

THE AUSTRALIAN RIVER RESTORATION CENTRE

RipRap



Celebrating
KATI THANDA-LAKE EYRE

OUR UNIQUE DESERT RIVER SYSTEM

EDITION 36, 2013

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THIS EDITION OF RIPRAP IS BROUGHT TO YOU BY:



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This edition of *RipRap* is dedicated to Laurie Stuart (Aaron's grandad passed way), Aunty Millie Warren and Ken Buzzacott who worked hard to achieve the Consent Determination for Kati Thanda–Lake Eyre.

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PHOTO: ANDREW TATNELL

Editorial

Firstly, WOW! This edition of *RipRap* has amazing articles featuring great people and places. It is a truly collaborative edition, with people sharing photographs, art and stories that celebrate the unique place that is Kati Thanda–Lake Eyre. Thank you to everyone who has helped me pull this edition together,

I have always wanted to produce a *RipRap* on this part of Australia and it is great to see that wish come true. Please help me to get this *RipRap* out to people, our website is newly updated, we have the new *RipRap* app and the edition is also available in hard copy through the ARRC shop.

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RETURN TO KATI THANDA

INTO THE DESERT ONE WOULD DREAM TO GAIN MY ANCESTRAL LAND IS HARDER THAN IT SEEMS, now read my story, from those that are gone, looking after country from here on.

The 'Journey for Consent Determination' has been a long and hard struggle for the Arabana people in dealing with government, state and federal, including other industry and Aboriginal tribes.

The original Arabana claim commenced in May 1996.

On 22 May 2012 at a small unknown location called Finnis Springs, which has no great value to our great nation, an important contemporary ceremony takes place in the stony deserts.

My thoughts: the handing back of the Arabana traditional lands, which includes 71,000 square kilometres, is estimated to be the size of Switzerland-and-a-half.

It was strange to drive into Finnis Springs on 21 May and set up camp with three or four hundred others. On dusk you could hear the wailing and crying of the Arabana people for the loved ones they have lost. Our dream finally became a reality.

Upon dark I drove to the top of a hill to look down on this small outpost surrounded by sand hills, it was like a million stars from the sky had fallen on the stony desert and had landed all over the place. These were the campfires. With the yellow moon rising above and providing us light, we knew the next day that dark would turn into light!

That night when the wailing stopped, the dingoes took over with their soft howls, putting the Arabana people slowly to bed, and if awoken by fright, the old people's spirits will comfort their loved ones so they will be all right.

It was one great occasion that would bring so many tears, OH how I wish our loved ones were here.

As I awoke with the break of dawn, the butterflies settled in as old memories mourn. The coming of more vehicles seemed to overwhelm such a small place in this lonely world.

As a large crowd gathers and ushers into the court tent, I feel shaky on my knees. I take a seat and choke, finding it hard to breathe, thinking of lost loved ones that have been taken by death. The clerk of the court yells out from his chest! "The Federal Court of Australia is now in session." The figure of a man in dark takes over oppression with a 20-minute ruling. All smiles and glee, the judge hands out the court orders to all families. It's my turn to speak. I move forward with ease, trying to hide my glossy tears of future dreams. I grab the mic[rophone] and welcome all who were there, and thank all those who were involved from my position as the Native Title Chair.

I look at the Federal Justice Paul Finn, and state! "Native title is not complete; we have a large mistake, regarding the biggest lake?"

He looks at me with that ruling stare, I say to him, it has a name before Edward John Eyre?

The Arabana call it 'Kati Thanda', the place of spiritual wonder, I now tell you this, and we will change the name for all Arabana and Australia as we wish.

On 20 December 2012, Kati Thanda was made public by the South Australian Geographical names unit as we wish.

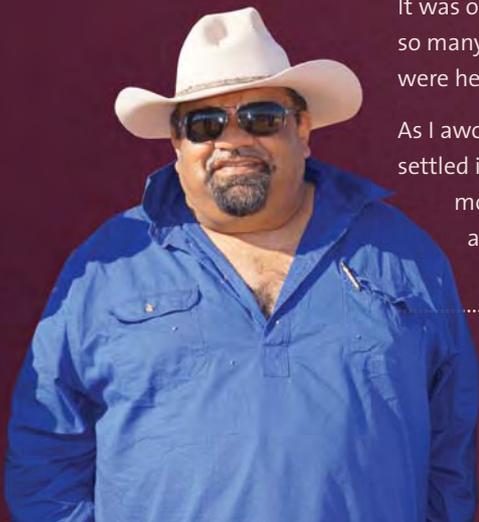
This name lives on after 150 years of Lake Eyre; the spiritual name is now greatly shared.

Taking its rightful place in front of Edward John Eyre!

On 25 May 2013, Arabana and Australians gathered for this ceremony at this large lake to traditionally unchange the name, of this great mistake, song and dance with ancient chants relaxed the spirits of this great brown land.

On 25 May 2013 the lease of Finnis Springs Station had come to formation with many there to see such a signing that we all shared, and now to this day, we feel the old people sleep away, not knowing the achievements of what was done yesterdays?

All is quiet; all is done; now we must come together, for the climate one.



AARON STUART, ARABANA DIRECTOR CHAIRPERSON, PRESCRIBED BODIES CORPORATE
1 AUGUST 2013



Something in the Eyre

DR STEVE MORTON, CHAIR OF THE LAKE EYRE BASIN SCIENTIFIC ADVISORY PANEL, AND AN HONORARY FELLOW WITH CSIRO IN ALICE SPRINGS, TALKS ABOUT WHY THE LAKE EYRE BASIN IS SUCH A SPECIAL PLACE.

Around 57,000 people live in the Lake Eyre Basin. I am among that number because of my enjoyment of the independent mindset of lots of the residents, and because I, like many others, am drawn to the natural beauty of the place. There are few of us, though, for such a vast region. The Lake Eyre Basin has an area of around 1.2 million square kilometres, one-sixth of the Australian continent and similar in size to the Murray–Darling Basin. The natural grandeur, a sparse human population and immense scale, provide a fascinating setting for the management of the Basin’s resources. Like many others, I find myself thinking about better management pretty often, and work on ways to give our part of Australia a confident and a healthy future.

The natural qualities of the Lake Eyre Basin mean it is an area of high conservation significance globally. It has been subject to much less disturbance since European settlement than other parts of Australia, and many ecosystems remain largely intact, despite being subject to pest plants and animals, and certain types of development. The biggest contributor to this quality is that the rivers of the Basin are among a handful of large systems remaining relatively untouched by water resource development world-wide. Additionally, several of these rivers, notably Cooper Creek and the Diamantina River, are icons of Australian folklore, and there is a long history of Aboriginal occupation. Maintaining the current overall excellent natural condition of the Basin’s rivers and their cultural and heritage values, while supporting economic activity and human communities, is the big challenge for future management.

The image used on the cover and several others throughout this edition of *RipRap*, including the one above, have been generously provided by photographer Peter Elfes. This photo was taken in May 2009 and shows calm morning air with low-lying clouds reflected on the surface of water that has just filled Madigan Gulf, at the southern end of Kati Thanda—Lake Eyre North. Peter’s account of his travels is on pages 8–9.

FOR FURTHER INFORMATION

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The challenge of natural resource management begins on the one hand with recognition that the Lake Eyre Basin contains areas of high economic value in pastoralism, tourism, oil and gas extraction, and mining. Mining and energy (petroleum and gas) make up the largest economic activity by value, while pastoral production is the largest land use by area. Service provision and tourism are also important economic activities. While natural gas extraction has occurred in the Basin for many years, recent identification of the coal-bearing Arckaringa, Pedirka and Galilee Basins as sites of potential coal seam gas development, has added spice to the management mix.

A second significant feature, is that the river systems of the Lake Eyre Basin are subject to some of the most variable climatic and hydrological conditions in the world. Periods of protracted drought are interrupted by extremely wet periods throughout single years to decades. The sheer contrariness of the rainfall, its stubbornly perverse unpredictability, gives to our place its excitement and glamour. The resulting variability in the dynamics of resources and of plant and animal populations —the boom and the bust—throws up significant implications for the way the health of the Basin might be monitored and managed.

The background of natural significance, economic activity and forthright human communities that I have sketched out here led, in October 2000, to the signing of the Lake Eyre Basin Intergovernmental Agreement. Initially the signatories were the Australian Government, the Queensland and South Australian Governments; and the Northern Territory (signed in 2004). The primary purpose of the Intergovernmental Agreement is to “provide for the development or adoption, and implementation of Policies and Strategies concerning water and related natural resources in the Lake Eyre Basin Agreement Area to avoid or eliminate, so far as reasonably practicable, adverse cross-border impacts”.

The Agreement is something different and stimulating on the Australian scene. It represents a partnership between all jurisdictions and interested parties—natural resource management bodies, pastoralists, mining companies, Aboriginal people, tourist enterprises, and scientists. To ensure the necessary conversations continue, and momentum is maintained through the years the big rivers come and go, a suite of networks has been built up under the Agreement—the Lake Eyre Basin Ministerial Forum, Community Advisory Committee and Scientific Advisory Panel.

From the perspective of monitoring and science, the big development from these cooperative arrangements is the Lake Eyre Basin Rivers Assessment, known inevitably as LEBRA (see page 50). The purpose of the LEBRA is to gain an understanding of the evolving condition of the Lake Eyre Basin in order to:

- underpin responses to condition as a result of on-ground management and policy,
- form consistent messages about condition and potential responses,
- guide further investigation and monitoring so that they form an increasingly reliable basis for management and policy responses.

The questions we might ask of the LEBRA are, of course, those thrown up by current pressures on the Basin—water development proposals, cumulative impacts of minor water developments, spread of introduced pest plants and animals (especially their impact on waterholes), isolation of floodplains through levees or roadways, impacts of pastoral activities, tourism and mining, and impacts of climate change on water resources.



LAKE EYRE BASIN MINISTERIAL FORUM

The Lake Eyre Basin Intergovernmental Agreement (the Agreement) provides for the management of water and related natural resources in the Lake Eyre Basin (LEB) Agreement Area; particularly so as to avoid adverse cross-border impacts. The Agreement was signed by the Australian, Queensland and South Australian Governments in 2000 (ratified in 2001); and by the Northern Territory in 2004. Ministers from those governments make up the LEB Ministerial Forum, which has overall responsibility for implementing the Agreement. To do this, the Forum receives advice from the LEB Senior Officers Group; the LEB Community Advisory Committee and the LEB Scientific Advisory Panel.

As required under the Agreement, the LEB Ministerial Forum arranges a Conference every two years for all interested parties to exchange information and views on issues relevant to the Agreement.

This year, the 6th Biennial Lake Eyre Basin conference is being held in Port Augusta, South Australia, with articles in this edition of RipRap by many of the people presenting at the conference.

PHOTO CHRISTOPHER WATSON (WIKIMEDIA COMMONS).

The LEBRA is now established. The first rounds of monitoring have been undertaken for hydrology, fish, and water quality, and will now be continued. Critically, the LEBRA will adopt a ‘strategic adaptive management’ framework to guide its use. Strategic adaptive management is a phrase meaning ‘learning-by-doing’. However, it formalises that natural instinct, and forces everyone to look closely at the monitoring information as it is coming in, and to ask ‘Do we need to alter our management in any way as a result of what we are learning?’ Importantly, strategic adaptive management insists on opening up the debate about what values are at stake in natural resource use. It does so by giving a place at the discussion table to all the players, not just government people but pastoralists, Aboriginal people, miners, tourism operators and so on. Plans for testing this adaptive approach are now well under way.

In summary, implementation of the LEBRA and the early steps towards strategic adaptive management are big challenges—and wonderful opportunities! The challenges and prospects include:

- gaining a comprehensive baseline of condition in the Basin,
- defining thresholds of potential concern to trigger new responses,
- providing access to anyone interested in information on observed changes,
- providing opportunities to participate in interpreting results,
- stimulating the adaptive learning process.

The arrival to the stage of coal seam gas and related initiatives demonstrates the necessity to operate the LEBRA in an adaptive fashion. Although not entirely new activities, they seem

to have ramped up at an accelerating pace so quickly that concerns have been expressed in some quarters. The Basin frequently experiences the playing-out of forces from well beyond its boundaries, and coal seam gas and related activities provide the most recent example of such a pressure. In this case the driver is global. The desire for more and more energy is world-wide, and in a carbon-constrained environment, gas is the big transitional element in the gradual shift from ‘dirtier’ to ‘cleaner’ fuels. The force is inescapable; how it might be responded to within the Basin is up to us all. LEBRA is poised to help.

Governments have heard community concern loud and clear. The Commonwealth and states have instituted a series of ‘bioregional assessments’ for priority regions to establish an information base on potential impacts on water resources of coal seam gas and large coal mining projects (see pages 64 and 66). One is a Lake Eyre Basin Rivers Monitoring project (LEBRM), which aims to collate a baseline of knowledge on the hydrology and ecology of surface-water assets. Collaborative arrangements will ensure strong intersection between the bioregional LEBRM and LEBRA, in order to create efficiencies in the targeting of knowledge gaps and synergy among monitoring programs.

The articles in this edition of *RipRap* describe further details of some of these exciting developments, as shown at the 6th Biennial Lake Eyre Basin Conference held in this especially dynamic year of 2013. Not only is the Basin one of the most interesting parts of our country, but it is also an arena for challenging issues facing Australian society. How best can communities and natural resources respond to a wave of potentially intensive resource development? How best can community, industry and science respond to new political winds as fresh governments are elected with different policy directions? How best can a future of climate change be anticipated and managed? Can the admirable aspects of the social and natural makeup of the Basin be maintained through such stresses? The conference papers and other articles in this edition of *RipRap* give a snapshot of these developments and issues. On behalf of the Scientific Advisory Panel to the Lake Eyre Basin Ministerial Forum, I urge you to read and then, to contribute your own voice.



Lake Eyre Basin





LET ME TELL YOU ABOUT SAM

VOL NORRIS, LAKE EYRE BASIN FACILITATOR EXPLAINS HOW 'SAM' IS BEING USED TO RESPOND TO OPPORTUNITIES AND CHALLENGES ACROSS THE REGION.

A photo of Siltcrete Island, Belt Bay, Kati Thanda–Lake Eyre North, taken by Peter Elfes in June 2012 showing that the combination of pink water and reflected blue sky can create amazing and unreal colours.

For human beings, that most highly adaptable of species, Strategic Adaptive Management (SAM) provides a way to recognise and celebrate our instinct for learning-by-doing, and to build it into a negotiated framework of shared values, experimental actions, and clear-headed observation of change.

In natural resource decision making, the human disciplines of knowledge and management are notorious for their tendency to proceed along separate pathways, poorly connected with each other. In the Lake Eyre Basin (LEB), so enormously variable through time and across its geographic extent, this separation between knowledge and management has the potential to be especially cumbersome, if not disastrous for fragile ecosystems.

SAM is a process that not only recognises the inherent uncertainties of dynamic and unpredictable ecosystems, but also tests these uncertainties, progressively improving management. It forces us to connect what we know (our knowledge base) with what we do (our decisions), in a learning cycle that allows us to be flexible without being capricious, planned and structured without being rigid, and cautious in the face of our knowledge gaps, without being paralysed by doubt. It also provides the framework and imperative to be open and inclusive.

In the LEB, we have a legislative responsibility to report on watercourse and catchment condition across the Basin. In a first for Australia at such a scale, we also have agreement among governments to carry out this assessment within a SAM framework. This begins with negotiating and clearly expressing a widely shared vision for the future:

Lake Eyre Basin: Australia's unique, natural, desert river system — Healthy environments, sustainable industries, vibrant communities, adaptive cultures.

This vision has been developed over the past three years through consultation and negotiation among LEB stakeholders. Like all elements of the SAM approach, it is contestable and open to change, yet it has been road-tested widely enough to get us started on firm footing.

FOR FURTHER INFORMATION

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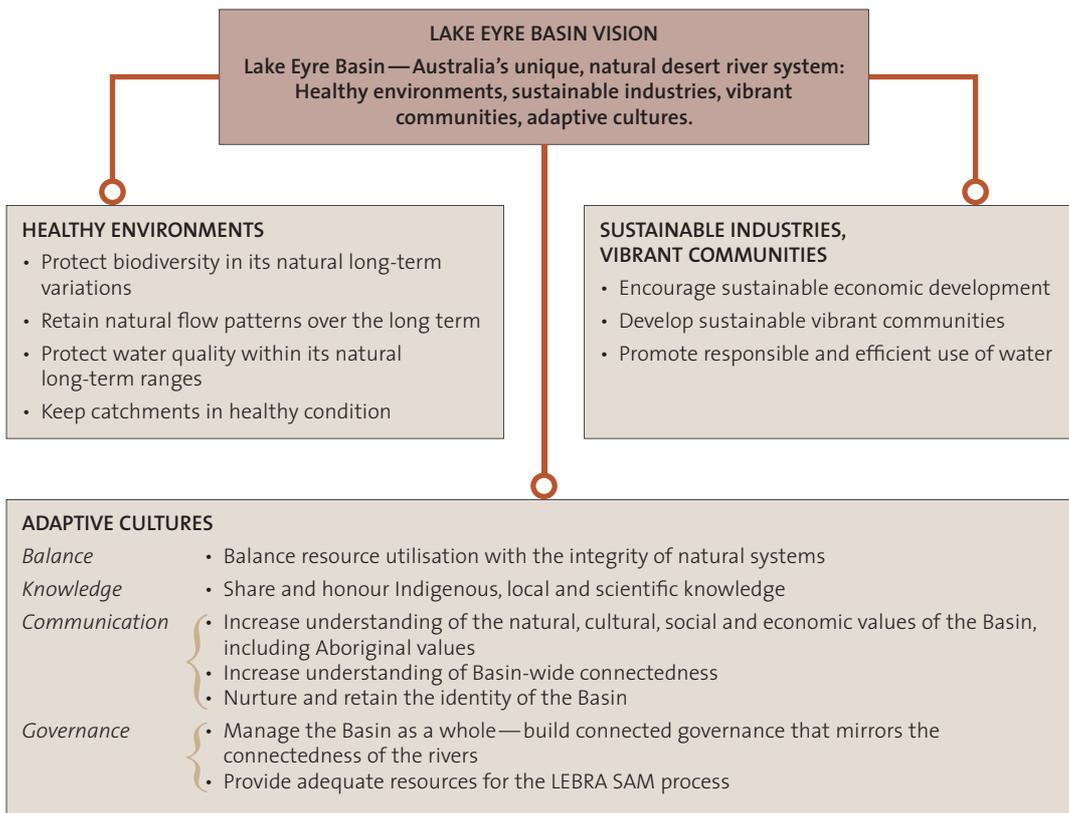
Based on this vision, the SAM approach requires clear, shared objectives. Governments participating in the LEB Intergovernmental Agreement, together with the LEB Community Advisory Committee and Scientific Advisory Panel, offer the following objectives as our guideposts for long-term sustainability and prosperity in the Basin (see figure below). We invite you to share in their pursuit, and to join the continuing discussion on their fitness for purpose in achieving our vision.

Anchored in these foundations is the paramount importance of reliable knowledge and strong relationships, that are cornerstones of the SAM approach. In the 13-year life of the LEB Intergovernmental Agreement, our knowledge and relationships have grown and strengthened. Following the recent three years of Basin-wide monitoring, the challenge of using our knowledge for appropriate, shared decisions will be met by bringing together science, community, industry and management players to negotiate thresholds of potential concern (TPCs)—the levels of change in the Basin that are widely agreed to be of some concern for the future. Negotiating TPCs, and how we respond to them, will require a close working relationship among stakeholders, especially those whose decisions and activities will affect the condition of the water and natural resources in the Basin.



“Arabana Udjyurlarcarrie” by Noblelene MacKenzie-Stuart. This painting is of Arabana women hunting traditional Arabana food, sleepy lizards and goanna.

The challenges of the SAM journey relate to maintaining sufficient flexibility, in spite of our tendency to develop rigid protocols in human organisations, building collaborations with genuine buy-in from all players, and dealing with co-learning and inevitable questions of power and influence. The SAM journey for the LEB is likely to be a complex and changing one, but such an approach is surely the only honest way to interact with an enormous landscape that is itself highly complex and constantly changing. We invite you to be part of this exciting journey.



DESERT CHANNELS QUEENSLAND HAVE PRODUCED A SERIES OF SHORT FILMS FEATURING PEOPLE WHO LIVE IN THE LAKE EYRE BASIN. INCLUDED ARE CONTRIBUTORS TO THIS EDITION OF *RipRap*.

BASIN PEOPLE

Known for its timeless, harsh beauty and pulses of life that follow uncertain rains, the arid landscapes of Lake Eyre Basin are home to distinctive plants and animals. Equally distinctive are the people and characters who live in the deserts and the channel country, bound by their passion for the country and their drive to care for it. They are on a journey to ensure this landscape continues to be a lifeblood for generations to come.

A new online collection of short films produced by DC Digital (part of the Desert Channels Group) celebrates these characters by capturing their stories of why they go that extra mile to look after the Basin—their commitment is inspiring and their messages are strong.

The films feature Rick Briton, Petria Cavanagh, Peter and Elizabeth Clark, Steve Eldridge, Angus Emmott (further on page 32), Rod Fensham, Travis Gotch, Adam Kerezsy, Sandy Kidd, Bill Lennon, Douglas Lillecrapp, Rhett and Alison Mobbs, Des Nelson, Colin Saltmere, George Scott, Jen Silcock (page 40), Max Tischler, Damien Williams (page 49), Peter Whip and Trevor Wright (page 34).

Lake Eyre Basin—People and Passion is a joint project of the Lake Eyre Basin Community Advisory Committee, Desert Channels Queensland and Territory Natural Resource Management, made possible with funding from the Queensland Government's Regional Natural Resource Management Investment program, the Lake Eyre Basin Ministerial Forum and Territory Natural Resource Management.

View this inspiring collection of short films—www.dcq.org.au/lakeeyrebasin



Opening shots from the films of (from top) Angus, Jen, Damien and Trevor.



“Kati Thanda” by Jody Warren. The painting shows the lake and women gathering bush tucker and children running around with the seven sisters (stars) above.

THROUGH MY EYES

PHOTOGRAPHER PETER ELFES SHARES HIS KATI THANDA–LAKE EYRE JOURNEY.

In 2009, motivated by the reports of the filling of Kati Thanda–Lake Eyre, considered such a rare event and one of the natural wonders of the world, I travelled to document this extraordinary and beautiful display of nature. My journey into Australia’s interior led me on a five-year odyssey, where I would witness the transformation of our deserts into a land exploding with life! A journey that not only changed my life, but also changed my perception of what these vast areas of desert interior mean to me, ecologically and spiritually.

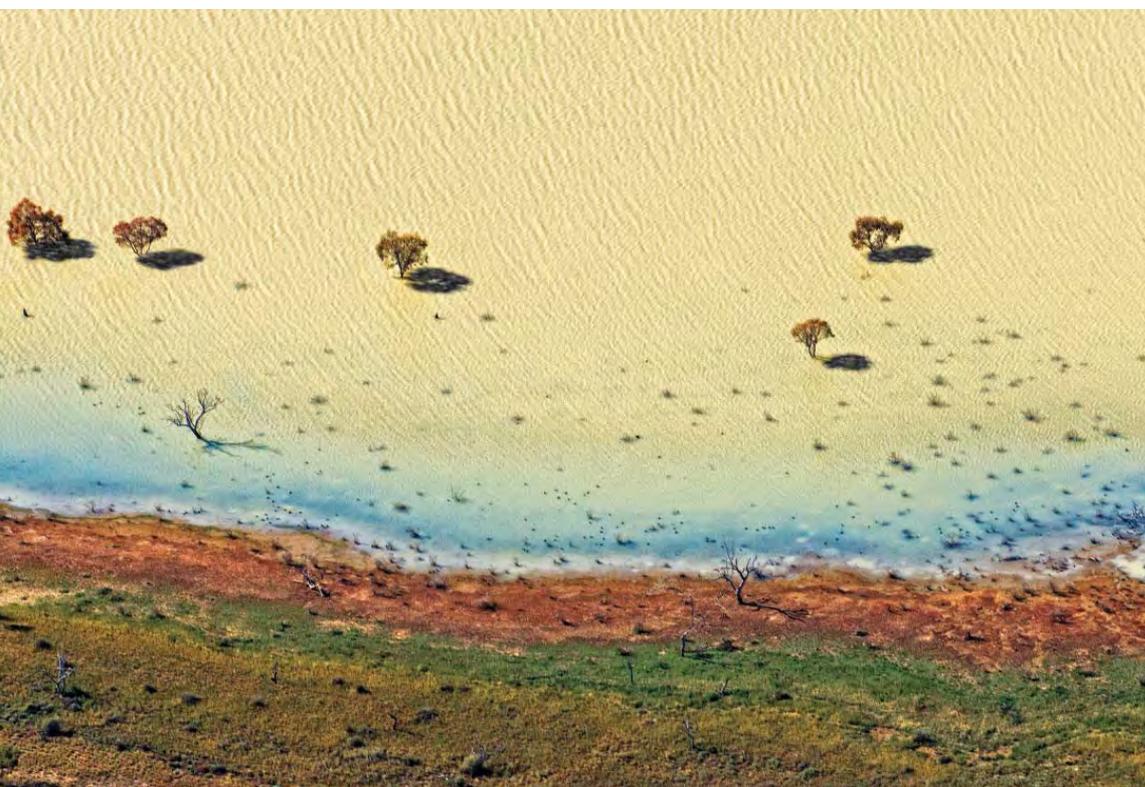
This was an event of such enormity that it stirs up every layer of nature, from deep below the arid sands to high above in the stratosphere. Fish eggs that have been waiting patiently for years are awakened, plants seeds that have lain dormant spring to life, entire ecosystems are revitalised by the arrival of this life-giving water. Only this time, each season of monsoonal rain would be followed by another. Even the great flood of 1975 only lasted a season. This was to be the beginning of the rebirth of the great inland sea, and its effects would reach further than most of us could imagine.

On my first trip to the Lake I remember the strange feeling coming over me as I walked over the spinifex-covered dunes. I could smell the sea! but I know that’s almost a thousand kilometres away, this is the red centre?

I finally arrive at a point where I see it; Water! Covering the sparkling salt, like a blanket, trillions of litres of it. It has travelled over a thousand kilometres to reach this vast salt pan, I start to wonder how can so much water be here? How can it travel over so much parched desert and still manage to cover an area almost 10,000 square kilometres with metres of water? How much water did this equate to? I knew that modern science could answer some of these questions, but what if I lived in a world where science was a story passed on from generation to generation, how then would I explain such a event?

Walking around in the open desert near the mound springs, I tried to imagine what it must have been like for the Aboriginal people living here, and being content to stay in such an unforgiving environment. I realise they didn’t just pass through here, they made this place their home, and thinking about what their lives must have been like, one can’t help but have enormous respect for all the Aboriginal tribes that managed to do this for tens of thousands of years.

When I photograph this place I try and see it through the eyes of the people that have occupied this land for millennium. You can see their unique perspective in Aboriginal art which almost always represents some part of nature.



An ancient river system near Sturt's Meadow in the north-west of New South Wales takes on an abstract appearance as mosses and algae flourish in water containing lime, sulphur, salt and other oxides. Aluminium, iron oxides and clay in the earth combine with magnesium salts, lime and other minerals dissolved in the water, and even in this harsh environment the algae and mosses can thrive. Photo taken in May 2011.

Taken in June 2012, this topographical view of an island in Kati Thanda–Lake Eyre highlights the extraordinary colours produced by micro bacteria even in this highly saline environment.

The small things, and the infinite horizon which seem in contrast with each other can often be represented in one Aboriginal painting. These infinite horizons constantly demand my attention and overwhelm my visual sense, but the observation of the small things in Aboriginal life was the key to their survival, like the way ants will plug their huge mounds when rain is imminent.

Seeing and photographing the channel country from the air, with its rivers and creeks flowing so freely towards the Lake, will remain as one of the most incredible experiences I have ever had. When I first witnessed this in 2009, I knew almost nothing of the science associated with this event. I was there for the spectacle—a spectacle that was so moving it demanded that I answer many questions which were asked of me after viewing my photographs. Why did the water change from green to blue to pink? How did the birds know that water had reached the basin, and when it would be able to support fish? These questions were just the obvious ones, there were many others that needed understanding and more research.

After five years and many trips back to Kati Thanda–Lake Eyre, I was pleased that I had informed myself about some of the science behind this natural phenomenon, because it gave me a much greater appreciation for the uniqueness of it. It also put a perspective on the time it has taken for these systems to evolve in the way they exist today. It made me realise we are just travellers through this place, observers of its changing state. It has existed with its cycles of wet and dry for millions of years. Our observations and measurements are just a blink in its history, but the importance of water to this environment cannot be ignored. Even in the short time we have been recording the arrival of water into this salt pan, the extraction of water from its basin by resource and mining companies has noticeably lowered the water levels of all the mound springs, and this is despite the last four years of flooding. Any further impact on this ecosystem (an area which is equal to that of France, Spain and Portugal combined) will have devastating effects on its future.



“I hope that my photographs can properly convey the beauty of this place and give all of us a greater appreciation for the significance of this still wild ecological haven, so that future generations can also appreciate it for its unspoilt beauty.”

FOR FURTHER INFORMATION

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Towards arid zone security

NINTI ONE WAS CREATED IN 2003, AND IS A NOT-FOR-PROFIT COMPANY THAT BUILDS OPPORTUNITIES FOR PEOPLE IN REMOTE AUSTRALIA. FUTURE WATER SECURITY IN THE ARID ZONE IS DISCUSSED IN THIS ARTICLE.

Arid and semi-arid Australia cover 5.3 million square kilometres—or 70 per cent—of the continent, but only about 3 per cent of the nation’s population live and work there. This vast area generates 45 per cent of our export income, while also servicing various domestic markets. It supports more than 2000 types of plants, 605 vertebrate species, and countless invertebrates, some of which have persisted on this continent for millions of years. This makes arid and semi-arid Australia a globally significant region for biodiversity. It is also culturally rich, with 18 per cent of the rangelands under Aboriginal ownership, providing significant links with Australia’s long cultural history.

The rangelands’ biggest asset, however, is water, with much of it underground in vast aquifers. Few Australians realise it, but more than 90 per cent of our continent’s fresh water is underground, both out of sight and out of mind. Some comes to the surface at iconic sites such as the mound springs of the Great Artesian Basin, the relict streams of Australia’s Central Ranges, and the springs and gorges of the Pilbara. Important surface waters include the permanent billabongs and waterholes on our inland river systems, especially those of the Kati Thanda–Lake Eyre region.

FOR FURTHER INFORMATION

www.nintione.com.au

www.nccarf.edu.au/publications/climate-resilience-arid-zone-freshwater-biota

www.feralcamels.com.au



“Water pennies are a fascinating species and are symbolic of many aquatic organisms that are found across Australia’s arid zone. How they got there, and how they have survived for hundreds of thousands of years are important questions. Answering these questions is critical for the future management of landscapes and their wetlands and river networks under climate change.”

Professor Jenny Davis has been investigating aquatic life in the arid zone since the mid-1980s when she focused her PhD research on the water penny. Water pennies are small, trilobite-like, aquatic invertebrates that live in waterholes and streams along the east coast of Australia. There is also a small group of isolated populations in the middle of Australia, surrounded by desert, experiencing soaring temperatures over the summer and less than reliable rainfall. How these water pennies came to be in the waterholes of Watarrka National Park (Kings Canyon) and the West MacDonnell Ranges in the Northern Territory is not fully understood.

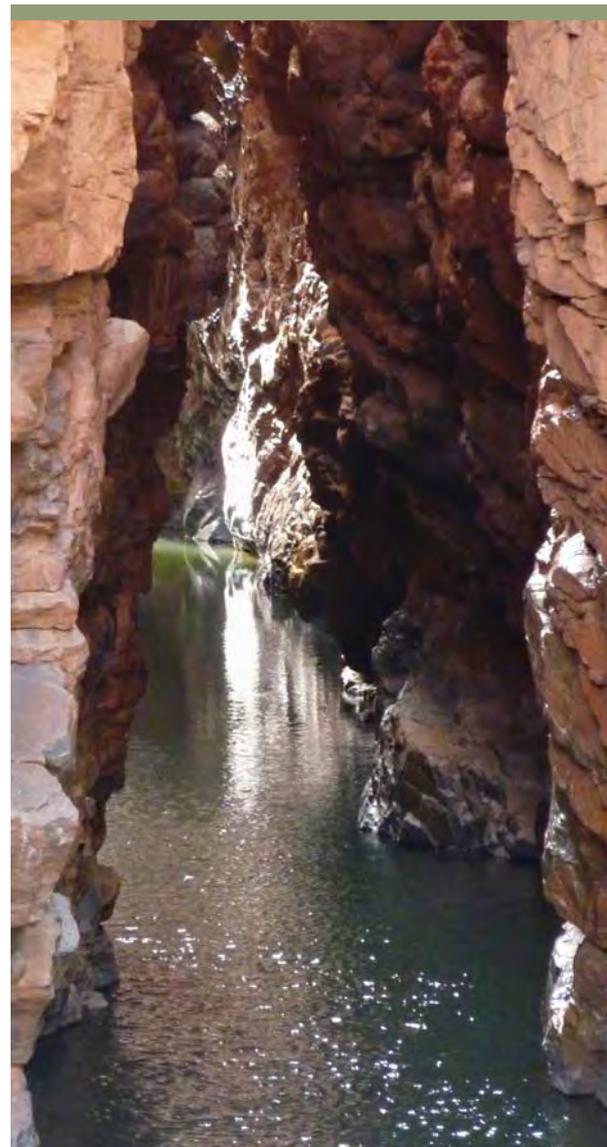
Building on her earlier work, Jenny has been leading an investigation into the likely impacts of climate change on arid zone freshwater plants and animals. Recommendations from this study are summarised in the *National Guidelines for Climate Adaptation Planning for Arid Zone Aquatic Ecosystems and Freshwater Biodiversity*, a report supported by the National Climate Change Adaptation Research Facility. The report identifies a portfolio of adaptation approaches to maintaining aquatic habitats, the water resources that support them, and the species dependent upon them, within a framework of strategic adaptive management.

Jenny argues that securing water for these aquatic ecosystems is vital.

“We need to deliver water security for environmental, cultural, community and industrial use across the arid zone under a changing climate. Aboriginal people have strong cultural links to water in the landscape and have a wealth of knowledge about how these places have been managed to sustain life over thousands of years. It’s also important to recognise that mining, pastoralism and tourism use the water located across the arid zone, and that there is a need to consider this on a national scale.”

Through Jenny’s work and that of her collaborators in Central Australia, there is now a greater understanding of arid zone water places and the threats to them.

Dr Jayne Brim-Box, from the Northern Territory’s Department of Land Resource Management, has undertaken extensive surveys of waterholes throughout central Australia as part of the environmental monitoring efforts of the Australian Feral Camel Management Project (AFCMP) coordinated by Ninti One.



MAIN PHOTO ETHABUKA SPRING
ANGUS EMMOTT. INSET WATER
PENNY ERIN HAYES-PONTIUS
(WIKIMEDIA COMMONS).

Relict streams in the
Central Australian Ranges
typically occur in deeply
shaded, south-facing
gorges such as the
Serpentine Gorge in
the Northern Territory,
photo Christopher Watson
(Wikimedia Commons).

Feral camels are having a profound impact on desert waterholes and springs because of their ability to cover large distances and out-compete native wildlife for access to water. Describing her work Jayne said:

“We’ve found feral camels drinking waterholes completely dry over the course of a night. This obviously has severe impacts on the aquatic species that have relied on this water to survive. While most species need some adaptation to wetting and drying cycles that are experienced in desert areas, the increase in feral camel numbers over the last 30 years has accelerated these processes with often detrimental impacts on waterholes, the species within them, and the native species that rely on them.”

Monitoring results of the AFCMP have emphasised the awareness that aquatic ecosystems in the dry part of the continent are extremely valuable, and are of global significance because of the varied habitats and unique life forms they support. They support plants and animals that have, in some cases, persisted through climatic changes spanning millions of years.

A new collaboration led by Ninti One aims to link researchers, land and water managers and stakeholders across remote Australia to address arid zone water security and create a management framework for the future.

Jan Ferguson, Managing Director of Ninti One says “Through the Australian Feral Camel Management Project, we’ve shown that the best way to manage NRM issues is to look at them on a landscape scale, and not on a land tenure and jurisdiction basis. Once the appropriate management scale is determined, collaboration with the landholders across the management area is the first step to achieve the required changes”.

The new arid zone water security initiative aims to engage stakeholders across Australia to answer the broad questions of: Where is the water and how much is there? Who and what is using it? What is the best way for it to be managed to achieve all stakeholder aims?

Jan continues, “We are currently looking at opportunities for funding the arid zone water security initiative, which is always challenging although this is a fundamental issue for remote Australia and we intend to give it the priority it deserves”.

PHOTO BELOW R. BUGG
LOWERMOST PHOTO R. SLEEP.





Smart scientific decisions

MICHELE AKEROYD, TONY MINNS, NEIL POWER AND DALE McNEIL EXPLAIN THE ROLE OF THE GOYDER INSTITUTE IN UNDERTAKING SCIENCE TO INFORM DECISION MAKING IN KATI THANDA–LAKE EYRE.

The Goyder Institute for Water Research was established in 2010 by the South Australian Government in recognition of the need to have excellent science available to underpin policy and decision making. Since its inception, the Goyder Institute has commissioned a series of short- and long-term research and development (R&D) activities aimed at improving the capacity of the South Australian Government to develop and deliver science-based policy solutions in water management.

Research investment at the Goyder Institute is focused across four enduring research themes: climate change, environmental water, urban water, and water for industry. Within these themes, priority areas of R&D investment have been identified in consultation with government stakeholders, end-users and the

research community. ‘Roadmaps’ have been developed that link R&D activities to policy outcomes for South Australia over the initial five-year time horizon of the Institute. More specifically, each roadmap identifies specific policy outcomes related to a given roadmap topic. In this way, it is possible to identify existing knowledge and other ongoing R&D activities, and to prioritise the knowledge gaps and tools needed to fulfil the strategic policy outcomes.

Under the environmental water theme, a key research objective has been the provision of scientific support to improve the management of rivers and wetlands in South Australia. Activities are now underway to fulfil this objective in the Lake Eyre Basin (LEB).

Photos throughout this article Dale McNeil, SARDI.





What's in a name?

George Woodroffe Goyder (24 June 1826 to 2 November 1898) was a surveyor in South Australia during the latter half of the 19th century, and was appointed Surveyor-General in 1861. George Goyder observed the difference in vegetation type as a result of rainfall gradients as he traversed the state. He used these observations to set a limit beyond which cropping would be unsustainable. His predictions were highly unpopular at the time, but he proved to be right. This line is now called 'Goyder's Line', and was an early example of science being used to inform policy.

Assessing the condition and vulnerability of the Lake Eyre Basin

The rivers in the LEB are generally considered by governments and the community to be in relatively good condition, and make up one of the last unregulated, dryland river systems in the world. However, our knowledge of the ecology of these arid rivers and their catchments is limited, and not uniform across the Basin. There are increasing pressures on the LEB that are both natural (e.g. climate-induced) and human-induced.

An improved understanding of the water resources of the LEB, including its hydrology and groundwater dependent ecosystems, is needed to develop and implement sustainable water resource plans. Two important initiatives are currently underway in the LEB:

1. Lake Eyre Basin—River Monitoring (LEBRM) program.
2. Lake Eyre Basin Rivers Assessment (LEBRA).

The LEBRM program is being funded by the Office of Water Science to support the Bioregional Assessment program of the LEB. The LEBRA program will review the condition of all watercourses and catchments within the LEB, as a requirement of the LEB Intergovernmental Agreement (see page 3). The LEBRA program aims to develop a suitable methodology that will provide the basis for evaluating changes in the status and ecological health of LEB water resources.

The Goyder Institute is providing support and guidance to ensure all proposed LEB activities in South Australia will be productive in advancing the objectives of the LEBRM and LEBRA programs, and to maximise the synergy between these programs. The goal is to improve our understanding of the ecology, hydrology and cultural values of the LEB, while improving the ability for the states, Commonwealth, and local communities to develop policies and to assess future development proposals based on the best available scientific information and management practices.

FOR FURTHER INFORMATION

enquiries@goyderinstitute.org
www.goyderinstitute.org



The arid rivers of the Basin are home to a ‘boom and bust’ ecology adapted to enormously variable flow conditions. This variability makes it difficult to pick up trends in resource condition. The knowledge gap being addressed by the Goyder Institute is to identify suitable indicators of resource condition that account for preceding hydrological conditions, and to demonstrate if changes to the system have occurred. Appropriate scales for measuring specific condition indicators and their usefulness as predictive, rather than responsive indicators, will also be addressed. The approach will use existing hydro-ecological monitoring data and methods (e.g. LEBRA), as well as new approaches (e.g. remote analysis) to build and trial a scientifically rigorous condition assessment methodology that will improve our ability to understand and manage the unique environment of the LEB.

In particular, it is expected that monitoring and assessment methods will be able to:

- determine the condition of the watercourses and catchments across the LEB,
- detect changes (taking into account variability),
- suggest thresholds of potential concern for key indicators,
- determine areas that are at risk or vulnerable.

An improved understanding of the condition of the LEB will:

- underpin responses to condition, including on-ground management options, government and industry policy development, enterprise and personal decision making, and local and regional resource planning actions,
- form consistent and appropriate messages to encourage constructive dialogue between specific target audiences about the condition, outlook and appropriate responses,
- guide ongoing research, investigation and monitoring efforts so that they can form a reliable basis for evidence-based responses.

This work will effectively engage governments and government agencies, in identifying science needs and knowledge gaps, bringing together leading experts to address those gaps with excellent science, and ensuring that the science is relevant and directly applicable to policy makers.

The Goyder Institute is a \$50 million partnership over five years between the South Australian Government through the Department of Environment, Water and Natural Resources, CSIRO, Flinders University, the University of Adelaide, and the University of South Australia. The Institute brings together South Australia’s leading water research capabilities, in collaboration with CSIRO, into a single, comprehensive research program aimed at providing expert, independent scientific advice that informs policy and decision making, identifies future threats to water security, and assists in an integrated approach to water management.



Aboriginal map making

PROJECT COORDINATORS **MICHELLE RODRIGO** AND **VOL NORRIS** PROVIDE
A GLIMPSE OF THE LAKE EYRE BASIN ABORIGINAL MAP.

The forthcoming ‘Lake Eyre Basin Aboriginal Way’ will celebrate the richness, diversity and vibrancy of Aboriginal culture across the Lake Eyre Basin (LEB) in a way that honours the desire of Aboriginal people to tell their story.

To be published as a poster with accompanying booklet, these products will be the first of their kind to show multiple layers of information about Aboriginal groups, places, cultures and histories across the whole of the Basin—that’s one sixth of Australia! They will use photographs, colourful graphics and personal stories of Aboriginal people from all corners of the Basin to convey messages of respect and recognition for the traditional and contemporary presence and culture of Aboriginal people in this region. The intended audience is all people (both Aboriginal and non-Aboriginal) who want to learn more about the natural and cultural significance of the Basin.

George Cooley, South Australian Aboriginal representative on the LEB Community Advisory Committee when speaking about the LEB Aboriginal Map through his involvement in the project management team said:

“The Lake Eyre Basin has always been a home to Aboriginal people, and it remains rich in meaning for Aboriginal culture, shared by us in story and in song. This map is a small taste of our places, songlines, stories and histories, and an invitation to learn more. It is not about native title or land rights, it’s about working together to look after this unique place for our grandchildren’s future. We hope you will join us on this journey.”

The poster and booklet will show the immense generosity of spirit from scores of Aboriginal people across the Basin who have contributed sage advice, photographs, knowledge, stories and support for this project.

This project has grown into a partnership between Aboriginal people and organisations across the Lake Eyre Basin, the LEB Community Advisory Committee, the governments of South Australia, Queensland, the Northern Territory and the Australian Government (through the LEB Ministerial Forum), the mining industry and regional natural resource management groups. These partners have generously committed cash or in-kind support to the project. A project management team, comprising Aboriginal and non-Aboriginal people from across the Basin, has been steering the project since its formal inception in 2011, and plan to publish the final product later in 2013.

FOR FURTHER INFORMATION

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Water cycles in the dry lands

NATURAL RESOURCES SOUTH AUSTRALIAN ARID LANDS IS UNDERTAKING A RANGE OF PROJECTS TO BETTER UNDERSTAND AND MANAGE THE LAKE EYRE AND GREAT ARTESIAN BASINS.

In the South Australian Arid Lands (SAAL) region, water is the magnet that attracts people, biodiversity and industry. It is the key resource in an otherwise dry environment. For a region where rainfall is so low, there is an amazing ability to support a huge diversity of life through a phenomenon known as ‘boom and bust’.

North of the ‘dog [dingo] fence’ the region is dominated by four major catchments Neales-Peake, Cooper Creek, Georgina-Diamantina, and Macumba, all large surface-draining networks that terminate at Lake Eyre.

‘Boom’ periods occur when floodwaters from interstate and major rainfall events enter the catchments and recharge the region’s lakes, dams and wetlands including the Ramsar-listed Coongie Lakes (see page 46). Plants regenerate, and waterbirds and fish use the opportunity to breed in large numbers, attracting thousands of visitors wanting to experience this unique phenomenon.

During frequent and prolonged droughts, or ‘bust’ periods, waterbodies with permanent fresh water such as Algebuckina Waterhole in the Neales River catchment, and Cullyamurra Waterhole in the Cooper Creek catchment provide critical refuge for plants and animals.

Underlying the Lake Eyre Basin is the Great Artesian Basin (GAB), one of the largest groundwater basins in the world. The GAB is characterised by groundwater-fed springs that support unique aquatic life forms. Dalhousie Springs, a popular tourist destination, is one of the best examples of a GAB spring complex in Australia. It supports a number of endemic aquatic species.

In the southern region, including the Gawler Ranges and North Flinders, rainfall is low and catchments are generally small. Surface flows are generated on hilly-rocky headwaters, and the majority is rapidly lost as the flows pass onto the plains, or into shallow terminal lakes where it evaporates. Rain-fed rockholes and groundwater-fed springs are important cultural and ecological features in these landscapes.

The water resources of the SAAL region are, to a large extent, unmodified and in good condition. However, there are threats from pest species, tourism, and from the mining industry for water requirements. In such an unpredictable climate with high variability from year to year, and so much life dependent on a healthy water supply, careful management of water in the region is critical.

Photo above by Peter Elfes. The Warburton Groove is in the north of Kati Thanda–Lake Eyre, where it breaks into the salt pan. When this photo was taken in June 2012 the surrounding desert was still wet from the water that had travelled 1000 kilometres to reach the basin and was beginning to recede after four years.

PHOTOS THROUGHOUT ARTICLE PROVIDED BY THE AUTHOR.

Science shapes water policy

Two Australian Government-funded projects will help shape future water management for the SAAL region.

1. THE GAB SPRINGS PROJECT

The 'Allocating water and maintaining springs in the Great Artesian Basin' project has advanced our understanding of the south-western margin of the GAB's water balance and pressure dynamics, and the interdependent relationship between aquifer pressure and the flow patterns of natural mound springs of the western GAB. As water users in the SAAL region are well aware, the primary GAB environmental assets are natural mound springs, with many supporting unique species and ecosystems, and which are reliant on aquifer pressure for flows to continue.

This project mapped about 5000 spring vents (both flowing and extinct) in South Australia, and extended knowledge of the high genetic diversity present in the GAB springs, with 25 new species of invertebrates being discovered that are found nowhere else.

With the interdependent relationship between the hydrogeology of the underlying aquifers and the health of natural mound springs based on natural flow rates now better understood, it will be possible to put in place management practices that preserve these natural assets. The comprehensive mapping of the springs included baseline measurements of vegetation growth around major spring groups.

Ongoing monitoring will measure any decline or increase in surrounding vegetated wetlands, as this will indicate any change in flow rates from the natural spring vents. This monitoring will identify potential impacts of water affecting activities and future developments in the region. It will also support the development of effective mitigation strategies and adaptive management practices that will maintain healthy spring-dependent biological communities. Future groundwater extractions and development in the region will now be more accurately targeted towards areas that do not support high-value ecosystems or other groundwater dependent assets.

FOR FURTHER INFORMATION

www.naturalresources.sa.gov.au/aridlands



Dalhousie Springs is one of the best examples of a GAB spring complex in Australia and a popular tourism destination.

Key findings

- The overall recharge and inflow into the western GAB is less than assumed or estimated in previous studies. Much of the inflow along the western margins occurred in a geological period more than 10,000 years ago under a very different climate than today.
- The western GAB is in a state of natural, long-term pressure decline.
- There is a large volume of water in storage in the western GAB, and continuing inflows into South Australia from the eastern states occur over long periods of time.
- Diffuse leakage (water permeating slowly upwards where it is evaporated from the soil) is much less than is estimated in the current Far North Prescribed Wells Area Water Allocation Plan, but new findings show vertical leakage via preferential flow paths is much greater than previously estimated.
- Around 5000 spring vents (both flowing and extinct) have been mapped with elevations of the outflow points recorded.
- High genetic diversity and a high degree of endemism is present in the GAB springs, with 25 new species of invertebrates discovered that are found nowhere else in the world.

The four-year project was delivered by the SA Arid Lands Natural Resources Management Board with \$17 million of funding from the Australian Government's National Water Commission, in partnership with Flinders University, Adelaide University, CSIRO, the South Australian Department of Environment, Water and Natural Resources, and the Northern Territory Department of Natural Resources and Environment.

2. GREAT ARTESIAN BASIN SUSTAINABILITY INITIATIVE

Groundwater, particularly from the GAB, is critical to the health of ecological communities and the viability of regional pastoral, mining and tourism industries. Eleven bores were decommissioned and three were re-drilled as part of the Great Artesian Basin Sustainability Initiative (GABSI), a national program aimed at reducing groundwater waste from the GAB.

Since the program commenced in 1999, GABSI has been working with land managers to rehabilitate (cap) uncontrolled bores, and replace earthen bore drains with pipes. There have been 1143 wells capped and 24,843 kilometres of bore drains removed and replaced with 27,000 kilometres of piping. This has resulted in an annual water saving of 191,862 megalitres.

In 2011, a particular highlight was the decommissioning of the Big Blyth Bore which has saved more than 1000 megalitres of water each year from the GAB, and increased the health of surrounding waterholes. A free-flowing bore located on Peake Station, Big Blyth was drilled in 1917 and flowed freely for about 90 years, releasing more than 1000 megalitres of water, and almost 2500 tonnes of salt each year. In its non-rehabilitated state, Big Blyth had negligible productive benefits to the pastoral industry and low ecological value—but it was a major source population of *Gambusia*, an introduced pest fish. This population is thought to be a

source of re-infestation into the Neales and Peake River system after flood events, and the capping of Big Blyth is expected to substantially reduce *Gambusia* numbers and increase the health of waterholes such as Algebuckina—the most important permanent waterhole in the Neales-Peake River catchment.

Sealing the bore was technically complex and very challenging because it involved locating the original drill-hole within an overgrown artificial wetland and significantly-corroded bore casing. Big Blyth's closure should have major benefits for nearby GAB springs as it should increase pressure to Freeling Springs, leading to improved flow and wetland health. The protection of these springs is important as they are nationally recognised as one of the more biologically-significant spring groups in the GAB.

Land managers are also expected to benefit through an anticipated increase of pressure and improved water quality at controlled bores, while the conversion of Big Blyth's artificial wetland to more manageable grazing country on the Peake Creek floodplain, is expected to improve grazing management outcomes.

The 'Far North Prescribed Wells Area Water Allocation Plan' led by the SA Arid Lands Natural Resources Management Board will undergo a scheduled revision in 2014. Findings will also assist South Australians—and the nation—in setting future policy positions against a backdrop of progressing sustainable development that considers environmental, economic, cultural and social impacts.

GABSI is capping free-flowing bores in the western margin of the Great Artesian Basin.



FOR FURTHER INFORMATION

www.naturalresources.sa.gov.au/aridlands

Learning more about the Cooper Creek

The ‘Cooper Creek project’, supported by Natural Resources SA Arid Lands with funding from the Australian Government’s ‘Caring for our Country’ program, has investigated the natural features and human influences on key waterholes and wetlands along the iconic Cooper Creek.

The Cooper Creek catchment is an important, but relatively poorly understood wetland system, that supports unique and important biodiversity, as well as a range of industries including pastoralism, mining, and tourism. This project used the rare opportunity of the 2010–12 floods to gather ecological information to improve understanding of how the Cooper Creek responds during flooding.

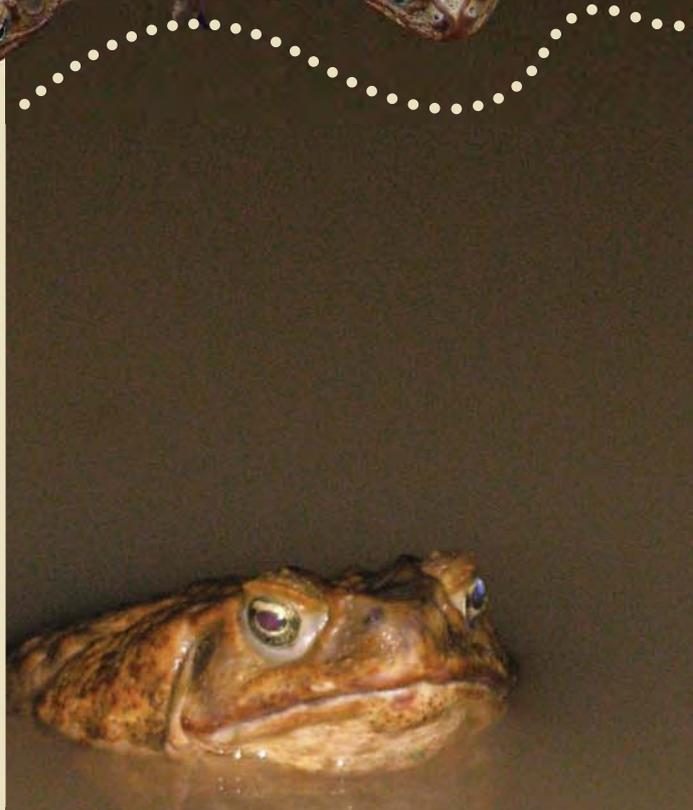
With floodwaters come pests, and the project looked for evidence of pest animals such as *Gambusia* (or Mosquito fish), cane toads, feral pigs and rabbits, gathering information on pest impacts to determine their influence on the catchment. Data on fish assemblages and vegetation condition— important indicators of catchment health—was also gathered. Highlights of this work included a cane toad alert consumer campaign, and data collection from a unique arid lands fishery.

CANE TOAD ALERT CAMPAIGN

A 2011 survey of the south-west Queensland region by Biosecurity SA found that cane toads are still about 500 kilometres from the north-east border of South Australia. While there is no imminent danger of cane toads reaching the state, there is concern they will use floodwaters and permanent waterholes as stepping stones to the permanent Cullyamurra Waterhole, or the Ramsar-listed Coongie Wetlands.

As a pre-emptive campaign, Natural Resources SA Arid Lands released a ‘Cane Toad Alert’ pack, designed to help any visitor or resident of the region quickly identify cane toads and report any sightings to the Natural Resources Centre in Port Augusta. Australian frog expert Mike Tyler launched the new pack at Innamincka in April 2012.

There are four components to the Cane Toad Alert pack—a poster, DVD (including recordings of the cane toad’s call), factsheet and stuffed cane toad—which is available at key tourist information centres in the region. Factsheets and DVDs were posted to land managers in north-east South Australia and south-west Queensland, with people encouraged to be ‘alert but not alarmed’, and report any audio or visual contact with cane toads.



FOR FURTHER INFORMATION

www.naturalresources.sa.gov.au/aridlands



ARID LANDS FISHERY

The catch from a unique sustainable fishery at Lake Hope on Mulka Station is providing important information on the health of the Cooper Creek catchment. Run by station manager Gary Overton, who has the only commercial fishery licence in the region, the fishery is activated under strict conditions when flow volumes at Innamincka reach a certain level during flood. Consequently, it has only operated four times—in the mid-1980s, 1990s, 2001 and 2011–12.

As a terminal lake of the Cooper Creek catchment, Lake Hope is an important indicator of the system's ecological health, and what we observe here can be an indication of what is happening further up the catchment. Fish catch is an important measure of ecological health—if Lake Hope yields good numbers and sizes of fish, and there is little disease, then the system is probably functioning in a healthy state.

Gary has kept data from each catch stretching back to the mid-1980s. He has consistently sampled at one locality, providing a unique opportunity to analyse this information to gauge, and ultimately manage, the system's health. Lake Hope provides a way to learn how an industry that operates at limited times can function in the SAAL region through the sustainable harvest of native freshwater fish.

Findings from these projects and other work in the region have been shared in community workshops. These workshops focused on applying the science to practical on-ground outcomes, with group discussions enabling all present to ask questions and consider the implications of the research for the Cooper Creek. A series of reports based on this research will be available from the Natural Resources SA Arid Lands website in late 2013.

Mapping weeds in Innamincka and Coongie Lakes

Weed mapping surveys and control activities provided a 'winter snapshot' of Weeds of National Significance (WoNS) and priority weeds in the Innamincka Regional Reserve and Coongie Lakes National Park. The surveys were largely focused on identifying new invasions of WoNS species. Several WoNS occur upstream of Innamincka, and given the levels of rainfall and flooding in 2010–11, it was expected some species could have made their way down the Cooper Creek and into the Reserve. The priority survey areas included the Cooper Creek, Coongie Lakes and associated wetlands, major and selected minor drainage points, high visitation/high-use areas, known weed locations and nearby areas, and areas adjacent to high value natural resources.

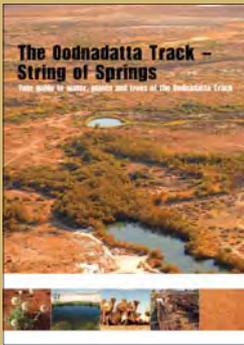
The WoNS of most serious concern are prickly acacia (*Acacia nilotica*), parkinsonia (*Parkinsonia aculeata*) and mesquite (*Prosopis* spp.). These weeds pose considerable risk to the biodiversity and natural beauty of the Reserve and Coongie Lakes National Park. Once established, they are difficult to completely remove, so ongoing monitoring is necessary to facilitate early detection and intervention. Although not WoNS declared, several other serious weeds are already known to exist at Innamincka, such as buffel grass (*Cenchrus ciliaris*), and mimosa bush (*Vachellia farnesiana* previously *Acacia farnesiana*).

Surveys were undertaken in 2011, 2012 and 2013, and revealed no new invasions of WoNS since the last surveys in 2001. However, an alarming increase in the distribution and intensity of buffel grass was found across the Reserve. Several major creeklines, some that flow directly into the Cooper Creek, were infested to the point best described as being buffel grass 'monocultures', and buffel grass was found along many of Innamincka's roadsides and tourist areas. A small infestation of noogoora burr (*Xanthium occidentale*) was also found at Innamincka. Several heavy mimosa bush infestations were also surveyed, and pastoral company S. Kidman & Co, who operate leases in the area, will be working with Natural Resources SA Arid Lands to control these infestations over the coming months and years.



Buffel grass infestation along the Oonabrinta Creek, Innamincka Regional Reserve, photo Rural Solutions SA. Right: Fruit of mimosa bush, photo Philmarin (Wikimedia Commons).

The surveys were conducted by Natural Resources SA Arid Lands and Rural Solutions, and supported by the Australian Government's 'Caring for our Country' program.



The Oodnadatta Track – String of Springs is a travel guide to the water, plants and trees of the Oodnadatta Track and the revised edition was recently released in the region. To get your copy contact the Natural Resources Centre SA Arid Lands on 08 8648 5300 or e-mail: SAAridlands@sa.gov.au or you can read it online at www.naturalresources.sa.gov.au/aridlands.

Working together to manage feral pigs

Innamincka and the Coongie Lakes are internationally significant wetlands, and are recognised as important water-bird breeding grounds by the Ramsar convention. Natural Resources SA Arid Lands has been actively managing feral pigs at Innamincka Regional Reserve and Coongie Lakes National Park since 2001.

In recent years, collaboration between land managers, Desert Channels Queensland, S. Kidman & Co, Santos, the Australian Government and Natural Resources SA Arid Lands has resulted in combined operations to remove more than 3000 feral pigs from seven properties along the Cooper Creek, with the operation beginning at Innamincka, and moving north-east to Mount Howitt Station in Queensland. The project has extended in the past two years to include feral pig removal in the Diamantina River area by various stakeholders, including land managers and conservation property managers.

Feral pigs have been present in the Cooper Creek catchment since the early 1900s. Domestic pigs were kept at homesteads, and escapees are thought to have led to a wild population at Embarka Swamp (50 kilometres south of Coongie Lakes). Feral pigs are a serious pest in Australia, and are found in New South Wales, Queensland and the Northern Territory, with lower densities in South Australia and Western Australia.

Estimations of feral pigs in Australia range up to 24 million at any one time, depending on seasonal conditions. They are the second most economically destructive pest to the agricultural industry after rabbits. Feral pigs can damage

stock and property, spread weeds, transmit diseases and dig up large areas of native vegetation. Their impacts on biodiversity include predation of small ground-nesting birds and their eggs, reptiles, and frogs.

Pigs were recognised as a serious pest in the mid-’90s, after successive flush seasons enabled a significant number to move downstream from Queensland via the Cooper Creek into Innamincka. Biological surveys in the late 1980s did not detect pigs along the north-west branch, Tirrawarra Swamp or the Coongie Lakes— but they were found at Embarka Swamp.

Surveys within the parks are held annually in September/October to monitor changes in the feral pig population. These surveys inform the requirements for control that usually occur in November when pigs move closer to permanent waterholes as water becomes less available.

Land managers and the community are encouraged to report sightings of any increase in numbers or changing distribution of pest animals or weeds to Natural Resources SA Arid Lands. While pest plant and animal numbers and distribution may fluctuate depending on seasonal conditions, information from land managers and the community assists in identifying trends and determining appropriate responses.



A male pig eats freshwater mussels on the Cooper Creek at Innamincka.
Inset: Natural Resources SA Arid Lands staff use canoes for pig surveying to cause less noise distraction.



Across the Outback is a respected newsletter of 21 years standing and continues to be a 'one stop shop' for information from South Australian Government agencies across the region.

It has become an essential read for nearly 1400 people and organisations with a stake or interest in the SA Arid Lands region.

Produced every two months, you can read *Across the Outback* online at www.naturalresources.sa.gov.au/aridlands. To join our mailing list contact the Natural Resources Centre SA Arid Lands on 08 8648 5300 or e-mail: SAaridlands@sa.gov.au

The National Rangeland NRM Alliance

The rangelands environment is very different to the more-developed agricultural areas of Australia, with most of the landscape managed by grazing of native pastures. The rangelands are generally managed by ecological methods, and building resilience in rangeland ecosystems is critical to managing variability in the landscape and climate.

The inherent links between productivity, biodiversity, social and financial issues mean that rangeland management needs to be seen, and approached, in a different manner to other landscape systems.

The National Rangeland NRM Alliance is a collaboration of 13 regional natural resources management bodies representing 81 per cent of Australia's landmass. The Alliance, established in 2008, provides a forum for rangeland natural resource management bodies to meet, discuss, and collaborate.

Initially, the Alliance concentrated on issues such as camels, cacti and cross-border funding applications in their collaborations. Over time, this focus has evolved into new thinking about structural change in the way the rangelands are resourced. Rangeland health is an issue of national importance, and stimulating investment in the rangelands at the national level is a key focus.

The Alliance has produced the Australian Rangelands Initiative (the Initiative) document to place the importance of productive and resilient rangelands on the national agenda. The Initiative is a blueprint that provides a basis for the long-term investment by government, industry, communities and producers in these natural resources.

The Initiative targets two key result areas.

1. Building the national rangelands agenda to create awareness of the importance of Australia's rangelands.
2. Demonstrating how this can be achieved by targeting groundcover as a driver of soil leaving the landscape, biodiversity and carbon storage.

A five-year implementation plan for the Initiative has been prepared as a draft investment case contributing to the delivery of the aims of the Australian Rangeland Initiative. This investment case has been presented to the 'Caring for our Country' program and Biodiversity Fund to discuss possible financial support.

The Alliance is also contributing to the development of a long-term project in the NRM Spatial Information Hub (the 'Hub'). The Hub aims to put in place sustainable capabilities and enablers that will provide systems, tools, data and skills to dramatically improve access to farm-scale information and knowledge that will underpin better management decisions and measurable improvements in landscape condition and productivity. Over the next five years the Hub will:

- implement on-line farm planning and information systems,
- provide coordination, information delivery, support and training services,
- provide support for paddock to national scale monitoring of pasture biomass, groundcover, biodiversity and environmental accounting and return on investment.

FOR FURTHER INFORMATION

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Stories to learn from

DR ANNE POELINA, A FELLOW OF THE PETER CULLEN WATER & ENVIRONMENT TRUST (2011), TALKS ABOUT WHY IT IS IMPORTANT TO SHARE STORIES SO ABORIGINAL EXPERIENCE AND KNOWLEDGE CAN BE INCLUDED IN LAND AND WATER MANAGEMENT DECISIONS.

I am a Yimardoowarra marnin, Nyikina woman of the Lower Fitzroy River in the Kimberley region of Western Australia. I am passionate about learning from the experience and knowledge of Aboriginal people living within the cultural and environmental landscapes of different parts of Australia; how traditional ecological knowledge can contribute to planning and development.

Above: Nyikina Kimberley Traditional Owners Dr Anne Poelina and Senior Elder Lucy Marshall. Photo Kirsty Cockburn 2011. Below: Fitzroy River floodplain. Photo Magali McDuffie 2011.



There is a current Australian story of vast potential resource projects which are placing some regions under overwhelming social, cultural and environmental pressure. Assessing the management of land and water inevitably raises questions of governance, and the implementation of science for impact studies on the practical development of unique locations. We know that despite the attractive presentations on mining companies' websites, mining often leads people to lose connection to their land and social ties. To understand how to keep these connections, we need to share stories, such as from the Lake Eyre Basin and regions such as the Super Canning Basin (Western Australia), so we can find meaning and opportunities to ensure the well-being of both humanity and nature, in the face of, or as partners in, development.

Australia's regions are at a critical point where some of the proposed resource developments present a real threat to land, water and food security, as well as to our unique Australian way of life. Many people who live in regions targeted for development are not anti-*development*; rather they are anti-*unethical* development—and they are particularly at odds with the notion of *development at all cost*.

Without financial and/or legal support there is currently limited opportunity for people in these areas to discuss the ‘facts’ about the impacts of resource extraction, processing and transporting methods.

As Australians we witness the loss of prime agricultural and grazing lands in southern and eastern regions. We question why we have not created international niche markets around our food security. We see individuals and companies who are not addressing due diligence requirements, and are failing to achieve community consent and social licence. We see short-, medium- and long-term financial losses, such as from stalled projects or disrupted production, because of legal challenges, local community, and native title opposition.

Listening to, and including, Aboriginal views

I believe that when responsibility and accountability in relation to economic development are shifted from the Commonwealth to state and territory governments, the result is unfairness and disadvantage to regional people and environments.

It can be different. Peoples in remote areas of Australia, such as the Lake Eyre Basin region and the north-west of Western Australia, are looking for a cooperative way to develop Australia’s multiple economies, using the wide body of information and world views that is available. The inclusion of Aboriginal views is required to provide genuine participation in the process. We believe we have an important role to play, based on the following points.

- Aboriginal people believe land, water and people are intrinsically entwined.
- Traditional knowledge is ancient wisdom generated over thousands of years of lived experiences and understanding about integrated land and water and natural resource management.
- Aboriginal people are custodians of the biodiversity of these regions.
- Aboriginal people can bring much to the science–policy dialogue about these remote areas where modern science is still in its infancy.
- The breadth of traditional ecological knowledge is grounded in holism, and the balance between social, human, cultural, environmental and economic values and assets.

- Aboriginal people want to be part of a cooperative paradigm in land-use discussions and decision making.
- Co-existence and co-management rely on policy makers and practitioners acknowledging cultural diversity and the inclusion of knowledge systems from local, national and international practice to inform better Australian practice.

It is important for decision makers engaged in land, water and environmental resource management to recognise they can bring representatives of Aboriginal people into the dialogue.

In the past, the best way to do this was to focus on catchment and basin management as an effective strategy for planning and managing, and for acknowledging diverse interests. The challenge was to develop a regional focus and to be inclusive, placing equal value on the representation of all members. Many groups using this approach

Senior Elder Jeanie Warbi caring for her grandfather’s special waterhole in the spring country that is covered with paperbark. Her family has been caring for this area from the beginning of time. Photo Ian Perdrisat.



found that, over time and with multiple forms of information management, decision-making principles and actions shifted from conflict to a cooperative way of doing business. Making a commitment to building trust and a cooperative spirit encouraged greater dialogue and a collective sense of managing land, water and environmental assets—from a regional point of view, rather than a state or Commonwealth operational framework.

Challenges and opportunities

I believe we now face new challenges: for example, how will governments of all persuasions and at all levels act ethically towards all Australians and the environment? How can we enmesh good science with traditional ecological knowledge, to work towards evidence-based ethical sustainable development?

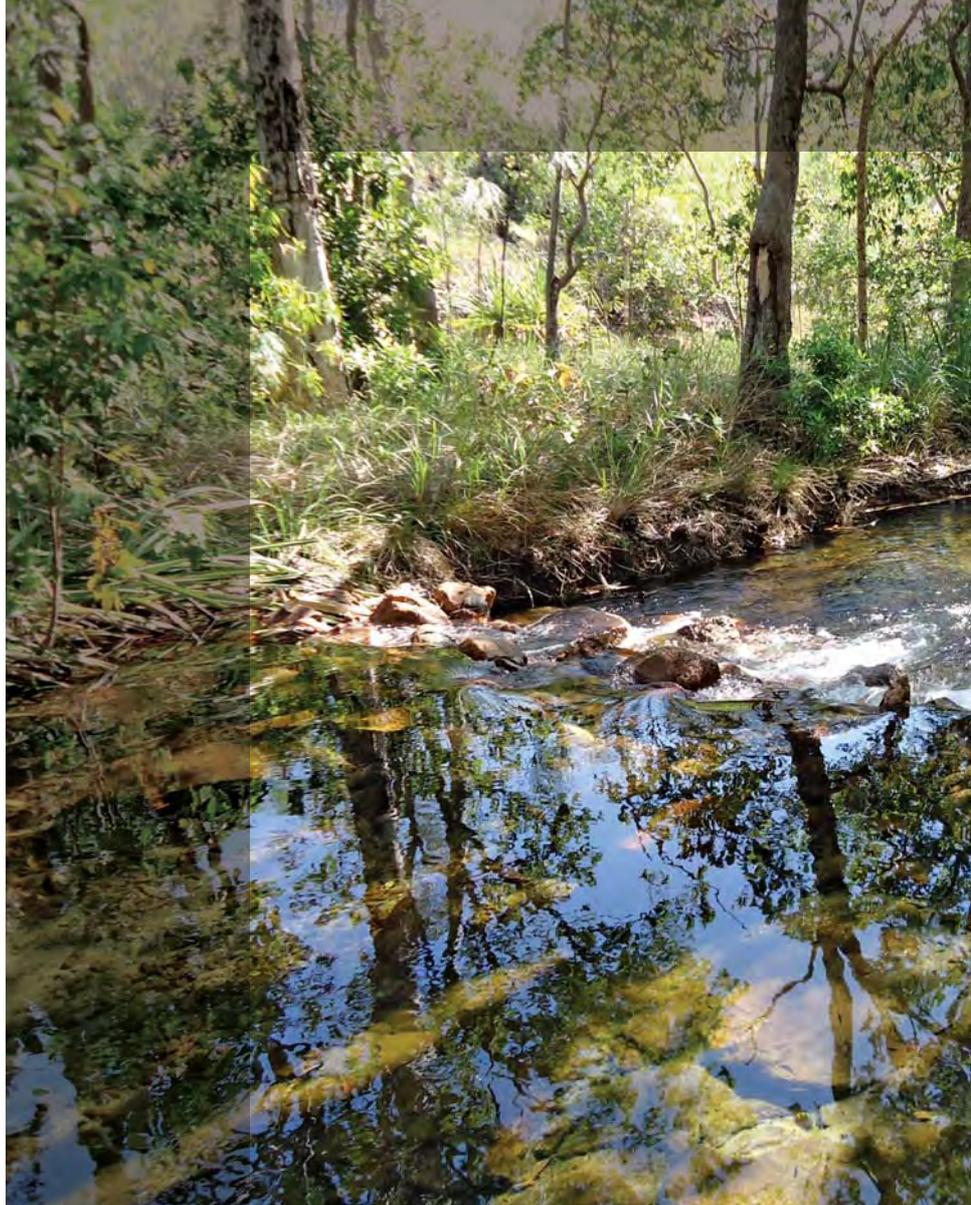
If we are to turn these challenges into opportunities, we need to support operational engagement frameworks at the level of regional governance. We need to build baseline data for ecosystem services by tapping into understandings of the landscape, cultural assets, and water resources held by Aboriginal people, scientists and others in regional communities. Baseline data will provide benchmarks for valuing environmental, social, cultural and economic relationships, and their role in land and water quality and sustainability. Using this approach, regional people will have the opportunity to reveal the impacts of each resource development project, and the cumulative effect of all of the industries proposed.

This requires cooperation. Governments, communities, leaders, individuals, industries and corporations can and must act together, to restore the balance that is essential for continued existence. I believe that by taking the time to listen and share stories we can find meaning and opportunities to ensure the well-being of people, land, water and biodiversity for a sustainable future.

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The Peter Cullen Trust works to strengthen bridges between science, policy and stakeholders in water-system management

FOR FURTHER INFORMATION

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NORTHERN AUSTRALIA— BACK ON THE AGENDA

THE **PETER CULLEN TRUST FELLOWS** (OF 2012), COMPRISING A GROUP OF SCIENTISTS, ENGINEERS, HYDROLOGISTS, ECONOMISTS AND COMMUNITY ADVOCATES, RECENTLY ENTERED THE NORTHERN AUSTRALIA DEBATE, CALLING FOR A SENSIBLE, CONSIDERED APPROACH IN THE DISCUSSIONS.

FOR FURTHER INFORMATION

www.petercullentrust.com.au

Rapidly developing northern Australia as the next food bowl for Australia and Asia is back in the national debate, particularly with Asian food markets expected to grow two-fold by 2050.

The Liberal–National coalition is calling for agricultural output from northern regions of Australia to be doubled, the tourist economy to increase to 2 million international tourists annually, and an energy export industry to be built worth \$150 billion to the economy. It is calling for public submissions on its ideas for the north.

According to a recent survey by the Institute of Public Affairs, 63 per cent of Australians think increasing the population in northern Australia would be a good thing for the area.

The Kati Thanda–Lake Eyre region (and a considerable area around it) is contiguous to, and part of, northern Australia. It is important that the landowners and leaseholders of this land, as well as the scientists who visit it to study its resources, take part in the conversations expected about developing the northern regions. Rivers feeding Kati Thanda–Lake Eyre rise to the north of the Basin, and the lake would be affected by development in their headwaters.

Policy making is sometimes referred to as ‘the art of persuasion’. This goes both ways. Policy makers themselves need to be convinced about the facts of a case; and the sooner that happens in the political and policy-making cycle, the better. Advocacy plays an important role here.

Our key message is this: developing the north is a complex and sensitive policy matter requiring careful consideration of the social, environmental and economic nature of the



We support our call with a seven-minute video, *Great northern land — a southern myth?*

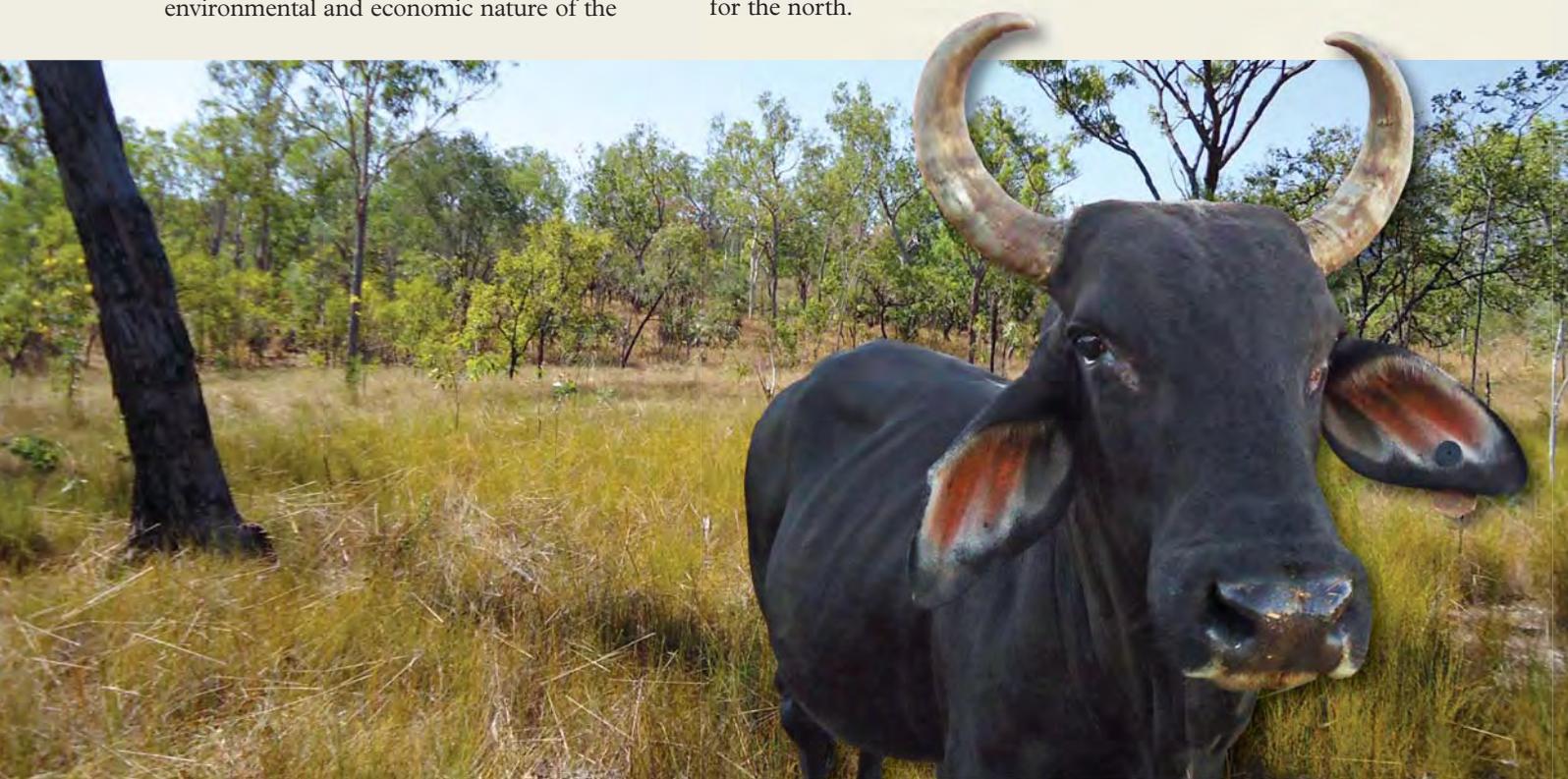
Watch it at www.youtube.com/watch?v=a4s8ethxifA

north. We believe that rapidly expanding the economy of northern Australia cannot be achieved without further development of water resources, which presents significant challenges: the landscape receives minimal rain for eight months of the year, and around 1 million gigalitres of rain during the wet season — which is a third of the nation’s rainfall.

Of course, policy making is more than just persuading; it is also about listening. To achieve sustainable development, local and indigenous communities need to be ‘front and centre’ of the policy process, to inform policy makers of the regional constraints and opportunities that need to be considered in the development process. Our Fellows group considers that communities *adjacent* to northern Australia, including those of the Kati Thanda–Lake Eyre region, should ensure they become involved in this listening and persuading process of policy making.

We have called for a strengthening of governance arrangements across northern Australia, and ongoing effort to build regional capability so local communities are involved at every step of any future development plan for the north.

Title photo: Clear waters run through Litchfield National Park, Northern Territory. Below: Savannah-woodland in tropical northern Australia and a resident of a cattle station near Adelaide River, Northern Territory. Photos A. Milligan.





It's wild out there

MATT TURNER IS PASSIONATE ABOUT PROTECTING THE SIMPSON DESERT.

The Wilderness Society has a keen interest in managing the natural assets of the Lake Eyre Basin. From protecting the intact and unregulated rivers such as Georgina/Diamantina River and Cooper Creek, to advocating for wilderness protection of the Simpson Desert, we are working with landholders, Aboriginal groups and others to sustainably manage the incredible natural resources of the Lake Eyre Basin.

The Simpson Desert is truly spectacular. It is one of the largest areas of high-quality wilderness left in Australia, being almost three times the size of Tasmania. Of particular importance is the southern Simpson Desert —the Kallakoopah region.

PHOTOS THROUGHOUT THIS ARTICLE AND ON PAGE 30 AND 35, MATT TURNER.

The Simpson is subject to boom and bust climatic cycles, where droughts are followed by massive flooding events that bring the desert to life. Birds visit from all over Australia resulting in spectacular breeding events. Very little of the Simpson is formally protected.

Straddling three states (South Australia, Queensland and the Northern Territory), the Simpson Desert is at the heart of the Lake Eyre Basin and Great Artesian Basin. The Simpson is home to a diverse range of plants and animals. Endless dune systems range in colour from burnt orange, through yellow to the white sands on the bank of the Kallakoopah Creek. Floodplains and salt lakes are important water sources following large, but infrequent rainfall events that bring the desert to life. At this time, a carpet of beautifully coloured wildflowers blanket what is the largest parallel dune system in the world.



The South Australian section of the Simpson Desert is the traditional lands of the Wangkangurru/Yarliyadi people. They maintain a strong connection with country and their stories are interconnected with the landscape. Many remain in the region in places such as Birdsville, Bedourie and Alice Springs.

Traditional life in an arid environment was largely dependent on a handful of mikiri—freshwater soaks that offered permanent water. Claypans, swamps and small salt lakes were important as secondary sources of food and water. These sources, along with rivers such as the Kallakoopah, Warburton, Macumba and Eyre Creek enabled travel through country.

Some of Australia's famous early explorers, including Captain Charles Sturt, and Burke and Wills were defeated when they encountered the Simpson Desert. The first successful crossing by a European occurred in 1936 by experienced bushman Ted Colson, with the help of Peter Ains, an Aboriginal man from Oodnadatta. In 1939 the first biological survey of the desert was conducted by a team lead by Cecil Madigan.

Today, 'Crossing the Simpson' is regarded as one of Australia's great outback expeditions, attracting increasing numbers of people seeking a genuine wilderness experience in an iconic and remote landscape.

Mining and petroleum exploration has increased exponentially in recent years. There are currently three mining applications proposed for the Kallakoopah region of the desert. Coal was identified beneath the Simpson Desert many years ago; but it is very deep and of a low grade.

Today, some companies believe that coal can be harnessed by contentious methods including coal seam gas/fracking and underground coal gasification. These technologies pose significant contamination risks to underground water resources, including the Great Artesian Basin.



The Wilderness Society calls on the South Australian Government to proclaim a Wilderness Protection Area in the Simpson Desert.

FOR FURTHER INFORMATION

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Russian roulette with wild rivers

KAREN TOUCHIE ASKS WHAT CHANCES ARE WE PREPARED TO TAKE WITH OUR RIVERS.

THE WILDERNESS SOCIETY

On 31 July 2013, Queensland's Natural Resources and Mines Minister, Andrew Cripps, formally announced his intention to scrap existing Wild River protections for the Georgina, Diamantina and Cooper Creek by the end of the year. What the new regime will actually look like, no-one knows. Minister Cripps' announcement provided little detail. All we know for certain is that it is clearly intended to facilitate expanded oil and gas exploration and development including, it would seem, in the region's rivers and floodplains.

More than 80 per cent of the water that eventually forms the globally significant desert wetlands in the Lake Eyre Basin comes from these three Queensland river systems. Under existing Wild River protections, floodplains, rivers and waterholes are given the highest protection, resulting in an effective prohibition on oil and gas development in those areas of the Channel Country.

Sounds extreme? Not really. Those areas equate to a mere 10 per cent of the total land area, and strike a workable compromise between environmental protection and resource development. With the removal of Wild River protections, oil and gas companies will no doubt be hoping for a rapid expansion of the unconventional gas industry in the Cooper Basin. However, if the Queensland Government goes through with this proposal, it will be writing the oil and gas industry an environmental blank cheque and ignoring the wishes of local pastoralists and traditional owners. Indeed, Minister Cripps' own hand-picked Western Rivers Advisory Group told him in July that Channel Country communities overwhelmingly wanted to keep their rivers and floodplains protected from oil and gas developments.

Resource companies are already making substantial profits from their Channel Country operations. Santos' 2012 *Fourth Quarter Activities Report* noted that crude oil production in the Cooper Basin was up by 14 per cent from 2011. Gas production in the Cooper Basin also went up, with bad weather—not environmental regulation—cited as the main factor impacting on gas production.

While companies have a responsibility to their shareholders to deliver a return on investment, it's important that they—and their supporters in government—remember they also have a responsibility to maintain the integrity of the environment and the confidence of the community. This is where the oil and gas sector has got it all wrong, particularly in respect to coal seam gas and shale gas. In their rush to the bottom line, industry operations have run ahead of scientific understanding, appropriate regulatory settings and, as we're seeing across Australia, a social licence to operate.

The announcement by Minister Cripps is yet another bleak example of industry and government failing the social licence test. It's also a clear sign that both the Queensland Government and the oil and gas industry are prepared to play Russian roulette with this majestic fragile environment, an established \$500 million grazing industry and a burgeoning tourism sector. Whether they are allowed to get away with it depends on each of us.

FOR FURTHER INFORMATION

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RED RIDGE

Red Ridge (Interior Queensland) Ltd, in partnership with Central West Aboriginal Corporation, Longreach Aboriginal & Torres Strait Islander Corporation, Central Queensland Indigenous Development, and Bedourie Aboriginal Corporation have curated an exhibition, titled “My Earth Calls” featuring works by 21 Indigenous artists residing in interior Queensland. The area stretches from Bedourie to Thanragmindah, Charleville, Tambo to Quilpie, incorporates 40 communities, some 24,000 people, in 512,000 square kilometres, and covers 33 per cent of Queensland.

In this inaugural exhibition sponsored by Arts Queensland, the Stockman’s Hall of Fame and CICADAS @ RAPAD, Indigenous artists will show their mixed-medium artworks (paintings, wood work, ceramics, emu eggs), that feature both traditional and contemporary subjects.

Red Ridge is a not-for-profit charitable regional arts organisation whose primary focus is to grow sustainable, effective and appropriate arts activities through a vast region.

“This painting is all about my country from the sand hills to the river country, where my ancestors and my parents have walked and hunted for food, when the country is green and the food is plentiful. This picture also has lots of meanings to me through spiritual and traditional connections which has been handed down to me and now the younger generations.”



Artist: (Anpanuwa) Joyce Crombie
Location: Bedourie
Artwork: All about Country
Medium: Sand/crushed gibbers/
acrylic on canvas
Joyce’s language group is
Wangkangurru/Yarluyinda



“My Earth Calls” is on display in the Dr Bruce Yeates Memorial cottage, at the Australian Stockman’s Hall of Fame, Longreach from 20 September to 5 October 2013, with the official opening on 20 September at 6.00 pm. All are welcome.

FOR FURTHER INFORMATION

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Facebook: My Earth Calls Exhibition



There's an air about this place...

SIWAN LOVETT, RIPRAP EDITOR, ARRC DIRECTOR

In all my years working in river and natural resources management, I have been privileged to meet wonderful people who have shown me the places that are special to them. Angus Emmott is a good friend of mine, and together with Vol Norris, opened my eyes to the beauty of the Lake Eyre Basin, Cooper Creek, Georgina and Diamantina Rivers. Although I live in Canberra—a special place for me—I feel a strong connection to inland Australia. I care about what happens to this fabulous part of our world, and I care about the people who live and work in this region.

It is important we have at the forefront of our minds that 'places' are inextricably linked to our identity—who we are. Too often decisions are made that trample on 'places' and, in so doing, the identities of people who are connected to that place. I am deeply concerned about the decision to alter Wild Rivers legislation in Queensland, as it may allow a lot of 'trampling' to occur in ecosystems that are vast, yet delicate. Angus Emmott has lived in the Lake Eyre Basin all his life, and I asked him to write something about his 'place' so his words might resonate and inspire us to do whatever we can to care for this part of our country.

ANGUS EMMOTT, NATURALIST, GRAZIER...

The Lake Eyre Basin is one of the largest internally draining basins in the world, containing the most highly variable rivers in the world, and occupying one sixth of Australia's land mass. Yet it is home to only 60,000 people, half of them living in Alice Springs, the rest being spread thinly across the Basin. As a third-generation landholder living in the red dust of the Queensland channel country, I am one of these people, and feel privileged to be operating a business from this extraordinary part of the world.

Growing up, my love for the land and keen interest in what was around me, developed into a passion for the natural environment. This has become a large part of what I do, and has led me to spend much of my time seeking a better future for the landscapes, ecosystems and natural resources of the Basin. These are truly remarkable on the world stage... unique flora and fauna adapted to the extreme boom and bust nature of the system, and ephemeral wetlands that attract waterfowl and shorebirds from thousands of kilometres away for huge feeding and breeding frenzies.

PHOTOS IN THIS ARTICLE, ANGUS EMMOTT.



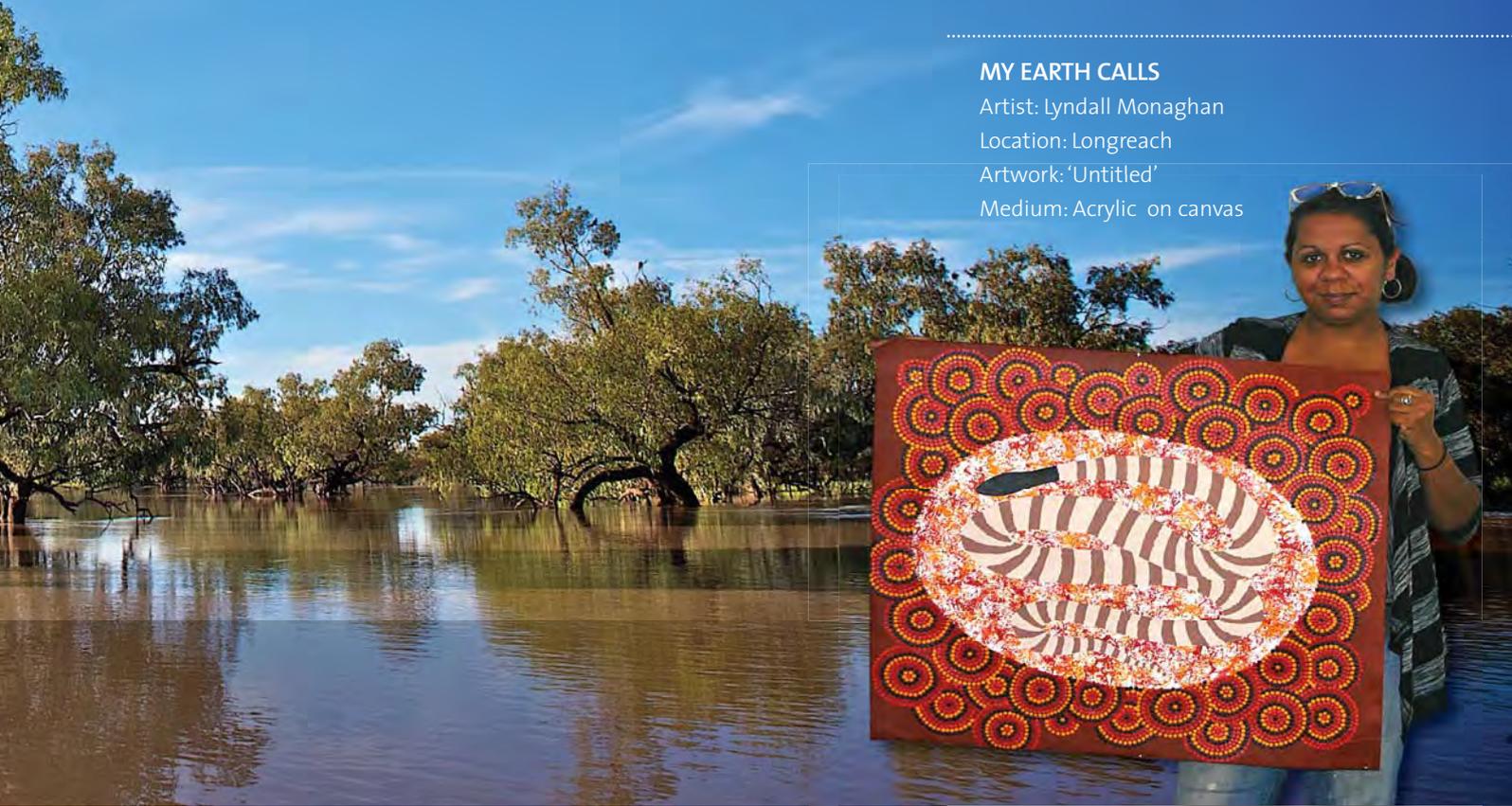
MY EARTH CALLS

Artist: Lyndall Monaghan

Location: Longreach

Artwork: 'Untitled'

Medium: Acrylic on canvas



In recent times, four big flood years in a row have brought water into Lake Eyre from all major tributaries, creating an unusually sustained 'boom' in this boom-and-bust system. Cooper Creek has flowed its entire length for the first time in decades, and flooding across the Basin has given the environment and the grazing and tourism industries a major boost. But with good times come tough times, requiring patience, courage, resolve and support from others. All who live and work in the Basin, having faced droughts and dire circumstances, are heavily invested in its long-term future and its ability to support our lives and livelihoods. This ability to prosper is fundamentally underpinned by a robust and healthy biodiversity. The natural environment is the controlling influence on everything we do; we are embedded in natural systems that provide all our opportunities and resources, as well as some of our constraints.

To keep this wonderful part of the world in healthy condition for our grandchildren, we need to think strategically and work together. I believe that a deepening understanding and appreciation of the special features of the Basin, together with cooperation and good will among all who value and influence the Basin, are the keys to a sustainable future.

DOWNLOAD your RipR'app'

As of May this year the beautiful Lake Eyre was renamed Kati Thanda—Lake Eyre to recognise the historical and spiritual connection of the Arabana people. Kati Thanda comes from the sacred name for the saltpan lake and means 'the name of the lake which was formed after the skin of a kangaroo was spread over the ground'.

To celebrate this special edition of *RipRap*, the ARRC is releasing another special treat for its readers. The magazine you've come to love is now in digital format! It is available on the iPad as a digital issue, along with the past two editions.

To get the RipR'app' visit riprapmag.com or head to the app store and search for *RipRap*.



BASIN PEOPLE

A lakeside location...



IN THESE PAGES WE HAVE THE THOUGHTS OF THREE PEOPLE WITH A LONG-TIME ASSOCIATION WITH KATI THANDA-LAKE EYRE.

TREVOR WRIGHT HAS BEEN OPERATING TOURIST FLIGHTS OVER THE LAKE FOR 25 YEARS.

DON RANSOM IS CLOSELY INVOLVED WITH DEVELOPING PUBLIC ACCESS ROUTES.

REX ELLIS BEGAN HIS NATURE-ORIENTED SAFARI OPERATIONS IN 1965.

.....

TREVOR WRIGHT—I've been fortunate to have been involved with Kati Thanda-Lake Eyre tourism for the past 25 years. I have had a very unique and privileged association with the Lake because I live and run my business in William Creek, the nearest community to the North Lake. You could say I live beside the Lake.



In the early days, there was little media interest in the Lake and its Basin, except perhaps for the world land speed records of 1963/64. The next lot of coverage was in 1974, when the Lake received a large amount of inflow and this generated some public interest. However, it was not until the year 2000 that media attention really grew, and the Lake became a destination by the middle aged and retirees (mainly) as they travelled around Australia (those who we now know as the 'grey nomads').

Between 2009 and 2012, the Lake received unprecedented attention that led to a whole new market for tourism operators. There was a flourish of activity, and the development of a range of new tourism products that rapidly entered the market place.

I believe that the growing level of media interest in the Lake is a reflection of changing public attitudes and interest in the environment. With improved information technology we have seen rapidly escalating interest and awareness in environmental values. People's understanding and knowledge about the importance of the environment to the sustainable future of our planet, our general health and well being is growing rapidly, and I believe this will continue.

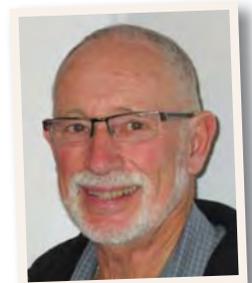
This interest in the environment has also meant a change in the types of tourism experience people are seeking. They are increasingly looking for high quality interactive experiences, involving a better understanding of the environment and its people. The Lake and its outback communities certainly offer an iconic Australian experience, and this has underpinned significant tourism opportunities, job growth and outback community development.

One of our big challenges is to improve marketing of the Lake during those periods when it either has little or no water in it, and to continue to develop other tourism experiences to add value to the Kati Thanda-Lake Eyre experience. This needs to be done in ways that are sensitive to the fragility of the environment, and which protect the region now and into the future.

Policies affecting the way we manage the Basin and its catchments will have a profound effect on the long-term integrity of this priceless natural asset. It will also have an impact on those people and their livelihoods in outback communities. We need to ensure the Lake is protected so it can be enjoyed by many future generations. This means that the decisions we make now will determine the future.

.....

DON RANSOM—When the rivers flow to Kati Thanda-Lake Eyre, it is spectacular and of great interest to many people. I suggest we need to do more to enable visitors to experience these wonderful places. The Lake Eyre Basin is a special place, and an increasing number of people are heading out into the region to see the wonders it contains.



When you reach some sites your view is limited, and is mostly of steep-banked waterholes with a lot of lignum and well-established trees. Between these spots there is a large variation of shallow water, floodplains, lakes and magnificent birdlife that cannot be seen. I believe we need to provide people with easier access to some of these special parts of the Basin so they can enjoy the wonders of the region in a way that preserves and protects these areas.

...with riverbank views



PHOTOS OF THE COOPER CREEK, ON OPPOSITE PAGE, HENRY MANCINI AND ABOVE, MATT TURNER.

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Perhaps a more equitable balance of usage of the natural resources of the area could be the answer. One possibility is to use the South Australia Pastoral Land Management and Conservation Act to provide the community with a system of access to, and through, pastoral land. This approach could find a balance between the pastoral and petroleum industry, and the community in enjoying the magnificent Lake Eyre Basin.

REX ELLIS—I've been travelling to Lake Eyre since 1974, when I was lucky enough to boat its entire length from north to south ... that was a remarkable year, the only time the Lake has been full in white man's memory. Conditions over the last three years are also unprecedented in my lifetime, with three consecutive years of flooding in the Warburton Creek and two on the Cooper Creek.

In 2010, the Cooper came down for the first time in about 19 years. It was a pretty special event because it's a heck of a long trip, but it took even longer than expected for the floodwater to reach the Birdsville Track, despite upstream waterholes being full from earlier rains. We shifted boat trips to the Warburton Creek as we waited for the Cooper to flow. Expecting turbid, murky water, it eventually came down a clear, greenish colour. It was fascinating, something I've never seen in my years spent on these rivers. It seems that the extraordinary mass of vegetation carpeting the floodplains higher in the catchment was acting as a sort of environmental septic, filtering out the sediments and sending clean, clear water downstream.

Equally amazing on the Cooper, has been the re-sprouting of centuries-old coolibah trees, some we had written off for dead during the last drought. The last time I witnessed this was during the '74 floods when the stumps of some coolibah trees on the Birdsville Track, felled to build cattle yards over 40 years earlier, suddenly sprang to life after the floodwaters receded.

On my last trip down the Cooper to Kati Thanda–Lake Eyre, bird numbers seemed almost back to pre-drought levels. But surprisingly, on islands where pelicans have traditionally nested, last year in 2011 there were hardly any, despite the abundance of food. I can only suggest this may have been due to significantly increased air traffic, buzzing islands on the Lake.

During the drought I was very concerned that we were going to lose several bird species, in particular the pelican, straw-necked ibis, pink-eared duck and black duck. These species didn't seem to bounce back as well, like they have after other droughts. I believe the reason for this lies in the added pressure of irrigation, sucking the water out of the country.

Tourists have been coming to this place for decades, especially in the wet years when they come in their thousands. I took the first party of tourists across the Simpson Desert in 1971...one of the greatest four-wheel drive adventures in the world. Tourist activity is fairly well managed here, in my opinion, and doesn't cause any major problems. There's always the odd person who might chainsaw a standing tree for firewood...shocking, but thankfully rare...although it doesn't take much to have a big impact in this relatively treeless landscape! But when the dry times come again, everyone will forget about Kati Thanda–Lake Eyre for another decade or so, and the landscape will have a chance to rest and recover from the tourist invasion of the boom years.

To properly look after Kati Thanda–Lake Eyre and surrounds, I think we need to address the threat of underground water extraction. As a society we have to start valuing the wealth of our natural desert environment—the mound springs, rare desert fish and spectacular bird colonies—in the same way we value the wealth afforded by our mineral resources.





Connected flows

JUANITA HAMPARSUM, ACTING CHAIR OF THE GREAT ARTESIAN BASIN COORDINATING COMMITTEE (GABCC) SHARES THE WONDER THAT IS THE GREAT ARTESIAN BASIN AND TALKS ABOUT THE ROLE OF THE GABCC IN MANAGING THIS PRECIOUS ASSET.

On a snowy day in New York, a shivering commuter slips on a pair of mittens. The wool of her mittens was shorn from a sheep that drinks from a trough near Marree in South Australia. The water in the trough has emerged under its own pressure, from a bore reaching down 1000 metres into the Great Artesian Basin (GAB), and after an underground journey lasting many hundreds of thousands of years.

The water first seeped into the earth during a downpour on the Great Dividing Range in eastern Australia. Some of the rain re-emerged in a nearby spring, where herds of giant wombat-like diprotodons drank. Some of it journeys on still, destined to meet the sun again in a million or so years in mound springs near Lake Eyre, where the local Aboriginal people teach their children how the springs are linked to their Dreaming.

In such ways the mysterious flows of the GAB connect us across time, distance and cultures.

It is sometimes tempting to envisage Australia's GAB as an enormous underground lake, separate from 'real' life above, until tapped for productive use. It is not, however, a lake at all; it is solid rock, with water stored in the pores between the coarse grains of sand in vast sandstone sheets. The Basin's water is connected to above-ground lifecycles, received as rain, and emerging in springs, streams and bores.



Title photo: Viewing platform protects mound spring fringing vegetation from trampling. Inset photo: Capped and piped Quilberry bore, courtesy of GABCC. Above: Historic photo of sheep at Cambridge Downs Station, Queensland c1894, image John Oxley Library 109158.

The springs are inextricably woven into stories and histories of Aboriginal people. They sustained early European exploration and settlement where permanent water was scarce. With the drilling of bores, artesian waters now sustain people, towns and industries across almost a quarter of the country, in Queensland, New South Wales, South Australia and the Northern Territory.

The Basin is much more than a reservoir for people to water the arid, sparsely populated land above. It is home to some of the oldest continuous cultures on Earth, and attracts thousands of visitors every year. Its waters contribute to the billions of dollars worth of industry that operate within the Basin, and support unique plants and animals. The Basin's waters offer considerable potential for increased levels and greater diversity of production, and ways of facing future challenges such as climate variability and low carbon energy sources.

The GABCC exists to provide advice on efficient, effective and sustainable whole-of-resource management of the GAB and to coordinate activity between stakeholders.

In 2009, the GABCC published the *GAB Strategic Management Plan: Progress and Achievements to 2008* detailing the progress in implementing the Plan between 2000 to 2008. It identified a need to refine and refocus efforts and the subsequent *GAB Strategic Management Plan: Focus and Prospects 2008–15* details objectives and targets that seek to ensure:

- GAB water and pressure resources are sustainably managed to retain and enhance productivity, social and economic value, biodiversity and cultural value, and future use options,
- GAB policy, planning and regulatory regimes are effective, cooperative, harmonised and appropriately applied,
- GAB science and technical capacities are comprehensive, robust and continually improving,
- communities and stakeholders within and beyond the Basin recognise and understand the GAB as a dynamic, nationally significant resource with multiple values.

FOR FURTHER INFORMATION

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The GABCC has worked to realise the outcomes of the Strategic Management Plan by co-investing in a range of projects.

Sustainable management of water and pressure

The GABCC has championed and monitored the 15-year, \$450 million Great Artesian Basin Sustainability Initiative (GABSI) which is jointly funded by federal and state governments and participating landholders. Up to June 2012, there have been 550 bores rehabilitated, 18,000 kilometres of bore drains eliminated, and more than 27,000 kilometres of piping installed (along with tanks and troughs) to deliver water to stock. There has been 190,000 megalitres of water returned to the environment every year, and this has helped in the recovery of artesian pressure.

Over the last three years, the GABCC has also focused on the extractive industry development in the Basin, recognising that its rapid growth across the landscape could significantly impact GAB water and pressure resources, and undermine the hard-won gains of GABSI.

Policy, planning and regulation

Governance and management of the GAB is multi-jurisdictional, multi-layered and complex. Comprehensive policy, planning and regulatory regimes are the foundation of effective GAB governance and management.

The GABCC has consistently put the case to ministers and jurisdictional agencies that all governments with control over the GAB should ensure their policy, planning and regulatory regimes are harmonised within and between jurisdictions; focused on achieving balanced and consistent outcomes across the GAB; adequately and continually enforced; and progressively improved and strengthened through adaptive management.

Science and technology

The GABCC has made important contributions to advancing Basin science and technology through the GAB Water Resource Assessment, a whole-of-basin monitoring network and a publications record. The Committee supports a technical working group and research and development committee, while a research prospectus and PhD top-up scholarships ensure knowledge gaps are filled. GABCC members encourage dialogue across organisations to enhance Basin research and harness the best available science to inform GAB policy and regulatory regimes.

Community awareness

The GABCC has also increased broader community recognition of the GAB as a nationally significant resource. Communications include a website, a DVD, booklet and a growing suite of factsheets. These factsheets highlight the wider ecological, cultural and social values of the Basin, including its pivotal role in the spiritual and cultural beliefs of Aboriginal communities.

The latest communication tool is the *Water Down Under Poster Map*, that tells the story of the GAB from its Gondwana beginnings, to its central place in the life, trade and culture of Aboriginal people, and to its critical modern day importance in the lives of more than 180,000 people and the viability of more than 120 towns and 7600 enterprises.

It has been widely distributed, so anyone visiting an iconic outback pub in the GAB area, or enjoying the hot mineral baths at Mitchell or Lightning Ridge, can see the *Poster Map*. Copies can be ordered through the GABCC's website — www.gabcc.org.au — and follow the links.



Changes for the Arabana

MELISSA NURSEY-BRAY TALKS ABOUT HER WORK WITH THE ARABANA PEOPLE IN RESPONDING TO CLIMATE CHANGE.

Aboriginal and Torres Straits Islander peoples across Australia and the world are being affected by, and responding to, climate change. The Arabana people of Kati Thanda–Lake Eyre (whose traditional lands include that region but who now live in Darwin, Alice Springs, Marree, Adelaide, Port Augusta, Oodnadatta and elsewhere) are no exception.

PHOTOS THROUGHOUT COURTESY OF THE AUTHOR. TITLE IMAGE: SUNSET AT FINNISS SPRINGS, BELOW PART OF THE MARREE TOWNSHIP AND ON THE OPPOSITE PAGE GIBBER PLAINS AND FOREBODING SKY.



The Arabana are starting the long journey of managing climate change in their country with the implementation of a climate change adaptation strategy, developed as a result of a partnership between researchers from the University of Adelaide and the Arabana people. As Aaron Stuart, Chair of the Arabana Board of Directors said in 2012:

“It’s very important. There are a lot of things that are affecting our country at the moment, but climate change is the one, the major one that we need to know about besides everything else, this one can change our country, this one can change who we are.”

Funded by the National Climate Change Adaptation Research Facility, the aims of the research were to:

1. Assess what the varying vulnerability and risks are to the Arabana people from projected climate change impacts, not just on Country, but in many of the different places that they live.
2. Establish what adaptive capacity existed that would assist adaptation to those changes, and could be put into action after wellbeing, resilience, governance and information and communications technology are investigated.
3. Develop adaptation options/actions for, and with, the Arabana peoples.

The scientific report produced as part of the project has shown that Arabana country will be affected by climate change, altering precipitation, with the region becoming much hotter and drier over time. Fieldwork results highlight that these predicted impacts concern the Arabana, wherever they live, as people are worried about the availability, access, quality and drying-up of water, especially in relation to their culturally significant mound springs. Groups involved in the study identified and described a number of changes (mainly environmental) that they had observed over time (a 90-year period). These included changes to flora, fauna, settlements and sea level, as well as the frequency of climatic factors including heat, cold, ice, dust, wind and cyclones.

In addition to seasonal changes, the Arabana are also concerned about the destruction and eroding away of cultural sites by wind, erosion or flooding. The maintenance of livelihoods was another issue that emerged, as well as how to build, and maintain family and cultural networks across the nation. Ultimately, the challenges Arabana people believe they face include reconciling economy and environment, acknowledging distinctions between an urban and a remote experience, and managing the legacy of a collective past.

Arabana country is highly vulnerable to the impacts of climate change, but the Arabana people are highly resilient and have been adapting to change for millennia. Today, this resilience is manifest in the way they have moved around the country, withstood the pressures of colonisation, and remained culturally strong with a resilient sense of identity, no matter where they live.

The adaptation strategy developed with the Arabana in response to these challenges presents a suite of adaptation options and has been structured under three programs:

1. Culture.
2. People.
3. Environment.

Specific adaptation options include establishing cultural centres in every place and city where Arabana people live, setting up economic businesses in tourism and pastoralism, moving back to Country, developing regular cultural camps and revitalisation programs, building partnerships, and setting up ranger, land management and monitoring and research programs.

Arabana people are now working on the implementation of the climate change adaptation strategy. However, as with all the other challenges they face, they cannot do this alone. Government, researchers, industry and all parties within the Kati Thanda–Lake Eyre region have an opportunity to support, work with, and learn from the Arabana.

“Arrubanna” (family), a painting by Aaron Stuart, see page 1.

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 community-based-adaptation-arabana](http://www.nccarf.edu.au/publications/community-based-adaptation-arabana)

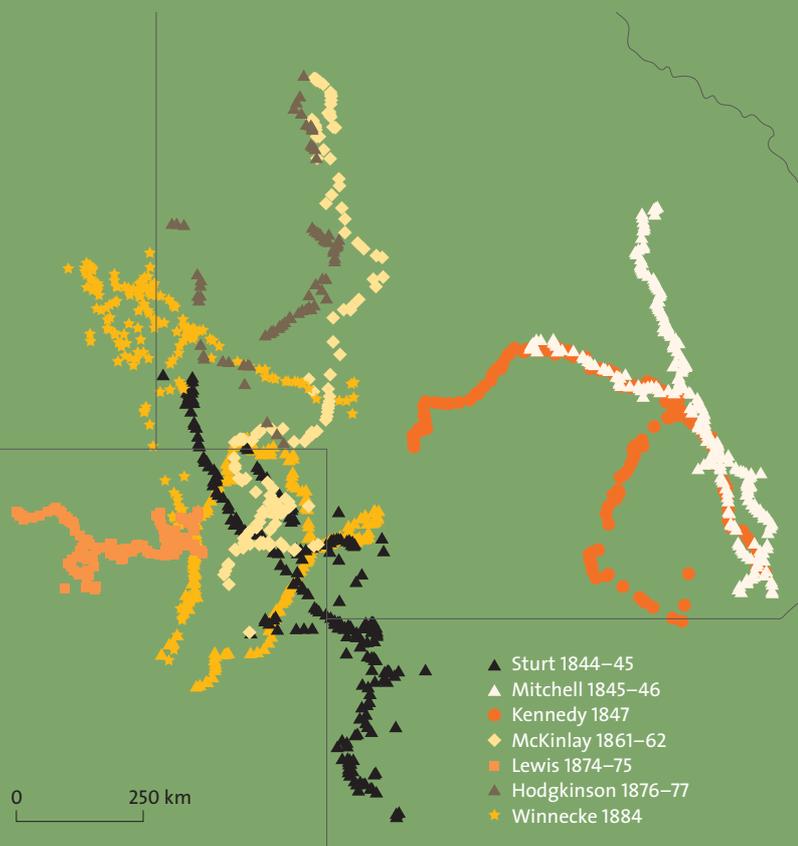
Arabana Elder Ken Buzzacott in 2012:

“We got to talk together,
 stick together and
 try to do something
 there ... work together,
 and everybody ...
 can get success.”



Degraded or just dusty?

QUEENSLAND BOTANISTS JEN SILCOCK AND ROD FENSHAM RELATE FINDINGS FROM THEIR WORK INVESTIGATING VEGETATION CHANGE IN THE BASIN.



Some of the explorer observations geo-referenced, spanning the period 1844–1919, observations of Landsborough (1861–62), Davidson (1885) and Basedow and Greenfell-Thomas (1919) are not shown.

The recent history of inland Australia is commonly presented as a tale of environmental destruction and devastation. Substantial degradation of the Lake Eyre Basin (LEB) over the past 150 years has been attributed to European land management practices. Symptoms of degradation include soil erosion and associated silting of rivers and waterholes, thickening of woody vegetation, altered fire regimes and changes in the composition and abundance of plant and animal species. While many examples of environmental change are irrefutable, others are not supported by empirical evidence, but have nevertheless become enshrined in the scientific literature and popular imagination as ‘conventional wisdom’.

Across the LEB, where the spread of European pastoralism was all-encompassing and abrupt, inferring the cause and magnitude of landscape change is frustrated by the rarity of records that pre-date this momentous biogeographic watershed.

We pursued four methods of investigating landscape change since pastoral settlement:

1. Systematic analysis of early explorer journals.
2. Analysis of grazing gradients.
3. Measurement of long-term exclosures.
4. Regional assessment of potentially rare and sensitive plant species.



Opposite: Some species considered 'rare' such as *Sclerolaena walkeri* can remain unseen for years then 'boom' when the conditions are right. *Sclerolaena walkeri* had not been collected since 1942 until it was found across large areas of floodplain in the Georgina, Diamantina, Bulloo and Paroo catchments in 2006–07.

Above: One of the genuinely endangered plants of the LEB, *Ptilotus brachyanthus*. Only three populations totalling about 300 plants have been found after hundreds of hours searching in suitable habitat after abundant rainfall.

All methods have advantages and limitations, but when used together can provide unique insights into ecological change, many of which are not consistent with existing dogma.

We tracked the paths of 14 explorers and geo-referenced 4500 observations, using their distances and bearings, landscape features, topographic maps and Google Earth. Between 1844 and 1919, these expeditions provided the first written descriptions of the LEB, just before the massive upheavals associated with pastoral settlement. Careful evaluation of these observations, and comparison with the contemporary landscape, suggest there has been little change in vegetation structure or waterhole permanence across the Basin. The sparse observations of fire, suggest burning was infrequent and mostly restricted to creek-lines and higher-rainfall grasslands in the east and north, and in spinifex deserts. Kangaroos were apparently uncommon in semi-arid areas where they are abundant today.

Obviously there is a lot more water in the landscape now than there was before the advent of bores and tanks. Without these artificial water-points, the grazing industry would only be a shadow of what it is today. We started out trying to find places that are a long way from water, with the expectation they might provide havens for grazing-sensitive species.

These places are rare, and where they exist they are usually harder and tougher environments than the well-watered country. The only place we could find reasonably 'sweet country' that was a long way from artificial waters, was in the swales of the Simpson Desert. Here the sweet gidgee country, wedged between the long red sand dunes, has only recently been opened up for grazing. Working out from the newly sunk bores we found some plants that were sensitive to grazing, but just as many that did very nicely from cattle as well. What we didn't find were plants that are so sensitive to grazing they only survive in the water-remote areas where the footprint of cattle has been light.

Our next approach was to look at long-term enclosures to see what they could tell us about the impact of livestock. We measured a network of enclosures (three in mulga, 18 in Mitchell grassland, and four in dunefields) more than 15 years after they had been established, and before the fences had started to fall apart. These fences included full netting to exclude all grazing animals, and wire fences that only excluded livestock. In all Mitchell grass enclosures there was only slight evidence of negative or positive impacts of grazing. Some species responded positively to grazing and others negatively, but the Mitchell grasses themselves seem unaffected, and their diversity was about the same across the treatments. One of the annual grasses known as river grass (*Chionachne hubbardiana*) was much more abundant inside the complete enclosure fences, indicating it is an 'ice-cream plant', that is highly preferred and gets taken out before grazing animals turn to lesser delicacies. In the mulga, the palatable perennials were reduced, but definitely not eradicated, in the open-grazed treatments. In the dunefields of north-eastern South Australia, we did not find any differences between grazed and ungrazed treatments in the richness or abundance of species or life-forms.

We then focused on individual species and identified those that seemed to be rare based on herbarium collections, and may have declined in the grazed landscape. From the total list of 1781 species in western Queensland, we have 106 that are rarely encountered. We have spent the past few years trying to find them, and have gradually managed to account for most. Some have specialised habitats, such as the rubble screes at the base of mesas; some are impossible to

FURTHER READING

Silcock, J.L., Pidcocke, T.P. & Fensham, R.J. (2013), 'Illuminating the dawn of pastoralism: Evaluating the record of European explorers to inform landscape change', *Biological Conservation*, 159, 321–331.

find in typical seasons and then pop up in abundance when the rains are just right; some are inconspicuous or grow in seldom-visited habitats so are simply under-collected; while some may be in serious trouble.

What we can say is that the flora seems a lot tougher than 'degradation stories' might suggest. This is mostly because the best way to avoid the harsh climate is to 'grow like billy-o' in good times, and throw down some seed in readiness for the next rain—even if it takes years to finally arrive. This ephemeral strategy doubles pretty well to avoid the worst impacts of grazing.

Long-lived perennial plants may be most susceptible, especially those within reach of herbivores. Ironically, the hotspot for rare and palatable perennials is in the hard hills where sheep and cattle rarely tread. This makes us wonder if goats may be an under-realised threat to our native flora. There are also a handful of plants that have only turned up in very small numbers, or not at all, despite many hours of searching in suitable habitat after abundant rainfall. Along with the shrubs that are heavily grazed, these species will be the focus of our surveys and studies over the coming year.

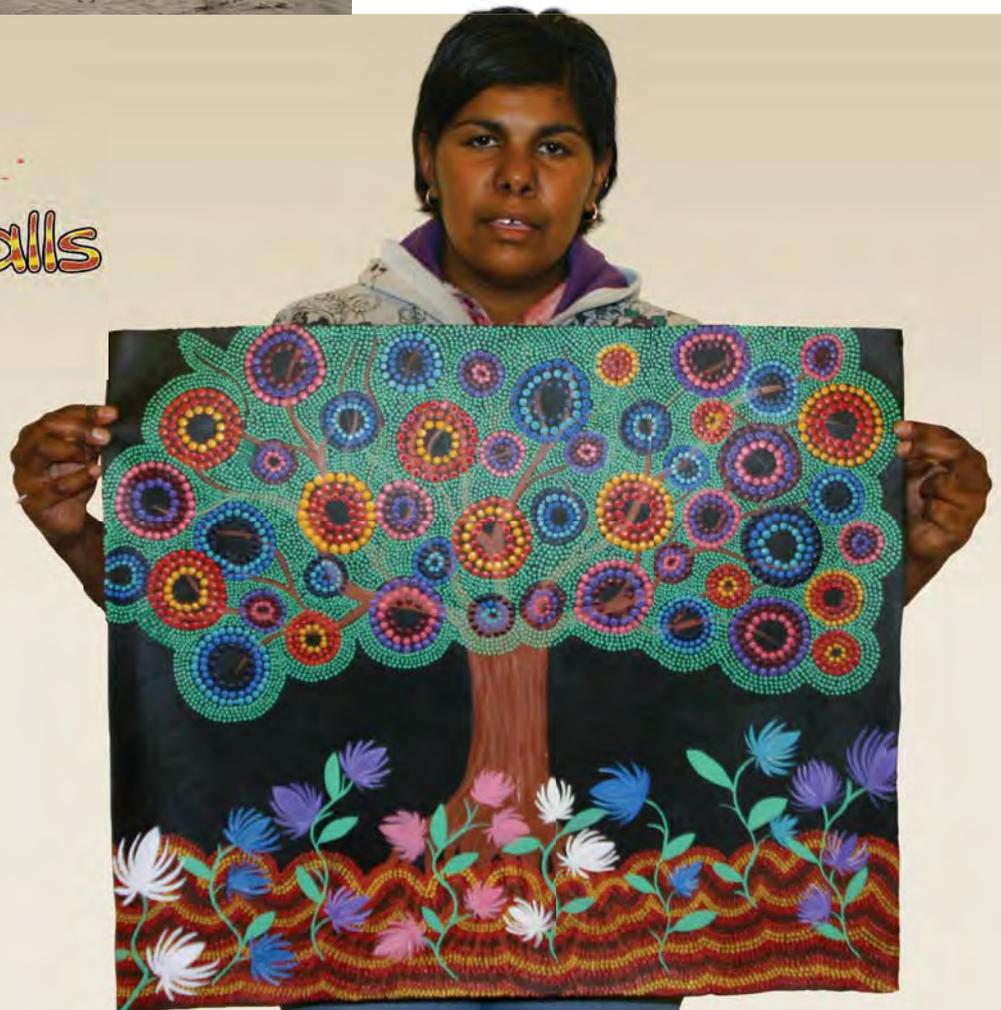
While current management is generally compatible with biodiversity conservation, the glaring exceptions are the plight of medium-sized mammals and ground-dwelling birds, as well as the historical demise and continuing threats to Great Artesian Basin spring wetlands and their unique communities. There are also serious threats posed to vulnerable species and habitats by invasive species across the Lake Eyre Basin.



A degraded landscape? Dead coolibahs stand above barren dunefields north of Lake Eyre.

FOR FURTHER INFORMATION

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Artist: Lorna Armstrong
Location: Longreach
Artwork: Family Tree
Medium: Acrylic on canvas
Lorna's painting represents all her family members.



Delicately smoked desert fish on a bed of lightly steamed bullrushes

Above: A moment of excitement — my first Golden Goby. Photos throughout this article courtesy of the author.

THE NORTHERN TERRITORY HAS BEEN A LATE STARTER IN DOCUMENTING DROUGHT REFUGE WATERHOLES IN ITS PART OF THE LAKE EYRE BASIN. IN THIS ARTICLE, **ANGUS DUGUID** LOOKS AT THE IMPORTANCE OF KNOWING WHERE THE LONG-LASTING WATERHOLES ARE AND UNDERSTANDING WHAT THEY ARE LIKE.

Entrée — a platter of tasty Northern Territory waterholes

Reality TV cooking show meets aquatic conservation. Is this what you get when you combine the search for important desert waterholes with a search for the best fish dinner?

The reality behind this show is that the Northern Territory (NT) has been a late starter in documenting drought refuge waterholes. Work in the NT portion of the Lake Eyre Basin (NT-LEB) has lagged well behind the Queensland and South Australian teams. We've also lagged well behind in surveying and monitoring desert fish. Fish are a key indicator group now being monitored for the Lake Eyre Basin Rivers Assessment (LEBRA). However, in the NT, the background knowledge of species distributions, habitat preferences and population dynamics was previously inadequate for interpreting monitoring data. Clearly, Team NT really needed to get cracking or face elimination from the show.

A majority of NT-LEB waterholes were not mapped at the outset of the current LEBRA monitoring program in 2011. Knowledge about hydrology and other vital ecological processes was almost non-existent for most places. In the context of relative ecological ignorance, it may be premature to talk blithely of on-ground works and management frameworks (very 'in vogue' natural resource management ingredients). However, a catalogue of inadequacy is not good for a contestant's future on a reality show except for contrasting the before and after (I can't wait to go on *Australia's Biggest Wetland Mapper*). Luckily Team NT has been turning things around, with help from lots of collaborators and even from the other teams (read Queensland, South Australia and the Australian Government). It is a reality show love-fest to rival *The voice*. Read more to find out how we've exploded out of the starting blocks.

FOR THE FULL MENU CONTACT THE 'CHEF'
Angus Duguid — angus.duguid@nt.gov.au

Soup of the day

The chefs on Team NT have sourced the finest fresh local ingredients. The NT portion of the LEB has several distinct river systems that are more or less isolated. Each is characterised by intermittent flows and long periods without flows. Not all NT-LEB rivers have fish in them, but for those with fish, the species diversity is correlated with the abundance of long-term drought refuges. The Finke River system is the biggest. Although it is isolated, it has nine species of native fish, of which three are endemic to the Finke. The most species rich is the Georgina River system, with 11 native fish species and relatively regular connection to other LEB rivers interstate. The Sandover River system is part of the Georgina, but only rarely connects to the main Georgina River through an extensive floodout. The connection may only occur every 10 years or so. Similarly, Ooratippra Creek only occasionally connects to the main Sandover River, but is significant because it may have the only permanent drought refuge waterholes in the Sandover system. Thanks to LEBRA, we now know there are six fish species in this catchment (previously only three species were recorded). The relative isolation of the Ooratippra catchment may well be reflected in genetically distinct fish populations.

Below: Dawn on Ooratippra Creek. Inset: Station kid helping with a survey in the Georgina catchment.

Main course—strong flavours and spicy overtones

Diners may wish to ask themselves about waterhole knowledge and how much we really need? This and other big questions hang over projects like LEBRA, including:

- What do we need to know in order to protect and manage river health?
- How do we know when a river is healthy?
- What do we measure to keep track of it?
- How healthy are our rivers?

These questions are not unique to the LEB, but the answers need to incorporate arid and semi-arid ingredients to match the LEB climate. The LEBRA monitoring has been established using the best available knowledge to select fixed monitoring sites. In the absence of information for a substantial proportion of the waterholes in a river system, however, it is extremely difficult to interpret monitoring data. Using the monitoring data to assess the relative importance of particular drought refuges or to estimate the possible consequences of development pressures, requires an adequate knowledge of the environmental context. It is the importance of this context that underpins the need for better waterhole mapping and survey. With that in place, a relatively small number of long-term monitoring sites can provide a powerful



measure of system health. That's why Team NT has been supplementing LEBRA with additional survey and mapping, in collaboration with various partners.

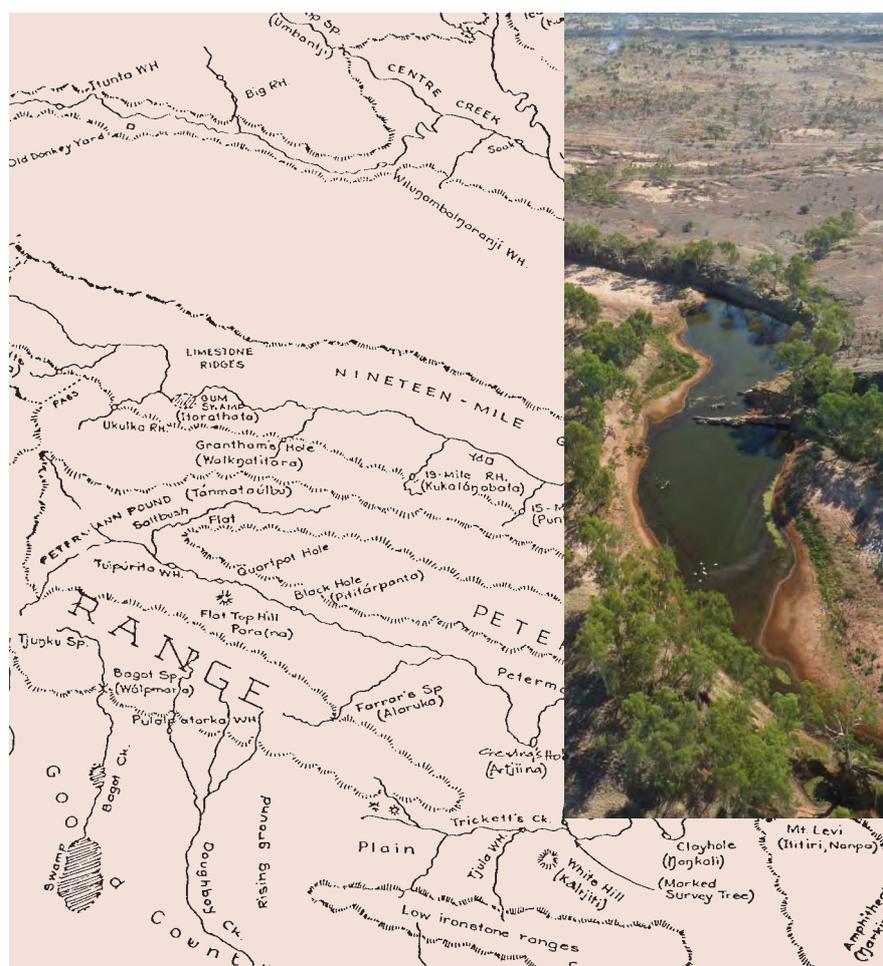
The focus has been on identifying permanent and other long-term drought refuges, and determining their key ecological attributes. In the process Team NT has been 'plating up' some delicious new knowledge about species distributions and habitat preferences. For example, previously unsurveyed springs now look like being critical drought refuges for the endemic Finke Gudgeon. In the mid-section of the Finke River we now have solid evidence of the importance of groundwater in maintaining waterholes. Furthermore, salt from the groundwater limits the impacts from introduced herbivores ('the salty fence'), while providing good habitat for the endemic gobies and hardyheads.

One thing where Team NT is out in front is pest fish—we don't have any in our LEB rivers. The results emerging from the LEBRA monitoring shows this front runner position is in stark contrast to the rest of the LEB. Through LEBRA, we should get advanced warning of exotics if, or when, they occur.

Dessert—after tastes and food for thought

Flavours in the entrée course hinted of advances made in recent surveys and mapping. Those surveys have been relatively piece-meal and were achieved through assorted projects with quite limited geographic range. While exciting new insights have been gained, there should be no illusion that mapping and survey have been comprehensive. For example, we still don't know which waterholes in the Ooratippra Creek catchment are the critical drought refuges, and if some are more important for certain species than others. In the Palmer River catchment there is still no survey data, or even a confirmed location for many springs that are only known from a historical map (made by Bowman and Scherer in 1948). Although many waterholes in the NT-LEB are not on any published map, they may be well known to locals. Working effectively with landholders is crucial for Team NT.

In the digital age, many of the 'unmapped' waterholes may be visible on satellite imagery, and some landholders would probably like to put 'no trespassing' signs on Google Earth!



Part of a 1948 map by Bowman and Scherer. Photo: One of the permanent refuge pools.

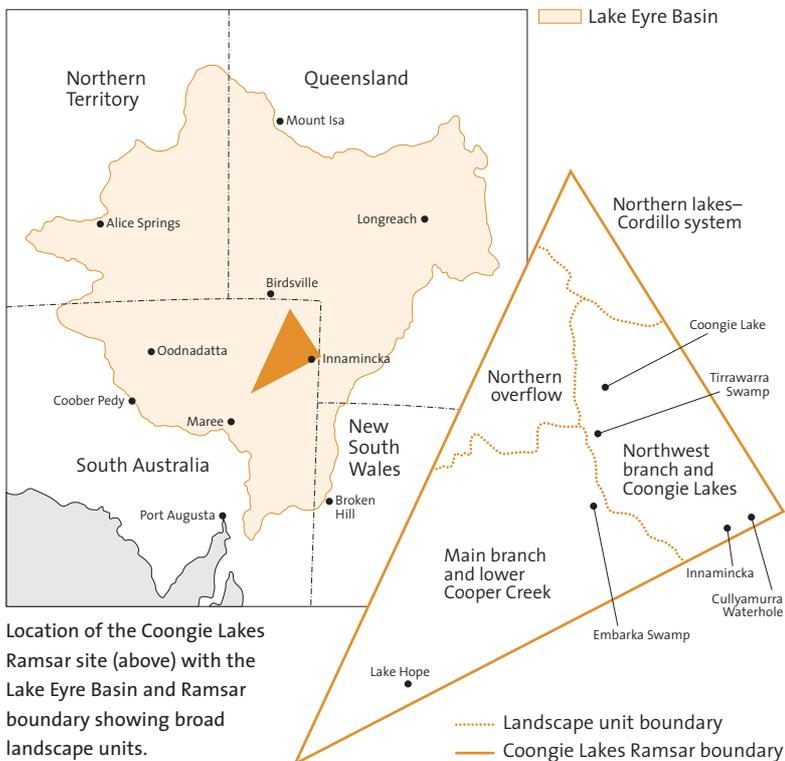
While some waterholes are on well-established tourist routes, others are on private land, and permission and information about access conditions are needed for visits. Aboriginal cultural issues and rules about access also exist, even when some people don't realise it. Landholders often say the best way to protect places is not to publicise them. In contrast, there is an increasing demand for adventurous four-wheel drive tourism. These issues will challenge waterhole mapping and management into the future.

The socio-economic context should not be ignored in further waterhole survey and mapping. Issues include who has knowledge, on what basis they will share it and how knowledge is subsequently managed. A related issue concerns funding opportunities for survey and research that are required to address key knowledge gaps. Such funding is scarce and funds tagged for natural resource management are not easily diverted from 'on-ground works', even when survey is a prerequisite for effective management.



Conserving Coongie Lakes

THIS ARTICLE TELLS US MORE ABOUT THE FABULOUS COONGIE LAKES, ONE OF AUSTRALIA'S IMPORTANT RAMSAR SITES.



Location of the Coongie Lakes Ramsar site (above) with the Lake Eyre Basin and Ramsar boundary showing broad landscape units.

Australia was one of the first countries to become a contracting party to the *Convention on Wetlands of International Importance especially as Waterfowl Habitat*, also known as the Ramsar Convention. The broad aims of the Convention are to halt and, where possible, reverse the worldwide loss of wetlands and to conserve those that remain through wise use and management.

The Coongie Lakes Ramsar site was designated in 1987. It is located in the north-east corner of South Australia near Innamincka. Coongie Lakes covers over 2.1 million hectares, and is an extensive and complex ephemeral and semi-permanent freshwater wetland system in the floodplain of Cooper Creek in the Lake Eyre Basin (LEB).

Dominant land tenures at the site include crown land-pastoral lease, crown land-national park and regional reserves, as well as land covered by petroleum exploration licences. Two major reserves fall within the boundary of the site—the Coongie Lakes National Park, and just over half of the Innamincka Regional Reserve—as well as two small areas of the Strzelecki National Park.

Coongie Lakes encompasses a wide diversity of wetlands that are representative of those of the Channel Country. These include permanent waterholes, near-permanent lakes, intermittently filled floodouts and channels,

FOR FURTHER INFORMATION

www.environment.gov.au (and search for Ramsar) or www.ramsar.org

fresh and saline wetlands, and inter-dunal wetlands and swamps. Cooper Creek is one of the largest unregulated river systems remaining in Australia, and is recognised internationally as a significant inland river system.

The geomorphology of the site is unique. There is a broad fan that emanates downstream of Innamincka giving rise to a unique array of lakes and interconnecting channels. These are in turn influenced by the regional parallel dune fields of the Strzelecki Desert. The lower Cooper Creek floodplain is a major natural floodplain and plays an important role in retaining water for other wetland systems downstream, including Kati Thanda–Lake Eyre.

The site's hydrology is one of the most variable in the world. Rivers in the LEB are characterised by extreme variations in discharge, flow duration and inundation. Much of the northern parts of the Ramsar site receive water every year via Cooper Creek, whereas the lower reaches receive water less frequently. Some wetlands rarely fill, others hold water for a limited period after flooding, and others are permanent. The main source of inflows is via the Cooper Creek from rainfall in the upper Cooper Creek catchment, as well as local rainfall events. Inflows from the Queensland portion of the LEB are fundamental to maintaining the ecological character at the site. Peak flows typically occur in late summer into autumn. The lakes of the Ramsar site are connected via a complex series of distributary channels that fill sequentially.

The large floods that inundate the Ramsar site ultimately feed into Kati Thanda–Lake Eyre and occur, on average, one in seven to eight years. Dry periods can last from a couple of months to years, depending on the location of the wetland within the site.

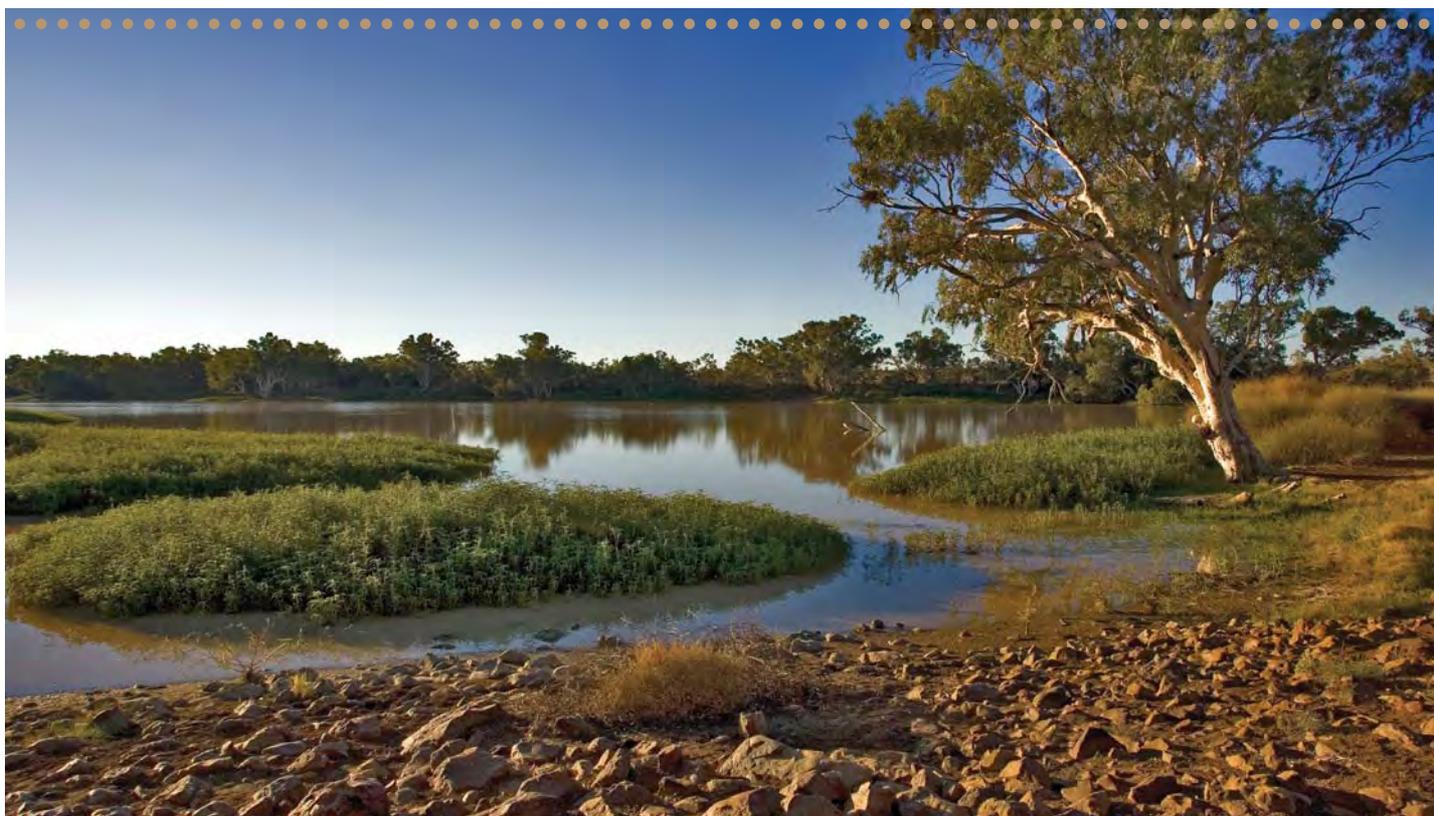
Coongie Lakes features several permanent and semi-permanent waterholes, including Cullyamurra which is the largest and deepest waterhole in the LEB system. When floodwaters recede, these permanent waterholes provide critical drought refuges that help maintain populations of obligate aquatic species and allow for recolonisation when the wetlands become inundated.

Coongie Lakes is one of the most diverse systems in the LEB for wetland dependent species. The site has high productivity and is important for biodiversity at the local and regional scale. Terrestrial biodiversity is also high, as species congregate around the regular water supply and take advantage of wetland vegetation and habitats. The species richness is comparatively high for most biota with 83 wetland dependent bird species, 10 frog species, at least 12 native fish species, over 135 wetland dependent plants and one wetland dependent mammal, the water rat (*Hydromys chrysogaster*), being recorded in the site area.

The highly variable nature of watering in Coongie Lakes engenders an ecological boom and bust character to the region. A major flood promotes a period of flourishing plant growth, and an influx of wildlife including macroinvertebrates, fishes and waterfowl.

Cullyamurra Waterhole,
photo Paul Wainwright.

Photo on previous page
Royal spoonbills (*Platalea regia*), Paul Wainwright.



Large numbers of waterbirds such as pelicans, cormorants, herons, ibises, spoonbills, ducks and waders congregate to feed and breed, then disperse as waters recede.

Coongie Lakes also supports significant numbers of migratory birds including 18 species listed under international migratory bird agreements, and 39 species listed as migratory or marine under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The site is vital for providing habitat during critical life stages and in periods of adverse conditions for supporting substantial breeding of waterbirds. There have been 55 species of waterbirds recorded breeding at the site since its listing in 1987. In terms of numbers, the most significant events occur after large-scale floods. For example, a record 50,000 Australian pelican nests were recorded on the islands of Lake Goyder in 1990/91.

The Coongie Lakes site supports six fauna and two flora species that are nationally or internationally listed species of conservation significance. The Australian painted snipe (*Rostratula australis*) is a wetland dependent bird that is listed as endangered under the EPBC Act and is on the World Conservation Union Red List.

Other nationally or internationally listed species to have been recorded at the site include the greater bilby (*Macrotis lagotis*), the dusky hopping-mouse (*Notomys fuscus*), plains rat (*Pseudomys australis*), woma python (*Aspidites ramsayi*), fawn hopping-mouse (*Notomys cervinus*), yellow swainson-pea (*Swainsona pyrophila*) and the Mount Finke grevillea (*Grevillea treueriana*).

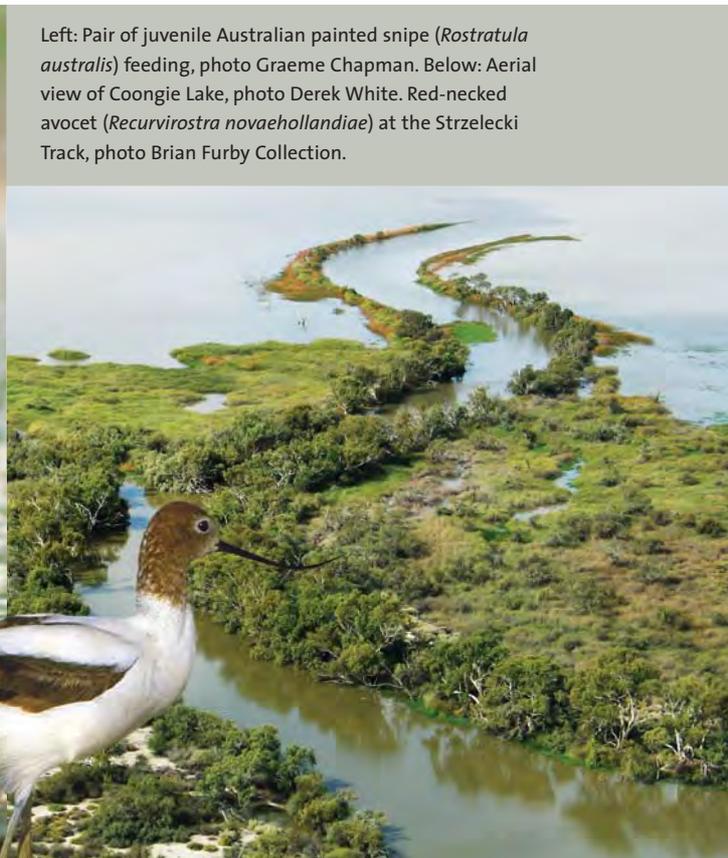
Coongie Lakes supports a number of native fish species. These fish respond to flood events to migrate and breed within different habitat areas of the site, and are also a source of colonists for Kati Thanda–Lake Eyre in large floods. There is a commercial fishery at Lake Hope in the lower reaches of the site that is supported by fish from upstream in the Coongie Lakes system.

The vegetation associations within the site are intimately connected to movement of water across an arid landscape. There is a clear juxtaposition of wetland and desert vegetation that can be expressed abruptly over a very short distance. Riparian associations fringing the river, channels and wetlands include coolibah (*Eucalyptus coolabah*), river red gum (*E. camaldulensis*), lignum (*Muehlenbeckia florulenta*), sedges (*Cyperus gymnocaulos*) and the water primrose (*Ludwigia peploides*). The narrow band of river red gum dominated riparian woodland along the north-west branch of the Cooper Creek supports a very rich bird community notable in the district.

Waterholes play important cultural, social and economic roles as well as ecological roles, as they provide a water supply for stock and, increasingly, areas of tourism and recreation.

There are a number of areas of significant cultural value both to Indigenous and European cultures in this Ramsar site, most in the vicinity of Innamincka and Coongie Lakes. Within the Innamincka Regional Reserve, 127 sites are listed as protected under the *Aboriginal Heritage Act 1988* (SA) including archaeological sites.

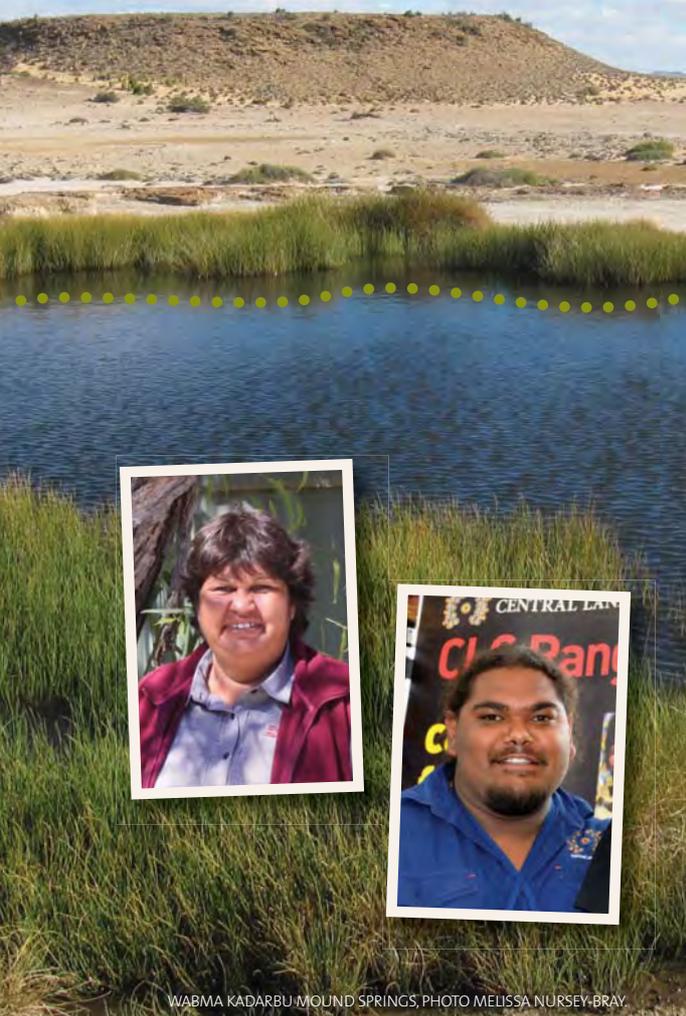
These sites are also important in regional tourism and recreation with over 30,000 people visiting Cullyamurra Waterhole annually for fishing, waterbird watching and boating.



Left: Pair of juvenile Australian painted snipe (*Rostratula australis*) feeding, photo Graeme Chapman. Below: Aerial view of Coongie Lake, photo Derek White. Red-necked avocet (*Recurvirostra novaehollandiae*) at the Strzelecki Track, photo Brian Furby Collection.

BASIN PEOPLE

Living on country...



WABMA KADARBU MOUND SPRINGS, PHOTO MELISSA NURSEY-BRAY

JO LEWINGTON, AN ABORIGINAL WOMAN FROM BIRDSVILLE IS LIVING AND WORKING IN BEDOURIE, SOUTH-WEST QUEENSLAND.

DAMIEN WILLIAMS IS A TJUWANPA INDIGENOUS RANGER, LIVING AT HERMANSBURG, NORTHERN TERRITORY.

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 Damien Williams—
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JO LEWINGTON—I have lived in the Diamantina Shire for most of my life, the last nine years working with the council as a community development officer. After two floods, two years running in 2010 and 2011, where it was so beautiful and green in the area, the country is now becoming dry around here.

During a flood, we can be isolated here for up to 10 weeks, that's going by road. The water is so widespread it goes out for kilometres and we look like a little island. There are still flights though, and we get food flown in. Normally the locals are pretty prepared with food in stock, although during that time you miss out on fresh fruit and vegetables. We can be prepared as we know when the Georgina River is going to run, and as soon as the water starts coming up we take the kids out to watch it rise. It's interesting to listen to new people who come to town and watch their reactions to the floods. At first they can't wait for the flood to come; then when it's here they start getting cabin fever! At other times our river is dry and we only see it run a couple of times a year.

In the last 12 months we've been catching yabbies, but it's been nearly 10 years since we've caught a decent feed of them. Instead of the blue yabbies, we are starting to see the red claws, the ones that have been introduced.

It's important to get out of town, enjoy the area when it's good and do some fishing. The yellowbelly we are catching are getting to be a good size. This year they are cleaner, but usually they have that muddy taste.

We realise the importance of the river system and how it can affect us if it's blocked off somewhere else, upstream. One thing that opened my eyes when I attended the Lake Eyre Basin Aboriginal Forum in Birdsville, was how sad it was to hear about the Murray–Darling Basin and how they had lost a lot of the birdlife. I never ever want that to happen out this way, especially as with the floods you get such a range of birdlife that are so good to photograph.

DAMIEN WILLIAMS—Our country has been pretty green and there's been lots of water about. It's unusual to have such a long wet period. The Finke has been flowing since 2010; it's slowed to a trickle now, but is still flowing, and that's weird for here. The country is going back to how it was in the old days. We are happy there are lots of fish because our people have always been fish eaters.

Finke River and Ellery Creek both flooded in 2011 and Hermannsburg was completely cut off from Alice Springs for a day or two. It wasn't really bad; it was one of the nicer floods.

After the rain we had a boom in grass growth, but now the long wet is over, we need to ease the fuel load. We've got a lot of outstations this way and a fair bit of infrastructure to protect. The rangers did quite a bit of prescribed burning to break up the country, so when the 2011/12 wildfires hit the fire breaks, they stopped. We'll have to burn again this year because we had a bit of rain after the fires and the burnt areas came back with a lot of grass.

We've been doing feral animal work, finding out where they are and trying to control them. Our community have always been horse people, so everyone has their own herd, but over the years they've grown and are now impacting on waterholes. We also have a few camels and cattle, but when they come out they get stuck in the freezer!

Our ranger group is made up of guys from all over the Land Trust, so there is always someone connected to the land out here. At Hermannsburg we have the Tjuwanpa ladies, a new group doing similar things, but in areas where men can't go. All the families are really close here; everyone's got family connections. Living on country and looking after it is great because a big part of our job is looking after our homelands, and it's really good to hear the community say that we're doing a really good job... it makes it all worthwhile.



Annual check up

RESEARCH SCIENTIST **DAVID SCHMARR** PROVIDES AN ACCOUNT OF MONITORING WORK
IN THE LAKE EYRE BASIN.

Lake Eyre Basin (LEB) is the largest endorheic (internally draining) basin in Australia and one of the largest in the world, making the rivers of the LEB unique on a global scale. In this arid area, river flows are highly variable and unpredictable, creating a distinctive ‘boom and bust’ ecology. Both high and low flows have important ecological functions and are vital to maintaining the ecology of the LEB. Due to its remote location and variable climate, the Basin is relatively unregulated with no large-scale water development. This provides the unique opportunity to assess the health of the system, and inform management of the industries developing in the area before it is altered beyond repair (as has occurred in other regions of Australia). Given the highly variable and unpredictable nature of this system, understanding what constitutes normal ecological condition in the Basin is vital for detecting impacts from human development.

FOR FURTHER INFORMATION

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The Lake Eyre Basin Rivers Assessment (LEBRA) aims to assess the condition of watercourses and catchments within the LEB Agreement Area. LEBRA now includes a long-term monitoring program, which is the first multi-disciplinary and systematic whole-of-basin program to be established in this unique central Australian environment.

So far the LEBRA monitoring has focused on three main indicators of ecosystem health: fish, water quality and hydrology. Government departments from South Australia, Queensland and Northern Territory have been conducting annual surveys at 45 sites across the Basin, using standard gear and methods to provide consistent data. We use two types of fyke nets (a type of fish trap), seine nets and bait traps to sample the fish population. We measure water quality parameters at every site (temperature, dissolved oxygen, salinity, pH and turbidity). In addition to the sparse flow monitoring network already in place in the Basin, over 20 LEBRA data loggers (conductivity/temperature/depth) have been deployed to monitor river flow and salinity, and we have been documenting the bathymetry (underwater depth) and dimensions of key waterholes throughout the Basin.

The LEBRA monitoring program is now in its third year after commencing in 2011. We were able to catch the peak in the 'boom' period that began with very wet conditions in 2010, continuing into 2011. This period saw large flows down most of the rivers entering Lake Eyre, with associated booms in flora and fauna of the rivers and floodplains.

In 2013 we have encountered a drier period, with many rivers experiencing much lower flows compared to 2011, and some waterholes drying completely. Some rivers in the Basin, for example the Finke River in the Northern Territory, have not seen significant flows in the last 16 months, but this is not uncommon. It is not unusual for some systems to be without flows for up to five years or more, for example, Strzelecki Creek in the Cooper catchment.

Monitoring data from autumn 2013 could be considered the first set of LEBRA data collected in a dry period, and we are beginning to see the impact on water quality and fish populations. Fewer fish numbers are now being found at many LEBRA sites, with fish counts typically an order of magnitude less than those encountered in 2011. Although quite startling, this difference is actually within the normal expectations for the Basin. In some locations such as the Finke, counter to the trend in declining abundance, salinity tolerant species like Finke hardyhead and gobies have increased in abundance.

It is not just the number of fish that can vary between years, but also what species are found where, and what species are most common. In 2012 and 2013, there were 21 native fish recorded (compared to 17 in 2011) with the Bony Bream being the most common across most sites, while in 2011, it was the Silver Tandans.

Since monitoring commenced, we have new fish species distribution records for the Basin, with the data collected in the Northern Territory being the first systematic population oriented sampling for all sites and catchments. In many catchments and sub-catchments, species were recorded for the first time (five in the Macumba, one in the Neales, three in the Ooratippra, one in the Rankin, four in the Sandover, four in the Palmer). Three exotic fish (Sleepy Cod, Eastern Gambusia and Goldfish) have also been recorded, although generally in low numbers. Continuing monitoring will reveal if these native and exotic species remain in these catchments,

or recede into the more permanent reaches waiting for the boom-time to return again. LEBRA monitoring will also act as a sentinel for other invasive species populations such as redclaw, cane toads and athel pine.

The LEBRA project has also provided an opportunity for stakeholders to become involved. Land managers, traditional owners, pastoralists, park rangers conservation groups and volunteer groups have all assisted with the monitoring fieldwork. Their participation has been invaluable to expanding our understanding of the system.

LEBRA builds upon the baseline information already available from South Australia and Queensland, and has established baseline data for the Northern Territory. The program uses partnerships to efficiently gather data in a limited funding environment. There are moves to expand the scope of LEBRA through a consortium of research partners, thus expanding the number of indicators of ecosystem health. LEBRA monitoring continues to improve our understanding of the Basin's rivers and catchments, our ability to determine if the condition of the Basin is shifting beyond what we would normally expect, and the scientific integrity behind our management decisions. An interim report on the progress of LEBRA and the health of the Basin will be produced in 2014, followed by another five years of monitoring. At its conclusion, we will have a long-term picture of the health of the Lake Eyre Basin capturing all of its spectacular variability.

MY EARTH CALLS

Artist: Zane Douglas
Location: Longreach
Artwork: Barramundi
Medium: Acrylic
on canvas

The painting titled 'Barramundi', is part of series of four freshwater paintings, included in a complete artwork of 12 canvases titled 'Saltwater, Land, Freshwater'.

Saltwater represents Zane's father, and freshwater represents Zane's mother.

Zane's Indigenous language group is Kjuriji and Tagalaka.





Cooper's waterholes

HENRY MANCINI
DETAILS THE WORK
OVER THE PAST
THREE YEARS ON
THE BIOPHYSICAL,
ECOLOGICAL
AND CULTURAL
SIGNIFICANCE OF
THE WATERHOLES
AND WETLANDS OF
COOPER CREEK.

Cooper Creek has one of the most variable flow regimes in the world. At present, it has an unregulated flow with minimal levels of water extraction. Maintenance of this unregulated flow regime is vital for the ecology of the river system and for the social, cultural, economic and environmental benefits that depend on a healthy functioning ecosystem.

The 'Cooper Creek Critical Refugia' project collected baseline data, providing objective evidence and findings to inform community, land managers and industry on the processes, functioning and vulnerability of these aquatic ecosystems. The project has resulted in a deeper understanding of the social, cultural and biophysical drivers of the system—it is as much about the people, community, industry and enterprises that influence and use the resources, as it is about the natural features that attract this use.

This project was epic in terms of the spatial scale, covering a vast complex mosaic of inundated wetlands during a once in a generation hydrological cycle driven by a pronounced La Niña episode of the El Niño-Southern Oscillation climatic cycle (2010–13).

The epic proportions extended to the challenges of accessing sites and collecting data during this exceptionally productive period in the region. We used a multi-disciplinary approach, integrating data from:

- hydrology (flow patterns, inundation and flooding extent),
- geomorphology (understanding geology, landform and fluvial processes),
- vegetation (responses to hydrological patterns),
- bird/floristics (bird assemblage and structural integrity patterns of bird distribution),
- soils (carbon, nutrient and vegetation associations),
- riparian ecological condition assessments (basis for determining health, pressures, threats and impacts),
- cultural landscape values (the human interaction with water resources),
- tourism management and interpretation (management through education and understanding visitor needs and behaviour).

Investigations focused on finding out how humans impact the ecosystem processes and functioning of high priority waterholes and wetlands, so that threats and pressures could be identified.

THE KEY FINDINGS

- The waterholes of the Cooper Creek system provide vital habitat for a range of fish and other aquatic species, such as crustaceans, mussels and turtles. Permanent waterholes such as Cullyamurra are very important as refuges for fauna in times of drought, providing the only habitat to sustain life through extended dry periods. Maintenance of natural flow regimes is critical for conservation of these aquatic ecosystems. Threats from exotic animals such as *Gambusia*, goldfish, pigs and potentially cane toads, as well as impacts from stock grazing and infrastructure such as bridges and road construction can impede natural flow regimes. Geomorphological assessments show that the Cooper Creek system in South Australia is, contrary to some predictions, vulnerable to invasion by cane toads.
- Cooper Creek has an unregulated flow regime with minimal levels of water extraction, and is one of the best examples of a low gradient, intermittent, dryland river. As it is unregulated, natural associations between the ecology and flow patterns are largely intact and characterised by the boom and bust dynamics that are a feature of arid and semi-arid environments. The boom–bust sequence is driven by the variability of flow, with Cooper Creek having one of the most variable flow regimes in the world. The hydrological assessments confirmed the importance of Cullyamurra Waterhole as a critical refuge for aquatic biota due to its permanency and ability to hold water and sustain life in long dry periods. It is the deepest waterhole in the LEB with the deepest section recorded at 26 metres.
- Any impediment to natural flow regimes and connectivity patterns between river channel and floodplains can have a detrimental effect on nutrient transfer, dispersal and recruitment of plant and aquatic species. The temporal and longitudinal connectivity along the channel, and lateral connectivity of the river system with adjacent floodplains, are critical to the vegetation and soils of the Cooper Creek. These findings can assist in developing best practice design and construction for infrastructure development, such as roads, bridges or culverts on riverine and floodplain environments.
- Cooper Creek is characterised by a steep gradient of decreasing discharge, with distance downstream. In its upper parts, around Innamincka and Coongie Lakes, annual flows are expected, and there are well-formed structurally complex diverse riparian vegetation consisting of river red gum, bean trees and coolibahs. We found that a sequence of key structural vegetation species, such as river red gum and coolibah is influenced by flooding frequency and salinity. Lower parts of the study area towards Kati Thanda–Lake Eyre by comparison are saline, arid and receive infrequent flows, resulting in sparse vegetation, with only coolibah present at variable and low densities.
- Cooper Creek wetlands have high conservation value. They are valued for their aesthetic, cultural and recreational values. Healthy wetlands also add to the capital value of a grazing property because of the environmental services they provide for pasture and grazing. Acknowledging the environmental and economic benefits of wetlands is vitally important to gain a better understanding of their ecological function, natural processes and vulnerability.

These findings are now being shared with land managers, industry and the community using an adaptive management approach. This enables management actions to be developed that meet multiple needs, for example, maintaining groundcover and protecting regeneration of key canopy species such as river red gum and coolibahs around major waterholes will help prevent channel incision and erosion (a plus for the land manager), as well as the potential loss of a critical aquatic refuge waterhole. This approach can assist land managers to develop best practice grazing management strategies at key waterholes with high ecological value aquatic ecosystems.

Another aspect of the project was to work collaboratively with Aboriginal groups to improve the management of a cultural site. Through on-site investigation and discovery, a collaborative project was developed with the Dieri Aboriginal community to protect the cultural values and manage visitor and tourism pressures at Killalpaninna Lutheran Mission near the Birdsville Track. Interpretive signs and information leading to site protection are being developed in partnership with the Aboriginal community and landholders to protect this special site. The site will have a better chance of protection by informing visitors and managing behaviour. This is one example of an adaptive management approach that requires ongoing support and monitoring to ensure original aspirations are met.

We are continuing to work collaboratively with community, land managers and industry to translate our research findings into practical on-ground management strategies. It is hoped through sharing our knowledge and leaning from others, we can build management systems and protocols to achieve protection long into the future.

FOR FURTHER INFORMATION

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Digging the dirt on EMUs

CAMILLA OSBORN FROM THE CENTRALIAN LAND MANAGEMENT ASSOCIATION EXPLAINS A DIFFERENT TYPE OF 'EMU' BEING USED TO CONSERVE SOIL AND MANAGE LANDSCAPE FLOWS.

In April 2013 the Centralian Land Management Association (CLMA) ran one in a series of soil conservation workshops. This workshop took place on Wintinna Station, South Australia, and focused on rehabilitating a section of the old Stuart Highway. These practical five-day workshops have been running successfully in the southern regions of the Northern Territory for several years, and allow participants to gain nationally accredited machinery tickets while learning and doing on-ground soil conservation works. Tickets obtained at this workshop included skid steer, dozer, loader and grader. Importantly, participants are trained how to use the machines in ways that fit in with natural processes, rather than disrupt them—as happens so often.

The workshops get participants to recognise water flow patterns across the landscape and how to minimise disruption to this flow. Almost everyone has a track or a fence line that has become impassable because of erosion on their property. This course teaches soil conservation techniques using heavy machinery to fix current soil erosion problems and build tracks and infrastructure to prevent future ones. Techniques used include building whoaboys, erosion check banks and track installation and maintenance that does not cause erosion or disrupt natural water flow.

Col Stanton from the Northern Territory Government who has been working with landholders and mentoring CLMA staff for the last 42 years says the main rules to remember when managing water in the landscape is 'let it go, let it flow', meaning let water flow across the landscape on its natural path, 'don't just monitor soil erosion, manage it' and 'it's worth saving, if you don't have soil you don't have anything'.

The CLMA uses the Ecosystem Management Understanding (EMU™) process and philosophy with its members. This simple but profound process was originally developed by landscape ecologists Dr Ken Tinley and Dr Hugh Pringle in the Western Australian rangelands using techniques Ken developed while working with local people in Africa.

The CLMA is a not-for-profit landcare group based in Alice Springs who provide support for landholders in central Australia. Thank you to the landholders, Northern Territory Government, South Australian Arid Lands NRM Board and Territory NRM. This project is funded by the 'Caring for our Country' program.

FOR FURTHER INFORMATION

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EMU PHOTO, ANGUS EMMOTT.
OTHER PHOTOS COURTESY OF
THE AUTHOR.

EMU's two most important features are:

- its close attention to power relations in order to provide an enabling environment for participants,
- a truly holistic ecological perspective.

Both founders are trained geomorphologists, as well as ecologists/biologists, and this allows a broader, 'systems' level of understanding to be used more.

EMU™ introduces land managers to the ecological management of landscape and habitats by learning to recognise and read processes, condition and change in the landscape. The process begins with managers recording their property knowledge in a baseline mapping overlay exercise. This is followed by air and ground assessment of key areas, landscape-scale management planning, and in many cases on-ground rehabilitation of the prioritised management issues. All stages are completely voluntary and led by the land managers in terms of the level of information provided and what their priority projects are. EMU™ is completely confidential with all information belonging to, and kept by, the land manager. There are no government files on participating EMU properties, with this as a condition of using EMU in an area.

EMU™ is not just soil conservation, it encompasses all forms of property management including grazing strategies that make most of landscape diversity, weeds, feral animals, protecting special places, etc. The process is driven completely by the land manager so projects are prioritised according to them. It is currently being used on 19 properties in southern Northern Territory and a similar number across the SA Arid Lands region, as well as in Western Australia, Queensland and Africa.

CLMA and Territory Natural Resource Management have engaged Dr Hugh Pringle to run an inaugural landscape literacy course for those supporting natural resource management activities in central Australia, and following its success, these field-based courses are likely to be a regular event. Hugh has run two similar courses in arid South Australia and a similar course is planned in Western Australia for October, led by Dr Ken Tinley through Rangelands NRM Western Australia.

“I learned a lot in this workshop. I definitely look at my surroundings more closely now and read what the land is trying to tell me.”

“Thanks to the efforts of all the workshop participants, I think it's safe to say the water in that paddock will be slowing right down.”

CURATE BEE

Optimising your website navigation—tips from ARRC's partner Curate Bee

The main navigation menu on your website is without a doubt the most important and essential component in how users interact with you. How you structure and display information menus to the end user could make or break your digital strategy.

NAVIGATION CONTENT

Limiting the number of menu items to seven is good, both for search engines and users. Avoid drop-down menus, as visitors are likely to have decided and clicked on a menu item before any drop-down options appear.

NAVIGATION LAYOUT

Studies have shown users tend to remember links on either end of the menu more clearly, and it is suggested the 'contact' link is on the far right, as it is a standard location for a call-to-action item. For items in between, place related items near each other, and prioritise importance from left to right.

NAVIGATION TITLES

The naming of navigation links is largely dependent on the type of organisation you are, and the expectations of your customers. Most commonly used across the web, object-based navigation allows for content to sit under solid categories (often nouns), e.g. services, products, portfolio, resources, etc.

Transactional sites benefit from action-oriented navigations. Visitors to banking websites are more likely to perform an action such as 'apply' for a bank loan or 'deposit' funds into accounts, so it makes sense for navigation items to be action-based.

Your choice of navigation content, layout and titles will depend on your data and customers. Prioritise the items, order and words that are most relevant to your visitors and track changes you make over time to watch the effects on your conversions.

If you want help in designing your website or curating content, get in touch with Siwan at ARRC or Sandra at Curate Bee.

<http://curatebee.com.au/>



Longer lasting streams

RUSSELL GRANT AND PAUL THEAKSTON FROM THE WESTERN CATCHMENT MANAGEMENT AUTHORITY EXPLAIN THE IMPORTANCE OF EPHEMERAL FLOODOUTS, AND HOW BEST TO MANAGE THEM TO REDUCE EROSION AND PROTECT INFRASTRUCTURE AND HABITAT.

When people think of river and wetland health in semi-arid western New South Wales, the focus is usually on the Murray–Darling Basin streams, especially the Darling River with its issues of flow levels and floodplain function, or the relatively intact Paroo–Cuttaburra system. Further west, however, the issues of ephemeral creek systems that lie within the semi-arid Lake Eyre Basin are poorly recognised and understood. In fact, most of Australia’s river channels lie within the semi-arid rangelands in the heart of the country, and are ephemeral in nature and lack a public or policy profile.

.....
Linear infrastructure such as roads interrupt ephemeral creek flows. The photo above shows four generations of a road and a history of drainage capture. The two oldest roads (on the far left) are now isolated from flows and remain as eroded channels. The third generation road is currently acting as a waterway and erosion features are now developing adjacent to the present roadway (right). Photo Peter Elfes.

Dry creeks and watercourses

These semi-arid zone ephemeral creeks behave differently to temperate zone watercourses typified by continuous channel systems and year-round flows. They reflect the boom–bust semi-arid climate and are usually dry, but may flow several times a year, either as small flows contained within the bank, or as episodic large flood events that spill over the floodplain.

Typically they are spatially discontinuous streams, which alternate between having channelled reaches, and areas of floodout where runoff and sediment spreads over broad areas. The channelled reaches can be a single channel or a network of distributaries. Each watercourse can be a broad shallow depression or an incised channel with steep margins and a rectangular cross-section. Floodouts consist of areas of sediment dumped in the stream path by large episodic floods which can move large quantities of alluvium in one event. These landforms have broad surfaces with low slopes that promote dispersal of in-channel flows as sheet flow. At the downstream toe of the floodout, a network of gullies may re-capture the sheet flow and direct it to a further channelled reach towards the next floodout area. The system usually ends in a terminal floodout or ephemeral lake. The channel-floodout processes operate at a range of scales across many of the semi-arid landscapes of inland Australia.

The floodouts

The low slope of floodout areas encourages flows to spread out, slow down and infiltrate the soil, dropping sediments, seeds, and organic matter. Floodouts become fertile patches with deep soil moisture, high groundcover, perennial native vegetation and more tree-cover than the surrounding landscape. This means that although they may lack permanent waterbodies, the floodout areas are important sites for terrestrial biodiversity and operate as relatively mesic* refugia in an otherwise dry environment. They are islands of fertility in a broader landscape where moisture and nutrients are limiting. Floodouts are also important sites for pastoral productivity, as they produce abundant and palatable forage in response to stream-flow, and are often the site of ground tank storages for stock water.

Unfortunately, the ephemeral floodouts have a key geomorphic weakness that can rapidly tip these systems from functioning fertile patches to desiccation and drought. The weakness lies in the instability that occurs when broad sheet flows are concentrated and channelled for some reason, leading to increased water velocities and erosion. When an incised erosion channel cuts

through a floodout area, the natural irrigation processes cease, vegetation cover is lost and tree-cover declines. The value for refugia and pastoral production then crashes.

Linear infrastructure

The key factor leading to the capture of sheet flows into confined channels has been identified as the impact of linear disturbances to soil surfaces, usually associated with pastoral, civil or mining infrastructure development. Where continuous linear earthworks associated with road, track, fence or pipeline infrastructure cross sheet flow areas, they divert and concentrate large volumes of runoff, increasing the depth and energy of the water. Ultimately this results in channel incision and erosion. Sediment and moisture is then delivered to areas where it may not be wanted while the natural floodout becomes desiccated. The linear features that contribute to these effects include:

- major roads where drainage is constructed to protect the infrastructure, not maintain landscape function,
- graded property access tracks, where the road surface is washed deeper with every storm,

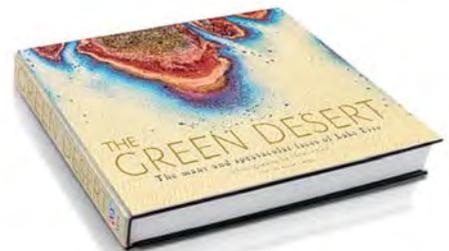
mesic—growing in or characterised by moderate moisture

THE GREEN DESERT

The many and spectacular faces of Lake Eyre
Photography by Peter Elfes

This beautiful coffee table book by award winning photographer Peter Elfes presents the transformation of the arid heart of Australia during the wettest years in recorded history. Peter's low level aerial images chronicle the changing faces of Lake Eyre and surrounding desert as seen through the eyes of an artist and environmentalist. His five year odyssey has brought the beauty of this remote part of Australia to the world's attention.

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- graded fencelines, where the windrow of loose dirt swept to one side can create a diversion bank many kilometres long,
- stock water pipeline installations where natural surface levels are not effectively reinstated,
- off-road vehicle tyre tracks, where vehicles have been driven in soft floodout soils after rain.

The extent to which linear surface disturbances disrupt semi-arid sheet flow systems is grossly underestimated, if recognised at all. In most cases, knowledge of the track, feature or rain event that initiated drainage incision pre-dates local awareness. However, field inspection and aerial photo interpretation usually provides clues that link many rills, gullies and new watercourses to current or disused tracks, fencelines or pipelines.

Is grazing pressure also a causal factor in this erosion? While increased runoff from low levels of groundcover can contribute to erosive energy, many examples of disrupted drainage patterns occur in ungrazed country, such as spinifex sandplain. The concentration of runoff caused by a linear feature crossing a broad sheet flow area gathers more than enough runoff to initiate erosion, even in well-vegetated areas.

Grader operator constructing an earthen bank to re-instate natural sheet flows at Theldarpa Station in the Lake Frome catchment. Photo Paul Theakston.



Repairing sheet flow systems

Over the past two decades, straightforward remedial techniques have been developed across inland Australia to address the issue of linear infrastructure impacts. However, there remains wide scope to promote wider adoption of these practices, as well as better ways of planning development to fit the landscape. Depending on local conditions, smart practices include:

- installing roll-over banks on new and existing tracks and fencelines to divert flows off the graded line,
- removing windrows from the edge of graded lines, or making sure there are regular breaks in the windrow to allow runoff to escape,
- installing infrastructure on high ground, even if the topography is subtle, avoiding sheet flow areas and following the lie of the land. This is contrary to popular approaches that favour long straight roads and fences.

Linear infrastructure designed and constructed to accommodate natural sheet flows can achieve both asset protection and improved landscape function. Flood damage to infrastructure, such as washed out access tracks and fencelines, can also be significantly reduced.

Since 2011, the Western Catchment Management Authority (CMA) has organised nine workshops and invested \$162,000 in partnership with 32 land managers to re-instate natural flows interrupted by linear ground disturbances such as roads and fencelines. The remedial earthworks consisted primarily of graded banks to block channelised flows with level sills to re-instate natural sheet flows at the outlet point. Paul Theakston, the Western CMA's Rangeland Rehabilitation Officer, has worked collaboratively with landholders in assessing erosion issues, designing remedial works and supervising the construction of the earthworks.

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A FROG WITH NO NAME

MICHAEL J. TYLER FROM THE UNIVERSITY OF ADELAIDE IS A FROG EXPERT, AND IN THIS SHORT ARTICLE EXPLAINS HOW THERE MAY BE NEW FROGS IN THE LAKE EYRE BASIN.

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Our knowledge of frogs of the Lake Eyre Basin (LEB) is changing all the time as new species are discovered, and those previously known are re-assessed due to new knowledge. Some frogs thought to have been members of one species have been regrouped into separate species.

Keeping track of these changes can be confusing and is not for the faint-hearted, but to a frog biologist, it is exciting and challenging. It is just one example of the staggering diversity of the living world we occupy, and whose complexity we ignore at our peril.

In 2011 (Tyler et al. 2011, *Frogs of the Lake Eyre Basin*), we knew there were 35 frog species within the LEB, with 17 found only at its periphery. We now believe few frog species can be considered major components of LEB frog fauna, in the sense that they have extensive distributions throughout the Basin. We also now consider there are three, possibly four, frog species whose distribution is confined to the LEB:

- *Pseudophryne robinsonae* described by Donnellan et al. (2012a) is from the extreme north-west of South Australia, and was thought to have been the Western Australian species *P. occidentalis* (Tyler, 1971) or an unknown new species of *Pseudophryne* (Tyler & Walker, 2011).
- *Crinia flindersensis* reported by Donnellan et al. (2012 b) throughout the Flinders Ranges. This hitherto undescribed species, together with an existing species found south of Port Augusta (*Crinia riparia sensu stricto*), were both once thought to have been *Crinia riparia* from the Flinders Ranges.
- ‘The new one with no name yet’. Of the 35 species mapped in the LEB in 2011, only *Litoria rubella* was thought to occupy most of the Basin. However, as of 2012, Donnellan has shown that *L. rubella* is in fact seven species, with one considered a ‘new species’ confined to the LEB. One of the three allopatric populations recorded is currently being described and will be named as a frog species new to science.
- *Litoria gilleni* may be a fourth species confined to the LEB, but despite its proximity to Alice Springs, little is known of its distribution and biology. A report of green tree frogs at a creek crossing north of Marla in South Australia is probably *L. gilleni*, but needs further investigation, and is an example of our incomplete knowledge of the frog fauna in the Lake Eyre Basin.

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Photos: *Litoria rubella* (top and adjacent) with *Crinia riparia* (centre), courtesy of the author.



Springs under threat



PHOTO BRIAN GRATWICKE (WIKIMEDIA COMMONS).

SARA CLIFFORD FROM THE QUEENSLAND GOVERNMENT'S Q-CATCHMENTS PROGRAM EXPLAINS WHY CANE TOADS ARE THREATENING UNIQUE SPRING ECOSYSTEMS.

FOR FURTHER INFORMATION

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On the border of the Mitchell Grass Downs and the desert uplands of central Queensland lies a unique oasis. A complex of spring wetlands fed by the warm waters of the Great Artesian Basin (GAB). The GAB spring complex is located within Edgbaston Reserve, a property owned and managed by Bush Heritage Australia. A permanent and isolated watery oasis in an otherwise arid environment, these springs are home to a diverse community of fish, plants and aquatic macroinvertebrates. The Edgbaston complex has the highest number of endemic macroinvertebrates of all spring complexes in Australia. It also contains three endemic fish: the endangered red-finned blue-eye, the vulnerable Edgbaston goby, and an as yet undescribed hardyhead. Unfortunately these springs are at risk.

Threats such as grazing, aquifer draw-down, feral animals and the excavation of springs have had a negative impact on dependent flora and fauna. As a result, GAB discharge spring communities are now listed as 'endangered' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Our understanding of how these threats influence spring communities is still being developed, however, a plan for the recovery of native species dependent on natural discharge of groundwater from the GAB has been produced. This plan outlines threats to these communities, such as the introduced cane toad.

Cane toads

Native to Central and South America, cane toads were introduced to Queensland in 1935 as an ultimately unsuccessful biological control agent for sugar cane pests. They have since spread widely throughout tropical and subtropical areas including much of Queensland and parts of the Northern Territory. Cane toads are opportunistic omnivores able to withstand a wide range of climatic conditions. There is some understanding of the impact of cane toads on terrestrial ecosystems, and cane toad tadpoles on freshwater ecosystems, but little current knowledge of adult cane toad impacts, distribution and density on spring ecosystems.

A team from the Queensland Government's Water Planning Ecology group conducting research within Edgbaston Reserve jumped at the chance to find out more about the pest. Cane toads were collected from a spring at Edgbaston and dissected to see if GAB spring fauna contributed significantly to their diet.

Aquatic macroinvertebrates were also collected from the same spring to determine which of the available aquatic taxa the cane toads were eating. Given their opportunistic feeding habits and the existence of the only permanent presence of water in these regions, we hypothesised adult toads would be consuming the aquatic invertebrates from within the GAB springs, including endemic* taxa.

Collected cane toads diet

The results of this study reveal the cane toads were indeed consuming aquatic invertebrates from the GAB springs, including rare and endemic taxa. Aquatic invertebrates were the main component of the cane toad diet, with aquatic beetles and snails accounting for the majority, in terms of both volume, and the number of individual prey items consumed. The discovery of these snails in the diet led us to conclude the toads are consuming endemic spring fauna, since all six hydrobiid snails found within the Edgbaston complex are endemic. The corresponding macroinvertebrate sample also confirmed that cane toads were consuming a large proportion of the available aquatic invertebrate taxa, this supports the notion that cane toads are opportunistic, generalist feeders.

It is of interest to note the cane toads were collected in mid-winter when the nightly air temperature was below 0°C. It was thought the cold temperature would suppress toad activity, however, all toads were active and found within three metres of the spring vents where the discharging groundwater temperature was 24°C, and remained above 20°C throughout winter. The temperature of the water drops significantly with increasing distance from the spring vent.

These results indicate that cane toads can potentially impact GAB spring communities through predation on aquatic invertebrates. These findings are important because previous research has shown terrestrial prey to be the principal diet of adult toads. Given the small spring size and the endemism of the aquatic invertebrate fauna, the local impacts of the case study could be significant.

Further research required

Now that we have established cane toads inhabit GAB springs and consume endemic taxa, we need to continue our work to determine the scale of the cane toad threat to GAB spring communities. Surveys in other GAB springs will help us to develop more accurate distribution maps, as well as determining if cane toads are using springs for breeding.

Due to harsh surrounding conditions limiting dispersal opportunities, GAB springs located in semi-arid or arid areas could also be ideal locations to trial emerging methods of cane toad control such as the use of fencing, parasites or pheromones. This could be particularly effective in the colder months when cane toads seem to congregate in warmer habitats around spring vents.

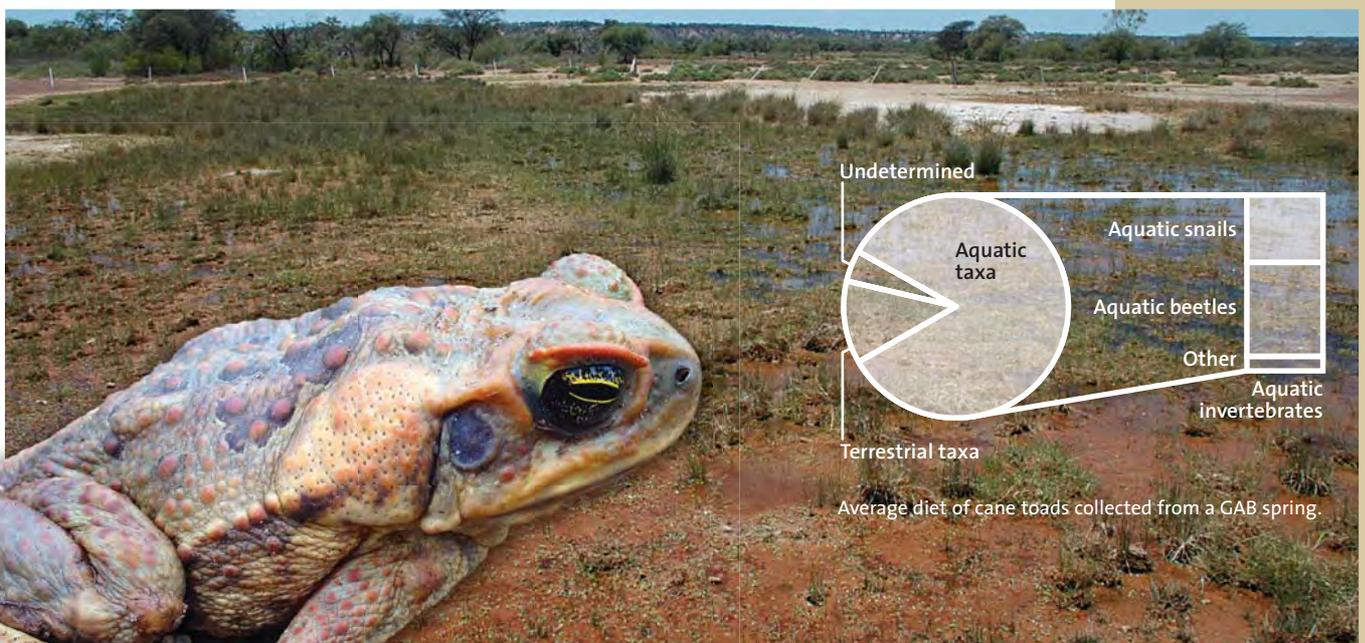
We suggest further surveys be conducted across a range of seasonal conditions to determine if cane toads venture away from spring vents in the warmer, wetter months, possibly switching to a diet of terrestrial taxa, which would potentially lessen any impact on spring fauna. Alternatively, it may reveal cane toads continue to preferentially feed on aquatic macroinvertebrates throughout all seasons, exerting ongoing pressure on endemic species and communities.

Clifford, S.E., Steward, A.L., Negus, P.M., Blessing, J.J. & Marshall, J.C. (in press), 'Do cane toads (*Rhinella marina*) impact desert spring ecosystems?', *Proceedings of the Royal Society of Queensland*.

This work was performed with permission from Bush Heritage Australia. Our thanks go to Adam Kerezy for his assistance with the collection of the cane toads and site access.

endemic taxa—populations characteristic of a specific place

Great Artesian Basin spring at Edgbaston, central Queensland. Photo Jen Silcock (see article page 40). Toad photo Sara Clifford.

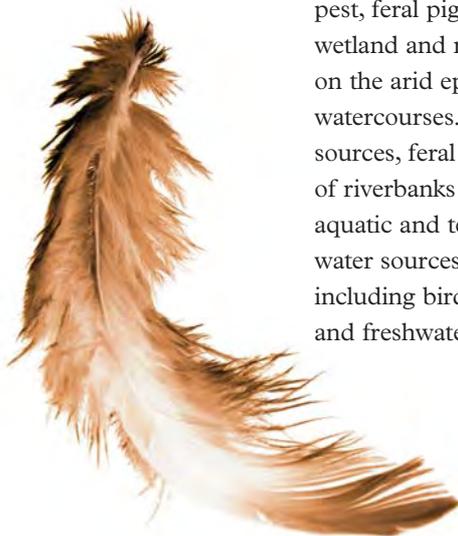




PIGS MIGHT FLY!

LEIGH DEUTSCHER FROM DESERT CHANNELS QUEENSLAND UPDATES US ON HOW THEIR PROJECT 'PIGS MIGHT FLY' IS TACKLING THE FERAL PIG PROBLEM IN THE LAKE EYRE BASIN.

Feral pigs (*Sus scrofa*) have colonised all of Queensland's catchments including the Cooper Creek, Diamantina and Barcoo Rivers which feed directly into the Ramsar-listed Coongie Lakes and Kati Thanda–Lake Eyre. In recent years, populations in these catchments have increased dramatically due to several successive above average wet seasons. Declared a Class 2 pest, feral pigs have a dramatic impact on wetland and riverine ecosystems, particularly on the arid ephemeral floodplains of these watercourses. Rarely straying far from water sources, feral pigs are responsible for erosion of riverbanks and floodplains, uprooting of aquatic and terrestrial vegetation, fouling of water sources, and predation on native species including birds, mammals, reptiles, amphibians and freshwater invertebrates.



FERAL PIG PHOTOS COURTESY OF THE AUTHOR. FEATHER HARIADHI. BACKGROUND OPPOSITE ARIVUMATHI (WIKIMEDIA COMMONS).

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The project

Desert Channels Queensland's 'Pigs might fly 2011–13' project, funded by the Australian Government's 'Caring for our Country' program was aimed at controlling feral pig populations along Queensland's inland river systems within the Lake Eyre Basin as well as protecting sensitive wetlands such as Coongie Lakes. The project, undertaken in collaboration with the South Australian Arid Lands Board (SAAL), built on previous control works, and incorporated coordinated aerial culls to ensure maximum impact on pig populations. Planning, landholder engagement, identification of critical areas and sites for monitoring, all built on the collaborative approach Desert Channels Queensland (DCQ) and SAAL have established with landholders within these areas.

The project covered 30 stations across an area of 3.4 million hectares, with a focus on rivers and wetlands. As a result of the extensive area to be covered, the isolated nature of pig populations, and the challenging terrain and dense riverine vegetation within the control area, aerial shooting was determined as the most cost effective and humane control technique.



Monitoring

Monitoring data was combined with community consultation to maximise efficiency of control works. Aerial surveys were used as the primary form of monitoring during this project because of the size of the project area. In November 2012 in conjunction with the SAAL, an aerial survey was undertaken covering the lower Diamantina from Coongie Lakes in South Australia to the lower reaches of Diamantina National Park in Queensland. August 2012 saw an extensive week-long aerial survey along the Lower Barcoo and Cooper Creek system, covering 15 properties from just north of Windorah to the South Australian border. These surveys provided baseline data on feral pig numbers across the three systems before control works started. This survey estimated approximately 178,507 feral pigs (or 8.9 pigs/km²) were in the system at the time. Since the report was produced, however, validation work has shown the actual number may be substantially less, and the initial number over-estimated due to extrapolation errors.

Control

Multiple control campaigns were carried out across the Cooper and Diamantina catchments between November 2011 and March 2013. At first, control activities were undertaken throughout the year, however, it was quickly determined these were most cost effective when animals were restricted to isolated water sources. This coincided with a period when vegetation, particularly lignum, was at its least dense, providing the best opportunity to sight target animals. The multi-stage control program consisted of aerial shooting carried out across the catchments, targeting feral pigs in summer roughly 12 months apart. Stage one involved 24 days of shooting across the three river systems, and culled 11,796 feral pigs. Stage two consisted of 19 days of shooting over new and previously controlled areas, and removed 11,247 pigs.

Animal health/autopsies

Feral pigs varied in size, and it was not uncommon for boars to be in excess of 220 kg. With the assistance of Biosecurity Queensland, almost 100 feral pigs were autopsied across the three river systems. Results from stomach content analysis found animals not only to be feeding on herbaceous vegetation such as nardoo, but also preying on freshwater mussels and crayfish, small mammals, and small birds. Blood samples were taken from animals and tested at Department of Primary Industry laboratories for exotic diseases. The pigs were found to be carrying numerous zoonotic diseases including *Melioidosis*, *Leptospirosis*, and *Brucellosis*, all transmissible to humans and livestock. Parasites including thorn-headed worms were also found in several animals in the Barcoo system.

Summary

This large-scale control program covering 30 properties and representing an area of 3.4 million hectares of channel country proved highly effective, with more than 23,000 feral pigs culled. The information gathered has been used to establish monitoring sites to measure population recovery, as well as developing ongoing feral animal control landscape management plans. Partnerships formed with landholders, government departments and interstate natural resource management organisations have been strengthened, and control works continue to be coordinated, ensuring maximum effectiveness.

Future direction/recommendations

- **Follow up control**—Feral pig populations can increase by 80 per cent in a 12-month period given the right conditions. Their extremely high fecundity rate is more similar to that of rabbits than any other herbivore, and this, combined with their ability to reproduce at a young age, allows the population to recover quickly after times of drought or control. It is well known that a rapid knock-down of a feral pig population, followed by regular control programs is the most effective means to reduce the potential for population recovery (Choquenot et al. 1996; DNRM 2005). To date, DCQ has culled 23,043 pigs. These pigs were eating approximately 33 tonnes of forage per year. This positive start is being followed up with three years of ground-based targeted baiting and further aerial shooting to further reduce the population at known hotspots. This control work, combined with the drying weather patterns, means populations will be stressed and this additional control is expected to be highly effective.
- **Monitoring activities**—Ongoing monitoring of feral pigs on the Barcoo, Diamantina, and Cooper systems through aerial surveys and the use of motion cameras will provide valuable data to validate the initial population estimates and provide information on population recovery. This will allow DCQ staff and landholders to decide when it will be necessary to carry out secondary large scale control programs.
- **Landscape management plans**—Our ultimate goals are to help landholders with their own control programs and methods, to encourage them to persist with feral pig control, and highlight the environmental and socioeconomic implications if they don't act. Developing joint landscape management plans that provide a framework for best practice control methods in the target areas would greatly assist this.

Speak friend and enter



MINING OFFERS CONSIDERABLE ECONOMIC GAINS WITH MANY COMPANIES SEEING THE LAKE EYRE BASIN AS AN AREA FOR ONGOING EXPANSION. RESEARCHER **GAVIN MUDD** IS EXPLORING THE BENEFITS AND COSTS THIS INDUSTRY POSES FOR THE LAKE EYRE BASIN AND ASKS THE QUESTION IS MINING 'FRIEND' OR 'FOE' TO THE REGION?

Mining has historically been important in many parts of regional and remote Australia, and mineral exports continue to dominate Australia's export earnings—but at what cost? The boom over the past decade has seen mining move into agricultural regions with no real history of the industry, as well as its ever-increasing scale leading to major problems such as water resources impacts, land use conflicts, mine waste management challenges, and much more.

Mining has often occurred around the margins of the Lake Eyre Basin—the Mount Isa province in north-west Queensland, or the Olympic Dam site in northern South Australia—but it is now proposing to move to the interior, creating widespread concern about water flows, water quality, land use conflicts and related social and economic impact issues. While there has been a conventional oil and gas industry in the centre of the Lake Eyre Basin for some decades (Moomba, South Australia), the potential for coal and coal seam gas, as well as expanded base metal and uranium mining in the Mount Isa province, points to a major shift in the potential for mining across the Basin.

In recent years the environmental and social costs of mining have received significant public and/or academic scrutiny—especially with the expansion of coal and coal seam gas mining. Although the industry has made substantial improvements in environmental planning and management, major pressures continue to be water resources (quality, quantity), disaster scenario planning and management (severe storms and flooding), waste management, greenhouse gas emissions and other air pollutants, land use conflicts (farming/agriculture versus mining), and the effectiveness of regulation, and especially rehabilitation (amongst other social and economic aspects).

Test pit for the proposed Alpha coal project, near Barcaldine. Photo N. Ham.

Case study examples showing the potential future of mining as a friend (or foe) to the Lake Eyre Basin.

Olympic Dam, northern South Australia

Currently an existing underground mine with a large processing complex (mill, smelter, refinery, hydrometallurgy) to produce copper, uranium, gold and silver, with plans for a mega-pit and associated infrastructure. The giant deposit is estimated at some 9.5 billion tonnes, and if the expansion ever proceeds, it could leave several billions of tonnes of radioactive mine tailings permanently above ground. The project remains a significant user of water from the Great Artesian Basin and is one of the world's most valuable metal deposits.

Lady Annie, western Queensland

Arguably one of Australia's worst modern mining disasters, this heap leach copper mine had a massive failure of its solution ponds in early 2009, leading to severe pollution of Saga and Inca Creeks which feed the upper reaches of the Georgina River. Although the mine was convicted and had to invest significant resources into re-engineer the site to improve water and environmental management, the failure should be a wake-up call that some mining companies and governments do not always live up to their rhetoric.

Cannington, western Queensland

A large lead-zinc-silver mine discovered and developed by BHP in the 1990s as an underground mine and mill, although approvals were recently sought to expand it as a large open cut mine, the project remains delayed due to depressed market conditions.

Coal seam gas (CSG) mining

A controversial new industry that is seeking to expand rapidly across Queensland, with the underlying geological Galilee Basin the main target in the eastern Lake Eyre Basin. The major issues that remain poorly addressed to date, include groundwater impacts (especially pressure levels and contamination risks) and gas migration risks, again highlighting the need for thorough environmental assessment and regulation processes that are truly responsive to community concerns and scientific needs.



Critical aspects and themes include water consumption, potential and actual impacts on surface water and groundwater resources, mine regulation and rehabilitation, and greenhouse gas emissions. By focusing on these mines as case studies I hope to highlight the complex interplay between markets, communities, corporations, regulations and governments. While there are some success stories in improving environmental outcomes, the main environmental challenge is becoming more difficult as mines, and projects, increase in size and complexity.

Overall, mining may be able to make a net-positive contribution to the future of the Lake Eyre Basin, but it will have to ensure it is truly friendly towards the existing values and users of the Basin and work hard to develop a 'social licence to operate'. It will be particularly important to ensure the various environmental and regulatory mistakes made elsewhere in the mining industry in Australia are not repeated.

Testing CSG-impacted groundwater at a farm near Tara, Queensland. Photo Gavin Mudd.

FOR FURTHER INFORMATION

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The whole picture



CHRIS MORAN DISCUSSES WHY IT IS IMPORTANT TO CONSIDER A VERY BIG PICTURE OF RESOURCE USES AND IMPLICATIONS TO FULLY DEBATE THE MERITS, OR OTHERWISE, OF EXTRACTING RESOURCES FROM THE LAKE EYRE BASIN.

When considering the issues around whether mining and other resources extraction should occur in the Lake Eyre Basin (LEB), it is helpful to frame the question. The framework that is most commonly used to define resource use is the well-known ‘5 capitals’ model. I have extended the model to ‘6 capitals’, namely:

1. Renewable natural capital.
2. Non-renewable natural capital.
3. Manufactured capital.
4. Social capital.
5. Human capital.
6. Financial capital.

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Non-renewable natural capital represents natural resources that are consumed and/or transported out of the region at a rate that far exceeds their rate of replenishment, for example, soil erosion by wind and water that is accelerated by human activity (generally denudation* of vegetation) in the landscape. Extraction of mineral and energy resources are equivalent. When we think about this from the perspective of sustainability, these activities are known as contributors to ‘weak sustainability’, as opposed to ‘strong sustainability’. This is because the resources are only exploited at the rate at which they are naturally replenished. This means that when one activity or another is to be declared ‘sustainable’, this fundamental definition is critically important.

The reason is because it introduces the notion of trade-off and choice. That is, society has a choice as to which natural capital will be transferred into what other forms of capital, as well as who benefits from the activity, and in what ways those benefits are ultimately shared. Conversion of natural capital requires primary production. Primary production creates value, and it is the distribution of that value throughout society which lies at the heart of decisions about resource extraction.

Classically, the most significant tension is where the benefits from resource extraction do not accrue sufficiently at the point of extraction, compared to other places and to the benefits of other people.

Mineral and energy resource extraction in Australia today faces this challenge perhaps more than any other commodity. The reason is the resources are being consumed dominantly to develop nations and lift hundreds of million of people out of poverty, but the impacts of extraction are located at the source, often tens of thousands of kilometres away from where the benefits are being felt.

I believe that there are four conditions that must be met to move towards being able to claim that resources extraction is ‘sustainable’.

1. Supply nations (like Australia) must be able to prosper as a result of resource extraction.
2. Demand nations (like China) must be given access to resources at a price that does not unreasonably deny them the right to a reasonable quality of life.
3. Those involved in discovering, extracting and transporting the commodities have to be able to return profits to their investors.
4. There must be sufficient consideration of future generations to ensure the creation of value today, is not undertaken at such a rate that future generations are compromised in being able to meet their needs.

What is needed is some way to measure and visualise the equity we would wish to see across these four conditions to ensure no one is over emphasised or neglected. How can decisions be made so that this equity is properly taken into account?

For the LEB, conditions 1 and 4 dominate. Under condition 1, if the region where the extraction occurs is unreasonably degraded it is difficult to claim prosperity. The tension is most evident where the nation may receive sufficient benefit, but not enough is passed to the region for there to be accord on the agreement to extract. Under condition 4, it may well be argued that resources extraction today limits future values being generated from the LEB, either the same minerals and energy resources, or the other ecosystem services that the LEB supplies into the future.



TITLE PHOTO COURTESY OF ED CLARKE. TYRE TRACK DUSTIN SCHMIEDING VIA BITTBOX. ABOVE T. ZORN (WIKIMEDIA COMMONS).

What is clearly needed at the local scale, that is, the scale of the LEB region, is a framework for informing such decisions. Such a framework should, at the very least, describe well the effects of resource extraction so decisions can be made in light of that information. To deliver such a framework, a conceptual model of the system is required and this, in turn will define the data requirements necessary.

Water is an example of how this might be approached. Mining, oil and gas extraction require water and can interfere with hydrological systems. Leading practices can be employed to ensure minimal adverse impacts from these activities. I believe it is critical that a risk-based approach be adopted from the outset for any development. The risk-based approach ensures data are acquired and information communicated in priority order, according to the risks faced. Such an approach also requires that mitigation and control measures are planned for, should an undesirable event occur.

Beyond the physical effects on water, water resources and the environments on which they depend, extractive resources activities also raise challenges associated with the livelihoods that preceded them. In most cases, these livelihoods depend on resources at, or near, the earth’s surface. One critical issue is the energy and mineral resources exit at depth, and so a potential conflict of access arises. Legally, the explorer has a right of access. Morally, it is very important this right is exercised in a respectful and thoughtful manner. When this does not occur conflict can arise that becomes very personal—often between the individuals involved, rather than via institutions and arms-length processes.

Finally, an issue of significance is the tension between access to information, resourcing of the research necessary to understand effects and the independence of the individual research leaders involved.

denudation—
sum of processes
wearing away the
earth’s surface

The highs and lows of modelling



JUSTIN COSTELLOE HIGHLIGHTS THE CHALLENGES OF MANAGING AND MODELLING WATER RESOURCES IN ARID ZONE RIVERS.

The floods and droughts of the unregulated rivers of the Lake Eyre Basin (LEB) drive spectacular booms and busts in ecosystem responses. In addition to their renowned environmental value, the rivers are central to the economy of the arid zone, sustaining pastoralism and tourism, and also interacting with important energy industries (oil, gas, geothermal). While the rivers are unregulated and currently experience only minor water resource use, there are constantly changing pressures on land use and water resource demands, particularly from expanding energy industries. In such lightly used rivers it could be argued that detailed observations of flows, and construction of complex hydrological models are not warranted. Without these data and tools, however, natural resource managers will be unable to identify changes in the flow regime of LEB rivers in response to any of these pressures, including climatic change, or to estimate how any changes proposed in the future may affect river functioning.

Gauging flow at sites with water level monitoring can greatly assist in building an improved capacity to model the rivers of the Lake Eyre Basin. Photos throughout courtesy of the author.

FOR FURTHER INFORMATION

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What are the water management needs of arid rivers?

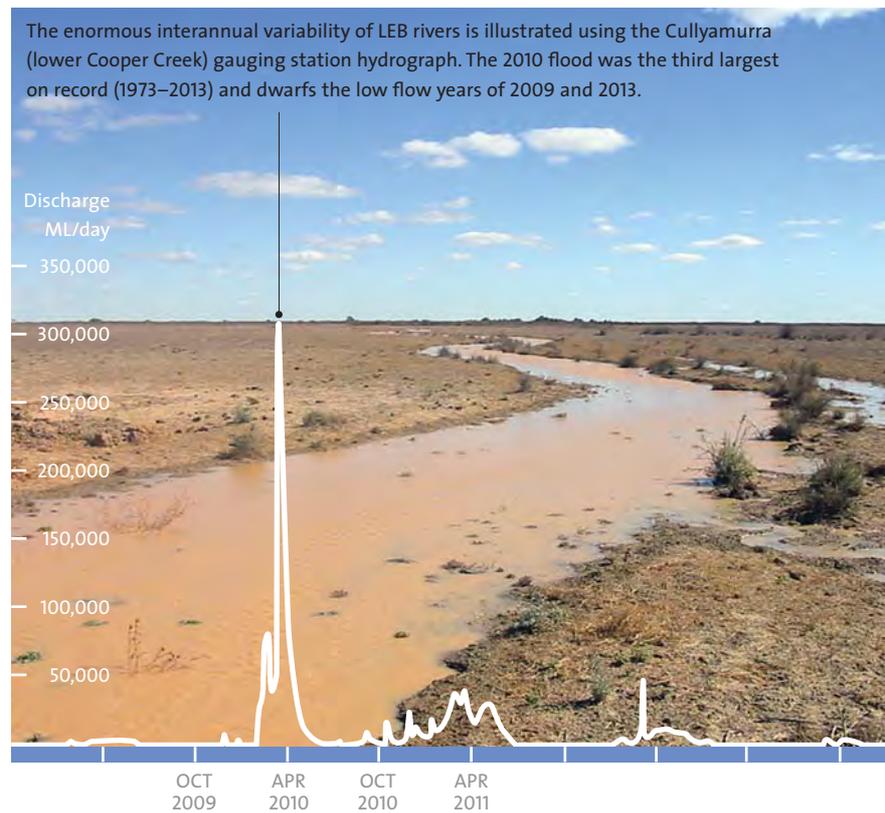
The rivers of the LEB experience water extraction volumes that are very low compared to the far more heavily regulated rivers of the neighbouring Murray–Darling Basin (MDB). In the MDB, Commonwealth and state governments are spending billions of dollars in water management due to historical over-allocation of water resources. The overriding management paradigm is to identify the minimum amount of environmental water that will maintain acceptable levels of ecological health for the rivers. In contrast, essentially all of the river flow in the LEB supports its current good state of ecological health. The management paradigm in the LEB should be, therefore, to determine how any development will affect the current healthy state of the rivers, rather than aiming to define minimum environmental flow requirements. This approach allows a much broader evaluation, where the costs and benefits of development can be compared against any reduction in the environmental and current economic value of the system.

Such comparisons are complex and contentious. Setting aside the politics, from a hydrological perspective we need to consider how the variability of the system, both in time and space, interacts with management needs. The very high temporal variability of flow in the LEB means the rivers are poorly suited to water resource developments that require a consistent, minimum level of extraction each year. This point has previously been eloquently argued by Walker et al. (1997). Variability in magnitude and timing of flow events means water extraction according to flow-based rules is going to be relatively unreliable for agricultural or mining requirements. For example, current extraction rules for inactive irrigation licences in the Channel Country of Cooper Creek (minimum flow threshold before extraction commences, maximum daily extraction rates and no storage) would mean that no flow could be extracted in 10–20 per cent of years in the Windorah (Currareva gauging station) flow record due to low annual flow volumes. These extraction rules help minimise the effects of potential water extraction, but are susceptible to change, particularly in response to demands from an operation that requires highly reliable, rather than opportunistic, water extraction.

The Channel Country reaches of the large rivers of the LEB (Cooper, Diamantina, Georgina) have exceptionally complex flow paths. These rivers occur over such low gradients that the overall floodplain width can be 50–60 kilometres in places. One of the major hydrological challenges for managing water resources is to determine how much water travels along the major flow paths over the complete range of flood sizes. The few gauging stations in the LEB are naturally located at points of flow convergence so they can most efficiently measure flow volumes. As a result, we have little information about what is happening between these monitoring points. Previous research has suggested some flow paths are more efficient than others, i.e. they experience lower transmission losses during flow (Knighton & Nanson, 1994). Somewhat surprisingly, the actual flow pathways used by the range of possible flows have not been accurately mapped, and potentially ‘efficient’ pathways un-identified. In terms of water resource management, identification of these pathways is very important. For instance, irrigation extraction from an efficient flow path would likely have a much larger downstream effect (e.g. in terms of flow reaching South Australia) than extraction from an inefficient pathway (although the latter extractions would have more impact on beneficial flooding of floodplain wetlands).

Looking after the small flows

The smaller annual flows are the most vulnerable to change, and yet we have the least capacity in accurately monitoring and identifying changes to these events from natural or man-made causes. Flow-based extraction rules go some way to protecting the smaller flows, but extraction from a particular flow path will have consequences that cannot be effectively modelled with our current limited understanding of flow distribution. In addition, for these low gradient rivers with their complex flow paths, non-extractive floodplain development (e.g. bunds to protect infrastructure, raised roads, etc) also have the potential for adversely affecting smaller flow events. Any changes in flow paths could increase losses with downstream consequences. For instance, slowing flow will increase evaporative losses or direct flow into previously dry flow paths to increase infiltration losses.



The enormous interannual variability of LEB rivers is illustrated using the Cullyamurra (lower Cooper Creek) gauging station hydrograph. The 2010 flood was the third largest on record (1973–2013) and dwarfs the low flow years of 2009 and 2013.

The ecosystems further downstream of the smaller annual flows will be most vulnerable to changes—the Ramsar-listed, iconic Coongie Lakes in the lower Cooper in South Australia is just such an ecosystem.

Improving our models

These river systems present considerable challenges to hydrological modelling. Despite the lack of extensive monitoring infrastructure, we can make targeted use of satellite data (including some new generation datasets) to improve our capacity to better model these rivers. For instance, rigorous mapping of flood patterns across a range of flood sizes, using existing satellite systems, can be combined with the new generation of digital elevation data as a possible way forward. This approach would allow the gathering of important information on flow paths that occur between the gauging stations. In addition, there has been increased government and private industry investment in flow monitoring stations in the past few years. A commitment to gathering flow discharge data at these sites would greatly increase their value in managing these magnificent rivers. A combination of a long-term commitment to data gathering and targeted research will also greatly increase our capacity to confidently analyse or model the effects of flow regime change on the spectacular arid zone rivers of the Lake Eyre Basin.

Photo: Front of a smaller flow event as it slowly moves across the very low gradient floodplain of Goyder Lagoon, Diamantina River. Losses during flow due to evaporation, infiltration and ponding can be very high.

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SMALL—BUT SIGNIFICANT



LUISE HERCUS OPENS OUR EYES TO THE MANY SIGNIFICANT ABORIGINAL SITES THAT ARE GRADUALLY DISAPPEARING.

‘Aboriginal people used to be **everywhere**—all over the country—but now they all live in town.’ Many will have no doubt heard this complaint from the old people.

This means that evidence of Aboriginal history and culture, some of it most ancient and most venerable, and some relatively more recent, is out there all over the country, and it is being destroyed day by day, or at least badly impacted and endangered in different ways—by roadworks and development, by sheer vandalism, by trail-bikes, by neglect, by stock and by natural causes. This is happening far away and out of sight of those Aboriginal people who would know about the unique significance of even the smallest things.

In the dry environment of the southern Lake Eyre Basin, rainmaking was an important tradition. The last Ngamani rainmaker Dinta Sam was particularly successful, even as a young man. So much so that early last century he was rewarded when Sidney Kidman gave him a splendid buggy. An essential component of rainmaking were shiny gypsum rain-stones, and even in his old age Dinta Sam and his wife Alice went in his buggy to a small rise just on the southern edge of the Kirrawadinna Creek

crossing on the Birdsville Track. He used a couple of old-style crowbars to lever out small sections of the shiny gypsum deposits on that little rise. The deposits remained there for half a century, but over the last couple of years roadworkers came with bulldozers and began destroying the site for road-metal. Despite appeals to stop the roadworks, operations there seem to be continuing, and the Birdsville Track looks ‘shiny’ for several kilometres.

That site was unique as it belonged to the last rainmaker from the Birdsville Track area, and it had general cultural significance.

Ancient engraving site

The very special place (pictured above) with dark rocks between the dunes, is a major site for the Aboriginal Fire History. Those flat rocks and some much larger, extend over a number of kilometres. The rocks represent people who have been burnt by the great Fire in the History Time. If you look carefully at some of them you can see tiny ancient engravings. If such a place existed in the old world, it would be revered—but here, cattle wander in and out leaving their footprints and droppings.

There are other sites like this near Morris Creek and on Callana Station where small engravings are similarly exposed to cattle and sheep. Sheep are more likely step on, or rub against the rocks.

Title photo: An ancient engraving site. Photo John Giacon 2012.



Above: A rain-stone site on the Birdsville Track. Photo Luise Hercus 2012.



Far left: Standing stones. Photo Bill Jeffery 1978.

Left: The Emu grandfather stone guarding the Emu ritual site at the Tunkalana waterhole. Photo Graham Hercus 1971.

Stone arrangements

The standing stones (pictured above) along with several more, are close to a much-used cattleyard. The stones represent a group of ancestral snakes walking about, with the site part of the Fire History. There used to be many more standing stones, but now they lie on their side. Interestingly, one land manager blamed Aboriginal people for the stones being knocked over, saying a rumour had gone about that if you laid one of the snake stones on its side this would make rain come. However, it is more likely that cattle are to blame.

The solitary standing stone (pictured below) is part of a ‘two men of initiation’ myth. It represents the head of a woman who was killed because she intruded on an initiation ceremony in the History Time. The stone is surrounded by ochre, which is a sign of its importance, but the significance of the smaller stones has not been explained. The stone is in a very saline environment that is not much frequented by stock, but a main road is not far away, and the danger to it would come from adventurous four-wheel drivers.

Solitary standing stone. Photo Bill Jeffery 1978.



Vandalism

The waterhole near the ‘guardian stone’ shown in the old photograph above was the most important site for the Emu History, and there were many songs and rituals dedicated to it. This stone, as well as two other significant stones, were found smashed to pieces amid an abundance of bottles. There is a stockyard nearby and the only people who would come to this location would be young stockmen. There obviously was nobody around who might have an inkling of the traditional importance of this site.

I put the pieces together under a nearby bush—perhaps one day someone may be able to put them together again.

Nothing left here

Appamurna *Ngapa-manha* ‘Bad water’ was the name of a station east of the Birdsville Track that belonged to Louis Reese and was written about by Philip Jones¹. About 50 Aboriginal people worked at the station at various stages and it seems that a few years ago the place was set on fire and razed to the ground. It was the source of many memories, and is of significance in Aboriginal historical heritage as well as European.

What can we do to arrest or at least curtail destruction and try to preserve these small but important parts of tradition and heritage? We are often told by well-meaning people ‘don’t worry there is still plenty of all this out there’, ‘there is more where this came from’ and so forth. This misses the whole point: all of the sites we have mentioned are unique. They have their own special significance and simply cannot be replaced.

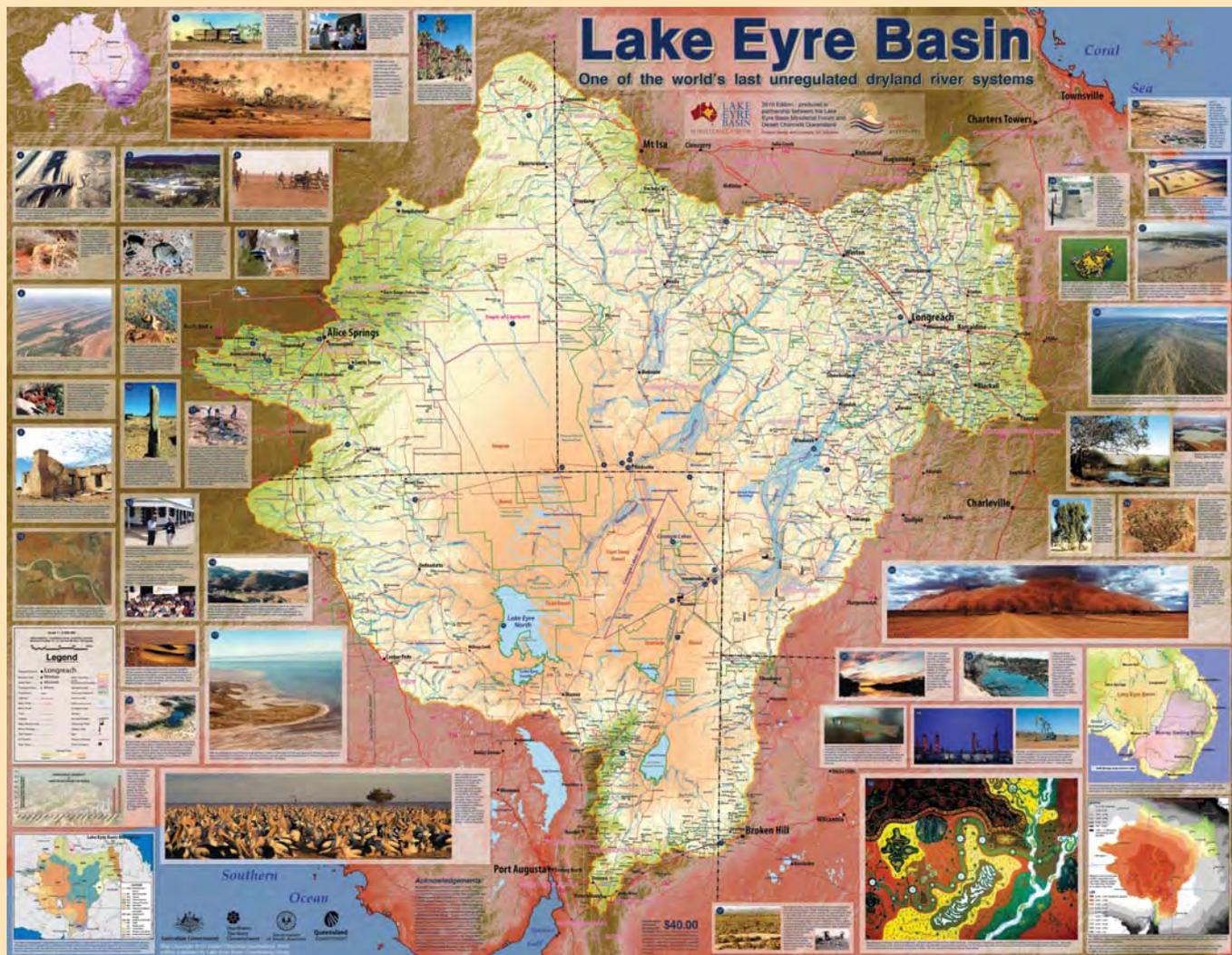
Nothing left at Appamurna. Photo John Giacon 2012.



FOR FURTHER INFORMATION

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1. Jones, P. (1990), ‘Ngapamanha: a case-study in population history’. In P. Austin, R.M.W. Dixon, T. Dutton & I. White (Eds), *Language and history: essays in honour of Luise A. Hercus*. Australian National University, Pacific Linguistics.



A GREAT BIG POSTER

Portraying a strong sense of place for people of the Lake Eyre Basin, as well as a story of discovery for tourists and non-residents who want to learn more about the region, the 'Lake Eyre Basin Poster Map' (shown above) is a powerful illustration of the Basin's most significant historical, cultural, hydrological, economic and biological features.

The poster captures the essence of the Lake Eyre Basin, one of the world's last unregulated dryland river systems, presenting some of the unique features of the region and its people to be found along the thousands of kilometres of arid rivers and creeks that flow to the icon of outback, Kati Thanda–Lake Eyre.

The large (867 x 1108 mm), colourful poster contains more than 40 images and diagrams, with lots of information about rivers and wetlands, plants and animals, climate, terrain, towns, homestead names, Aboriginal lands, parks and reserves, land use and management of natural resources in the Lake Eyre Basin.

The poster is available from Desert Channels Queensland in Longreach for \$40.00 (plus postage and handling), or just \$25.00 for residents of the Basin. To obtain a copy contact Desert Channels on 07 4658 0600.

The poster is published through a partnership between the Lake Eyre Basin Ministerial Forum and Desert Channels Queensland Inc. with all proceeds going towards activities that raise awareness of this unique part of Australia.

FOR FURTHER INFORMATION

www.dcq.org.au
07 4658 0600

My Diamantina

The lady, my Diamantina, she starts and comes down from the top end. Sweeping, carving, making her mark on the land. This is her country, my country, we share the land. She gives life to all who is on her path and can take it away without a thought of 'what if'. When in drought she still has a beauty of her own. In flood she comes, whishing, yelling, 'Get out of my way, I've got a job to do', rushing, pushing, twirling around and around and then going on strong. She is stubborn and powerful! There is no stopping her, if there is a blockage on her path she will go over, under or around. She was put here for a reason and that reason is to give life to the land, her people and her animals. My Diamantina has fresh water, she is spreading her fingers, clawing, grabbing, filling, taking and giving on her path. She has helped so many! My people talk about my Diamantina, 'floods that are coming — big blood they say'. They are depending on her to fill the rivers, lakes and the outside channels, that has been dry since the last big flood. All the water animals and the mythical water snakes, all dancing with joy. My people watch with excitement, and they do a dance of celebration. My Diamantina, moves on to meet her sister the Georgina and then on to Kati Thanda—Lake Eyre. When it is time for her to stop spreading water like her fingers, life will appear and then colours of the rainbow will be there for all to see and enjoy. Thank you my lady, my Diamantina — Happy travelling!

Story created by Aulpunda, Jean Barr-Crombie
Wangkangurru-Yarluyandi people, Birdsville.

This photo shows Lake Eyre drying down.
Part of the space shuttle cargo bay is just visible along the left edge of the image.
Photo NASA, December 1990.



At the Australian River Restoration Centre we believe in sharing knowledge, restoring and protecting our rivers for all to enjoy and valuing people and the work they do. We do this by:



Inspiring and supporting people passionate about rivers



Creating and distributing *RipRap* magazine



Sharing knowledge in multiple ways



Collaborating and networking with a range of organisations



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RipRap

EDITION 36, 2013



To get involved and find out more about what we do visit our website www.rrc.com.au and get in touch through Facebook, Twitter and LinkedIn.



Siltcrete Island in Belt Bay, Kati Thanda–Lake Eyre, June 2012. The four years that the Lake retained water allowed algae, bacteria and single-celled life forms known as archaeobacteria to form. These microorganisms are considered the oldest life forms on Earth. The colour of the water comes from pigments within the cell that produce carotenoids. Photograph Peter Elfes.