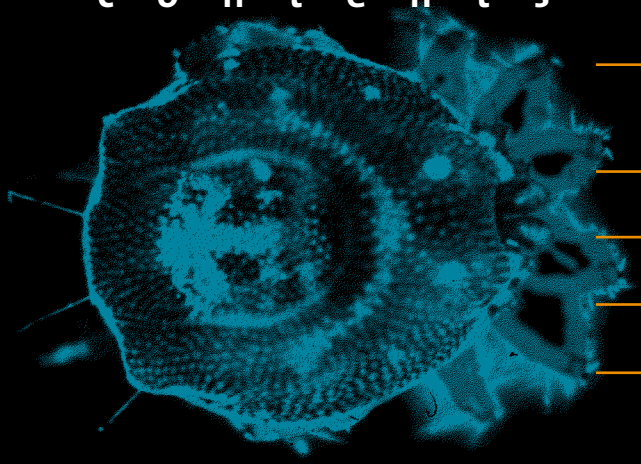
May 2000

WaterShed

contents



The Smart Regulator

by Professor Peter Cullen

The role of the regulator has so far escaped the spotlight of reform that has shone on much of the water industry. This has now changed with the Productivity Commission releasing a report on 'Setting Drinking Water Standards" (http://www.pc.gov.au). This report provides an outstanding analysis of many of the issues facing regulation in complex areas like public health and environment, where technical inputs must be weighed against social and economic factors in the setting of standards.

The time has come to examine what we expect of a smart regulatory system.

- What are the appropriate standards required to deliver societal objectives?
- How can catchment and water managers ensure that they meet societal objectives in a cost-effective way?
- How can society be assured that the required standards have been met?

Setting Standards

The desired outcomes must be determined before setting the required standards. These might be a mix of environmental, health and financial outcomes. We need a system of evidence-based regulation where we spend to achieve an agreed and clear outcome.

Evidence-based regulation has not always been the case, especially with strategies like "Best Management Practice" (BMP) that are input driven rather than outcome driven. The engineering profession quite likes BMP approaches because it means there is a continuity of work in upgrading facilities as technology leads to improvements. A bit like upgrading your computer each year although the old system does what you want. For Directors of water utilities who now carry personal responsibility for performance – why take risks with old technologies?

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Cooperative Research Centre for Freshwater Ecology

The Cooperative Research Centre for Freshwater Ecology improves the condition of Australia's rivers, lakes and wetlands

On the other hand, evidence-based standards are driven by the desired and specified outcomes. The CRC for Water Quality &Treatment has recently released a $3 million epidemiological study of 600 households in Melbourne that showed no health benefits for providing filtration in the Melbourne context. Such filtration would have cost water uses some $500 million. The study concluded " we have found no evidence of waterborne gastroenteritis from a chlorinated unfiltered water supply drawn from a protected catchment" indicating that the desired outcome of improving public health would not be achieved by such filtration.

Meeting Agreed Standards

Catchment and water managers have to meet agreed standards. If financial reasons prevent this, they should make it clear for what uses the water is safe. Where management agencies do not have the technical skills, and where this function is not outsourced, Governments should consider establishing new management arrangements. Where managers have been captured by a particular user of the resource, then consideration should be given to privatizing them and establishing a broad based regulatory manager to work in the wider public interest.

Monitoring Standards

Regulators are needed to ensure standards are being met. This is a policing function, and is a necessary part of any regulatory system. Regulators need to ensure that cost-effective monitoring programs are in place. This requires better planning and specification of what has to be achieved than is common. Many argue that regulators should ensure monitoring data is available on the web. These data should be used to improve management and for prosecution where necessary.

Encouraging Innovation

It is important to separate the three elements of regulation: standard setting, meeting standards and monitoring compliance. Regulators, industries and the wider public all have an interest in what standards are adopted. These are often lowest common denominator standards agreed across a number of political jurisdictions. Openness and transparency are required to help this process work well.

It is important for regulators to encourage managers to be innovative with different ways of delivering standards, which can involve taking risks. Never let us assume that what passes as BMP is in fact best, or even acceptable. There are probably always "better practices", and we need to encourage managers to trial and innovate. Regulators determine whether the industry operates in a climate of innovation or in a comfort zone equating expenditure with effectiveness.

Regulatory agencies are capable of being innovative in how they achieve goals, and this needs to be encouraged. Working with industries to improve practices and better feedback and reporting mechanisms are important examples.

Separation of Regulators

The States have separate systems for regulating human health, environmental and financial aspects of the water industry. Would we be better served by integrating these separate regulatory roles into one system? We commonly have price setting regulators, and we have the National Competition Council assessing progress under the COAG water reforms. Many regulators are under-resourced in comparison to the organisations they are attempting to regulate.

Productivity Commission

The Productivity Commission has reported on its benchmarking study of a number of countries. It claims that water quality regulation in Australia does not meet BMP and is well behind the USA where consultation is better and standards rigorously assessed. Also, regulatory agencies in the US are better staffed than their Australian counterparts. The Productivity Commission Report says that Washington State, which has a similar population to NSW, has 80-90 people involved in this area, compared to 4 in NSW.

Regulatory Reform

The Australian water industry has achieved an impressive suite of reforms since the release of the COAG Water Resources Policy in 1994. The Productivity Commission's report focuses our attention on the complex issues facing regulators and clearly there is scope to improve Australia's fragmented regulatory systems. The next wave of water reform should address Australia's current regulatory systems and practises.

Shrimps as a Model for Biodiversity, Conservation & Riverine Management

by Dr Satish Choy

The recent discovery of two new freshwater shrimps has added impetus to the use of these animals as biological indicators of river health. The discovery also provides an insight into the diversity, conversation and management issues relating to Queensland rivers and streams. The two new species were recently described by staff of the Resource Trend and Condition Unit, Queensland Department of Natural Resources, a new CRCFE partner, in a scientific paper published by the Queensland Museum.

The first new species, aptly named *Caridina confusa*, has previously been confused with another closely related species, *Caridina zebra*, which was first described in 1993. Both species are found in the Atherton Tableland (North Queensland) and superficially look very similar. However, their morphology and preferred habitats are quite different. *Caridina zebra* is generally very common and abundant in the relatively undisturbed rainforested streams of the Upper Tully, Johnstone, Herbert and Barron Rivers. The name "zebra" refers to the black and white markings often found on the back of the shrimps, similar to its namesake. *Caridina confusa*, on the other hand, is found in streams running through disturbed open grassland (pasture) areas of the upper Barron and upper North Johnstone Rivers. Wherever there are fragments of rainforest remaining in the predominantly grassland areas, both the species tend to exist together. However, one species is generally more abundant than the other, so that near the grassland fringe of the rainforest *Caridina confusa* is more abundant while in the rainforest section of the same stream *Caridina zebra* is more abundant. In some parts of the upper Barron and Johnstone Rivers *C. zebra* is found in disturbed areas, but never in high abundance.

The second new species, *Caridina spinula*, again closely related to *Caridina zebra* and *Caridina confusa*, was discovered in small streams in the Cape York Peninsula. Although the area is currently undisturbed there is evidence that the forest was selectively cleared in the past. It is interesting that none of the three species have been found in areas in between the Atherton Tablelands and Cape York. The rainforest areas of the Daintree would have been a likely place to find them, but intensive sampling has failed to find any of these species. Other species of shrimps are found in the lower reaches, however. The reason for this absence is still a mystery.

a mystery of absence

There is evidence that all three species arose from a common ancestor and isolation has resulted in their speciation. While all three of the species are endemic to Australia (ie. found only here) a fourth species, *Caridina typus* is found throughout the Indo-Pacific region. In Australia, it is found in the northeastern coastal areas of the mainland and nearby islands.

So, where was *Caridina confusa* before the rainforests in the Atherton Tableland were cleared? Could its speciation have occurred in the last 200 years since European settlement and rainforest clearing in the Atherton Tablelands? The answer to this is most likely to be no. Although new species can evolve over as little as 100 generations (100-200 years in the case of these shrimps), *Caridina confusa* must have been there from long before. It is likely that they did occur in the rainforests but were perhaps less successful and dominant than *Caridina zebra*. Recent studies by CSIRO (Trott, P. 1997) have shown that in the past 10,000 - 30,000 years rainforests were not as extensive in some areas as they are now. They have undergone cycles of expansion and retreat. Incursion of fireprone gum trees (*Eucalyptus*) have occurred, leaving a network of corridors and narrow strips of refuges of rainforest which then expanded during the warm, wetter periods. Some of the currently rainforested areas were therefore actually

covered by these fireprone gums during the drier periods of the past. Charcoal and pollen analyses indicate that *Eucalyptus* woodland extended in areas of upland rainforest around the crater lakes of Barrine, Eacham and Lynch's Crater during the cooler, drier conditions 10,000-30,000 BP. In some areas these gums yielded to rainforests only 3,800 ago. This would mean that *Caridina confusa* could have been favoured by these conditions in the past and their evolution could have taken place over an extended period.

The last intensive study of freshwater shrimps was done about fifty years ago. Since then, several new species have been discovered. Comparison of the current distribution and abundance of freshwater shrimps with information gathered in the 1950s can provide us with knowledge as to what is happening in streams and rivers.

It is interesting to note that not much has changed by way of shrimp distribution and abundance on a large scale. At localised scales, however, there is reason for concern. Some areas are becoming devoid not only of shrimps but of other aquatic fauna, while other areas are becoming infested by fauna not previously known to occur there or, if they did, were in low abundance. Such dynamics allow these fauna to be used as biological indicators to assess overall ecological condition and trend. As illustrated by the case of *Caridina zebra* and *Caridina confusa*, some species do better under modified conditions while others do not. In the coastal streams a species, *Caridina longirostris*, not previously recorded from Australia (but which would have existed and was mistaken for another closely related species, *Caridina nilotica*) is known to thrive in para grass (*Urochloa mutica*) infested streams and are relatively tolerant to pesticides and nutrients. Other species such as *Caridina serratirostris* are not as tolerant.

drastic changes in stream conditions

When riparian vegetation along streams is cleared the conditions in the streams change drastically. The streams become more exposed to light and temperature increases and fluctuations. Because of higher temperature and light conditions, the dissolved oxygen levels change. Because of increased light, more aquatic plants and algae grow, which often results in

Paratya Australiensis. *The species of shrimps found in a river will change if the river is disturbed or degraded. Photo: John Hawking*

the invasion by exotic weeds. Cleared vegetation also results in increased erosion and silt levels in the water. Silt is known to have an impact on many animals possessing gills, such as shrimps. Previous work by the author (Choy 1992) has shown that an initial increase in suspended silt levels leads to a corresponding increase in the breathing rates of shrimps. If there is a further increase in silt levels, breathing rates begin to decrease because the gills of the shrimps start to clog up. If high silt levels are maintained, the animals breathe less and eventually die from hypoxia (lack of oxygen). Silt also settles on stream beds and smother the small living habitats of many other invertebrates, along with their egg-laying sites.

The two species of shrimps from the Atherton Tablelands serve as very good indicators of stream conditions. It is very likely that clearing of forest vegetation will result in the decline of less tolerant species such as *Caridina zebra* and an increase in species favoured by the modified environmental conditions.

We are confident that there are still many undiscovered species in our streams and rivers. Given that we are rapidly modifying the condition of many of our streams and rivers, the question is how many undiscovered species have already disappeared or how many more are going to disappear before we even document their existence? For example, a single specimen of an undescribed species of shrimps was collected from the upper Barron River in 1994. Since then, no further specimens have been collected or seen, despite intensive sampling in the area. Is this species just rare or have we seen the last of it?

there are still many undiscovered species

Freshwater shrimps (Families: Atyidae and Palaemonidae) are perhaps the most common and abundant animals in Queensland's rivers and streams. At least 22 species are known to exist in the State. The highest diversity is generally in wet tropical areas but abundance of individual species is high, even in the western arid areas of the State (eg. Cooper-Thomson and Diamantina Rivers). One species (*Paratya australiensis*) occurs all the way from the tropics to Tasmania, while another species (*Caridina thermophila*) is known only from hot springs in central Queensland. The size of adult freshwater shrimps can range from a few millimetres to about 30 centimetres. Such diversity must have evolved over a long period of time and from exposure to slow changes in environmental conditions. Currently, conditions are being changed too rapidly by human actions to allow adaptation of these and other aquatic animals. Ideally, river managers should carefully consider the ecological values of this fauna and ecosystem, and ensure that changes are not too great or rapid and that impacts are minimised. It is vital to maintain river health in terms of physical, chemical and biological aspects.

Research projects within the CRCFE such as AUSRIVAS have been instrumental in the collection of valuable data on freshwater shrimps and other macroinvertebrates. To date the data have mainly been used for river health assessment. Future work will use existing data for taxonomic, biogeographic, biodiversity and conservation studies. Collaborative work with other CRC staff (Prof. Stuart Bunn and Assoc. Prof. Jane Hughes of Griffith University) has been looking at the genetics. Some of this work may extend into some of the proposed CRCFE projects.

References:

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Choy, S. & Marshall, J. 1997. Two new species of freshwater atyid shrimps (Crustacea: Decapoda: Atyidae) from Northern Queensland and the distributional ecology of the *Caridina typus* species-group in Australia. *Memoirs of the Queensland Museum*, Vol. 41, pp. 25-36.

Trott, P. 1997. When woodland ruled the Daintree. *ECOS*, Vol. 91, pp. 6-15.

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Snags – a Valuable But Scarce Resource

Trees and branches that fall into and lodge in our rivers are an essential part of the river's ecology. They provide a place for a wide range of plants and animals to live and as water flows over and around snags, they help shape the river.

Since de-snagging (removing snags) began, huge numbers of snags have been removed from our rivers. Between 1911 and the late 1960s, for instance, a snag boat removed about three million snags from the River Murray. Most of this de-snagging aimed to improve river navigation, because being holed by a snag was the major danger for early riverboats.

Most attempts at "improving" the river through de-snagging have actually damaged the river's ecology. For example, between 1960 and 1975 river-works in the Broken River in Victoria focussed on de-snagging to minimise flooding. It is now thought that this de-snagging has been a major cause of erosion of the stream bed, and because of snag removal the river now provides much less habitat for large native fish and other biota.

Understanding the importance of snags to the ecology of rivers and streams is an important aspect of research undertaken by the Cooperative Research Centre for Freshwater Ecology. Examples of current snag research include:

Golden Perch and Carp

Early results indicate that the native golden perch show a strong preference for snags in deep-water. Interestingly, introduced carp are not nearly so associated with deep-water habitats or snags. For this project, CRC for Freshwater Ecology PhD student David Crook is

Snags are hotspots of biodiversity.
Photo: Arthur Mostead

Snag utilisation: ibis at Lake Cowal-Wilbertoy Wetlands, NSW. Photo: W. Lawler, NPWS

precisely mapping snags in the river and attaching radio transmitters to the fish to see how and where they move around.

Restoring Fish Populations

How many snags need to be returned to the river to effectively restore fish populations? To answer this question, researchers at the Department of Natural Resources and Environment Victoria (DNRE) are comparing the number of fish with the amount of snags in the River Murray above and below Lake Mulwala. With this information, a pilot resnagging study will be undertaken.

Murray Cod, Trout Cod and Snags

Researchers at DNRE have found that Murray cod migrate long distances after flooding events, using snags as shelter rather than moving through the deepest parts of the river where the current is faster. Young Murray Cod remain in the river channel during large floods (rather than move to billabongs or onto the floodplain) where they use snags as shelter. Trout Cod also prefer snag habitat in the river.

New Ways to Bag Snags

Snags are very difficult to sample. They are often in deep water, slippery, hard to access, and provide lots of places for invertebrates to hide. To overcome these difficulties, researchers at the Murray Darling Freshwater Research Centre developed a new way of sampling invertebrates on natural snags. This involves wrapping a specially designed 'snag bag' around the snag and using a brush to dislodge invertebrates from the snag. The current flowing past the snag washes the invertebrates into the sampling bag. While the technique is effective, you still have to swim out to your snag!

Snags Contribute to Biodiversity

Preliminary results from Monash University research have shown that snags make an important contribution to the biodiversity (number of different types of invertebrates) in the Yarra River.

A Vital Link in the Food Chain

Researchers at Monash University have shown that the biofilm growing on snags contributes significantly to the amount of beneficial algal growth in the Ovens River. Biofilm growth is high in summer and autumn when warm temperatures and low flows provide ideal conditions for growth. Results indicate that the biofilm on snag surfaces contributes to the carbon supply and hence food supply in the river.

In a Nutshell

Snags are an important part of freshwater ecosystems. By providing a great variety of habitats, snags support a diversity of plant and animal life. It is now realised that the large-scale removal of snags from waterways has damaged overall river health. Snags should be protected wherever possible, and reinstated if possible.

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Communicating Science Through Art

Two recent public art projects have explored the themes of land and water sustainability. Both projects, one in South Australia and one in Mildura, have helped to bring complex land and water issues alive for the local community(ies), and along the way, generated immense community enthusiasm, discussion and involvement.

In Mildura, the Sunraysia community commissioned six artists to work on the Artists in Industry project, exploring different views of the land, people and environment and the connections between them. The project aim: to creatively engage the Region in thinking about sustainable futures into the 21st Century. The artists brief: to create innovative art works in collaboration with scientists, horticulturalists, industry and community groups. The result: two outdoor sculptures, a multi-media installation including a CD-ROM and video; a theatre performance and a multi-media exhibition. All the artworks interpret and communicate themes around land and water sustainability.

The Lower Basin Laboratory, part of the Cooperative Research Centre for Freshwater Ecology, hosted two multi-media artists who studied how, what and why the scientists research. The artists, Michael Donneman and Motoyuki Niwa, worked with the scientists over 18 months.

Dr Ben Gawne, the Scientist in Charge at the Lower Basin Laboratory, talks about the laboratory's experience with the world of public art:

'The Sunraysia community funds the Murray-Darling Freshwater Research Centre, Lower Basin Laboratory. Freshwater is the critical limiting resource in the region. Without a supply of good quality fresh water, none of the agricultural or horticultural industries could persist. The role of the laboratory is to generate knowledge about our freshwater ecosystems and then transmit that knowledge to people.

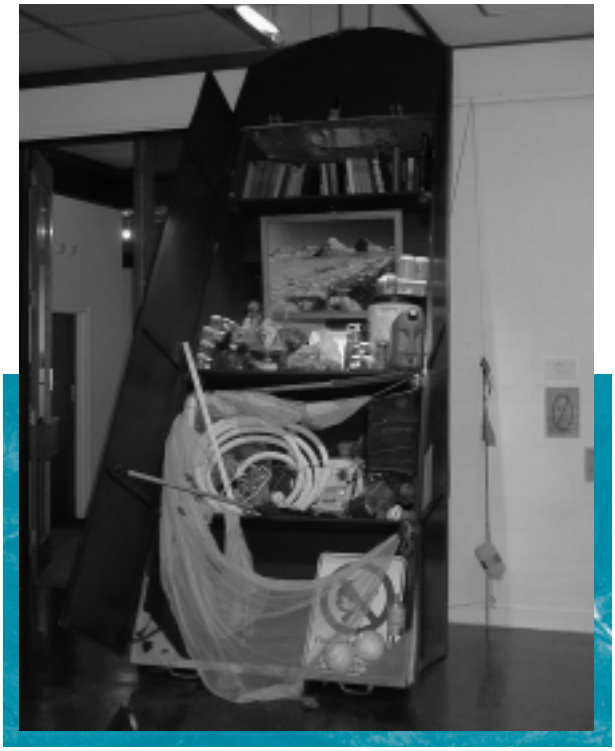
Because the future of the laboratory depends on the support of our community, it is important that the community understand not just the information that we generate, but also the way that that information is generated. It is difficult to translate scientific data into meaningful policy and management options. It is, however, even more difficult to communicate to the general public the day to day realities of being a scientist.

The Artist in Industry project offered the laboratory a means to expand its communication with its community, and expand the horizons of the individuals working at the laboratory. The project also offered us an opportunity to explore a novel and exciting way to communicate to the broader community. A form of communication that would express not just scientific data, but the humanity of science. Such opportunities are rare and not to be dismissed because one is too busy.

communication to the broader community

How Has the Reality Matched the Opportunity?

After some initial organising, the project has been fun. A welcome distraction from the hassles of seeking funding, keeping projects on track and sitting in meetings.



Art interpreting science.
Photo: B Gawne

Meetings with the artists are carried out in coffee lounges, park benches or aluminium punts rather than windowless rooms. You don't need a chairman or an agenda; you just talk about the stuff that is important to you and wonder at the ideas that are presented to you.

One of the most interesting things about the whole project has been comparing notes with an artist. The major revelation has been the similarity of artistic and scientific endeavour. Both fields are populated by people who love what they are doing to the extent that their judgement about other important life issues are often impeded. What other explanation is there for people who spend years at university and then years in the workforce in the vain hope that they might one day earn as much as a private in the Australian Infantry. It is because the work is a labour of love and not just a job.

If it be true that Humanity is created in God's image, then Art and Science are Humanity's attempt to emulate Genesis. Whilst it is true that some science is performed simply in order to better understand the Universe in which we live, this is still an act of creation; the creation of knowledge. Indeed many works of art have a similar outcome, in that by presenting an image or an idea in a new way, we may learn more about the world around or inside us. A further similarity between art and science is that both attempt to progress humanity. The fact that both are often abject failures should not obscure the motivation behind the creation.

I have very much enjoyed the unexpected meeting of the minds and the resultant stimulating comparison of the artistic and scientific world. It is a little depressing that it took us over 2000 years to rediscover what the Greeks knew, namely that science and art are merely different aspects of the same thing. There is a lot of art in science and for many scientists the passions that drive artists are the same ones that drive scientists, the expression is just different.

In addition to my personal gain I believe that our laboratory, the Sunraysia community and perhaps the broader community will all benefit from the art that is produced as a result of this collaboration between science and art.'

The exhibition opening in Mildura in March attracted over 250 people, and many more will see the exhibition, sculptures, CD-ROMs and web site. A Science/Art Symposium was held as a part of the project.

Michael and Motoyuki's exhibition about the Laboratory's work used video, photographs, an artists' book and slides projected through water. The boat, Planktn (sic), served as a display case for the tangible elements of water science: books, scientific instruments, samples, fish skeletons, plants and so on.

Artists in Industry website:
http://www.ruralnet.net.au/~artind21

South Australian waterworks project website:
www.countryarts.org.au

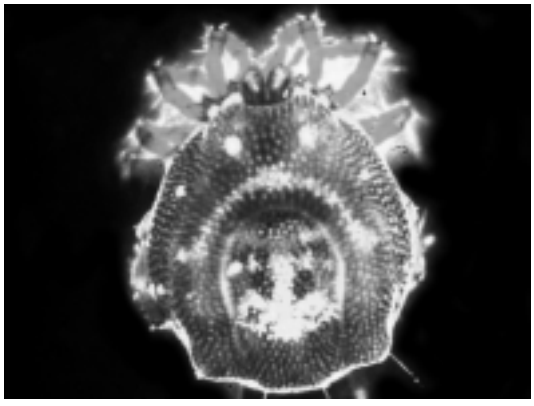


Photo: John Hawking

The feature creature for this issue:

Class Arachnida
Order Acariformes
Family Arrenuridae
Genus Arrenurus

This tiny red water mite is found in lakes, pools, streams and rivers all over Australia. Protected by hard armour and up to 1.5 mm in size, it often parisitises adult dragonflies

Carp Spawning Biology Reveals Control Clues

by Glenn Wilson

The Lower Basin Laboratory's carp research is revealing clues for controlling carp through flow manipulation. Some of the strongest indicators have come from investigating patterns in carp spawning[1]-timing along the Darling and Murray river systems, as well as a pond experiment examining the potential for egg destruction through draw-downs[2].

This work provides the first direct analysis of spawning patterns in an Australian freshwater fish over such a large area. During late 1998, carp spawning commenced earliest in sites along the Darling River and Anabranch. This coincided with a large flood-pulse, which seemed to produce a progression in spawning activity as the water mass passed down the Darling system and into the lower Murray River. Along the Murray River, wetland spawning was earliest in the Swan Hill and Mildura regions (mostly September), with spawning in Barmah Lake (Echuca) and the South Australian sites occurring later (October).

Interestingly, comparisons of spawning timing between close sites indicated that spawning was not necessarily synchronous in such situations. Pairs of sites most similar in spawning timing were also those with the greatest similarity in flow history.

A pond experiment was then conducted between April and December of last year, to directly test the hypothesis that drops in water level could be used to reduce carp breeding success. The series of 18 x 5 m ponds were stocked with three male and three female carp in July, and the ponds topped up by 40 cm to their full depth ('flooded') in October. This flooding provided the carp with access to shallow sections for spawning, as well as a likely cue to initiate this process.

Indeed, the carp started spawning behaviour soon after the pond flooding. Carp that had not been sighted since their placement in the ponds began to explore shallow sections within 30 minutes of filling, and spawned there overnight. This response alone suggests that the sudden inundation of a site may provide an opportunity to attract and trap large numbers of adult carp. This strategy would coordinate well with a subsequent draw-down to kill any eggs laid by those or other carp in the water.

an opportunity to attract & trap carp

Eggs laid on the grass stalks and straw across the shallow sections of ponds were noted to be fully dried-out within one hour of their exposure to air. This confirmed their fragile nature, and corroborated earlier laboratory work by University of Adelaide and Lower Basin Laboratory Honours student, Ben Smith.

Perhaps the most significant indication from this work is the ability to 'switch on' the spawning process in a carp population at a time when you are ready to undertake control efforts. Results from the pond experiment suggest that allowing water levels in a water body to recede before inundation by 30-40 cm in mid-Spring may trigger a large proportion of that year's spawning effort. Planned draw-downs can then follow in order to destroy the resulting eggs.

Controlling carp in our rivers.
Photo CRCFE

Interest in this work extended recently to New Zealand where Department of Conservation officers are developing plans for carp control on North Island. The next step for the Mildura researchers will be to extend tests of these techniques to actual wetland sites. This will require additional research funding, which is being sought through several Federal Government channels. Significantly, the work already has strong support from landholders and several natural resource management bodies. Stakeholder partnerships of this kind will be critical if we are to succeed in developing effective options for carp population control.

1 *spawning*: egg-laying
2 *draw-down*: a drop in water level as a result of releasing water from a reservoir.

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SideStream

International Ecology Institute

Peter Cullen has been elected a member of the International Ecology Institute (ECI) in the field of limnetic ecology. The Institute, based in Germany, was founded by Professor Otto Kinne in 1984. It seeks to promote exchange of information between the various fields of ecology and to promote environmental research.

Recent Publications

The technical report, *Likely Ecological Outcomes of the COAG Water Reforms* by P Cullen, J Whittington and G Fraser is now available and can be ordered from the MDFRC on 02 60582310; via email: enquiries@mdfrc.canberra.edu.au, or read it on the web at http://freshwater.canberra.edu.au and select publications, then select technical reports.

Mark Linterman's report *'Status of fish in the ACT'* is available from Environment ACT.

View Watershed on our website: http://freshwater.canberra.edu.au. Contributions to Watershed are welcome. Please send to the Communications Manager (contact details on the back cover). Deadlines for this years' issues are:

16 June
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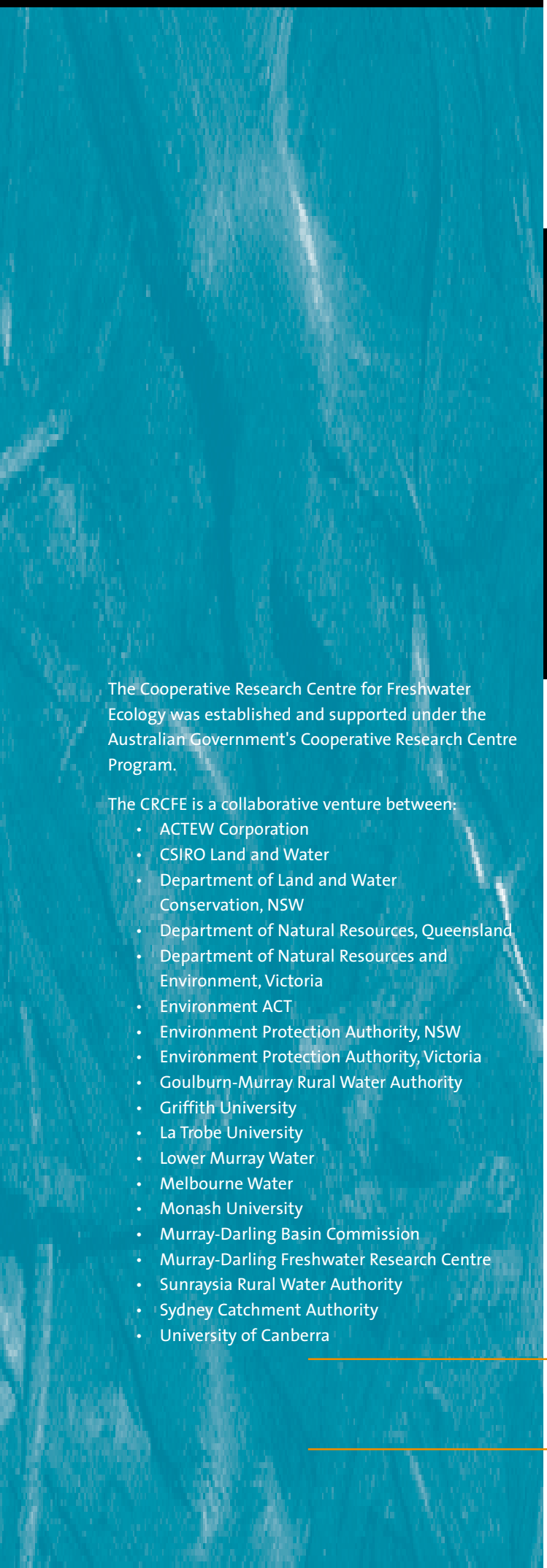
CRCFE web site:
http://freshwater.canberra.edu.au



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- La Trobe University
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