April 2001

WaterShed

contents

The Future of Agriculture

by Professor Peter Cullen

Australia and the world will need increasing amounts of food and fibre to support an increasing world population. These needs are not likely to be expressed as higher prices due to the distorted nature of world trade, and due to the inability of many of those needing these commodities to pay for the costs of production and the costs of storage and transport.

Globalisation and competition have become a mantra for Governments around the world, with little discussion about who will be winners and who will be losers. Economic efficiency and social cohesion and stability are not the same thing. While our farmers seek open access to world markets, they, like their international counterparts, view competition from overseas as unfair. Every country plays this game hard, seeking particular advantages. Trade restrictions will continue to hamper our access to world markets, perhaps more so as environmental standards and genetically modified foods are used as new trade barriers.

Our competitors will challenge the various subsidies we provide to agriculture, including the one where we allow farmers to degrade the common resource. The push to a free market system will mean Government regulation will have to get much smarter.

The current European problems with mad cow disease and with foot and mouth disease show how quickly threats can spread, and how drastic Government action might be.

In Australia few people were concerned about the insecticide endosulfan when it impacted on aquatic ecosystems, but when it threatened beef exports, Governments acted.

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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

The Cryptosporidium incident in Sydney perhaps shows us the starkest example. Urban voters are not going to tolerate real or perceived risks to their water supplies, and are starting to impose real pressures on what happens in their catchments. I see this pressure continuing and it will lead to changes in the way we do agriculture. Urban Australia is going to insist we stop farming marginal lands, especially where it degrades water supplies and destroys biodiversity. Those presently farming these lands need to be assisted to retire off the land; some will remain as land managers to manage the land not for production agriculture but for catchment protection.

Government regulation will have to get much smarter

Most farmers are price takers not price setters. Most of the farmers I deal with are committed to the land and farming it in a sustainable way. The buying power of supermarkets will continue downward price pressure on the domestic market, making it harder to farm in a sustainable manner. The dairy industry is the current example of these competitive downward pressures on price. Governments have embraced competition policy to encourage the efficient and discourage the inefficient. We need, however, to ensure that we avoid the situation where people go broke slowly, with a great deal of personal misery and substantial environmental damage.

Under this sort of price pressure, farmers have little choice but to cut costs, and if this means long term damage to their own land, or damage to neighbours downstream, then that becomes one of the costs of doing business.

Public education and peer pressure through programs like Landcare are unlikely to be sufficient to overcome these pressures.

It is not realistic to subject farmers to these competitive pressures without putting in place a much stronger regulatory environment. Urban Australians are not allowed to discharge their wastes to the next door property or to the street, and find it remarkable that this is still allowed in agriculture.

The COAG water reforms require charging for the full economic costs of water, and this requires building in a charge for the externalities.

The sorts of externalities we must deal with include those involved in capturing and storing water (especially effects on downstream flow regimes), the impacts of water returning to the environment carrying various contaminants and the costs of runoff water carrying increased contaminants due to the land use

Government regulations and financial penalties will insist that nutrients, sediment salt and agricultural chemicals are managed at the catchment scale, and this may well come down to regulation at the farm itself. The additional management costs that will be incurred must be passed on in the costs of production, not left as an optional extra as at present.

On our productive lands farming will continue to prosper. Prices will reflect the real costs of production and those on suitable land will be able to afford to farm the land properly. Those on inappropriate land will be encouraged to leave the land, and we need to find better ways to help them achieve this. It must be a cost we all help bear.

Prof Peter Cullen, Chief Executive of the CRC for Freshwater Ecology.
Photo: M Ashkanasy, courtesy of Melbourne Water

Rights of Passage: Fishways in Australia

Water managers in Australia find themselves in a worsening dilemma. Weirs and related structures are an integral part of our existence, but their impacts are increasingly recognised as environmentally damaging. Given that many of the thousands of existing weirs that help us exploit water resources will continue to be needed, what can be done to minimise their damaging effects?

Efforts to minimise the impact of dams and weirs are already under way such as building fishways to restore free movement of fish along a river course.

Fish passage and fishways

Obstructed fish passage is one of the main causes of declining biodiversity and fisheries production in Australian freshwater systems. It is also implicated in the listing of many Australian fish as threatened species.

Fish passage describes the directed movement of fish past a point in a stream. It particularly relates to the engineering and biological aspects of restoring free passage at weirs and other in-stream barriers. Fishways are structures that allow fish to pass barriers. Freshwater fish and some other aquatic fauna, such as shrimps, need to move freely between the various areas of their habitat to search for food, shelter or to reproduce. Of the 55 species of native freshwater fish living in New South Wales, 32 are recognised as migratory and known to require free passage to sustain populations. But all species have some requirement for passage.

Blocking migrations interferes with the fundamental biological processes that sustain populations: recruitment and growth. It also interferes with the dispersal of fish from drought-refuge areas, especially remnant deep pools, into newly regenerated habitats, such as billabongs.

River Health Forum

Dalby RSL Club, Queensland

Wednesday 16th May , 2001, 10.00 am to 4.15 pm

In response to strong community interest, the Queensland Department of Natural Resources has invited the Cooperative Research Centre for Freshwater Ecology to hold a community forum on river health in the Condamine-Balonne Valley.

Participants will hear the latest insights from scientists on the ecology of inland rivers with examples from the Condamine-Balonne. The forum will be interactive with ample opportunities for questions and discussion. Participants will be encouraged to put forward their local perspectives on river health.

Forum speakers include experts in a range of fields,: Professor Sam Lake; Assoc. Professor Richard Norris, Associate Professor Martin Thoms, Professor Stuart Bunn, Dr Satish Choy and Professor Gary Jones

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Dams, weirs and other structural barriers physically impede fish movement. However, free passage for most, if not all, Australian species can be partly or fully restored by fitting suitable fishways or adopting management practices that utilise existing structures in a more strategic way. Several approaches being investigated are:

- Applying a seasonal drawdown of the whole weir-pool at some gated weirs. The free flow of the river enables fish passage, restores the flow of sediments, enhances the flow of catchment nutrients and the processes of nutrient cycling. It removes stratification, aids in pest control and encourages recession of the groundwater mounds responsible for land salination through river regulation.
- Floodgates that impede the tidal flow in estuaries create complex environmental problems including physical and behavioural barriers to passage of fish and invertebrates and alteration of vegetation communities; the issues are numerous. It may be possible to minimise these problems by holding floodgates open until they are needed to prevent back-flow inundation during floods however, research is still needed and this type of management must be approached with caution.

There are also opportunities to enhance fish passage using the navigation locks on many Murray River weirs without major changes to their operations. An experimental study at Euston Weir showed that fish passage in the river could be effectively boosted by modifying the operating regime of the navigation lock. The modified regime involved slightly opening the lock gates to provide attraction flows to encourage fish to enter the lock before filling, then to pass upstream when the lock reached its full level. At some sites, these fish-passage flows could also contribute to environmental-flow regimes.

Without building fishways or removing weirs, fish passage can only occur infrequently when weirs are inundated or 'drowned-out' by high stream-flows. These 'drown-outs' were intended as an interim measure to permit some of the river's high flows to pass over weirs briefly so that some fish can pass over them. Whether such infrequent and brief drown-out flows are sufficient to help rehabilitate native fish is uncertain.

NSW Fisheries and the Cooperative Research Centre for Freshwater Ecology have allocated substantial resources to fish passage research over the past 15 years. What is desperately needed in the future is a greatly enhanced commitment to government support for comprehensive fish passage programs. The continuing demand for improved fishway designs and reduced fishway costs emphasises the need for ongoing research and development. Improving the knowledge base remains an urgent priority, especially in the areas of migratory fish behaviour, fishway hydraulics and design and innovations such as prefabricated modular fishways and less-expensive fishway designs.

Fish passage is just one issue being addressed as part of a wider strategy on weirs. A combination of the strategic approaches to weir management will not only benefit fish and other aquatic species but would provide far greater environmental benefits than would occur from any of these alterations alone.

The challenge is not small, but it is clear; it is to ensure that new generations of Australians grow up believing that healthy rivers and fish are part of their natural heritage.

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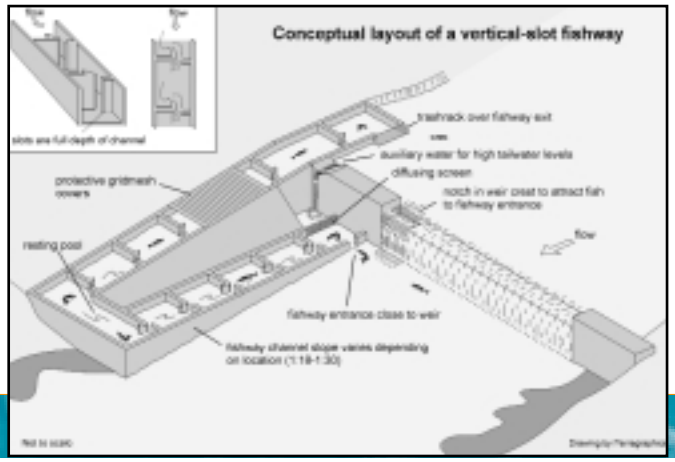

Conceptual layout of a vertical-slot fishway.

Outsmarting Carp

Dubbed the "rabbits" of the water, carp are one of the most abundant and despised fish species inhabiting our rivers. A multi disciplinary project aimed at excluding carp from wetlands is one approach being studied by the CRC for Freshwater Ecology and the University of Adelaide.

After 30 years of steadily increasing their range and number the European carp *(Cyprinus carpio)* has become one of our major natural resource concerns. Native to Asia, it is now established on all continents except Antarctica. It is the worlds most widely distributed freshwater fish and occurs in five Australian states including, most recently, Tasmania.

Three strains of carp have been introduced to Australia; an ornamental strain was released near Sydney in the mid 1800's and a Singaporean strain of koi was released in the Murrumbidgee River in 1876. However, it is the 'Boolara' strain of carp introduced into Victoria in 1961 that interbred with Murrumbidgee koi to produce a stock of carp with a very broad genetic make-up. The fish spread rapidly, assisted by the floods of the 1970's and are now the most common fish in the River Murray.

carp are the worlds most widely distributed freshwater fish

Associate Professor Keith Walker (Dept. of Evolution and Conservation Biology, University of Adelaide) a research associate of the Cooperative Research Centre for Freshwater Ecology has a long term commitment to wide-ranging studies of the environmental effects of flow regulation on the Lower River Murray and its floodplain communities. Away from plant ecology, Keith also has strong links to the Department of Civil and Environmental Engineering, where he and Martin Lambert, a hydraulics engineer, have co-supervised several teams of fourth-year students in projects equivalent in scope to an Honours degree in a science department. These projects have included work on numerical modelling of weir operations, bank erosion associated with boat traffic, hydraulic effects of instream structures, the effects of saline groundwater on floodplain vegetation and the behaviour of carp in relation to wetland inlet regulators.

It is in the last of these projects that Kane Scott a recent honours graduate has been involved. Under the supervision of Keith and Martin, Kane and fellow students, Shannon Dooland, Jonathan Giesecke and David Murchland investigated ways of excluding carp from riverine wetlands.

"This is a new and relevant area of research with a real application. Due to the lack of practical research on this topic we had to formulate design protocols in order to achieve statistically significant results, mindful that any attempt to exclude carp from an area must not in any way impact native species," said Kane.

"The Bookmark Biosphere Reserve, situated on the River Murray, near Renmark, South Australia was chosen as the field site for this research as it contains vast tracks of wetlands and most of the associated wetland structures needed to conduct our research".

Factors that effect the behaviour of carp at wetland inlets were also investigated to find the best configuration to discourage access to wetlands. Given the swim speed of carp (2.6m/s) and maximum velocities experienced during filling of a wetland (2m/s) the study suggests that a velocity of 0.4 m/s through a wetland inlet would create a velocity barrier that carp may not be able to negotiate. Thus reducing the number of carp that move into a wetland during filling. Research continues to determine how this strategy might affect native species.

Carp exclusion screen at Causeway Lagoon, near Renmark, SA. Photo: Kane Scott.

Excluding carp from wetlands without impacting native species is one of the challenges facing the Adelaide team.
Photo: CRC for Freshwater Ecology

Carp also appear to be deterred by light but this does not entirely exclude carp passage. It has been recommended that future wetland inlets be open topped box-culverts aimed at reducing the likelihood of carp access.

Protocols were also established as to when fish screens should be in place at wetlands. Fish screens are used at wetland inlets to prevent carp swimming upstream. It was found that screens should be employed between August and November when carp are most active. The fish screens should be subsequently removed from late November / early December onwards when the river level is rising and native fish become more active.

By incorporating the disciplines of engineering and biology an electronic fish counter was developed that utilises a difference in conductivity between fresh water and fish. The counter is able to detect the direction fish are swimming and with further development will be refined to measure fish length, swimming speed and to differentiate fish species. Such a device will have broad application for fish research.

More research is needed to determine the burst speeds of native fish and whether carp deterrents effect native fish. Implementing the fish counter for field and laboratory trials will help in determining the effects of long-term fish movement through wetlands, length of time taken to pass through a point and the effect of diurnal variations.

Further research is needed on ways to exclude carp from wetlands, nonetheless the first step has been taken.

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(Photo by John Hawking)

The feature creature for this issue:

Class	Crustacea
Order	Amphipoda
Family	Paramelitidae
Genus	*Austrogammarus*
Species	A. *australis* (the Dandenong amphipod)

Five of the six Austrogammarus species are restricted to streams draining the ranges at Melbourne's eastern fringe. *A. australis* is arguably the rarest. Like most amphipods, *Austrogammarus* species mainly feed on detritus and algae. *A. australis* occurs only in well-shaded streams with abundant in-stream organic matter.

Surviving in the City: The Dandenong Amphipod

By Dr Chris Walsh

Chris Walsh discusses how a small crustacean, once presumed extinct, is helping scientists measure the impacts of urbanisation on in-stream health.

One hundred years ago, the naturalist O. A. Sayce conducted an expedition through the farmland and forests east of Melbourne towards Mount Dandenong. At the wildly meandering Dandenong Creek, near the settlement of Bayswater, he dipped a net through its slow-flowing waters and found an animal new to science: a small, golden crustacean bristling with hairs, the Dandenong amphipod *(Austrogammarus australis)*. The species was found only twice more in the next twenty years, and then nothing.

In 1989, the zoologist Bill Williams returned to Bayswater to search for the long-lost Dandenong amphipod. Where Sayce had found a convoluted lowland stream, full of life and fringed by billabongs and a floodplain forest, Williams found a straight concrete channel in a grassed depression. Its habitat destroyed, the Dandenong amphipod had been lost, presumed extinct... until...

A survey for the amphipod in the 1990's by the Victorian Department of Natural Resources and Environment uncovered several remnant populations in small upland streams outside the metropolitan area, draining the lightly urbanised ridge of the Dandenong Ranges.

The plight of the Dandenong amphipod is symbolic of the impacts of urban expansion on stream ecosystems, and its distribution provides hints as to the attributes of urbanisation that are most damaging to in-stream biodiversity.

Historically, metropolitan urbanisation in the Melbourne area has resulted in widespread loss of in-stream habitat, deterioration of water quality, more frequent and intense floods and reduced base flows. With these changes, many invertebrate species that once inhabited these streams have been excluded, and replaced by a relatively small number of hardy, pollution-tolerant species. In the hinterland around the metropolitan area, small streams have suffered relatively little degradation. Even in hinterland streams with moderate levels of urbanisation, the degradation of invertebrate communities is much less severe than metropolitan streams with similar levels of urbanisation in their catchments.

The stark difference in condition between streams of comparable catchment urbanisation in the metropolitan area and in the hinterland suggest there is something about metropolitan urbanisation that makes it much more degrading to receiving streams than urbanisation in the hinterland. One likely explanation is that the metropolitan area is well served by stormwater pipes to reduce the risk of flooding, while in the hinterland, stormwater drainage is less intensive, often by means of open earthen drains. The efficient delivery of rainwater and associated pollutants by stormwater pipes in the metropolitan area is likely to exacerbate the impacts of urbanisation on stream ecosystems.

the Dandenong amphipod had been lost

The lower Merri Creek at Yarra Bend, overlooking the city of Melbourne. Although its catchment is only 13% impervious, the stream here is severely impacted by stormwater runoff. Photo: Chris Walsh

This explanation of the severe degradation of metropolitan stream communities is consistent with the principles of 'water sensitive urban design'. Such design requires that drainage systems permit maximum infiltration, and that stormwater is retained for treatment and possibly re-use before draining into receiving waters.

Studies by the CRC for Freshwater Ecology have determined relationships between catchment urbanisation (as measured by the proportion of the catchment covered by constructed hard surfaces: termed imperviousness) and measures of degradation in macroinvertebrate community composition. The slopes of these relationships differ between metropolitan and hinterland sites: e.g. for sites with 10% catchment imperviousness, hinterland communities were much less degraded than metropolitan communities. These relationships provide a first estimate of potential targets for the restoration of metropolitan streams following retrofitting of metropolitan stormwater systems. Alternatively they could provide targets for an acceptable level of degradation of stream communities following new urban development of a catchment.

a sensitive indicator of urban impacts

Having demonstrated that relationships between catchment imperviousness and community composition differ between metropolitan and hinterland streams, the CRC for Freshwater Ecology is now embarking on a project to investigate the relationships between catchment imperviousness and nutrient processes in these streams. Stormwater contributes large loads of nutrients to streams in urban areas. In Melbourne, urban stormwater loads of nitrogen have been identified as a serious threat to the health of Port Phillip Bay. However, the influence of urbanisation on the assimilation and transformation of nitrogen in streams is poorly understood. The new project will assess if catchment imperviousness and degree of stormwater connection are related to the ability of streams to process nutrients, particularly nitrogen.

Together, research into the effects of urban development on biological communities and nutrient processes will provide guidance to managers on strategies for:

- conservation of endangered species such as the Dandenong amphipod,
- better design of new urban areas to protect receiving waters, and
- restoration of degraded streams in urban areas.

Specifically, this work will provide vital ecological input into a decision support system for stormwater quality management being developed in collaboration with the CRC for Catchment Hydrology.

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The Dandenong amphipod, a sensitive indicator of the impact of urbanisation on stream health.
Photo: John Hawking

Living with Less: The Role of Drought in Aquatic Ecosystems

Australia has an extreme and variable climate, periodic droughts are a natural part of many ecosystems, but 'drought' means different things to different people. An International Drought symposium held in Albury in February 2001 brought together ninety delegates to discuss the meaning of drought and the role it plays in the functioning of aquatic ecosystems.

Models of global warming predict that the frequency and severity of extreme events such as drought will increase and affect areas previously free of drought. Coming to terms with these predictions may be difficult but a better understanding of how the environment copes with drought is necessary if impacts are to be minimised.

Some impacts are obvious, however long term studies are needed to understand the less obvious impacts of drought. Lake Bijiji, NSW. Photo: CRC for Freshwater Ecology.

Drought is defined in many different ways and there are definitions of drought for agricultural, economic and hydrological purposes. Separating negative, emotive images of drought from the ecological effects is important as is the need to recognise the critical role that drought plays in the functioning of aquatic ecosystems. Drought may be greatly exacerbated by human intervention, such as dam construction and water abstraction. Conversely, river regulation has meant that unnaturally high flows may be imposed on a river entirely eliminating natural droughts.

Drought is defined in many different ways

Numerous case studies were presented at the conference demonstrating the importance of drying/drought events on the 'health' or integrity of particular ecosystems and the viability of selected aquatic species. We now know that to maintain high biodiversity in some wetlands, the wetland must experience dry periods.

There remain serious gaps in our knowledge of drought. On the one hand we know a lot about the responses of fish, macroinvertebrates and plants (both aquatic and riparian) to drought but much less about the responses of microbes, microfauna and microflora. It was also clear that more is known about the responses of populations and communities than about the responses of ecological processes and total ecosystems.

The influences of scale in understanding drought were also addressed. 'Drivers' of drought operate on a global scale, yet the impacts of drought operate and may be studied at the local level eg. ponds.

While there are direct effects of drought such as loss of habitat, high water temperatures and habitat fragmentation; there are also important indirect effects such as degraded water quality in the remaining water.

Habitat fragmentation in terrestrial environments has gained much attention in recent years, but the impact of drought on river fragmentation and hydrological and ecological processes remains neglected.

Droughts may be a necessary ingredient of the normal functioning of rivers. Many plants and animals have evolved with drought and have an enormous capacity to withstand normal drought events. Many aquatic organisms rely on drought refugia (place of refuge) to sustain them through drought. While some organisms merely require a damp environment to survive (e.g. non-desiccated muds) other organisms require significant bodies of standing water. It is also important to recognise that the capacity of a river's biota to resist and recover from drought has been severely compromised in many cases by the depletion of drought refugia by human intervention, such as desnagging and channelisation.

Many of these refugia are sustained by groundwater. However, extraction of groundwater for human use is often at its peak during drought. Therefore, excessive groundwater extraction during droughts can threaten the existence of refugia. An interesting example was of a species of American bass, which uses groundwater springs in a lake as thermal refuges during summer. Excessive groundwater pumping during drought years causes the springs to cease flowing, resulting in death by thermal shock to the bass.

As our ability to more accurately predict drought events increases, it may be possible to study drought events, including over a pre-drought period. Whilst natural droughts are the most desirable to study, it should be recognised that controlled experiments in the laboratory and in the field may provide valuable information on responses and tolerances of biota and ecological processes to drought.

The symposium, organised by the Murray Darling Freshwater Research Centre and the CRC for Freshwater Ecology covered a broad range of disciplines, including ecology, chemistry, hydrology and climatology and included research findings from five continents. It has been an important first step in synthesising our knowledge on the role of drought in aquatic ecosystems.

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SideStream

The 28th SIL Congress

The 28th SIL Congress was held 4th -10th Feb 2001 at Monash University, Melbourne. The first SIL Congress in Australia attracted 750 delegates from 45 countries. Peter Cullen presented the opening address on 'Delivering Limnological Knowledge to the Water Industry'. Full details of the programme can be found on the conference web site: www.monash.edu.au/oce/sil2001

The 13th Taxonomic Workshop

The 13th Taxonomic Workshop was held at the Lake Hume Resort, near Albury on 12th - 13th February 2001. There were 70 participants from all Australian states and territories including Government agencies, Universities, consulting companies, Waterwatch and individuals. Five new ID guides were presented at the workshop; see page 11.

International droughts symposium

An International Symposium on the role of Drought in Aquatic Ecosystems held in Albury 12th -14th February 2001 brought together ninety delegates from five countries. A special issue of *Freshwater Biology* edited by conference organisers Dr. Darren Baldwin and Dr. Paul Humphries will feature selected papers from the conference.

A synopsis of the conference features in the current issue of Watershed (page 9).

Five New id Guides now available

These new guides can be ordered from the Murray Darling Freshwater Research Centre at Albury on: 02 6058 2300; Email: enquiries@mdfrc.canberra.edu.au

- Theischinger, Gunther. 2001. *Preliminary Keys for the Identification of Larvae of the Australian* Synthemistidae, Gomphomacromiidae, Pseudocorduliidae, Macromiidae *and* Austrocorduliidae. ID Guide no. 34. ($37.40 incl. GST & p&h).
- Govedich, Fredric. 2001. *A Reference Guide to the Ecology and Taxonomy of the Freshwater and Terrestrial Leeches* (Euhirudinea) *from Australia and Oceania*. ID Guide no. 35 ($37.40 incl. GST & p&h).
- Pearson, Melanie and Hawking, John. 2001. *A Bibliography to some of the Ecological and Biological Literature of Australian Aquatic Inland Invertebrates*. ID Guide no. 36 ($29.70 incl. GST & p&h).
- Hawking, John. 2001. *An Introduction to the Identification of Aquatic Caterpillars (*Lepidoptera*) Found in Australian Inland Waters*. ID Guide no. 37 ($37.40 incl. GST & p&h).
- Tsyrlin, Edward. 2001. *A Key to Victorian Nymphs of Leptoperla* (Plecoptera: Gripopterygidae). ID Guide no. 38 ($37.40 incl. GST & p&h).

New Technical Reports

Cottingham, P, Georges, A et al. 2000. *Managing Biodiversity in the Sydney Water Supply Catchments – Outcomes of a Specialist Workshop held at Warragamba Conference Centre, 12th and 13th October 2000*. Technical Report no. 9/2000.

Cullen, P. et al 2001. *Knowledge Seeking Strategies of Natural Resource Professionals. Synthesis of a Workshop held in Bungendore, NSW from 5-7th June 2000*. Technical Report no. 2/2001.

Both reports are available from our website at: http://freshwater.canberra.edu.au (Publications/Reports) or a free printed copy can be ordered from the MDFRC at Albury, Ph: 02 6058 2300; email: enquiries@mdfrc.canberra.edu.au

New Scoping Studies available on The Web

Six new reports are now available on the CRCFE website and can be viewed under Publications/Reports:

- Harper, Burden and Lawrence. February 2000. *Development of Options for a Quantitative Lowland River Model*. Final Report. ScA1.
- Hughes. September 2000. *Selection and Screening of Aquatic Taxa for Proposed Dryland Refugium Project*. Final Report. ScC1.
- Hyne and Maher. August 2000. *Macroinvertebrate Biomarkers: Links to Toxicosis and Changes in Population or Communities*. Final Report. ScD5.
- Kennard, Pusey and Arthington. February 2001. *Trophic Ecology of Freshwater Fishes in Australia*. Progress Report. ScD6.
- Norris, Coysh, Linke, Walsh and Choy. September 2000. *"Dirty Water" Models. Predicting Community Composition for Streams in Disturbed Landscapes*. Summary Report. ScD1.
- Udy, Hunter, Bunn, Browne and Fellows. February 2000. *Groundwater Nutrient Concentrations in Riparian Zones of Agricultural Catchments*. Final Report. ScB4.

CRCFE web site:
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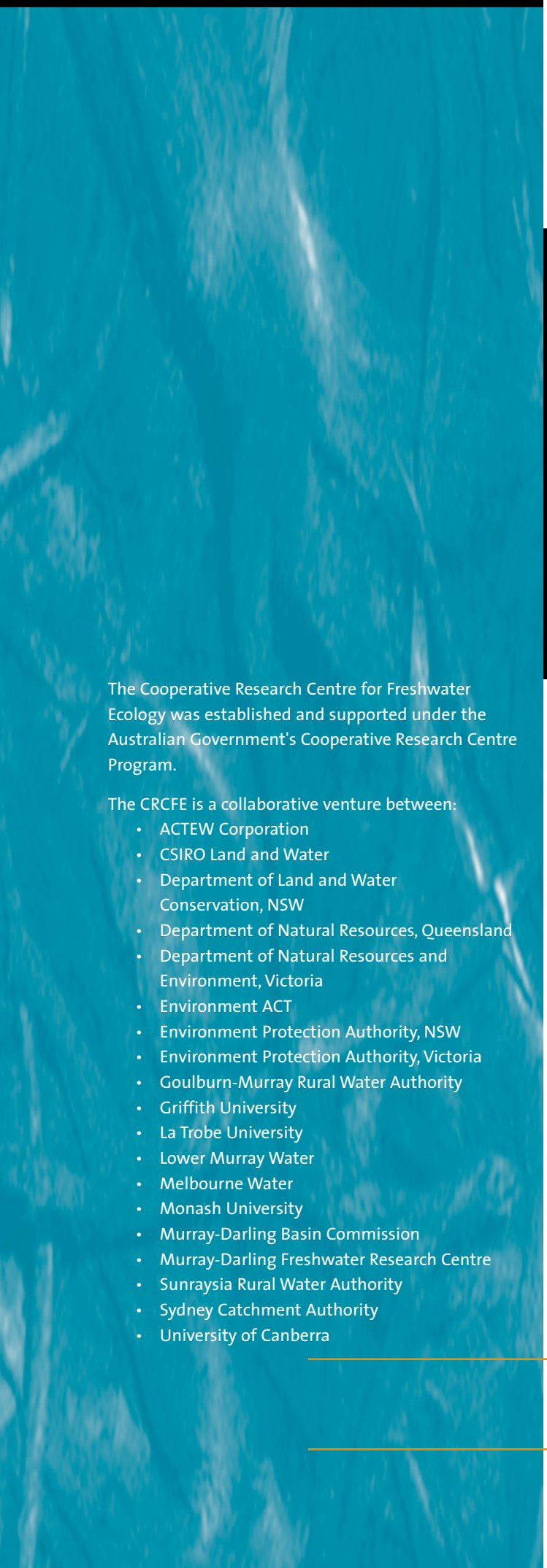

Comments, ideas and contributions are welcome and can be made to:

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- La Trobe University
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