Watershed

contents

The CRC was established under the Commonwealth Government's Cooperative Research Centre Program in July 1993.

The Cooperative Research Centre for Freshwater Ecology provides ecological understanding to improve inland waters by collaborative research, education and resource management.

The CRC is a collaborative venture between:

- *The ACT Government*
- *ACTEW Corporation*
- *The Albury-Development Corporation*
- *CSIRO*
- *Gippsland and Southern Rural Water*
- *Goulburn-Murray Water*
- *La Trobe University*
- *Melbourne Water*
- *Monash University*
- *Murray-Darling Basin Commission*
- *Murray-Darling Freshwater Research Centre*
- *NSW Fisheries*
- *University of Canberra*
- *Sydney Water Corporation*
- *Wimmera-Mallee Rural Water*

Healthy waterways ~ a question of flow

Fish populations in the Campaspe River are in a highly degraded state, initial ecological studies have indicated.

European carp and redfin perch, both introduced species, dominate the adult fish fauna in the Campaspe River, along with the small native species, Australian smelt and flat-head gudgeons. A handful of golden perch, river blackfish and the odd Murray cod has also been collected, but represents only a small percentage of the fish caught.

This ecological work is being conducted by the CRCFE in collaboration with the Victorian Marine and Freshwater Fisheries Research Institute at Snobs Creek and the Cooperative Research Centre for Catchment Hydrology (CRCCH). It is part of a long-term study, which aims to rehabilitate aspects of the ecology of the Campaspe River, through altering the flow regime downstream of Lake Eppalock, the major water storage in that system.

The experimental Campaspe Environmental Flows project is an attempt to balance the needs of the environment with human demands for water such as irrigation. The work is being funded by the CRCFE and the Land and Water Resources Research and Development Corporation.

The CRCFE and Goulburn-Murray Water, which manages Lake Eppalock, have come up with a system of redistributing flows to benefit the river ecology without impinging greatly on water demands for irrigation. The current flow regime in the section of the river most affected by irrigation reverses natural seasonal flow. Higher flows occur throughout summer and the duration of high winter flows is reduced as upstream flows fill Lake Eppalock. Once the irrigation season finishes, usually in early May, very little water is released for environmental purposes, until Lake Eppalock spills later in winter. The new regime, due to be implemented in May 1998, will release one-quarter of incoming flows between May and October, providing Lake Eppalock is two-thirds full.

As well as sampling the Campaspe River, this collaborative study includes comparisons with the much less regulated Broken River, which is a tributary of the Goulburn River.

Project leader, Dr Paul Humphries said that the experiment involved monitoring the abundances and composition of fish,

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Luciano Serafini sampling for adult fish on the relatively unregulated Broken River.

Sustainable urban rivers ~ *a contradiction in terms?*

Director, Prof Peter

The concept of land and water sustainability has penetrated community and political ethos. But will this support survive when communities understand the costs of achieving sustainable waterways? At present our task is to try to define what we mean by sustainability. We must also determine what actions are needed to bring about sustainability, and develop ways and indicators for measuring whether we are moving towards it.

The first step towards sustainability must surely be to ensure that our rivers and streams suffer no further damage. This is a necessary first step, but will not be sufficient to restore already degraded rivers. The Murray-Darling Basin Commission's decision to cap water extraction from the Murray-Darling Basin is a step forward, although a fairly obvious one when around 80% of the flow is already being extracted and the river is showing unacceptable health declines.

Moving towards sustainability for urban rivers requires both planning and management. Planning must be on a catchment basis and it must consider pollution loads from existing, as well as proposed, land uses in the whole catchment.

To restore the health of river ecosystems we must examine flow regimes, the nutrient and pollution inputs, as well as physical factors such as exotic species. It is essential to understand the ecology of the receiving waters, as well as what has caused their degradation. Rehabilitation requires removing or reducing the stresses that are causing undesirable conditions. Often, management understanding of rivers is insufficient to guide cost-effective, low-risk rehabilitation.

If the river is degraded, the first step is diagnosing the problem. Algal blooms come about from excess nutrients and insufficient flow. Deoxygenation or toxic inflows are often responsible for fish kills. Large sand deposits and excess turbidity may indicate soil erosion in the catchment or mismanaged riparian areas.

While coastal waters may be a concern in some cities, there are generally four types of waterbodies of interest in urban areas:

- large lowland rivers;
- the estuarine element of the river as it enters the coastal waters;
- smaller tributary streams, often little more than concrete-lined drains, with highly urbanised catchments;
- floodplains, wetlands and small lakes.

As we urbanise a catchment we increase the runoff into our rivers. In addition, we increase the 'peakiness' of the water runoff. Upstream dams capturing water to supply the city compound these fundamental changes to the river hydrology.

Urban runoff also contains levels of sediment, nutrients, toxicants, organic matter and microbial contaminants that may cause unacceptable impacts on the receiving waters. We know it is better to attack these issues at the source rather than attempt to rely on downstream solutions.

Best management in the 1990s and beyond must surely require:

- urban design that slows water flow, rather than disposing of it as soon as possible;
- using floodplains and wetlands for infiltration and detention, which can help reduce the hydrologic consequences of urbanisation;
- that the high and peaky flows in urban areas are regarded as an environmental flow issue;
- active soil conservation on construction sites and the maintenance of silt traps in the drainage network to reduce sediment flow;
- that gross pollutant traps are installed and maintained in most urban catchments;
- reducing the input of raw or partially treated sewage into streams;
- that catchments are sewered and sewage overflows minimised, monitored and licensed by EPAs;
- reducing nutrient input to streams at the source (parks and golf courses) and using pollution control ponds to discharge to receiving waters.

The above recommendations include a mix of planning and management strategies. The governmental arrangements used to manage urban areas tend to avoid any effective integration of these two functions. In fact the organisational arrangements divided between State (EPAs etc), regional agencies (water authorities etc) and local agencies (governments) seem designed to minimise integration.

Integration is the key to achieving sustainability. We have clearly demonstrated that treating each symptom in isolation does not work, and indeed compounds the problem. The principles of integration are similar to those of Total Catchment Management:

- Planning must consider water volumes and quality from each land use in the catchment.While these may vary with soil type and topography, we do have estimates of pollutant loads from many urban land uses.
- The pollutant loads that receiving waters can tolerate without unacceptable change is a function of the ecosystem. We need to understand the capacity of the receiving waters to receive pollutants before these loads can be determined.
- Acceptable contaminant loads are also a function of river flow, which drives a range of ecological processes. It is important to return some natural flow signals to the biota in regulated rivers by providing fluctuating flows that mimic natural variability, rather than some constant minimum release.
- Hefty penalties should be imposed for illegal dumping of industry wastes or even garden refuse (seeds of exotics). Sewer overflows need to be minimised since we now know that the organic matter encourages nutrient cycling as well as providing a microbial hazard and a load on the oxygen resources of the river.
- Effluent discharges to urban rivers should only be allowed when there is a substantial scientific capacity to predict the outcomes.
- Best practice design, such as the use of fishways to sustain migratory, native fish populations and multi-level off-takes to avoid releasing cold, anoxic water downstream, should be used to minimise the ecological damage caused by dams and weirs.
- Once erosion in a catchment has been addressed it may be appropriate to mine sand from rivers as a restoration measure.
- Removing willow trees that encroach upon waterways and reduce the cross-section of flow, as well as provide shade that interferes with riparian vegetation and in-stream processes is generally desirable, but active replacement with native riparian vegetation is necessary.
- When urban expansion is being considered, best practice in the 1990s requires litter and nutrient control and coarse sediment trapping.

Planners must do more than colour in maps; they must start to understand the ecological consequences of the land uses they allow. The form of the urban area and provision of water services are critical planning decisions that should not be left to other professionals once the planners have moved on.

Our communities should be able to go swimming, boating and fishing in our urban rivers, lakes and streams, without fearing health consequences. They do not want urban waterways that reek with noxious smells or are blighted by toxic or visually unattractive algal blooms. They seek attractive riparian areas rather than eroding banks.

Total Catchment Management has shown us the need for whole catchment thinking and analysis. Hopefully that simple lesson, now well understood in rural Australia, can be learned by our urban professionals before they make more costly mistakes. It is time to make a start.

– Peter Cullen

AUSRIVAS armies called in for river health program

The world's most extensive river monitoring program, AUSRIVAS, has commenced with armies of bug collectors descending on waterways throughout Australia to determine the health of the nation's rivers.

Water agencies in all States and Territories are participating in AUSRIVAS—which comes under the Monitoring River Health Initiative—that will see more than 2000 sites throughout Australia surveyed using biological monitoring techniques. The first autumn sampling run has been completed.

The CRCFE's Justen Simpson and Phil Sloane led the charge in the ACT, covering an area extending from Cooma-Canberra-Yass-Queanbeyan and including 65 test and 10 reference sites.

Justen said that the dry conditions had reduced the flow in many streams in the Cooma area. This meant that only one habitat could be sampled at some sites.

AUSRIVAS is part of the National River Health Program, which is jointly managed by the Land and Water Resources Research and Development Corporation and Environment Australia.

The CRCFE held three-half day training workshops for ACT agency staff involved in the AUSRIVAS monitoring program. The workshops, conducted by Richard Norris, Justen Simpson and Chris Williams, focused on sampling and data analysis methods.

Fish schools along the Campaspe

The Murray-Darling Freshwater Research Centre (MDFRC) has managed to catch two fish with the one net. The Fish Larvae Action Group (FLAG) has involved local school communities in a scientific river-monitoring program and helped the Centre solve a resource problem.

Dr Paul Humphries from the MDFRC has been working on the environmental flows project on the Broken and Campaspe rivers, which is investigating a possible link between river regulation and native fish numbers. Due to the large number of sites that needed to be visited and time and resource constraints, sampling could only be carried out once a month. Paul was worried about the accuracy of his samples and results—what was happening to fish numbers the other three weeks? This was going to be a particular problem in the months from November to January when most fish spawn.

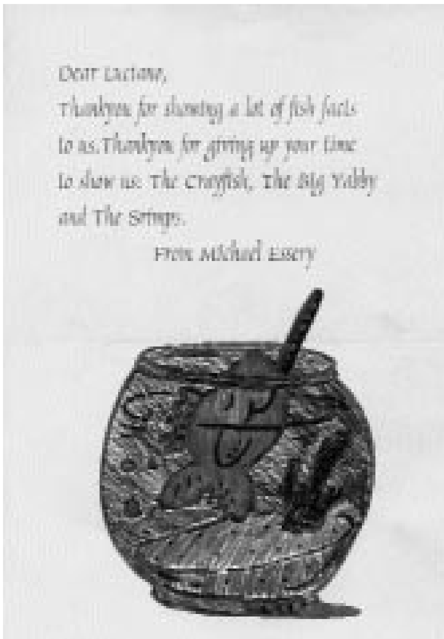
Paul came up with the idea of approaching schools along the Broken and Campaspe rivers for their help. Together with the MDFRC's education officer, Mike Copland, he devised the FLAG program.

Five schools are involved in FLAG: Shepparton High School and Currawa, Ballandella, Elmore and Rochester primary schools. Each school has its own routine with some schools involving whole classes in the sampling process while other FLAG teams are made up of only a sole teacher and student.

Principal of the Elmore Primary School, Mr Peter Stone, said that FLAG had brought an awareness of the presence and role of fish larvae in streams to the 18 children (ages 10–12) involved in the Elmore program.

"The program worked really well because it was hands-on," Peter said. "It developed the children's interest in another area of the environment—that of streams. And we did get feedback about the work that had been done."

Data from the FLAG program is providing further evidence that flow regulation is having a negative impact on native fish. The FLAG work will also provide important data that can be compared with data gathered after the flow regime of the Campaspe River has been changed. This will enable researchers to measure any benefits the changed flow may have on native fish.



'Data from the FLAG program is providing further evidence that flow regulation is having a negative impact on native fish.'

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fish larvae, macroinvertebrates and plants and examining sediment transport before and after the change in the flow regime.

Sampling for fish and fish larvae began in October 1995, for plants and sediments in July 1996 and for macroinvertebrates in February 1997.

"Although we are still in the 'before' stage of the experiment, the data that we have collected for the fish and fish larvae confirm that this particular group is in a highly degraded state," Dr Humphries said.

The larvae of only seven species of fish have been collected from the Campaspe River, compared with 11 species in the Broken River. Only four of the seven species of larval fish in the Campaspe are native, whereas seven of the 11 species in the Broken are native.

In addition, indications suggest that few native fish are spawning in the regulated Campaspe River. Larger native species, such as Murray cod, are not spawning while relatively large numbers of Murray cod larvae are being collected quite regularly in the Broken River.

Distinct differences are also evident in the macroinvertebrate faunas among the three sections of the Campaspe, which experience different hydrological regimes as a result of irrigation flows. More will be revealed as more samples are taken and sorted.

Dr Humphries said that the damming of most large rivers in Australia, and the altering of their flows, had coincided with declines in native fish stocks.

"We acknowledge that there have been many other changes to our river systems, such as loss of habitat, land clearing, salinisation, eutrophication, introduction of exotic species and over-fishing," he said.

Fish and macroinvertebrate samples taken from the relatively unregulated Broken River, pictured, are being compared to those gathered from the highly regulated Campaspe River.

"However, the construction of weirs and dams and river regulation has without doubt played a major role in reducing the abundance and range of many native fishes and changes to macroinvertebrate communities.

"Environmental catastrophes, such as blue-green algal blooms and booming numbers of European carp, have certainly stirred community outrage and prompted natural resource agencies to action to try and improve the state of our rivers. And this is what this project is all about."

The experiment is due to run until mid 2001 and will provide about six years of data, one of the longest data sets of its kind in Australia.

" We should be in a good position by that time to determine whether, in the case of the Campaspe River, the demands placed upon a river by man and the needs of the environment can be met by a relatively simple redistribution of water," Dr Humphries said.

"However, flow is only one part of a multi-faceted problem that our rivers face. Only by addressing these problems on a catchment-wide basis will we come anywhere near to making our rivers ecologically sustainable."

For further information about this project, contact Paul Humphries on (060) 582 317 or email, hump@mdfrc.canberra.edu.au

Another frog *croaks?*

Another Australian frog may be slipping from our grasp, a comprehensive survey of stream-breeding frogs in far East Gippsland has revealed.

Masters student Simon Holloway and frog expert Dr Will Osborne, who are both based at the University of Canberra and are members of the Cooperative Research Centre for Freshwater Ecology, conducted the study.

The research was based in forested mountains and included parts of the Coopracambra and Alfred national parks as well as State Forest areas of the northern Cann River region. The area chosen included sites where two rare Victorian frogs, the southern barred frog and the giant burrowing frog, had been previously recorded.

While the frog fauna in the area was found to be moderately rich, the southern barred frog was not detected during the study which included 25 survey trips between January 1995 and December 1996.

The study was conducted for the Victorian Department of Natural Resources and Environment, which requested that methods be developed for surveying stream-breeding frogs in forest areas that were harvested for hardwood production.

Specific aims of the study included conducting field surveys for both the southern barred frog (*Mixophyes balbus*) and the giant burrowing frog (*Heleioporus australiacus*) in the Upper Cann Valley and the adjacent areas, including the Coopracambra National Park and Coast Range. The study also sought to gather data on the distribution and abundance of other riverine frogs as well as comparing survey techniques suitable for riverine frogs and assessing habitat parameters at survey sites.

Simon Holloway dip-netting for frog larvae in a montane stream, East Gippsland.

A range of non-destructive techniques were used to survey the frogs including night surveys using torches, active daytime searches which included turning rocks and fallen timber along stream transects, and dip-netting for tadpoles. The mating calls of the giant burrowing and southern barred frogs were played at some sites in an attempt to elicit a response from individuals of those species. In addition, timer-activated tape recorders were placed at 10 sites for two weeks, during summer and autumn of 1995-6. The recorders were activated for one minute during dusk, one minute an hour after dusk and one minute two hours after dusk. Recorders were also used at six sites in the spring of 1996 in conjunction with an automatic weather station. The researchers also listened for adult male frog calls while moving slowly along stream sections. Driving transects were conducted opportunistically as well as during a number of warm, moist evenings. Weather variables were recorded at the beginning and end of each survey and during the survey if conditions had obviously changed.

The common eastern froglet (*Crinia signifera*), which occurred along most streams, was the most widespread of all the 14 species detected in the study area. The leaf green tree frog (*Litoria phyllochroa*), was the most common of the stream-breeding species.

A single giant burrowing frog was found near a fire dam, providing the only record of this rare species. However, no adult or larval individuals of the southern barred frog were found during the surveys.

Simon said that the absence of the southern barred frog during the survey raised concern for the status of the species in Victoria since historic data indicated that this frog was once more abundant in East Gippsland and adjacent NSW forests.

Downloading data from a portable automatic weather station in the Gippsland forest. Simon Holloway has developed survey techniques for stream-breeding frogs in the East Gippsland region.

"It is likely that this species has suffered a serious decline in Victoria," he said. "We conducted numerous targeted surveys as well as using automatic call recorders at known historic sites for the southern barred frog. Most sites surveyed for these species were relatively undisturbed apart from the occasional logging activities upstream.

"Reasons for the decline of this species aren't obvious. It's a forest dependent species, and is likely to be vulnerable to forest disturbance because of its large adult size and lengthy larval duration."

Recommendations from the study included:

1. Wider application of the sampling protocols developed in this study to other frog species.
2. Intensive monitoring of populations of the southern barred and giant burrowing frogs to determine how frequently these elusive species can be found using standard survey techniques.
3. A high priority given to conducting extensive surveys for the southern barred frog in sites where the species is likely to occur throughout the broader East Gippsland region.
4. Conduct further surveys targeted to smaller, slower-moving streams in more open vegetation (heath, open forest) for the giant burrowing frog.

Yabby study throws light on billabongs

Australia's common yabby has the potential to significantly alter nutrient cycling as well as the composition of aquatic plants in floodplain billabongs, CRCFE postgraduate research has revealed.

Jacqui Brooks, based at Monash University, examined the ecological role of the freshwater yabby, *Cherax destructor*, within billabongs on the Ovens River floodplain, in north-eastern Victoria.

The project, Trophic Ecology of a Freshwater Crayfish, *Cherax destructor,* in Billabongs of South-eastern Australia, was aimed, in part, at increasing our understanding of the ecology of Australian billabongs. It focused on two issues: the effects of *C. destructor* as consumers of dead and decaying material, and the effects of *C. destructor* as consumers of aquatic macrophytes.

Jacqui explained that the consumption of dead and decaying material was thought to be one of the main ecological roles of many freshwater crayfish species.

"Crayfish have been labelled as "key energy transformers" in streams and lakes where litter input comes from the surrounding floodplain," she said. "The crayfish earned this title through their ability to process decaying wood and leaves which would otherwise have remained in the system for many years."

While it seemed reasonable that crayfish might have this type of energy transforming effect, there were few studies that actually looked at the litter processing capabilities of these invertebrates.

Jacqui's work, which included both laboratory and field studies, did in fact show that *C. destructor* could significantly affect the rates at which river red gum leaves, *E. camaldulensis*, were decomposed, which could affect the rates of nutrient cycling within billabongs. This effect, however, was only felt when rates of litter input were relatively low or when yabby densities were particularly high.

Jacqui Brooks setting bait traps on an Ovens River billabong to catch the yabby, C. destructor, for population studies.

Studies on the effects of *C. destructor* on aquatic plants were also conducted in both the laboratory and the field.

Jacqui said that it was clear that yabbies had the potential to effect the biomass and density of aquatic plants.

"The removal of aquatic plants from a billabong, whether it be by disturbance or consumption, can have significant effects on the entire food web," she said.

"Studies have shown that rooted plant species link the sediments of the billabong with the overlying water. This provides an important conduit for the transfer of oxygen to the sediments during growth, and nutrients to the water during decay. Aquatic plants also provide growth sites for epiphytes (which live on other plants), which in turn provide food for a range of macroinvertebrate and fish species. Many of the larger plants also provide refuge for insect larvae and small fish.

"One of the most interesting outcomes of this study, has been the implication that *C. destructor* has the potential to alter billabong food webs by selectively removing certain aquatic plant species."

Laboratory experiments indicated that the yabby preferred the tender, young stems of the common rush, *Juncus usitatus*, rather than mature stems. Selective removal of juvenile plants from the billabong could significantly alter the structure of the aquatic plant community, Jacqui pointed out.

The combined effects of the yabby as consumers of red gum detritus and as consumers of aquatic plants were likely to be of considerable importance to the structure of billabong communities, she said. Given the high conservation value of Australia's large river floodplains, further studies of this type were surely warranted.

The study has contributed to our general understanding of the trophic ecology of freshwater crayfish and has provided valuable information about the ecology of south-eastern Australia's highly productive, yet little understood, billabongs.

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Sediment ~ sinks or sources for nutrients?

The role of sediments in the functioning of our waterways is the issue at the centre of collaborative work being conducted by the Cooperative Research Centre for Freshwater Ecology.

The work, being funded by the Murray-Darling Basin Commission and the Land and Water Resources Research and Development Corporation through the National Eutrophication Management Program (NEMP), is aimed at determining where and when nutrients in Australian lowland rivers are likely to be released from sediments.

The team doing the work includes Drs Phillip Ford, Ian Webster and Yunhu Tan from the CSIRO Division of Land and Water, and Prof Barry Hart and Dr Mike Grace from the Water Studies Centre at Monash University.

Dr Grace said that nutrient release from sediments was a crucial management issue because under certain conditions phosphorus could be released from sediments to drive the formation of toxic algal blooms.

To explore the issue of nutrient release from sediments, the researchers are developing a computer model that incorporates the key microbial and chemical processes involved in nutrient/sediment interactions.

Graduate students Jason van Berkel (left) and David Halliwell preparing to dive for sediment cores in Lake Nagambie.

The model, which also includes physical transport systems, will predict nutrient movement within the sediment and also between the sediment and the overlying water," Dr Grace said.

"Water resource managers will be able to use this predictive computer model to develop strategies that will minimise the conditions that are likely to favour the release of nutrients from the sediments," Dr Grace said.

Research to date has focused on adapting an existing nutrient model, developed by Prof Bernie Boudreau at Dalhousie University in Canada, for Australian conditions.

The field work is concentrated on the Goulburn River and Lake Nagambie near Shepparton, Victoria.

"The Goulburn-Broken River system has been identified by the NEMP management committee as one of its four 'focus catchments'," Dr Grace explained.

(The others are the Namoi River in NSW, Willson's Inlet in WA and the Fitzroy River in Queensland).

"It is believed that this 'focus catchment' approach will help provide 'The Big Picture' of how the entire ecosystem functions."

The researchers have collected sediment cores from Lake Nagambie and then segmented them in an air-free environment to prevent the chemistry of the sample from changing as a result of oxygen contact with the sediment.

The water within the sediment segments has been analysed for a variety of chemicals including phosphate, nitrate, ammonia, and dissolved iron, allowing a depth profile to be built of how these chemicals change as you get deeper into the sediment.

Dr Grace explained that the experimental profiles could then be compared with theoretical predictions derived from the computerised model.

"This will allow us to fine tune the model for conditions within Lake Nagambie at the time of sampling," he said.

The next stage of field work will investigate whether sediment behaviour in Lake Nagambie is affected by environmental conditions such as recent rainfall, wave action or water temperature. The research team hopes that this will help them identify key factors in the physical environment that determine nutrient movement into and out of the sediment.

The research team will then turn its attention to determining how well the model's predictions might be applied to other localities. The team hopes it will then be able to identify key geographic variables that affect sediment functioning.

"The final and most important stage in the whole process is to involve water resource managers and use the experimentally validated, predictive capabilities of the model to assess the likely outcomes of a particular management action," Dr Grace said.

The project is expected to be completed in 1999. For further information, contact Dr Mike Grace at the Water Studies Centre, Monash University on (03) 9903 2326.

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