10	Integrated Marine Observing System (IMOS)	48
Bachelor of Philosophy/Master of Research Program	11	SUSTAINABILITY ACTIONS IN 2014	49
Quality Assurance of Programs and Units	12	FINANCIAL STATEMENTS 2014	50
Learning and Teaching Initiatives	12	Research Income	50
Learning and Teaching Grants	12	Income Statement	51
Teaching Excellence Awards	13	PUBLICATIONS IN 2014	52
Undergraduate Student Prizes	14	Book Chapters	52
Milthorpe Lecture 2014	14	Journal Articles	53
Future Directions	14		
RESEARCH	15		
Research Grants	15		
Australian Research Council Grants – 2014 Outcomes	16		
Academic Staff Profiles	20		
Research Stories	24		
Research Impact Stories	26		
HIGHER DEGREE RESEARCH STUDENTS	34		
Genes to Geoscience Research Enrichment Program	35		
Grants, Prizes and Commendations	36		
List of HDR Students who Completed in 2014	37		
TECHNICAL STAFF, SCIENTIFIC OFFICERS AND ADMINISTRATION	38		
SAFETY INITIATIVE	39		
FACILITIES	40		
Teaching Laboratories	40		
Acid Leaching Facility	40		
Plant Growth Facility	40		
Sydney Institute of Marine Science	40		
Seawater Facility	41		
Fauna Park Animal Facility	41		
Microscopy	41		
Biological Sciences Museum	41		

Cover images starting lower left in clockwise direction
 Thorny Devil. Photo by Siobhan Dennison.
 Purple flowers. Photo by Michael Gillings.
 Canis dingo. Photo by Eloise Déaux.
 Ctenophorus pictus. Photo by Martin Whiting.
 Main image: Palaeo fieldwork. Photo by Sarah Jacquet.

Welcome from the Head of Department

2014 – A YEAR OF PLANNING, REVIEW AND CONSOLIDATION

In 2014, Macquarie University published its Research Framework, which sets ambitious targets for the next 10 years.

As one of the strongest research departments in the University, we will continue the growth in our research capacity and strongly contribute to meeting these targets. Accordingly, our research outputs, in terms of research papers, continue to grow without losing the focus on quality. In 2014 alone, staff in the Department published four papers in Nature and Science, with many more in other high impact journals. Similarly, our research income, whilst somewhat variable between years, has a strong upward trend.

A new initiative in Synthetic Biology was launched in 2014 by the Deputy Vice-Chancellor (Research), Professor Pretorius. Along with the Department of Chemical and Biomolecular Sciences, the Department of Biological Sciences will be a strong contributor to this initiative, with new appointments planned in 2015.

Our undergraduate cohort continues to grow, with almost 6000 enrolments across three semesters. The success of our teaching programs demands careful management and planning into the future. As a consequence, the Department has taken the decision to embark on a major curriculum review with the aim of focusing and updating the Biology major. The new major will be implemented from 2016. We also look forward to the newly refurbished teaching laboratories, scheduled for completion in 2015.

2014 was the second year of the newly introduced Master of Research, which has attracted strong numbers. We are continuing to review and consolidate the program. Higher Degree Research enrolment remains steady, consisting of a mix of domestic and international students. Our HDR students enliven every aspect of the Department, contributing to undergraduate teaching, research and to the overall departmental culture.

Several members of staff have won outstanding awards in 2014, including a Eureka prize to Lesley Hughes, the Fenner Medal to Ian Wright, the New South Wales Scientist of the Year Award to Mark Westoby, a Macquarie University Research Excellence Award to Elizabeth Madin and a Lecturer of the Year award to Michael Gillings.

An external review panel visited the Department in October 2014 and commended our exceptionally high research and teaching performance, facilitated by the positive culture that underpins the Department. The review panel delivered an insightful review report with helpful suggestions, which will be implemented over the next 24 months.

I would like to congratulate and sincerely thank all members of the Department for a successful, rewarding and enjoyable year.



PROFESSOR MARIELLA HERBERSTEIN
 Head of Department



PROFESSOR MARIELLA HERBERSTEIN
 Head of Department

Several members of staff have won outstanding awards in 2014, including a Eureka prize...

History of the Department of Biological Sciences

FOUNDED IN 1964 AS A TRULY INTEGRATIVE DEPARTMENT OF BIOLOGICAL SCIENCES

The School of Biological Sciences, founded by Professor Frank Mercer, was set up as a multidisciplinary school that encompassed botany, zoology, biochemistry, ecology, genetics, physiology and later molecular biology and microbiology – disciplines that were then usually housed in separate departments in other universities.

Frank Mercer was a visionary and inspirational leader who recognised that:

- (i) the most important scientific innovation arose at discipline boundaries;
- (ii) an atmosphere encouraging interdisciplinary collaborations was essential;
- (iii) quality teaching and research were inextricably linked; and
- (iv) small group practical/tutorial teaching of science was most effective.

The School admitted its first postgraduate students in 1965 and its first undergraduates in 1967.

Professor Mercer's appointment was followed by those of Professor Fred Milthorpe and Professor Geoff Sharman (subsequently elected as a Fellow of the Australian Academy of Sciences), both of whom also served terms as elected Heads of School. Subsequent Heads of School/Department were Des Cooper (two terms), Jan Gebicki (two terms), Andy Beattie, Jack Bassett, Jean Joss, Hatch Stokes (two terms), Michael Gillings, David Briscoe, Lesley Hughes and Marie Herberstein (current). The senior staff were ably assisted by other academic staff as well as technical and administrative personnel who embraced Frank's vision, much of which has endured and remains strong.

Following Frank's visionary and inspirational early leadership, the School prospered as a home of excellent teaching and research, and as an enjoyable and harmonious place to work. It has grown into one of the strongest biology units of its size in the country and one with internationally recognised research strengths in many biological disciplines. The School pioneered external teaching of biology in Australia and was one of the first to do so in the world. Many of our graduates have prospered and are found working throughout Australia and overseas. Several of our current academic staff were trained here and returned after periods at other institutions.

With subsequent University restructuring, the School became a Department in the Division of Environmental and Life Sciences, and later in the Faculty of Science. In the course of these changes, several staff and teaching programs in biochemistry, molecular biology and microbiology were transferred into the Department of Chemical and Biomolecular Sciences. Most recently, the Department has been joined by the Palaeobiology Research group and merged with the Department of Brain, Behaviour and Evolution.



Professor Frank Mercer

Professor Fred Milthorpe

FUTURE OF THE DEPARTMENT OF BIOLOGICAL SCIENCES

The Department continues to chart its path into the future within the Macquarie University framework. We have a strong sense of purpose and direction in terms of what we want to achieve with research, teaching and engagement. The Department is experiencing a period of renewal, with several new academic staff starting in 2015. Our new curriculum will also require refinement over the next few years.

Overall, the Department is in a very strong position to fully take advantage of this exciting period.

Governance

THE DEPARTMENT'S GOVERNANCE IS BASED ON AN INCLUSIVE AND COLLEGIATE COMMITTEE STRUCTURE

The Head of Department appoints an executive group and the chairs of the departmental committees.

The executive group consists of the Head and Deputy Heads of Department and the department's executive officer. The Head of Department, the executive group and Department committees are responsible for defining and implementing the strategic direction for the Department.

DEPARTMENT COMMITTEE STRUCTURE

Head of Department		
Mariella Herberstein		
Executive Group		
Mariella Herberstein, Michelle Leishman, Grant Hose, Andrew Barron, Sharyon O'Donnell		
Committees		
Boating and Diving Jane Williamson	Curriculum Michelle Power	Enrollment Darrell Kemp
Field Work Martin Whiting	Glasshouses Michelle Leishman	Higher Degree Research Glen Brock
Master of Research Grant Hose	Prizes Rob Harcourt	Research Simon Griffith
Work Health Safety Marita Holley		

We ensure broad departmental representation by including academic staff, professional administrative staff, technical staff and HDR students on committees as appropriate. Committees meet at regular intervals and communicate with the entire Department via electronic updates or during regular Department meetings. The chairs of committees also meet regularly with the executive group to update on progress or pertinent issues. The Head of Department produces weekly email newsletters and schedules formal and informal monthly department meetings.

In addition to the formal committees, we have a number of working groups that coordinate equipment, space, timetables, the Millthorpe Memorial Fund, the Greg Mills and Tony Price Bequest Funds and the Barbara Rice Fund. Departmental members of staff are represented on Faculty and University committees and report updates to the Department. The Head of Department attends regular meetings of the Faculty Advisory Committee and with the Executive Dean of the Faculty of Science and Engineering.



1. Belinda Fabian, a Masters of Research student using a LiCor to conduct photosynthesis measurements for her project. Photo by Belinda Fabian.
2. Biology 349 students. Photo by Michelle Leishman.

Department staff

THE ACADEMIC, PROFESSIONAL AND TECHNICAL MEMBERS OF STAFF IN THE DEPARTMENT OF BIOLOGICAL SCIENCES COOPERATE IN DELIVERING THE CORE ACTIVITIES OF TEACHING AND RESEARCH EXCELLENCE.

We are one of the largest departments at Macquarie University and pride ourselves on our collegial and friendly working environment.

HEAD OF DEPARTMENT

Professor Marie Elisabeth (Mariella) Herberstein

PROFESSORS

Ken Cheng	Michael Gillings
Robert Harcourt	Sandy Harrison
Michelle Leishman	Colin Prentice
David Raftos	

ARC LAUREATE FELLOW & DISTINGUISHED PROFESSOR

Mark Westoby

DISTINGUISHED PROFESSOR

Lesley Hughes

EMERITUS PROFESSORS

Andrew Beattie	Richard Frankham
----------------	------------------

ADJUNCT PROFESSORS

Graham H Pyke

ASSOCIATE PROFESSORS

John Alroy	Brian Atwell
Andrew Barron	Melanie Bishop
Glenn Brock	Culum Brown
Jenny Donald	Belinda Medlyn
Grant Hose	Phil Taylor
Adam Stow	Jane Williamson
Martin Whiting	

SENIOR LECTURERS

Drew Allen	Leanne Armand
Linda Beaumont	Matthew Kosnik
Darrell Kemp	Julia Raftos
Michelle Power	

LECTURERS

Katherine (Kate) Barry	Matthew Bulbert
Sham Nair	David Nipperess
Luke Strotz	

ASSOCIATE LECTURERS

Katherine McClellan	James O'Hanlon
Wallace Fellow	Jennifer Clarke

VICE CHANCELLOR'S INNOVATION FELLOW

Ian Jonsen

ARC FUTURE FELLOWS

Simon Griffith	Robert Lanfear
Joshua Madin	Ian Wright

AUSTRALIAN ANTARCTIC DIVISION/MACQUARIE UNIVERSITY RESEARCH FELLOW

Andrés Rigual-Hernández

MACQUARIE UNIVERSITY RESEARCH FELLOWS

Rachael Gallagher	Tim Green
Trevor Keenan	

ARC DECRA RESEARCH FELLOWS

Graeme Lloyd	Elizabeth Madin
Dan Warren	Melanie Zeppel

RESEARCH FELLOWS AND SENIOR RESEARCH FELLOWS

Monica Awasthy	John Baumgartner
James Camac	Victoria Clarke
Belinda Cooke	Andrea Leigh Crino
Martin De Kauwe	Bradley Evans
Daniel Falster	Richard Fitzjohn
Ryan Ghan	Anais Gilbert
Ines Hessler	Douglas Kelley
Kathryn Korbel	Yan-Shih Lin
Fleur M Ponton	Karen Ross
Andrew Scafaro	Carolynn Smith
Andrea Stephens	Emma Thompson
Wade Tozer	Steve Van Sluyter
Han Wang	Elizabeth Wenk
Rhys Whitley	

EXECUTIVE OFFICER

Sharyon O'Donnell

PROFESSIONAL STAFF

Lara Ainley	Marie Howitt
Laura McMillan	Anne-Marie Monchamp
Samantha Newton	Veronica Peralta
Teresa Potalivo	Vincenzo Repaci
Dalila Rendon-Casteneda	Leigh Staas

TECHNICAL STAFF & SCIENTIFIC OFFICERS, INCLUDING RESEARCH OFFICERS

Sanscha Aberg	Craig Angus
Stuart Allen	Amy Asher
Lachlan Byatt	Ray Cameron
Maria Castillo-Pando	Sarah Collison
Ray Duell	Libby Eyre
Negin Farzadian	Henrique Furstenau Togashi
Marita Holley	Andrew Irvine
Pridhee Kapoor	Monika King
Claire Laws	Winnie Man
Vivian Mendez	Muhammad Masood
Samantha Newton	Soo Jean Park
Tarun Rajan	Jennifer Rowland
Liette Vandine	Adam Wilkins

FACULTY/UNIVERSITY STAFF IN THE DEPARTMENT

Debra Birch	Anthony Gurlica
Rekha Joshi	Jenny Minard
Nicole Vella	

HONORARY ASSOCIATES

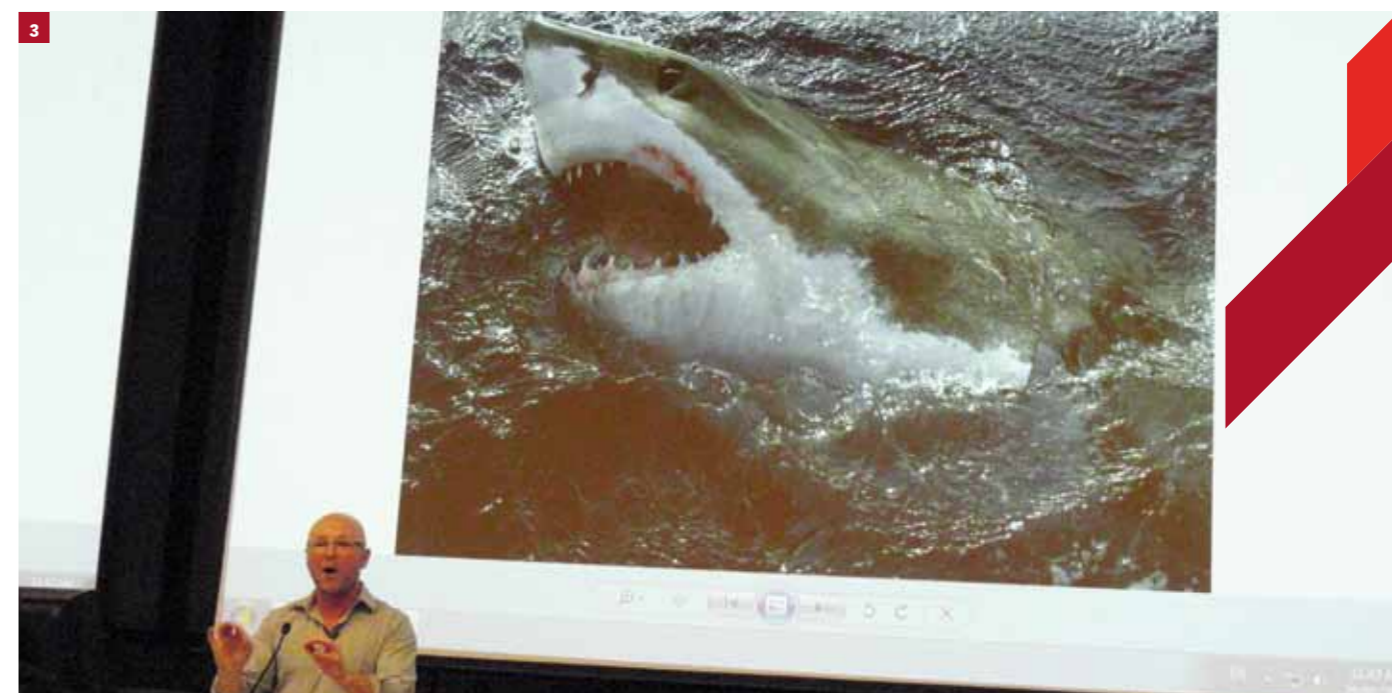
Valter Amaral	Andrew Baird
Geoffrey Bedford	Herbert Dartnall
Alison Downing	Kevin Downing
Duursma Remko	Jennifer Ekman
Mark Elridge	Janusz Gebicki
Dinah Hales	Roger Hiller
Robert Kooyman	John Laurie
Briony Mamo	Clive McMahon
Ron Oldfield	Hannelore Paxton
Ross Peacock	Irina Pollard
Amanda Ridley	Moninya Roughan
Patricia Selkirk	David Slip
Peter Smith	Shannon Smith
Paul Story	Luke Strotz
Stephanie Stuart	Noel Tait
Diana Tsoulos	Kate Umbers
Koa Webster	Rudiger Wehner
David Wells	Amy Zanne

VISITING ASSOCIATES

Aaron Harmer	Eileen Hebets
Marcus Lincoln Smith	Elsa Perez
Lee Ann Rollins	Douglas Wartzok

VISITING SCHOLARS

James Baxter-Gilbert	Rafael De Fraga
Jodie Gruber	Raquel Miatto
Diana Rojas Ahumada	Tina Wunderlin



3. James Woodford speaking at the Milthorpe Lecture. Photo by Peter Schlegel.

Learning and teaching

THE DEPARTMENT OF BIOLOGICAL SCIENCES RECOGNISES THAT STUDENT LEARNING AND SATISFACTION ARE CRITICAL TO THE SUCCESS OF THE DEPARTMENT.

We strive to engage students by maintaining high quality curricula that are at the forefront of scientific discovery and relevant to real-world issues.

Our goal is to produce high quality graduates with the necessary capabilities for tackling global problems. At the undergraduate level, strong emphasis is placed on enquiry-based laboratory sessions and on research-led teaching.

We recognise that our postgraduate students require skills beyond research capabilities, therefore our learning and teaching extends to modules within the Genes to Geoscience Research Enrichment Program that aim to equip our postgraduates with diverse skills.

Table 1. Undergraduate units offered by the Department of Biological Sciences in Session 1, 2014.

Session 1		
Unit Code	Unit Title	Enrolled
BIOL108	Human Biology	1028
BIOL114	Evolution and Biodiversity	450
BIOL121	Marine Biology and Ecosystems	100
BIOL206	Genetics	199
BIOL210	Plant Structure and Function	100
BIOL257	Neurophysiology	299
BIOL262	Evolution	81
BIOL313	Plants: Cells to Ecosystems	21
BIOL316	Invertebrates: Evolution, Behaviour and Diversity	72
BIOL345	Human Genetics Theory	69
BIOL369	Vertebrate Evolution	101
BIOL373	Marine Ecology	34
BIOL379	Reef Evolution and Dynamics	32
BIOL391	Biological Sciences Capstone	72
BIOL399	Special Interest Topics in Biology	4
BBE100	Introduction to Brain, Behaviour and Evolution	547
BBE304	Contemporary issues in Brain, Behaviour and Evolution	14
BBE305	Animal Communication	34
MAR202	Marine Environment Issues	48
MAR303	Marine Science Project	4



UNDERGRADUATE OFFERINGS

The Department administers diverse undergraduate specialisations. Within the Bachelor of Science the Department offers four majors: Biology, Brain Behaviour and Evolution, Human Biology and Palaeobiology. The Department also manages three specialised degrees: the Bachelor of Medical Sciences, the Bachelor of Biodiversity and Conservation and the Bachelor of Marine Science. We offer 43 undergraduate units across three sessions (Tables 1–3). Our units also contribute to specialisations administered within the Faculty of Science and Engineering such as Biomolecular Sciences and Chiropractic Science.

Table 2. Undergraduate units offered by the Department of Biological Sciences in Session 2, 2014.

Session 2		
Unit Code	Unit Title	Enrolled
BIOL108	Human Biology	187
BIOL115	The Thread of Life	628
BIOL208	Animal Structure and Function	160
BIOL227	Ecology	90
BIOL235	Experimental Design and Data Analysis for Biology	84
BIOL247	Systems Biology	298
BIOL260	Science of Sex	310
BIOL261	Palaeontology	88
BIOL334	Conservation and Ecological Genetics	60
BIOL349	Biodiversity and Conservation	41
BIOL362	Freshwater Ecology	37
BIOL367	Immunobiology	117
BIOL372	Marine Birds and Mammals	67
BIOL376	Advanced Human Physiology	76
BIOL381	Invertebrate Palaeontology	21
BIOL392	Greensteps	21
BIOL399	Special Interest Topics in Biology	10
BBE 200	Animal Behaviour	109
BBE 303	Independent Research Project in Brain, Behaviour and Evolution	1
BBE 306	Behavioural Genomics	50
MAR303	Marine Science Project	9



Table 3. Undergraduate units offered by the Department of Biological Sciences in Session 3, 2014.

Session 3		
Unit Code	Unit Title	Enrolled
BIOL260	Science of Sex	225
BIOL341	Parasitology	43



4. BIOL349 students with NPWS. Photo by Michelle Leishman.

5. A bee taking a moment's rest on a lotus plant with an aquatic fern floating on the water's surface at the Plant Growth Facility. Photo by Belinda Fabian.

6. Laura Fernandez. Photo by Marina Fagundes.

Learning and teaching

POSTGRADUATE COURSEWORK PROGRAMS

In 2014, the Department administered two coursework postgraduate Masters degrees: the Master of Marine Science and Management and the Master of Science in Biodiversity Conservation. Shorter courses are also available in the Biodiversity Conservation program at the postgraduate certificate and postgraduate diploma level. These programs are orientated towards students aiming to become practitioners and managers rather than researchers in their chosen field and, consequently, there is an emphasis on applied knowledge and skill development. We recognise that research is integral to science and hence the latest research is imbedded in the course content. Students have the opportunity to conduct a small research project as part of their studies.

MASTER OF MARINE SCIENCE AND MANAGEMENT

The Master of Marine Science and Management is specifically designed to provide a new generation of Australian marine scientists with the skills necessary to take leading roles in protecting and conserving Australia's coastal and oceanic environments, whilst appreciating and respecting the positions of all stakeholders in this area. Marine science incorporates a broad range of disciplines, from molecular genetics to ecology, oceanography and geosciences. It is essential that professional marine scientists are skilled in a range of these disciplines. Our Master of Marine Science and Management program is designed to encompass this need for a broad range of experiences.

The Master of Marine Science and Management is unique in Australia (and perhaps the world) as it is built around cross-institutional study, giving students access to the expertise of four partner universities: Macquarie University, the University of Technology Sydney, the University of Sydney and the University of New South Wales. This provides the broadest possible range of options for students. The collaborative nature of the Master of Marine Science and Management is focused around the Sydney Institute of Marine Science, which is a consortium of the four partner universities. This focus is exemplified by the Master of Marine Science and Management capstone unit (MAR801: Topics in Australian Marine Science), which is offered simultaneously by the four partner universities and is taught collaboratively at the Sydney Institute of Marine Science. In the remaining seven units of study, students are strongly encouraged to take up to two units as cross-institutional study at our partner universities. This is an ideal structure because it exposes students to a broad range of marine science topics. The collaborative nature of the Master of Marine Science and Management has proven to be extremely attractive, with 40 students (including a large cohort of international students) currently enrolled across the four partner institutions.

BIODIVERSITY CONSERVATION PROGRAMS (MSc, PG DIP AND PG CERT)

The Biodiversity Conservation specialisation is available for the Master of Science (MSc), Postgraduate Diploma (PG Dip) of Science and Postgraduate Certificate (PG Cert) of Science. The program focuses on the theory, practice and ethics of conserving Earth's biodiversity, from wildlife populations to entire ecosystems. There is an emphasis on the unique biodiversity of Australia and its connections with the southern continents and the rest of the globe. The program was revised in 2013 and the new format was offered for the second time in 2014. The program provides students with the capabilities necessary for employment in the growing field of biological conservation, especially for positions with non-government organisations. The program content provides graduates with a range of skills including wildlife survey, risk assessment, computer modelling and conservation planning. During 2014, 28 students were enrolled in the Biodiversity Conservation specialisation within the Master of Science and PG Dip degree programs. The cohort included eight international students from as far away as Mexico, Taiwan and Botswana. Recent graduates have taken up positions with a range of employers in the conservation sector around the world, including private consultancies, government departments, international organisations and educational institutions.

Table 4. Number of enrolments and units offered for postgraduate coursework.

Unit Code	Unit Title	Semester Offered	Enrollments
BIOL860	Biology Research Experience	S1 & S2	5
BIOL861	Conservation of Australasian Wildlife	S2	48
BIOL887	Biodiversity Conservation	S1	51
GSE853	Wildlife Management: Principles and Practices	S1	38
GSE854	Biodiversity Survey and Habitat Assessment Techniques	S1	15
GSE855	Communication and Wildlife Management	S2	35
CLIM803	Climate Change Impacts	S2	22
CLIM804	Climate Change and the Climate System	S1	15

BACHELOR OF PHILOSOPHY/MASTER OF RESEARCH PROGRAM

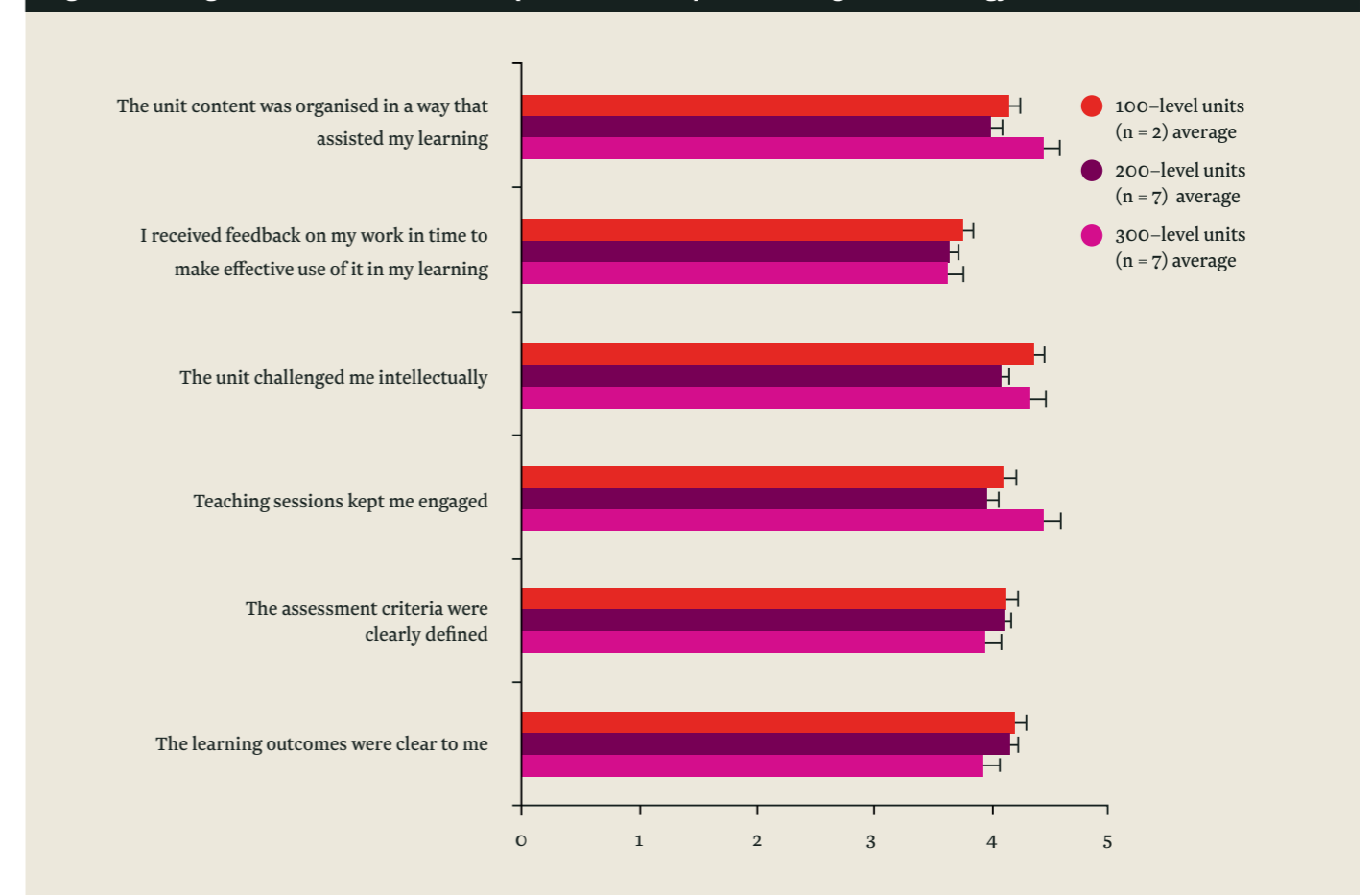
The Department administers core biology units and electives for the Bachelor of Philosophy/Master of Research training pathway required for entry into a PhD. The first year comprises advanced-level coursework and the second year involves a full-time research project. Students leaving the program after successful completion of Year 1 are awarded a Bachelor of Philosophy and those completing Year 2 submit a Masters thesis and are awarded a Master of Research.

The Department of Biological Sciences had 21 students enrolled into Year 1 of the program in 2014. The students were predominantly domestic undergraduate students, however the program also attracted three international students. The research year (800-Level) was offered for the first time in 2014 with 14 students commencing in January and four students commencing mid year. We offered 12 advanced (700-level) units in the Bachelor of Philosophy/Master of Research program in 2014 (Table 5).

Table 5. Units offered plus enrolment in the Master of Research program.

Unit Code	Unit Title	Semester Offered	Enrollments
BIOL700	Research Frontiers in Biology	S1	21
BIOL706	Advanced Studies in Neuroethology	S2	2
BIOL711	Topics in Evolution	S1	26
BIOL713	Plant Ecosystem Function	S1	5
BIOL760	Biology in the 21st Century	S2	17
BIOL761	Conservation of Australian Wildlife	S2	5
BIOL766	Advanced Studies in Palaeobiology	S2	5
BIOL767	Advanced Immunobiology	S2	2
BIOL773	Advanced Marine Ecology	S1	4
BIOL777	Scientific Research Diving	S3	4
BIOL787	Biodiversity Conservation	S1	13
BIOL799	Advanced Research Topics in Biology	S2	17

Figure 1. Average student evaluation scores (± standard error) for 16 undergraduate biology units.



Learning and teaching

LEARNING AND TEACHING INITIATIVES

The Department of Biological Sciences has implemented several learning and teaching initiatives to facilitate the exchange of information and ideas, to recognise excellence in learning and teaching and to develop relevant skills. Many of these initiatives have been operating since 2012 and continue to be highly successful in supporting staff development and training.

Staff training: The Genes to Geoscience Research Enrichment Program provides training for sessional staff (tutors) in learning and teaching modules, including development of learning outcomes, assessment marking, development of rubrics, student diversity and providing and receiving feedback. Tutors are further encouraged to develop their skills in learning and teaching through attendance at University courses and workshops. The Department also funds sessional staff to undertake tutor induction programs and learning and teaching courses offered by the University's Learning and Teaching centre.

Staffing of units: Super tutors continue to support large units. Super tutors have previous tutor experience, allowing them to perform additional unit administrative roles and mentoring of less experienced tutors. Super tutors are often associated with the unit over several offerings and provide continuity between offerings. Super tutors support student learning and develop learning and teaching skills in our postgraduate students, preparing them for future academic roles.

QUALITY ASSURANCE OF CURRICULA

The Department's Curriculum Committee oversees learning and teaching and quality assurance of curricula. In addition to program and unit review processes undertaken to meet the quality teaching framework, the Department holds annual whole-department curriculum days and small working group meetings to facilitate learning and teaching conversations. Unit review procedures have been optimised to assess the quality of curricula, student satisfaction, to provide alignment to program level outcomes, to provide feedback to the convener and to establish enhancement strategies. We review units on a three-year cycle and in 2014 we reviewed 16 units encompassing both undergraduate and postgraduate offerings.

We consider student feedback as being integral to high quality curricula and require all units to gather feedback on a regular basis. The Head of Department reviews student feedback and discusses outcomes with unit conveners. In 2014, student evaluation surveys were performed for 16 biology units. Evaluations for individual biology units demonstrate high satisfaction for 300 level units (Figure 1). Examples of student scores for organisation, feedback, intellectual challenge and engagement are provided.

During 2014 the Department continued to develop a new framework for the biology major. The Department identified a need to integrate our undergraduate programs with the Bachelor of Philosophy/Master of Research program. The new framework was established by October 2014 through a comprehensive consultative process that included entire department workshops and small focus groups. The program will be presented for Senate approval in early 2015.

LEARNING AND TEACHING GRANTS

In 2014, three staff were awarded faculty learning and teaching grants to explore initiatives to enhance learning and teaching within the Department (Table 6).

The 'Kickstart your technical laboratory skills' workshop was developed in collaboration with technical staff and academics with the goal of improving the transition from high school to university. The program provides a bridging course in laboratory skills that builds student confidence and provides experience in a university practical lab setting. During the two-day intensive lab skill workshop, students learn a broad array of skills such as pipetting, microscopy, computer data analysis and workplace health and safety. Concepts such as the scientific method of investigation and molecular biology form part of the skills learning process. The Kickstart program will run for the first time in February 2015.



The Department is working towards enhancing research-led teaching, and in 2014 two faculty learning and teaching grants supported development in this area (Table 6). A team led by Dr David Nipperess has been working to establish a long-term biodiversity monitoring plot in the ecology reserve as the basis for research projects for conservation biology postgraduate coursework students. A permanent study plot has been established in line with the international protocol, RAPELD, including common protocols for biodiversity monitoring. From 2015, students will begin data collection in the plot to establish a baseline dataset.

Dr Leanne Armand's learning and teaching grant resulted in the Marine National Facility (RV Investigator) allocating a 3-year pilot program, starting in 2017/18, to evaluate a national masters-level at sea training initiative. The pilot resulted in a published scoping document (Armand, L., Coleman, R., Coffin *et al* (2015) Strategic Marine Alliance Research, Teaching and Training (SMART2): A national Master-level at sea training initiative). The team will pursue further funding in 2015 to continue developing this national pilot program.

A/Prof Melanie Bishop was awarded Faculty Partnership Program support 'Engaging marine science students through a flipped classroom model – Phase 2'. This helped to facilitate the first offering of MAR202 in flipped classroom format, and resulted in the production of resources for convenors considering flipping their units.

Table 6. Learning and teaching grants awarded to Department staff.

Investigator/s	Title	Grant Scheme
Herberstein M, Joshi R and Bulbert M.	Kickstart your technical lab skills	Learning and Teaching Enhancement Program
Armand LK and McGrane P.	Strategic Marine Alliance for Research, Teaching and Training (SMART2)	Faculty Learning and Teaching Grant
Nipperess D, Herberstein M, Harcourt R, Stow A, Leishman M and Allen D.	Developing a research project portfolio to work-ready post-graduate coursework students	Faculty Learning and Teaching Grant
Bishop M.	Engaging marine science students through a flipped classroom model – Phase 2	Faculty Partnership Program

TEACHING EXCELLENCE AWARDS

Members of the Department were recognised for teaching excellence through external and internal awards:

- Professor Michael Gillings ranked fourth in the UniJobs online poll for "Australian Lecturer of the Year 2014" for teaching excellence in Human Biology (BIOL108)
- Associate Professor Melanie Bishop was awarded a Faculty of Science and Engineering Learning and Teaching Award
- The Department Learning and Teaching awards for 2014 yielded a strong field of awardees representing academic, sessional and technical staff (Table 7).

Table 7. Departmental Learning and Teaching awards were introduced for 'Creativity and Contributions to Learning and Teaching' in 2014.

Recipient	Topic
A/Prof Melanie Bishop	Piloting the flipped classroom approach
Dr Leanne Armand	Fact sheets with a purpose
A/Prof Jane Williamson	Tropical ecosystem field trip experience: Research project design and manuscript development
Prof Ken Cheng & A/Prof Phil Taylor	Facilitated large class debate translating biological principles into the 'real world' context
A/Prof Grant Hose	Peer review

7. PhD student Priscila Goncalves and the subject of her research Sydney rock oysters (*Saccostrea glomerata*), at Sydney Institute of Marine Science (SIMS). Photo by Gabriel Fonseca.
8. Ants enjoying the extrafloral nectar bounty from a fallen native cotton leaf (*Gossypium sturtianum*). Photo by Belinda Fabian.
9. Staff in a teaching lab. Photo by Rekha Joshi.



Learning and teaching

UNDERGRADUATE STUDENT PRIZES

Five undergraduate prizes were awarded to students undertaking units of study in biological sciences in the areas of Botany, Genetics, Parasitology and General Biological Sciences (Table 8). We are grateful to support from the beneficiaries, federations, scientific supply companies and scientific societies that provide the prizes, and we continue to engage with our supporters through invitations to departmental events.

MILTHORPE LECTURE 2014

The Milthorpe Lecture for 2014 was organised by the Milthorpe Memorial Fund committee, with Professor Mark Westoby as Chair. The lecture was given on the 29th of May by Eureka Prize winner and distinguished writer James Woodford, who spoke on the topic "The people who make discoveries in biology". The lecture was open to the public and included a stimulating question and answer session, followed by lunch in the Biological Sciences tearoom.

FUTURE DIRECTIONS

There are a number of learning and teaching initiatives that will be undertaken by the Department of Biological Sciences in 2015. We will continue activities associated with our learning and teaching strategy established in 2012, primarily the roll-out of the new framework for the biology major and the development of curricula associated with the new framework. This will see us reach a significant learning and teaching milestone. We will begin to establish a new learning and teaching strategy that will take us through the next five years and include evaluations of the new biology curriculum and further development of the Bachelor of Philosophy/Master of Research program.

We will continue to foster the professional development of all staff in learning and teaching. We recognize that the student voice is important and we will examine ways to include student participation in our learning and teaching strategy. We will also strive to improve student satisfaction and focus attention on improving some areas and lifting student evaluation scores. In addition, we will endeavour to establish mechanisms to enable greater and more formal interactions between local schools and science teachers.



10. Leanne Armand with winning fact sheets.
Photo by Anne Marie Monchamp.

Table 8. Student awards and prizes in Biological Sciences, 2014.

Prize	Awarded for	Recipient
Mollie Thomson Prize	Proficiency in two 100-level Biological Science units	Michael O'Sullivan
Australian Federation of Graduate Women NSW (North Shore Branch) Prize	Proficiency by a female student in at least 2 units at 200-level in Biological Sciences	Kirsty Reeve
Brendan Searle Prize	Proficiency in the unit BIOL206 Genetics	Erin Kummerow
Milthorpe Memorial Prize	Proficiency in a 300-level Plant Biology unit	Alan Baldry
Australian Society for Parasitology Prize	Proficiency in the unit BIOL341 Parasitology	Ashley Bacales

Research

AS A TRULY INTEGRATIVE DEPARTMENT OF BIOLOGICAL SCIENCES, OUR RESEARCH SPANS THE BROAD SPECTRUM OF BIOLOGY.

Our work ranges from genetics and genomics, to physiology, behaviour, paleobiology, conservation, ecology, evolution, parasitology and climate change. We study the full range of organisms including microbes, plants and animals in all habitats: terrestrial, freshwater and marine.

We strive to produce the highest quality of research with impactful outcomes. Our research has been externally recognised through the Excellence in Research for Australia initiative (ERA), ranking biological science research at Macquarie University 'above world standard'. Examples of some recent research stories that illustrate our broad scope are on pages 24-26.

Research Output (Figure 2, see also full list of publications on pages 52-65) has been progressively increasing over the last five years. Our publication strategy prioritizes quality over quantity, encouraging staff and students to generate significant bodies of work that have broad impact. We support this by running publication discussions and workshops for staff and HDR students, and by supporting open access publication where appropriate. Our direction is to maintain this strategy and to mentor junior staff and students in the art and science of impactful research. In 2014 we continued in our

efforts to ensure that our students are assisted and mentored in the publication of their work. During each student's annual review we requested that they submit a major piece of writing that they had done in the year, and also focused on their manuscript writing plans for the coming year. We also continued the direct support in paper writing with another off campus residential and intensive five-day 'Paper writing boot camp'.

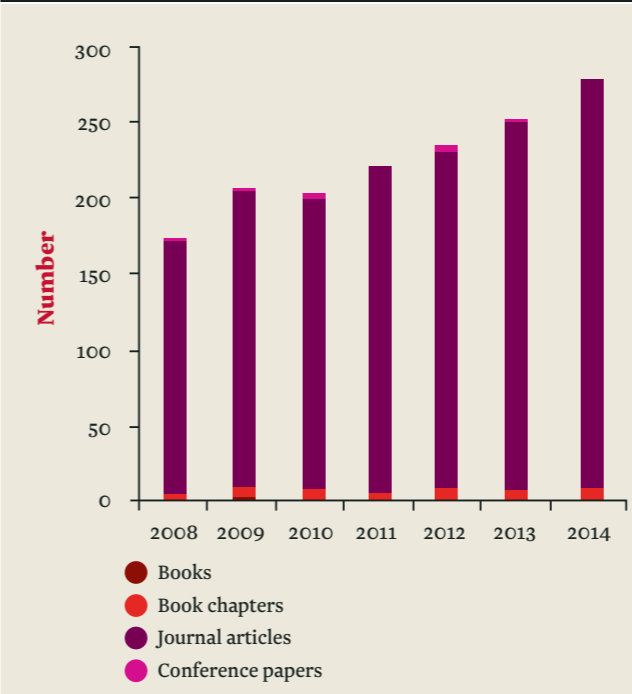
More broadly the culture of paper writing was supported in the Department by the promotion of new publications in hard copy on the prominently placed noticeboard outside the tea room, and in the Department Matters weekly newsletter. Prof Michael Gillings also gave a presentation to the Department highlighting the importance of making high impact contributions through reviews, and commentaries, particularly in influential publications such as the *Trends* journals.

Several departmental initiatives were continued through 2014 to directly support and enhance publication outcomes. A number of staff took advantage of the mini-sabbatical scheme to create the mind-space that enabled them to work with colleagues, and away from everyday distractions to write up papers. Other staff were supported in the costs associated with open access publication, and we will monitor the citation rates of these papers in relation to others in traditional journals and closed access delivery.

The Department's research funding derives from a broad range of national and international funding bodies (Table 9). In 2014, our HERDC reported research income (see page 50 for financial statements) was \$5 million. Our performance in obtaining ARC funding (Discovery, DECRA, Future Fellowships, Linkage and LIEF grants) remains strong, but we recognise the need to further diversify our research income streams.

In an effort to support our drive towards a greater diversity of research support, we held a mid-year research retreat 'Beyond ARC', which focused specifically on the range of alternative pathways to external funding. The workshop was well attended and identified a breadth of experience (within the Department) in dealing with external partners and a variety of sources of funding that staff have accessed previously and can be the focus of future efforts. We also recognised the need to better promote success in those achieving significant funding through non-ARC sources on the Australian Competitive Grants Register, both at the Department and University level, and below we have afforded these the same status as ARC outcomes.

Figure 2. Number of HERDC reported publications produced by the Department of Biological Sciences over the last seven years. (Source: Macquarie University Research Office)



Research

Australian Research Council Grants – 2014 outcomes (for 2015 funding)

Members of the Department of Biological Sciences are indicated in bold.

DISCOVERY PROJECTS

DP150101363

Dr Melanie Bishop, Dr Wayne O'Connor, **Prof David Raftos**

Genetic solution or dilution: can selective breeding future-proof oysters?

Total: \$347,900

This project aims to test whether the flow of beneficial genes from farmed oysters into wild oysters can make natural oyster beds and the ecological communities that they support more resilient to environmental change. Wild oysters are critical to the function of coastal ecosystems. However, wild oyster populations are threatened by environmental change in Australia and around the world. Selectively bred oysters bearing stress resistance genotypes are now commercially farmed in many estuaries on Australia's east coast and may be used to bolster wild oyster populations. This project endeavours to develop novel genetic strategies to future-proof oysters. Thus, the outcome of this project has potential to benefit entire ecosystems that depend upon oysters.

DP150101172

Prof Ken Cheng, Prof Jochen Zeil, Dr Ajay Narendra, **A/Prof Andrew Barron**, Prof Rudiger Wehner

Navigating brains: the neurobiology of spatial cognition

Total: \$913,900

Navigation is one of the most crucial and most challenging problems animals face. Behavioural analyses have shown that animals make use of a number of different mechanisms to navigate, but very little is known of how different forms of spatial information are processed and integrated by the brain. The project aims to tackle this by placing tethered ants in a virtual-reality simulation of their real environment allowing precise control of visual navigational cues, as well as the opportunity to study the brains of the tethered ants as they solve the real-world challenge of finding home. This may reveal how simple brains efficiently solve navigational tasks, which may inform both cognitive biology and bio-inspired computation.



11. Sydney rock oysters (*Saccostrea glomerata*).
Photo by Gabriel Fonseca.

DP150101037

Dr Martha Ludwig, **A/Prof Brian Atwell**, Dr John Lunn, Prof Mark Stitt

Exploiting natural variation to discover tools to increase crop plant yield

Total: \$438,700

This project aims to identify the specific biochemical and underlying molecular modifications that contributed to the evolution of the C4 pathway by studying C3, C4 and C3-C4 intermediate *Flaveria* species. Most land plants use C3 or C4 photosynthesis to assimilate CO₂. Plants using the C4 pathway evolved from C3 ancestors in multiple plant lineages, and show higher rates of photosynthesis and conversion of solar radiation to biomass in arid, high-light and saline environments, which are expanding due to global climate change. The outcomes of this project could define what is required to engineer plant varieties with increased yield and the ability to withstand effects of climate shift, and contribute to our understanding of convergent evolutionary processes.

FUTURE FELLOWSHIPS

FT140100452

A/Prof Andrew Barron

Comprehending and modelling the workings of the animal brain

Total: \$690,204

Truly understanding how the brain operates is a grand challenge of 21st century neuroscience. Progress toward this goal can be made through studying small-brained animals, like the honey bee. This project aims to use microscopy and pharmacology to analyse the neural mechanisms by which bees learn and classify complex things. This will enable the construction of a computational model of decision making in the bee brain. Analysing this model will test what is understood about the operation of the animal brain, and what simulates it. This project aims to reveal how neural circuits make complex decisions; establish key principles and foundational studies for comprehending larger more complex brains, and yield new approaches to machine learning.



12. A Lepidopteran with a dusting of blue on its wings resting in the bush food garden.
Photo by Belinda Fabian.

FT140100843

Dr Robert Lanfear

Understanding somatic mutation in plants: new methods, new software, new data

Total: \$768,699

Somatic mutations accumulate as plants grow, affecting everything from short-term ecological interactions to long-term evolutionary dynamics. These mutations have important consequences for plant industry and conservation, but because they are so hard to measure almost nothing is known about them. This project aims to develop new methods and software to detect, analyse, and compare the genome-wide history of somatic mutation in individual plants, providing an unprecedented level of detail into an important but understudied source of biological variation. By applying these methods to an iconic experimental population, this project aims to provide the first insights into the genome-wide causes and consequences of somatic mutation in plants.

ARC LINKAGE PROJECTS

LP140100319

A/Prof Culum Brown, Dr T Guttridge, Dr J Wiszniewski, Dr N Knott, Mr M Gregor

Movement, migration and social networks in wild shark populations

Total: \$267,097

Sharks are vital components of marine ecosystems and contribute significantly to ecotourism and fisheries. Due to their slow rate of growth and reproduction, sharks are susceptible to over exploitation. A lack of knowledge regarding their behaviour and movement patterns is a key impediment to effective management. This project will examine social interactions and migration patterns of Port Jackson sharks using a unique combination of genetic techniques, novel acoustic tag technology, behavioural manipulations and modern social network analysis. Once verified, the approach developed can be applied to other marine predators of particular management concern. The data generated will directly inform fisheries and conservation management policy.

LP140100232

Prof Belinda Medlyn, **Dr Linda Beaumont**, **Dr Bradley Evans**

Total: \$331,000

Severe drought can cause large-scale forest death, transforming landscapes with potentially catastrophic consequences for biodiversity. This project will quantify the risk of drought mortality across NSW for key tree species under a range of future climate change scenarios, enabling management of this risk in conservation planning

LINKAGE INFRASTRUCTURE GRANTS

LE150100031

Prof Marc Wilkins, Prof Ricardo Cavicchioli, A/Prof Kevin Morris, A/Prof Torsten Thomas, Prof Ian Charles, Prof Steven Djordjevic, A/Prof Aaron Darling, Dr Nicola Petty, Prof Ian Paulsen, **Prof Michael Gillings**, Prof Edward Holmes, Prof David James, Prof Claire Wade, A/Prof Marcel Dinger

PacBio long read sequencer for the Ramaciotti Genomics Consortium of New South Wales

Total: \$630,000

PacBio long read sequencer for the Ramaciotti Genomics Consortium of New South Wales: This will be one of the first PacBio sequencers for a service facility in Australia. Unlike other next-generation sequencers that have read lengths of 100 to 700 bases, the PacBio long read sequencer generates an average read length of 8,000 bases and a maximum of 20,000 bases. It will be used for research in genomics, metagenomics and transcriptomics.



Research

Major Funding from non-ARC sources recognised on the Australian Competitive Grants Register

Members of the Department of Biological Sciences are indicated in bold.

Awarding body: Office of Environment and Heritage

Prof L Hughes, Dr L Beaumont, Prof M Leishman, Dr R Gallagher, Dr N Hancock

Biodiversity Node of the NSW Adaptation Research Hub

Total: \$945,000

This research area is led by Climate Futures at Macquarie University, with support from CSIRO. It will focus on increasing knowledge of the capacity of species, ecosystems and landscapes to adapt to current and future climate variability, identify refuges where species can survive extreme events, and explore ways to make integrated decisions for local land use plans that optimise biodiversity outcomes.

Awarding body: Marine National Facility Research Vessel Investigator

Dr LK Armand, Dr P O'Brien, Prof A Leventer, Dr F Donda, Prof E Domack, Prof L De Santis, Dr A Post, Dr B Opdyke, Dr C Escutia-Dotti

Interactions of the Totten Glacier with the Southern Ocean through multiple glacial cycles

Total: \$7.9 million logistical support for 2017 voyage

The Totten Glacier is a large outlet glacier in East Antarctica that drains a very deep subglacial basin, the Aurora Basin, which contains thickest ice in Antarctica. Recent observations suggest that the Totten Glacier is thinning rapidly in a similar manner to the Pine Island Glacier in West Antarctica. Rapid retreat of the Totten Glacier into the Aurora Basin could cause accelerated draw down of the East Antarctic Ice Sheet and matching acceleration in sea level rise. It has been proposed that the Totten Glacier is melting because of intrusion of warm Circumpolar Deep Water onto the continental shelf, as is happening in Pine Island Bay. We will investigate whether such a mechanism was involved in past retreats of the Totten Glacier by studying how the Totten Glacier behaved during past times of warming climate recorded by the sediment it delivered to the continental slope. We will map the geomorphology and shallow seismic stratigraphy of slope sediments to understand their mode of origin and to identify the best places to collect long piston cores to obtain records of past ice advance and retreat. These cores will be dated and their sediment types and fossil content examined to time the advances and retreats of the Totten Glacier and to discern which oceanic water masses were in contact with them when they were deposited. These results will be compared to results obtained by a US survey on the adjacent continental shelf in 2014. Sea floor video data will be collected to help understand the sedimentary processes active on the slope, identify coring sites for this survey and a potential Integrated Ocean Drilling Program expedition. These videos will also be to study sea floor habitats in a new Marine Protected Area, which covers the study area.

Awarding body: Horticulture Australia Ltd Research & Development Grant

A/Prof P Taylor, Dr P Crisp, Dr O Reynolds, Mr A. Jessup, Ms S Chang, Dr B Fanson, Dr I Jamie & A/Prof M Riegler

Larval diets for high-productivity mass rearing of Queensland fruit fly

Total: \$850,000

New, nutritionally optimised, diets are required for mass-rearing of 100 million Queensland fruit flies per week for environmentally benign Sterile Insect Technique control programs in which released sterile flies mate with wild populations and induce reproductive failure. We will use nutritional geometric approaches to develop new liquid and semi liquid diet formulations that design candidate diets from first principles, drawing on a detailed understanding of nutritional need.

Awarding body: Horticulture Australia Ltd Research & Development Grant

Dr I Jamie, A/Prof P Taylor, Dr S Park, Dr M Siderhurst, Ms J Royer & Dr B Dominiak

New and improved fruit fly lures for border security and management

Total: \$500,000

Australian horticulture is threatened by numerous exotic fruit fly pests, and for some of these we currently lack attractants that could be used for detection and monitoring of incursions. Such species could invade and establish robust populations before we even know they are here. In this project we will identify and synthesize promising molecules from the literature and develop additional new lure analogs, through systematic structural modifications of known molecules, for testing against a wide range of fruit fly species in Australia and overseas.

Awarding body: Horticulture Australia Ltd Research & Development Grant

Dr J Ekman, Dr G Rogers, Mr D Papacek, **A/Prof P Taylor,** Dr C Daynes

New in-field treatment solutions to control fruit fly

Total: \$525,000 (\$89,000 to Macquarie University)

Fruit flies are the world's most serious insect pests for horticulture. They can breed rapidly, disperse widely and infest most fruit and fruiting vegetables. The larvae not only destroy infested fruit, but are a major quarantine issue for both domestic and international markets. In-field treatment solutions are needed to meet domestic and export market requirements. Until August 2011, cover sprays of dimethoate and/or fenthion insecticides were commonly used to meet both production and market access requirements. Following suspension of these chemicals from most use patterns, new ways are needed to control fruit fly. The aim of this project is to develop integrated pest management options for fruit fly control for the Australian Vegetable industry.

Awarding Body: Australian Marine Mammal Centre

A/Prof S Goldsworthy, Dr A Mackay, Dr A Lowther, Mr D Holman, Dr M Double, Dr S Childerhouse, **Prof R Harcourt,** Dr G Parra, Ms M Watson, Dr E Carrol

Offshore migratory movement of southern right whales: addressing critical conservation and management needs

Total: \$105,878

This project will contribute to advancement in the management and conservation of southern right whales by providing data on the offshore migratory movements of whales from the Head of Bight (HoB) and Fowlers Bay (FB) aggregations, South Australia. Detailed information on the distribution and behaviour of southern right whales is fundamental for their conservation and management. This proposal addresses two 'High' priority actions listed in the Federal Government Recovery Plan for this species; understanding offshore distribution and, characterising baseline behaviour. Characterising migratory movements will also inform management of potential risks from human activities, such as offshore development(s).

Awarding Body: Australian Marine Mammal Centre

Ms M Watson, Mr I Westhorpe, Mr J Bannister; Ms S Hedley, **Prof R Harcourt**

Assessment of Numbers and Distribution of Southern Right Whales in South-east Australia – Year 2

Total: \$107,838

There are no accurate abundance or trend estimates available for the south-east Australian southern right whale. We are replicating methodology used in south-west Australia to conduct aerial surveys from Ceduna to Sydney (including Tasmania) for a minimum of three years, to obtain a snapshot of population size and gain insights into possible emerging areas of importance across the region. The results of this project will aid in determining the need for and design of a longer term survey plan for the region. This project directly implements a Very High Priority Action in the Draft Conservation Management Plan for the Southern Right Whale 2011 – 2016.



13. Tiny flowers in the bush food garden. Photo by Belinda Fabian

Academic staff profiles

ANDREW ALLEN – SENIOR LECTURER

I am a theoretical ecologist whose research interests lie at the interface of organismal physiology and community and ecosystem ecology. I have worked on mathematical models to describe a range of biological phenomena including broad-scale biodiversity gradients, rates of DNA evolution, and nutrient cycles in organisms and ecosystems. My current entails developing and testing a new class of biodiversity models that relate contemporary biodiversity to speciation-extinction dynamics in the fossil record and ecologically induced changes in population abundance through time. This work aims to provide a better understanding of how environmental changes, including those induced by human activities, influence the numbers of species present in ecosystems.

JOHN ALROY – ASSOCIATE PROFESSOR

Quantifying biodiversity and extinction has always been the main theme of my research. I have focused largely on methodological issues and on patterns in the deep fossil record of mammals and marine invertebrates. My methods can be used to generate numerical time scales, compute extinction rates, find the chance that a single species is extinct, quantify the similarity between communities, and estimate species richness. I'm also interested in the evolution of body mass and Pleistocene megafaunal extinctions. I'm currently shifting my focus to living organisms and I'm studying latitudinal diversity gradients, shapes of abundance distributions, and captive breeding programs.

LEANNE ARMAND – SENIOR LECTURER

I have a strong interest in the distribution of individual species related to the physical oceanic environment, and the subsequent preservation of this environmental relationship in the fossil record. I use the records of fossil diatoms in deep sea cores between Australia and Antarctica to estimate past climatic conditions, such as sea ice extent and sea surface temperatures over the last glacial cycle (~240,000 yr). My current focus is on the living diatom community of the Southern Ocean near Heard and Kerguelen Islands and along the East Antarctic continental margin near the Mertz and Totten glaciers.

BRIAN ATWELL – ASSOCIATE PROFESSOR

I investigate the biology of plant growth and mechanisms of tolerance to abiotic stress. Areas of interest include growth, development and canopy architecture of Australian native rice species (*Oryza* spp.) and the tolerance of *Oryza* species to a range of abiotic stresses such as heat, drought, salinity and anoxia. I am also working on the proteomics of cereal grains with a view to tracing provenance and improving milling qualities. A second major research strand involves the physiology of various eucalypt species under drought, particularly with respect to the carbon-water nexus and the biochemistry of volatile organic emissions.

ANDREW BARRON – ASSOCIATE PROFESSOR

My research explores the neurobiology of major behavioural systems such as memory, reinforcement and stress from a comparative and evolutionary perspective. Most of our research is with honey bees, and current major projects include: the neuromolecular basis of drug abuse and addiction, the role of epigenetic systems in long term memory and a sociobiological analysis of honey bee colony collapse disorder.

KATHERINE (KATE) BARRY – LECTURER

I am interested in the ecology and evolution of sexual reproduction, but my specific area of interest lies in the evolutionary outcome of reproductive conflict between the sexes. My research focuses on the evolution of mating strategies, sexual signalling and mate choice (both pre and post-copulatory). The majority of my research has focused on praying mantid mating systems, where I am particularly interested in the evolution of sexual cannibalism and its effect on male mate choice and reproductive success.

ANDY BEATTIE – EMERITUS PROFESSOR

Until recently I was the Director for the Commonwealth Key Centre for Biodiversity and Bioresources with research in the exploration of invertebrate and microbial diversity. Currently my main interests are the evolutionary ecology of antimicrobials, interactions between arthropods and microorganisms and the role of microbes in the evolution of sociality. I am also interested in conservation especially with reference to the economic valuation of biodiversity.

LINDA BEAUMONT – SENIOR LECTURER

My research explores biological responses to climate change. I am particularly interested in understanding and reducing uncertainty in species distribution modelling, assessing biological responses to climate change (e.g. shifts in distributions; changes to the timing of life-cycle events; invasive species; allergenic species), as well as the adaptive potential of species and conservation implications.

MELANIE BISHOP – ASSOCIATE PROFESSOR

My research investigates natural and human-mediated processes that control coastal biodiversity and its important ecosystem functions. I use manipulative field experiments to investigate effects of global and local change, often producing results that could not have been predicted using theoretical or modelling approaches.

GLENN A. BROCK – ASSOCIATE PROFESSOR

My research activities focus on elucidating the evolution, biodiversity, ecology, biogeography and biostratigraphy of the earliest (stem group) members of the three major supergroups of bilaterian animals (Ecdysozoa, Spiralia and Deuterostomia) that radiated during the Cambrian Explosion. I am part of an international research team excavating, investigating and conserving the globally important lower Cambrian Emu Bay Shale deposit containing fossils of exceptional preservation, evolutionary significance and vital natural heritage.

CULUM BROWN – ASSOCIATE PROFESSOR

I am primarily interested in Behavioural Ecology particularly predator avoidance behaviour, personality and cognition fishes. In addition to this theoretical work, I have interests in applied research in conservation biology and fisheries management. My research often takes a comparative approach in an effort to understand how natural selection has shaped the brains and behaviour of animals in the context of their natural environment.

MATTHEW BULBERT – LECTURER

My research focuses on specialisation and animal communication in an ecological context. I am interested in: how natural selection drives organisms to become 'specialists'; defining what exactly constitutes specialisation and; understanding the underlying mechanics of specialised strategies. I am particularly interested in how predator-prey interactions lead to the evolution of specialised predatory tools and tactics as well as elaborate prey defensive strategies. I am also interested in how the selection for these strategies intersects with competing selective pressures such as sexual selection, eavesdropping, and habitat structure.

KEN CHENG – PROFESSOR

My research crosses mechanistic, functional and evolutionary questions in the study of animal behaviour. A central theme of my research concerns how animals process information. Dealing with information is crucial for many important behaviours in an animal's life, including choosing a mate, avoiding predators, and finding food. The range of species I have studied include humans, rats, pigeons, chickadees, Clark's nutcrackers, desert ants, and honeybees. A large part of my research has concentrated on how animals deal with space and time. I have collaborations with a number of researchers around the world.

JENNIFER CLARKE – WALLACE FELLOW

My lab group focuses on the form and function of animal communication and its application in conservation - particularly in highly social species (elk, bison, coatis, ptarmigan, wolves, dingoes, flying-foxes, and Tasmanian devils). Understanding animal communication not only sheds light on critical aspects of a species' evolution and biology but it can also be an invaluable tool to aid in conservation, management, and species' preservation. Our lab studies aspects of alarm calling, food calling, acoustic signatures, contact calls and the role of vocalisations in social transmission of information - with conservation applications.

RICHARD FRANKHAM – EMERITUS PROFESSOR

My research focusses on conservation and evolutionary genetics. Currently, I am leading an international team writing a book on genetic management of fragmented animal and plant populations. Projects in this area include work on the implications of different species concepts for conserving biodiversity, and a meta-analysis on the use of gene flow to genetically rescue small inbred populations. Other projects include a revision of population size guidelines for retaining the genetic health of populations, and work on the evolution of weeds.

MICHAEL GILLINGS – PROFESSOR

My lab investigates how genetic diversity and genome complexity are generated, and the evolutionary consequences arising from these phenomena. We use diverse systems, from viruses to

mammals, but are currently focussing on how lateral gene transfer contributes to bacterial diversity and adaptation. Particular projects involve characterising gene diversity in the metagenome, examining the basal rate of bacterial evolution in fluctuating environments, and tracing the formation of complex mobile DNA elements assembled under the agency of human selection pressure.

SIMON GRIFFITH – ASSOCIATE PROFESSOR & ARC FUTURE FELLOW

My research investigates the many sources of variation that determine the differential reproductive fitness of individuals in populations and focuses on birds which, as a group, are very amenable to these questions due to their accessibility for life-history research focused on elements of behaviour and physiology. We study a range of species in both the field and laboratory and have established particularly good opportunities for research with the zebra finch and house sparrow. The issues that we are currently investigating include plasticity in responses to climatic variation, the evolution of cooperative behaviour, personality and social behaviour, genetic structuring within populations and alternative reproductive tactics.

ROBERT HARCOURT – PROFESSOR

My main interests revolve around the importance of individual variation in behaviour to foraging, communication, mating tactics and life experience. My research has focused on individual differences and evolutionary mechanisms, combining observation and experimental manipulation of behaviour in the field with genetic methods. My second major thrust has been the use of technology to 'open a window' into the world of large marine predators. This research has helped transform our understanding of how warm-blooded animals cope with environmental extremes as they forage and breed in the marine environment. Since 2006 I have been Facility Leader for the animal tracking facility of the Integrated Marine Observing System, a national initiative to observe large marine life, see <http://imos.org.au/aatams.html>.

SANDY HARRISON – PROFESSOR

I am a palaeoclimatologist, with a special interest in how climate changes affect the land-surface, terrestrial biosphere and hydrological processes, and how changes in these components of the Earth system, in turn, feedback to or modulate regional climates. My work involves the development and use of numerical models in conjunction with observations to understand the mechanisms of climate change. I use continental to global scale syntheses of palaeoenvironmental observations to document and quantify regional changes during the Late Quaternary. I use numerical models of the terrestrial biosphere, which couple hydrological processes, vegetation dynamics and disturbance, in conjunction with outputs from state-of-the-art climate models, to explore how climate changes are registered at a regional scale.

MARIELLA HERBERSTEIN – PROFESSOR & HEAD OF DEPARTMENT

I investigate the behavioural ecology of invertebrates including spiders and insects within an evolutionary framework. My research focuses on three main areas of behavioural ecology: mating behaviour, colour signals and deceptive signals. I am particularly interested in establishing spiders as significant models in behavioural and evolutionary research.

Academic staff profiles

GRANT HOSE – ASSOCIATE PROFESSOR

My research interest is the ecology and ecotoxicology of river and groundwater ecosystems. My background is in bio-assessment and the use of invertebrate communities to reflect water quality and health of freshwater environments. Mostly now I work on groundwater ecosystems, their function and how they respond to contamination, but I remain interested and actively researching pesticide, metal and other contaminants on rivers, ponds and streams.

LESLEY HUGHES – DISTINGUISHED PROFESSOR

My work concerns the impacts of climate change, especially on terrestrial species and ecosystems. I am particularly interested in how conservation strategies can be developed to increase the resilience and adaptive capacity of ecosystems to climate threats. I am also interested in climate change communication, especially in how communication strategies need to be tailored for scientists, policy makers and the general public.

DARRELL KEMP – SENIOR LECTURER

I am broadly interested in the evolution and ecology of sexual reproduction. My research blends quantitative genetics, developmental biology, physiology and behavioural ecology and addresses questions relating to the evolution of mating strategies, contest behaviour, mate choice and sexual signalling. I choose model organisms appropriate to answering these questions, and have worked particularly with butterflies, wasps, flies and guppies. I use a range of observational and experimental methods designed to test theoretical hypotheses, and incorporate quantitative genetics and interdisciplinary conceptual perspectives (i.e., life history perspectives of sexual selection) to illuminate the evolution of sexual traits and behaviours.

MATTHEW KOSNIK – SENIOR LECTURER

I use marine sedimentary records to provide historical context to modern ecosystems and their fauna. More than just obituaries for lost ecosystems, I seek to quantify how western colonisation and development have impacted Australian marine ecosystems. In order to achieve this goal, I am actively working to understand the preservation of biological remains, the chronology of sediment deposits, and the idiosyncrasies of palaeobiological assemblages. More generally, I am interested in the interplay between ecological and evolutionary processes and the broadest spatial and temporal scales.

ROBERT LANFEAR – SENIOR LECTURER & ARC FUTURE FELLOW

I am an evolutionary biologist, and I'm particularly interested in phylogenetics, genomics, and molecular evolution. My work bridges spatial and temporal scales, from mutations that occur within a single individual over a few decades, to the long-term evolution of globally-distributed clades of species over millions of years. I also work on theoretical aspects of molecular evolution, develop new statistical methods and software to analyse huge DNA datasets, and study the behaviour and misbehaviour of scientists by analysing the published literature.

MICHELLE LEISHMAN – PROFESSOR

I am a plant ecologist with broad research interests in plant functional ecology and global change. My current research focuses on understanding the success of invasive plants, understanding the impact of climate change on plants and vegetation, and developing sustainable vegetation restoration methods. We use a range of techniques in my lab including field and glasshouse experiments, trait-based comparative analyses and bioclimatic modelling. My work is applied to management issues in conservation biology, such as development of adaptation strategies for threatened species under climate change.

JOSHUA MADIN – SENIOR LECTURER & ARC FUTURE FELLOW

I am a quantitative ecologist interested in a wide range of ecological questions. Broadly speaking, my two primary research interests are in coral reef ecology and ecological informatics. However, I have explored questions in a range of other fields, including palaeoecology, reef fish biogeography, and macroecology. My recent coral reef research focuses on understanding and predicting reef coral dislodgement and the consequences of hydrodynamic disturbances (e.g., cyclones) on community structure. This work draws on approaches in near-shore oceanography, hydrodynamics, biomechanics and statistics. Given the many large and diverse data sets that I work with, I have also become involved with several informatics projects focused on developing tools for finding, integrating and analysing multiple (often large) data sets more effectively, making it easier to include cross-disciplinary information in addressing complex ecological questions.

BELINDA MEDLYN – ASSOCIATE PROFESSOR

My research focuses on how plants, especially forests, respond to increasing atmospheric carbon dioxide (CO₂) and climate change. I work at the interface between experiments and models: my aim is to develop better models of how ecosystem productivity, water use and species composition will be affected by global change, and to do so I work closely with a number of experimental teams world-wide to test and improve ecosystem models. I use data analysis techniques to synthesise and interpret experimental results, and I use simulation models to extrapolate from experimental data to predict long-term changes in ecosystem function.

DAVID NIPPERESS – LECTURER

I have broad interests in community ecology, biogeography and conservation biology. My current research centres on the development of new methods of measuring biodiversity that incorporate information on the evolutionary relationships of organisms. I am applying these novel methods to research in biodiversity assessment, community ecology, biogeographical classification and conservation planning.

COLIN PRENTICE – PROFESSOR

I study the global land biosphere and its interactions with climate, especially the scaling up from plant and microbial processes to land-atmosphere exchanges of water, carbon dioxide and trace gases. My research now focuses on the “next generation” of ecosystem and land surface models, incorporating new developments in ecology and ecophysiology including optimal allocation theory and plant hydraulics, and on the quantification of land-atmosphere feedbacks using various data sources and models.

MICHELLE POWER – SENIOR LECTURER

My broad research interests are in the area of host-parasite interactions and using this association to identify human impacts in fragile ecosystems. Within this framework my research extends to questions encompassing co-evolution, adaptation, diversity, taxonomy and epidemiology. My group's research targets a range of parasites including protozoa and nematodes, and diverse hosts (rock wallaby, Australian sea lion and grasshoppers).

ADAM STOW – ASSOCIATE PROFESSOR

My work broadly covers the fields of behavioural ecology, evolutionary biology and conservation genetics. Some of the topics I work on are mating systems and reproductive character displacement, genetic erosion in declining species, gene flow in human impacted environments and refugium during climate change. My research group develops and applies field and molecular based approaches and work on a range of vertebrate and invertebrate animals in marine and terrestrial environments.

LUKE STROTZ – LECTURER

My research interests concentrate on how Foraminifera can be used to address a range of fundamental questions in biology and the geosciences. One of my major interests is understanding how macroevolutionary dynamics influence biodiversity over geological timescales, with an emphasis on quantifying the mechanisms that drive speciation. My current research focuses on how selection pressures that operate in estuaries influence biodiversity in marginal marine systems at the macroevolutionary level, distinguishing opportunistic taxa in tropical reef settings, and the importance of varying selective drivers, evolutionary trade-offs and metabolic pathways associated with photosymbiosis.

JULIA RAFTOS – SENIOR LECTURER

My current interest is in the anti-oxidant systems in the human red blood cell and at present my studies center on the antioxidant glutathione. Red blood cells are especially vulnerable to oxidative damage because of their role in oxygen transport. Every day up to 3% of the haemoglobin in the red cell is oxidised and this process releases oxygen radicals that have the potential to react with cell proteins and lipids producing a cascade of events that can disrupt the function of critical cell constituents. Without a nucleus the red blood cell cannot replace these damaged components. These cells are also exposed to oxidants that are released into the blood by activated cells of the immune system and from sites of inflammation. As red blood cells circulated through all tissues and organs their anti-oxidant systems have a significant function in maintaining the redox state of the whole body.

DAVID RAFTOS – PROFESSOR

My research group studies the effects of environmental stress on marine invertebrates at the cellular and molecular levels. We are particularly interested in the effects of chemical pollution, elevated temperature and ocean acidification on disease susceptibility. Most of our work is on oysters, and so we have developed extensive research collaborations with state government agencies and the Australian aquaculture industry.

PHIL TAYLOR – ASSOCIATE PROFESSOR

Research of my group is based on terrestrial invertebrates as convenient and tractable models for a wide diversity of questions addressing the evolutionary origins, functions, and mechanisms

of animal behaviour. Current work focuses on reproductive and nutritional biology of Queensland fruit flies (*Bactrocera tryoni*, aka ‘Q-fly’) and communication, assessment, learning, and decision-making of jumping spiders. In addition to addressing questions of basic Behavioural Biology, we have a parallel interest in applying the concepts and techniques of Behavioural Biology to current issues of environmentally benign pest management. In particular, current research focuses on the Sterile insect Technique and lure-and-kill approaches for control of Q-fly and related fruit fly pests.

MARK WESTOBY – DISTINGUISHED PROFESSOR & ARC LAUREATE FELLOW

Understanding and predicting from evolutionary principles the physiognomy and traits of vegetation. Structure and chemistry of plant tissues has decisive influence on geochemical, hydrological and habitat functions in terrestrial ecosystems. Field research is along an East Australian Transect from Tasmania to North Queensland, and also across rainfall gradients. Theoretical research builds models of the competition process and how it gives rise to strategy mixtures in vegetation.

MARTIN WHITING – ASSOCIATE PROFESSOR

Research in my lab is broadly focused on behavioural and evolutionary ecology, for which we use lizards as a model system although we have also studied mole-rats, snakes, cichlids, tree frogs and cane toads. Currently, we are focused on three major themes:

1. animal communication;
2. cognition;
3. and social behaviour, social organisation and understanding the early evolution of sociality in vertebrates.

JANE WILLIAMSON – ASSOCIATE PROFESSOR

My research focuses on life-history aspects of marine organisms, particularly the relative effects of recruitment versus post-recruitment processes on the demography of marine herbivores. My current interests are diverse and can be broadly categorised into the following areas: effects of climate-induced changes on early life stages of marine invertebrates, the ecology and behaviour of marine organisms, and conservation of endangered species. I have particular interests in fisheries biology and aquaculture. Past projects include: chemical cues as mediators for the demography of marine herbivores, sustainable aquaculture of edible sea urchins, the effects of elevated nutrients on marine algae and corals, epifaunal composition of marine algae, and effects of natural disturbances on the community structure of soft-bottom macro-invertebrates.

IAN WRIGHT – ASSOCIATE PROFESSOR & FUTURE FELLOW

In my lab group we investigate the functional ecology and ecological strategies of plants - the “how and why” of differences among species in their structural, chemical and physiological traits - and the implications of this variation for ecosystem-scale processes. In some studies we investigate the detailed anatomical and physiological underpinnings of variation in functional traits; in others we quantify trait relationships (and influences of climate and soils) at regional to global scales. Through collaboration with a range of research groups we work towards incorporating this knowledge in global vegetation and primary production models.

Research

SELECTED STORIES OF HIGH IMPACT RESEARCH PUBLISHED BY STAFF OF THE DEPARTMENT OF BIOLOGICAL SCIENCES IN 2014.

METHANE FLUXES SHOW CONSISTENT TEMPERATURE DEPENDENCE ACROSS MICROBIAL TO ECOSYSTEM SCALES

Methane (CH₄) is an important greenhouse gas because it has 25 times the global warming potential of carbon dioxide (CO₂) by mass over a century. Recent calculations suggest that atmospheric CH₄ emissions have been responsible for approximately 20% of Earth's warming since pre-industrial times. Understanding how CH₄ emissions from ecosystems will respond to expected increases in global temperature is therefore fundamental to predicting whether the carbon cycle will mitigate or accelerate climate change. Methanogenesis is the terminal step in the remineralization of organic matter and is carried out by strictly anaerobic Archaea. Like most other forms of metabolism, methanogenesis is temperature-dependent. However, it is not yet known how this physiological response combines with other biotic processes (for example, methanotrophy, substrate supply, microbial community composition) and abiotic processes (for example, water-table depth) to determine the temperature dependence of ecosystem-level CH₄ emissions. It is also not known whether CH₄ emissions at the ecosystem level have a fundamentally different temperature dependence than other key fluxes in the carbon cycle, such as photosynthesis and respiration. Here we use meta-analyses to show that seasonal variations in CH₄ emissions from a wide range of ecosystems exhibit an average temperature dependence similar to that of CH₄ production derived from pure cultures of methanogens and anaerobic microbial communities. This average temperature dependence (0.96 electron volts (eV)), which corresponds to a 57-fold increase between 0 and 30°C, is considerably higher than previously observed for respiration (approximately 0.65 eV)¹¹ and photosynthesis (approximately 0.3 eV). As a result, we show that both the emission of CH₄ and the ratio of CH₄ to CO₂ emissions increase markedly with seasonal increases in temperature. Our findings suggest that global warming may have a large impact on the relative contributions of CO₂ and CH₄ to total greenhouse gas emissions from aquatic ecosystems, terrestrial wetlands and rice paddies.

Gabriel Yvon-Durocher, **Andrew P. Allen**, David Bastviken, Ralf Conrad, Cristian Gudasz, Annick St-Pierre, Nguyen Thanh-Duc & Paul A. del Giorgio (2014). Methane fluxes show consistent temperature dependence across microbial to ecosystem scales. *Nature*; 507: 488–491.

THREE KEYS TO THE RADIATION OF ANGIOSPERMS INTO FREEZING ENVIRONMENTS

Early flowering plants are thought to have been woody species restricted to warm habitats. This lineage has since radiated into almost every climate, with manifold growth forms. As angiosperms spread and climate changed, they evolved mechanisms to

cope with episodic freezing. To explore the evolution of traits underpinning the ability to persist in freezing conditions, we assembled a large species-level database of growth habit (woody or herbaceous; 49,064 species), as well as leaf phenology (evergreen or deciduous), diameter of hydraulic conduits (that is, xylem vessels and tracheids) and climate occupancies (exposure to freezing). To model the evolution of species' traits and climate occupancies, we combined these data with an unparalleled dated molecular phylogeny (32,223 species) for land plants. Here we show that woody clades successfully moved into freezing-prone environments by either possessing transport networks of small safe conduits and/or shutting down hydraulic function by dropping leaves during freezing. Herbaceous species largely avoided freezing periods by senescing cheaply constructed aboveground tissue. Growth habit has long been considered labile, but we find that growth habit was less labile than climate occupancy. Additionally, freezing environments were largely filled by lineages that had already become herbs or, when remaining woody, already had small conduits (that is, the trait evolved before the climate occupancy). By contrast, most deciduous woody lineages had an evolutionary shift to seasonally shedding their leaves only after exposure to freezing (that is, the climate occupancy evolved before the trait). For angiosperms to inhabit novel cold environments they had to gain new structural and functional trait solutions; our results suggest that many of these solutions were probably acquired before their foray into the cold.

Amy E. Zanne, David C. Tank, William K. Cornwell, Jonathan M. Eastman, Stephen A. Smith, **Richard G. FitzJohn**, Daniel J. McGlenn, Brian C. O'Meara, Angela T. Moles, Peter B. Reich, Dana L. Royer, Douglas E. Soltis, Peter F. Stevens, **Mark Westoby**, **Ian J. Wright**, Lonnie Aarssen, Robert I. Bertin, Andre Calaminus, Rafaël Govaerts, Frank Hemmings, **Michelle R. Leishman**, Jacek Oleksyn, Pamela S. Soltis, Nathan G. Swenson, Laura Warman & Jeremy M. Beaulieu (2014). Three keys to the radiation of angiosperms into freezing environments. *Nature*; 506:89

Rich Fitzjohn is a postdoctoral fellow in the Westoby Lab. He is a computational biologist who studies macroevolution, phylogenetics, and the generation and maintenance of biological diversity

Mark Westoby is an ARC Laureate Fellow and a Distinguished Professor. He is an evolutionary ecologist with strong research interests in plant function.

Ian Wright is an Associate Professor and ARC Future Fellow in the Dept of Biological Sciences. His research focuses on plant functional ecology, particularly global-scale trade-offs in plant traits.

Michelle Leishman is a Professor in the Dept of Biological Sciences. She is a plant ecologist with research interests in plant functional ecology, invasion biology and plant conservation.

SAVANNA VEGETATION-FIRE-CLIMATE RELATIONSHIPS DIFFER AMONG CONTINENTS

Ecologists have long sought to understand the factors controlling the structure of savanna vegetation. Using data from 2154 sites in savannas across Africa, Australia, and South America, we found that increasing moisture availability drives increases in fire and tree basal area, whereas fire reduces tree basal area. However, among continents, the magnitude of these effects varied substantially, so that a single model cannot adequately represent savanna woody biomass across these regions. Historical and environmental differences drive the regional variation in the functional relationships between woody vegetation, fire, and climate. These same differences will determine the regional responses of vegetation to future climates, with implications for global carbon stocks.

Caroline E. R. Lehmann, T. Michael Anderson, Mahesh Sankaran, Steven I. Higgins, Sally Archibald, William A. Hoffmann, Niall P. Hanan, Richard J. Williams, Roderick J. Fensham, Jeanine Felfili, Lindsay B. Hutley, Jayashree Ratnam, Jose San Jose, Ruben Montes, Don Franklin, Jeremy Russell-Smith, Casey M. Ryan, Giselda Durigan, Pierre Hiernaux, Ricardo Haidar, David M. J. S. Bowman, William J. Bond (2014). Savanna Vegetation-Fire-Climate Relationships Differ Among Continents. *Science*; 343:548–552. doi: 10.1126/science.1247355.

Caroline Lehmann was a Macquarie University Research Fellow in the Department working on the biogeography and ecology of tropical savannas from 2010 – 2013, and she is now based at the University of Edinburgh working as a Lecturer in Biogeography in the School of GeoSciences.



14. Ants crawling all over Australian native wild cotton leaves (*Glossyptium robinsonii*) in the search for extrafloral nectar. Photo by Belinda Fabian.

PHYLOGENOMICS RESOLVES THE TIMING AND PATTERN OF INSECT EVOLUTION

Insects are the most speciose group of animals, but the phylogenetic relationships of many major lineages remain unresolved. We inferred the phylogeny of insects from 1478 protein-coding genes. Phylogenomic analyses of nucleotide and amino acid sequences, with site-specific nucleotide or domain-specific amino acid substitution models, produced statistically robust and congruent results resolving previously controversial phylogenetic relationships. We dated the origin of insects to the Early Ordovician [~479 million years ago (Ma)], of insect flight to the Early Devonian (~406 Ma), of major extant lineages to the Mississippian (~345 Ma), and the major diversification of holometabolous insects to the Early Cretaceous. Our phylogenomic study provides a comprehensive reliable scaffold for future comparative analyses of evolutionary innovations among insects.

Bernhard Misof, Shanlin Liu, Karen Meusemann, Ralph S. Peters, Alexander Donath, Christoph Mayer, Paul B. Frandsen, Jessica Ware, Tomáš Flouri, Rolf G. Beutel, Oliver Niehuis, Malte Petersen, Fernando Izquierdo-Carrasco, Torsten Wappler, Jes Rust, Andre J. Aberer, Ulrike Aspöck, Horst Aspöck, Daniela Bartel, Alexander Blanke, Simon Berger, Alexander Böhm, Thomas R. Buckley, Brett Calcott, Junqing Chen, Frank Friedrich, Makiko Fukui, Mari Fujita, Carola Greve, Peter Grobe, Shengchang Gu, Ying Huang, Lars S. Jeremiin, Akito Y. Kawahara, Lars Krogmann, Martin Kubiak, **Robert Lanfear**, Harald Letsch, Yiyuan Li, Zhenyu Li, Jiguang Li, Haorong Lu, Ryuichiro Machida, Yuta Mashimo, Pashalia Kapli, Duane D. McKenna, Guanliang Meng, Yasutaka Nakagaki, José Luis Navarrete-Heredia, Michael Ott, Yanxiang Ou, Günther Pass, Lars Podsiadlowski, Hans Pohl, Björn M. von Reumont, Kai Schütte, Kaoru Sekiya, Shota Shimizu, Adam Slipinski, Alexandros Stamatakis, Wenhui Song, Xu Su, Nikolaus U. Szucsich, Meihua Tan, Xuemei Tan, Min Tang, Jingbo Tang, Gerald Timelthaler, Shigekazu Tomizuka, Michelle Trautwein, Xiaoli Tong, Toshiaki Uchifune, Manfred G. Walz, Brian M. Wiegmann, Jeanne Wilbrandt, Benjamin Wipfler, Thomas K. F. Wong, Qiong Wu, Gengxiang Wu, Yinlong Xie, Shenzhou Yang, Qing Yang, David K. Yeates, Kazunori Yoshizawa, Qing Zhang, Rui Zhang, Wenwei Zhang, Yunhui Zhang, Jing Zhao, Chengran Zhou, Lili Zhou, Tanja Ziesmann, Shijie Zou, Yingrui Li, Xun Xu, Yong Zhang, Huanming Yang, Jian Wang, Jun Wang, Karl M. Kjer, and Xin Zhou (2014). Phylogenomics resolves the timing and pattern of insect evolution. *Science*; 346:763–767. doi: 10.1126/science.1257570.

Rob Lanfear joined the Department in 2014 and works on phylogenomics, bioinformatics, and molecular evolution.

Research impact stories

THE RESEARCH GENERATED BY STAFF AND STUDENTS GENERATES NATIONAL AND INTERNATIONAL IMPACT.

We recognize that our research results in a range of different impacts with our stakeholders. Impacts may include media coverage, the uptake of methodology by industry or other researchers or the academic impact of research findings in the form of citations and downloads. Below are several examples of recent impacts from research produced by staff and students.

MISTAKING GEOGRAPHY FOR BIOLOGY

Warren DL, Cardillo M, Rosauer DF and Bolnick DI, 2014. Mistaking geography for biology: inferring processes from species distributions. *Trends in Ecology and Evolution*; 29: 572–580.

In this paper, Warren and coauthors highlight the ways in which evolutionary history and spatial autocorrelation interact, and discuss how these interactions can lead to misleading results from many commonly used tests in ecological biogeography. They visit the fields of community phylogenetics, species distribution modeling, and generalised dissimilarity modeling, discussing the ways in which these methods can generate spurious inferences when speciation is predominantly allopatric. They also highlight recent methodological developments that may help to deal with some of these issues, and suggest possible directions for future methodological research.

Although published relatively recently, this paper has already become the top-downloaded paper of the past two years from *Trends in Ecology and Evolution*, the highest-impact journal in the field of ecology in the most recent ISI rankings: https://twitter.com/Trends_Ecol_Evo/status/598137889843732480

NEW METHODS FOR PHYLOGENETIC ANALYSES

Lanfear R, Calcott B, Ho SYW, Guindon S, 2012. PartitionFinder: Combined selection of partitioning schemes and substitution models for phylogenetic analyses. *Molecular Biology and Evolution*; 29:1695–1701.

This paper proposes a number of new methods for phylogenetic analyses, and includes software that implements these methods. The methods have now become widely accepted in the scientific community, and have changed how people approach phylogenetic analysis. The software is now an integral part of phylogenetic analysis around the world, and by improving the models we use to build phylogenetic trees, it improves the accuracy of what we understand about evolutionary history. The paper sparked a number of new approaches in the field of phylogenetic models, and has led to a number of new developments, which will continue to improve phylogenetic analyses in the future.

In 2014, the paper was cited 286 times, and the software downloaded 8604 times. Since publication in 2012, the paper has been cited 555 times and the software downloaded over 15,000 times.

“TWEETING” SEALS COLLECT OCEAN DATA FOR INTERNATIONAL DATABASE

Diving marine animals are proving to be an essential way of collecting oceanographic data especially in hard to reach areas such as the ice-bound Polar Regions. Prof Rob Harcourt leads the Australia's Integrated Marine Observing System (IMOS) animal tracking facility that tags seals in the Southern Ocean with special ocean sensing data logger/transmitters programmed to collect ocean profiles in parallel to biological information when animals dive for food.

National oceanographic data centres and researchers are now able to access data collected by marine animals via the Marine Mammals Exploring the Oceans Pole-to-pole (MEOP) Portal (www.meop.net). The international MEOP consortium formed during the International Polar Year in 2008–2009, with participants from ten countries (Australia, Brazil, Canada, China, France, Germany, United Kingdom, Norway, South Africa, United States). When the MEOP site was launched, views and tweets garnered more than 522,000 hits globally.

1. McMahon CR and Harcourt R, 2014. Seals collect more Southern Ocean data. *Nature*; 513: 33
2. Roquet F, Williams, G, Hindell MA, Harcourt R, McMahon C, Guinet C, Charrassin J-B, Reverdin G, Boehme L, Lovell P and Fedak MA, 2014. A Southern Indian Ocean database of hydrographic profiles obtained with instrumented elephant seals. *Scientific Data* 1. doi: 10.1038/sdata.2014.28
3. Raymond B, Lea M-A, Patterson T, Andrews-Goff V, Sharple, R, Charrassin J-B, Cottin, M, Emmerson L, Gales N, Gales R, Goldsworthy S, Harcourt R, Kato A, Kirkwood R, Lawton K, Ropert-Coudert Y, Southwell C, van den Hoff J, Wienecke B, Woehler EJ, Wotherspoon, S., Hindell MA, 2014. Important marine habitat off East Antarctica revealed by two decades of multi-species predator tracking. *Ecography*; 37: 001–009.
4. Roquet F, Wunsch C, Forget G, Heimbach P, Guinet C, Reverdin G, Charrassin J-B, Bailleul F, Cotsa D, Huckstadt L, Goetz K, Kovacs K, Lydersen C, Biuw M, Nost O, Bornemann H, Ploetz J, Bester M, McIntyre T, Muelbert M, Hindell M, McMahon C, Williams G, Harcourt R, Field I, Boehme L, Fedak M, 2013. Estimates of the Southern Ocean General Circulation Improved by Animal-Borne Instruments. *Geophysical Research Letters*, Ocean; 40(213): 6176–6180.

TRANSFER OF HUMAN PARASITES TO AUSTRALIAN SEA LIONS

Delport TC, Asher AJ, Beaumont LJ, Webster KN, Harcourt RG and Power ML, 2014. *Giardia duodenalis* and *Cryptosporidium* occurrence in Australian sea lions (*Neophoca cinerea*) exposed to varied levels of human interaction. *International Journal for Parasitology: Parasites and Wildlife*; 3:269–275.

The protozoan parasites, *Giardia* and *Cryptosporidium* are among the most common protozoan parasites identified as causing enteric disease in pinnipeds. The majority of information on the occurrence of these parasites in marine mammals has been generated from the Northern Hemisphere. Tiffany Delport and colleagues examined the occurrence of *Giardia* and *Cryptosporidium* in the Australian sea lion (*Neophoca cinerea*). *Giardia* was detected in 10% of sea lion samples while *Cryptosporidium* was not detected. The geographic distribution of sea lion populations sampled in relation to human settlements indicated that *Giardia* presence in sea lions was highest in populations less than 25 km from humans. Using molecular analyses the team determined the *Giardia* species and strains of parasites present in sea lions were the same as those strains typically observed in humans and other terrestrial vertebrates. The outcomes suggest that the presence of *G. duodenalis* in the endangered Australian sea lion is likely the result of dispersal from human or domestic animal sources.

This research will inform sea lion population management and risks posed by wastewater disposal in natural habitats frequented by sea lions and humans. These data will also inform captive management strategies relating to treatment options for water quality in captive marine tanks and best practice to maintain high quality water to reduce risks of parasite transmission.

PREMENSTRUAL SYNDROME INTERPRETED FROM AN EVOLUTIONARY PERSPECTIVE

Gillings MR, 2014. Were there evolutionary advantages to premenstrual syndrome? *Evolutionary Applications*; 7:897–904.

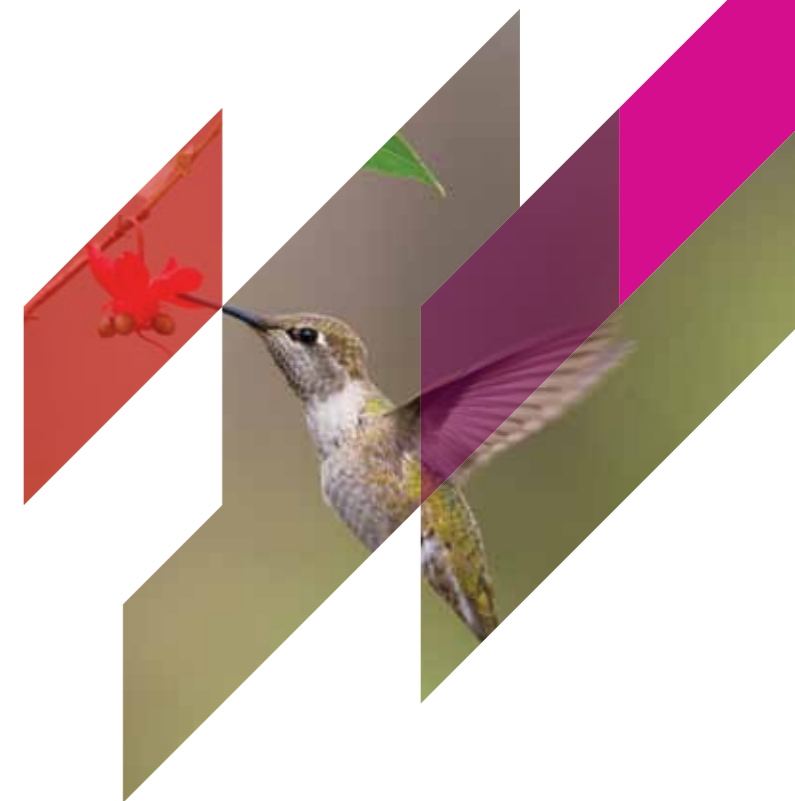
This paper looks at premenstrual syndrome in women from an evolutionary perspective asking if it could have conveyed a selective advantage in the past. The author suggests that premenstrual syndrome increased the chance of dissolving an infertile pair bond – fewer pregnancy would result in more cycles and hence higher frequency of premenstrual syndrome. Evidence to support this idea comes from the high heritability of premenstrual syndrome.

The Macquarie media release had >60,000 page views in 24 hours, with more than 25 media pieces in the first two days, including both radio and TV interviews, with an estimated circulation to over 8.5 million people. The Altmetric score (a measure of online attention) was 214, placing it in the top 0.2% of the 90,000 scientific publications in the 12-week window around this paper.

IMPROVING QFLY PEST MANAGEMENT

Queensland fruit flies (Qflies) are Australia's worst insect pest of horticulture. Qflies can be controlled through the Sterile Insect Technique, which has potential to greatly reduce reliance on environmentally harmful insecticides. In Sterile Insect Technique, millions of sterile flies are released into the environment where they mate with the wild population and, by inducing reproductive failure, reduce numbers in the next generation. Factory-reared flies are sterilized using gamma radiation, which induces mutations and disrupts gamete production. Through a series of studies published over six years, we demonstrated that the dose of gamma radiation used has been excessive, resulting in un-necessary somatic damage and reduction in fly quality. We have carefully mapped out the dose response to gamma radiation, and identified an optimal dose range that maximizes sterility induction with minimal somatic damage. As a direct consequence of these studies, irradiation doses used for SIT have been reduced in line with our recommendations, yielding improvements in fly quality and hence efficacy and cost-effectiveness of environmentally benign pest management.

1. Dominiak BC, Sundaralingam S, Jiang L, Fanson BG, Collins SR, Banos C, Davies JB and Taylor PW, 2014. Evaluating irradiation dose for sterility induction and quality control of mass-produced fruit fly *Bactrocera tryoni* (Diptera: Tephritidae). *Journal of Economic Entomology*; 107:1172–1178.
2. Collins SR, Perez-Staples D. and Taylor PW, 2012. A role for copula duration in fertility of Queensland fruit fly females mated by irradiated and unirradiated males. *Journal of Insect Physiology*; 58:1406–1412.
3. Collins SR and Taylor PW, 2011. Fecundity, fertility and reproductive recovery of irradiated Queensland fruit fly *Bactrocera tryoni*. *Physiological Entomology*; 36:247–252.



Research funding

Table 9. External research grants and fellowships funded in 2014. (Source: Macquarie University Research Office). Staff from the Department Biological Sciences, are highlighted in bold.

Project title	Granting body	Investigator
Wild shark social networks: Impacts of human intervention	Sea World Research and Rescue Foundation Inc	A/Prof Culum Brown , Dr Tristan Guttridge, Dr Joanna Wiszniewski
Improving the heat tolerance of rice through wild rice germplasm	Bayer CropScience	A/Prof Brian Atwell
Are lizards toast? Climate warming, fire and lizard extinctions in the Australian arid zone	Hermon Slade Foundation	A/Prof Adam Stow , Dr Michael Kearney
Australian Savanna Landscapes: Past, present and future	Australian Research Council	Dr Brad Evans , Dr Jason Beringer, Prof Qiang Yu, Dr Stanislaus Schymanski, Prof Steven Higgins, Dr Vanessa Haverd, Dr Yingping Wang, Dr Mathew Williams
Evolution and ecology of integron gene cassettes: Exploring the protein universe	Australian Research Council	Prof Michael Gillings , Prof Ian Charles
Reproductive plasticity and climate change: insights from an opportunistic breeder	Australian Research Council	A/Prof Simon Griffith , A/Prof Katherine Buchanan, Dr Melissah Rowe
The danger within: assessing the threats to an endangered finch from genetic incompatibility, limited dispersal and effective population size	Australian Research Council	A/Prof Simon Griffith , Dr Lee Rollins, Prof Terence Burke
Phytoplankton characterisation and related biogeochemical processes in a biological hotspot: Solitary Island Marine Park, Eastern Australia	Linnean Society of New South Wales	Linda Armbrecht
The biology of environmental stress: Genetic and physiological adaptation in Sydney rock oysters with prolonged exposure to contaminants	Sydney Institute of Marine Science NSW	Aroon Melwani , Prof David Raftos
Evolutionary ecology of vegetation	Australian Research Council	Prof Mark Westoby
A framework and toolbox for assessing and monitoring swamp condition and ecosystem health	Australian National University	A/Prof Grant Hose , Dr Kirstie Fryirs, Dr David Keith
Monitoring coral reef health from space: how herbivore behaviour alters reef structure	Macquarie University	Dr Elizabeth Madin
Integrative analysis of honey bee colony function and performance	Macquarie University	A/Prof Andrew Barron , Mr William Meikle
More than mud: how will disruption of soft-sediments threaten coastal biodiversity?	Australian Research Council	A/Prof Melanie Bishop
Cryptic male choice in a sexually cannibalistic praying mantid.	Linnean Society of NSW	Dr Kate Barry
Testing the diversity-function paradigm for the provision of clean water in aquifers	Australian Research Council	A/Prof Grant Hose , Prof John Ellis, A/Prof Adam Stow , Prof Hartmut Arndt, Dr David Nipperess
Answering longstanding plant ecology questions with new technology: the effects of changes in leaf proteins with age	Australian Research Council	Prof Mark Westoby , Dr Steve Van Sluyter , Prof Paul Haynes, Prof Steven Gygi
Sexual antagonism and the consequences of sex-specific selection	Australian Research Council	Dr Darrell Kemp , Professor Nina Wedell

Project title	Granting body	Investigator
Grass of the Oceans: quantifying biodiversity, environmental and climatic connectivity from a decade-long capture of Southern Ocean diatoms	Australian Antarctic Division	Dr Leanne Armand , Prof Thomas Trull, Mr Stephen Bray, Dr Andres Rigual-Hernandez
SPLAT cue-lure based management of Queensland fruit fly	Horticulture Australia Ltd	A/Prof Phil Taylor , Dr Peter Crisp, Dr Peter Leach, Greg Baker, Olivia Reynolds, Andrew Jessup, Bill Woods, Adrienne Twisk
Fruit fly research: gap analysis	Horticulture Australia Ltd	A/Prof Phil Taylor , Jenny Ekman, Dan Papacek, Gordon Rogers
New in-field treatment solutions to control Fruit Fly	Horticulture Australia Ltd	A/Prof Phil Taylor , Jenny Ekman, Gordon Rogers, Dan Papacek, Dr Cathal Daynes
DEMO-TRAITS -Tree demography, function traits and climate change	European Commission	Prof Mark Westoby , Dr Benoit Courbaud
Extreme reproductive conflict: sexual cannibalism, female deception, and the evolution of male mate choice	Hermon Slade Foundation	Dr Kate Barry
Dingo vocal communication: a tool for management and conservation?	Hermon Slade Foundation	Dr Jennifer Clarke-Mackessy
Appointment as a Climate Councillor for the Climate Council	Climate Council of Australia	Prof Lesley Hughes
Understanding and predicting southward range expansions of corals	Environmental Trust NSW	Dr Josh Madin
Movement, migration and social networks in wild shark populations	Australian Research Council	A/Prof Culum Brown , Dr Tristan Guttridge, Dr Joanna Wiszniewski, Marlin Gregor, Nathan Knott
Controlling disease in aquaculture: Antiviral immunity in oysters	Macquarie University	Dr Timothy Green , Prof David Raftos
Integrating silk biomechanics and spider ecology to understand spider web evolution.	Hermon Slade Foundation	Dr Aaron Harmer
Sex, symbiosis and 'she-males': Probing the bizarre reproductive manipulations imposed by bacterial endosymbionts upon Australian butterflies	Australia and Pacific Science Foundation	Dr Darrell Kemp , Dr Kate Barry , Dr Markus Riegler
Appointment as Member of the ARC College	Australian Research Council	Prof David Raftos
Genetic distinctiveness and fine-scale population structure of the southeast Australian southern right whale wintering ground	Australian Antarctic Division	Prof Robert Harcourt , Dr Emma Carroll, Ms Mandy Watson, Ms Rachael Alderman
Building better climate change vegetation models: How do leaves allocate nitrogen among photosynthesis and stress proteins in future climate scenarios?	Science and Industry Endowment Fund	Prof Mark Westoby , Dr Steve Van Sluyter
Responses- Adaptation protection options-nourishment and seawalls	Office of Environment and Heritage, NSW	A/Prof Melanie Bishop

Research funding

Project title	Granting body	Investigator
Risk Assessment and Strategic Response - NSW Estuaries	Office of Environment and Heritage, NSW	A/Prof Melanie Bishop
Identifying the cause of Oyster Oedema Disease (OOD) in pearl oysters (<i>Pinctada maxima</i>), and developing diagnostic tests for OOD	Fisheries Research and Development Corporation	Prof David Raftos
Isotopic techniques to constrain the timing and cause of macrobenthic community changes in Port Jackson and Port Hacking	Australian Institute of Nuclear Science and Engineering	Dr Matthew Kosnik , A/Prof Dorrit Jacob, Dr. Darrell Kaufman, Dr Quan Hua, Mr Atun Zawadzki, Ms Patricia Gadd, Henk Heijnis, Dr Gavin Birch, Mr Juan Dominguez Sarmiento
Ecological impact of myrtle rust (<i>Puccinia psidii</i>) in native and managed ecosystems	CRC Plant Biosecurity	Prof Michelle Leishman , Laura Martina Fernandez
Development of a low cost, global-scale remote monitoring for MPAs	World Wildlife Fund (WWF)	Dr Elizabeth Madin
Grass of the oceans: quantifying biodiversity, environmental and climatic connectivity from a decade-long capture of Southern Ocean diatoms.	Macquarie University	Dr Andres Rigual Hernandez , Dr Leanne Armand
Impacts of climate change on Australian tree species: making robust predictions by integrating ecological and physiological perspectives	Macquarie University	A/Prof Belinda Medlyn , Dr Linda Beaumont , Prof Lesley Hughes , Dr Trevor Keenan
Navigating brains: the neurocomputational foundations of insect spatial cognition	Macquarie University	Prof Ken Cheng , A/Prof Andrew Barron , Prof Rudiger Wehner
NCRIS 2013 - eMAST Facility	Department of Industry	Dr Brad Evans
It's not all peachy: what is the adaptive role of colour change in frogs?	Australia and Pacific Science Foundation	Dr Matthew Bulbert
Wildlife conservation: altering host-parasite interactions and impacts to biodiversity and ecology	Australian Research Council	Dr Michelle Power , Prof Michael Gillings , Dr Mark Eldridge, Dr Deborah Ashworth
Monitoring coral reef health from space: how herbivore behaviour alters reef structure	Australian Research Council	Dr Elizabeth Madin
Shifting rainfall from spring to autumn: tree growth and water use under climate change	Australian Research Council & Macquarie University	Dr Melanie Zeppel
Support for Face Experiments	U.S. Department of Energy	A/Prof Belinda Medlyn
Co-funding for AAD Postdoctoral Fellowship Application	Macquarie University	Dr Leanne Armand , Dr Andres Rigual Hernandez
Climate change and extinction risk for Australian flora	Macquarie University	Prof Michelle Leishman
Modelling impacts of drought on forests globally	Macquarie University	A/Prof Belinda Medlyn
Prediction of south Indo-Pacific and Southern Ocean apex predator movements and distribution in a changing climate	Macquarie University	Dr Ian Jonsen
Southern Ocean diatoms: biological occurrences, geological interpretations	Macquarie University	Dr Leanne Armand
The evolution of sexual colouration in the field and laboratory	Macquarie University	Dr Darrell Kemp

Project title	Granting body	Investigator
Understanding somatic mutation in plants: new methods, new software, new data	Australian Research Council	Dr Robert Lanfear
Integrating biomechanics and ecology: moving from an individual- to population-level understanding of the effects of environmental change (ARC)	Australian Research Council & Macquarie University	Dr Josh Madin
The Terrestrial Ecosystem Research network (TERN) for the Education Investment Fund: Ecosystem Modelling and Scaling infrastructure (e-MAST)	Department of Education, Employment and Workplace Relations (DEEWR)	Dr Brad Evans , Prof Colin Prentice , Prof Brendan Mackey, Dr Helen Cleugh, Dr Simon Ferrier, Prof Damian Barrett, Prof Lindsay Botten, Prof Stephen Williams, Prof Barry Brook,
Quantitative metrics for determining aquifer ecosystem state	Australian Research Council	A/Prof Grant Hose , James Mitchell, A/Prof Steven Cooper, A/Prof William Humphreys, Prof Jed Alan Fuhrman, Peter Goonan, Anne Northway, Dr Satish Choy, Dr Justin Seymour
Reproductive plasticity and climate change: insights from a region of opportunistic birds	Australian Research Council - Future Fellowship	A/Prof Simon Griffith
Intergovernmental Panel on Climate Change Fifth Assessment Report Authors: Helping to Shape a Global Change Solution - an Australian Government Initiative	Department of Climate Change and Energy Efficiency	Prof Lesley Hughes
Towards a trait-based ecology: new directions in leaf economics research	Australian Research Council	A/Prof Ian Wright
Adapting to climate change: Does enhanced metabolism provide heritable protection against ocean acidification and increasing temperature in oysters?	Australian Research Council	Prof David Raftos , A/Prof Paul Haynes, Wayne O'Connor, Laura Maree Parker, A/Prof Pauline Ross, Hans Portner
Fossils, rocks and early Cambrian clocks: Calibrating body plan assembly and lineage splits in ancestral animals from Gondwana	Australian Research Council	A/Prof Glenn Brock , Dr John Paterson
How does your garden grow? Scaling functional traits to whole-plant growth	Australian Research Council	A/Prof Ian Wright , Lucas Cernusak, Dr Caroline Lehmann , Dr Ross Peacock
Next generation vegetation model based on functional traits	Australian Research Council	A/Prof Ian Wright , Prof Colin Prentice
Quantitative Reconstructions of Australian Climates since the Last Interglacial	Australian Research Council	Prof Sandy Harrison
Turning water into carbon: a synthesis of plant water-use efficiency from leaf to globe	Australian Research Council	A/Prof Belinda Medlyn , Prof Colin Prentice , Almut Arneth, Remko Duursma
What happens to coral reefs without cleaner fish?	Australian Research Council	Dr Elizabeth Madin
Heatwave alert levels research project	The Health Administration Corporation	Dr Brad Evans , Dr Ines Hessler , Dr Richard Broomes
Management of coastal lakes to minimise invasion	Australian Research Council	A/Prof Melanie Bishop , Dr Melinda Coleman, Dr Timothy Glasby, Dr Brendan Kelaher
Disentangling the factors mediating marine trophic cascades over a latitudinal gradient in Australia	National Science Foundation (NSF)	Dr Elizabeth Madin
Developing the groundwater health index as an industry-wide monitoring tool	Cotton Research and Development Corporation	A/Prof Grant Hose , Dr Kathryn Korbel

Research funding

Project title	Granting body	Investigator
Fieldwork vehicle for use in the Australian arid zone	Macquarie University	A/Prof Simon Griffith
Biodiversity Node of the NSW Adaptation Research Hub	Office of Environment and Heritage, NSW	Prof Lesley Hughes
Frayed at the edges? Integrating evolutionary genetics into the study of species distributional limits	Australian Research Council	Dr Darrell Kemp , Dr Carla Sgro, Dr Belinda van Heerwaarden
Putting adaptation into vegetation models: towards a predictive theory of trait diversity and stand structure	Australian Research Council	Dr Daniel Falster , Prof Hanna Kokko, Dr Joseph Wright
Quantifying the effects of western colonisation on Great Barrier Reef molluscan communities	Australian Research Council	Dr Matthew Kosnik
Quantifying the tree of life's diversity with the paleobiology database	Australian Research Council	A/Prof John Alroy
Palaeoclimate Dynamics: an observational basis and theoretical framework for Earth System science	Macquarie University	Prof Sandy Harrison
Predator vs. facilitator: trophic impact of the invasive European shore crab, <i>Carcinus maenas</i> , in southeast Australian estuaries	Ecological Society of Australia	A/Prof Melanie Bishop , Daniel Bateman , A/Prof Grant Hose
Dispersal, diversity and survival: lessons from the fossil record	Australian Research Council	Dr Graeme Lloyd
A genetic approach to the conservation of grey reef sharks in Northern Australia and Indonesia	Sea World Research and Rescue Foundation Inc	A/Prof Adam Stow
Stress-testing koalas: a non-invasive method for monitoring koala health	James N Kirby Foundation	Dr Koa Webster , Dr Edward Narayan
Accurate and early yield predictions through advanced statistical modelling	Grape and Wine Research and Development Corporation	Dr Steve Van Sluyter , A/Prof Greg Dunn, Gioia Small, Dr Linda Beaumont
The biology and fishery of angel sharks and sawsharks in NSW	NSW Department of Industry and Investment	Mr Vincent Raoult , A/Prof Jane Williamson
Towards a Bionic Brain	Macquarie University	A/Prof Andrew Barron
Is it a one-way street? Pathogen transfer between flying-foxes and humans	Ian Potter Foundation	Dr Michelle Power , Dr Koa Webster , Dr Kerry Parry-Jones
Functional biogeography: a novel fusion of plant traits, genomics and climate change science	Macquarie University	Dr Rachael Gallagher , A/Prof Ian Wright
Understanding potential climate change impacts on Australian ecosystems through integrating models with data	Macquarie University	Dr Trevor Keenan , Prof Colin Prentice
Assessing and mitigating the effects of climate change on little penguins in NSW	Birdlife Australia	Prof Lesley Hughes , Gemma Frances Carroll
Diversity and evolution of Australian alpine grasshoppers (Orthoptera: Acrididae: Oxyinae: Praxibulini)	Department of Sustainability, Environment, Water, Population and Communities	Prof Marie Herberstein , Dr Hojun Song
Understanding soft coral population viability in the face of climate change	Great Barrier Reef Marine Park Authority	Marcela Diaz Jaramillo, Dr Josh Madin , Andrew Baird

Project title	Granting body	Investigator
Australian National Data Service - Major Open Data Project	Department of Industry	Dr Brad Evans
Larval diets for high-productivity mass-rearing of Queensland fruit fly for SIT	Horticulture Australia Ltd	A/Prof Phil Taylor , Dr Peter Crisp, Andrew Jessup, Dr Ian Jamie, Stella Chang, Benjamin Fanson, Dr Markus Riegler
Unravelling the relationship between microbial communities and seagrass carbon stores	Macquarie University	A/Prof Melanie Bishop
Assessment of Numbers and Distribution of Southern Right Whales in South-east Australia - Year 2	Australian Antarctic Division	Prof Robert Harcourt , Mandy Watson, Ian Westhorpe, John Bannister, Rachael Alderman
Offshore migratory movement of southern right whales: addressing critical conservation and management needs.	Australian Antarctic Division	Dr Simon Goldsworthy, Dr Alice McKay, Prof Robert Harcourt et al
Integrated Marine Observing System Animal tracking facility- Acoustic	NCRIS	Prof Robert Harcourt
Integrated Marine Observing System Animal tracking facility- Biologging	NCRIS	Prof Robert Harcourt
NSW IMOS	NSW Government, Research Attraction and Acceleration Program	Prof Peter Steinberg, Prof Robert Harcourt , Dr Moninya Roughan, Prof Stefan Williams, A/Prof Martina Doblin
Isotopic techniques to determine sedimentation rates, bioturbation, and time-averaging in the One Tree Reef Lagoon	Australian Institute of Nuclear Science and Engineering	Dr Matthew Kosnik
Contract in relation to the services of Professor Lesley Hughes to act as Climate Commissioner	Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education	Prof Lesley Hughes
Forest ecosystem water use: Does species diversity matter?	Australian Research Council	A/Prof David Ellsworth, A/Prof Belinda Medlyn
Macquarie University Genes to Geoscience Research Centre (MUGGRC)	Macquarie University	Prof Mark Westoby
Sequencing the Sydney rock oyster genome	University of the Sunshine Coast	Prof David Raftos , Prof Abigail Elizar, Dr Sham Nair , Dr Wayne O'Conner
Breeding Better Oysters (Part of ITTC for Molecular Technology in the Food Industry)	ARC Industrial Transformation and Training Centre	Prof Paul Haynes, Prof David Raftos , Prof Ian Paulsen, Prof Nicki Packer, Prof Helena Nevalainen, A/Prof Mark Malloy

Higher degree research students

THE DEPARTMENT OF BIOLOGICAL SCIENCES STRIVES TO PROVIDE AN INCLUSIVE AND INTELLECTUALLY STIMULATING ENVIRONMENT FOR OUR POSTGRADUATE STUDENTS.

The Department of Biological Sciences has a consistent enrolment of higher degree research (HDR) students of between 110–130 in any given year (Figure 3), one of the highest in the Faculty of Science and Engineering. In 2014, the average number of HDR students per principal supervisor was approximately three, consisting of a mix of domestic and international Master of Research (MRes), Master of Philosophy (MPhil) and Doctor of Philosophy (PhD) students.

Cotutelle and joint PhD arrangements have been established between PhD students enrolled in the Department of Biological Sciences and partner institutions in Europe and North America. In 2014 there were seven cotutelle PhD students, one joint PhD student and another two PhD students being supported and supervised within the Department as part of the Brazilian Science without Borders program. Cotutelle and joint PhD programs require the students to spend at least 12 months at each partner University.

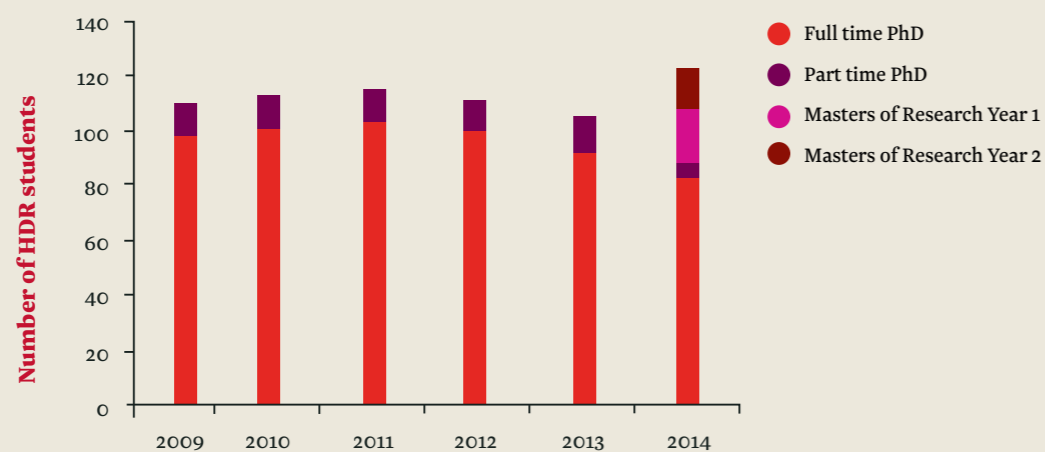
In 2014, we implemented a twice-annual review of progress, overseen by a review panel for each student. There are 13 review panels, each consisting of three academic staff (one of whom is the chair), and each panel typically reviews between three and seven HDR students. Our HDR students present a progress seminar during the HDR conference, typically held in November. In 2014, approximately 60 seminars were presented over three days,

followed by a celebratory lunch for the entire Department. For those students unable to participate in the November conference because of field-work and other commitments, a supplementary mini-conference was held for 12 HDR students in February 2015.

In 2014, 23 PhD Students, two MPhil students and 15 MRes students successfully completed their theses, and of these, six students participated in a newly developed option of providing a celebratory completion seminar to the department (Table 10). The process of collating information on the career paths of alumni from postgraduate research degrees in the Department of Biological Sciences commenced in 2014, and when complete will provide information on the range and frequency of various career paths undertaken after postgraduate research.

In addition to pursuing their research program, our postgraduate students participate in and contribute to various departmental activities, such as tutoring and undergraduate teaching, the departmental seminar series, social events, and departmental and faculty committees. An annual survey is conducted to evaluate the satisfaction of PhD candidates in several areas (Figure 4). There is mild year-to-year variation with 2014 showing an upturn in 5 of the 6 categories assessed.

Figure 3. Number of HDR students enrolled in the Department of Biological Sciences 2009–2014. (Source: Faculty of Science and Engineering)



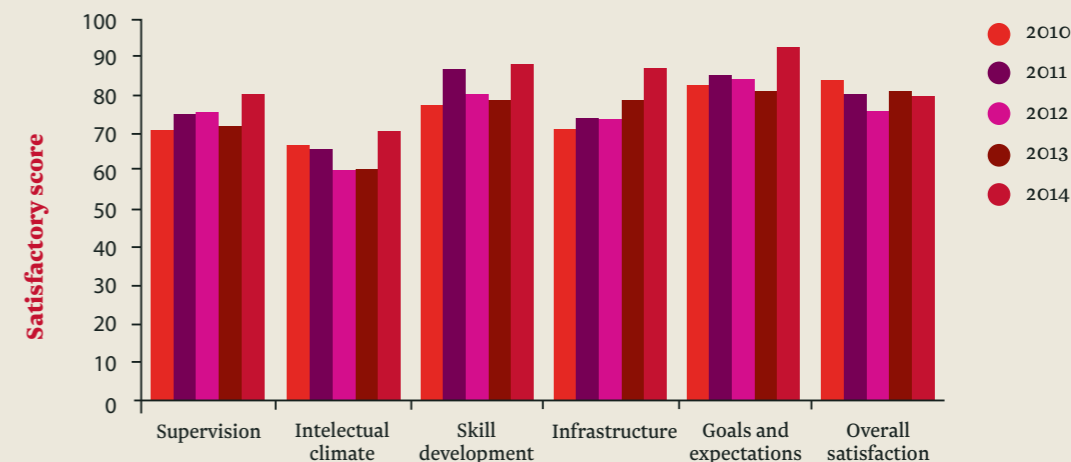
GENES TO GEOSCIENCE RESEARCH ENRICHMENT PROGRAM

A central support structure for our HDR students is the Genes to Geoscience Research Enrichment Program. The program offers master classes to the laboratory groups affiliated with the research centre. In 2014, HDR students could select from 15 different master classes ranging from technical and generic skills to soft skills and various scientific topics. Modules included R-statistics classes, Writing and Communicating for Science and Assessing Student Literacy.

GRANTS, PRIZES AND COMMENDATIONS

Our postgraduate research students continue to attract external funds and awards in recognition of their research. Congratulations to our Masters and PhD Students who received grants, awards and commendations in 2014 (Table 9).

Figure 4. HDR student satisfaction scores 2010–2014 (Source: Macquarie University).



15. Belinda Cooke and Matt Phillips in Byron Bay. Photo by Alan Baldry.



16. Vincent Raoult preparing shark samples for the Synchrotron. Photo by An Grobler.

Higher degree research students

Table 9. Student Awards and Grants in 2014.

Student name	Name of Award/Grant	Title	Amount
Diego Barneche Rosado	Best student talk at the International Biogeography Society Early Career Conference (ANU, Canberra, Jan 2014)	Talk title: Scaling metabolism from individuals to reef-fish communities at the global scale	
Shuangxi Zhou	Visiting research fellow, Institute of Geochemistry, Chinese Academy of Sciences	Model-oriented data synthesis and analysis of plant photosynthetic traits in karst ecosystem	
Gemma Carroll	Australian Bird Environment Foundation grant	Assessing and mitigating the potential effects of climate change on little penguins	\$1,500
Gemma Carroll	Barbara Rice Memorial Field Research Proposal Award	Assessing the potential effects of climate change on the thermoregulation and energetics of little penguins in NSW	\$500
Gemma Carroll	Best presentation of laboratory based research at Dept. Biological Sciences student conference	Pingu goes fishing: a supervised machine learning approach to identifying prey capture from accelerometry	
Daniel Bateman	Jill Landsberg Trust Fund Scholarship	Awarded by the Ecological Society of Australia to support field work	\$6,000
Jasmin Ruch	Vice Chancellor's Commendation	Awarded for an excellent PhD thesis	
Tom White	Royal Society Travel Grant	For travel to the Commonwealth Science Conference	\$1,150
Priscila Goncalves	EMBL Australia PhD Travel Grant	Travel to EMBL Heidelberg, Germany	\$3,500
Priscila Goncalves	Molluscan Research Grant from Malacological Society of Australasia	Understanding climate change impacts on oysters	\$1,500
Joseph Kenworthy	University of St Andrews CAPOD training grant	For attendance at the Ocean Sciences Meeting, Honolulu	£150
Joseph Kenworthy	Steve Farrell Memorial Fund	For attendance at the Ocean Sciences Meeting, Honolulu	£200
Joseph Kenworthy	Marine Biological Association student award	For travel to World Conference on Marine Biodiversity, China	£100
Joseph Kenworthy	St Andrews Biology Research Committee Research Award	For travel to World Conference on Marine Biodiversity, China	£200
Joseph Kenworthy	British Ecological Society Training and Travel Award	For travel to World Conference on Marine Biodiversity, China	£500
Joseph Kenworthy	British Phycological Society student award	For travel to World Conference on Marine Biodiversity, China	£615
Silvia Pineda-Munoz	Pre-doctoral Research Fellowship National Museum of Natural History Smithsonian Institution	Smithsonian Institute	\$23,500

Table 10. List of Doctorate and Master of Research students who completed in 2014.

Name	Thesis title
Heidi Ahonen, PhD	Population structure and mating system of the Australian sea lion (<i>Neophoca cinerea</i>)
Lara Ainley, PhD	Intraspecific variation in the leaf traits and decomposition of estuarine primary producers across spatial gradients
Linda Armbrrecht, PhD	Phytoplankton and oceanography of the Coffs Harbour region, Eastern Australia
Maria Asmyhr, PhD	Biodiversity assessment and conservation of groundwater ecosystems

Name	Thesis title
Sofia Baig, PhD	Elevated CO ₂ effects on vegetation: informing modelling through meta-analysis and targeted experiments
Marco Barquero Arroyo, PhD	Geographic variation in male agonistic display among three populations of the lizard <i>Amphibolurus muricatus</i> : the role of habitat structure, predation risk and temperature
Jacqueline Bell, PhD	Urchin mediated positive interactions
Alexander Bush, PhD	Impacts of climate change on freshwater macroinvertebrates and conservation prioritisation
Lun-Hsien Chang, MPhil	Behavioural influences of precocious foraging induced by juvenile hormone analogue methoprene on the flight history and short-distance navigation of worker honeybees (<i>Apis mellifera</i>)
Miranda Christopher, MPhil	Class 1 integrons and their impact on the mobility of antibiotic resistance in clinical environments
Cliff Garside, PhD	Abiotic and biotic factors influencing the invasion of <i>Carcinus maenas</i> in southern New South Wales, Australia
Naila Even, PhD	Physiological and behavioural stress responses in the social honeybee, <i>Apis mellifera</i>
Pascal Geraghty, PhD	Life history and genetic structure of three commercially targeted sharks in temperate eastern Australian waters
Raelene Giffney, PhD	Maternal care and social behaviour in the hibiscus harlequin bug, <i>Tectocoris diophthalmus</i>
John Hunter, PhD	Seven generations healing: traditional ecological knowledge recording, application, maintenance and revival
Yuna Kim, PhD	Foraging Ecology of the Threatened Gould's Petrel, <i>Pterodroma leucoptera</i>
Erin Kydd, PhD	Life Skills Training in Hatchery Reared Fish
Doug Kelley, PhD	Modelling Australian fire regimes
Luke McCowan, PhD	The influences of social learning on predator avoidance in the zebra finch.
Emilie Perez, PhD	Communicating about stress: modulation of vocalisations in the zebra finch.
Jasmin Ruch, PhD	Evolution and maintenance of sociality in crab spiders (Thomisidae)
Alexandra Schnell Cisneros, PhD	Signalling, mating and conflict resolution in the giant Australian cuttlefish, <i>Sepia apama</i> .
Gemma White, PhD	Spatial learning in intertidal gobies
Kasia Zieminska, PhD	Anatomical variation in twig wood across Australian angiosperms
Nicholas Anning, MRes	Character displacement as a mechanism for coexistence in moa (Aves: Dinornithiformes)
Hayley Bell, MRes	Character displacement in pleistocene kangaroos
Victoria Bywater, MRes	Song and duet function of the Chirruping Wedgebill (<i>Psophodes cristatus</i>)
Nicolette Armansin, MRes	Are wobbegongs social? Social networks of the spotted wobbegong shark (<i>Orectolobus maculatus</i>) in a small marine protected area
Penelope Carbia, MRes	Spatial learning and memory retention in intertidal gobies
Louise Chow, MRes	The effect of sub-inhibitory concentrations of antibiotics on bacterial evolution
Kelly Davis, MRes	Behaviour of an asocial carnivore in a social context: Social organisation of Tasmanian devils (<i>Sarcophilus harrisi</i>) at the individual level
Cody Freas, MRes	A panoramic virtual reality system for visual navigation studies in solitary foraging ants
Md. Mohasinul Haque, MRes	A legacy of sampling: Exploring spatial patterns among occurrence records in Australia's Virtual Herbarium
Holly Luland, MRes	Testing spatial models of genetic connectivity for European <i>Raja clavata</i> and <i>Sepia officinalis</i> in response to seascape resistance
Ryan Nevatte, MRes	Rostral tooth microwear and ultrastructure of the barbels and rostrum tip in the Common Sawshark <i>Pristiophorus cirratus</i> and their proposed behavioural implications
Vanessa Pirota, MRes	Migrating humpback whales (<i>Megaptera novaeangliae</i>) do not respond to underwater construction or whale alarms off Sydney, Australia
Shanna Rose, MRes	Vocalisations of captive sumatran tigers (<i>Panthera tigris sumatrae</i>)
Sheena Su, MRes	Persistence of an isolated population of the temperate coral <i>Plesiastrea versipora</i>
Rachael Woods, MRes	Environmental factors limiting fertilisation and larval success in corals

Technical staff, scientific officers and administration

PRACTICAL EXPERIENCE IS ESSENTIAL TO BIOLOGY TEACHING AND RESEARCH.

The Department of Biological Sciences recognises and supports its specialised technical staff in delivering high quality and high performance technical services to learning, teaching and research.

These services incorporate significant innovation, sharing of resources, and integration of expert knowledge, talent management, and open communication within the team. The Department's multi-disciplined technical team provides technical support to all academics, HDR students, teaching, and related activities. Research support is provided in various disciplines through managing facilities, fieldwork, bio-safety, quarantine and infrastructure for research.

2014 has been particularly successful in increasing collaboration between academic, administrative and technical staff. Specifically in the area of learning and teaching, we were awarded the "Learning and Teaching Enhancement program grant" to run the pilot

program to build confidence in Science students by strengthening and developing foundation skills in laboratory methods. Technical and academic staff worked in close collaboration to develop this successful workshop.

In a strong lab culture, team members are productive and involved in the delivery of a safe work environment. The team Work Health Safety training program is focused on providing technical staff with best practice examples of behaviour that demonstrate safety leadership and drive change in the teaching laboratories. All technical team members understand the importance of implementing a safety culture within their work teams.

Table 11. During 2014, staff across the technical team have successfully achieved and won various grants and prizes on merit.

Recipient(s)	Award
Rekha Joshi	2014 National Excellence Award for Tertiary Technical Staff.
Sarah Collison, Winnie Man and Rekha Joshi	Department of Biological Sciences Annual Award 2014
Andrew Irvine	Personal Staff Development Grant for Dive Medical Training (\$3,550)
Rekha Joshi (Mariella Herberstein)	Learning and Teaching: Enhancement Program (\$14,000)
Amanda Sordes	Personal Staff Development Grant for Dive Supervisor Training (\$3,662)
Monika King	WHS safety award for 'Warden of the year'

The Department of Biological Sciences' Administrative team works effectively and efficiently together to deliver incomparable service and support to all academic, professional and research staff and students. The Department recognises the superior service and support provided by the administration, allowing its staff to focus on delivering high quality teaching and research objectives.

Administrative support is delivered through outstanding service, innovation and process improvement. Team members have their own area of focus, but work together to achieve goals and meet deadlines. This skills management enables all members of the Department to quickly and easily match the appropriate staff member to the support required. With clear and open communication, other administrators are also able to provide extra support when needed. The administration team is lead by the Executive Office and consists of the Student Administrator, HDR

Officer, Finance Officer, HR Officer, Department Administrator and the Purchasing Officer.

The team continually strives to improve and streamline current processes and procedures. In an effort to reduce over-handling and processing, a number of procedures are now online including budget management, leave and absences, fieldwork requests and academic advising requests. Furthermore, online resources have been set up to allow members of the Department to quickly and easily find help and assistance. These resources include a Biology FAQ; iLearn pages for students, staff, HDR students, convenors and technical staff; directed mailing lists; and the Thesis Register which allows Biology alumni to be contacted and stay in touch with the Department.

The Administrative team has also been involved in Rapid Improvement Events to help develop and implement a new onboarding process and induction, providing support for new staff and students to "hit the ground running".

Safety initiative

AFTER THE SUCCESS OF MAD MAY IN 2013 THE DEPARTMENT OF BIOLOGICAL SCIENCES KEPT ITS FOCUS ON SAFETY AND CONTINUED TO DEVELOP A POSITIVE WHS CULTURE BY LAUNCHING SAFETY IN SEPTEMBER (SIS) IN 2014.

The week long program commenced with a Healthy Breakfast and included sessions on Field Work Safety, Stress Management and Chemical Labeling.

An engaging seminar was given by Australia's leading WHS lawyer, Paul Cutrone. Members of the Department were able to relax and unwind with Yoga or Tai chi in the Biology courtyard and Safety Bingo tested their WHS knowledge. The safety initiative concluded with the increasingly popular seated chair massages. To maintain the momentum the Biology Spring Safety Fair is planned for 2015.



- 17. Zen leaf arranging as stress management by Michael Gilling. Photo by Belinda Fabian.
- 18. Leaf flammability. Photo by Ifenna Tooth.
- 19. Leaf flammability. Photo by Anthony Manea.



Facilities

THE DEPARTMENT OF BIOLOGICAL SCIENCES HOUSES SEVERAL FACILITIES FITTED WITH STATE-OF-THE-ART EQUIPMENT FOR TEACHING AND RESEARCH.

TEACHING LABORATORIES

The Department's teaching laboratories provide students with a world-class, modern and highly interactive environment. All labs are fitted with the latest digital technology, including digital whiteboards and digital microscopes fitted with cameras, allowing students to project high-resolution images onto their computer screen and to share discoveries with others in the class.

ACID LEACHING FACILITY

The Acid Leaching Facility is a key facility for chemical processing and preparation of fossil and Geologic materials for teaching and research within the Department of Biological Sciences as well as other Departments in the Faculty. In 2012, the facility underwent a \$500,000+ refurbishment resulting in a state-of-the-art specialist facility that ranks amongst the best in the Southern Hemisphere.

PLANT GROWTH FACILITIES

The University's large-scale Plant Growth Facility was built in 1999 and houses a wide range of experimental programs. It provides a basis for undergraduate and postgraduate biology teaching and research, and is an important resource for many national and international collaborative projects. Facilities include 14 glasshouses, 14 growth cabinets, research laboratories and the Downing Herbarium. Temperature- and CO₂-controlled glasshouses house a range of climate change experiments. The facility is scheduled for a significant update in 2015-16 as part of the Department's strategic research plan.



SYDNEY INSTITUTE OF MARINE SCIENCE

The Sydney Institute of Marine Science (SIMS) is the key marine science research facility on Australia's southeast coast. Macquarie is one of four partner universities that contribute to SIMS teaching and research activities. The SIMS campus at Chowder Bay on Sydney Harbour was commissioned in 2012 after extensive refurbishment funded by the Australian Government's Education Investment Fund, the NSW Government's Science Leveraging Fund and the Ian Potter Foundation.

These refurbished facilities are available to all marine scientists from Macquarie. The facilities include an extensive, state-of-the-art research aquarium with PC2 containment and environmental control (temperature, CO₂, etc.) capabilities, PC2 research laboratories for cell biology, molecular biology and microbiology, PC1 research laboratories for ecology, field biology and geosciences, modern teaching laboratories, residential accommodation and conference facilities. SIMS also hosts a substantial contingent of scientists and managers from the NSW Department of Primary Industries. Other associate members of SIMS include the University of Western Sydney, the Australian Museum, and the NSW Office of Environment and Heritage. Staff from the Department of Biological Sciences have senior administrative roles at SIMS including membership of the SIMS Board, Chair of the Institute's Scientific Advisory Committee, Chair of the Work Health Safety Committee, and Facility Leader of the Integrated Marine Observing System, animal tracking facility.

SIMS currently houses eight Macquarie HDR students and four postdoctoral research fellows, as well as academic staff from the Department of Biological Sciences. They are working on a range of ARC and other Federal and State government grants. SIMS administers the NSW node of the Commonwealth funded Australian Integrated Marine Observing System, which has received in excess of \$100m in infrastructure funding. A major component of SIMS' IMOS node is administered by staff from the Department of Biological Sciences. Other collaborative SIMS research programs to which Macquarie staff and students contribute include the Sydney Harbour Research program funded by ARC Linkage, and the NSW Adaptation Research Hub for Coastal Processes and Responses with support from the NSW Office of Environment and Heritage and the Australian Climate Change Adaptation Research Network for Settlements and Infrastructure (ACCARNSI).

SIMS is also the focus for Macquarie's new Master of Marine Science and Management degree. This unique Masters degree is offered concurrently by all four of SIMS' partner universities, and its capstone unit of study, Topics in Australian Marine Science, is taught collaboratively at SIMS.

SEAWATER FACILITY

Operating since August 2004, the Seawater Facility supports academic research and undergraduate teaching in the Faculty of Science. The facility is used by marine scientists at Macquarie and their collaborative partners to conduct controlled experiments and to temporarily house marine specimens. Projects this past year have looked at fish spatial memory, invasive crab species, rock oyster resilience and climate change impacts on sea urchins. The facility is scheduled for a significant refurbishment and relocation in 2015.



FAUNA PARK ANIMAL FACILITY

The Macquarie University Fauna Park stretches over 11 hectares, one-third of which is endangered Sydney Turpentine Ironbark Forest. The area is committed to non-intrusive research, e.g. learning to avoid predation, and other natural animal behaviours. Vertebrates (birds, fish, reptiles) or invertebrates (bees, flies, spiders) are observed in natural settings with minimal disruption to their normal environment. Animals are fed, watered, and checked for health on a daily basis by trained staff. The fauna park allows the researchers to verify findings they have documented in the field. Other areas of investigation are aquatic ecology and the competitive abilities of native trees.

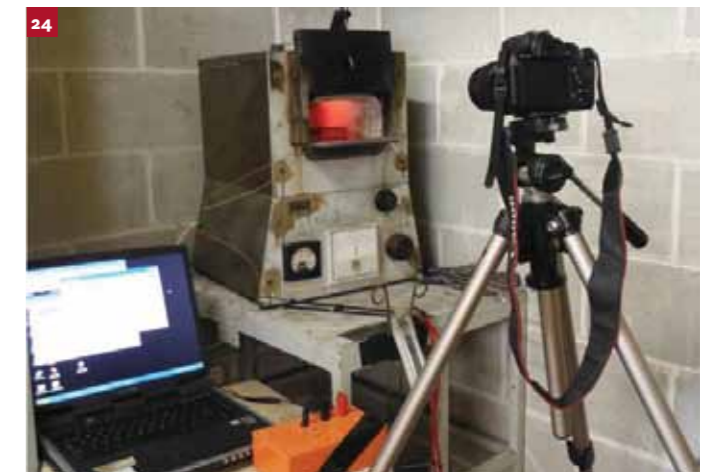


MICROSCOPY

The Microscopy Unit contains a range of modern scientific equipment specialising in light microscopy, electron microscopy, confocal microscopy, histology and digital image capture. Training in the use of this equipment is provided by our friendly staff who have experience in a range of specimen preparation techniques.

BIOLOGICAL SCIENCES MUSEUM

The Department houses the Biological Sciences Museum, which contains a range of specimens centred on Australian fauna. The collections are comprehensive and are regularly visited by university students and researchers, school groups, overseas visitors and media organisations. The past year has seen some of the live displays refurbished and static displays redeveloped, with further redevelopment scheduled for 2015.



- 20. Seedling emergence study. Photo by Jessica O'Donnell.
- 21. Seedling emergence study. Photo by Jessica O'Donnell.
- 22. Anthony Manea flammability expt glasshouse. Photo by Anthony Manea.
- 23. Plant flammability experiment. Photo by Anthony Manea.
- 24. Leaf flammability experiment setup. Photo by Michelle Leishman.

Outreach activities

THE DEPARTMENT OF BIOLOGICAL SCIENCES ACTIVELY PARTICIPATES IN MANY OUTREACH ACTIVITIES AT LOCAL AND INTERNATIONAL LEVEL.

2014 was no exception to our ongoing goal of actively sharing and promoting science and research with the community. Academic and technical staff communicate research findings through public workshops, radio interviews and the 'Scientist in Schools' program, which facilitates the study of science in schools through hands on activities with researchers.

Additionally, Department members visit a large number of primary and high schools each year to present lectures, workshops, and to participate in career days. Departmental outreach has been further enhanced through the Sydney Institute of Marine Science (SIMS), which runs a number of curriculum-linked school science modules on site, and who are currently building a new state-of-the-art discovery centre. The discovery centre, due to open in mid 2015, showcases information on Port Jackson (Sydney Harbour), current research and SIMS, and topics of community interest, such as the impacts of pollution on our coasts and oceans. The Department has also played a strong role in the 'Turning the Pages' environmental program that promotes the significance of the Pages River in a science versus art context.

Outreach is not limited to Australian schools. In 2014, the "Totten Antarctic Expedition" website followed the science and voyage undertaken by Dr Leanne Armand aboard the icebreaker RV Nathaniel B. Palmer to the Sabrina Coast, East Antarctica. The website was hugely successful in informing the public of the Totten Glacier and its future as one of East Antarctica's greatest drainage basins.

In 2014, members of the Department have been very active on the radio, giving interviews on topics ranging from why we have a big toe to antibiotics and superbugs. Prof Gillings' research on evolution and PMS received substantial national and international attention, resulting in numerous popular articles and over a dozen interviews. Other highlights include over 30 interviews on radio (plus occasional TV grabs) in relation to impacts on climate change by Prof Lesley Hughes (who is also a member of the Climate Council), and A/Prof Culum Brown's lectures on "smart fish" as part of the Ku-ring-gai Council Wildthings talks and their school environment program.

Prof Hughes' report entitled *Be Prepared: Climate Change and the Victorian Bushfire Threat* received extensive international media attention. Substantial coverage was given to the numerous articles written by members of the Department and published in *The Conversation*, an online website with analyses, viewpoints and articles directly from researchers. A/Prof Simon Griffith's popular article titled *Bird tree of life shows 'explosive evolution'*, published in December 2014, received over 11,000 hits by readers.



Staff in the Department of Biological Sciences are active participants in Macquarie University's Open Day, which was held on September 8, 2014. Staff promoted aspects of their research through a range of media interfaces including exhibits, posters and lectures. Active, hands-on participation was encouraged where possible. Activities run by staff and students in the Department of Biological Sciences included:

- Interactive exhibits on marine life, the world of spiders, bugs, bees and fossils
- Extraction of DNA from strawberries
- Exhibits of Australian native fauna and flora
- A talk on Australian reptiles, including handling of the animals by the public
- Donations of and information about free native plants
- Science treasure hunt for primary school age children.

We continue to maintain strong ties and partnerships with Aboriginal and Torres Strait Islander communities, and with underprivileged and regional groups through several public lectures in regional areas in 2014.



- 25. Student outreach volunteer in Biology lab. Photo by Rekha Joshi.
- 26. Plant display at Open Day showing the effect of fertiliser and elevated carbon dioxide on three plant species
- 27. Plant display at Open Day showing the effect of fertiliser and elevated carbon dioxide on three plant species (marigolds, snap dragons and petunias). Photos by Belinda Fabian.



External boards and services

THE DEPARTMENT OF BIOLOGICAL SCIENCES CONTRIBUTES TO THE SCIENTIFIC AND BROADER COMMUNITY THROUGH ACTIVE PARTICIPATION IN NATIONAL AND INTERNATIONAL SCIENTIFIC COMMITTEES, WORKING GROUPS AND ADVISORY BOARDS.

Members of the Department contributed to working groups or served on committees or advisory boards of international and national organisations (Table 11). In addition, a number of staff served as councillors or contributed to a range of professional organisations including the Australian Flora Foundation and the Australian Marine Sciences Association, Terrestrial Biodiversity Adaptation Research Network, the National Climate Change Adaptation Research Facility, the Terrestrial Ecosystem Research Network Executive Advisory Committee and the Integrated Marine Observing System.

Academic staff from the Department also contributed to review panels for international funding bodies such as the U.S. National Science Foundation, and to editorial boards of a wide range of international journals including *Frontiers in Marine Science*, *Journal of Ecology*, *Journal of Animal Ecology*, *Animal Behaviour*, *PLoS ONE*, *International Journal of Biodiversity*, *Animal Cognition*, *Frontiers in Comparative Psychology*, *Journal of Experimental Psychology*, *Behavioral Ecology and Sociobiology*, *Processes*, *Annals of Botany*, *Plants*, *ISRN Zoology*, *Journal of Comparative Psychology*, *Learning and Motivation*, *Endangered Species Research*, *Ethology*, *Scientific Reports* and *Frontiers in Aquatic Physiology*.



28. A brilliant lotus flower at the Plant Growth Facility
29. Water droplets poised on the leaf of a legume after a rain shower at the Plant Growth Facility
 Photos by Belinda Fabian.

Table 11. List of staff who served on committees or boards of national and international organisations.

Organisation	Staff name
Asian Bioethics Association's Board (Vice President, Pacific)	Irina Pollard
Australian Academy of Science Sectional Committee 10	Mark Westoby (chair)
Australian Academy of Science National Committee for Ecology Evolution and Conservation	Mark Westoby (chair)
Australian Committee IUCN	Ross Peacock
Australian Flora Foundation	Michelle Leishman
Australian Forestry Standard Scientific and Technical Committee	Ross Peacock
Australian Research Council's College of Experts	Michelle Leishman, David Raftos
Australian Society for Fish Biology	Culum Brown
Australian World Heritage Advisory Committee	Ross Peacock
Board of Terrestrial Ecosystem Research Network	Mark Westoby
Climate Council of Australia	Lesley Hughes
Expert Advisory Panel of the Environment Group for the Browse Basin	Rob Harcourt
Expert Advisory Panel of the SKM Chevron Wheatstone Environment	Rob Harcourt
Fisheries Society of the British Isles Council	Culum Brown
Forest Stewardship Council of Australia	Ross Peacock
Forestry Scholarship Fund	Ross Peacock
Gondwana Rainforests of Australia Technical and Scientific Advisory Committee	Ross Peacock
Intergovernmental Panel on Climate Change	Lesley Hughes
Institute of Foresters of Australia	Ross Peacock
Independent Science Panel of the Great Australian Bight Research Program	Rob Harcourt
International Association of Bryologists	Alison Downing
International Scientific Advisory Committee Ocean Tracking Network	Rob Harcourt (Chair)
Maxwell Jacobs Fund	Ross Peacock
National Forestry Masters Scholarships Fund	Ross Peacock
National Marine Mammal Scientific Committee	Rob Harcourt
New South Wales Scientific Committee	Michelle Leishman (Chair)
New South Wales Fisheries Scientific Committee	Jane Williamson (Chair)
Palaeoclimate Commission of the International Quaternary Association	Sandy Harrison (President)
Palaeoclimate Modelling Intercomparison Project	Sandy Harrison (Co-Chair)
SIMS Scientific Advisory Committee	Rob Harcourt, David Raftos
Sydney Institute of Marine Science	Culum Brown
Tasmania Climate Action Council	Lesley Hughes
UNESCO's Bioethics and Education committees	Irina Pollard
UNESCO's School of Ethics	Irina Pollard
UNESCO's International Forum of Teachers	Irina Pollard
UNESCO's Education Department	Irina Pollard
UNESCO's Research Committee	Irina Pollard
WWF Australia	Lesley Hughes

Research Centres and Facilities

SEVERAL RESEARCH CENTRES AND FACILITIES ARE BASED AT THE DEPARTMENT OF BIOLOGICAL SCIENCES

GENES TO GEOSCIENCE

A four-way fusion is emerging among comparative genomics, functional ecology, earth system science and the informatics needed to bring them together. New high-impact research questions are needed, and it is against this background that the Genes to Geoscience Research Centre aims to incubate forward-looking research ideas. Participants in MUGGRC are a federation of 45 independent labs spread across the Departments of Biological Sciences, Environment and Geography, Earth and Planetary Sciences, and Chemistry and Biomolecular Sciences. MUGGRC activities are designed to complement those of departments and of individual labs rather than to compete with them.

During 2014, eleven speakers visited Macquarie for the Genes to Geoscience seminar series. Fifteen masterclasses for postgraduates and postdocs were delivered within the framework of the Genes to Geoscience Research Enrichment Program. Six of the masterclasses were new in 2014. A working group met with the purpose of developing collaborative databases for traits of coral species. The resulting website <http://coraltraits.org/> now aggregates over 70,000 trait observations across 1,555 species. The flagship Genes to Geoscience Outlook meeting featured four distinguished visiting speakers as well as eight Macquarie laboratory leaders. Discussions over two days targeted future research possibilities. We are confident that fresh collaborations will emerge.

CLIMATE FUTURES

Climate Futures is a multi-disciplinary research centre that includes members from all four Faculties, with significant representation from the Department of Biological Sciences (including Co-director). The Centre aims to bridge the divide between climate and adaptation research, policy and practice needs, by serving as a hub for interaction between leading climate researchers, governmental decision-makers, non-governmental organisations, businesses and other stakeholders, including vulnerable communities.

During 2014, Climate Futures members were awarded over five million dollars for climate-related research, produced 20 books and book-chapters, 53 journal articles, and supervised 61 postgraduate students undertaking climate or environmental research.

The Centre focused on three main areas of research in 2014: identifying challenges for communities adapting to climate change impacts across Australia; investigating impacts and management responses to climate change relevant to the conservation of biodiversity in New South Wales and Australia; and investigating solutions for climate change adaptation of green infrastructure including the provision of food security, reducing the heat island effect, and providing biodiversity habitat.

THE NSW ADAPTATION RESEARCH HUB – BIODIVERSITY NODE

The Biodiversity Node is led by Climate Futures at Macquarie University, with support from CSIRO. It focuses on increasing knowledge of the capacity of species, ecosystems and landscapes to adapt to current and future climate variability, identifying refuges where species can survive extreme events, and exploring ways to make integrated decisions for local land use plans that optimise biodiversity outcomes.

Our vision for the Biodiversity Node of the NSW Adaptation Research Hub is a dynamic, collaborative, partnership of researchers with OEH scientists, managers and policy makers, incorporating a broad spectrum of partners from universities, CSIRO Climate Adaptation Flagship (CAF), local governments, community groups and business. The Node is a facilitative body catalysing and supporting the research efforts of the wider adaptation community by providing leadership and coordination with an emphasis on linking researchers to end-users.

The focus for the Biodiversity node is to address three key priority research areas:

- **Refugia and connectivity:** Research in this area aims to identify current and future refuges for species to allow for their survival in extreme events, such as bushfire and flood.
- **Current variability and resilience to climate change:** Research in this area will grow our knowledge of the capacity of species, ecosystems and landscapes to adapt to current climate variability and extreme events, as well as expected future impacts.
- **Integrated decision-making:** This area explores ways in which communities and governments can work together to make integrated decisions and implement local plans that optimise biodiversity outcomes for public and private landholders.

Table 12. Eleven projects have been funded by the Biodiversity Node in 2013–2014.

Chief investigator	Project title
Prof Michelle Leishman (Biological Sciences)	Risk assessment & website development for exotic plants under future climates
Dr Alex Bush	Predicted effects of climate change on freshwater biodiversity
Dr Rachael Gallagher (Biological Sciences)	Best practice translocation guidelines for climate change adaptation in NSW
Dr Stuart Whitten (CSIRO)	How does an adaptation lens change the way we invest in landscapes for biodiversity?
Dr Melanie Bishop (Biological Sciences)	How does the design and position of seawalls influence the resilience of sandy beach ecosystems to sea level rise?
Prof Michelle Leishman (Biological Sciences)	Assessing the vulnerability of endangered species and ecosystems to climate change in NSW
Prof Michelle Leishman & Dr Rachael Gallagher (Biological Sciences)	Delivering ecological range metrics for the entire NSW flora
Dr Linda Beaumont (Biological Sciences)	Identifying likely climate refugia and corridors to support species range shifts project
Dr Nola Hancock (Biological Sciences)	Population viability and climate change - increasing the predictive capability of pre-existing threats to NSW plant populations under climate change.
Dr Tim Ralph (Environmental Sciences)	Water regime thresholds, aquatic metabolism and microbial diversity in floodplain wetlands
Dr Alana Grech (Environmental Sciences)	Evaluating the status of the NSW terrestrial reserve system under a changing climate

In addition to hosting the Biodiversity Node, Climate Futures is a major partner in the Coastal Processes and Responses Node that is hosted by the Sydney Institute of Marine Science.

ECOSYSTEM MODELLING AND SCALING INFRASTRUCTURE FACILITY (EMAST)

The Ecosystem Modelling and Scaling Infrastructure Facility (eMAST) operates under the TERN (Terrestrial Ecosystem Research Network) funded by NCRIS (National Collaborative Research Infrastructure Strategy), The Australian National Data Service and the Australian Research Council under a series of grants awarded to its Director, Dr Bradley Evans and Collaborators. eMAST's scientific research focuses on terrestrial land surface processes, such as the interaction of vegetation with carbon, water and nutrient cycles

through space and time. eMAST is a network of researchers located at Australian National University, the National Computational Infrastructure, the University of New South Wales, and the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

In 2014, eMAST consolidated its software infrastructure and data sets at the NCI, delivered over 100 new research datasets and extended outreach activities. eMAST led national and international workshops and meetings with stakeholders to promote wider knowledge and use of its infrastructure.

The following were delivered:

- The eMAST ANUClimate datasets were made available via <http://dap.nci.org.au> with fully compliant RIF-CS metadata published to Research Data Australia and the TERN Data Discovery Portal.
- The ecophysiological land and biosphere data management (ePLANT) system has been upgraded in preparation for incoming data streams from TERN's plot networks (ASN, AusPlots & ATN) and beyond.
- CSIRO data assimilation products developed using remotely sensed soil moisture and the AWRA model were made available via <http://dap.nci.org.au> with fully compliant RIF-CS metadata published to Research Data Australia and the TERN Data Discovery Portal
- Bioclimatic summaries of the ANUClimate datasets were made available via <http://dap.nci.org.au> with fully compliant RIF-CS metadata published to Research Data Australia and the TERN Data Discovery Portal. The code used to describe them was made available in the eMAST R-Package and shared with national and international collaborators
- A number of international and national workshops were held around themes of mapping models to data, delivery of data services and how to access and use TERN data.
- An international collaborative workshop on the coupling of the NCAR Data Assimilation Research Testbed (DART) system to Australia's national land surface model CABLE was conducted at the NCI and resulted in the CABLE-DART data assimilation system

Research centres and facilities

INTEGRATED MARINE OBSERVING SYSTEM (IMOS)

IMOS, Australia's Integrated Marine Observing System, was established in 2006/2007 under the National Collaborative Research Infrastructure Strategy, and has since attracted over \$310 million in investment funding. IMOS facilities deploy a range of observing equipment in the oceans around Australia, and provide free open access to all data gathered through the electronic Marine Information Infrastructure Facility. These data streams, long-time-series of key physical, chemical and biological variables, represent an important source for the Australian marine and climate science community as well as for international collaborators. IMOS has been positioned to establish itself as a world leading national marine observing system, integrated across scales and variables in line with strategically important questions of relevance to the global community.

The IMOS Seals as Oceanographers Program, lead by Prof Rob Harcourt from Macquarie's Department of Biological Sciences, is part of the Australian Government Integrated Marine Observing System (IMOS) and has been collecting data with seals since 2008. In collaboration with French, American, British and Norwegian and New Zealand programs, seals now collect over 70 % of oceanographic profiles south of 60°S. These animals are fundamentally altering our understanding of the Southern Ocean and its influence on the world's climate.



WEDDELL SEALS, A NEW BREED OF OCEANOGRAPHER

Robert Harcourt

Antarctica is the last wilderness. Only now are we beginning to realise the importance of this great southern continent in regulating Earth's climate. It is in the waters that surround Antarctica that the global currents linking all of the World's oceans are born. Understanding how, where, and when these currents form is central to understanding global climate. However, gathering the vital physical information needed to study current formation is not easy and in the deep south is almost impossible in winter when most of the Southern Ocean is a vast almost impenetrable ice-sheet.

The seas below this expansive ice-covered world are home to a new generation of super marine scientists – the southern seals. By carrying small data loggers that transmit information to satellites, seals have joined the ranks of the Pasteur and Hawking. While they may not wear white coats, they are helping drive new discoveries. The information encoded by these loggers tells us not only what the seals are doing as they swim beneath the ice, but how the oceans are changing. They do this by collecting the very information; depth, water temperature and salinity that we need to describe ocean structure and function. Moreover, because the seals are able to collect this information at a time and place – the harsh Antarctic winter – when most of this area is inaccessible to conventional sampling platforms such as ship or ocean buoys, this information is revolutionising our understanding of the oceans.

Weddell seals inhabit some of the coldest, darkest waters known, deep within the Ross sea ice. Weddell seals dive very deep below the surface, to nearly 1000m and for more than an hour. As seals are mammals, like us they must surface to breathe and when they surface they can transmit information to circulating satellites. As Weddell seals swim up and down below the ice they collect high quality oceanographic information on the structure of the water column, right through autumn and winter into early spring. By diving to the bottom and back over and over, they provide multiple casts of the water structure. This provides very precise measurements of ice formation over winter, and of ice melt in spring, information impossible to gather in any other way and advancing our understanding of these crucial ice processes.

30 Coral Trait Database

The Coral Trait Database is a growing compilation of administrative, coral life history, physiological and biogeographic data. As of today, there are 59056 coral observations with 16204 trait entries of 130 traits for 1547 coral species in the database. Most of these entries are for shallow-water, reef building species.

Sign up to become a member and receive periodic news about the database. Sign up is not required to access public data. Please email coraltraits@gmail.com with any comments, to become a contributor, or for more information.



30. Coral Trait Database website <http://coraltraits.org/>
31. Wild Australian sea lions in their natural habitat. Photo by Rob Harcourt.

Sustainability actions in 2014

IN 2014, THE DEPARTMENT OF BIOLOGICAL SCIENCES CONTINUED ITS CAMPAIGN TO RAISE AWARENESS AND IMPLEMENT SUSTAINABLE PRACTICES.

PACE STUDENT LIGHTING AUDIT

Biology hosted two PACE (Professional and Community Engagement) students to conduct an audit of the office lighting in the E8 Buildings. The students visited 64 separate offices in a two-week period to measure the lighting levels with lights on and off, to gather feedback from staff, and to make an assessment of what measures could be taken to improve lighting conditions for staff and students. Action will be taken in 2015 to respond to the recommendations.

TARGET SUSTAINABILITY

Macquarie Sustainability introduced *Target Sustainability* in the second half of 2014 as part of the Department Sustainability Challenge. *Target Sustainability* is a program designed to go beyond the challenge, to guide departments in improving their behaviour across the four areas of: leadership and governance; participation and engagement; learning, teaching and research; and facilities and operations. The Department of Biological Sciences was awarded a certificate of participation as an early adopter of the *Target Sustainability* process. From our initial participation we have identified a number of actions to complete in 2015.



DEPARTMENT SUSTAINABILITY CHALLENGE

Biological Sciences was the winning department in the Faculty of Science's 2014 Challenge. The challenge ran from August to October. We were involved in campus-wide initiatives such as reducing MOOP (Matter out of Place) around campus and promoting tap water over bottled water (*Tap It, It's Fresh and Free*). In addition to our achievements within target sustainability, we scored points for department initiatives such as collecting mobile phones and spectacles for disadvantaged people, and investigating options for renewable energy for specific lab spaces.

WORM FARM/VEGETABLE GARDEN

Our worms and garden continued to flourish thanks to a steady supply of lunch scraps. Towards the end of 2014 the garden and worm farms were moved to new locations, to make room for lab infrastructure. The new garden location receives more sun and should do well in 2015.

VEHICLES

In 2013 we offset our vehicle emissions (12 tonnes of CO₂) through carbon neutral. In 2014 we conducted more fieldwork and our vehicles produced 25.4 tonnes of CO₂, which we again offset through carbon neutral's reforestation program.



32. Worm farm. Photo by Samantha Newton.
33. Biology Staff on campus for Sustainability. Photo by Alison Downing.

Financial statements 2012–2014

Research Income Statement for the year 2014 (Source: Faculty of Science and Engineering)

Research Income	2012	2013	2014
AINSE	7,400	13,460	
ARC Discovery Early Career Research Award	253,078	276,294	524,890
ARC Discovery Projects	1,610,475	1,541,601	1,453,342
ARC Future Fellows	830,960	550,511	771,836
ARC Laureate Fellow	626,704	651,124	670,796
ARC Linkage Projects	129,892	128,702	115,060
Australian Antarctic Division		263,613	59,719
Australian Marine Mammal Centre		14,545	25,761
CSIRO	17,000		
Cotton Research and Development			67,589
Fisheries Research & Development Corporation		51,405	69,692
Grape and Wine			49,315
Hermon Slade Foundation			37,846
Horticultural Australia Limited	44,000	74,000	246,000
National Taxonomy Research Grant	45,000	45,000	
NCCARF	76,150		
NHMRC Project Grants	71,000		
Rural Industries Research Development	51,375		
SIEF John Stocker Postdoctoral Fellowships		92,000	92,000
Commonwealth Other	137,891	171,020	94,943
Local Government	23,501		
State Government	205,656	581,491	148,125
Australian - Contracts	88,138	151,558	165,362
Australian - Grants			2,560
Donations, Bequests, Foundations	85,589	61,735	56,361
International A	84,932	115,417	63,622
International B	67,708	318,133	228,245
International HDR Fees	191,219	165,994	\$84,773
Total	4,647,668	5,267,603	5,027,837

Notes:

Numbers might not add up due to rounding.

Unless stated otherwise the amounts presented in this report are consolidated operating and non operating amounts.

Since operating and some non operating funds do not carry forward, it is not intended for balance brought forward amounts to be reconcilable with surplus/deficit (-) amounts in the report.

1. Department operating funds are based on the Department's annual budgeted/forecast net operating expenditure.
2. Operating: In general unexpended operating funds and other operating income do not carry forward.
3. Non-operating: Unexpended research grants and contracts; donations; and consultancy, selected service and investment income typically carry forward.



Income Statement for the year ended 31 December 2014 (Source: Faculty of Science and Engineering)

	NOTE	2014	2013
INCOME			
Department Operating Funds	1	9,649,693	8,895,209
Research Grants and Contracts		5,547,710	5,536,226
Donations		3,445	11,892
Consultancy, Service and Investment Income		100,319	55,011
Other Income - Fees, Sundry Income		158,677	190,802
Internal University Income		97,862	145,330
Internal University Fund Transfers		2,190,433	1,699,416
Total income		17,748,140	16,533,886

EXPENDITURE			
Academic Salaries		10,336,428	9,995,316
Professional Salaries		3,240,118	3,105,717
Salaries		13,576,545	13,101,033
Contractors and Other Employment		714,465	920,765
Student, Printing and Publications		136,219	88,061
Consumables excluding Internal		581,425	559,264
Internal Consumables and Services		276,483	354,850
Grants to External Organisations		138,258	66,855
Other General Costs		81,608	67,443
Facilities and Equipment		1,255,782	745,042
Travel		1,032,813	912,720
Non salary costs		4,217,054	3,715,000
Total direct costs		17,793,599	16,816,033

DIRECTLY CONTROLLABLE SURPLUS/DEFICIT (-)	-45,459	-282,147	
Infrastructure Costs		53,787	118,442
Faculty Overhead		0	0
Indirect costs		53,787	118,442
Total direct/indirect costs		17,847,386	16,934,475

SURPLUS/DEFICIT (-) REPRESENTED BY:	-99,246	-400,589	
Operating	2	49,475	-114,564
Non Operating	3	-148,721	-286,025
	NOTE	2014	2013

BALANCE BROUGHT FORWARD			
Operating	2	0	22,739
Non Operating	3	5,074,061	5,456,566
		5,074,061	5,479,305

2014 publications

THE DEPARTMENT CONTINUES TO SUPPORT AND FOSTER IMPACTFUL PUBLICATIONS BY ALL RESEARCH STAFF AND STUDENTS.

This list of publications may include papers that were not reported in the 2014 HERDC. Please note that in our discipline it is internationally recognised common practice for research team leaders to be named as last author on peer-reviewed publications, with mentored PhD students or research fellows as first named author.

BOOKS

Dartnall HJG, 2014. Lost in the mists: Leslie Russell Blake: Mawson's cartographer and hero of Pozières. Australian Scholarly Publishing, Kew Victoria, Australia.

Laurie JR, Paterson JR & Brock GA. Eds. 2014. Cambro-Ordovician Studies V. Memoirs of the Association of Australasian Palaeontologists 45: 1–419. ISBN 978-0-949466-35-8. ISSN 0810-8889.

Stow A, Maclean, N & Holwell GI. Eds. 2015. Austral ark: the state of wildlife in Australia and New Zealand. Cambridge University Press, Cambridge, UK

BOOK CHAPTERS

Ambler T, Chavan M, Clarke J, Matthews N, 2014. Climates of Communication: Collegiality, Affect, Spaces and Attitudes in Peer Review. In: Sachs J, Parsell M, editors. Peer Review of Learning and Teaching in Higher Education: Springer Netherlands. pp. 67–84.

Cabrelli A, Beaumont L, Hughes L, 2014. The impacts of climate change on Australian and New Zealand flora and fauna In: Stow A, Maclean N & Holwell GI, editors. *Austral Ark: The state of wildlife in Australia and New Zealand*. Cambridge University Press, Cambridge, UK. pp. 65–82.

Gallagher RV & Leishman, M.R. (2014) Invasive plants and invaded ecosystems in Australia: implications for biodiversity. In: Stow A, Maclean N & Holwell GI, editors. *Austral Ark: The state of wildlife in Australia and New Zealand*. Cambridge University Press, Cambridge, UK. pp. 105–133.

Gillings M, 2014. Pollution by antibiotics and resistance genes: dissemination into Australian wildlife. In: Stow A, Maclean N & Holwell GI, editors. *Austral Ark: The state of wildlife in Australia and New Zealand*. Cambridge University Press, Cambridge, UK. pp. 186–196.

Harcourt R, Marsh H, Slip D, Chilvers L, Noad M, Dunlop R, 2014. Marine mammals, back from the brink? Contemporary conservation issues. In: Stow A, Maclean N & Holwell GI, editors. *Austral Ark: The state of wildlife in Australia and New Zealand*. Cambridge University Press, Cambridge, UK. pp. 322–353

Hose GC, Asmyhr MG, Cooper SJB, Humphreys WF, 2014. Down under Down Under: Austral groundwater life. In: Stow A, Maclean N & Holwell GI, editors. *Austral Ark: The state of wildlife in Australia and New Zealand*. Cambridge University Press, Cambridge, UK. pp. 512–536.

Jakobsen KG, Brock GA, Nielsen AT, Mathieson DK, Harper DAT, 2014. Brachiopods associated with stromatoporoid mounds from the Middle to Upper Ordovician Cashions Creek Limestone, Tasmania. In: Laurie JR, Paterson JR, Brock GA, editors. Cambro-Ordovician Studies V. pp. 249–265.

Laurie JR, 2014. Middle Cambrian (Series 3) arthropods (Trilobita, Agnostida) from CRA Exploration Scan 1 drillhole, central Georgina Basin, Northern Territory. In: Laurie JR, Paterson JR, Brock GA, editors. Cambro-Ordovician Studies V. pp. 297–303.

Momigliano P, Harcourt RG, 2014. Shark conservation, governance and management The science-law disconnect. In: Shark Conservation, Governance and Management. Techera EJ, Klein N, editors. Taylor & Francis Ltd

Momigliano P, Jaiteh VF, Speed CW, 2014. Predators in danger: shark conservation and management in Australia, New Zealand and their neighbours. In: Stow A, Maclean N & Holwell GI, editors. *Austral Ark: The state of wildlife in Australia and New Zealand*. Cambridge University Press, Cambridge, UK. pp 467–491.

Nipperess DA, 2014. A separate creation : diversity, distinctiveness and conservation of Australian wildlife. In: Stow A, Maclean N & Holwell GI, editors. *Austral Ark: The state of wildlife in Australia and New Zealand*. Cambridge University Press, Cambridge, UK. pp 1–23.

Smith PM, Brock GA, Paterson JR, Topper TP, 2014. New bradoriid arthropods from the Giles Creek Dolostone (Cambrian Series 3, Stage 5; Templetonian), Amadeus Basin, central Australia. In: Laurie JR, Paterson JR, Brock GA, editors. Cambro-Ordovician Studies V. p. 233–248.

Wehner R, Cheng K, Cruse H, 2014. Visual Navigation Strategies in Insects: Lessons from Desert Ants. In: The New Visual Neurosciences. Werner JS, Chalupa LM, editors. MIT Press Cambridge, MA. p. 1153–1163.

Thompson, EL, 2014. Indicators of anthropogenic change and biological risk in coastal aquatic environments. In: Reference module in Earth Systems and Environmental Sciences, Elsevier, doi: 10.1016/B978-0-12-40958-0.09106-5

Wehner, R., Cheng, K., & Cruse, H. (2014). Visual navigation strategies in insects: lessons from desert ants. In J.S. Werner & L.M. Chalupa (Eds.), *New Visual Neurosciences* (pp. 1153–1164). Cambridge MA: MIT Press.

JOURNAL ARTICLES

Adams MP, Smith PL, 2014. A systematic approach to model the influence of the type and density of vegetation cover on urban heat using remote sensing. *Landscape and Urban Planning* 132:47–54.

Ah-King M, Barron AB, Herberstein ME, 2014. Genital Evolution: Why are females still understudied? *PLoS Biology* 12. doi: 10.1371/journal.pbio.1001851.

Ahonen H, Stow AJ, Harcourt RG, Charrier I, 2014. Adult male Australian sea lion barking calls reveal clear geographical variations. *Animal Behaviour* 97:229–239. doi: 10.1016/j.anbehav.2014.09.010.

Ajani PA, Allen AP, Ingleton T, Armand L, 2014. A decadal decline in relative abundance and a shift in microphytoplankton composition at a long-term coastal station off southeast Australia. *Limnology and Oceanography* 59:519–531. doi: 10.4319/lo.2014.59.2.0519.

Allen LE, Barry KL, Holwell GI, 2014. Different paths to sexual size dimorphism in two praying mantids, *Pseudomantis albofimbriata* and *Hierodula majuscula*. *Insect Science* 21:227–233. doi: 10.1111/1744-7917.12016.

Alroy J, 2014a. Accurate and precise estimates of origination and extinction rates. *Paleobiology* 40:374–397. doi: 10.1666/13036.

Alroy J, 2014b. A simple Bayesian method of inferring extinction. *Paleobiology* 40:584–607. doi: 10.1666/13074.

Amaral V, Cabral HN, Bishop MJ, 2014. Prior exposure influences the behavioural avoidance by an intertidal gastropod, *Bembicium auratum*, of acidified waters. *Estuarine Coastal and Shelf Science* 136:82–90.

Andersen A, Beringer J, Bull CM, Byrne M, Cleugh H, Christensen R, French K, Harch B, Hoffmann A, Lowe AJ, Moltmann T, Nicotra A, Pitman A, Phinn S, Wardle G, Westoby M, 2014. Foundations for the future: A long-term plan for Australian ecosystem science. *Austral Ecology* 39:739–748. doi: 10.1111/aec.12188.

Anderson A, Bonaldo R, Barneche D, Hackradt C, Félix-Hackradt F, García-Charton J, Floeter S, 2014. Recovery of grouper assemblages indicates effectiveness of a marine protected area in Southern Brazil. *Marine Ecology Progress Series* 514:207–215. doi: 10.3354/meps11032.

Andrew SC, Perry CJ, Barron AB, Berthon K, Peralta V, Cheng K, 2014. Peak shift in honey bee olfactory learning. *Animal Cognition* 17:1177–1186. doi: 10.1007/s10071-014-0750-3.

Arias A, Paxton H, 2014a. First record of the *polychaetous annelid* *Diopatra micrura* Pires *et al.*, 2010 in the Mediterranean Sea. *Mediterranean Marine Science* 15:5–8.

Arias A, Paxton H, 2014b. Hidden diversity within the polychaete *Onuphis eremita* sensu lato (Annelida: Onuphidae)-redescription of *O. eremita* Audouin & Milne-Edwards, 1833 and reinstatement of *Onuphis pancerii* Claparede, 1868. *Zootaxa* 3861:145–169.

Armbrecht LH, Roughan M, Rossi V, Schaeffer A, Davies PL, Waite AM, Armand LK, 2014. Phytoplankton composition under contrasting oceanographic conditions: Upwelling and downwelling (Eastern Australia). *Continental Shelf Research* 75:54–67. doi: 10.1016/j.csr.2013.11.024.

Armbrecht LH, Smetacek V, Assmy P, Klaas C, 2014. Cell death and aggregate formation in the giant diatom *Coscinodiscus wailesii* (Gran & Angst, 1931). *Journal of Experimental Marine Biology and Ecology* 452:31–39. doi: 10.1016/j.jembe.2013.12.004.

Arnold RJ, Harcourt R, Pietsch TW, 2014. A new genus and species of the frogfish family Antennariidae (Teleostei: Lophiiformes: Antennarioidei) from New South Wales, Australia, with a diagnosis and key to the genera of the Histiophryninae. *Copeia*:534–539. doi: 10.1643/ci-13-155.

Asher AJ, Holt DC, Andrews RM, Power ML, 2014. Distribution of *Giardia duodenalis* assemblages A and B among children living in a remote indigenous community of the Northern Territory, Australia. *PLoS ONE* 9. doi: 10.1371/journal.pone.0112058.

Asmyhr MG, Hose G, Graham P, Stow AJ, 2014. Fine-scale genetics of subterranean syncarids. *Freshwater Biology* 59:1–11. doi: 10.1111/fwb.12239.

Asmyhr MG, Linke S, Hose G, Nipperess DA, 2014. Systematic conservation planning for groundwater ecosystems using phylogenetic diversity. *PLoS one* 9:e115132.

Atwell BJ, Wang H, Scafaro AP, 2014. Could abiotic stress tolerance in wild relatives of rice be used to improve *Oryza sativa*? *Plant Science* 215:48–58. doi: 10.1016/j.plantsci.2013.10.007.

Ausmus DM, Clarke JA, 2014. Mother knows best: functionally referential alarm calling in white-tailed ptarmigan. *Animal Cognition* 17:671–679. doi: 10.1007/s10071-013-0698-8.

Barneche DR, Kulbicki M, Floeter SR, Friedlander AM, Maina J, Allen AP, 2014. Scaling metabolism from individuals to reef-fish communities at broad spatial scales. *Ecology Letters* 17:1067–1076. doi: 10.1111/ele.12309.

Beaumont LJ, Gallagher RV, Leishman MR, Hughes L, Downey PO, 2014. How can knowledge of the climate niche inform the weed risk assessment process? A case study of *Chrysanthemoides monilifera* in Australia. *Diversity & Distributions* 20:613–625. doi: 10.1111/ddi.12190.

Bedford GO, 2014. Advances in the control of rhinoceros beetle, *Oryctes rhinoceros* in oil palm. *Journal of Oil Palm Research* 26:183–194.

2014 publications

Bell JE, Bishop MJ, Taylor RB, Williamson JE, 2014. Facilitation cascade maintains a kelp community. *Marine Ecology Progress Series* 501:1–10. doi: 10.3354/meps10727.

Bender MG, Machado GR, Silva PJD, Floeter SR, Monteiro-Netto C, Luiz OJ, Ferreira CEL, 2014. Local ecological knowledge and scientific data reveal overexploitation by multigear artisanal fisheries in the southwestern atlantic. *PLoS ONE* 9. doi: 10.1371/journal.pone.0110332.

Bestley S, Jonsen ID, Hindell MA, Harcourt RG, Gales NJ, 2014. Taking animal tracking to new depths: synthesizing horizontal–vertical movement relationships for four marine predators. *Ecology* 96:417–427. doi: 10.1890/14-0469.1.

Betts MJ, Topper TP, Valentine JL, Skovsted CB, Paterson JR, Brock GA, 2014. A new early Cambrian bradoriid (Arthropoda) assemblage from the northern Flinders Ranges, South Australia. *Gondwana Research* 25:420–437. doi: 10.1016/j.gr.2013.05.007.

Bibost AL, Brown C, 2014. Laterality influences cognitive performance in rainbowfish *Melanotaenia duboulayi*. *Animal Cognition* 17:1045–1051. doi: 10.1007/s10071-014-0734-3.

Binet MT, Doyle CJ, Williamson JE, Schlegel P, 2014. Use of JC-1 to assess mitochondrial membrane potential in sea urchin sperm. *Journal of Experimental Marine Biology and Ecology* 452:91–100. doi: 10.1016/j.jembe.2013.12.008.

Birch GF, Melwani A, Lee JH, Apostolatos C, 2014. The discrepancy in concentration of metals (Cu, Pb and Zn) in oyster tissue (*Saccostrea glomerata*) and ambient bottom sediment (Sydney estuary, Australia). *Marine Pollution Bulletin* 80:263–274. doi: 10.1016/j.marpolbul.2013.12.005.

Birnbaum C, Bissett A, Thrall PH, Leishman MR, 2014. Invasive legumes encounter similar soil fungal communities in their non-native and native ranges in Australia. *Soil Biology & Biochemistry* 76:210–217. doi: 10.1016/j.soilbio.2014.05.017.

Bistinas I, Harrison SP, Prentice IC, Pereira JMC, 2014a. Causal relationships versus emergent patterns in the global controls of fire frequency. *Biogeosciences* 11:5087–5101. doi: 10.5194/bg-11-5087-2014.

Bistinas I, Harrison SP, Prentice IC, Pereira JMC, 2014b. Causal relationships vs. emergent patterns in the global controls of fire frequency. *Biogeosciences Discuss* 11:3865–3892. doi: 10.5194/bg-d-11-3865-2014.

Blackman CJ, Gleason SM, Chang Y, Cook AM, Laws C, Westoby M, 2014. Leaf hydraulic vulnerability to drought is linked to site water availability across a broad range of species and climates. *Annals of Botany* 114:435–440. doi: 10.1093/aob/mcu131.

Briner JP, Kaufman DS, Bennike O, Kosnik MA, 2014. Amino acid ratios in reworked marine bivalve shells constrain Greenland Ice Sheet history during the Holocene. *Geology* 42:75–78. doi: 10.1130/g34843.1.

Brown C, Bibost AL, 2014. Laterality is linked to personality in the black-lined rainbowfish, *Melanotaenia nigrans*. *Behavioral Ecology and Sociobiology* 68:999–1005. doi: 10.1007/s00265-014-1712-0.

Brown C, Irving E, 2014. Individual personality traits influence group exploration in a feral guppy population. *Behavioral Ecology* 25:95–101. doi: 10.1093/beheco/art090.

Brown, C. & Morgan, J. (2014) Predator recognition and responses in the endangered Macquarie perch (*Macquaria australasica*) *Marine and Freshwater Research* 66(2) 127–134

Bshary R, Brown C, 2014. Fish cognition. *Current Biology* 24:R947–R950.

Bulbert MW, Herberstein ME, Cassis G, 2014. Assassin bug requires dangerous ant prey to bite first. *Current Biology* 24:R220–R221. doi: 10.1016/j.cub.2014.02.006.

Burden CT, Stow AJ, Hoggard SJ, Coleman MA, Bishop MJ, 2014. Genetic structure of *Carcinus maenas* in south-east Australia. *Marine Ecology Progress Series* 500:139–147.

Bush A, Hermoso V, Linke S, Nipperess D, Turak E, Hughes L, 2014a. Freshwater conservation planning under climate change: demonstrating proactive approaches for Australian Odonata. *Journal of Applied Ecology* 51:1273–1281. doi: 10.1111/1365-2664.12295.

Bush A, Nipperess DA, Theischinger G, Turak E, Hughes L, 2014b. Testing for taxonomic bias in the future diversity of Australian Odonata. *Diversity and Distribution* 20:1016–1028. doi: 10.1111/ddi.12196.

Bush AA, Nipperess DA, Duursma DE, Theischinger G, Turak E, Hughes L, 2014c. Continental-scale assessment of risk to the australian odonata from climate change. *PLoS ONE* 9. doi: 10.1371/journal.pone.0088958.

Cabrelli AL, Stow AJ, Hughes L, 2014. A framework for assessing the vulnerability of species to climate change: a case study of the Australian elapid snakes. *Biodiversity and Conservation* 23:3019–3034. doi: 10.1007/s10531-014-0760-0.

Calvo MM, Prentice IC, Harrison SP, 2014. Climate versus carbon dioxide controls on biomass burning: a model analysis of the glacial-interglacial contrast. *Biogeosciences* 11:6017–6027. doi: 10.5194/bg-11-6017-2014.

Cantalapiedra JL, FitzJohn RG, Kuhn TS, Fernandez MH, DeMiguel D, Azanza B, Morales J, Mooers AO, 2014. Dietary innovations spurred the diversification of ruminants during the Caenozoic. *Proceedings of the Royal Society B-Biological Sciences* 281. doi: 10.1098/rspb.2013.2746.

Carazo P, Noble DWA, Chandrasoma D, Whiting MJ, 2014. Sex and boldness explain individual differences in spatial learning in a lizard. *Proceedings of the Royal Society B-Biological Sciences* 281. doi: 10.1098/rspb.2013.3275.

Carroll G, Hedley S, Bannister J, Ensor P, Harcourt R, 2014a. No evidence for recovery in the population of sperm whale bulls off Western Australia, 30 years post-whaling. *Endangered Species Research* 24:33–43. doi: 10.3354/esr00584.

Carroll G, Slip D, Jonsen I, Harcourt R, 2014b. Supervised accelerometry analysis can identify prey capture by penguins at sea. *The Journal of Experimental Biology* 217:4295–4302. doi: 10.1242/jeb.113076.

Chambers LE, Beaumont LJ, Hudson IL, 2014. Continental scale analysis of bird migration timing: influences of climate and life history traits—a generalized mixture model clustering and discriminant approach. *International Journal of Biometeorology* 58:1147–1162. doi: 10.1007/s00484-013-0707-2.

Chan NR, 2014. Does size variation in *Genyornis newtoni* (Aves, Dromornithidae) encompass eggshell safety limits? *Journal of Vertebrate Paleontology* 34:976–979. doi: 10.1080/02724634.2013.826668.

Chen L, Zhang, Zhiqiang, Zeppel, Melanie, Liu, Caifeng, Guo, Junting, Zhu, Jinzhao, Zhang, Xuepei, Zhang, Jianjun, Zha, Tonggang, 2014. Response of transpiration to rain pulses for two tree species in a semiarid plantation. *International Journal of Biometeorology* 58:1569–1581. doi: 10.1007/s00484-013-0761-9.

Chen LX, Zhang ZQ, Zeppel M, Liu CF, Guo JT, Zhu JZ, Zhang XP, Zhang JJ, Zha TG, 2014. Response of transpiration to rain pulses for two tree species in a semiarid plantation. *International Journal of Biometeorology* 58:1569–1581. doi: 10.1007/s00484-013-0761-9.

Cheng K, Schultheiss P, Schwarz S, Wystrach A, Wehner R, 2014. Beginnings of a synthetic approach to desert ant navigation. *Behavioural Processes* 102:51–61. doi: 10.1016/j.beproc.2013.10.001.

Clark BF, Amiel JJ, Shine R, Noble DWA, Whiting MJ, 2014. Colour discrimination and associative learning in hatchling lizards incubated at ‘hot’ and ‘cold’ temperatures. *Behavioral Ecology and Sociobiology* 68:239–247. doi: 10.1007/s00265-013-1639-x.

Collins SR, Reynolds OL, Taylor PW, 2014. Combined effects of dietary yeast supplementation and methoprene treatment on sexual maturation of Queensland fruit fly. *Journal of Insect Physiology* 61:51–57. doi: 10.1016/j.jinsphys.2014.01.002.

Colmer TD, Armstrong W, Greenway H, Ismail AM, Kirk GJD, Atwell BJ, 2014. Physiological Mechanisms of Flooding Tolerance in Rice: Transient Complete Submergence and Prolonged Standing Water. In: Luttge U, Beyschlag W, Cushman J, editors. *Progress in Botany* 75:255–307.

Cooke BC, Goodwin ID, Bishop MJ, 2014a. Small-scale spatial structuring of interstitial invertebrates on three embayed beaches, Sydney, Australia. *Estuarine Coastal and Shelf Science* 150:92–101. doi: 10.1016/j.ecss.2013.10.031.

Cooke GM, Landguth EL, Beheregaray LB, 2014b. Riverscape genetics identifies replicated ecological divergence across an amazonian ecotone. *Evolution* 68:1947–1960. doi: 10.1111/evo.12410.

Cornwell WK, Westoby M, Falster DS, FitzJohn RG, O’Meara BC, Pennell MW, McGlenn DJ, Eastman JM, Moles AT, Reich PB, Tank DC, Wright IJ, Aarssen L, Beaulieu JM, Kooyman RM, Leishman MR, Miller ET, Niinemets U, Oleksyn J, Ordóñez A, Royer DL, Smith SA, Stevens PF, Warman L, Wilf P, Zanne AE, 2014. Functional distinctiveness of major plant lineages. *Journal of Ecology* 102:345–356.

Crino OL, Driscoll SC, Breuner CW, 2014. Corticosterone exposure during development has sustained but not lifelong effects on body size and total and free corticosterone responses in the zebra finch. *General and Comparative Endocrinology* 196:123–129. doi: 10.1016/j.ygcen.2013.10.006.

Crino OL, Driscoll SC, Ton R, Breuner CW, 2014. Corticosterone exposure during development improves performance on a novel foraging task in zebra finches. *Animal Behaviour* 91:27–32. doi: 10.1016/j.anbehav.2014.02.017.

Crino OL, Prather CT, Driscoll SC, Good JM, Breuner CW, 2014. Developmental stress increases reproductive success in male zebra finches. *Proceedings of the Royal Society B-Biological Sciences* 281. doi: 10.1098/rspb.2014.1266.

Dani KGS, Jamie IM, Prentice IC, Atwell BJ, 2014. Evolution of isoprene emission capacity in plants. *Trends in Plant Science* 19:439–446.

Dani KGS, Jamie IM, Prentice IC, Atwell BJ, 2014. Increased ratio of electron transport to net assimilation rate supports elevated isoprenoid emission rate in Eucalypts under drought. *Plant Physiology* 166:1059–1072. doi: 10.1104/pp.114.246207.

Dani KGS, Jamie, IM., Prentice, IC., Atwell, BJ, 2014. Evolution of isoprene emission capacity in plants. *Trends in Plant Science* 19:439–446. doi: 10.1016/j.tplants.2014.01.009.

Davis JMP, van Heerwaarden B, Sgro CM, Donald JA, Kemp DJ, 2014. Low genetic variation in cold tolerance linked to species distributions in butterflies. *Evolutionary Ecology* 28:495–504. doi: 10.1007/s10682-013-9684-5.

Dawson TJ, Webster KN, Maloney SK, 2014. The fur of mammals in exposed environments; do crypsis and thermal needs necessarily conflict? The polar bear and marsupial koala compared. *Journal of Comparative Physiology B* 184:273–284.

de Fraga R, Stow AJ, Magnusson WE, Lima AP, 2014. The costs of evaluating species densities and composition of snakes to assess development impacts in Amazonia. *PLoS ONE* 9. doi: 10.1371/journal.pone.0105453.

De Kauwe MG, Kala J, Lin, YS, Pitman AJ, Medlyn BE, Duursma RA, Abramowitz G, Wang YP, Miralles DG, 2014. A test of an optimal stomatal conductance scheme within the CABLE Land Surface Model. *Geoscientific Model Development Discussion* 7:6845–6891. doi: 10.5194/gmdd-7-6845-2014.

De Kauwe MG, Medlyn BE, Zaehle S, Walker AP, Dietze MC, Wang YP, Luo YQ, Jain AK, El-Masri B, Hickler T, Warlind D, Weng ES, Parton WJ, Thornton PE, Wang SS, Prentice IC, Asao S, Smith B, McCarthy HR, Iversen CM, Hanson PJ, Warren JM, Oren R, Norby

2014 publications

RJ, 2014. Where does the carbon go? A model-data intercomparison of vegetation carbon allocation and turnover processes at two temperate forest free-air CO₂ enrichment sites. *New Phytologist* 203:883–899. doi: 10.1111/nph.12847.

de Vos A, Pattiaratchi C, Harcourt R, 2014. Inter-annual variability in blue whale distribution off Southern Sri Lanka between 2011 and 2012. *Journal of Marine Science and Engineering* 2:534–550.

Delpont TC, Asher AJ, Beaumont LJ, Webster KN, Harcourt RG, Power ML, 2014. *Giardia duodenalis* and *Cryptosporidium* occurrence in Australian sea lions (*Neophoca cinerea*) exposed to varied levels of human interaction. *International Journal for Parasitology: Parasites and Wildlife* 3:269–275. doi: <http://dx.doi.org/10.1016/j.ijppaw.2014.09.001>.

Desprez M, Harcourt R, Hindell MA, Cubaynes S, Gimenez O, McMahon CR, 2014. Age-specific cost of first reproduction in female southern elephant seals. *Biology Letters* 10. doi: 10.1098/rsbl.2014.0264.

Dheilly NM, Adema C, Raftos DA, Gourbal B, Grunau C, Du Pasquier L, 2014. No more non-model species: The promise of next generation sequencing for comparative immunology. *Developmental & Comparative Immunology* 45:56–66. doi: 10.1016/j.dci.2014.01.022.

Domazou AS, Gebicki JM, Nauser T, Koppenol WH, 2014. Repair of protein radicals by antioxidants. *Israel Journal of Chemistry* 54:254–264. doi: 10.1002/ijch.201300117.

Dominiak BC, Fanson BG, Collins SR, Taylor PW, 2014. Automated locomotor activity monitoring as a quality control assay for mass-reared tephritid flies. *Pest Management Science* 70:304–309. doi: 10.1002/ps.3559.

Dominiak BC, Sundaralingam S, Jiang L, Fanson BG, Collins SR, Banos C, Davies JB, Taylor PW, 2014. Evaluating irradiation dose for sterility induction and quality control of mass-produced fruit fly *Bactrocera tryoni* (Diptera: Tephritidae). *Journal of Economic Entomology* 107:1172–1178. doi: 10.1603/ec13421.

Downing A, Peacock R, Ramsay H, 2014. Some new and noteworthy bryophytes from Antarctic Beech (*Nothofagus moorei*) forests of north-eastern New South Wales. *Telopea* 17:239–250.

Duckett PE, Stow, Adam J., 2014. Predicting impacts of global climate change on intraspecific genetic diversity benefits from realistic dispersal estimates. *Australian Journal of Zoology*:-. doi: <http://dx.doi.org/10.1071/ZO13097>.

Duursma RA, Barton CVM, Lin YS, Medlyn BE, Eamus D, Tissue DT, Ellsworth DS, McMurtrie RE, 2014. The peaked response of transpiration rate to vapour pressure deficit in field conditions can be explained by the temperature optimum of photosynthesis. *Agricultural and Forest Meteorology* 189:2–10. doi: 10.1016/j.agrformet.2013.12.007.

Edmunds PJ, Burgess SC, Putnam HM, Baskett ML, Bramanti L, Fabina NS, Han XY, Lesser MP, Madin JS, Wall CB, Yost DM, Gates RD, 2014. Evaluating the causal basis of ecological success within

the scleractinia: an integral projection model approach. *Marine Biology* 161:2719–2734. doi: 10.1007/s00227-014-2547-y.

Fabricant SA, Exnerova A, Jezova D, Stys P, 2014. Scared by shiny? The value of iridescence in aposematic signalling of the hibiscus harlequin bug. *Animal Behaviour* 90:315–325. doi: 10.1016/j.anbehav.2014.01.021.

Fabricant SA, Smith CL, 2014. Is the hibiscus harlequin bug aposematic? The importance of testing multiple predators. *Ecology and Evolution* 4:113–120. doi: 10.1002/ece3.914.

Feary DA, Pratchett MS, Emslie MJ, Fowler AM, Figueira WF, Luiz OJ, Nakamura Y, Booth DJ, 2014. Latitudinal shifts in coral reef fishes: why some species do and others do not shift. *Fish and Fisheries* 15:593–615. doi: 10.1111/faf.12036.

FitzJohn RG, Pennell MW, Zanne AE, Stevens PF, Tank DC, Cornwell WK, 2014. How much of the world is woody? *Journal of Ecology* 102:1266–1272. doi: 10.1111/1365-2745.12260.

Flores O, Garnier E, Wright IJ, Reich PB, Pierce S, Diaz S, Pakeman RJ, Rusch GM, Bernard-Verdier M, Testi B, 2014. An evolutionary perspective on leaf economics: phylogenetics of leaf mass per area in vascular plants. *Ecol Evol* 4:2799–2811.

Forstmeier W, Nakagawa S, Griffith SC, Kempenaers B, 2014. Female extra-pair mating: adaptation or genetic constraint? *Trends in Ecology & Evolution* 29:456–464. doi: 10.1016/j.tree.2014.05.005.

Foster PN, Prentice IC, Morfopoulos C, Siddall M, van Weele M, 2014. Isoprene emissions track the seasonal cycle of canopy temperature, not primary production: evidence from remote sensing. *Biogeosciences* 11:3437–3451. doi: 10.5194/bg-11-3437-2014.

Frankham R, Bradshaw CJA, Brook BW, 2014. Genetics in conservation management: Revised recommendations for the 50/500 rules, Red List criteria and population viability analyses. *Biological Conservation* 170:56–63. doi: 10.1016/j.biocon.2013.12.036.

Frankham R, Bradshaw, C. J. A., Brook, B. W., 2014. 50/500 rules need upward revision to 100/1000-Response to Franklin *et al.* *Biological Conservation* 176:286–286. doi: 10.1016/j.biocon.2014.05.006.

Frankham R, Lacy, R. C., Ballou, J. D., Dudash, M. R., Eldridge, M. D. B., Fenster, C. B., Mendelson, J. R., Porton, I. J., Ralls, K., Ryder, O. A., 2014. Species concepts for conservation - Reply to Russello and Amato. *Biological Conservation* 170:334–335. doi: 10.1016/j.biocon.2013.12.039.

Freitas R, Luiz OJ, Silva PN, Floeter SR, Bernardi G, Ferreira CEL, 2014. The occurrence of *Sparisoma frondosum* (Teleostei: Labridae) in the Cape Verde Archipelago, with a summary of expatriated Brazilian endemic reef fishes. *Marine Biodiversity* 44:173–179. doi: 10.1007/s12526-013-0194-z.

Friedl MA, Gray JM, Melaas EK, Richardson AD, Hufkens K, Keenan TF, Bailey A, O’Keefe J, 2014. A tale of two springs: using recent climate anomalies to characterize the sensitivity of temperate forest phenology to climate change. *Environmental Research Letters* 9. doi: 10.1088/1748-9326/9/5/054006.

Fryirs K, Gough J, Hose GC, 2014. The geomorphic character and hydrological function of an upland swamp, Budderoo plateau, southern highlands, NSW, Australia. *Physical Geography* 35:313–334. doi: 10.1080/02723646.2014.890092.

Gallagher RV, Randall RP & Leishman MR, 2014. Trait differences between naturalized and invasive plant species independent of residence time and phylogeny. *Conservation Biology* 29: 360–369.

Gallo-Cajiao E, 2014. Evidence is required to address potential albatross mortality in the New South Wales Ocean Trawl fishery. *Pacific Conservation Biology* 20: 328–335

Gardham S, Chariton AA, Hose GC, 2014. Invertebrate community responses to a particulate- and dissolved-copper exposure in model freshwater ecosystems. *Environmental Toxicology and Chemistry* 33:2724–2732. doi: 10.1002/etc.2728.

Gardham S, Hose GC, Stephenson S, Chariton AA., 2014. DNA metabarcoding meets experimental ecotoxicology: advancing knowledge on the ecological effects of copper in freshwater ecosystems. *Advances in Ecological Research*, Vol 51: Big Data in Ecology 51:79–104. doi: 10.1016/b978-0-08-099970-8.00007-5.

Garside C, Bishop MJ, 2014. The distribution of the European shore crab, *Carcinus maenas*, with respect to mangrove forests in southeastern Australia. *Journal of Experimental Marine Biology and Ecology* 461:173–178. doi: 10.1016/j.jembe.2014.08.007.

Garside CJ, Glasby TM, Coleman MA, Kelaher BP, Bishop MJ, 2014. The frequency of connection of coastal water bodies to the ocean predicts *Carcinus maenas* invasion. *Limnology and Oceanography* 59:1288–1296. doi: 10.4319/lo.2014.59.4.1288.

Gawryszewski FM, 2014. Evidence suggests that modified setae of the crab spiders *Stephanopis spp.* fasten debris from the background. *Zoomorphology* 133:205–215. doi: 10.1007/s00435-013-0213-4.

Geraghty PT, Macbeth WG, Harry AV, Bell JE, Yerman MN, Williamson JE, 2014. Age and growth parameters for three heavily exploited shark species off temperate eastern Australia. *Ices Journal of Marine Science* 71:559–573. doi: 10.1093/icesjms/fst164.

Geraghty PT, Williamson JE, Macbeth WG, Blower DC, Morgan JAT, Johnson G, Ovenden JR, Gillings MR, 2014. Genetic structure and diversity of two highly vulnerable carcharhinids in Australian waters. *Endangered Species Research* 24:45–60.

Giffney RA, Kemp DJ, 2014. Does it pay to care? Exploring the costs and benefits of parental care in the hibiscus harlequin bug *Tectocoris diophthalmus* (Heteroptera: Scutelleridae). *Ethology* 120:607–615

Gillings M, Hagan-Lawson E, 2014. The cost of living in the Anthropocene. *Earth Perspectives* 1:2.

Gillings MR, 2014. Integrins: past, present, and future. *Microbiology and Molecular Biology Reviews* 78:257–277. doi: 10.1128/mmbr.00056-13.

Gillings MR, 2014. Rapid extraction of PCR-competent DNA from recalcitrant environmental samples. *Environmental Microbiology* 1096:17–23. doi: 10.1007/978-1-62703-712-9_2.

Gillings MR, 2014. Were there evolutionary advantages to premenstrual syndrome? *Evolutionary Applications* 7:897–904. doi: 10.1111/eva.12190.

Gillings MR, Paulsen IT, 2014. Microbiology of the Anthropocene. *Anthropocene* 5:1–8.

Gillings MR, Westoby M, 2014. DNA technology and evolution of the Central Dogma. *Trends in Ecology & Evolution* 29:1–2.

Gleason SM, Blackman CJ, Cook AM, Laws CA, Westoby M, 2014. Whole-plant capacitance, embolism resistance and slow transpiration rates all contribute to longer desiccation times in woody angiosperms from arid and wet habitats. *Tree Physiology* 34:275–284. doi: 10.1093/treephys/tpu001.

Goncalves P, Guertler C, Bachère E, de Souza CRB, Rosa RD, Perazzolo LM, 2014. Molecular signatures at imminent death: Hemocyte gene expression profiling of shrimp succumbing to viral and fungal infections. *Developmental & Comparative Immunology* 42:294–301.

Gonzalez-Tokman D, Ruch J, Pulpitel T, Ponton F, 2014. Cuticular antifungals in spiders: density- and condition dependence. *PLoS ONE* 9. doi: 10.1371/journal.pone.0091785.

Green TJ, Benkendorff K, Robinson N, Raftos D, Speck P, 2014. Anti-viral gene induction is absent upon secondary challenge with double-stranded RNA in the Pacific oyster, *Crassostrea gigas*. *Fish & Shellfish Immunology* 39:492–497. doi: 10.1016/j.fsi.2014.06.010.

Green TJ, Robinson N, Chataway T, Benkendorff K, O’Connor W, Speck P, 2014. Evidence that the major hemolymph protein of the Pacific oyster, *Crassostrea gigas*, has antiviral activity against herpesviruses. *Antiviral Research* 110:168–174. doi: 10.1016/j.antiviral.2014.08.010.

Grigorov I, Rigual-Hernandez AS, Honjo S, Kemp AES, Armand LK, 2014. Settling fluxes of diatoms to the interior of the Antarctic circumpolar current along 170 degrees W. *Deep-Sea Research Part I-Oceanographic Research Papers* 93:1–13. doi: 10.1016/j.dsr.2014.07.008.

Grote R, Morfopoulos C, Niinemets U, Sun ZH, Keenan TF, Pacifico F, Butler T, 2014. A fully integrated isoprenoid emissions model coupling emissions to photosynthetic characteristics. *Plant Cell and Environment* 37:1965–1980. doi: 10.1111/pce.12326.

Gutowsky S, Gutowsky L, Jonsen I, Leonard M, Naughton M, Romano M, Shaffer S, 2014. Daily activity budgets reveal a quasi-flightless stage during non-breeding in Hawaiian albatrosses. *Movement Ecology* 2:23.

Guttridge TL, Brown C, 2014. Learning and memory in the Port Jackson shark, *Heterodontus portusjacksoni*. *Animal Cognition* 17:415–425. doi: 10.1007/s10071-013-0673-4.

2014 publications

Hancock N, Gallagher R, 2014. How ready are we to move species threatened from climate change? Insights into the assisted colonization debate from Australia. *Austral Ecology* 39:830–838. doi: 10.1111/aec.12151.

Hancock N, Hughes L, 2014. Turning up the heat on the provenance debate: Testing the ‘local is best’ paradigm under heatwave conditions. *Austral Ecology* 39:600–611. doi: 10.1111/aec.12122.

Harcourt R, Pirotta V, Heller G, Peddemors V, Slip D, 2014. A whale alarm fails to deter migrating humpback whales: an empirical test. *Endangered Species Research* 25:35–42.

Harley P, Eller A, Guenther A, Monson RK, 2014. Observations and models of emissions of volatile terpenoid compounds from needles of ponderosa pine trees growing in situ: control by light, temperature and stomatal conductance. *Oecologia* 176:35–55.

Harrison SP, Bartlein PJ, Brewer S, Prentice IC, Boyd M, Hessler I, Holmgren K, Izumi K, Willis K, 2014. Climate model benchmarking with glacial and mid-Holocene climates. *Climate Dynamics* 43:671–688. doi: 10.1007/s00382-013-1922-6.

Harrop SJ, Wilk KE, Dinshaw R, Collini E, Mirkovic T, Teng CY, Oblinsky DG, Green BR, Hoef-Emden K, Hiller RG, Scholes GD, Curmi PMG, 2014. Single-residue insertion switches the quaternary structure and exciton states of cryptophyte light-harvesting proteins. *Proceedings of the National Academy of Sciences of the United States of America* 111:E2666–E2675. doi: 10.1073/pnas.1402538111.

Hazlitt SL, Goldizen AW, Nicholls JA, Eldridge MDB, 2014. Three divergent lineages within an Australian marsupial (*Petrogale penicillata*) suggest multiple major refugia for mesic taxa in southeast Australia. *Ecology and Evolution* 4:1102–1116. doi: 10.1002/ece3.1009.

He XJ, Tian LQ, Barron AB, Guan C, Liu H, Wu XB, Zeng ZJ, 2014. Behavior and molecular physiology of nurses of worker and queen larvae in honey bees (*Apis mellifera*). *Journal of Asia-Pacific Entomology* 17:911–916. doi: 10.1016/j.aspen.2014.10.006.

Heavener SJ, Carthey, A. J. R., Banks, P. B., 2014. Competitive naïveté between a highly successful invader and a functionally similar native species. *Oecologia* 175:73–84. doi: 10.1007/s00442-013-2874-6.

Herberstein ME, Baldwin HJ, Gaskett AC, 2014. Deception down under: is Australia a hot spot for deception? *Behavioral Ecology* 25:12–16. doi: 10.1093/beheco/art105.

Herberstein ME, Wignall AE, Hebets EA, Schneider JM, 2014. Dangerous mating systems: Signal complexity, signal content and neural capacity in spiders. *Neuroscience and Biobehavioral Reviews* 46:509–518. doi: 10.1016/j.neubiorev.2014.07.018.

Hessler I, Harrison SP, Kucera M, Waelbroeck C, Chen MT, Anderson C, de Vernal A, Frechette B, Cloke-Hayes A, Leduc G, Londeix L, 2014. Implication of methodological uncertainties for mid-Holocene sea surface temperature reconstructions. *Climate of the Past* 10:2237–2252. doi: 10.5194/cp-10-2237-2014.

Hoarau L, Ainley L, Jean C, Ciccione S, 2014. Ingestion and defecation of marine debris by loggerhead sea turtles, *Caretta caretta*, from by-catches in the South-West Indian Ocean. *Marine Pollution Bulletin* 84:90–96. doi: 10.1016/j.marpolbul.2014.05.031.

Hodgson DA, Graham, A. G. C., Roberts, S. J., Bentley, M. J., Cofaigh, C. O., Verleyen, E., Vyverman, W., Jomelli, V., Favier, V., Brunstein, D., Verfaillie, D., Colhoun, E. A., Saunders, K. M., Selkirk, P. M., Mackintosh, A., Hedding, D. W., Nel, W., Hall, K., McGlone, M. S., Van der Putten, N., Dickens, W. A., Smith, J. A., 2014. Terrestrial and submarine evidence for the extent and timing of the Last Glacial Maximum and the onset of deglaciation on the maritime-Antarctic and sub-Antarctic islands. *Quaternary Science Reviews* 100:137–158. doi: 10.1016/j.quascirev.2013.12.001.

Hook SE, Johnston EL, Nair S, Roach AC, Moncuquet P, Twine NA, Raftos DA, 2014. Next generation sequence analysis of the transcriptome of Sydney rock oysters (*Saccostrea glomerata*) exposed to a range of environmental stressors. *Marine Genomics* 18:109–111.

Hose GC, Bailey J, Stumpp C, Fryirs K, 2014. Groundwater depth and topography correlate with vegetation structure of an upland peat swamp, Budderoo Plateau, NSW, Australia. *Ecohydrology* 7:1392–1402. doi: 10.1002/eco.1465.

Hughes AR, Gribben PE, Kimbro DL, Bishop MJ, 2014. Additive and site-specific effects of two foundation species on invertebrate community structure. *Marine Ecology Progress Series* 508:129–138. doi: 10.3354/meps10867.

Jacquet SM, Brock GA, Paterson JR, 2014. New data on *Oikozetetes* (Mollusca, Halkieriidae) from the lower cambrian of South Australia. *Journal of Paleontology* 88:1072–1084. doi: 10.1666/13-137.

Jakobsen KG, Brock GA, Nielsen AT, Topper TP, Harper DAT, 2014. Middle Ordovician brachiopods from the Stairway Sandstone, Amadeus Basin, central Australia. *Alcheringa* 38:190–208. doi: 10.1080/03115518.2013.858204.

Jakobsen KG, Nielsen AT, Harper DAT, Brock GA, 2014. Trilobites from the Middle Ordovician Stairway Sandstone, Amadeus Basin, central Australia. *Alcheringa* 38:70–96. doi: 10.1080/03115518.2013.828253.

Janssen R, Eriksson BJ, Tait NN, Budd GE, 2014. Onychophoran Hox genes and the evolution of arthropod Hox gene expression. *Frontiers in Zoology* 11. doi: 10.1186/1742-9994-11-22.

Jones J, Higham TFG, Oldfield R, O’Connor TP, Buckley SA, 2014. Evidence for prehistoric origins of Egyptian mummification in late neolithic burials. *PLoS ONE* 9. doi: 10.1371/journal.pone.0103608.

Journet E, Balkanski Y, Harrison SP, 2014. A new data set of soil mineralogy for dust-cycle modeling. *Atmospheric Chemistry and Physics* 14:3801–3816. doi: 10.5194/acp-14-3801-2014.

Julle-Daniere E, Schultheiss P, Wystrach A, Schwarz S, Nooten SS, Bibost AL, Cheng K, 2014. Visual matching in the orientation of desert ants (*Melophorus bagoti*): the effect of changing skyline height. *Ethology* 120:783–792. doi: 10.1111/eth.12247.

Jung V, Albert CH, Violle C, Kunstler G, Loucougaray G, Spiegelberger T, 2014. Intraspecific trait variability mediates the response of subalpine grassland communities to extreme drought events. *Journal of Ecology* 102:45–53. doi: 10.1111/1365-2745.12177.

Kala J, Andrys J, Lyons TJ, Foster IJ, Evans BJ, 2014. Sensitivity of WRF to driving data and physics options on a seasonal time-scale for the southwest of Western Australia. *Climate Dynamics*:1–27. doi: 10.1007/s00382-014-2160-2.

Keenan TF, Darby B, Felts E, Sonnentag O, Friedl MA, Hufkens K, O’Keefe J, Klosterman S, Munger JW, Toomey M, Richardson AD, 2014a. Tracking forest phenology and seasonal physiology using digital repeat photography: a critical assessment. *Ecological Applications* 24:1478–1489.

Keenan TF, Gray J, Friedl MA, Toomey M, Bohrer G, Hollinger DY, Munger JW, O’Keefe J, Schmid HP, SueWing I, Yang B, Richardson AD, 2014b. Net carbon uptake has increased through warming-induced changes in temperate forest phenology. *Nature Climate Change* 4:598–604. doi: 10.1038/nclimate2253.

Keenan TF, Hollinger DY, Bohrer G, Dragoni D, Munger JW, Schmid HP, Richardson AD, 2014. Air pollution and forest water use reply. *Nature* 507:E2–E3. doi: 10.1038/nature13114.

Kelley DI, Harrison SP, Prentice IC, 2014. Improved simulation of fire-vegetation interactions in the Land surface Processes and eXchanges dynamic global vegetation model (LPX-Mv1). *Geoscientific Model Development* 7:2411–2433. doi: 10.5194/gmd-7-2411-2014.

Kelaiah, I., Kavakli, M., & Cheng, K. (2014). Associations between simulator sickness and visual complexity of a virtual scene. *Frontiers in Psychological and Behavioral Science*, 3, 27–35.

Kemp DJ, Jones D, Macedonia JM, Krockenberger AK, 2014. Female mating preferences and male signal variation in iridescent *Hypolimnas* butterflies. *Animal Behaviour* 87:221–229. doi: 10.1016/j.anbehav.2013.11.001.

Kemp DJ, White TE, 2014. Exploring the perceptual canvas of signal evolution: comment on Kelley & Kelley. *Behavioral Ecology* 25:467–468. doi: 10.1093/beheco/aru012

Kessler, M., Harcourt, R., Bradford, W. 2014. Will whale watchers modify personal experience to minimise harm to whales? *Tourism in Marine Environments* 10 (1–2), 21–30

Kim Y, Priddel D, Carlile N, Merrick J, Harcourt R, 2014. Do tracking tags impede breeding performance in the threatened Gould’s Petrel *Pterodroma leucoptera*. *Marine Ornithology* 42:63–68.

Kirk GJD, Greenway H, Atwell BJ, Ismail AM, Colmer TD, 2014. Adaptation of Rice to Flooded Soils. In: Luttge U, Beyschlag W, Cushman J, editors. *Progress in Botany* 75:215–253.

Kokko H, Griffith SC, Pryke SR, 2014. The hawk-dove game in a sexually reproducing species explains a colourful polymorphism of an endangered bird. *Proceedings of the Royal Society B-Biological Sciences* 281. doi: 10.1098/rspb.2014.1794.

Kooyman RM, Wilf P, Barreda VD, Carpenter RJ, Jordan GJ, Sniderman JMK, Allen A, Brodribb TJ, Crayn D, Feild TS, Laffan SW, Lusk CH, Rossetto M, Weston PH, 2014. Paleo-antarctic rainforest into the modern old world tropics: the rich past and threatened future of the “southern wet forest survivors”. *American Journal of Botany* 101:2121–2135. doi: 10.3732/ajb.1400340.

Lagos PA, Ebensperger LA, Herberstein ME, 2014. A quantitative test of the ‘economic’ and ‘optimal’ models of escape behaviour. *Animal Behaviour* 97:221–227. doi: 10.1016/j.anbehav.2014.09.019.

Larson ER, Gallagher, R. V., Beaumont, L. J., Olden, J. D., 2014. Generalized “avatar” niche shifts improve distribution models for invasive species. *Diversity and Distributions* 20:1296–1306. doi: 10.1111/ddi.12233.

Larsson CM, Skovsted CB, Brock GA, Balthasar U, Topper TP, Holmer LE, 2014. *Paterimitra pyramidalis* from South Australia: scleritome, shell structure and evolution of a lower Cambrian stem group brachiopod. *Palaeontology* 57:417–446.

Lategan MJ, Hose, GC, 2014. Development of a groundwater fungal strain as a tool for toxicity assessment. *Environmental Toxicology and Chemistry* 33:2826–2834. doi: 10.1002/etc.2748.

Lee KA, Huvneers C, Gimenez O, Peddemors V, Harcourt RG, 2014. To catch or to sight? A comparison of demographic parameter estimates obtained from mark-recapture and mark-resight models. *Biodiversity and Conservation*:1–20. doi: 10.1007/s10531-014-0748-9.

Lee KA, Huvneers C, Macdonald T, Harcourt RG, 2014. Size isn’t everything: movements, home range, and habitat preferences of eastern blue groppers (*Achoerodus viridis*) demonstrate the efficacy of a small marine reserve. *Aquatic Conservation: Marine and Freshwater Ecosystems* 25: 174–186. doi: 10.1002/aqc.2431.

Legge ELG, Wystrach A, Spetch ML, Cheng K, 2014. Combining sky and earth: desert ants (*Melophorus bagoti*) show weighted integration of celestial and terrestrial cues. *Journal of Experimental Biology* 217:4159–4166. doi: 10.1242/jeb.107862.

Lehmann CER, Anderson TM, Sankaran M, Higgins SI, Archibald S, Hoffmann WA, Hanan NP, Williams RJ, Fensham RJ, Felfili J, Hutley LB, Ratnam J, San Jose J, Montes R, Franklin D, Russell-Smith J, Ryan CM, Durigan G, Hiernaux P, Haidar R, Bowman D, Bond WJ, 2014. Savanna vegetation-fire-climate relationships differ among continents. *Science* 343:548–552. doi: 10.1126/science.1247355.

Lehtonen J and Lanfear R (2014) Generation time, life history, and the substitution rate of neutral mutations. *Biology Letters* 10:20140801. doi: 10.1098/rsbl.2014.0801

Leishman MR, Cooke J, Richardson DM, 2014. Evidence for shifts to faster growth strategies in the new ranges of invasive alien plants. *Journal of Ecology* 102:1451–1461.

Li G, Harrison SP, Prentice IC, Falster D, 2014. Simulation of tree-ring widths with a model for primary production, carbon allocation, and growth. *Biogeosciences* 11:6711–6724. doi: 10.5194/bg-11-6711-2014.

2014 publications

Lidgard DC, Bowen WD, Jonsen ID, McConnell BJ, Lovell P, Webber DM, Stone T, Iverson SJ, 2014. Transmitting species-interaction data from animal-borne transceivers through Service Argos using Bluetooth communication. *Methods in Ecology and Evolution* 5:864–871. doi: 10.1111/2041-210x.12235.

Lindh M, Zhang L, Falster DS, Franklin O, Brännström Å (2014) Plant diversity and drought: The role of deep roots. *Ecological Modelling* 290: 85–93. doi: 10.1016/j.ecolmodel.2014.05.008

Lobato FL, Barneche DR, Siqueira AC, Liedke AMR, Lindner A, Pie MR, Bellwood DR, Floeter SR, 2014. Diet and diversification in the evolution of coral reef fishes. *PLoS ONE* 9. doi: 10.1371/journal.pone.0102094.

Lott MJ, Hose GC, Isberg SR, Power ML, 2014. Genetics and infection dynamics of *Paratrichosoma* sp in farmed saltwater crocodiles (*Crocodylus porosus*). *Parasitology Research* 114:727–735.

Lott MJ, Hose GC, Power ML, 2014. Towards the molecular characterisation of parasitic nematode assemblages: An evaluation of terminal-restriction fragment length polymorphism (T-RFLP) analysis. *Experimental Parasitology* 144:76–83. doi: 10.1016/j.exppara.2014.06.011.

Lovich JE, Ernst CH, Ernst EM, Riley JL, 2014. A 21-year study of seasonal and interspecific variation of hatchling emergence in a nearctic freshwater turtle community: to overwinter or not to overwinter? *Herpetological Monographs* 28:93–109.

Luiz OJ, Comin EJ, Madin JS, 2014. Far away from home: the occurrence of the Indo-Pacific bannerfish *Heniochus acuminatus* (Pisces: Chaetodontidae) in the Atlantic. *Bulletin of Marine Science* 90:741–744. doi: 10.5343/bms.2013.1046.

Lynch KE, Kemp DJ, 2014. Nature-via-nurture and unravelling causality in evolutionary genetics. *Trends in Ecology & Evolution* 29:2–4. doi: 10.1016/j.tree.2013.10.005.

Madin JS, Baird AH, Dornelas M, Connolly SR, 2014. Mechanical vulnerability explains size-dependent mortality of reef corals. *Ecology Letters* 17:1008–1015. doi: 10.1111/ele.12306.

Madsen A, Madin JS, Tan C-H, Baird AH, 2014. The reproductive biology of the scleractinian coral *Plesiastrea versipora* in Sydney Harbour, Australia. *Sexuality And Early Development In Aquatic Organisms* 1:25–33. doi: 10.3354/sedao00004

Mainwaring MC, Deeming DC, Jones CI, Hartley IR, 2014. Adaptive latitudinal variation in Common Blackbird *Turdus merula* nest characteristics. *Ecology and Evolution* 4:841–851. doi: 10.1002/ece3.952.

Mainwaring MC, Hartley IR, Lambrechts MM, Deeming DC, 2014. The design and function of birds’ nests. *Ecology and Evolution* 4:3909–3928. doi: 10.1002/ece3.1054.

Maleszka R, Mason PH, Barron AB, 2014. Epigenomics and the concept of degeneracy in biological systems. *Briefings in Functional Genomics* 13:191–202.

Manea A, Leishman MR, 2014. Leaf area index drives soil water availability and extreme drought-related mortality under elevated CO₂ in a temperate grassland model system. *PLoS ONE* 9:e91046.

Manea A, Leishman MR (2014) Competitive interactions between established grasses and woody plant seedlings under elevated CO₂ levels are mediated by soil water availability. *Oecologia* 177: 499–506.

Manning LM, Peterson CH, Bishop MJ, 2014. Dominant macrobenthic populations experience sustained impacts from annual disposal of fine sediments on sandy beaches. *Marine Ecology Progress Series* 508:1–15. doi: 10.3354/meps10870.

Marangon M, Van Sluyter SC, Waters EJ, Menz RI, 2014. Structure of haze forming proteins in white wines: *Vitis vinifera* thaumatin-like proteins. *PloS ONE* 9:e113757.

Mark AF, Josh MG, Eli KM, Andrew DR, Koen H, Trevor FK, Amey B, John OK, 2014. A tale of two springs: using recent climate anomalies to characterize the sensitivity of temperate forest phenology to climate change. *Environmental Research Letters* 9:054006.

Marquet PA, Allen AP, Brown JH, Dunne JA, Enquist BJ, Gillooly JF, Gowaty PA, Green JL, Harte J, Hubbell SP, O’Dwyer J, Okie JG, Ostling A, Ritchie M, Storch D, West GB, 2014. On Theory in Ecology. *Bioscience* 64:701–710. doi: 10.1093/biosci/biu098.

Martin Calvo M, Prentice IC, Harrison SP, 2014. Climate vs. carbon dioxide controls on biomass burning: a model analysis of the glacial-interglacial contrast. *Biogeosciences Discussion* 11:2569–2593. doi: 10.5194/bgd-11-2569-2014.

McCowan LSC, Griffith SC, 2014. Nestling activity levels during begging behaviour predicts activity level and body mass in adulthood. *Peerj* 2. doi: 10.7717/peerj.566.

McCowan LSC, Rollins LA, Griffith SC, 2014. Personality in captivity: More exploratory males reproduce better in an aviary population. *Behavioural Processes* 107:150–157. doi: 10.1016/j.beproc.2014.08.020.

McMahon CR, Harcourt RG, 2014. Antarctica: Seals collect more Southern Ocean data. *Nature* 513:33–33. doi: 10.1038/513033e.

Mellick R, Wilson PD, Rossetto M, 2014. Demographic history and niche conservatism of tropical rainforest trees separated along an altitudinal gradient of a biogeographic barrier. *Australian Journal of Botany* 62:438–450. doi: 10.1071/bt14103.

Mencio A, Korbel KL, Hose GC, 2014. River-aquifer interactions and their relationship to stygofauna assemblages: A case study of the Gwydir River alluvial aquifer (New South Wales, Australia). *Science of the Total Environment* 479:292–305. doi: 10.1016/j.scitotenv.2014.02.009.

Mendez V, Eberhard, WG, 2014. Removal of genital plugs and insemination by males with normal and experimentally modified palps in *Leucauge mariana* (Araneae: Tetragnathidae). *Journal of Arachnology* 42:284–292.

Miller ET, Wagner SK, 2014. The vocalisations and species status of the White-lined and Kimberley Honeyeaters. *Emu* 114:116–120. doi: 10.1071/mu13073.

Mirzaei M, Soltani N, Sarhadi E, George IS, Neilson KA, Pascovici D, Shahbazian S, Haynes PA, Atwell BJ, Salekdeh GH, 2014. Manipulating root water supply elicits major shifts in the shoot proteome. *Journal of Proteome Research* 13:517–526. doi: 10.1021/pr400696u.

Misof B, Liu SL, Meusemann K, Peters RS, Donath A, Mayer C, Frandsen PB, Ware J, Flouri T, Beutel RG, Niehuis O, Petersen M, Izquierdo-Carrasco F, Wappler T, Rust J, Aberer AJ, Aspöck U, Aspöck H, Bartel D, Blanke A, Berger S, Böhm A, Buckley TR, Calcott B, Chen JQ, Friedrich F, Fukui M, Fujita M, Greve C, Grobe P, Gu SC, Huang Y, Jeremiin LS, Kawahara AY, Krogmann L, Kubiak M, Lanfear R, Letsch H, Li YY, Li ZY, Li JG, Lu HR, Machida R, Mashimo Y, Kapli P, McKenna DD, Meng GL, Nakagaki Y, Navarrete-Heredia JL, Ott M, Ou YX, Pass G, Podsiadlowski L, Pohl H, von Reumont BM, Schütte K, Sekiya K, Shimizu S, Slipinski A, Stamatakis A, Song WH, Su X, Szucsich NU, Tan MH, Tan XM, Tang M, Tang JB, Timelthaler G, Tomizuka S, Trautwein M, Tong XL, Uchifune T, Walz MG, Wiegmann BM, Wilbrandt J, Wipfler B, Wong TKF, Wu Q, Wu GX, Xie YL, Yang SZ, Yang Q, Yeates DK, Yoshizawa K, Zhang Q, Zhang R, Zhang WW, Zhang YH, Zhao J, Zhou CR, Zhou LL, Ziesmann T, Zou SJ, Li YR, Xu X, Zhang Y, Yang HM, Wang J, Wang J, Kjer KM, Zhou X, 2014. Phylogenomics resolves the timing and pattern of insect evolution. *Science* 346:763–767. doi: 10.1126/science.1257570.

Moir ML, Hughes L, Vesk PA, Leng MC, 2014. Which host-dependent insects are most prone to coextinction under changed climates? *Ecology and Evolution* 4:1295–1312.

Moles AT, Perkins SE, Laffan SW, Flores-Moreno H, Awasthy M, Tindall ML, Sack L, Pitman A, Kattge J, Aarssen LW, Anand M, Bahn M, Blonder B, Cavender-Bares J, Cornelissen JHC, Cornwell WK, Diaz S, Dickie JB, Freschet GT, Griffiths JG, Gutierrez AG, Hemmings FA, Hickler T, Hitchcock TD, Keighery M, Kleyer M, Kurokawa H, Leishman MR, Liu KW, Niinemets U, Onipchenko V, Onoda Y, Penuelas J, Pillar VD, Reich PB, Shiodera S, Siefert A, Sosinski EE, Soudzilovskaia NA, Swaine EK, Swenson NG, van Bodegom PM, Warman L, Weiher E, Wright IJ, Zhang HX, Zobel M, Bonser SP, 2014. Which is a better predictor of plant traits: temperature or precipitation? *Journal of Vegetation Science* 25:1167–1180. doi: 10.1111/jvs.12190.

Momigliano P, Robbins WD, Gardner M, Stow A, 2014. Characterisation of 15 novel microsatellite loci for the grey reef shark (*Carcharhinus amblyrhynchos*). *Conservation Genetics Resources* 6:661–663. doi: 10.1007/s12686-014-0174-z.

Moncrieff GR, Lehmann CER, Schnitzler J, Gambiza J, Hiernaux P, Ryan CM, Shackleton CM, Williams RJ, Higgins SI, 2014. Contrasting architecture of key African and Australian savanna tree taxa drives intercontinental structural divergence. *Global Ecology and Biogeography* 23:1235–1244. doi: 10.1111/geb.12205.

Morfopoulos C, Sperlich D, Penuelas J, Filella I, Llusia J, Medlyn BE, Niinemets U, Possell M, Sun ZH, Prentice IC, 2014. A model of

plant isoprene emission based on available reducing power captures responses to atmospheric CO₂. *New Phytologist* 203:125–139. doi: 10.1111/nph.12770.

Müller AH, Sawicki A, Zhou S, Tabrizi ST, Luo M, Hansson M, Willows RD, 2014. Inducing the oxidative stress response in *Escherichia coli* improves the quality of a recombinant protein: Magnesium chelataze ChlH. *Protein Expression and Purification* 101:61–67.

Murphy BP, Lehmann CER, Russell-Smith J, Lawes MJ, 2014. Fire regimes and woody biomass dynamics in Australian savannas. *Journal of Biogeography* 41:133–144. doi: 10.1111/jbi.12204.

Murray S, Momigliano P, Heimann K, Blair D, 2014. Molecular phylogenetics and morphology of *Gambierdiscus yasumotoi* from tropical eastern Australia. *Harmful Algae* 39:242–252.

Niinemets U, Keenan T, 2014. Photosynthetic responses to stress in Mediterranean evergreens: Mechanisms and models. *Environmental and Experimental Botany* 103:24–41. doi: 10.1016/j.envexpbot.2013.11.008.

Niinemets U, Keenan TF, Hallik L, 2014. A worldwide analysis of within-canopy variations in leaf structural, chemical and physiological traits across plant functional types. *New Phytologist*:203:973–993 doi: 10.1111/nph.13096.

Niu SL, Luo YQ, Dietze MC, Keenan TF, Shi Z, Li JW, Chapin FS, 2014. The role of data assimilation in predictive ecology. *Ecosphere* 5. doi: 10.1890/es13-00273.1.

Noble DWA, Byrne RW, Whiting MJ, 2014. Age-dependent social learning in a lizard. *Biology Letters* 10. doi: 10.1098/rsbl.2014.0430.

Noble DWA, Fanson KV, Whiting MJ, 2014. Sex, androgens, and whole-organism performance in an Australian lizard. *Biological Journal of the Linnean Society* 111:834–849. doi: 10.1111/bij.12252.

Noble DWA, McFarlane SE, Keogh JS, Whiting MJ, 2014. Maternal and additive genetic effects contribute to variation in offspring traits in a lizard. *Behavioral Ecology* 25:633–640. doi: 10.1093/beheco/aru032.

Nomano FY, Browning LE, Nakagawa S, Griffith SC, Russell AF, 2014. Validation of an automated data collection method for quantifying social networks in collective behaviours. *Behavioral Ecology and Sociobiology* 68:1379–1391. doi: 10.1007/s00265-014-1757-0.

Nooten SS, Andrew NR, Hughes L, 2014. Potential impacts of climate change on insect communities: a transplant experiment. *PLoS ONE* 9. doi: 10.1371/journal.pone.0085987.

Nooten SS, Hughes L, 2014. Potential impacts of climate change on patterns of insect herbivory on understory plant species: a transplant experiment. *Austral Ecology* 39:668–676. doi: 10.1111/aec.12129.

O’Hanlon JC, Holwell GI, Herberstein ME, 2014. Pollinator deception in the orchid mantis. *American Naturalist* 183:126–132. doi: 10.1086/673858.

2014 publications

O'Donnell J, Fryirs K, Leishman MR, 2014. Digging deep for diversity: riparian seed bank abundance and species richness in relation to burial depth. *Freshwater Biology* 59:100–113. doi: 10.1111/fwb.12249.

O'Hanlon JC, 2014. The roles of colour and shape in pollinator deception in the orchid mantis *Hymenopus coronatus*. *Ethology* 120:652–661. doi: 10.1111/eth.12238.

O'Hanlon JC, Holwell GI, Herberstein ME, 2014. Predatory pollinator deception: Does the orchid mantis resemble a model species? *Current Zoology* 60:90–103.

Oulton LJ, Taylor MP, Hose GC, Brown C, 2014. Sublethal toxicity of untreated and treated stormwater Zn concentrations on the foraging behaviour of *Paratya australiensis* (Decapoda: Atyidae). *Ecotoxicology* 23:1022–1029. doi: 10.1007/s10646-014-1246-2.

Parr CL, Lehmann CER, Bond WJ, Hoffmann WA, Andersen AN, 2014. Tropical grassy biomes: misunderstood, neglected, and under threat. *Trends in Ecology & Evolution* 29:205–213. doi: 10.1016/j.tree.2014.02.004.

Paxton H, Arias A, 2014. Brooding deep-water onuphid polychaetes (Annelida) from the Bay of Biscay. *Marine Biology Research* 10:892–905. doi: 10.1080/17451000.2013.863354.

Pennell MW, Eastman JM, Slater GJ, Brown JW, Uyeda JC, Fitzjohn RG, Alfaro ME, Harmon LJ, 2014. geiger v2.0: an expanded suite of methods for fitting macroevolutionary models to phylogenetic trees. *Bioinformatics* 30:2216–2218. doi: 10.1093/bioinformatics/btu181.

Penton CR, Gupta V, Tiedje JM, Neate SM, Ophel-Keller K, Gillings M, Harvey P, Pham A, Roget DK, 2014. Fungal community structure in disease suppressive soils assessed by 28s lsu gene sequencing. *PLoS ONE* 9. doi: 10.1371/journal.pone.0093893.

Peppe DJ, Lemons CR, Royer DL, Wing SL, Wright IJ, Lusk CH, Rhoden CH, 2014. Biomechanical and leaf-climate relationships: a comparison of ferns and seed plants. *American Journal of Botany* 101:338–347. doi: 10.3732/ajb.1300220.

Pepper M, Barquero MD, Whiting MJ, Keogh JS, 2014. A multi-locus molecular phylogeny for Australia's iconic Jacky Dragon (Agamidae: *Amphibolurus muricatus*): Phylogeographic structure along the Great Dividing Range of south-eastern Australia. *Molecular Phylogenetics and Evolution* 71:149–156. doi: 10.1016/j.ympev.2013.11.012.

Perez-Sanz A, Li G, González-Sampériz P, Harrison SP, 2014. Evaluation of modern and mid-Holocene seasonal precipitation of the Mediterranean and northern Africa in the CMIP5 simulations. *Climate of the Past* 10:551–568. doi: 10.5194/cp-10-551-2014.

Peso M, Barron AB, 2014. The effects of brood ester pheromone on foraging behaviour and colony growth in apicultural settings. *Apidologie* 45:529–536. doi: 10.1007/s13592-014-0270-9.

Peso M, Telford L, Backwell PRY, 2014. Comparison shopping: detectability and mate preferences in a fiddler crab. *Animal Behaviour* 88:107–111. doi: 10.1016/j.anbehav.2013.11.021.

Peterson CH, Bishop MJ, D'Anna LM, Johnson GA, 2014. Multi-year persistence of beach habitat degradation from nourishment using coarse shelly sediments. *Science of the Total Environment* 487:481–492. doi: 10.1016/j.scitotenv.2014.04.046.

Pietsch KA, Ogle K, Cornelissen JHC, Cornwell WK, Bonisch G, Craine JM, Jackson BG, Kattge J, Peltzer DA, Penuelas J, Reich PB, Wardle DA, Weedon JT, Wright IJ, Zanne AE, Wirth C, 2014. Global relationship of wood and leaf litter decomposability: the role of functional traits within and across plant organs. *Global Ecology and Biogeography* 23:1046–1057. doi: 10.1111/geb.12172.

Pineda-Munoz S, Alroy J, 2014. Dietary characterization of terrestrial mammals. *Proceedings of the Royal Society B-Biological Sciences* 281. doi: 10.1098/rspb.2014.1173.

Potter S, Close RL, Taggart DA, Cooper SJB, Eldridge MDB, 2014. Taxonomy of rock-wallabies, *Petrogale* (Marsupialia: Macropodidae). IV. Multifaceted study of the brachyotis group identifies additional taxa. *Australian Journal of Zoology* 62:401–414. doi: 10.1071/z013095.

Prentice IC, Dong N, Gleason SM, Maire V, Wright IJ, 2014. Balancing the costs of carbon gain and water transport: testing a new theoretical framework for plant functional ecology. *Ecology Letters* 17:82–91. doi: 10.1111/ele.12211.

Price CA, Wright IJ, Ackerly DD, Niinemets U, Reich PB, Veneklaas EJ, 2014. Are leaf functional traits 'invariant' with plant size and what is 'invariance' anyway? *Functional Ecology* 28:1330–1343. doi: 10.1111/1365-2435.12298.

Priddel D, Carlile N, Portelli D, Kim Y, O'Neill L, Bretagnolle V, Ballance LT, Phillips RA, Pitman RL, Rayner MJ, 2014. Pelagic distribution of Gould's Petrel (*Pterodroma leucoptera*): linking shipboard and onshore observations with remote-tracking data. *Emu* 114:360–370. doi: 10.1071/mu14021.

Pyke GH, 2014. Achieving research excellence and citation success: what's the point and how do you do it? *Bioscience* 64:90–91. doi: 10.1093/biosci/bit022.

Pyke GH, 2014. Evaluating the quality of taxonomic publications: a simple alternative to citations and effort. *Bioscience* 64:961–962. doi: 10.1093/biosci/biu154.

Pyke GH, Ehrlich PR, 2014. Conservation and the holy grail: The story of the night parrot. *Pacific Conservation Biology* 20:221.

Qi Y, Noble DWA, Wu YY, Whiting MJ, 2014. Sex- and performance-based escape behaviour in an Asian agamid lizard, *Phrynocephalus vlangalii*. *Behavioral Ecology and Sociobiology* 68:2035–2042. doi: 10.1007/s00265-014-1809-5.

Radford IJ, Dickman CR, Start AN, Palmer C, Carnes K, Everitt C, Fairman R, Graham G, Partridge T, Thomson A, 2014. Mammals of Australia's tropical savannas: a conceptual model of assemblage structure and regulatory factors in the Kimberley region. *PLoS ONE* 9. doi: 10.1371/journal.pone.0092341.

Raftos DA, Kuchel R, Aladaileh S, Butt D, 2014. Infectious microbial diseases and host defense responses in Sydney rock oysters. *Frontiers in Microbiology* 5. doi: 10.3389/fmicb.2014.00135.

Rahman HMT, Sarker SK, Hickey GM, Haque MM, Das N, 2014. Informal institutional responses to government interventions: lessons from Madhupur National Park, Bangladesh. *Environmental Management* 54:1175–1189. doi: 10.1007/s00267-014-0325-8.

Raymond, B. Lea, M-A., Patterson, T., Andrews-Goff, V., Sharples, R., Charrassin, J-B., Cottin, M., Emmerson, L., Gales, N., Gales, R., Goldsworthy, S., Harcourt, R., Kato, A., Kirkwood, R., Lawton., K., Ropert-Coudert, Y., Southwell, C., van den Hoff, J., Wienecke, B., Woehler, E.J., Wotherspoon, S., Hindell, M.A. 2014. Important marine habitat off East Antarctica revealed by two decades of multi-species predator tracking. *Ecography* 37: 001–009

Rasmann S, Pellissier L, Defossez E, Jactel H, Kunstler G, 2014. Climate-driven change in plant-insect interactions along elevation gradients. *Functional Ecology* 28:46–54. doi: 10.1111/1365-2435.12135.

Reynolds AM, Schultheiss P, Cheng K, 2014. Does the Australian desert ant *Melophorus bagoti* approximate a Lévy search by an intrinsic bi-modal walk? *Journal of Theoretical Biology* 340:17–22.

Reynolds OL, Orchard BA, Collins SR, Taylor PW, 2014. Yeast hydrolysate supplementation increases field abundance and persistence of sexually mature sterile Queensland fruit fly, *Bactrocera tryoni* (Froggatt). *Bulletin of Entomological Research* 104:251–261. doi: 10.1017/S0007485313000758.

Richards AE, Wright IJ, Lenz TI, Zanne AE, 2014. Sapwood capacitance is greater in evergreen sclerophyll species growing in high compared to low-rainfall environments. *Functional Ecology* 28:734–744. doi: 10.1111/1365-2435.12193.

Ridgeway PA, Lindsay K, Pou D, Visintin A, 2014. Indications of diverse behavioural ecologies in the morphologically conservative Australian land snails *Pommerhelix* and *Meridolum* (*Stylommatophora: Camaenidae*). *Molluscan Research* 34:25–39. doi: 10.1080/13235818.2013.866179.

Rogers A, Medlyn BE, Dukes JS, 2014. Improving representation of photosynthesis in Earth System Models. *New Phytologist* 204:12–14. doi: 10.1111/nph.12972.

Roquet F, Williams G, Hindell MA, Harcourt RG., McMahon C, Guinet C, Charrassin J-B, Reverdin G, Boehme L, Lovell P, Fedak M, 2014. A Southern Indian Ocean database of hydrographic profiles obtained with instrumented elephant seals. *Scientific Data* 1. doi: 10.1038/sdata.2014.28

Rosell JA, Gleason S, Mendez-Alonzo R, Chang Y, Westoby M, 2014. Bark functional ecology: evidence for tradeoffs, functional coordination, and environment producing bark diversity. *New Phytologist* 201:486–497. doi: 10.1111/nph.12541.

Rosell JA, Olson ME, 2014. The evolution of bark mechanics and storage across habitats in a clade of tropical trees. *American Journal of Botany* 101:764–777. doi: 10.3732/ajb.1400109.

Roth MO, Wilkins AG, Cooke GM, Raftos DA, Nair SV, 2014. Characterization of the highly variable immune response gene family, HE185/333, in the sea urchin, *Heliocidaris erythrogramma*. *PLoS ONE*. doi: 10.1371/journal.pone.0062079.

Ruch J, Herberstein ME, Schneider JM, 2014. Families hunt more successfully: effect of group composition on hunting and communal feeding. *Animal Behaviour* 91:171–178. doi: 10.1016/j.anbehav.2014.03.013.

Ruch J, Herberstein ME, Schneider JM, 2014. Offspring dynamics affect food provisioning, growth and mortality in a brood-caring spider. *Proceedings of the Royal Society B-Biological Sciences* 281. doi: 10.1098/rspb.2013.2180.

Ruch J, Riehl T, Michalik P, 2014. Re-description of *Xysticus bimaculatus* L. Koch, 1867 (Araneae, Thomisidae) and characterization of its subsocial lifestyle. *Zookeys*:1–19. doi: 10.3897/zookeys.427.7450.

Rymer TL, Thomson RL, Whiting MJ, 2014. At home with the birds: Kalahari tree skinks associate with sociable weaver nests despite African pygmy falcon presence. *Austral Ecology* 39:839–847. doi: 10.1111/aec.12152.

Sackett O, Armand L, Beardall J, Hill R, Doblin M, Connelly C, Howes J, Stuart B, Ralph P, Heraud P, 2014. Taxon-specific responses of Southern Ocean diatoms to Fe enrichment revealed by synchrotron radiation FTIR microspectroscopy. *Biogeosciences* 11:5795–5808. doi: 10.5194/bg-11-5795-2014.

Scalon MC, Rossatto DR, Franco AC, 2014. Do litter manipulations affect leaf functional traits of savanna woody plants? *Plant Ecology* 215:111–120.

Scheiner R, Toteva A, Reim T, Sovik E, Barron AB, 2014. Differences in the phototaxis of pollen and nectar foraging honey bees are related to their octopamine brain titers. *Frontiers in Physiology* 5. doi: 10.3389/fphys.2014.00116.

Schlegel P, Havenhand JN, Obadia N, Williamson JE, 2014. Sperm swimming in the polychaete *Galeolaria caespitosa* shows substantial inter-individual variability in response to future ocean acidification. *Marine Pollution Bulletin* 78:213–217. doi: 10.1016/marpolbul.2013.10.040.

Schmidt GA, Annan JD, Bartlein PJ, Cook BI, Guilyardi E, Hargreaves JC, Harrison SP, Kageyama M, LeGrande AN, Konecky B, Lovejoy S, Mann ME, Masson-Delmotte V, Risi C, Thompson D, Timmermann A, Tremblay LB, Yiou P, 2014. Using palaeo-climate comparisons to constrain future projections in CMIP5. *Climate of the Past* 10:221–250. doi: 10.5194/cp-10-221-2014.

Schnell, A.K., Smith, C-L., Hanlon, R.T., Harcourt, R. 2014. Female receptivity, mating history and familiarity influence the mating behavior of cuttlefish. *Behavioral Ecology and Sociobiology* DOI:10.1007/s00265-014-1841-5

Schwartz SK, Wagner WE, Hebets EA, 2014. Obligate male death and sexual cannibalism in dark fishing spiders. *Animal Behaviour* 93:151–156. doi: 10.1016/j.anbehav.2014.04.037.

2014 publications

Schwarz S, Julle-Daniere E, Morin L, Schultheiss P, Wystrach A, Ives J, Cheng K, 2014. Desert ants (*Melophorus bagoti*) navigating with robustness to distortions of the natural panorama. *Insectes Sociaux* 61:371–383. doi: 10.1007/s00040-014-0364-4.

Shoemaker JK, Keenan TF, Hollinger DY, Richardson AD, 2014. Forest ecosystem changes from annual methane source to sink depending on late summer water balance. *Geophysical Research Letters* 41:673–679. doi: 10.1002/2013GL058691.

Simoes PI, Stow A, Hodl W, Amezquita A, Farias IP, Lima AP, 2014. The value of including intraspecific measures of biodiversity in environmental impact surveys is highlighted by the Amazonian brilliant-thighed frog (*Allobates femoralis*). *Tropical Conservation Science* 7:811–828.

Skovsted CB, Topper TP, Betts MJ, Brock GA, 2014. Associated conchs and opercula of *Triplicatella disdoma* (Hyalolitha) from the early Cambrian of South Australia. *Alcheringa* 38:148–153. doi: 10.1080/O3115518.2014.843381.

Smith CKLL, Zielinski SL, 2014. Brainy Bird. *Scientific American* 310:60–65.

Smith, P., Brock, G.A., Paterson, J.R. & Topper, T.P. 2014. New Cambrian (early Templetonian) bradoriid arthropods from the Giles Creek Dolostone, Amadeus Basin, Central Australia. *Cambro-Ordovician Studies V, Memoirs of the Association of Australasian Palaeontologists* 45: 233–248.

Sovik E, Even N, Radford CW, Barron AB, 2014. Cocaine affects foraging behaviour and biogenic amine modulated behavioural reflexes in honey bees. *PeerJ* 2. doi: 10.7717/peerj.662.

Stephens AEA, Myers JH, 2014. Testing biological control agent compatibility: *Cyphocleonus achates* and *Larinus minutus* on diffuse knapweed. *Biological Control* 70:48–53.

Stockin KA, Amaral AR, Latimer J, Lambert DM, Natoli A, 2014. Population genetic structure and taxonomy of the common dolphin (*Delphinus* sp.) at its southernmost range limit: New Zealand waters. *Marine Mammal Science* 30:44–63. doi: 10.1111/mms.12027.

Sun Y, Qiu J-W, 2014. A new species of Chaetopterus (Annelida, Chaetoptera) from Hong Kong. *Memoirs of Museum Victoria* 71:303–309

Tatarnic NJ, Cassis G, Siva-Jothy MT, 2014. Traumatic insemination in terrestrial arthropods. In: Berenbaum MR, editor. *Annual Review of Entomology* 59:245–261.

Thuiller W, Munkemüller T, Schifffers KH, Georges D, Dullinger S, Eckhart VM, Edwards TC, Gravel D, Kunstler G, Merow C, Moore K, Piedallu C, Vissault S, Zimmermann NE, Zurell D, Schurr FM, 2014. Does probability of occurrence relate to population dynamics? *Ecography* 37:1155–1166. doi: 10.1111/ecog.00836.

Tooth IM, Leishman MR, 2014. Elevated carbon dioxide and fire reduce biomass of native grass species when grown in competition with invasive exotic grasses in a savanna experimental system. *Biological Invasions* 16:257–268. doi: 10.1007/s10530-013-0448-5.

Trompf L, Brown C, 2014. Personality affects learning and trade-offs between private and social information in guppies, *Poecilia reticulata*. *Animal Behaviour* 88:99–106. doi: 10.1016/j.anbehav.2013.11.022.

Ukkola AM, Murray SJ, 2014. Hydrological evaluation of the LPX dynamic global vegetation model for small river catchments in the UK. *Hydrological Processes* 28:1939–1950. doi: 10.1002/hyp.9735.

Umbers KDL, Fabricant SA, Gawryszewski FM, Seago AE, Herberstein ME, 2014. Reversible colour change in Arthropoda. *Biological Reviews* 89:820–848. doi: 10.1111/brv.12079.

Verges A, Steinberg PD, Hay ME, Poore AGB, Campbell AH, Ballesteros E, Heck KL, Booth DJ, Coleman MA, Feary DA, Figueira W, Langlois T, Marzinelli EM, Mizerek T, Mumby PJ, Nakamura Y, Roughan M, van Sebille E, Sen Gupta A, Smale DA, Tomas F, Wernberg T, Wilson SK, 2014. The tropicalization of temperate marine ecosystems: climate-mediated changes in herbivory and community phase shifts. *Proceedings of the Royal Society B-Biological Sciences* 281. doi: 10.1098/rspb.2014.0846.

Vermeulen PJ, 2014. Crown depth as a result of evolutionary games: decreasing solar angle should lead to shallower, not deeper crowns. *New Phytologist* 202:1249–1256. doi: 10.1111/nph.12729.

Viddi, F., Harcourt R. 2014. Behaviour of Chilean and Peale's dolphins in southern Chile: interspecific variability of sympatric species. *Journal of the Marine Biological Association of the United Kingdom* DOI: <http://dx.doi.org/10.1017/S0025315414000216>

Walker AP, Hanson PJ, De Kauwe MG, Medlyn BE, Zaehle S, Asao S, Dietze M, Hickler T, Huntingford C, Iversen CM, Jain A, Lomas M, Luo YQ, McCarthy H, Parton WJ, Prentice IC, Thornton PE, Wang SS, Wang YP, Warlind D, Weng ES, Warren JM, Woodward FI, Oren R, Norby RJ, 2014. Comprehensive ecosystem model-data synthesis using multiple data sets at two temperate forest free-air CO₂ enrichment experiments: Model performance at ambient CO₂ concentration. *Journal of Geophysical Research-Biogeosciences* 119:937–964. doi: 10.1002/2013jg002553.

Wang H, 2014. A multi-model assessment of climate change impacts on the distribution and productivity of ecosystems in China. *Regional Environmental Change* 14:133–144. doi: 10.1007/s10113-013-0469-8.

Wang H, Prentice IC, Davis TW, 2014. Biophysical constraints on gross primary production by the terrestrial biosphere. *Biogeosciences* 11:5987–6001. doi: 10.5194/bg-11-5987-2014.

Wang YP, Chen BC, Wieder WR, Leite M, Medlyn BE, Rasmussen M, Smith MJ, Agosto FB, Hoffman F, Luo YQ, 2014. Oscillatory behavior of two nonlinear microbial models of soil carbon decomposition. *Biogeosciences* 11:1817–1831. doi: 10.5194/bg-11-1817-2014.

Warren DL, Cardillo M, Rosauer DF, Bolnick DI, 2014. Mistaking geography for biology: inferring processes from species distributions. *Trends in Ecology & Evolution* 29:572–580.

Warrington MH, McDonald PG, Rollins LA, Griffith SC, 2014. All signals are not equal: acoustic signalling of individuality, sex and breeding status in a cooperative breeder. *Animal Behaviour* 93:249–260. doi: 10.1016/j.anbehav.2014.05.007.

Warrington MH, McDonald PG, Sager AK, Griffith SC, 2014. The vocal repertoire of the cooperatively breeding Apostlebird (*Struthidea cinerea*). *Emu* 114:206–221. doi: 10.1071/mu13051.

Webster KN, Hill NJ, Burnett L, Deane EM, 2014. Ectoparasite infestation patterns, haematology and serum biochemistry of urban-dwelling common brushtail possums. *Wildlife Biology* 20:206–216. doi: 10.2981/wlb.00027.

Wells DA, Jones DN, Bulger D, Brown C, 2014. Male brush-turkeys attempt sexual coercion in unusual circumstances. *Behavioural Processes* 106:180–186. doi: 10.1016/j.beproc.2014.06.002.

White GE, Brown C, 2014. A comparison of spatial learning and memory capabilities in intertidal gobies. *Behavioral Ecology and Sociobiology* 68:1393–1401. doi: 10.1007/s00265-014-1747-2.

Wignall AE, Kemp DJ, Herberstein ME, 2014. Extreme short-term repeatability of male courtship performance in a tropical orb-web spider. *Behavioral Ecology* 25:1083–1088. doi: 10.1093/beheco/aru083.

Wood PA, de Bie J, Clarke JA, 2014. Behavioural and physiological responses of domestic dogs (*Canis familiaris*) to agonistic growls from conspecifics. *Applied Animal Behaviour Science* 161:105–112. doi: 10.1016/j.applanim.2014.10.004.

Wu N, Zhang YM, Downing A, Aanderud ZT, Tao Y, Williams S, 2014. Rapid adjustment of leaf angle explains how the desert moss, *Syntrichia caninervis*, copes with multiple resource limitations during rehydration. *Functional Plant Biology* 41:168–177. doi: 10.1071/fp13054.

Wystrach A, Philippides A, Aurejac A, Cheng K, Graham P, 2014. Visual scanning behaviours and their role in the navigation of the Australian desert ant *Melophorus bagoti*. *Journal of Comparative Physiology A* 200:615–626.

Wystrach A, Schwarz S, Schultheiss P, Baniel A, Cheng K, 2014. Multiple sources of celestial compass information in the Central Australian desert ant *Melophorus bagoti*. *Journal of Comparative Physiology A* 200:591–601. doi: 10.1007/s00359-014-0899-x.

Yvon-Durocher G, Allen AP, Bastviken D, Conrad R, Gudasz C, St-Pierre A, Thanh-Duc N, del Giorgio PA, 2014. Methane fluxes show consistent temperature dependence across microbial to ecosystem scales. *Nature* 507:488–+. doi: 10.1038/nature13164.

Zaehle S, Medlyn BE, De Kauwe MG, Walker AP, Dietze MC, Hickler T, Luo YQ, Wang YP, El-Masri B, Thornton P, Jain A, Wang SS, Warlind D, Weng ES, Parton W, Iversen CM, Gallet-Budynek A, McCarthy H, Finzi A, Hanson PJ, Prentice IC, Oren R, Norby RJ, 2014. Evaluation of 11 terrestrial carbon-nitrogen cycle models against observations from two temperate Free-Air CO₂ Enrichment studies. *New Phytologist* 202:803–822. doi: 10.1111/nph.12697.

Zanne AE, Tank DC, Cornwell WK, Eastman JM, Smith SA, FitzJohn RG, McGlenn DJ, O'Meara BC, Moles AT, Reich PB, Royer DL, Soltis DE, Stevens PF, Westoby M, Wright IJ, Aarssen L, Bertin RI, Calaminus A, Govaerts R, Hemmings F, Leishman MR, Oleksyn J, Soltis PS, Swenson NG, Warman L, Beaulieu JM, 2014. Three keys to the radiation of angiosperms into freezing environments. *Nature* 506:89–92. doi: 10.1038/nature12872.

Zeppel MJB, Wilks J, Lewis J, 2014. Impacts of extreme precipitation and seasonal changes in precipitation on plants. *Biogeosciences* 11:3083–3093.

Zeppel MJB, Lewis JD, Phillips NG, Tissue DT, 2014. Consequences of nocturnal water loss: a synthesis of regulating factors and implications for capacitance, embolism and use in models. *Tree Physiology* 34:1047–1055. doi: 10.1093/treephys/tpu089.

Zeppel MJB, Wilks JV, Lewis JD, 2014c. Impacts of extreme precipitation and seasonal changes in precipitation on plants. *Biogeosciences* 11:3083–3093. doi: 10.5194/bg-11-3083-2014.

Zhang ZF, Li GX, Holmer LE, Brock GA, Balthasar U, Skovsted CB, Fu DJ, Zhang XL, Wang HZ, Butler A, Zhang ZL, Cao CQ, Han J, Liu JN, Shu DG, 2014. An early Cambrian agglutinated tubular lophophorate with brachiopod characters. *Scientific Reports* 4. doi: 10.1038/srep04682.

Zhou SX, Medlyn B, Sabate S, Sperlich D, Prentice IC, 2014. Short-term water stress impacts on stomatal, mesophyll and biochemical limitations to photosynthesis differ consistently among tree species from contrasting climates. *Tree Physiology* 34:1035–1046. doi: 10.1093/treephys/tpu072.

Zimmer SM, Schneider JM, Herberstein ME, 2014. Can males detect the strength of sperm competition and presence of genital plugs during mate choice? *Behavioral Ecology* 25:716–722. doi: 10.1093/beheco/aru045.

Zolfaghar S, Villalobos-Vega R, Cleverly J, Zeppel M, Rumman R, Eamus D, 2014. The influence of depth-to-groundwater on structure and productivity of Eucalyptus woodlands. *Australian Journal of Botany* 62:428–437. doi: <http://dx.doi.org/10.1071/BT14139>.

Zuberi A, Brown C, Ali S, 2014. Effect of confinement on water-borne and whole body cortisol in wild and captive-reared rainbowfish (*Melanoteania duboulayi*). *International Journal of Agriculture and Biology* 16:183–188.

Zuk M, Garcia-Gonzalez F, Herberstein ME, Simmons LW, 2014. Model Systems, Taxonomic Bias, and Sexual Selection: Beyond *Drosophila*. In: Berenbaum MR, editor. *Annual Review of Entomology* 59:321–U977.

Social activities



DEPARTMENT OF BIOLOGICAL SCIENCES

Macquarie University NSW 2109 Australia

T: +61 (2) 9850 8179

bio.mq.edu.au



MACQUARIE
University