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 through collaborative research, education and resource management.

Keep the Darling flowing

toxic algae study finds

If we want to minimise toxic algal blooms, we must keep our rivers flowing.

This was one of the findings to come out of a three-year study that looked at the likely causes of the infamous blue-green algal (cyanobacterial) bloom that extended for some 1000km along the Darling River during 1991.

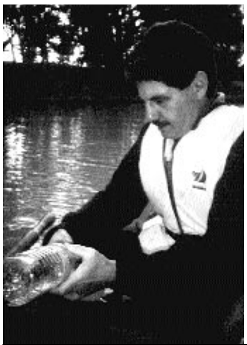
The collaborative study, conducted by the CRCFE and CSIRO Land and Water, showed that the stimulation of toxic algal blooms, was a multi-step process. Low flows resulted in increased salinity due to groundwater seepage, and this caused a decrease in turbidity improving light penetration into the water to a level conducive to algal growth. Only at this point was it then necessary for algae to have access to quantities of nutrients such as phosphorus and nitrogen.

The Darling River is known for its high phosphorus loads and management strategies have been aimed at reducing the levels of this nutrient.

Funded by the Murray-Darling Basin Commission under its Natural Resources Management Strategy (NRMS), the study focused on the role of phosphorus in controlling the size of algal blooms.

The Darling River is known for its high phosphorus loads and river management strategies have been aimed at reducing the levels of this nutrient. This study sought to find out whether that was in fact possible.

While the CRCFE team looked at the different types of phosphorus that occurred in the river and how much of this nutrient was available for algal growth, the CSIRO team focused on where the phosphorus was coming from. Was the phosphorus coming from point sources such as sewage treatment plants; from diffuse sources associated with agricultural practices; or was the phosphorus derived mainly from naturally occurring sources such as basaltic soils in the catchment? Furthermore,



Prof Barry Hart taking bottle samples from the Darling River to determine the different types of phosphorus that occur in the river and how much of this nutrient was available for algal growth.

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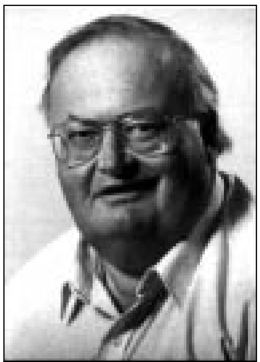
COOPERATIVE RESEARCH CENTRE FOR FRESHWATER ECOLOGY

The CRC is a collaborative venture between:

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

Resolving conflicts over water



Director, Prof Peter Cullen

Water is a scarce and precious resource and there are differing views in society as to how we should use it.

Productive agriculture, urban areas, golf courses, nature conservation, tourism and recreation all make their claim on our water resources. How can we reconcile the conflicts arising from different interest groups pushing what they see as the most important use of water?

We seek win-win outcomes where each interest group substantially gets its needs met. While this may not always be possible, it should be our aim. Win-lose outcomes are often unstable, as winners gloat and losers scheme.

We have learned much over the last 20 years about the special features of environmental conflicts, and we are developing new ways of resolving them. There are six principles emerging:

- All the players and interests need to be actively involved
- Knowledge needs to be shared
- There needs to be some process to manage negotiation to avoid stalling and stalemate
- A good solution will meet everyone's needs as much as possible
- People often have different needs that must be identified
- The solution needs to be clear and well-documented so that it is not challenged later by someone who thinks they might gain a greater advantage.

It is also a mistake to assume there is a fixed amount of water to fight over. One person's wastes may be another person's resource.

Recent work on environmental allocations indicates that we might be able to return flow signals to the environment without greatly reducing the amount of water available for other uses. The environmental flows experiment being conducted by this CRC is looking to restore flow pulses to the Campaspe River by transmitting a percentage of inflows through the dam, at Lake Eppalock. This adds a marginal risk to the time it may take for the dam to fill and spill. While it does not put a demand on the amount of water available to irrigators, it should give a considerable benefit to the environment.

Inherent in any conflict is five key elements, each of which requires a different strategy to resolve.

1. Interest elements refer to the self-interests of the people involved. Players may be competing to exploit a resource for irrigating crops or for tourism. They have a personal financial involvement in the outcome.
2. Value elements involve fundamental belief systems about the importance of things like our responsibility for land, water and the plants and animals that depend upon them. Players need not have any personal involvement, nor even to be theoretically well-versed, to have a strong position on these values.
3. Data elements arise when people lack the information to make wise decisions. They may be misinformed about likely outcomes or may disagree about what data are relevant or how it should be interpreted. The amount of water required to support the environment and its delivery is a classic situation where imperfect information makes resolution difficult.
4. Labelling elements enter a conflict when players give other players negative labels that may introduce misconceptions and stereotypes. "Greenies", "dole bludgers" and "blacks" can all be used as pejorative terms to avoid listening to what people are saying and responding to the substance of their concern. A good rule for conflict resolution is 'be soft on people, hard on issues'.
5. Structural elements relate to the organisational structures that we erect to manage a resource. Conflicts between water agencies and environment protection agencies are one example.

We have an emerging set of tools for dispute resolution, and the community is slowly learning to use these tools effectively.

Better knowledge is fundamental to better decision making, and it needs to be available to all. It also needs to be good enough for us to make reasonable predictions on how systems will respond if we implement changes.

Knowledge will not, however, help us decide whether those changes are socially acceptable. We invented politics to deal with those sorts of value judgements.

Peter Cullen
Director

Keep the Darling flowing

toxic algae study finds

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if naturally occurring phosphorus sources were important, had the delivery of phosphorus been accelerated by human activities in the catchments.

The CSIRO team sampled an extensive area of the Darling River catchment, including its tributaries.

"By using radioactive tracers and the magnetic mineral characteristics of the sediments, we found that they most of the phosphorus entering the Darling River came from basalt rich soils in the catchment," Dr Jon Olley, CSIRO project leader said.

However, quantifying just how much of this sediment-associated phosphorus was available for the growth of blue-green algae remains a point of contention because tracking its transformations "or the way it changes from one form to another" is extremely difficult.

"However, we do know that phosphorus concentrations on the sediments have not changed significantly during the last 300 years," Dr Olley said.

"Algae take up and use the soluble form of phosphorus. Although there is also a certain amount of phosphorus on particles which comes off very quickly and can be used by the algae to grow, there is also some phosphorus that remains firmly bound to the sediments and is not available for algal growth.

"Taking a sewage treatment plant off-stream may reduce the soluble phosphorus - the particular form which the algae utilise – even though the total amount of phosphorus has not gone down very much."

An underwater sensor measures the amount of light in the Darling River.

Work conducted by the CRCFE was concentrated on the Darling River's Bourke Weir pool, as well as sites upstream and downstream of the pool.

"Algal blooms are most likely to occur first in weir pools where the water is relatively still," CRCFE project leader, Dr Rod Oliver from the Murray-Darling Freshwater Research Centre, said.

"We also looked at sites downstream of the weir pool because we knew there were saline groundwater inflows which were likely to have an effect on the water quality."

While phosphorus was necessary for algal growth, it was not, by itself, responsible for initiating blooms, the CRCFE found.

"Even when the phosphorus in the river is high you don't get high levels of algae when the river is flowing and turbid, or muddy," Dr Oliver said. "This is because the algae don't receive enough light to grow.

"What happens in the Darling is that once you stop the flow, the small particles suspended in the water column slowly start sinking to the bottom. The water clears and allows light to penetrate. Once light is available to the algae, away they go."

Phosphorus is still an important ingredient, however, because it sustains algal growth and determines the likely size of a bloom. The extent of the algal growth will depend on how much phosphorus is available. Sewage input, urban runoff and catchment erosion through land clearing and stock grazing have undoubtedly accelerated phosphorus inputs to our rivers since European settlement.

Nitrogen, which was found to be in short supply in the Darling River, is another nutrient required by most algae for growth – and this is where toxic blue-green species such as *Anabaena circinalis*, which can fix their own nitrogen from the air, have the advantage.

The Darling River team was not short of eager volunteers to help out with field work – particularly if it meant getting wet!

While blue-green algal blooms most certainly occurred before river regulation, they would not have been nearly as extensive or as long-lived.

"In the past, when the river dried up, it really dried up," Dr Oliver explained. "There were no deep weir pools like there are now. Blue-green algae would have occurred, but just in isolated pools and they would have grown in conjunction with all sorts of things that would have competed for nutrients and space. But once you've got deep weir pools, then things that float in the water column, such as blue-green algae, have a distinct advantage."

The study highlights a suite of management activities that are likely to be effective in controlling algal blooms in the Darling River, including manipulating flow, light and the nutrients entering the system.

The most easily managed aspect of the system is flow and in this respect the study's findings supports recommendations which came from work on the Maude Weir pool on the Murrumbidgee River that was aimed at developing and evaluating flow management strategies to control blue-green algae outbreaks. This work, conducted by CSIRO Land and Water and the CRCFE, investigated the effects of water discharge on thermal stratification and mixing within weir pools, and the resulting effects on algal growth.

Loss of species and diversity in Pedder

The concerns of scientists over the damming of Lake Pedder in south-west Tasmania have been borne out by the results of a long-term study that has shown a loss of species and biodiversity since the lake's inundation 25 years ago.

Sorting macroinvertebrate samples on the shores of Lake Pedder – the animals displayed "a cycle of boom and bust that mirrors what happens in overseas' dams".

The small native fish, Pedder galaxias, *Galaxias pedderensis*, known only to occur in Lake Pedder, has not been found in the dam since 1980 and scientists now fear for its survival. Similar fears are held for other endemic species, including a crustacean, a flatworm and two species of caddisfly.

Renowned for its unique natural setting, pink quartzite sands and dramatic seasonal changes, Lake Pedder was the battle-ground for the Australian conservation movement's first major campaign. The war cry was raised in 1967 when the Tasmanian Hydro-Electric Commission announced plans to dam the lake. Among the campaigners who fought unsuccessfully for almost a decade to save Lake Pedder and its lesser-known neighbours, Lakes Maria and Edgar, was Dr Sam Lake, a zoology lecturer at the University of Tasmania.

Dr Lake was one of the volunteer ecologists who provided evidence to the Lake Pedder Committee of Enquiry 1974 that the 9km^2 lake harboured an abundant and distinctive suite of plants and animals, including a unique beach-dwelling fauna of crustaceans and insects. Meanwhile 'official' biological investigations of the lake failed to find anything unique or unusual about its plants and animals.

The findings of the ecologists, particularly those predicting loss of species, were dismissed as "exaggerated" and the "drowning" of Lake Pedder began in 1972. In 1974 when the inundation of Lake Pedder was almost complete, the Lake Pedder Committee of Enquiry, in tabling its final report, recommended that funds be set aside for long-term monitoring of the new impoundment. This was never acted upon.

Deciding that Lake Pedder was not about to die without, at least, a post-mortem, Dr Lake and a team of like-minded biologists from the University of Tasmania packed their nets and a rather unsteady 3.1m aluminium runabout and began an 11-year sampling program, taking in 12 sites from near Edgar and Scotts Peak dams to the Lake Pedder basin.

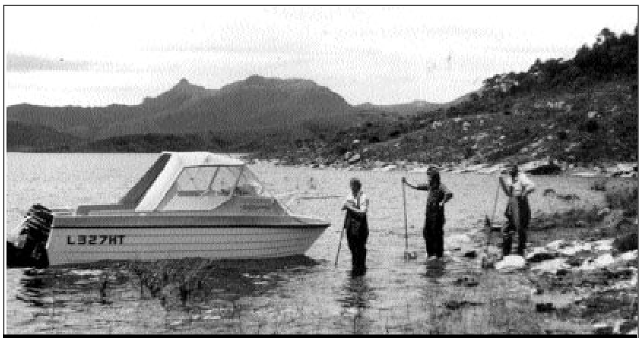
The sampling sites were chosen randomly, based on accessibility and position in relation to the shoreline and ranged from swampy sites protected from prevailing southwest winds to exposed rocky sites. At each site four three-minute samples were taken by wading along the shore with a mesh net. Preliminary sorting was conducted in the field and then the samples were preserved and returned to Monash University for further sorting, identification and counting.

Eleven years after sampling began, Dr Lake, now a Professor of Ecology at Monash University and Flowing Waters Program Leader for the Cooperative Research Centre for Freshwater Ecology, believes that the results validate the earlier scientific predictions.

More importantly, as Dr Lake points out, the long-term data obtained from the monitoring is the first to provide an understanding of the succession of plants and animals in an Australian impoundment after the construction of a large dam.

Over the 11-year study period 75 species of aquatic macroinvertebrates and two species of fish were sampled. Among the invertebrates collected were 64 species of insects, five species of water mites, three species of molluscs and one species each of crustacean, worm and flatworm.

Dr Lake said that the monitoring revealed a



A long-term study has shown a loss of species diversity in Lake Pedder since its inundation 25 years ago.

progressive shift in numerical dominance from insects to just one crustacean.

"In the early years, the case-building caddisfly larvae, *Notalina parkeri,* dominated the samples at most sites. By 1996, however, this insect occurred at only two sites and made up less than 0.7% of the total animals collected" Dr Lake said.

By 1986 the crustacean, *Austrochiltonia australis,* which had been confined to sites around the Edgar basin, had become the dominant animal and occurred at all sites.

"What happened in the lake was a cycle of boom and bust that mirrors what has been witnessed in overseas dams," Dr Lake said. "Between 1975 and 1977 there was a huge increase in the numbers of macroinvertebrates sampled. The number peaked at 766 animals per site in 1977 and then plummeted to just 27 animals per site by 1996.

"When the dam was still quite young there was a lot drowned and detached vegetation that provided habitat and nutrients to support a large variety and abundance of animals," Dr Lake said. "It was just after flooding, for example, that Lake Pedder gained a reputation as a fishery for monstrous trout."

Decay, erosion and wave action, however, soon depleted these newly created habitats, leaving a uniformly set of simple habitats throughout the dam.

Initially, it was the exposed sites that were noted for their poor abundance of fauna and species richness. Dr Lake predicts, however, that further simplification of the dam's sheltered areas will result in sites that eventually harbour an identical fauna: one low in abundance and species diversity.

According to Dr Lake it is unlikely that draining the Huon-Serpentine impoundment to restore Lake Pedder would result in a return of the species that have been lost since the drowning.

This loss, he says, shouldn't detract from the idea of restoring the lake on aesthetic and cultural grounds.

Dr Lake says that the study demonstrates the huge benefits of long-term monitoring to detect trends in data and to test hypotheses over appropriate time and spatial scales.

And long-term monitoring need not be expensive. Each of the 11 Lake Pedder survey trips was conducted on the frugal budget of $750.

"All that is needed is a clear set of predictions, a commitment to carry out the study and not be put off by political intervention, and a robust form of sampling that doesn't require changing during the course of the study," Dr Lake said.

"Perhaps the fashion for small-scale, short-term studies that promise quick returns and many short papers is too strong to accommodate the need for long-term studies. The recent and increasing trend for resource management agencies to employ consultants on a short-term basis is counter to understanding major environmental problems effectively in the long term."

Exotic snail thrives in degraded aquatic systems

Originating in New Zealand, the aquatic snail, *Potamopyrgus antipodarum,* has successfully invaded streams and lakes across the world, including Australia, England, continental Europe and the United States.

While the snail has been in Australia for more than 100 years – thought to have been introduced in ship ballast or drinking water containers – there had not, until recently, been any work done on its impacts, biology or life history in this country.

CRC for Freshwater Ecology postgraduate student, Sabine Schreiber, investigated the reasons for this exotic snail's success in southern Victorian streams. Ms Schreiber, who is based at Monash University's Department of Ecology and Evolutionary Biology, also looked at the snail's abundance, population structure and reproductive success.

"What comes first the degraded system or the snail" – Sabine Schreiber.

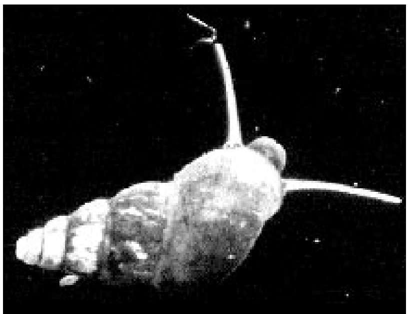
Sampling at 73 stream sites in southern Victoria during 1994 revealed that water quality variables (such as nutrients, salinity and pH) were not related to the distribution of the snail. Rather, high flow variability and disturbance seemed to favour the animal's presence. Like weeds, the snails were more likely to be found in prolific numbers in highly disturbed sites than in sites that were not affected by human activities such as agriculture and forestry.

While the snail certainly seemed to prefer disturbed sites, its success was also connected to its biology, particularly its method of reproducing, Ms Schreiber explained.

"In its native New Zealand *P. antipodarum* reproduces both sexually and asexually," she said.

"In the areas it has invaded, however, the low number of males suggests that most reproduction takes place asexually, through parthenogenesis whereby the females essentially clone themselves.

"Another factor contributing to the success of this snail in Australia is that the females don't lay eggs, but give birth to live young. This allows populations to build up incredibly fast because the period between 'hatching' and reproductive maturity is shortened. In addition, this snail will eat almost anything, from bacteria to algae to carrion to rotting leaves. Wide temperature and salinity ranges don't seem to bother it either."



The aquatic snail, Potamopyrgus antipodarum, is another exotic which has obtained a foothold in Australian waterways.

An examination of the snail's biology in four South Gippsland streams during 1995-96, found little change in population densities. In the Bass River and Wilkur Creek the snail continued to occur in very high numbers, despite periodic dry periods in both these study sites. In the Franklin and Tarra rivers, however, the snails remained relatively sparse throughout the study period. Data from these two types of streams will enable Ms Schreiber to compare low-density and high-density populations and their reproductive strategies.

Studies in the Tarra River in 1996 found that the snail did not have much impact on native fauna, particularly its early colonisation, Ms Schreiber said. In fact one insect, the midge larvae, *Polypedilum,* almost doubled its densities in the presence of the snail.

"This particular midge larvae is indicative of nutrient-rich waters, so it's possible that the snail's faeces are providing it with extra food," Ms Schreiber said.

"This finding highlights the importance of field experiments. Unless I had deliberately set out to investigate how this midge larvae had been affected by the snail, I would never have seen this impact in the laboratory."

Ms Schreiber recommends longer-term studies to investigate issues such as why the snail is so successful in degraded environments. Does it out-compete resident native fauna or is it able to survive where native fauna cannot?

"While we don't really know what comes first, the degraded system or the snail, I suspect the degraded environment allowed the snail a foothold in Australian waterways. It seems the more we mess up our rivers, the more we allow exotics to get in."

Ms Schreiber is supervised by Prof Sam Lake and Dr Gerry Quinn from DEEB, Monash University.

Diving for snags in bags

Bugs beware! A new sampling device, the snag bag, promises to drag even the most reluctant invertebrates from their riverine homes, into the sorting trays of researchers.

Developed by CRCFE researchers this simple, yet effective sampling tool presents the first opportunity to quantitatively sample snag invertebrates in Australia.

Dr Jane Growns said that the snag bag was developed in response to the difficulty experienced sampling the large and dense river red gum snags in the Murray–Darling Basin's lowland rivers. Dr Growns is a CRC researcher working on a project aimed at assessing the response of fish and invertebrates to a change of flow regime in the Campaspe River.

"Elsewhere snags may be simply pulled from the water whole or parts sawn off," Dr Growns said. "These methods aren't practical for river red gum snags, unless you've got Arnold Schwarzenegger on your sampling team."

The snag bag – even a bug can't hide!

Snags, the coarse woody debris dropped into the river by overhanging trees, provide a major source of habitat for invertebrates in Australia's lowland rivers. The types of invertebrates found living on snags are quite different from those that make their homes in other habitats such as the stream bottom or aquatic plant beds and backwaters.

"Unlike sandy and muddy stream bottoms, typical of lowland rivers, snags provide a solid and complex habitat for invertebrates," Dr Growns said. "Filter-feeding organisms such as caddis fly and black fly larvae make their homes on snags. Large areas of snags are often covered by freshwater sponges. Small shrimps and the larger prawns also use snags, feeding on biofilms, or the scum which develops on the surface."

The snag bag, which can be used in both still and flowing waters, consists of a mesh bag with the sides sealed by velcro strips. The bag is slipped under a snag and sealed around the area to be sampled. The wetsuit-clad sampler can then place their arm inside the bag through a sleeve and brush down the surface of the snag to dislodge the invertebrates. The bag is removed by gradually loosening the velcro at the top and closing it at the bottom, to prevent loss of the sample.

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Diving for snags in bags

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"We're looking at snag invertebrates in the regulated Campaspe and less-regulated Broken rivers," Dr Growns said. "Our aim is to see if the invertebrates respond to changes in flow regimes. The preliminary results are showing clear differences for many groups of invertebrates between snags at heavily regulated sites and those in less regulated conditions.

"Our next challenge is to see if the invertebrates respond to the experimental change in the release regime from Lake Eppalock on the Campaspe River."

At present, almost no water is released after the end of the irrigation season in April until Lake Eppalock spills in late winter. Next May more water will be released during early winter – 25% of incoming flows will be released provided Lake Eppalock is two-thirds full.

"The work will increase our understanding of the ecology of these types of river," Dr Growns said.

"We know that invertebrates are an essential part of these ecosystems because of their roles in breaking down organic matter and as food for fish, platypuses, water birds and so on. However, we know almost nothing of the details of these linkages.

"As they grow fish will eat different parts of the invertebrate fauna. There are likely to be bottlenecks during the lives of fish that will determine the size and vigour of their populations.

"One bottleneck could be a need for the correct type of food, in sufficient amounts at some critical life history stage."

The Campaspe Environmental Flows project, led by Dr Paul Humphries and Prof Sam Lake, is a collaborative project between the CRCFE and the CRC for Catchment Hydrology and the Victorian Marine and Freshwater Resources Institute. Funded by the CRCFE and the Land and Water Resources Research and Development Corporation, the work is being conducted in cooperation with Goulburn-Murray Water, the agency responsible for managing Lake Eppalock and the Campapse River in north-east Victoria.

The project is aimed at providing water managers with alternatives for managing flow regimes that both meet environmental needs as well as the demands of agricultural and urban users.

For more information about snag bags or the environmental flows project, contact Dr Jane Growns at the Murray-Darling Freshwater Research Centre in Albury on (02) 60 58 2324 or **grownsj@mdfrc.canberra.edu.au**

Jane Growns sampling snags in the Campaspe River with the snag bag, a simple yet effective devise designed to overcome the difficulty of sampling snags in lowland rivers.

The Campaspe Weir. Jane Growns and team will be assessing how invertebrates respond to the experimental change in the release regime from Lake Eppalock to the highly regulated Campaspe River.

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