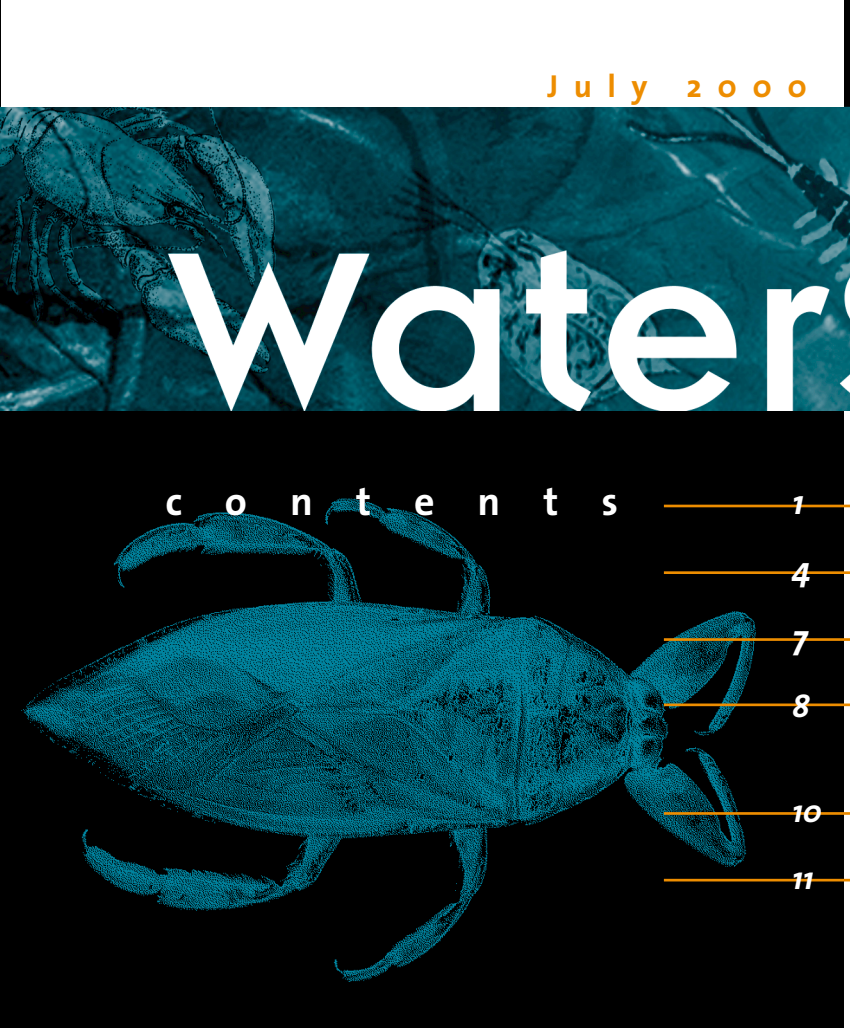
July 2000

WaterShed



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Can We Really Measure River Health?

by Professor Peter Cullen

We frequently get asked if we can show how river health will improve as we make environmental allocations and deliver more appropriate flow regimes. Those who believe society would get a better return by diverting more water for irrigation in particular want to see real outcomes for what they see as their sacrifices.

The CRC for Freshwater Ecology has been asked to develop a way of measuring the health of the rivers to better inform the various trade-offs that society must make. Our proposals will be considered by the Murray Darling Basin Ministerial Council in August.

People are interested in biological outcomes when they think of rivers. For too long we have tried to use water quality measures and then hydrologic measures as surrogates for river health, rather than trying to measure it directly. These factors are inputs that lead to certain biological outcomes, but they are not useful as outcomes in themselves.

We now have national data sets of aquatic invertebrates collected by the states under the National River Health Program. These are being used by the CRC to provide the biological elements of the waterways condition part of the Land and Water Audit. They will also be used in the 2001 Federal State of the Environment Report. Assoc Prof Richard Norris is leading the team that is breaking new ground internationally in the biological assessment of river health.

Many people equate river health with fish populations. The CRC has also developed tools for fish survey, and

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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

these have been demonstrated in the NSW Rivers Survey. These tools need to be used more widely to ensure we have a good knowledge of both native fish, sporting fish and nuisance fish, all of concern to the public.

There are other biological elements that are important. Algal populations, algal blooms, aquatic plants, aquatic weeds, riparian vegetation and water birds are all being used in some parts of the Murray Darling Basin (MDB) to track the condition of aquatic ecosystems.

a proposal for a Sustainable Rivers Audit...

We are proposing a Sustainable Rivers Audit that measures river health based initially on two sources of information -the AUSRIVAS models of aquatic invertebrates, and a measure of fish populations such as the Index of Biotic Integrity.

Beneath these two measures of biological outcome, we need three further measures - an index of water quality (probably combining Total Phosphorus, electrical conductivity, pH and turbidity), an index of flow regime and an assessment of habitat. These three elements are drivers of the biological outcomes and serve as useful diagnostics in interpreting why the biological measures have moved.

The proposal is that the biological measures, along with the water quality and flow index would be reported annually for each river valley in the MDB. A more comprehensive sustainability assessment would be carried out initially, and thereafter every five years.

There is still much work to be done after these broad ideas are accepted. We have to develop the various indices based on data that's common across the States of the Basin. We need to identify the sampling density needed to give useful answers. We need to work out how to scale the various measures to a common base, and how to aggregate them to get a meaningful set of information. Hopefully we might be able to get to the traffic light system being developed in Queensland as part of the WAMP process where we can show red, amber and green zones of river health. A red or amber result might then trigger more intensive monitoring or special studies to investigate what is going wrong.

...and that states agree on a common basis for monitoring river health

We are proposing that States agree on a common basis for monitoring river health based on invertebrates and fish. They also need to collect data on the drivers and report them in a common format. These would provide the input into a negotiation with some experienced ecologists who would discuss the result with State experts on a river valley basis. This is now happening with the auditing of the Cap in the Basin where the Independent Audit Group has a dialogue with State experts to resolve the flow allocation issues.

The habitat assessments are novel and draw heavily on the innovative work being done in the National Land and Water Audit. There are five elements to be reported:

Professor Peter Cullen, Chief Executive CRCFE.

1. Connectivity - reporting weirs and other blockages to fish movement, and length of levees which may block the interchange between the river and its floodplain during flood.
2. Riparian condition - an assessment of the riparian community, including weed plants like willows.
3. Woody debris in stream - critical fish habitat which we now appreciate needs to be protected.
4. Geomorphic - a measure of sand deposition, bank erosion and bed movement.
5. Wetland elements - the extent and condition of Ramsar and other nominated wetlands needs to be assessed.

There is much to be done to develop these broad ideas into a workable reporting system. Most States are now collecting much of this information. The challenge is to agree on the important information and then to collect it in a way that allows comparison across States. We do not need to keep building railway systems with different gauges that create difficulties when crossing State borders. We can do better than that: there is no excuse for continuing to make these sorts of mistakes when it comes to managing scarce and valuable resources like water.

Bug Lab Team Complete Projects

Three different projects for study designs have recently been completed by the bug lab team at University of Canberra: environmental flows for the Woronora (Sydney Catchment Authority) and Cotter Rivers (ACT government and ACTEW Corporation, Heath Chester) and effectiveness of fish habitat rehabilitation in the Murrumbidgee River (ACT Government, Nerida Davies, Phil Sloane and Richard Norris).

Nicholas Bauer Joins the National Land and Water Audit Team

Nicholas Bauer starts work with the National Land and Water Audit team at the University of Canberra soon. He will undertake much of the GIS work asso-ciated with the project.

Photo and description courtesy J Hawking from the Colour Guide to Invertebrates of Australian Inland Waters

The feature creature for this issue:

Class Insecta
Order Hemiptera
Family Belostomatidae
Genus *Lethocerus*
Species *L. insulanus*

Giant Water Bugs feature an abdomen without a respiratory siphon but with two flat, retractable respiratory filaments, and strong raptorial (grasping) forelegs. Up to 70mm in size, these carnivores are found amongst water weeds of still or slow-flowing waters in northern and eastern Australia.

The Australian Alps Stream Health Monitoring Project

Researchers from the CRC for Freshwater Ecology sampled and measured the stream invertebrate fauna and a wide range of habitat features at 95 sites within the national parks of the Australian Alps early this year. The Australian Alps Liaison Committee provided funding for the model development.

Seventy-nine reference sites were used to provide baseline conditions and to build an AUSRIVAS predictive model, which can be used to assess the condition of alpine rivers and streams. Sixteen test sites (with suspected or known impacts) were sampled and assessed using AUSRIVAS. AUSRIVAS uses environmental characteristics that are unaffected by human activities (e.g. latitude, longitude, altitude, position in the catchment) as an independent way of matching test sites with reference sites. The AUSRIVAS model then uses the macroinvertebrates found at a site as an indicator of river health.

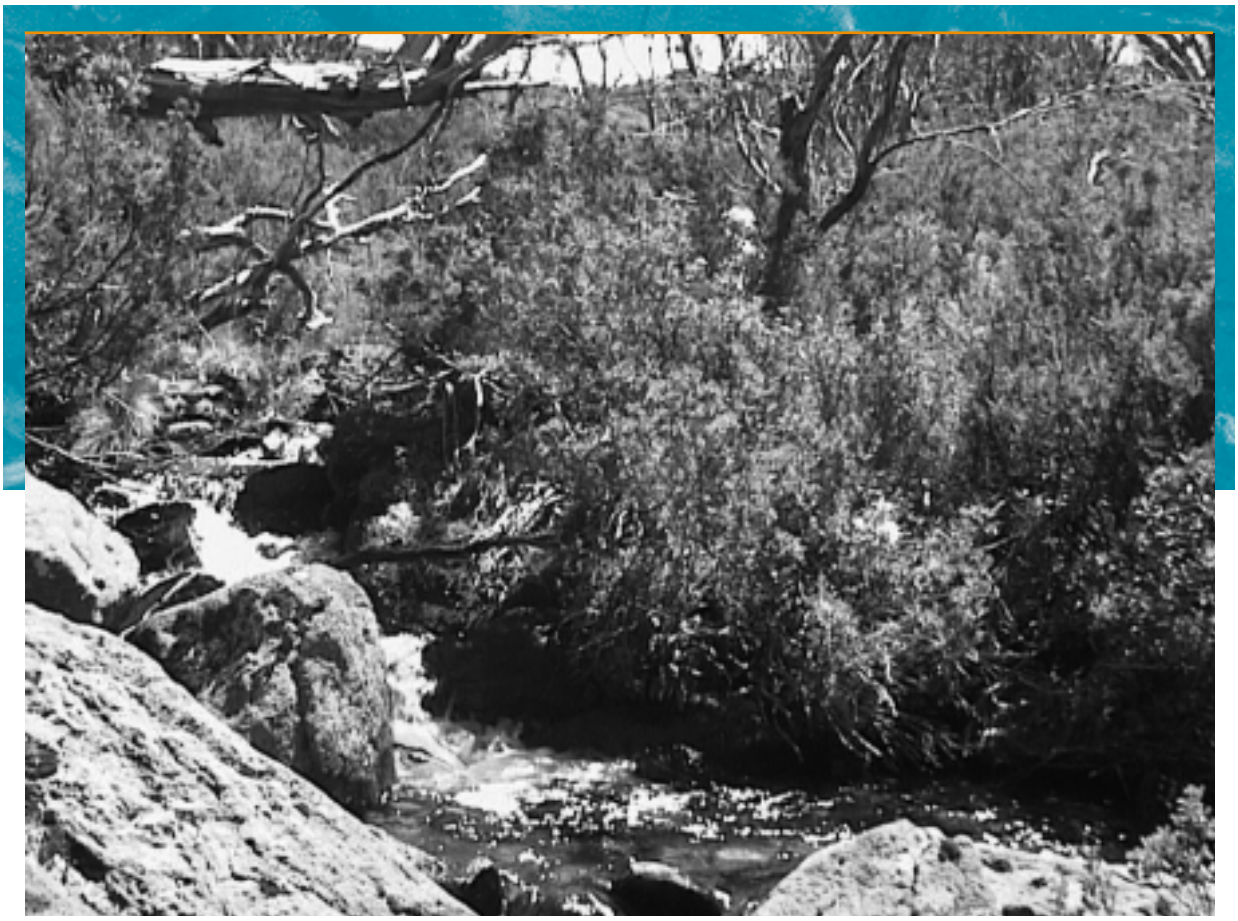
79 reference sites were used to build an AUSRIVAS predictive model

Once test sites are matched to reference sites with similar characteristics, the macroinvertebrates

Guthrie Creek in Kosciuszko.

Bogong Creek in Kosciuszko.

Phil Sloane completes a data sheet for the AASHM Project.



Tributary of Langford East Aqueduct in the Bogong Unit of Alpine National Park, Victoria.

expected (E) if there were no environmental stress, can be compared to the macroinvertebrates found (O). For example, an O/E of 0.7 would indicate that about 30% of the different sorts of animals expected were not collected. The missing animals indicate an unhealthy river.

the AUSRIVAS predictive models are valuable tools

A site displaying no biological impairment should have an O/E ratio close to one. The information from the 79 reference sites forms the basis of the predictive model.

The AUSRIVAS predictive models are valuable tools for identifying possible effects of land use and management practices on the biological communities of rivers and streams within the Australian Alps national parks. The impacts of management activities on rivers and streams such as track construction and fire as well as dispersed recreation can be easily assessed using the Alps model.

Stock grazing on the Bogong High Plains (Cope Creek and Tawonga Hut Creek) and the discharge of treated sewage (Thredbo River and Perisher Creek) are two of the land uses identified in the study that may be adversely affecting the rivers and streams of the Australian Alps national parks.

The Alps summer riffle AUSRIVAS predictive model and a description of the methods is available on the Internet (Coysh et al. 2000, http://ausrivas.canberra.edu.au/ausrivas).

For further information, please contact
Nerida Davies
phone: 02 6201 2080
email: ndavies@enterprise.canberra.edu.au
or
Mark Lintermans
Phone: 02 62072117
Email: mark.lintermans@dpa.act.gov.au

Modelling Phosphorus Release from Sediments

By Dr Mike Harper

As part of their commitment to translating research findings into tools and information that resource managers can use, the CRC for Freshwater Ecology has commissioned a number of projects which include the development of mathematical models for important ecosystem processes. One example of the benefits of this investment is a recently completed model of nutrient release from sediments.

The central strategy in controlling algal blooms has been the reduction in phosphorus (P) inputs to natural waters. However, the effects of these changes can take time to be felt. In particular, sediments act as a temporary store for phosphorus in freshwater systems, and when water columns become anoxic[1], sufficient P can be released from sediments to initiate or sustain algal blooms.

How Sediments Release Phosphorus

Nearly all the phosphorus in sediments is adsorbed[2] to surfaces of particles, with most being adsorbed to the surfaces of iron oxide and hydroxide particles. When the bottom-water becomes anoxic, these iron oxide particles start to dissolve, and the phosphorus adsorbed onto their surfaces may become released into the overlying water. When the water column re-oxygenates, iron oxide particles start to form again, causing the phosphorus to readsorb.

Although iron oxide particles can dissolve quite quickly (~ days), the released phosphorus might not be released to the overlying water for months. Instead, most of the released phosphorus may become readsorbed to other particles, apart from iron oxides, that are capable of adsorbing phosphorus. Even where released phosphorus is not readsorbed, it can take days or weeks for a molecule of phosphorus to travel just a few centimetres through the sediment.

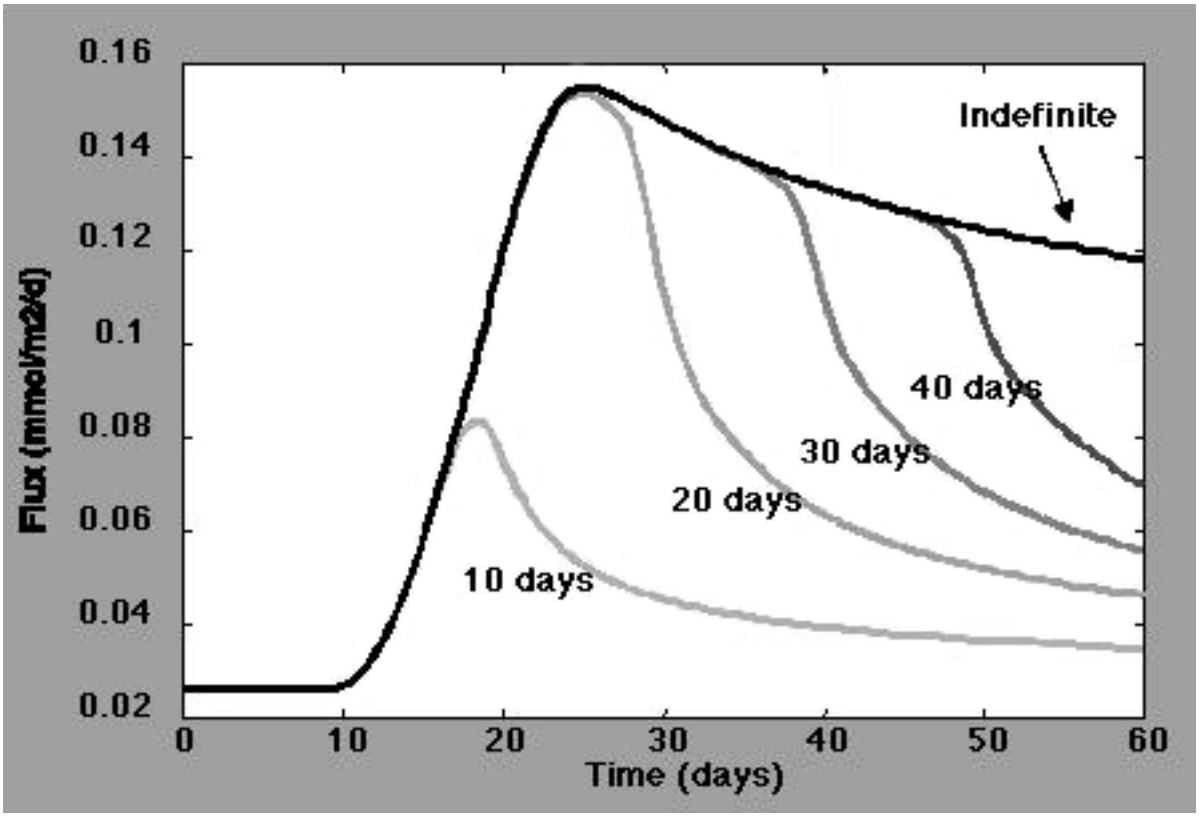
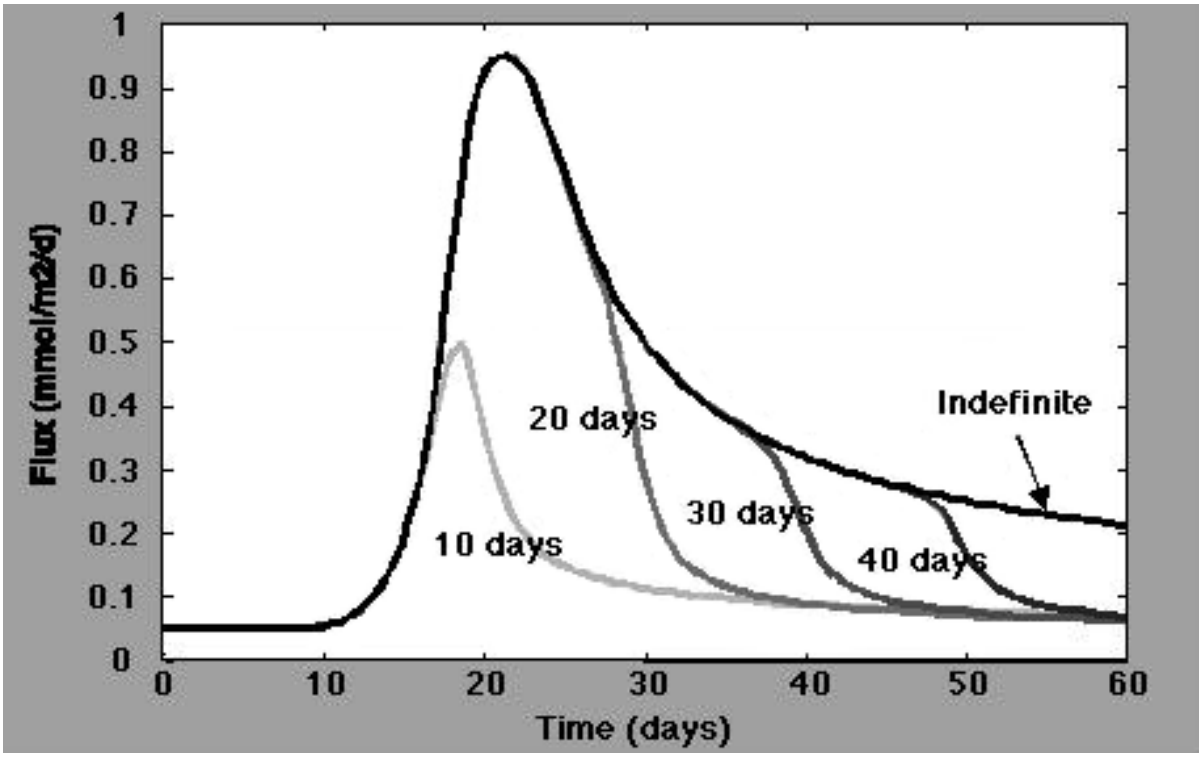


Figure 1: Sediment–water flux of phosphate from a poorly adsorbing sediment.

Figure 2: Sediment–water flux of phosphate from a well adsorbing sediment.



A Model of Nutrient Release from Sediments

A model of nutrient release from sediments, SNAPP (Sediment Nitrogen and Phosphorus in Sediments), has been developed by Dr Mike Harper at the Water Studies Centre, Monash University. The aims were twofold: to help researchers understand the processes and patterns of phosphorus release and to evaluate the implications of management strategies.

The model has been used to simulate the effect of different sediment types on the release of phosphorus during anoxic conditions. Two of these simulations are shown in Figures 1 and 2. Figure 1 shows the sediment-water flux of phosphate from sediment that has a poor capacity for phosphorus to adsorb to sediment particles apart from iron oxide. The anoxia starts after 10 days, and the times in the figure legend indicate approximately how long the anoxia lasts before re-oxygenation. Figure 2 shows the same thing but for a sediment with a greater capacity for particles other than iron oxide to adsorb phosphorus.

The enhanced flux during the 10 day period of anoxia in Figure 1 corresponds to an increase in chlorophyll concentration of 85µg.L-1 in the water column, assuming that all phosphorus released from the sediment is taken up by phytoplankton growth (in a water body of 1.5 m depth). Clearly this is not the case, but the figure illustrates that sediment fluxes are capable of initiating phytoplankton blooms.

Conclusions

The model—and its application to real data sets—is still being evaluated, but some of the most important provisional findings are:

- Fluxes will increase significantly above the pre-anoxia level after only a few days.
- If sediments contain a lot of particles, apart from iron oxide, capable of adsorbing phosphorus, a moderately high flux of phosphate will be sustained for a long time.
- If not, an extremely high flux of phosphorus will result, but will diminish within two or three weeks.

1 *Anoxic*: without oxygen
2 *Adsorbed*: loosely bound to the surfaces of particles, for example by electrostatic attraction.

For further information, please contact
Dr Mike Harper
phone: 03 9905 4094
email: michael.harper@sci.monash.edu.au

The North American Benthological Society (NABS) 2000 Annual Meeting

Professor Stuart Bunn and Associate Professor Richard Norris attended the annual meeting of the North American Benthological Society (NABS) at Keystone, Colorado 28 May to 1 June. The conference was attended by nearly 1000 benthologists who presented over 500 oral and poster presentations.

There was a good deal of interest in the CRC for Freshwater Ecology's work on new methods 'Good Management Practices' and 'Dirty Water Models'. As a result, Richard Norris has been invited by Susan Jackson, Head of the USEPA program on biological assessment for the Office of Science and Technology, to talk about the approaches with her Washington based EPA colleagues.

Peter Davies and Stuart Bunn's talk on ecological processes in Australia's arid zone rivers presented work straight out of the field resulting from the floods only a few weeks earlier in Cooper's Creek. Great photos of distributary channels and a huge flood plain, coupled with convincing results, produced quite an impact.

international attention received

Sandra Postel, Director of the Global Water Policy Institute at Amherst, gave an interesting talk from the world perspective. Of note was her mention of Australia's effort to implement a cap on water extraction from the Murray-Darling River, indicating the international attention that the Cap has received. Brian Richter, Director of the Freshwater Initiative at the Nature Conservancy provided hopeful news with examples of implementation of scientifically based environmental flows.

About one third of all the papers concerned bioassessment, continuing a trend of growth in this area in recent years.

There were a couple of highlights. A paper presented on a modification of the 'triad approach' to assessment, first developed for marine situations, provided a convincing approach for arguing 'weight of evidence'. Another paper using bankful sheer stress to account for expected substratum particle size as a major controlling variable of invertebrates and possible mismatches resulting from degradation was also enlightening. The 'multimetric/predictive model' debate continues to grind forward and is perhaps beginning to be resolved with the wider adoption of the models with incorporation of metrics into them.

At NABS, Vince Resh (UC Berkeley) and Richard Norris agreed on the outline for a collaborative project submitted to the US NSF that will use a conference and its proceedings as the test example of how collaboration works. This is to be run developing methods for an asynchronous conference via the Internet (2001). The conference, 'Habitat assessment: Its time!', will bring together geomorphologists and ecologists from Australia, USA, Europe, New Zealand, South Africa, Canada, and the UK. The conference organising committee is Leon Zhao (Arizona State University Business School), Vince Resh, Richard Norris, and Martin Thoms

SideStream

Prime Minister's Environment Awards

Professor Peter Cullen has been Highly Commended for outstanding individual achievement in this year's Prime Minister's Environment Awards. The Prime Minister acknowledged Peter for his significant and extraordinary contribution to the well being of the environment of Australia.

Save the Planet Award

The Rotary River Health Camp, organised by the CRC for Freshwater Ecology's Lower Basin Laboratory and Rotary, has won the Save the Planet Award at the District 5120 Rotary Conference. The 3-day camp brings together Years 9 and 10 students to learn about the costs and benefits of water resource development. The students enjoyed sampling fish, bugs and water quality; participating in role-plays; canoeing and teamwork.

Students go canoeing on Lake Cullulleraine

Knowledge Exchange Workshop

A number of CRCFE staff and others, including representatives from LWRRDC, BRS, NRE Vic., and CRC for Catchment Hydrology, recently attended a 3-day workshop on Knowledge Seeking Strategies for Natural Resource Professionals. Jointly organised by the CRCFE and the Rivers Consortium, the workshop investigated the models and processes by which we both disseminate and search for knowledge, and ways to ensure better adoption of new insights. David Johnson, author of "Information Seeking - an Organizational Dilemma", presented some illuminating case studies about his research.

Recent Publications

The technical report, Fish Passage and Fishways in New South Wales: A Status Report by Garry Thorncraft & John H. Harris, technical report no. 1/2000, is now available and can be ordered from the MDFRC on 02 6058 2310; email: enquiries@mdfrc.canberra.edu.au. An A4 fact sheet that summarises the main findings of this report is also available from MDFRC

Snags: A Valuable But Scarce Resource

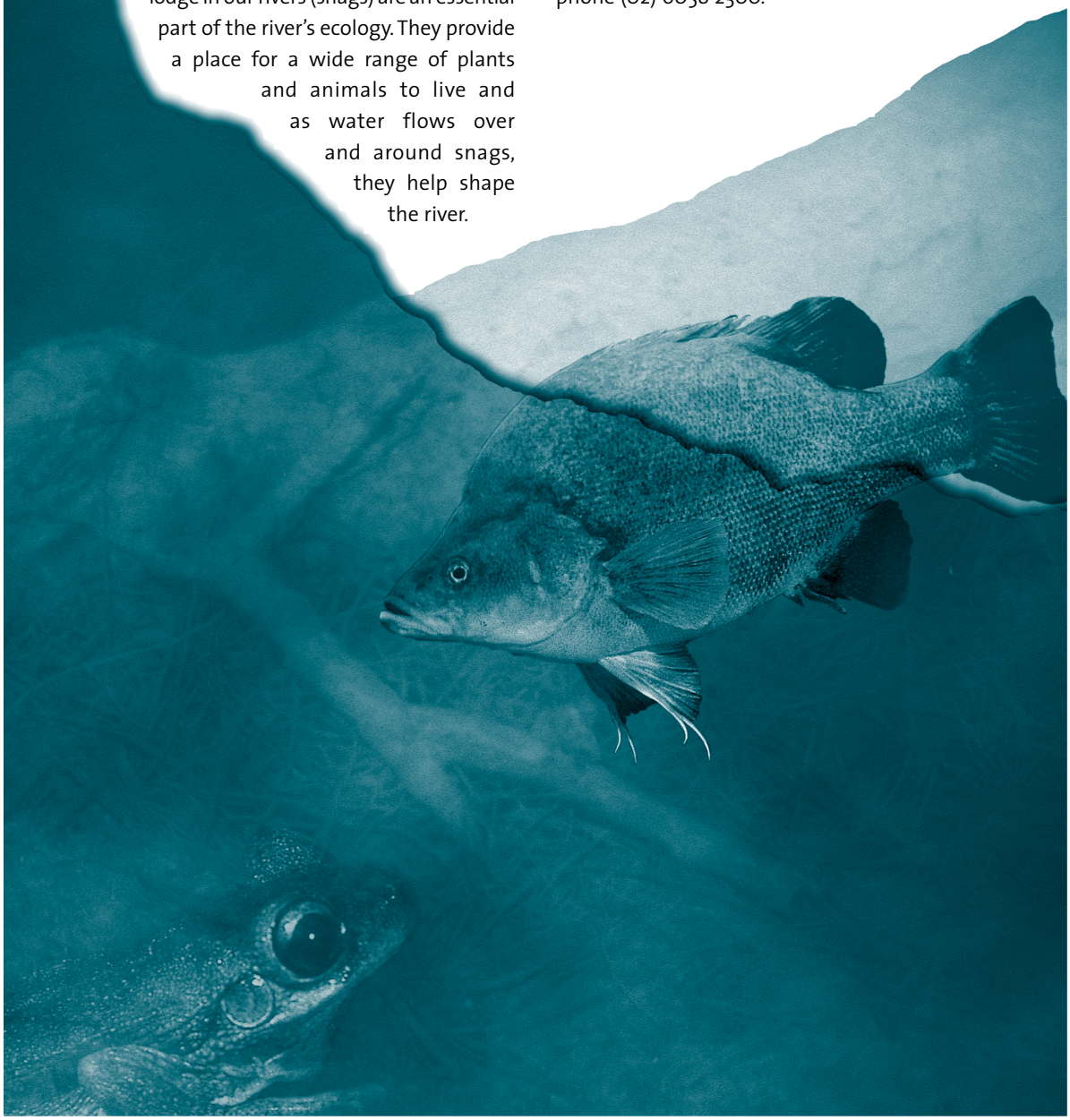
A new brochure is soon to be released about the importance of snags to the ecology of rivers.

Trees and branches that fall into and lodge in our rivers (snags) 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.

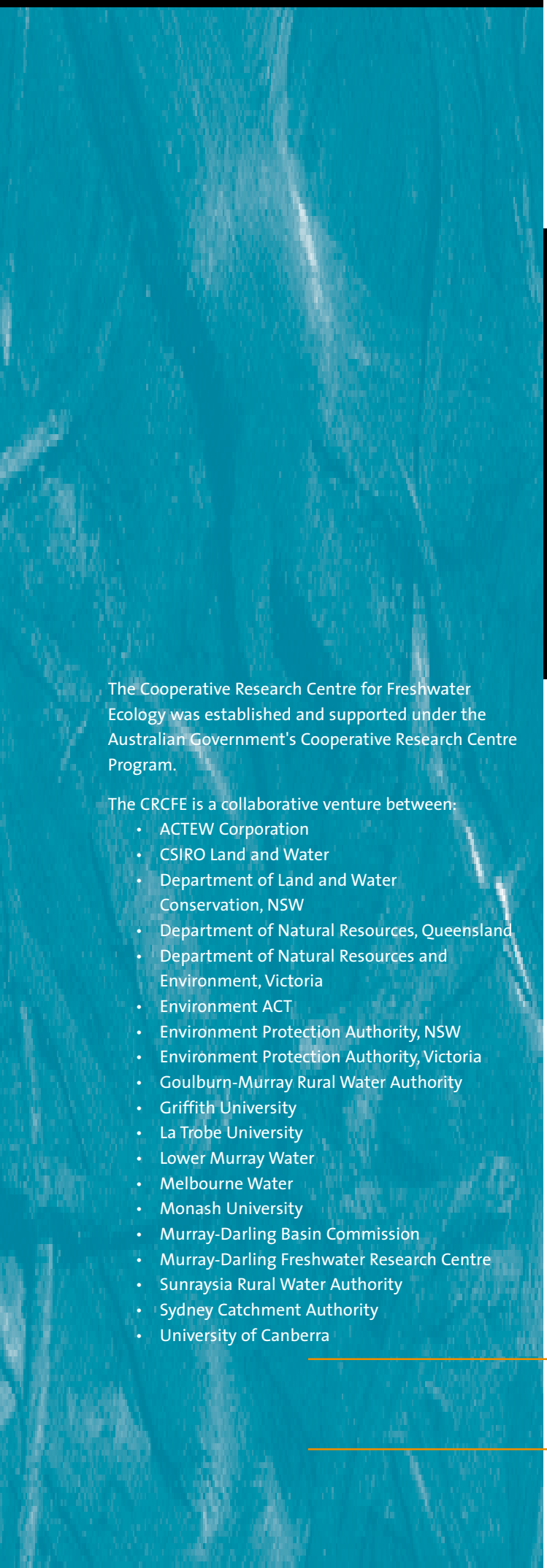
Across Australia, a huge amount of snags and other riverbank plants have been removed from streams in an attempt to improve river navigation and control flooding and erosion. In fact, this may have caused more problems for rivers and streams than it solved.

This brochure explains why snags are an essential part of river health and why they should be left intact wherever possible. With this information, river and catchment management committees, resource managers and community groups will be able to confidently argue for the conservation and restoration of snags in our rivers.

If you wuld like to order a copy of this brochure, phone (02) 6058 2300.



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



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

The Communication Manager
CRC for Freshwater Ecology
Building 15
University of Canberra ACT 2601
Tel: 02 62012109
Fax: 02 62015038
Email: lsealie@enterprise.canberra.edu.au

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- La Trobe University
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