Watershed

contents

The Cooperative Research Centre for Freshwater Ecology exists to provide the knowledge for the sustainable management of freshwater systems in Australia. Its research program includes: STANDING WATERS AND EUTROPHICATION - FLOWING WATERS - WATER QUALITY & ECOLOGICAL ASSESSMENT - URBAN WATER MANAGEMENT - FISH ECOLOGY - FLOODPLAIN & WETLAND ECOLOGY.

computer model aids assessment of our rivers

AUSRIVAS, the first national assessment of river health, is officially up and running following it's recent launch by Minister for the Environment, Senator Robert Hill, on the shores of the Molonglo River in Canberra.

A key part of getting the national assessment up and running has been the development of a predictive computer model which establishes a standardised platform for measuring river health throughout Australia. The model, developed by the CRCFE's Richard Norris and his team Justen Simpson and Paul Blackman, was based on 1500 reference sites that were sampled across Australia. These reference sites were selected for sampling on the basis of minimal disturbance, or minimal impacts by pollution, to provide a benchmark against which the condition of test sites could be assessed.

Richard explained that assessing the health of a site involved sampling macroinvertebrates, sorting and identifying the samples and then entering the data into the predictive model. The computer matches the new test site against appropriate groups of reference sites so a comparison can be drawn, and then rates the site based on the ratio of observed-expected aquatic macroinvertebrates.

Sites are classified accordingly: Band A - good condition/equivalent to reference conditions; Band B - slightly impaired; Band C - moderately impaired; and Band D - grossly impaired.

The AUSRIVAS program is likely to involve community groups and schools who will also have access to the predictive model.

"A feature of the predictive model is that it's simple to use," Richard said. "The user does not require an understanding of statistical analysis.

"The sampling required for data collection is also fairly straightforward which is why this program intends to involve the community in both sampling and analysing various sites in an effort to raise public awareness of river health."

A further 2000 sites will be sampled during 1997. It is envisaged between 5000 and 6000 sites will be sampled across Australia by 1999 to attain a comprehensive picture of river health.

AUSRIVAS will sample another 2000 sites across Australia this year. Kerry Beggs (left) and Chris Williams from the CRCFE demonstrate sampling techniques for Senator Robert Hill at the AUSRIVAS launch.

Photo: LWRRDC

The CRC is a collaborative venture between:

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

salinity proves threat to wetlands

Increasing salinity may have serious effects on wetland plants and animals, according to the results of a recent CRC project. It may also have human health implications by favouring species, such as flies and mosquitos, which are better adapted to saline conditions.

Drs Paul Bailey and Nigel Warwick from Monash University conducted the project at a lowland river and a wetland, both unaffected by salt, in south-east Victoria. The Land and Water Resources Research and Development Corporation funded the work.

Prompted by the devastation wrought by human-induced salinity on Australia's natural and agricultural lands, the four-year project was aimed at determining what effect increasing salinity levels had on a range of salt intolerant riverine and wetland species, including aquatic plants, macroinvertebrates and amphibians. The work was complemented with glasshouse experiments that looked at the effects of different salinity treatments on the growth and reproduction of aquatic plants.

The river experiment, conducted at Hughes Creek near Seymour, focused on the effect of increasing salinity on invertebrate communities. Using a system of open-ended plastic channels that were placed in the creek, salt concentrations were increased to 1000mg/l or 2000mg/l for six days. Comparisons were made between the effect of high doses of salt on invertebrate communities over a short period to that of moderate concentrations of salt over longer periods.

Minimal effects were observed at 1000mg/l, however salt concentrations at 2000mg/l did affect the abundance of some invertebrates.

Dr Bailey said that short releases of highly concentrated saline wastewater were more detrimental to aquatic invertebrates than long releases of dilute saline water.

"The results indicate that how we release saline water to the environment is crucial if we want to minimise its impacts on aquatic plants and animals," he said.

Another component of the project was conducted on an ephemeral wetland, Raftery's, on the Goulburn River. During the dry phase, from March to August, nine artificial ponds were constructed within the wetland and subjected to three treatments including a control. After the wetland had flooded in September, six ponds were flooded and then dosed with salt to increase the salinity to either 600mg/l or 1800mg/l - similar to the salinity range seen in the local groundwater.

After 10 weeks much of the water had evaporated, increasing the salinity in the experimental ponds more than threefold, Dr Bailey said.

"What we saw was a significant reduction in the diversity of invertebrate species," he said. "This is likely to have a huge impact on the wetland foodweb by reducing the food available to fish and birds as well as decreasing the amount of carbon and nutrients being processed within the system."

"The abundance of salt sensitive species such as dragonflies, water beetles, snails and crustaceans was reduced. At the same time, the abundance of salt tolerant species such as mosquitoes and flies increased substantially, by as much as 400%."

While not affected to the same extent as the invertebrate communities, increased salt levels did inhibit the growth and reproduction of some aquatic plants. This, Dr Bailey said, was likely to reduce the range of food and shelter available to wetland animals, including invertebrates, fish and birds.

"It could also lead to a complete change in the structure of the wetland through salt tolerant plants out-competing sensitive species," he said. "The loss of diversity and abundance in both plants and animals is likely to be long-lasting because many of these species are not good at recolonisation."

Another significant effect of the increased salinity was the change to acidic conditions within the wetland which was likely to compound the environmental damage.

Dr Bailey said that salinity was likely to have a much greater impact on wetlands than river systems, because wetland plants and animals appeared to be more sensitive to salinity than their riverine cousins.

A database of salt intolerant riverine and wetland species is now being developed which will be available to water managers throughout south-east Australia.

Discussion groups and workshops will be conducted with resource managers with the aim of establishing guidelines for the discharge of saline wastewater to riverine and wetland systems.

probing the microscopic world for clues on river health

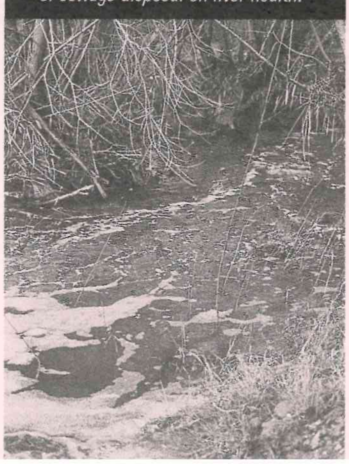
It is only in the last decade that water quality researchers have realised the importance of biological indicators as a measure of the health of waterbodies. Potential indicators include microinvertebrates, macroinvertebrates and microbial populations such as bacteria. By looking at the diversity and numbers of biological indicators it is possible to learn much more about the state of rivers and lakes than chemical testing alone can reveal.

Jennifer Dreissen, a CRCFE postgraduate student, is researching the links between microorganisms and river health. Jennifer's study, *Microbital populations in lowland rivers,* is being carried out on the Loddon River/Campbells Creek system. She is working under guidance of Prof Barry Hart at the Water Studies Centre, Monash University where she completed her Honours in microbiology.

Jennifer will look at the effect sewage disposal has on river health. The Loddon-Campbells site was chosen as it has a single point sewage inlet at Castlemaine which allows sewage-affected sites and those not affected by sewage to be compared within a short distance of each other. As both sites are located in the same creek, the chance of the results being swayed by other variables, such as different catchment chemistry, are reduced.

Sewage disposal into rivers usually results in a higher concentration of nutrients and organic compounds which can lead to a lower concentration of oxygen. Lack of oxygen in the water may lead to the death of animal life including fish and invertebrates. Only the very hardy can survive these conditions which is why there are usually high populations of worms in organically polluted rivers as these are one of the few species which can tolerate low oxygen levels.

This study looks at the effect of sewage disposal on river health.



The microbial population plays a crucial role in river systems through the cycling of carbon, mineral nutrients and trace gases. Many microbial groups are convert organic matter, such as dead leaves, into inorganic carbon and recycle nutrients into a form which larger animals on the food web, such as zooplankton and fish, can consume. Many populations are sensitive to changes in their environment which means that their use as a pollutant indicator can be added to the long list of other jobs they perform.

Jennifer says that scientists have long recognised the need for a warning system to protect aquatic ecology, one which can detect an early change in river health. Microbial communities, she says, have the potential to be very good indicators of sewage pollution and the impact that this pollution is having on a given environment.

"Microbial communities react quickly to ecosystem change because of their short generation times," she says. "Species composition and numbers are modified in response to ecosystem change.

It's therefore possible to evaluate the impact pollution is having on a particular water system by identifying changes in species diversity, population numbers and activities."

Jennifer is using a variety of testing methods at her sites including molecular biological analysis which will give total bacteria and coliform counts and tritiated thymidine and leucine uptake experiments which measure the growth rate and activity of the microbial population.

Jennifer's work is supported by the River Basin Management Society.

- Leonora Nicol

The Loddon-Campbell river system was chosen to allow sewage affected sites to be compared to those not impacted by sewage.

common reed rescues river banks

Solutions to soil erosion need not be costly or time consuming, according to Judy Frankenberg who has spent the last six years studying the practicalities of using the native reed, *Phragmites australis*, to control stream bank erosion in the Murray-Darling Basin with excellent results.

Recommendations for using this common reed for rehabilitation work are contained in Ms Frankenberg's recently released booklet, *Guidelines for Growing Phragmites for Erosion Control.*

Serious erosion has been a feature of the Murray River over the last 30 years. It is a problem that is often observed in Australia's regulated rivers, which includes most of our lowland rivers.

"Bank erosion results in large areas of land collapsing into the river as well as the loss of valuable nutrients from the soil to the river," Ms Frankenberg said. "The rivers themselves become muddy and unattractive and riparian habitat is lost."

River banks denuded of vegetation were particularly susceptible to erosion as plants performed a vital role in holding soil in place and providing something of a barrier to rising waters and run-off from inland areas, she said.

The unnatural flow regime of rivers regulated for irrigation, including low flows in winter and high water levels in summer, made it difficult for bank vegetation to develop and thereby hastened erosion.

Previous studies had confirmed that planting reeds on bare banks provided good protection against erosion.

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The common reed, Phragmites australis, is being used to control stream bank erosion with excellent results.

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the world water crisis


Director, Prof Peter Cullen.

The world faces a looming water crisis. Throughout the world, waterborne disease takes more lives every year than would three 747 jets crashing each day. In 1991 alone, about 14,000 people died as a result of cholera. While the world's population is expected to rise to 8 billion in the next 25 years, many of our water systems are already overdeveloped or contaminated. Taking more water to sustain our increasing population is not an option in many places. How we handle the conflict between those wanting to use water for drinking, those wanting to irrigate food crops and those who want water retained to maintain the integrity of the rivers themselves, promises to be the biggest environmental issue confronting the next century.

This global conflict is reflected in the squabbling over property rights for water in Australia. Water-borne health problems are apparent to the world in our Aboriginal and remote communities.

We have absolutely no grounds for complacency. But we do have opportunities to provide global leadership. We have a strong water research sector, supported and linked to the water industry through CRCs and through university and CSIRO research groups. The Murray-Darling Basin Initiative, where States are prepared to sacrifice self interest to maintain and benefit the whole Basin is an international example in organisational arrangements. If we can implement the cap on extraction and implement the other Council of Australian Governments (COAG) reforms in a manner which is both equitable to all interests and sustainable in the long term, we will be providing unequalled global leadership.

Australia is already at the forefront of developing a new paradigm for water management, but we must go further to explore and demonstrate the superiority of key principles, including:

- Water is scarce and valuable and must be treated as both a social and economic resource.
- Ignorance and greed have clearly been shown to degrade water systems. Any strategy for going forward needs to be knowledge driven. Knowledge needs to be widely available to all interests.
- Managing bits of a system normally fails. Management must be integrated across natural resources (forests and parks, agricultural and urban land) and jurisdictions (States and local governments) as well as integrated across the research-policy- implementation continuum.
- Effective management is based on strong community participation. It is clear that all interests have to be included if planning is to provide an agreed vision and management can be focused to achieve desirable outcomes. We need effective bargaining arenas to allow dialogue to take place. We may need to build the skills of participants to operate effectively in such an environment.
- Ownership and accountability are important but often difficult to achieve in cross-cultural, upstream-downstream situations and across state and national boundaries.
- Evaluation, effective monitoring and assessment is fundamental to knowing if we are going forward. Australia has a number of mechanisms - State of the Environment reports, environmental impact analysis, Land and Water Audits - but none are yet providing the necessary feedback, and all need further development.

Achieving sustainable land and water management and improving the condition of our degraded waterways remains a challenge for the research community, water managers, consumers and our governments. We have made a promising start with the reforms of the last five years. We have many challenges remaining. If we are able to put this jigsaw together we will be the first country to do so and will be able to provide true leadership and perhaps help avert the looming water crisis.

- Peter Cullen

artificial billabongs shed light on natural systems

The billabongs were planted with water milfoil and ribbonweed prior to their initial flooding.

While billabongs were long ago immortalised in Australian folklore, knowledge of their role in maintaining the health of our river systems is only just developing.

A two-year study being conducted on 16 artificial billabongs on the outskirts of Albury is helping scientists understand how flooding influences the productivity of these waterbodies, which may in turn affect the health of our rivers.

The study, funded by the Land and Water Resources Research and Development Corporation, is one of a suite of projects being conducted by the Cooperative Research Centre for Freshwater Ecology (CRCFE) which investigate the interactions occurring between billabongs and rivers during flooding.

Studies have indicated that billabongs harbour perhaps 1000 times more biodiversity than do the rivers which run by them. Flooding not only revitalises drying billabongs, but as the waters recede from these waterholes, they infuse the river with a rich soup of microscopic life.

Of particular interest in the current study is the effect that the timing and duration of floods have on the microscopic life, aquatic insects and plants which inhabit billabongs.

The 16 billabongs constructed at the Michael Ryan Field Laboratory represent four different flooding patterns: a control representing natural water fluctuations, a permanently flooded waterbody, a regime mimicking a winter flood and another mimicking the summer floods now regularly experienced as a result of river regulation. Each flooding pattern was replicated four times to minimise the potential for errors. The billabongs were all planted with water milfoil, *Myriophylum papillosum* and ribbonweed, *Vallisneria sp*, prior to their initial flooding.

The native fish species carp gudgeon, were introduced to a sectioned-off half of each billabong to determine the effects of predation on the aquatic insects.

The billabongs have each been 'treated' with two winter and two summer floods.

Early results indicate that the duration of floods may be more important than timing to the composition of the billabong communities.

Daryl Nielsen, a CRCFE postgraduate student working on the project, said microscopic animals, such as rotifers and microcrustaceans, appeared to be opportunistic in their response to flooding, irrespective of the season.

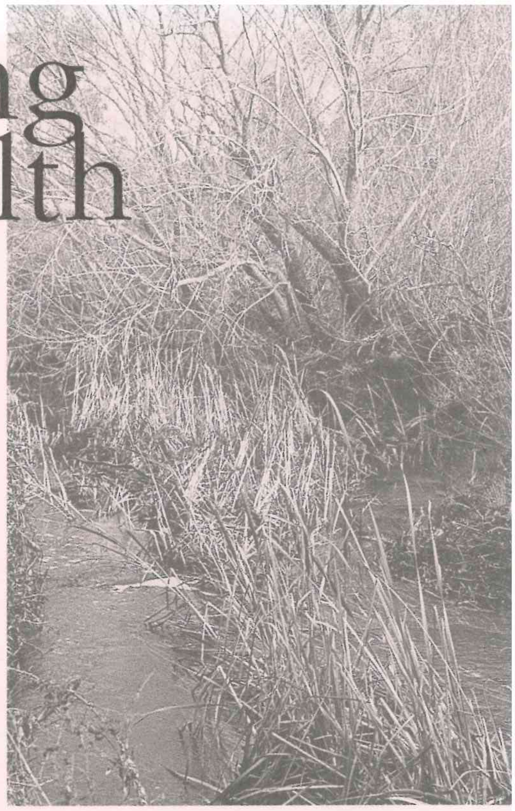
"While there seems to be more diversity in the composition of microscopic fauna during winter-spring floods, flooding at any time of the year stimulates a bloom in the populations of these organisms," Daryl said.

"In natural billabongs this increase in abundance may be likened to a huge banquet being laid out for juvenile fish from the main river channel."

Aquatic plants, on the other hand, appeared to respond to seasonal changes in flooding as well as to differing hydrological regimes. Reducing the variability of hydrological regimes, as occurred during the summer and permanent treatments, resulted in reduced diversity in the plant community with many of the seasonal species such as sedges being lost and very few terrestrial species occurring.

Daryl Nielsen trapping aquatic insects over the artificial billabong.

enhancing river health in urban streams



freshwater scientists are keen to see that urban water managers get more bang for their management buck.

Now in its third and final year, a collaborative study being conducted in Melbourne is shedding light on how management activities such as bank stabilisation might be refined so that the work produces a number of benefits, including enhancing river health.

The study, which is aimed at improving the biological health of smaller urban streams–those streams which have been directly impacted by urbanisation–is a joint project between the CRC for Freshwater Ecology and the CRC for Catchment Hydrology.

Project Leader Dr Peter Breen said the work was also providing a better understanding of how biological organisms, such as macroinvertebrates and algae, might be used to monitor the health of streams.

"We're keen to see that the health of streams is reflected in the dollars being spent on management activities," Dr Breen said. "Restoration work may, for instance, result in a physically stabilised stream, but it might not be creating the type of habitat that would promote a healthy stream ecosystem."

Urban water management has mostly been aimed at minimising floods or increasing drainage capacity, although this simple approach is now changing. Urban stream channels are often highly modified or even concreted. Removing structures such as riparian vegetation and in-channel rocks and snags destroys habitat for macroinvertebrates and other aquatic fauna. Removing these structures, which create the pools and riffles within the stream, also reduces diversity of flow.

"While a lot of work has been done on the factors that influence macroinvertebrate and algal composition in pristine and rural streams, very little research has focused on urban streams which are typically subjected to a high level of human impacts," Dr Breen said.

There are three components to the study which is being conducted at 50 sites in six urban and four non-urban streams in the Melbourne area.

The first component was aimed at obtaining a broad picture of the relationships between macroinvertebrate and algal communities and water quality, and involved surveying the 50 sites over one year. The second part comprised an intensive survey of two streams, the Merri and Dandenong creeks.

Preliminary results indicate that catchment geology is important in determining the type of algae found in the study streams. The catchment geology is thought to determine the chemical composition of stream flow.

"When sampling macroinvertebrates you need to consider a range of parameters which potentially affect their presence or absence, including flow pattern, habitat, oxygen requirements as well as water quality." Dr Breen said. "Because microscopic algae, or diatoms, are not so strongly affected by flow and habitat variables, they may be useful tools for specifically assessing water quality."

The scientists working on the project have identified the types of algal communities that may be found in sedimentary, basalt and highly urbanised catchments. Urbanisation tends to reduce the differences between these natural groupings. Further analysis will be done on algae linked to highly urbanised catchments to determine smaller groups which may be associated with particular types of disturbance.

A third component of the study is investigating the ability of different physical structures, such as rocks, within streams to create habitat and thereby increase biological diversity.

"The diversity of macroinvertebrates is generally quite low in urban streams with midges, worms and other pollution-tolerant species tending to dominate samples collected from urban sites," Dr Breen said. "Recent efforts to improve the water quality of urban streams in Melbourne did not seem to increase macroinvertebrate diversity. We turned to physical habitat features, such as the stream bottom material, to see whether restoring this component of the stream would increase macroinvertebrate diversity."

For this experiment surveys of macroinvertebrates and physico-chemical parameters were conducted before and after artificial riffles were placed in six urban creeks. Two treatments and a control were tested. The first treatment comprised the placement of small-to-medium sized rock in three streams while the second treatment used single-sized large rock in another three streams.

Dr Breen said the samples collected prior to the placement of riffles were dominated by oligochaetes (worms)-as typically found in degraded environments. While analysis of the samples collected after the riffles were placed is not yet completed, an increase in species diversity is anticipated.

crc web site:
http://lake.canberra.edu.au/crcfe

common reed rescues river banks

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'Often fencing a bank allows land owners to do little or no re-planting as natural regeneration is often sufficient to restore a healthy riverbank'

Phragmites was chosen for the erosion trial because it was native and didn't have a negative impact on other plant life. It was also able to survive unnatural flow fluctuations and could grow in water up to two metres deep. Phragmites was particularly useful in stopping bank erosion as it formed an underground network of stems as well as a root system with a mass often greater below than above ground. This underground system provided a kind of anchor in the soil, effectively stopping collapse of soil into the water.

Trial plantings of Phragmites were conducted on the River Murray between Lake Hume and Lake Mulwala over six years. Phragmites were established on bare river banks by a variety of methods including the use of seedlings, cuttings and transplants. While transplanted Phragmites gave the quickest result, they were bulky to transport and the source area often could not provide enough plants without causing environmental damage. Cuttings and seedlings, while taking longer to become established, were used successfully and were easy to transport and to produce in large numbers.

Ms Frankenberg pointed out that while Phragmites had been successful in halting bank erosion, the remedy did not occur overnight.

"It takes the plants a number of years before they are established sufficiently to anchor the soil," she said. "Initial establishment can be difficult on unstable sediments and protection, such as matting or current deflectors, might be needed in the initial stages."

Another method that was successfully trialed entailed planting the Phragmites on fenced, stable river banks and allowing them to develop a dense growth on the upper bank, allowing the reeds to gradually invade the unstable sections.

Grazing was a major threat both to newly planted Phragmites and existing stands, Ms Frankenberg said. She emphasised that fencing was essential to prevent stock from grazing river banks.

"Often fencing a bank allows land owners to do little or no re-planting as natural regeneration is often sufficient to restore a healthy riverbank," she said.

Guidelines For Growing Phragmites for Erosion Control contains easy to follow instructions for planting Phragmites as well as an explanation of the methods best suited to different types of river banks, depending on degree of erosion and flow levels. Anyone interested in obtaining a copy of the guidelines should contact Judy Frankenberg at the Murray-Darling Freshwater Research Centre on (060) 582 300.

- Leonora Nicol

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