



## Australian Sustainable Development Institute

# NEWSLETTER

We're changing today for tomorrow



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*climate variability from a global to local perspective.*

The iLecture for this event is available from the ASDI website: [http://www.asdi.org.au/news\\_\\_events/events.cfm](http://www.asdi.org.au/news__events/events.cfm)

I'd also like to draw your attention to the Events page of this newsletter and the **Flourish Biodiversity Festival** in Margaret River from the 7th-9th October.

**Charlie Thorn, Executive Director**

## CONTACT:

Australian Sustainable Development Institute  
Curtin University

**Street address:**  
Kent Street, Bentley, WA 6102

**Postal address:**  
GPO Box U1987, Perth, WA 6845

**Tel:** +61 8 9266 1792

**Fax:** +61 8 9266 3793

**Email:** [c.thorn@curtin.edu.au](mailto:c.thorn@curtin.edu.au)

### Welcome from the Executive Director

Recently, ASDI Board Member, Mr Malcolm McCusker resigned following his appointment to the role of Governor of Western Australia. We congratulate and thank Malcolm for his commitment to sustainable development as an inaugural Board member and we are pleased to announce that His Excellency Mr Malcolm McCusker, AO QC has accepted ASDI's invitation to become the new Patron of ASDI in his role as Governor of WA. We also thank the Dr Ken Michael for his Patronage and strong support of ASDI over its formative years.

### Public Transport Plan

The newly released Public Transport for Perth in 2031 document is the State Government's vision for improved and expanded public transport in Perth. The plan will play a vital role in addressing congestion and accessibility issues as

Perth grows to an expected population of 2.5 million by 2031.

Professor Peter Newman from the Curtin University Sustainability Policy Institute offers his initial thoughts on the plan in this issue on page 7 and asks, *Is this plan going to be enough for Perth's future growth?*

The plan can be found online here: <http://www.transport.wa.gov.au/aboutus/23281.asp>

### Haydn Williams Fellow

In early 2011 Curtin University awarded the Haydn Williams Fellowship to Professor Janet Bormman. Janet's background is in the plant sciences (photobiology, physiology) with research interests in plant stress, mainly from climate change factors.

At the end of June, Professor Bormman delivered a public lecture at Curtin, titled, *Implications of environmental impacts of*

**Research by a team of Curtin University plant biologists shows Australian plants have been exposed to fire for 40 million years longer than previously thought.**

### Goundbreaking discovery in plant adaptations to fire

Research by a team of Curtin University plant biologists shows Australian plants have been exposed to fire for 40 million years longer than previously thought.

Led by Banksia expert, Emeritus Professor Byron Lamont, of Curtin's Department of Environment and Agriculture, the findings reveal Banksias have evolved in the presence of fire for 61 million years, and have developed many adaptations to cope as a result.

fire, and the fact that many species hang onto to their dead flowers.

"If the plant dies from drought it does not release its seeds – they just rot in the cone. Therefore, a fire is essential to melt the resin that keeps the woody fruits closed, in order to release the seeds onto the post-fire seed bed that is now ideal for germination.

"Putting these findings together, we concluded that Banksias must have evolved in the presence of fire right from the time it departed from its rainforest ancestors."

"Our research helps us to understand how the plants got to have the traits that they show today. But it does not mean that all species can cope with frequent fire," he said.

"Research is still required to understand the optimal fire regime for conservation of different species. This can be critical for threatened species but there are many success stories of rare species re-appearing and flourishing after fire, supporting a general adaptation to fire in the Australian flora."

Professor Lamont said with projected climate change outcomes, some regions of Australia would become more fire-prone and others less.

"Only an understanding of the optimal fire requirements of individual species will assist the most suitable fire management as conditions change," he said.

Professor Lamont was made a Member of the Order of Australia in 2010 and has studied the fire ecology of Banksias for more than 30 years, making them the best understood plant group in Australia. This study was done in conjunction with two other Curtin researchers, Adjunct Senior Fellow, Dr Tianhua He and Visiting Fellow, Dr Katherine Downes.

Professor Lamont's study was funded by Curtin's Office of Research & Development and the Australian Research Council, with support from the Department of Environment and Conservation and Kings Park Botanic Gardens.

The results were recently published in the international plant science journal *New Phytologist*.



Professor Lamont said the significance of the findings contradicted recent claims that fire had only existed in the Australian landscape for 15-20 million years. Previously, it was thought that the 50-100 million-year-old Australian flora was only adapted to drought and poor soil conditions.

"Fossil records indicate that Banksias have been in Australia for at least 60 million years. By tracing back the evolutionary history of Banksia, as revealed by our genetic studies and fossil pollen and cone ages, we discovered that Banksias probably had the ability to retain their seeds in their cones since the very origin of the genus 61 million years ago," Professor Lamont said.

"We examined features of Banksias that have long been considered examples of adaptations to fire, such as their ability to re-sprout after fire, the retention of seeds in woody cones that are released after

Professor Lamont said the study also revealed for the first time that many species of Banksia retained their dead leaves indefinitely, helping to provide the necessary heat for fruit opening, with ash providing nutrients for the new seedlings.

"These discoveries mean that biologists must now take seriously the possibility that fire has had a profound effect on the direction of evolution in Australia for more than 60 million years," he said.

"It is just as important as drought and strong seasonality, high air temperatures and poor soils as limiting factors in the evolution of plants and animals."

Professor Lamont said the discoveries opened the way for new ideas on the role of fire in shaping many features of plants and animals once they emerged from the rainforests into the typical harsh Australian environment we know today.

Source: Andrea Barnard, Public Relations, Curtin



Research by a Curtin University genomic scientist has identified a novel evolutionary process in the fungi that contribute to 10 to 40 per cent of crop losses worldwide.

### Crop fungi evolving at a faster rate than ever

Research by a Curtin University genomic scientist has identified a novel evolutionary process in the fungi that contribute to 10 to 40 per cent of crop losses worldwide.

These fungi, known as filamentous Ascomycetes, cause the diseases, wheat Stagonospora (Septoria) nodorum, tan (or yellow) spot, and canola blackleg, and contribute the most damage to Australian crops.

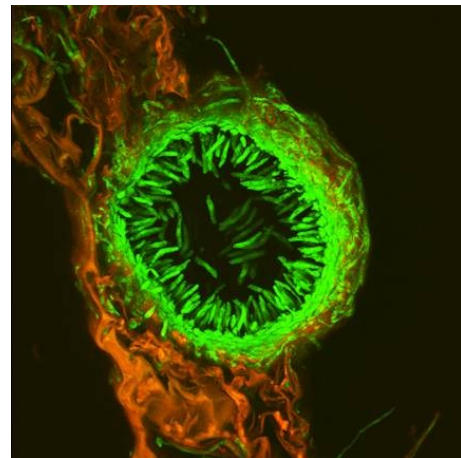
Led by biochemist and fungal pathology expert, Professor Richard Oliver, from Curtin's Department of Environment and

designated "mesosynty", that was not observed in any fungal, plant or animal groups.

"The mesosynty mode of evolution, which is peculiar to this group of fungi, differentiates it from the more common micro and macrosynty seen in other organisms," he said.

"Mesosynty appears to be restricted to filamentous Ascomycetes, which represent a group of fungi that include many important human, animal and plant pathogens.

"The phenomenon is most striking between species in the Dothideomycetes, a group which



"We need to ask how this happens and what evolutionary processes are allowing fungal pathogens to evolve so fast.

"It is tempting to speculate that mesosynty allows these pathogens to acquire genes from other species, as we have seen in the case of tan spot, which we believe emerged as a disease only 70 -80 years ago."

Professor Oliver said the results should reinforce the need for vigilance in plant pathology at home and abroad.

"Our next step involves the sequencing of more species to include the pathogens that devastate the barley, pea, chickpea, lentil and faba bean crops," he said.

"We want to see if mesosynty has contributed to the pre-eminence of the Dothideomycetes fungal pathogens, and if can we find tools to enable breeders to select resistant crops."

Professor Oliver's research was funded by the Australian Grains Research and Development Corporation.

Source: Andrea Barnard, Public Relations, Curtin



Agriculture, the research identified these fungi evolve faster and more dramatically than previously thought possible.

Professor Oliver said the research was conducted via a simple approach involving the comparison of genomes (all genes) of one species of fungus against others.

"We drew a chart known as a dot plot. Dot plots compare one genome on the x-axis with another on the y-axis; where DNA sequences are very similar, we place a dot," Professor Oliver said.

"We would normally expect to see a diagonal line showing decay over evolutionary time. Instead, we saw dots in boxes."

Professor Oliver said these results indicated a novel form of evolution,

includes the most damaging pathogens on all major crops in Australia."

Professor Oliver said the results demonstrated that the threat from rapidly evolving and mutating pathogens was ongoing.

"We normally think of these processes occurring on timescales measured in millions of years but we have clear evidence that new species of pathogens have evolved in the last 100 years," he said.

"We can see that these pathogens overcome new resistance genes and fungicides in two to five years, and even see evolution occurring during the course of a growing season lasting only a few months.

# MARINE SCIENCE

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THIS ARTICLE FIRST APPEARED IN THE JAN/FEB 2011 EDITION OF WESTERN FISHERIES MAGAZINE, PUBLISHED BY THE DEPARTMENT OF FISHERIES.

**When I tell people at parties that I listen to fish spawning for a living, I do get some funny looks.**

There has already been significant Western Australian research carried out in the recording of sounds made by spawning mulloway to learn more about their abundance and behaviour. **Ben Carlish of the Department of Fisheries** spoke to Curtin University marine scientist Dr Miles Parsons about his preparations to expand on that research and find out if species like pink snapper and dhufish produce noises when spawning.

scientist. And he cops more raised-eyebrows from boaties who pass by his research vessel out on the Swan River on certain nights in the summer, confronted with the spectacle of a guy with his face eerily illuminated by a console, sitting in a stationary boat sporting a pair of 'old skool' earphones, apparently doing nothing but listening intently.

can identify the grounds that the species are using to spawn," explained Dr Parsons.

"So if fishers say there's a lot of fish of a particular species that turn up in a specific area, we can record the sounds there and confirm they're using it as a spawning ground, so maybe we should be monitoring, managing or protecting this area."

Dr Parsons worked with former Department of Fisheries scientist Mike Mackie and a team on some research back in 2005 looking at, or rather listening to, the noises fish make to build a better understanding of their behaviour – specifically when spawning. The pioneering work, funded by the Fisheries Research and Development Corporation (FRDC), initially focused on mulloway spawning in the Mosman Bay area of the Swan River.

Now, Dr Parsons is developing the initial research methodology for the next phase of the project, also FRDC funded, in collaboration with the Department of Fisheries. This will look at mulloway in a number of other key areas around the State, but also seeing if fish like pink snapper and the enigmatic Western Australian dhufish make noises and, if so, what can be learned about where, how and when they spawn as a result.

"We don't know that much about dhufish, including when and where they spawn," said Dr Parsons. But if we can find out if they do vocalise when they spawn – and there's evidence to suggest there's every possibility they do – then it could lead to another method to find out what they're doing, how they're spawning and ultimately to potentially help monitor the dhufish spawning population."

But let's rewind the tape for a minute – for many people it might seem surprising that fish can actually communicate by making noises; a common perception is they swim around, mouths gaping dumbly. But fish don't communicate with their mouths – at least not using vocal cords – and their means of detecting sound waves are via internal biomechanisms that pick up sound vibrations through the water. They do possess ears of a sort, but they are located inside liquid-filled cavities in their head. In these cavities are small bone-

Swan song – Curtin University marine scientist Dr Miles Parsons prepares to deploy a hydrophone in Mosman Bay to record a chorus of spawning mulloway. Photo: Frank Thomas



By his own admission, while Curtin University's Dr Miles Parsons admits his job may involve listening intently to melodic noises, it certainly ain't rock 'n' roll.

"When I tell people at parties that I listen to fish spawning for a living, I do get some funny looks," says the marine

On the surface of it, listening in on spawning fish does seem a somewhat odd thing to do, but it can and does provide some vital clues about how, when and where certain species spawn. In turn, this information can help fisheries managers ensure fish populations remain sustainable.

"Once you can identify a species using its call for spawning purposes then you



**Dr Parsons said that in quiet conditions it's possible to hear mulloway calling from as far as 500 metres away.**

like structures called 'otoliths' – one part of the system involved in balance, sound perception and even depth perception, similar to the inner ear system of mammals. Fish also sense vibrations along their flanks, under which a series of tiny sensory cells called 'neuromasts' are located. These are contained within a mucus-filled passage called the lateral line. Small perforations in scales allow small vibrations to penetrate the fish's lateral line, which in turn is 'hardwired' into nerve-endings that send direct messages to the brain.

Fish produce noise or 'vocalise' using three main techniques. One is by rubbing certain bones together in the body, rather like a cricket does with its legs. Fish using this technique, referred to as 'stridulation', often use their jaws to gnash their teeth together to make a noise. Most fishers will be familiar with the small grunting like sound blowies (toadfish) make when caught – this is caused by stridulation and is thought to be a warning sound to rival males or would-be predators.

Some fish, like mulloway, can produce a low frequency drumming or throbbing sound by pulsating their sonic muscle against their swim bladder. There is an incredible array of noises fish can produce using this method – for example the humble haddock, commonly found in cold Northern Hemisphere waters, is something of a Julio Iglesias among fish, serenading potential female mates with an impressive repertoire of calls.

Other fish produce sound 'hydrodynamically' as they travel through the water and change direction rapidly. These noises may provide information on feeding opportunities. For example, large schools of fish such as jacks or ladyfish will feed voraciously when they locate an abundance of prey. During these feeding frenzies, rapid changes in their swimming speed produce low frequency hydrodynamic sounds that may attract other fish to the area. The downside is that such noises may also attract predators, such as sharks. Researchers believe that sharks are attracted to low frequency, pulsating sounds. These sounds can be generated by schooling fish being attacked breaking the surface and other sharks that are actively feeding, as well as wounded or struggling fish. But even if there is all this communication going on down in the depths, why should we, or more specifically, Dr Parsons, listen in?

"We're looking at expanding on what we've done before especially in this area for mulloway, which we know are a very vocal fish," said Dr Parsons. "We want to develop the technique a bit further – to a level where it could contribute towards estimating the number of fish in a spawning aggregation. This could be used to supplement data from other more 'traditional' sources, including catches, catch rates and so on."

The technique Dr Parsons is referring to is dropping underwater microphones called 'hydrophones' into an area where vocalising species of fish are suspected to be spawning. Hydrophone operators are able to listen in on the fish to ensure they are in the right spot and the corresponding recordings can then be analysed back on land. With the right expertise, a lot of important information in relation to the composition and behaviour of the fish's spawning populations can be 'read' from these recordings.

"What you are doing is using an underwater microphone to record the fish noises. You then start to look at the volume and frequency of those noises to work out how many fish there are," explained Dr Parsons. "And in terms of being able to locate other aggregations of spawning fish, you can deploy hydrophones in other similar locations with the right physical and/or environmental characteristics to see if there are spawning aggregations there."

For Dr Parsons this kind of research is a happy marriage of his previous background as an engineer post-graduate with a passion for marine science. Dr Parsons had been working in Western Australia for a couple of years on a sponsored engineering placement when he did a dive master course in Coral Bay and discovered his true vocation, leading to a PhD in Marine Biology. So with a strong technical background and a passion for marine biology, he is well equipped to develop this method, with much of his initial work revolving around mulloway. Mulloway constitute an excellent target species for Dr Parsons, principally because they are so vocal and because of the locations they spawn in.

"Mulloway is a good model for us to use," affirmed Dr Parsons. "It's an ideal situation for us to work out the extent of what we can use 'passive acoustics' for. In the Swan River you've got a very vocal fish, they move in small numbers and I've counted up to 15 individual fish calling at one time in quiet periods of the evening,

and then more and more fish come in – until it becomes a dense chorus.

"Their spawning also takes place in what are effectively waters protected from the elements. So you don't have the problems of ambient noise you have in open water, such as from wind-driven waves. The downside you have in the Swan River, though, is all the vessel traffic – on the other hand, you can listen to the amount of human noise that is being made and begin to evaluate if that impacts on the fish and their calling."

Dr Parsons said that in quiet conditions it's possible to hear mulloway calling from as far as 500 metres away. This is in part due to the sound-conducting quality of water but also due to the advances made in hydrophone technology over the years, which have also added to how much information they can store.

"In the last 10 years or so, we have been able to develop these underwater 'noise loggers' that can record near-continuously. You can throw them overboard and leave them on the sea floor or have them floating or hovering mid-water and they will record remotely for up to several months, even years depending on the size of the batteries you put in.

"What that means is that you can monitor changes in noise levels for however long you want," explained Dr Parsons. "So you can work out when the peak time of spawning is for mulloway by the noise levels – and you can begin to associate those noise levels with environmental drivers behind spawning."

This can give some insight as to how much noise levels generated by humans are impacting on fish as well. There are theories that light pollution from street lamps and so on has impacted on tailor catches along metropolitan beaches, but noise as an environmental factor has rarely been considered, if at all. But it's certainly a factor that Dr Parsons is compelled to take into consideration.

"If a fish is making a sound at a certain intensity then that's going to have an associated range at which a female is able to receive that sound," he said.

**Dr Parsons' enthusiasm for this quest and the technique generally is tempered with a healthy amount of realism and scientific detachment.**

"If you've then got a boat going past making a noise of its own, or you've got increased ambient sound, then the range the female is able to discern that male is reduced, so we can start to evaluate what sort of effect it's having. It comes down to how much we are reducing the range that they can hear each other by."

This ability to pinpoint individual fish making noises allows Dr Parsons to be very precise in identifying fish movement and behaviour. This has led to some 'imaginative' presentations by Dr

Back on a more serious note, Dr Parsons explained monitoring the noise fish make has a distinct advantage as a method of understanding more about their breeding behaviour and their numbers over some other research methods.

"It's non-intrusive and non-destructive, so you don't have to affect the behaviour of the fish and you don't have to sample them by pulling them out of the water in order to tag and release, to monitor where a fish is caught again or by using an acoustic tag.

"The reports say there are chemicals in their system that suggest the muscles they have attached to their swim bladder are super fast-twitch muscles. This means they can potentially vibrate their swim bladders very, very quickly, generally a pre-cursor for producing sound in this way. If that species can produce sounds, it could well apply to Western Australian dhufish for all intents and purposes. But it's going to be hard to get to the bottom of, because they are a very shy species of fish."

What makes it even more challenging for Dr Parsons is that we don't really know how dhufish behave when they spawn – there appears to be little knowledge of where and to what extent they do aggregate.

"No one really knows how they're spawning," said Dr Parsons. "Mike Mackie [formerly with the Department of Fisheries] did a fair bit of work in this area and there was the suggestion of a male with a harem of females and possibly a juvenile male there as well, but he wasn't able to work out their definitive spawning behaviour."

Dr Parsons' enthusiasm for this quest and the technique generally is tempered with a healthy amount of realism and scientific detachment.

"It's not a 'silver bullet,' for fisheries research," he admitted. "In WA, we need to take a look at the stock status and behaviour of certain species by adopting a suite of techniques, but in the right circumstances this is certainly one of them. And with more and more species being reported as producing sound, and with us discovering more and more of them as we go along, it's all the more relevant."

So Dr Parsons could be making some big noises with fish sounds in the not-too distant future.



Parsons at conferences on the subject.

"I went through a period where I localised fish and decided I was going to name each fish after a singer," recalled Dr Parsons wryly. "So when I was presenting a paper at a conference where I had all of these locations of individual fish I named them Elvis and Frank – I think I put one down as John Farnham just to keep everyone happy."

And you certainly can't accuse Dr Parsons of being a stuffy, dry scientist given some of his ideas in making the subject even quirkier than it already is.

"One day I'd love to make a chorus of jingle bells using mulloway calls just to see the reaction of people at conferences," he chuckled mischievously. "It would be even better playing it back to the fish to see what they make of it."

"However some species such as Western Australian dhufish, mulloway and black jewfish are particularly susceptible to barotrauma [damage to the fish's internal organs caused by rapid changes in water pressure] and handling stress. So it's an advantage not to have to bring out or pull up individual fish."

As alluded to by Dr Parsons, this would make the method a potential complimentary way to monitor Western Australian dhufish and their spawning behaviour, of which we know very little about. There's obviously a big 'if' here though – that is, *if* they produce spawning noises in the first place.

But Dr Parsons says there is sufficient evidence to suggest this could be the case.

"Glaucosomatids [the family of fish that dhufish is part of] have been studied in a few places. Researchers have tried to work out if one of the species in Taiwan produce sound," said Dr Parsons.

**A survey into the identification of many invertebrate animals on Barrow Island has seen Curtin entomologists' work celebrated by having a number of species named after them.**

### **Curtin scientists immortalised in the names of local animals**

A survey into the identification of many invertebrate animals on Barrow Island has seen Curtin entomologists' work celebrated by having a number of species named after them.

Commissioned by Chevron Australia as part of its preparation for the Gorgon Project's environmental approval, the study funded Curtin and 25 taxonomists from around the world to spend a number of years surveying and identifying native invertebrates.

outstanding example of the co-existence of industry on a nature reserve.

"Using various entomological tools and techniques, our team managed to obtain species names for 20 percent of the revealed 2067 species of land-living invertebrates found on the Island, and the number is still growing," Professor Majer said.

"Taxonomists have now commenced describing these new species, meaning that measurements are made, descriptions are recorded, and the finished product is published in a peer-

Professor Majer said Barrow Island was very unique in that it represents a piece of the Australian ecosystem that had been largely uninhabited and isolated for several thousand years.

"There are no introduced herbivores or predators, such as house mice, rabbits and foxes to disrupt the ecology surviving there. There are also minimal weeds growing on the Island," he said.

Professor Majer said his team would continue to monitor the Island two-three times per year to conduct baseline surveys in order to ensure no further non-Indigenous species were introduced.

### **About the Gorgon Project and Barrow Island's values**

The Gorgon Project is operated by an Australian subsidiary of Chevron and is a joint venture of the Australian subsidiaries of Chevron (approximately 47 percent), ExxonMobil (25 percent) and Shell (25 percent), Osaka Gas (1.25 percent), Tokyo Gas (one percent) and Chubu Electric Power (0.417 percent).

The Gorgon Project will develop the Greater Gorgon Area gas fields, located about 130 kilometres off the north-west coast of Western Australia.

It includes the construction of a 15 million tonne per annum (MTPA) Liquefied Natural Gas (LNG) plant on Barrow Island and a domestic gas plant with the capacity to provide 300 terajoules per day to supply gas to Western Australia.

Effective quarantine management is at the core of the Gorgon Project's commitment to safeguarding Barrow Island's conservation values.

After 40 years of oil operations on the island and the production of more than 300 million barrels of oil, the island's full suite of native species remains intact.



Curtin invertebrate conservationist and Project Team Leader, Professor Jonathan Majer, said over 2000 terrestrial invertebrate species were found on the Island, with up to 70 percent of discoveries being completely new to science.

Barrow Island, located about 90 kilometres north-west of Onslow on the North West Shelf, is Western Australia's second largest island, approximately 25 kilometres long by 10 kilometres wide and totalling 23,400 hectares.

The island has been home to Australia's largest and oldest onshore oilfield on Barrow Island for the past 45 years and is now the location for the Gorgon Project. Barrow Island has also been recognised internationally as an

reviewed scientific article.

"Much to our surprise, members of the team have had species from the Island named after them. In two cases, the genus itself bears the name of the Curtin researcher."

Professor Majer, who has a long list of insects named after him, added a new thrips genus, *Majerthrips barrowi*, to his list and said it was a rare privilege for his team, including Dr Nihara Gunawardene, who had her own plant bug (Homoptera) christened *Gunawardenea linnaei*.

"Finding new species is relatively common but discovering a new genus is quite special and most certainly an honour to have one named after you, as in Dr Gunawardene's case."

Source: Andrea Barnard, Public Relations, Curtin



# AUSTRALIA-ASIA-PACIFIC INSTITUTE

PAGE 8 (FURTHER INFORMATION AND CONTACTS [HTTP://AAPI.CURTIN.EDU.AU](http://aapi.curtin.edu.au))

## The Australia-Asia-Pacific-Institute (AAPI) is a Curtin research institute in the Faculty of Humanities established in July 2011.

It is a continuation of the Centre for Advanced Studies in Australia, Asia and Pacific (CASAAP) established in 2006. AAPI members are drawn from a wide range of disciplines and intellectual orientations and seek to foster closer links between Australian, Asian and Pacific studies.

The Institute's values and research



practices stem from the broad research traditions of the Humanities and the Social Sciences, valuing collegiality, critical analysis, intellectual engagement and the communication of knowledge throughout the academy and beyond.

## Research

The Institute has three main areas of research:

- social-cultural, economic, political and environmental change and development in Australia, Asia and the Southwest Pacific;
- Asian, Southwest Pacific and related ethnic communities within Australia and the region, and
- changing relations between Australia, Asia and the Southwest Pacific.

To progress these activities the Institute has three major research foci within which are pursued a number of cognate themes. Members of the Institute are mostly involved in two, sometimes three of these

research themes, providing for collaborative cross-disciplinary outcomes. Each of the themes is under continual review, while the research foci are reviewed regularly to ensure ongoing relevance, to allow for emerging and innovative research developments and to accommodate membership changes.

## Cultural Identities

- National identity/ies
- Gender and sexuality
- Class formations
- Race and ethnicity
- Indigeneity, Colonialism/Post-colonialism

- Literature Language and Media

## Regional Transformations

- Heritage
- Tourism
- Regional development
- Health
- Social and cultural policy
- Sustainable environments
- Natural Resource Management and sustainable livelihoods

## International and Interregional Relations

- Terrorism and fundamentalism
- Refugees, asylum seekers, immigration
- War and peace, memorialisation
- Transnational political and social movements
- Human rights
- Government and political systems
- Global environmental change

## Activities

Institute members publish nationally and internationally in the peer reviewed journals of their fields and with major national and international academic presses. The Institute also publishes its own research monographs through the series 'Studies in Australia, Asia and the Pacific'.

## Researcher Development

AAPI has a multi-faceted approach to research training that aims to stimulate a cooperative research environment within which members may further develop their research interests and also identify potential research partners within the group. Related initiatives and activities include:

- Program of development funding for grant applications, publications and targeted conference contributions and associated outcomes
- Ongoing workshop series relating to publication, grant-getting skills, research project management, etc.
- Mentoring at all career levels
- 'Hot groups' (small-medium groups including both ACR/s and ECR/MCRs with focus on a specific research outcome)
- Seminar program of AAPI and visitors
- Associate membership program for Early Career Researchers

AAPI also organises and co-sponsors state, national and international conferences and seminars.

## Researcher Partners and Networks

AAPI researchers and research groups have many existing collaborations with government, industry, academia, cultural institutions and many communities within Australia, Asia and the Pacific. Many Institute researchers hold nationally and internationally competitive grants from such organisations as the Australian Research Council and the World Bank and are also associated with ARC Networks, CRCs and related research entities.



**Curtin University bio-energy researcher, Professor Chun-Zhu Li, has been awarded a \$50,000 Commercialisation Australia Skills and Knowledge Grant to develop a business model for Curtin's state-of-the-art low-rank fuel gasification technology.**

### **Curtin researcher awarded commercialisation grant**

Curtin University bio-energy researcher, Professor Chun-Zhu Li, has been awarded a \$50,000 Commercialisation Australia Skills and Knowledge Grant to develop a business model for Curtin's state-of-the-art low-rank fuel gasification technology.

The 2010 Curtin Commercial Innovation Award winner and Director of Curtin's Fuels and Energy Technology Institute (FETI), Professor Li, has led a team of researchers to develop the technology which converts biomass and/or brown coal into clean combustible gaseous fuels that can be used to generate base-load electricity, with funding from the Australian Government as part of the Asia-Pacific Partnership on Clean Development and Climate.

Professor Li said the innovative gasification technology could efficiently deliver green base-load power, helping energy generators to meet renewable energy targets, especially in distributed power generation.

"A pilot-scale gasifier, processing at a rate of 4 kilograms per hour, has been operating and demonstrating the technology successfully at FETI. We are now working toward the construction of a larger demonstration plant at Curtin with a fuel feedstock throughput of 100 kilograms per hour," Professor Li said.

"A critical part of this Skills and Knowledge Grant expenditure will be used to find a commercial partner, such as a feedstock provider, power generator. "We are excited by this opportunity as the grant from Commercialisation Australia provides us with the funding necessary to package this innovative technology into a structure attractive to investors and collaborators," Mr McDougall said.

Professor Li said his research was aimed at developing innovative, sustainable and economically viable solutions to the long-term need for renewable energy within Australia and beyond.

"This technology is cheaper than many other similar processes developed elsewhere in the world as gasification is carried out at relatively low temperature and at atmospheric pressure and does not need expensive high pressure vessels," he said.

or distribution company to help develop and commercialise the technology."

Curtin Director of IP Commercialisation, Rohan McDougall, said the grant would also support the building of a strong business case around the technology, comprising a product development plan, market analysis, intellectual property strategy, costing and pricing modelling and sales forecasts in order to help secure commercialisation partners.

Professor Li said Western Australia could potentially produce 10 million tonnes of dry mallee biomass annually, which could equal one gigawatt electricity capacity.

The Commercialisation Australia Skills and Knowledge Grant was secured with the help of Curtin IP Commercialisation specialists Rohan McDougall and Kelly Clarke.

### **Margaret River leads the way on environmental protection**

Curtin University and Winewatch have recently secured \$300,000 funding from the Australian Government's Caring for our Country program to provide further support to the wine industry.

The funds will be used to continue assistance to the Margaret River wine industry to secure membership of Entwine Australia, the wine industry's national environmental assurance scheme.

Curtin's Head of Department of Environment and Agriculture, Professor Mark Gibberd, said the high level of local engagement in the scheme to date demonstrates the considerable value much of the wine industry place on their local environment.

"The Margaret River area is well recognised for its high biodiversity and aesthetic values, its unique cave systems, magnificent coastline, and interesting and diverse landscape," Professor Gibberd said.

Winewatch Project Officer, Genevieve Hanran-Smith, said the funding would enable Winewatch to assist companies to meet the requirements of environmental certification.

"Over the last 18 months we have funded preparation of nearly 70 biodiversity protection plans, fencing and re-vegetation. "The reputation and appeal of Margaret River wine rests in part on these values and it is in the wine industry's best interest to ensure that the environment is protected."

Winewatch Project Officer, Genevieve Hanran-Smith, said the funding would enable Winewatch to assist companies to meet the requirements of environmental certification.

Since the scheme's launch in December 2009, 11 wineries and 67 vineyards in the Margaret River wine region have demonstrated their commitment to protecting the environment by completing the training required to achieve Entwine membership.

Thirty of these have achieved environmental certification following an independent third party audit, and it is envisaged that most of the remaining 48 enterprises will progress to certification over the next twelve months.

The next round of environmental certification training is scheduled for July and anyone interested in attending or knowing more about the scheme should contact Genevieve Hanran-Smith at [genevieve.ccg@westnet.com.au](mailto:genevieve.ccg@westnet.com.au)

The Margaret River Education Campus is located 280 km south of Perth in Western Australia's premium grape growing region. The Campus is a joint initiative of the Margaret River Senior High School, Department of Training and Workforce Development, South West Regional College of TAFE, Curtin University and Edith Cowan University.

Within the Campus, Curtin is the lead partner in the Centre for Wine Excellence, which comprises a teaching winery, chemistry laboratories, sensory evaluation and research laboratories, classrooms and resource centre. This pivotal location allows Muresk Institute's viticulture and oenology students to access leading vineyards and wineries to complement their theoretical studies.

Source: Andrea Barnard, Public Relations, Curtin

### Comment from Peter Newman, Professor of Sustainability, Curtin University on Perth's new Public Transport Plan.

I am delighted to see a Public Transport Plan for Perth. This is the first time we have had a strategic plan for public transport. Up until now most major public transport initiatives were achieved through political intervention. This at least led to a rail revival that is internationally recognised and the astonishing growth in the rail system from 9.7 to 54.7 million passengers in 20 years.

However it is better to have a plan. Is this plan going to be enough for Perth's future growth?



It is a dramatic step forward to commit our city to a light rail system. There is a global light rail revolution occurring and we are likely to be well behind other Australian cities like Adelaide, Melbourne, Sydney and Gold Coast who are actually building new light rail (mostly funded through Infrastructure Australia).

The 'wishbone' light rail proposed is a fantastic concept to get light rail going in Perth. Now we need the 'wish' to be fulfilled by a Master Plan that contains a financing mechanism including IA funds, state funds and private funds from land development opportunities.

This needs to be done quickly as IA still do not have a proposal from WA on public transport.

Other parts of the city that have significant urban development plans like Stirling and Cockburn Coast could be part of this submission if they are able to raise the local funds from a land value capture mechanism. Calling for expressions of interest in being part of an IA submission for light rail-based urban development, should be done to 'prove' to Treasury that such potential financing exists.

There is one fundamental flaw in the Public Transport Plan. The Plan makes some bold predictions for public transport growth that are significantly less than the trends we are now seeing. 8% growth is happening and 3.85% growth is predicted.

The massive growth being experienced in Perth's public transport may continue and not drop as suggested. The growth has taken the planners by surprise but it shouldn't as it seems to be related to rising fuel prices that are now seen to be as continuing for the next 20 years. It is also related to the city's changing growth patterns which are now coming back in at a faster rate as people want to live closer to jobs and services. And the cultural change of Gen Y who like public transport more than us baby boomers. I see no reduction in these trends, only an acceleration. So we may continue to grow rapidly in public transport, even faster than predicted.

This Plan does not fully deal with this contingency. It does start light rail and it does have a ten year bus purchase plan but it has NO ten year rail car purchase plan. Why does rail car purchasing remain subject to political intervention only (like the recent embarrassing revelations of empty rail cars while people were unable to use present services provoking the most recent rail car contract). Surely the purpose of a Public Transport Plan is to establish a mainstream process for expansion. Yet the crown jewels of the transit system over the past 20

years still has no mainstream plan for its simple rail car expansion.

### ASDI's sponsors Ross Garnaut event on 3 June

In November 2010, Ross Garnaut was commissioned to provide an update to the 2008 Climate Change Review for the Australian Government and community. Since then, the Garnaut Climate Change Review—Update 2011 has released a series of papers addressing developments across a range of areas including climate change science and impacts, international mitigation progress, land, carbon pricing, innovation and the electricity sector.

Professor Garnaut addressed an audience of 400. The event was sponsored by ASDI, JCIPP and SEA, on the key findings of his update and present his recommendations for action on climate change in the national interest.



Mr Tony Tate, Director Research and Development, Curtin University with Professor Ross Garnaut



**Curtin University PhD student, Christiane Vitzthum von Eckstaedt, has developed a technology to distinguish sources of major pollutants in the environment, known as volatile organic compounds (VOCs), including emissions.**

## **Curtin PhD student to reduce carbon footprint one step at a time**

Curtin University PhD student, Christiane Vitzthum von Eckstaedt, has developed a technology to distinguish sources of major pollutants in the environment, known as volatile organic compounds (VOCs), including emissions.

Under the guidance of Professor Kliti Grice, Director of Curtin's WA Centre for Organic and Isotope Geochemistry, international student and CRC for Containment Assessment and Remediation of the Environment scholarship recipient, Mrs Vitzthum von Eckstaedt, said the findings would be used to further develop tracing of VOCs back to their original source(s).

Mrs Vitzthum von Eckstaedt said her research involved chemically identifying and analysing compounds via stable isotope analysis in complex mixtures, allowing scientists to potentially distinguish between the origins of VOCs.

"By understanding and tracing these sources, we can further understand the processes, such as controlled burnings for fire prone areas and car exhaust emissions, to significantly reduce their impact on the environment and our health," Ms Vitzthum von Eckstaedt said.

"This research will also help to assist prevention of environmental impacts and will allow us to take action on our carbon footprint."

Mrs Vitzthum von Eckstaedt said the method and development for her research was extensive and provided enormous potential.

"When you relate the source of the compounds, you can learn more about the fate of VOCs which is where we will be putting our efforts for the next step of this research," she said.

"Once we achieve this step, we can apply the tracing of sources to a range of environmental VOCs."

The study authors have three papers under review in the international *Journal of Environmental Science and Technology*, *Journal of Chromatography A* and *Atmospheric Environment*.

## **Curtin researchers map the North Kimberley to reduce carbon emissions**

Curtin University researchers have begun mapping the structural vegetation, fire history and habitats of the northern Kimberley as part of the North Kimberley Fire Abatement Project (NKFAP).

The project, which aims to achieve positive social and ecological benefits, as well as reduced greenhouse gas emissions for the area, is funded by the Department of Environment and Conservation (DEC), Kimberley Land Council (KLC) and The Nature Conservancy.

Project Leader, Professor Laco Mucina and Research Assistant, Glen Daniel, of Curtin's Vegetation Survey and Mapping group, are helping to gather data to identify potential fire fuel loads (biomass) and sources of greenhouse gas emissions.

Professor Mucina said conservation of the environment and culture in the Kimberley through the application of an improved fire management program was a big priority for governments, traditional owners and the broader community.

The mapping project was essential to providing a better understanding of the vegetation and fuel types present on the land in order to implement the new fire program, and to monitor the impacts on the environment.

"Early European colonisation and disruption of traditional fire management practices has resulted in a shift from cool and patchy early dry season burning to larger and more destructive fires," Professor Mucina said.

"The intense late season fires that are typical of the modern fire regime consume more fuel and leave fewer unburnt refuges than milder fires do."

"This has harmful effects on biodiversity and cultural sites and results in the release of more greenhouse gas than would be the case under a milder fire regime."

Professor Mucina said knowledge of fire history, vegetation structure and biomass distribution was essential in understanding the potential for release of emissions and subsequent fire management in the north Kimberley.

"Mapping of fine scale habitat types is therefore important for monitoring changes that may have occurred with altered burning regimes, particularly for fire sensitive habitats such as rainforest," he said.

"Our mapping will use a combination of satellite imagery analysis and fieldwork with field data collected collaboratively by the vegetation mapping team that includes staff from the DEC and KLC and traditional owners."

Professor Mucina said the mapping process would be completed by mid 2012. He said the map would show vegetation structure, revealing the horizontal and vertical distribution of biomass within the vegetation.

"Structure includes consideration of the number of layers of vegetation that are present and the height and density of each layer," he said.

"This structural information will be supplemented by information about the composition of the vegetation (dominant species) and its appearance or physiognomy (dominant growth forms)."

The NKFAP will also compile a 10-year fire history of the mapping area, developed using satellite imagery. The fire history will be partially validated using data collected by traditional owners as part of field exercise to assess fuel loads across the region.

The basis of NKFAP is the sale of credits for greenhouse gas abatement that results from the regime of large, destructive fires being reverted to one of smaller, milder fires. The income generated by the sale of credits will be used by land managers and traditional owners to employ rangers to undertake the required burning in a culturally and environmentally sensitive manner.

Source: Andrea Barnard, Public Relations, Curtin

# WA-ORGANIC ISOTOPE GEOCHEMISTRY CENTRE

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### Curtin PhD candidate receives award

Anais Pages has received an award for best overall presentation in Isotope category (early career < 5 years since PhD) at the 11th Australasian Environmental Isotope Conference and 4th Australasian Hydrogeology Research Conference in Cairns in July. The prize was sponsored by AMS, Cairns. Anais' talk was titled, Hydrolysis of extant microbial mats, corals, sponges and jelly fish to yield biomarkers preserved in the rock record.



Researchers at Curtin University from WA-OIGC (including PhD student Anais Pages, Prof Kliti Grice and Dr Robert Lockhart) have been investigating the use of innovative hydro(Hy)pyrolysis to generate molecular fossils (biomarkers) derived from biolipids from a modern layered smooth mat collected from Shark Bay on a recent field trip, Western Australia (together with Prof. Lindsay Collins and Ricardo Jorge Jahnert, Department of Applied Geology). Samples from the rock record have also been analysed by WA-OIGC. The biomarker and stable carbon isotope data generated from the smooth mat support the presence of a consortium of sulfate reducing bacteria also found in samples of varying geological ages (billion to several hundreds of millions of years in age).

### PhD Completions

Christiane Eiserbeck PhD thesis is entitled- Molecular and Isotope Chronostratigraphy of Tertiary Source Rocks and Crude Oils.

Eiserbeck, C.; Nelson, R.K.; Grice, K.; Curiale, J; Reddy, C.M., Raiteri P., Separation of 18 $\alpha$ (H)-, 18 $\beta$ (H)-oleanane and lupane by comprehensive two-dimensional gas chromatography. *Journal of Chromatography A*, in press (2011). Excellence Research Australia (ERA) A\* rated publication.

Eiserbeck, C.; Nelson, R.K.; Grice, K.;

analysing  $\delta$ D and  $\delta$ 13C of atmospheric VOCs by thermal desorption-compound specific isotope analysis. In Press. *Journal of Chromatography A*. ERA A\*.

Vitzthum von Eckstaedt C., Grice K., Ioppolo-Armanios M., and Jones M., 2011,  $\delta$ 13C and  $\delta$ D of volatile organic compounds in an alumina industry stack emission. In Press. *Atmospheric Environment*. ERA A.

Vitzthum von Eckstaedt C., Grice K., Ioppolo-Armanios M., Kelly D., and Jones M., 2011, Source comparison of  $\delta$ 13C and  $\delta$ D values of VOCs by compound specific isotope analysis. Accepted subject to changes. *Environmental Science & Technology*. ERA A\*.

### PhD Project Available

A 3 year PhD project is available from Jan 2012. **Entitled – Biomarkers and stable isotopes in cherts spanning the greatest extinction event (Permian/Triassic) and its subsequent recovery.** The project is open to national applicants holding CUPS or APA or full international scholarship. The project will involve a combination of organic geochemical techniques including GC–MS, GC–IRMS, LC–MS, PY–GCMS. Please also see our website for additional information. Contact [K.Grice@curtin.edu.au](mailto:K.Grice@curtin.edu.au)

### Sundowner

A Sundowner for the WA-OIGC and Curtin Water Quality Research Centre was held on 20th June.

A lecture given by Professor Roger Summons (MIT, US) followed by presentations by CWQRC and WA-OIGC staff and students followed by drinks. The event was well attended and was opened by Chief Scientist of WA Prof. Lyn Beazley.

### Invited Keynotes

2011 K. Grice Invited keynote Exploring mass extinction events (Triassic/Jurassic & Permian/Triassic): Association with global warming events. 13th Conference on Australasian Vertebrate Evolution Palaeontology and Systematics Perth 2011.

2011 K. Grice Invited keynote Exploring mass extinction events: Association with global warming events 11th Australasian Environmental Isotope Conference & 3rd Australasian Hydrogeology Research Conference 12-14 July Cairns,

Curiale, J; Reddy, C.M. Robust study of applications and comparison of sophisticated chromatographic techniques including GC X GC for characterising higher plant biomarkers in Tertiary oils and sediments. *Geochimica et Cosmochimica Acta* (2011). Submitted. Excellence Research Australia (ERA) A\* rated publication.

Eiserbeck, C.; Grice, K.; Curiale, J. Proliferation of angiosperms reveal the age of oil within 10 million years. *Geology* (2011). Excellence Research Australia (ERA) A\* rated publication.

Christiane Desiree Vitzthum von Eckstaedt PhD thesis is entitled Sourcing volatile organics in emissions by compound specific isotope analysis.

Vitzthum von Eckstaedt C., Grice K., Ioppolo-Armanios M., Chidlow G., and Jones M., 2011, Method development for



# FRIENDS OF THE ENVIRONMENT (FOTE)

PAGE 13 ([HTTP://FOTE.ORG.AU/PAGE/WELCOME-TO-FRIENDS-OF-THE-ENVIRONMENT.ASPX](http://fote.org.au/page/welcome-to-friends-of-the-environment.aspx))

## The FOTE forum on industry and innovation

The FOTE Forum on Industry and Innovation was an inspiring event made possible by the generous sponsorship from the Perth Airport and the support of Kobi Bradshaw.

Representatives from industry, educational institutions and environmental groups attended and all were inspired by the event and the people they met. John Cugley of Kimberley Toad Busters travelled from

sustainable development. He said it was a timely message, because as News of the World had recently discovered, "companies seeking approvals need a 'social licence to operate', beyond merely legal requirements."

He said there are also recruitment advantages since younger people want to work for companies where they like the values, especially the environmental values.

According to Mr Ripper, business will play a critical role in reducing carbon

manager of Earth Assist at Conservation Volunteers Australia, showcased this outstanding community service initiative and gave statistics to demonstrate what can be done in partnership with industry.

Dr Peter Cock, Chief Operating Officer with the Perth Airport, delivered an overview of the work being undertaken that is establishing the Corporation as a leader in environmental sustainability. Marion Stoker of Maida Vale Primary School contributed some history and background to the growth of schools involvement in the project.

On conclusion of the Forum, Kobi Bradshaw lead a tour of the Kwenda Marlark wetlands. This was another opportunity to network while we walked in the sunshine and took in the splendour and challenges of this constructed wetland.

The next Forum is to be held on 23 October 2011, hosted by DEC EcoEducation in Mundaring.

To be part of the next event or for more information about FOTE, contact Diane Smith, FOTE Executive officer on [foteteam@gmail.com](mailto:foteteam@gmail.com) or 0467 467 456.

FOTE is a not-for-profit multidisciplinary organisation dedicated to supporting the teaching of environmental, cultural and



social sustainability. FOTE began in 2005 to supply an opportunity for teachers to network with other environmentally minded educators. The result is cross-pollination from science, heritage and industry that benefits the education of children across ever expanding and diverse geographic regions

Source: FOTE



**From left: Steve Gibellini, (FOTE Board member) with Prue Kraft (Curtin University student and FOTE marketing team leader), Hon. Eric Ripper, Shadow Premier and Charlie Thorn (Executive Director of the Australian Sustainable Development Institute**

the Kimberley to be part of the Forum.

A heart warming and thoughtful welcome to country was delivered by Richard Wilkes, Nyoongar elder of the indigenous community and member of the Perth Airport Aboriginal Steering Group. Dr Penny Atkins then addressed the Forum on behalf of Lyn Beazley, Chief Scientist of WA and esteemed Patron of FOTE.

The Hon. Eric Ripper presented an insightful introduction outlining the advantages for industry to engage in

emissions under Labor's plan. "Once a price of carbon is in the system, we will be relying as a society on the creativity and flexibility of businesses to deliver reductions in carbon emissions."

Charlie Thorn presented an overview of the work at the Australian Sustainability Development Institute. He drew our attention to some of the more concerning climate trends and research that was being carried out to address the issues. The audience was left with a desire to hear more from Charlie and the Institute he leads. We plan to arrange opportunities for this in the near future.

A scrumptious morning tea was the time for enthusiastic networking. This is often reported as being the most rewarding aspect of FOTE events.

The meeting resumed to hear from Trisha Comerford of RIO Tinto, who presented the range of environmental projects supported by the company, including Earth Assist. Noleen Philippe,

# EVENTS & BOARD MEMBERSHIP

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### Upcoming Events

Supporting material (iLectures, notes, etc) for the majority of the following events can be found at [www.asdi.org.au](http://www.asdi.org.au)



### 7 October—9 October Curtin Institute for Biodiversity & Climate (CIBC)

**Flourish Biodiversity Festival** in Margaret River—symposium and participant information  
[www.flourishmargaretriver.com/](http://www.flourishmargaretriver.com/)

“**Flourish** is so much more than just another environmental exhibition; it’s about living with nature, sustaining our magnificent natural landscapes and celebrating this unique region. The inaugural event extends over three days on the weekend of 7, 8 and 9 October 2011 and will include a symposium, exhibitors, entertainers, displays, educational activities, workshops, topical speaker sessions, interactive demonstrations, kid’s activities, the exclusive Under the Stars Dinner and much more.

**Flourish is THE place to find energy saving products, vegie and sustainable gardening information and tips, go night frogging, join wildflower photography workshops, try bush cooking classes, head out mountain biking and see the region as never before - Flourish will have something for every member of the family.**

### Board Changes

There have been some recent changes to the ASDI Board following the resignation of both Mr Malcolm McCusker QC and Mr John Akehurst.

Mr McCusker resigned following his appointment to the role of Governor of Western Australia.

ASDI thanks Malcolm for his commitment to ASDI as an inaugural Board member. We are pleased to announce that His Excellency Mr Malcolm McCusker, AO QC has accepted ASDI’s invitation to become the new Patron of ASDI in his role as Governor of WA, following

the departure of the previous Governor of Western Australia, Dr Ken Michael, whom we thank for his strong support of ASDI over its formative years.

Our gratitude is also extended to Mr John Akehurst for his valuable contribution to ASDI as an inaugural Board member.

We are pleased to welcome new external Board member, Ms Michelle Andrews, Deputy Director General, Strategic Policy at the Department of Mines and Petroleum and new internal Board member, Professor Duncan Bentley, Pro Vice-Chancellor, Curtin Business School.

### ASDI External Board

#### Mr Keith Spence (Chair)

Keith was most recently Executive Vice President Enterprise Capability for Woodside and was responsible for ensuring the business operated with the best people, technology and processes. He was also responsible for building a skilled and technologically advanced workforce through targeted recruiting and enhanced training and played a key role in representing Woodside’s interests to the government and the public. In addition, he was responsible for Woodside’s Western Australian gas supply interests.

#### Mr Barry Carbon, FTSE, AM

Mr Carbon’s experience includes: Chief Executive of the Ministry for the Environment, New Zealand; Director General-Queensland Department of Environment and Heritage; Director General-Queensland Environment Protection Agency, including Parks and Wildlife; Executive Director, EPA, Commonwealth of Australia; The Supervising Scientist,

Commonwealth Representative, National Environment Protection Council Committee and served on the Environment Protection Authority of Western Australia as Chairman from 1985 – 86 and as Chairman and Chief Executive from 1986-93.

#### Ms Michelle Andrews

Michelle Andrews has recently commenced as the Deputy Director General, Strategic Policy at the Department of Mines and Petroleum (DMP). Prior to the position she was the Executive Director of State Initiatives at the Department of State Development (DSD).

She has also contributed to the State Government’s approval process reforms, including establishing the new Office of the Environmental Protection Authority (EPA).

She has been involved in environmental approvals for major development projects, including the Gorgon project, Chevron’s Wheatstone project and the Oakajee Port and Rail project.

### ASDI Internal Board

**Professor Graeme Wright**, Acting Deputy Vice-Chancellor, Research and Development

**Professor Andris Stelbovics**, Pro Vice-Chancellor, Science and Engineering

**Professor Majella Franzmann**, Pro Vice-Chancellor, Humanities

**Professor Duncan Bentley**, Pro Vice-Chancellor, Curtin Business School



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# AFFILIATED INSTITUTES AND CENTRES

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## **Centre for Advanced Studies in Australia, Asia and the Pacific**

Professor Graham Seal  
Tel: +61 8 9266 3234  
Email: g.seal@curtin.edu.au  
research.humanities.curtin.edu.au/  
centres/casaap

## **Centre for Excellence in Cleaner Production**

A/Professor Michele Rosano  
Tel: +61 8 9266 4240  
Email: m.Rosano@curtin.edu.au  
cleanerproduction.curtin.edu.au

## **Centre for Marine Science and Technology**

Dr Kim Klaka  
Tel: +61 8 9266 7543  
Email: k.klaka@curtin.edu.au  
cmst.curtin.edu.au

## **Centre for Materials Research**

Professor Arie van Reissen  
Tel: +61 8 9266 7090  
Email: a.vanreissen@curtin.edu.au  
cmr.curtin.edu.au

## **Centre for Sport and Recreation Research**

Professor Marian Tye  
Tel: +61 8 9266 4844  
Email: m.tye@curtin.edu.au  
research.humanities.curtin.edu.au/  
centres

## **Fuels and Energy Technology Institute**

Professor Chun-Zhu Li  
Tel: +61 8 9266 1133  
Email: chun-zhu.li@curtin.edu.au  
energy.curtin.edu.au

## **Curtin Institute for Biodiversity and Climate**

Grant Wardell-Johnson  
Tel: +61 8 9266 3702  
Email: g.wardell-johnson@curtin.edu.au

## **Department of Agriculture and Environment**

A/Professor Mark Gibberd  
Tel: +61 8 9266 7907  
Email: m.gibberd@curtin.edu.au  
muresk.curtin.edu.au

## **Curtin University Sustainability Policy (CUSP) Institute**

Professor Peter Newman  
Tel: +61 8 9266 9032  
Email: p.newman@curtin.edu.au  
sustainability.curtin.edu.au

## **Curtin Water Quality Research Centre**

Associate Professor Jeffrey Charrois  
Tel: +61 8 9266 7267  
Email: j.charrois@curtin.edu.au  
cwqrc.curtin.edu.au

## **Digital Ecosystems and Business Intelligence Institute**

Professor Elizabeth Chang  
Tel: +61 8 9266 1235  
Email: elizabeth.chang@cbs.curtin.edu.au  
debii.curtin.edu.au

## **Food Science and Technology Program**

Professor Sue Fyfe  
Tel: +61 8 9266 7126  
Email: s.fyfe@curtin.edu.au  
publichealth.curtin.edu.au/programs/

## **Housing and Urban Research Institute of Western Australia**

Dr Steven Rowley  
Tel: +61 8 9266 7721  
Email: steven.rowley@cbs.curtin.edu.au  
huriwa.edu.au

## **John Curtin Institute of Public Policy**

Professor John Phillimore  
Tel: +61 8 9266 2849  
Email: j.phillimore@curtin.edu.au  
jcipp.curtin.edu.au

## **Research Centre for Stronger Communities**

Dr Amma Buckley  
Tel: +61 8 9266 3713  
Email: strongercommunities@curtin.edu.au  
strongercommunities.curtin.edu.au

## **WA Organic and Isotope Geochemistry Centre**

Professor Kliti Grice  
Tel: +61 8 9266 2474  
Email: k.grice@curtin.edu.au  
chemistry.curtin.edu.au/  
research/  
wa-oigc.cfm