



THE UNIVERSITY
of ADELAIDE

Environment Institute



2013 Annual Report



Environment Institute

2013 Annual Report

Contents

02	Connecting knowledge to create change
03	2013 highlights
04	Aligning with the State's economic priorities
06	Overviews
08	Sustaining viable landscapes
10	Delivering hard evidence and leadership on climate change
12	Understanding the ecology of our oceans
14	Animal Armageddon scientist joins the Environment Institute
16	Ancient teeth reveal the secret to modern day health
17	Engaging with the community
18	Our leading members
20	Publications

The Environment
Institute exists to deliver
outstanding research across
environmental sciences.
By connecting world class
researchers with government,
industry and the community,
we can develop and apply
solutions that can meet
today's and future needs.

Connecting knowledge to lead change

Our environmental specialists work together
on projects to deliver innovative, relevant and
actionable research outcomes in areas including:

- > water
- > biodiversity
- > conservation
- > landscape transformation
- > oceans and marine biology
- > climate change, resilience and adaptation
- > genetics, ancient DNA and DNA barcoding
- > sustainable and clean energy technology
and carbon sequestration

2013 highlights

Grant success

- 5** Discovery Projects
- 2** Linkage Projects
- 4** Future Fellowships
- 2** Discovery Early Career Researcher Awards (DECRA)
- 1** Linkage Infrastructure, Equipment and Facilities (LIEF)

20 high impact publications (IF > 9.8)

- 3** Science
- 2** Nature Climate Change
- 1** Nature Genetics
- 2** Nature Communications
- 6** Proceedings of the National Academy of Sciences

Number of peer reviewed papers

- 168** from 18 leading researchers
- 531** from extended member group

Researchers

- 18** Leading researchers
- 400** Total research members
- 2** New leading researchers
(Professor Peter Ward and
Associate Professor Lian Pin Koh)

Grant income

Category 1	\$8,210,808
Category 2	\$4,618,297
Category 3	\$3,073,328
Category 4	\$133,175
Total grant income for 2013	\$16m+

Congratulations to Environment Institute members

- > **Landscape Futures Analysis Tool (LFAT)** wins the Environment and Sustainability category at the South Australian Spatial Excellence Awards.
- > **Barry Brook** awarded the Elsevier Scopus Young Researcher Award in the Life Sciences and Biological Sciences category
- > **Martin Breed** has won the South Australian Science Excellence Award for PhD Research Excellence-Life and Environmental Sciences
- > **Graeme Dandy** was awarded The Premier's Water Medal for 2013. The award recognises an eminent individual for outstanding contribution to the South Australian water industry or management or conservation of water in the state.
- > **Justin Brookes** and the **Water Research Centre (WRC)** received the SA Research Innovation Award for his work on the impact of climate change on the ecology of algal blooms. This award recognises significant contribution to research projects in the water industry.
- > **Tina Schroeder**, honours student of Bertram Ostendorf, was the Spatial Excellence Award Winner - Best Graduate Project 2013

Aligning with the State's economic priorities

“ Science knowledge is only one part of the decision making process. We need to take into account social systems and influences as well as community values. ”

Professor Wayne Meyer,
Director, Landscape Futures Program

“ Through my research using Conservation Drones, I aim to build connections with conservation workers and researchers worldwide, especially those in developing countries. We aim to raise public awareness of conservation challenges in those regions, and inspire others to adapt emerging technologies for conservation. ”

Lian Pin Koh, Associate Professor and Chair
of the Applied Ecology & Conservation group

Several projects hosted by the Environment Institute are making substantial contributions to help government, industry and the community to make informed decisions that shape Australia's future.

South Australia is at the epicentre of this research. Our State stands to benefit immensely from the innovative research taking place within the Institute.

Sustainable and efficient natural resource management

The Landscape Futures program strives to protect the natural environment, while at the same time capturing opportunities that provide potential for innovation and economic growth. Careful monitoring of our changing landscape enables key recommendations to be developed to ensure optimum natural resource management strategies.

Through collaborative projects we are connecting rural landholders, government and communities in order to enable a decision making process that optimises the economic output of the land, while minimising mistakes of the past.

- > Unlocking the full potential of South Australia's resources, energy and renewable assets (priority 1)

Protecting the quality of our seafood exports

As part of the Spencer Gulf Ecosystem Development Initiative we are leading a major marine investigation to enable credible, evidence based development options to maintain the health of the Gulf and safeguard the quality of seafood exports. Major industry partners on this project include: BHP Billiton, Santos, Arrium, Flinders Ports, Centrex metals, Alinta Energy and the Fisheries Research and Development Corporation.

Hosting research with international impact to attract students from around the world

The local environment of our state provides opportunities for research such as natural resource management and temperate ocean research distinct from anywhere in the world. Our participation in international research collaborations continues to attract students from around the globe. Led by Professor Alan Cooper, samples from internationally renowned fossil sites are brought to the University of Adelaide for analysis at the Australian Centre for Ancient DNA.

Maintaining the gulf as a pristine tourist destination

The Spencer Gulf provides many exceptional opportunities for diving and fishing and is home to many unique wildlife species. The giant Australian cuttlefish congregate at Point Lowly for the largest breeding aggregation worldwide, has long been a highlight for visitors. Research conducted by the Institute seeks to monitor cuttlefish and other marine species and provide recommendations to allow the tourism industry to continue to flourish.

- > Premium food and wine produced in our clean environment and exported to the world (priority 2)
- > South Australia – growing destination choice for international and domestic travellers (priority 5)

“ The Spencer Gulf Ecosystem Development Initiative (SGEDI) paves the way for research and initiatives that ensure that the gulf remains a thriving, vibrant and pristine part of South Australia's future. ”

Professor Bronwyn Gillanders,
Director, Marine Biology Program

Commercialising sustainable innovation

The Environment Institute works with Adelaide Research and Innovation (ARI) to commercialise research and help give Australian businesses an edge. Professor Andrew Lowe leads a team that is able to track illegally harvested timber from around the world through DNA fingerprinting. Research and commercialisation partners are working with governments in Europe, America and Australia to develop DNA tools to support new legislation.

- > The Knowledge State – attracting a diverse student body and commercialising our research (priority 4)
- > Growth through innovation (priority 6)

“ We've been able to advance DNA fingerprinting to the point that large-scale screening of wood material can be done cheaply, quickly and with a statistical certainty that can be used in a court of law. ”

Professor Andrew Lowe, Director,
Australian Centre for Evolutionary
Biology and Biodiversity

Creating new strong global connections

The appointment in 2013 of Associate Professor Lian Pin Koh and Professor Peter Ward adds to the international influence of the Environment Institute's research. Both are both engaging speakers who are keen to communicate their research, as evidenced by their fascinating TED talks.

Associate Professor Koh comes to Adelaide following research positions and established collaborative projects at Princeton, ETH Zurich and the National University of Singapore. His non-profit ConservationDrones.org has research collaborators across the USA, UK, Switzerland. The Conservation Drones are low-cost unmanned aerial vehicles that are currently being used by partners to enhance conservation and environmental monitoring efforts across the globe, including South East Asia, Nepal, Chile, Germany, Scotland and Greenland.

Professor Ward is an internationally renowned palaeontologist. His research concerns the Earth's mass extinctions and data is collected from field sites in Antarctica, the Canning Basin of Australia, South Africa and Western Canada, as well as ongoing study of living nautilus off the Great Barrier Reef of Australia. He has written numerous popular science books and a TV documentary series for Animal Planet.

With their international connections and passion for communicating their research, Associate Professor Lian Pin Koh and Professor Peter Ward are poised to showcase the state as a hub for high impact research and innovation.

- > Promoting South Australia's International connections and engagement (priority 9)

Overviews

Board members

Dr Steve Morton (Chair)

Honorary Fellow, CSIRO
Ecosystems Sciences

Carl Binning

Managing Director,
Creating Communities

Paul Duldig

Vice-President,
Services and Resources,
The University of Adelaide

Allan Holmes

Chief Executive,
Department of Environment,
Water and Natural Resources

Professor Bob Hill

Executive Dean,
Faculty of Sciences,
The University of Adelaide

Professor Mike Brooks

Deputy Vice Chancellor and
Vice-President (Research),
The University of Adelaide

Pauline Gregg

General Manager – Environment,
Telstra

Deputy Vice-Chancellor (Research)



The University of Adelaide's research strategy is premised on supporting excellence, pursuing the big research questions, developing critical mass, and aligning with state and national priorities. With this in mind, I was very pleased that the Vice-Chancellor approved a second 5 year term for the Environment Institute, commencing at the end of its first term in November 2013.

The University's investment in the Institute continues to pay dividends, with Institute researchers producing some tremendous outcomes in areas including evolutionary biology, climate change, marine research and landscape science. It was gratifying to see some impressive results in the 2013 Australian Research Council funding rounds, including four new Future Fellowships and five Discovery Grants. It is also noteworthy to see the wide-ranging interaction our researchers have with the community, for example with the Spencer Gulf Ecosystem and Development Initiative, bringing together essential social, economic and biophysical information to understand the Gulf's environment, and assess the growing pressures on it.

Building on a long tradition of research with cutting-edge facilities, innovative approaches by great people, and a collaborative outlook, researchers in the Environment Institute are delivering excellent outcomes for the University and the wider community.

Professor Mike Brooks

Deputy Vice Chancellor & Vice-President (Research)

Chair



I am delighted to be associated with the Environment Institute, with its exciting aim of a culture of innovation and collaboration to advance the University's status.

The Environment Institute is now firmly established as a centre for research excellence. It brings together outstanding scientists who add to the stature of the University as a leader in environmental science in Australia and a highly noteworthy

contributor on the global scene. The considerable research achievements of the past year – a string of publications in the very best of the world's scientific journals, including *Science* and *Nature* – demonstrate the academic standing of the Institute in clear terms. Several of the Institute's researchers have won substantial awards during the year, thereby displaying further the quality of their achievements.

In coming years, the advisory board will continue to encourage and support these superb researchers. Board members are most excited by research efforts to help solve complex environmental issues, the large-scale environmental problems that confront us as a society, with collective and collaborative approaches. The board aims to assist direction of the superb expertise of the Institute's researchers towards big issues for South Australia and the world beyond.

Achieving these aspirations will see the University shine even more brightly in environmental research for years to come.

Dr Steve Morton

Chair, Environment Institute Advisory Board

Director



During 2013, we have undergone continued impressive growth and development within the Environment Institute. Our core group contains a large number of relatively young researchers who are at the top of their fields and represent the future for the University of Adelaide. I have been pleased to see these talented people making the transition to become leaders in their fields, capable of nurturing and developing the next

crop of early career researchers and adding further depth to the Institute. This is the University's Research Institute strategy delivering in the best possible way.

2013 has been a highly successful year for the institute. The international strength of our research leaders is reflected by the high level of citation and publication in high impact journals. From 2013 we are poised to further enhance our research capacity and international connections with the appointment of high-impact researchers Associate Professor Lian Pin Koh and Professor Peter Ward.

Developing strong collaborations and external engagement continues to be a priority of the Institute, in order to most effectively address today's environmental problems. Our vital partnerships bring together research teams from university, government and business organisations, both nationally and internationally. Having joined the ARID Recovery board in 2013, I look forward to personally increasing

engagement and research outcomes through this important restoration initiative. We can now clearly point to some major initiatives that would almost certainly not have developed without the financial support of the Environment Institute and these initiatives further demonstrate the value of the Research Institute strategy.

In 2013 we have experienced a high level of success with ARC funding applications, including five successful new Discovery Project applications. Also a highlight is the highly prestigious Future Fellowship grant success. Of a total ten University wide, Environment Institute researchers were awarded four ARC Future Fellowships, three of these to early career researchers.

Our research outcomes are not only in line with the fundamental objectives of the university but also deliver on the economic priorities of the state. Our projects aim to enhance the productivity of the land while protecting our pristine habitats and engaging with government, industry and community leaders. Through evidence-based recommendations derived from sound research, The Environment Institute provides invaluable support to South Australia's economy and future prosperity.

Professor Bob Hill

Director, Environment Institute

Sustaining viable landscapes

The sustainability of Australia’s agriculture and native habitat are at risk as a result of a multitude of transformational pressures.

Researchers from the Environment Institute work collaboratively with communities and non-government organisations to protect and improve the sustainability of the Australian landscape.

Our research recognises that while the Australian landscape can be harsh and unforgiving it is also extremely sensitive to policy decisions concerning land management. Careful natural resource management (NRM) is required in order to balance the preservation of our native species while at the same time enabling both effective and profitable food production in the long term.

Science is essential in order to inform and support critical environmental limits. However scientific knowledge is only one part of implementing change. The Environment Institute recognises that landscape systems are complex and are subject to a number of biophysical, economic and social drivers.

In order to maintain viable landscape management solutions our Landscape Futures research program:

- > takes a cross-disciplinary approach by supporting researchers to work alongside professionals in adjacent fields and with members of the community to best inform policy decisions

Learning from extreme weather events

The OzFlux flux tower at Calperum station, 20 kilometres north of Renmark is an important part of a network of flux stations across the country. The tower had been providing data on the levels of carbon dioxide and water vapour being exchanged by the mallee vegetation since 2010. The breaking of a 10 year dry period in 2011 saw more than double the average rainfall for the year. The result was much increased growth of the vegetation. In fact this growth occurred over very large areas of arid and semiarid Australia. The Calperum

measurements showed significant increases in carbon dioxide uptake, an effect that was repeated across the land. The data from the national flux tower network is being collated and is expected to show that this huge growth flush was large enough to temporarily slow the inexorable rise in worldwide carbon dioxide levels. Natural weather events such as this can be used to show the effect and efficiency of revegetation projects used as part of carbon dioxide reduction schemes.

- > delivers improvements to the access and use of measurement techniques and analysis tools for measurement and monitoring of natural resource systems
- > fosters knowledge exchange, engagement, trust and relationship building through working closely with communities and decision makers

Learning from the land to plan for the future

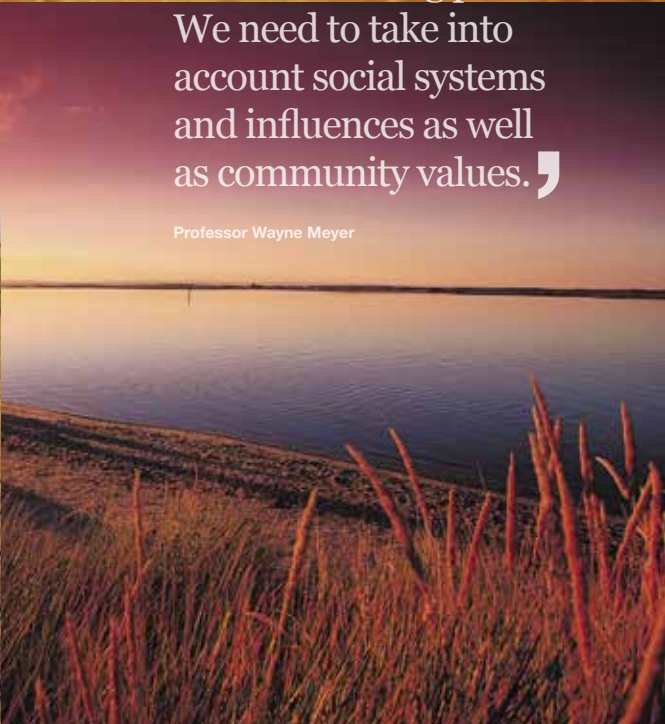
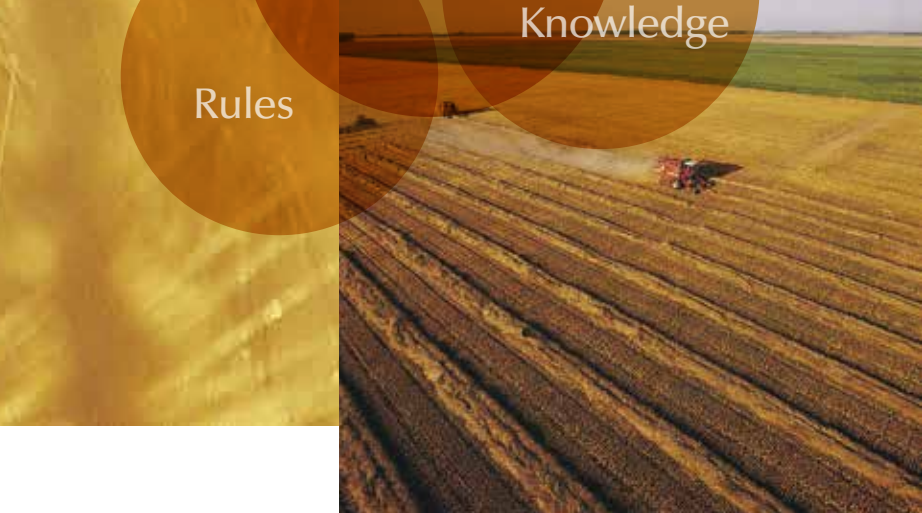
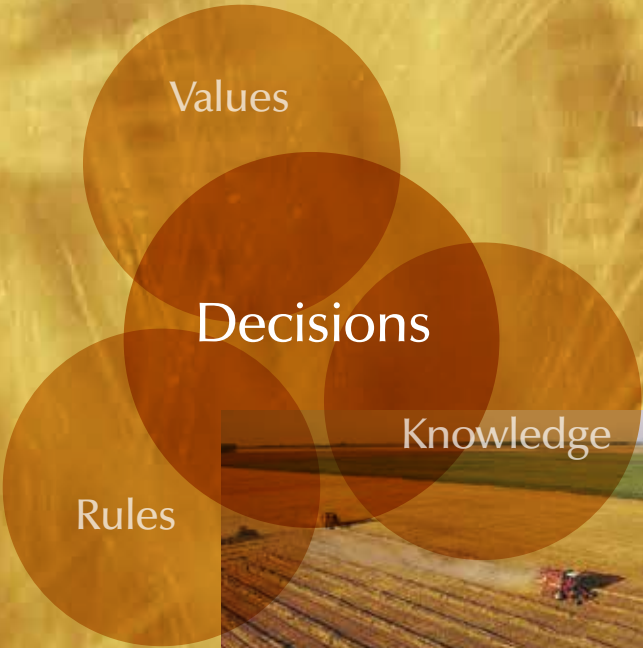
Monitoring and modelling projects focussed on the Eyre Peninsula and South Australia’s Murray-Darling Basin regions and evidence from other NRM regions in Australia are providing insight into key drivers of changes to the landscape. Current findings indicate that the Australian landscape is set to experience its second industrial transformation since the first began in 1788. Analyses show that six new ‘emerging economies’ will exert intensifying transformational pressure on land use.

These drivers are set to have an impact beyond traditional agricultural production and conservation functions of landscapes.

They are:

- > carbon
- > water
- > food
- > energy
- > amenity
- > mining

Each of these will combine with other forces, such as changing global commodity demands and climate change in influencing land use and management. The good news



Science knowledge is only one part of the decision making process. We need to take into account social systems and influences as well as community values.

Professor Wayne Meyer

is that Australia has shown remarkable resilience and responsiveness to innovation in order to meet past environmental challenges.

This research engages cross-disciplinary expertise such as corporate change management to best advise how to provide an opportunity for Australian landscapes to thrive within environmental limits. Key recommendations arising from the research are:

- > foster new partnerships between government, science, the private sector and local communities
- > empower regional areas in natural resource governance-to make location specific adaptations and changes
- > use science to identify critical environmental limits, and rationalise environmental laws
- > establish innovative social processes, such as the engagement of the private sector with communities

The aim is to deliver key recommendations to avoid the mistakes of the past, such as large scale ecological degradation and species extinction, soil erosion and salinisation, pest invasion and over extraction of water resources. This research identifies regional scale options that support rural landholders, exposes inevitable trade-offs

Satellite imagery tells a 25 year story

Land managers are keen to know whether vegetation cover and condition over large areas of arid Australia are being maintained despite various pressures such as grazing, feral animals, introduced weeds and climate change. Australia is a large continent and it is difficult to gather adequate information to answer these questions. Field surveys are expensive and time consuming and long-term studies are required to separate short and long term climate variability. In order to determine the efficacy of land management, landscape changes that occur must be separated from natural cycles.

To uncover the story of Australian arid vegetation researchers at the Environment Institute have used 25 years of satellite images to demonstrate how the landscape varies in space and time. The images covered a zone of over 5 million km² and showed the relative amounts of plant cover and greenness. The data can help identify changes as a result of land use and help interpretation of field samples. It also adds to existing mapping in the arid zone, giving a new picture of the distribution of vegetation types.

and indicates both positive and negative consequences. Rather than presenting challenges, the six emerging economies can be used to provide opportunities for innovative land use, improved community well-being and critical resource conservation.

This research was published in *Current Opinion in Environmental Sustainability* 2013, 5:278-287

Delivering hard evidence and leadership on climate change

Climate change is global in its causes and consequences, and the response should be international and collaborative. It is a topic that has become increasingly polarised and now more than ever requires evidence based recommendations and leadership from scientists. Environment Institute researchers continue to contribute significantly to the dialogue in 2013.

Comprehensive study finds human fingerprints all over climate change

A research project that analysed 34 years of satellite temperature data provides further strong evidence of human influence on climate change.

Professor Tom Wigley is part of a team of international climate scientists that released a comprehensive study investigating the causes of temperature changes in Earth's atmosphere. The study builds on previous work published by the same group based at the Lawrence Livermore National Laboratory in the United States. The 1996 *Nature* paper, 'A search for human influences on

the thermal structure of the atmosphere', was the first published work to clearly identify the human fingerprint in observed temperature changes.

This publication builds on earlier work with another 20 years of data. This adds further strong evidence for the human impact on our climate.

The study focuses on the vertical structure of atmospheric temperature change (from the troposphere or lower levels of the atmosphere through to the stratosphere or upper reaches of the atmosphere), comparing satellite temperature data over 34 years compared with results from more than 20 different climate models.



“Other published work has already shown a convincing and growing pile of pebbles of evidence for the dominant role of humans in climate change. Our paper adds a huge boulder to that pile.”

Professor Tom Wigley

Saving the Iberian lynx requires adapted conservation measures

Dr Damien Fordham and Professor Barry Brook led an international study that has found the world's most endangered cat species, the Iberian lynx, could be driven to extinction within 50 years due to climate change.

This study is the most comprehensive conservation-management model yet developed of the effects of climate change on a predator and its prey.

Since 1994 over €90 million has been spent on saving the Iberian lynx, including reintroductions into suitable habitats. Although there is evidence that lynx numbers have increased in the last ten years in response to intensive management, this study warns that the ongoing conservation strategies could buy just a few decades before the species goes extinct.

The study shows that climate change could lead to a rapid and severe decrease in lynx abundance in coming decades, and probably lead to its extinction in the wild within 50 years.

As a result of developing new forecasting methods, researchers have managed for

“Current management efforts could be futile if they don't take into account the combined effects of climate change, land use and prey abundance on population dynamics of the Iberian lynx.”

Dr Damien Fordham

the first time to simulate demographic responses of lynx to spatial patterns of rabbit abundance conditioned by disease, climate change, and land use modification.

The study shows that a carefully planned reintroduction programme, accounting for the effects of climate change, prey abundance and habitat connectivity, could avert extinction of the lynx this century.

The results demonstrate, for the first time, why considering prey availability, climate change and their interaction in models is important when designing policies to prevent future biodiversity loss.

This research was published in *Nature Climate Change*, 2013, 3(10):899-903.

“Human influence on climate change is undeniable.”

Professor Tom Wigley

Understanding the ecology of our oceans

Ocean acidification: mitigating global effects with local solutions

Ocean acidification as a result of increased carbon dioxide emissions will affect the ecosystems of our marine life and reduce the ecosystems capacity to process waste. This will result in creased productivity of our fisheries industries, and increased pollution. The negative effects on costal zones will be felt by the community and industry alike.

Atmospheric carbon dioxide has increased from a preindustrial level of approx. 280 ppm to approx. 385 ppm with further increases (700 – 1000 ppm) anticipated by the end 21st century. Global average temps have also increased, by approx. 0.2 degrees per decade with most additional energy absorbed by oceans (0.8 degree rise in sea surface temperatures).

This rapid absorption of the extra carbon dioxide and heat energy from the atmosphere causes changes in seawater carbonate chemistry. Specifically, a decrease in pH and carbonate saturation, and an increase in dissolved carbon dioxide and bicarbonate ions. This is collectively called ocean acidification.

Ocean acidification is also occurring alongside other environmental changes- warming, pollution and excess nutrients, depletion of oxygen in the water (hypoxia). The combined and cumulative effects of these factors are poorly understood.

In the past, research surrounding the consequences of warming and ocean acidification has predominantly focussed on calcifying (shell forming) organisms. This overlooks direct and indirect effects of increased carbon dioxide for non- calcareous organisms.

Our marine researchers are studying the larger effects on the ecosystem of the ocean

Cuttlefish population studies

Professor Bronwyn Gillanders is leading a research study to determine the movement patterns and population structure of cuttlefish in northern Spencer Gulf. The study will also assess and evaluate the response of the cuttlefish population to environmental and human factors.

The annual spectacle of winter spawning by the giant Australian cuttlefish offshore from Point Lowly has drawn scientists, recreational divers and tourists since the phenomenon was documented in the 1990s. At the height of spawning, observers had noted mating and egg laying activity at a density of one cuttlefish per square metre.

Then from 1999 onwards, population numbers declined by a staggering 90 per

cent - from around 183,000 individuals in 1999 to 18,530 in 2012. A further survey revealed a decline from 18,530 in 2012 to 13,500 in 2013, a slower decline than previous years. Recently, the numbers have increased again as the cuttlefish returned to Point Lowly for breeding. Is this all part of a natural cycle?

When ecosystems are interrupted, there is a reduction in the amount of nutrient

such as species interactions. For example, an increase in carbon dioxide concentrations provide the right conditions for weedy species such as algal turfs to flourish at the expense of kelp forests. Kelp forests are highly species diverse and are particularly important for supporting natural ecosystems.

Professor Gillanders says population changes may be due to acoustic trauma from increased shipping, changes in gulf salinity or it could be just part of a natural cycle, as newspaper articles in 1910 and 1947 reported beaches covered in dead cuttlefish. Environment Institute research aims to establish the big picture, examining population movement and status - including whether this is an entirely different species – and viability, assessing what is affecting population numbers.

“ Researchers can make recommendations for solutions at the local level to help mitigate the effects of global changes. ”

Dr Bayden Russell

waste that these systems process for us. This can lead to decreased productivity of fisheries industries, and increased localised pollution. Ocean acidification can also have some direct effects, such as reduced growth and survival of species such as abalone, scallops, oysters and pippis.

The good news is, while we can't do much about global ocean acidification on our local scale, researchers are coming up with ways to minimise other sources of stress that are placed on these systems, to allow them to be more resistant and resilient to ocean acidification. Researchers can make recommendations regarding waste water and storm water discharge to mitigate the effects of ocean acidification at the local scale.

The solutions may be for local implementation, but the recommendations can be applied worldwide. The European Commission's Environment Directorate-General has recognized this work as a world first for demonstrating that local management solutions can reduce the effects of climate change. This research offers a unique insight into the vital

scientific issues relevant to current EU environmental policy.

Closer to home, SA Water have been taking these findings seriously and base some of their environmental management policy on research coming out of the Environment Institute. Careful policy implementation has the potential to have positive effects not only today, but well into the future, by maintaining costal habitats and improving water quality.

Looking to the future, this research hopes to work towards habitat restoration to improve conservation and also the economic needs of our state. A prime example is the oyster reefs that used to cover most of our coastline, but have been made extinct in our quest for food. Not only to oysters provide a valuable food source, but as filter feeders oysters are able to strip the water of pollutants.

This in itself is a valuable resource that would improve our marine environment, a natural alternative to wastewater treatment plants. The benefits are two-fold, clean oceans improve conservation and economic remuneration in the form of direct and indirect increased food production.

“ Ocean acidification and ocean warming are predicted to have substantial impacts not only on marine biodiversity but on ecosystem functioning and service provision. ”

Professor Sean Connell

Animal Armageddon scientist joins the Environment Institute

You may come to the conclusion that the research of Professor Peter Ward is somewhat fatalistic. He did after all, coin the term Medea Hypothesis, which proposes that multicellular life as we know it is suicidal. However, he has uncovered that the very poison of complex life may also be able to save it.

For 25 years, paleobiologist Professor Peter Ward has been driven to discover the identities of which species lived and which died the great mass extinctions of Earth's history. This is research immersed in philosophy, which extends to the depths of the oceans. Ward's fascination with the Nautilus shell has inspired a career researching a creature that has prevailed for 500 million years.

Initially, the closest Ward could get to the nautilus as an academic was through the studies of fossils at McMaster University in Ontario, where he earned his PhD in 1976, aged 26. But after offering himself up as an assistant to University of Washington professor Arthur Martin on his trip to New Caledonia in 1975, he was able to get a whole lot closer to nautilus. New Caledonia is an archipelago less than 2000 kilometers east of the Great Barrier Reef, and the only place on Earth where nautilus swim in water shallow enough for a scuba diver to see them.

As it turns out, Ward had already started learning the practical skills required for a

career researching a deep sea creature from the age of 16, when he built his first scuba tank from an old fire extinguisher and a \$15 used regulator. Now, he was the first scientist to be able to follow the nautilus in their natural habitat.

However, rather than become a focussed specialist with respect to the Nautilus, Ward wanted answers to some big questions. What caused the periodic mass extinctions in our planet's history? What does this mean for the future of life on Earth? In particular, the Great Permian extinction, when 95 percent of the planet's species suddenly disappeared, captured his attention.

Professor Ward was invited to present a TED talk in 2008, and in it, he tells a story of the mass extinctions of Earth's past in that is in stark contrast to the plot of Hollywood blockbusters *Deep Impact* and *Armageddon*. He proposes that many of the mass extinctions or 'Animal Armageddons' of Earth's history have been caused not by the impact of extraterrestrial bodies, but by bacteria.

Rapid global warming causes oceans to become depleted in oxygen, which allows

buildup of a gas poisonous to complex life, hydrogen sulfide (H₂S). Bacteria on the other hand, thrives on H₂S and so its domination of the planet is abetted.

As it turns out, the hydrogen sulfide poison present at the boundary of these mass extinctions may actually have a medical application to sustain human life. Not all mammals were wiped out during the mass extinctions of the past. Those that survived underwent adaptation to cope with small amounts H₂S due to the series of exposures to high atmospheric hydrogen sulfide they experienced.

Hydrogen Sulfide may be used to facilitate lowering of core body temperature following trauma, to allow time for transport to hospital. Through an understanding of Earth's history, an opportunity to revolutionise medicine is provided.

Professor Ward's work to uncover the secrets of Earth's mass extinctions has been profiled in internet think tank BigThink.com, and inspired the Animal Planet eight hour series written by Ward, *Animal Armageddon*.



Peter Ward with an iconic nautilus

“I have been able to tell a very plausible evolutionary story about how the nautilus has survived over 500 million years by side-stepping the dinosaur-killing asteroid and every other menace the earth and cosmos have thrown it. It was not because it was especially adaptable, it was because it had the incredible good fortune to prefer deep waters and a metabolism suited to life in the slow lane.”

His latest research concerns new data coming from the K/Pg mass extinction at field sites in Antarctica, the late Devonian mass extinction based on work just finished in the Canning Basin of Australia, and the Permian mass extinction from new work in both South Africa and Western Canada, as well as ongoing study of living nautilus off the Great Barrier Reef of Australia, a line of work that has morphed into studies of living cuttlefish in South Australia.

The Environment Institute welcomes Professor Peter Ward!

Ancient teeth reveal the secret to modern day health

A world first study led by Professor Alan Cooper has revealed that changes to the ecology of the mouth over generations makes our mouth a dangerous place.

An unusual mix of ancient-DNA genetics, dentistry, ecology and nutrition, the study revealed that changes to a simplified diet first dominated by basic carbohydrates, and subsequently purified sugars, has essentially led to widespread ecosystem degradation in the mouth's bacterial community.

The research team extracted and used bacterial DNA preserved in dental calculus on ancient European skeletons to study ancient diseases, then examined how the modern human diet has negatively impacted our health and our bacteria.

Samples were isolated from the Mesolithic Period, 7550-5450 years before present (BP), Neolithic Period, (7400-4000 years BP), Neolithic Bronze Age (4200-3000 BP) Medieval Period (1100-400 years BP) and finally from modern, living humans. Study of these samples found a marked decline in bacterial diversity over time.

There was a decrease in diversity and an increase in prevalence of specific bacterial pathogens after farming became widespread in the Neolithic, followed by a second, acute decrease in diversity after the Industrial

Revolution about 150 years ago, when refined sugars and flour became widely available.

Over time, we have dangerously simplified our natural mouth ecosystem, resulting in a loss of the mouth's natural microbiome and leaving the way open for disease-causing bacteria.

Dental caries is now a major endemic disease that affects 60–90% of school-aged children in industrialised countries. Periodontal disease occurs in 5-20% of the adult population worldwide. Oral bacteria is also associated with arthritis, cardiovascular disease, diabetes and other systemic diseases.

Environmental ecosystems regularly confirm the fact that higher species diversity generally results in greater resilience. This study is clear evidence that biodiversity in both our diets and our environment is vital for better health.

This was reported in *Nature Genetics* (2013) 45, 450–455



Photo: Alan Cooper, Australian Centre for Ancient DNA

Engaging with our community

In the news

The Environment Institute continues to feature heavily in the media. The Institute and our researchers actively publicise their research to help inform and engage the community on Environmental issues.

Events

This year our researchers have taken part in well attended events such as Research Tuesdays seminar series (The Carbon Key and Where will we source our energy?), WOMADelaide and TEDx Adelaide Forum to communicate their research to a wide audience.

The Institute also continues to see great attendance at seminars such as Water Wednesday's, and at public lectures hosting international speakers such as British anthropologist Professor Chris Stringer, FRS.

The Curious Country

Corey Bradshaw and Barry Brook were part of a hand-picked group of 27 academic experts and science writers from across Australia who contributed to publication released by the Chief Scientist of Australia entitled "*The Curious Country*".

Corey Bradshaw (right) with (from left) Bernie Hobbs, Paul Ehrlich and Graham Turner at the WOMADelaide Planet Talks.



Photo: Scott Hedges

The book is available for free download and is a collection of essays designed to "quench the curiosity of everyday Australians". Australians were asked directly what were the important issues they wanted science to address? What were their concerns about science? What inspires them? 1186 Australians were surveyed, men and women ages 18 to 65, from all education levels and locations around Australia.

The book is designed to bridge the gap between heavy scientific papers for specialists, and those wanting more accurate, up-to-date information about science than what currently filters through the mainstream media.

Climate along with health issues were the top scientific curiosities and concerns in the minds of Australians at 30% and 32% respectively. Pollution and water were the environmental issues of greatest concern.



Our leading members



Professor Bob Hill, Director
Director, Environment Institute*



Professor Alan Cooper
Director, Australian Centre for Ancient DNA*
Australian Research Council Future Fellow



Professor Andy Austin
Deputy Director, Australian Centre for Evolutionary Biology and Biodiversity



Professor Andy Lowe
Director, Australian Centre for Evolutionary Biology and Biodiversity*



Professor Barry Brook
Co-Director, Global Ecology Laboratory
Director of Climate Science, Environment Institute*
Foundation Sir Hubert Wilkins Chair of Climate Change
Australian Research Council Future Fellow



Professor Bronwyn Gillanders
Director, Marine Biology Program*
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Professor Corey Bradshaw
Co-Director, Global Ecology Laboratory
Director, Ecological Modelling, Environment Institute*
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Associate Professor Frank Grutzner
Australian Research Council Fellow



Associate Professor Ivan Nagelkerken
Australian Research Council Future Fellow



Associate Professor Jeremy Austin
Deputy Director, Australian Centre for Ancient DNA
Australian Research Council Future Fellow



Associate Professor Justin Brookes
Director, Water Research Centre*



Professor Martin Kennedy
Director, Sprigg Geobiology Centre*



Professor Michelle Waycott
HBS Womersley Chair in Systematic Botany
Chief Botanist, State Herbarium of South Australia



Associate Professor Phill Cassey
Co-Director, Global Ecology Laboratory
Director, Biosecurity, Environment Institute
Australian Research Council Future Fellow



Professor Sean Connell
Australian Research Council Future Fellow



Professor Steve Cooper
Principal Research Scientist, South Australian Museum Evolutionary Biology Unit



Professor Tom Wigley
Australian Research Council Discovery Outstanding Researcher Award



Professor Wayne Meyer
Director, Landscape Futures Program*

Our Management Team

Together with the research leaders indicated with an “*” the following people also serve on the Management Team.

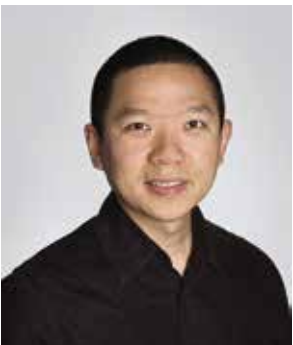


Professor Mike Wilkinson
Head of the School of Agriculture, Food and Wine



Associate Professor Jenny Watling
Head of the School of Earth and Environmental Sciences

Joining our research leaders in 2013



Associate Professor Lian Pin Koh
Chair of Applied Ecology & Conservation



Professor Peter Ward
Sprigg Geobiology Centre

Publications

A selection of publications by the Environment Institute’s 18 leading researchers follows. In 2013, 168 journal articles were published by leading researchers and 531 across the whole Institute. To view this extensive list, please visit: www.adelaide.edu.au/environment/news

1. Adler, C. J.; Dobney, K.; Weyrich, L. S.; Kaidonis, J.; Walker, A. W.; Haak, W.; Bradshaw, C. J. A.; Townsend, G.; Soltysiak, A.; Alt, K. W.; Parkhill, J.; Cooper, A. Sequencing ancient calcified dental plaque shows changes in oral microbiota with dietary shifts of the Neolithic and Industrial revolutions. *Nature Genetics* 2013, 45 (4), 450-455.

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3. Bell, J. D.; Ganachaud, A.; Gehrke, P. C.; Griffiths, S. P.; Hobday, A. J.; Hoegh-Guldberg, O.; Johnson, J. E.; Le Borgne, R.; Lehodey, P.; Lough, J. M.; Matear, R. J.; Pickering, T. D.; Pratchett, M. S.; Gupta, A. S.; Senina, I.; Waycott, M. Mixed responses of tropical Pacific fisheries and aquaculture to climate change. *Nature Climate Change* 2013, 3 (6), 591-599.

4. Blomqvist, L.; Brook, B. W.; Ellis, E. C.; Kareiva, P. M.; Nordhaus, T.; Shellenberger, M. Does the Shoe Fit? Real versus Imagined Ecological Footprints. *PLoS Biology* 2013, 11 (11).

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6. Brandt, G.; Haak, W.; Adler, C. J.; Roth, C.; Szécsényi-Nagy, A.; Karimnia, S.; Möller-Rieker, S.; Meller, H.; Ganslmeier, R.; Friederich, S.; Dresely, V.; Nicklisch, N.; Pickrell, J. K.; Sirocko, F.; Reich, D.; Cooper, A.; Alt, K. W. Ancient DNA reveals key stages in the formation of Central European mitochondrial genetic diversity. *Science* 2013, 342 (6155), 257-261.

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8. Brook, B. W.; Ellis, E. C.; Perring, M. P.; Mackay, A. W.; Blomqvist, L. Does the terrestrial biosphere have planetary tipping points? *Trends in Ecology and Evolution* 2013, 28 (7), 396-401.

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