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WaterShed

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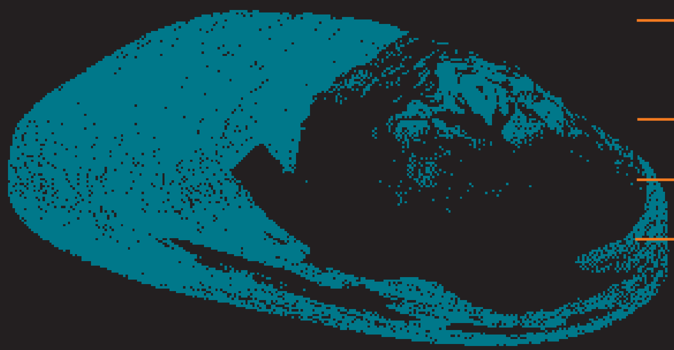

The scientific journey behind the Living Murray process

by Professor Gary Jones

On 14 November the Murray Darling Basin Ministerial Council agreed to a first-step environmental allocation of 500 gigalitres for the River Murray system. The decision has received warm support from most major irrigator and environmental groups. This investment in the future health of the Murray will cost taxpayers up to $500 million over the next five years, on top of $150 million already allocated for structural and operational improvements.

The Ministerial Council's decision has balanced a complex array of environmental, economic and social concerns, at least for now. Of course, as in all things, the proof is in the pudding. No doubt all stakeholders will wait to see how the decision is implemented, and how the $500 million is used by the Commonwealth and States, before reaching a final judgement.

CRCFE staff and their knowledge played a leading role in the provision of scientific advice to guide the Ministerial Council's November decision. At the request of the MDBC we selected senior researchers from the CRCFE and elsewhere across the Murray-Darling Basin to become the Scientific Reference Panel (the SRP). The panel's role was to oversee the scientific assessment process and to write the interim report submitted in October[1]. Our Knowledge Exchange team held the whole process together through many busy and often turbulent months.

More will be said about the science behind the Living Murray in this edition of *Watershed* and in the future. Here though, I want to take the opportunity to comment on the human face of the scientific advisory process. Looking back on the past very hectic couple of years, I think there are several behavioural and cultural

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lessons that have been learned by the people involved. I think these learnings will help us as we move into the implementation phase of the first-step decision, and as we broaden our conversation with community stakeholders around the science supporting the Living Murray.

1. To have science seen as reasonable and acceptable by all, we need to strive for trust as well as credibility. We must not fall into the trap of believing that only the latter is important. Without trust, even sage advice from a Nobel Prize winner may be dismissed by wary stakeholders. Hence, the scientists engaged in the science advisory process need to be scientists that the community trusts. In some cases, this will mean we need to involve river ecologists who are funded through sources other than government taxpayers' funds; that is, privately funded ecological consultants. The benchmarks for participation should be proven scientific skills, relevance of scientific field of work, and track record — not who the scientist is employed by. None of us can claim the moral high-ground on independence or objectivity. The old 'Trust me, I am from the government' approach does not have much credence now, if it ever did!

Professor Gary Jones, Chief Executive of the CRC for Freshwater Ecology. Photo: L Sealie

2. We need to continually improve the ecological decision systems and predictive models we use to support and frame the scientific advice provided to government and the community. Until the Living Murray assessments this year, there had been a reliance on 'expert opinion' and scientific advisory processes that the public could not easily scrutinise. In contrast, the (MFAT) ecological decision support system used by the SRP consists of a structured process for assembling and analysing scientific knowledge in a manner that is transparent, repeatable and fully documented. (Anthony Scott writes more about MFAT in this issue of *Watershed*.)
3. Scientists provide independent and robust scientific advice, but they are now also becoming aware of the relevance of the social and political context in which their advice is being heard. And they are realising that their choice of words is important. For example, they may say a river is 'degraded', when the data show it is significantly different from reference condition. The statement may be scientifically legitimate, but members of the community may attach a different meaning to the term 'degraded'. Such mismatches of values and meanings can fuel disagreements that could hinder cooperation between scientists and communities who both nevertheless want to ensure the River Murray is a healthy working river.
4. Finally, returning to a point raised in my last *Watershed* article, we have learnt that it is very important to separate scientific advice from environmental advocacy. It is all too easy for environmental scientists, even the very best environmental scientists, to embed their views (albeit unintentionally) about desirable ecological outcomes in the advice they are providing to government and the public. In doing so there is a very significant risk of alienating key stakeholder groups. Separating scientific advice from advocacy is critical, and this was an over-riding principle in all the advice provided by the SRP.

Much has been said and written about the science behind the Living Murray process, some of it well informed, some of it proffered out of misunderstanding or for political or personal reasons. Many consider the report an outstanding achievement by the more than 60 scientists involved. Indeed, the independent international reviewers of the SRP Interim report concluded that the report 'represents a major first achievement in the integration of science within large-scale water resource management in Australia' and displayed a 'high degree of scientific honesty and integrity'.

I hope that by adopting the learnings and principles outlined above we can move forward with the next stage of the Living Murray process in a manner which is more cooperative and less confrontational. Some may consider that aspiration naïve. For me it is a challenge that the CRCFE will emphatically embrace.

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References

1 CRC for Freshwater Ecology 2003. Ecological Assessment of Environmental Flow Reference Points for the River Murray System: Interim Report. http://www.thelivingmurray.mdbc.gov.au/content/index.phtml/itemId/15978/fromItemId/

Further Reading

Young, W.J. 2001. *Rivers as Ecological Systems: The Murray-Darling Basin.* Murray-Darling Basin Commission, Canberra.

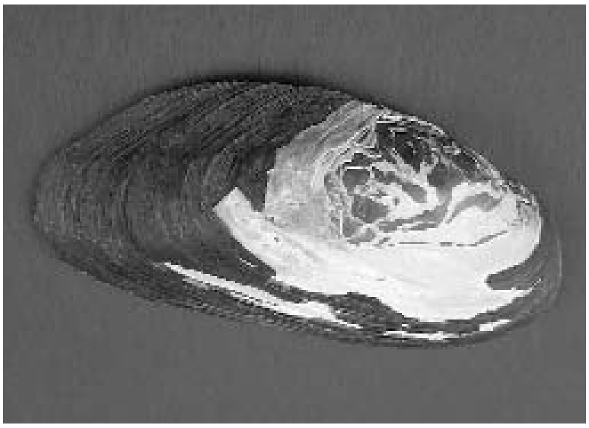
The creature feature for this issue is the river mussel, *Alathyria jacksoni*.

Family: Hydriidae
Genus: *Alathyria*
Species: *Alathyria jacksoni*

The river mussel (*Alathyria jacksoni*) is one of two species of mussel found in the Murray-Darling Basin. The other is the billabong mussel (*Velesunio ambiguus*).

River mussels burrow in the sediments along the river's edge (they can be found in sediments under water as deep as 5 metres). They have a blade-like shell and a strong muscular foot that they use like an anchor. Mussels sit in the river-bed sediment with only the rear end of the shell sticking out. The siphon protrudes to draw in water containing plankton and other morsels of food.

River mussels live for about 30 years and may reach up to 15 cm long. They need, and are well adapted to, strong and persistent currents, and are usually found only along relatively large streams and rivers. One form of river mussel is adapted for strong currents, having a shell with a pronounced arch-shaped back which enables it to dig its foot deeper into sediment and hold on strongly. The other form of river mussel has an oval shell with a straight blade on the back. It is better suited to moderate river currents.



Alathyria jacksoni, *the river mussel.*
Photo: J Hawking

Each spring or summer, female mussels produce thousands of tiny larvae (called glochidia). The glochidia attach themselves to certain types of fish (this does no harm to the fish) and metamorphose over about three weeks. When ready, the new tiny mussel drops off the fish and buries itself in the river bed, where it stays until it reaches maturity at 3 or 4 years of age.

MFAT: transparent in process, if not in name

By Anthony Scott, Ann Milligan and Bronwyn Rennie

MFAT ('em-fat'), the Murray Flow Assessment Tool, was an essential part of the deliberations of the Scientific Reference Panel that recently presented its interim report on the Living Murray to the Murray-Darling Basin Ministerial Council.

But what is MFAT, and how did the panel use it to reach their conclusions?

When managers need to predict how the environment will react to management actions, they base their assessment on a combination of accumulated knowledge, expertise, scientific data and ecological models. This information can be organised into a framework called a decision support system. MFAT is such a decision support system.

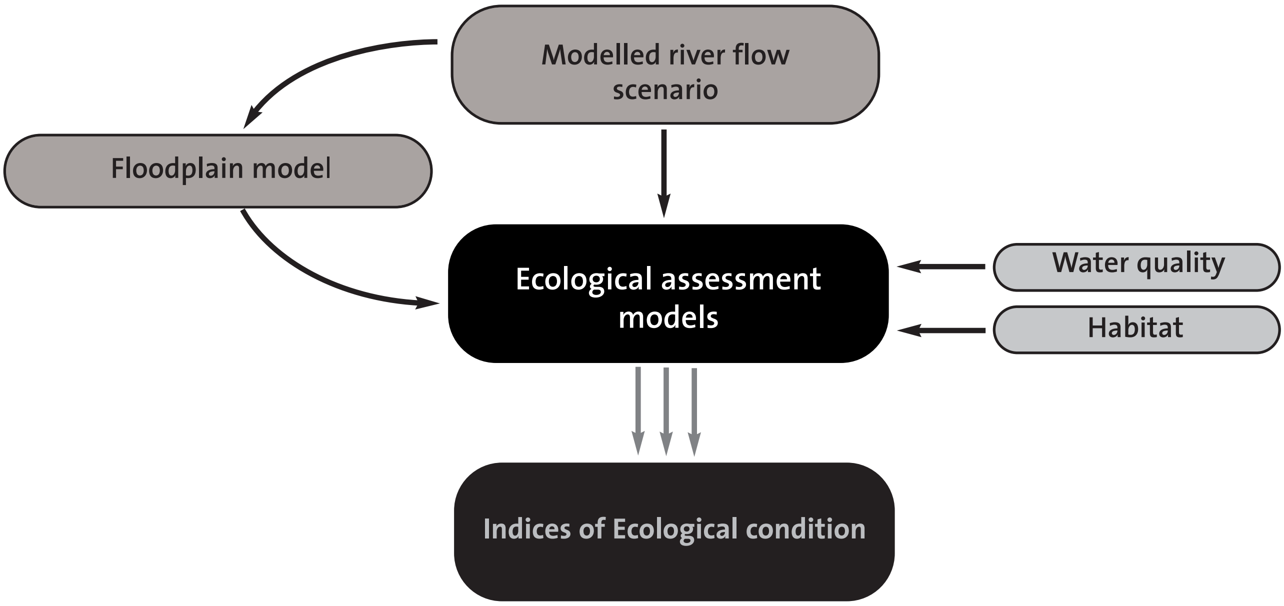
A decision support system allows the user to ask numerous 'what if?'-type questions and answer them from a structured assemblage of knowledge on the subject. Decision support systems like MFAT contain models that allow you to test theoretical management scenarios and see what is likely to happen over time. Nothing else available at present can integrate scientific knowledge in such a rigorous way for large river systems.

Living Murray

In October 2002, the Murray-Darling Basin Commission (MDBC) contracted an independent Scientific Reference Panel (SRP), chaired by Professor Gary Jones of the CRC for Freshwater Ecology (CRCFE), to advise the Ministerial Council on the potential ecological effects of three theoretical allocations of extra water for the River Murray — 350, 750 and 1500 gigalitres per year.

Of several tools available in Australia and overseas for assessing the ecological effects of flow, the SRP chose the Environmental Flows Decision Support System (EFDSS), developed by CSIRO for the MDBC in the late 1990s, as the best option.

Under the guidance of the SRP, CSIRO adapted the EFDSS to match the River Murray system, and also ensured that the most up to date ecological knowledge was being used. The new tool was named the Murray Flow Assessment Tool (or MFAT).



How MFAT works. Diagram: G Jones

The SRP invited scientific experts, with good knowledge about local and regional ecology, to form regional evaluation groups (REGs). Each group was to assess the effects of flow scenarios for one of 10 zones along the Murray. Each REG was supplied with the same MFAT software, to ensure that overall assessments would be consistent, repeatable and transparent along the whole river system.

How MFAT works

Put simply, for a given management scenario, MFAT uses daily flows for the river channel to estimate the inundation patterns of surrounding floodplains and wetlands.

The combined information for the river channel and floodplain is then applied to a set of five ecological models which estimate the response of selected groups of freshwater plants and animals that inhabit the River Murray system.

Finally, MFAT makes statistical analyses of the results, integrates them and produces a suite of 'Dow-Jones'-like ecological indexes. The indexes represent effects on localities, zones, and the entire river system.

In more technical detail

The MFAT *floodplain configuration model* represents the floodplain system as a network of waterbodies and 'pipes' (in a mathematical sense). For a given flow scenario in the river channel, it calculates when, where and for how long water will be on the floodplain and in the wetlands at any given level of flow.

The MFAT decision support system answers numerous 'what if?'- type questions. Photo: B Rennie

The effects of various flow scenarios on ecological response are then simulated in five MFAT *ecological models*, representing freshwater plant and animal groups for which we have good scientific knowledge. Four of these models describe the relationship between river or floodplain hydrology and 'habitat condition' for communities of native fish, waterbirds, wetland vegetation, and floodplain vegetation.

Model 1

The floodplain vegetation model mimics the conditions available for germinating seeds, establishing seedlings and full-grown adults. It considers river red gum forest, river red gum woodland, black box woodland, lignum shrubland, and rats tail couch grassland.

Model 2

The wetland vegetation model deals with habitats at the wetland edge and in open water. There are models

The Hume Reservoir and Weir, near Albury-Wodonga. Photo: A Tatnell

Waterplants at the water's edge provide valuable habitat.
Photo: A Tatnell

for the effects of daily flows on four emergent species — cumbungi, giant rush, common reed, and spiny mudgrass (or Moira grass) — and one submerged species — ribbonweed.

Model 3

The waterbird model assesses the flooding and drying patterns on floodplains, riverine lakes, billabongs and lagoons that provide habitat for waterbird foraging and breeding. MFAT considers two groups of birds, 'colonial nesting waterbirds', such as ibis, egret, heron and spoonbill, and 'waterfowl and grebes' including flood-dependent species such as grey teal, pink-eared duck, freckled duck, Australasian shoveller, great-crested grebe, hoary-headed grebe.

Model 4

For fish, MFAT assesses the effects of given flow scenarios on groups of species that live in similar types of habitat. Fish found in more than one type of habitat appear in more than one group. Assessments are made for adult fish (spawning and non-spawning) and larval juveniles. Seven fish groups are assessed:

- Flood spawners: golden perch, silver perch (which spawn and recruit following flow rises; major spawning occurs during periods of floodplain inundation);
- Macquarie perch (which require clean gravel substrate; floodplain inundation is not required, but spawning is probably enhanced by rising flows);
- Wetland specialists: Australian smelt, bony herring, carp gudgeons, southern pygmy perch, hardyheads, Galaxias rostratus (which spawn and recruit in floodplain wetlands and lakes, anabranches and billabongs during in-channel flows);
- Freshwater catfish (which spawn in coarse sediment beds, usually sand or gravel, during any flow conditions);
- Main channel generalists: Australian smelt, bony herring, flathead gudgeons (which spawn and recruit in high or low flow in the main channel);
- Main channel specialists: Murray cod, trout cod, river blackfish, two-spined blackfish (which spawn and recruit during high or low flow in the main channel; woody debris is an important part of their habitat); and
- Low-flow specialists: crimson-spotted rainbow fish, carp gudgeons (which only spawn and recruit during low flow, in channel or floodplain habitats).

Model 5

MFAT also has an ecological model that predicts algal growth for blue-green algae in weir pools. The model uses river flow, water turbidity and climate data, to estimate the likelihood of stratification in the water. While the water column is stratified, the algal population in the model grows (up to a maximum), and when it is unstratified, the modelled population decays (down to a minimum).

The River Murray. Photo: A Tatnell

MFAT in overview

MFAT is designed to help the user assess the ecological benefits of increased environmental flows. It is based on relationships between flow and ecology, identified through years of scientific study and observation. Assessment of the River Murray using MFAT is consistent, repeatable and transparent for all localities and regions along the river — an advance on the expert panel approach that has been used in recent years. MFAT contains up-to-date ecological knowledge, published and unpublished, about the River Murray environment, and it documents the sources of this information.

The evidence that supports the ecological knowledge contained in the MFAT comes from a range of sources. The MFAT includes a simple structure where the user can record the quality and source of the ecological knowledge that has been used at each stage. The evidence recorded allows the sources of data to be critically reviewed.

MFAT is best applied at the scale of river zone (10s to 100s of kilometres) or whole-of-river. It considers flow-related water quality and habitat effects such as temperature and turbidity, loss of snags, and bank erosion and sedimentation. It tells us the change in habitat condition that will probably occur when there is a particular flow volume and pattern in the river and on its floodplains. Used prudently, it can suggest the size of ecological response at specific sites.

MFAT is being further developed to enhance its performance and capture new ecological knowledge of the species being assessed, to support the implementation of the Living Murray first-step decision.

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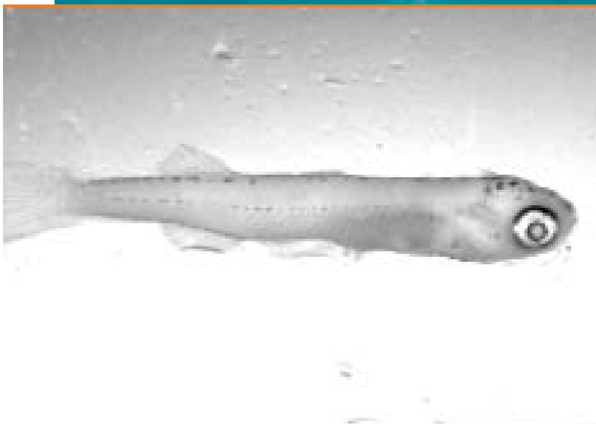
A weirpool and neighbouring wetlands on the R. Murray. Photo: A Tatnell

Sustainable environment = sustainable economy



Larva of Murray Hardyhead, approximately 1 cm long.
Photo: A Conallin

The staff of the Lower Basin Laboratory of the CRCFE and MDFRC* at Mildura held a Freshwater Forum called 'Sustainable environment = sustainable economy', in May this year. The forum brought together staff of government agencies and private industry, and members of the community, to learn about research being undertaken at the laboratory. It was also a chance for the gathering to discuss the broad environmental issues that matter to people in the Mildura region.

The laboratory is researching a range of issues. At the forum, staff presented overviews of three major projects examining:

- fish recruitment and environmental flows,
- the differences in ecology between weir pools and free-flowing reaches of the River Murray, and
- costs, causes and cures for blue-green algae.

Shaun Meredith outlined the studies of larval fish at Lindsay Island in relation to flows. The researchers are finding larval fish in three 'flow habitats': fast-flowing creeks, weir pools, and shallow ponded creeks. Some larvae, such as those of flathead gudgeon, Australian smelt and crimson-spotted rainbowfish, occur in all three flow habitats. Murray cod larvae are being found in fast-flowing creeks and slow-flowing weir pools, and, by contrast, carp and hardyhead larvae are being found only in weir pools or shallow ponded situations. The presence of larvae shows that spawning occurs from late winter through to late autumn, with carp and smelt larvae found in August–October, flathead gudgeon, rainbowfish and Murray cod found in November–January, and hardyhead among the larvae found during February–April.

Pelicans at the Mildura weir pool during a drawdown.
Photo: B McCarthy

The research is suggesting that management of flow pulses and floodplain inundation in appropriate habitats at suitable times of year should be able to improve the spawning and recruitment success of local native fish.

Bernard McCarthy spoke about weir pools — a dominant feature in the reaches of the Murray downstream of Mildura. The weir pools of lock and weir numbers 10, 11 and 15 are each about 60 km long, but there are free-flowing sections of river upstream of the lock 11 and 15 pools. By comparing weir pools to free-flowing sections, researchers at Mildura are investigating the impacts of weir pools on riverine ecology. Findings so far include these:

- Weir pools effectively trap large loads of sediment, both organic and inorganic, as suspended particles settle from the water-column in the low flow-velocity conditions.

- River-bed sediments in weir pools contain many more fine particles and more organic carbon than the sediments in free-flowing sections.
- In the weir pools, biofilm is dominated by algae; but that is not the case in the free-flowing sections.
- The communities of snag-dwelling macro-invertebrates that rely on the biofilm are denser and more diverse in the weir pools than in the free-flowing sections.

Another clear difference occurs in the riverside vegetation. In weir pools you can find species typical of wetlands, but those species do not survive in the fast-flowing sections of river.

The research is helping river managers plan their weir manipulations, by providing information about the probable effects of changes in weir management.

Oliver Scholz described the Lower Basin Lab's work with blue-green algae. Lab staff have been monitoring blue-green algal populations in the Mildura, Wentworth and Euston weir pools since 1997, and are developing a good understanding of the environmental conditions that lead to blooms. Now they are investigating various ways of mitigating blooms in the Mildura weir pool. At present, the research team is comparing flow manipulation, mechanical destratification, management of nutrient levels in the water, and management of organisms that graze on the algae.

Numerous other research projects are also in progress at the laboratory, many in collaboration with government agency and community groups.

The forum was an opportunity for general discussion about environmental issues. The audience consisted of people engaged in private industry (including local growers), natural resource management, water management via water authorities and irrigation trusts, scientific research, university and TAFE education, and local government via councils.

This diverse audience nevertheless gave remarkably similar priorities to current environmental issues. Collated results of a quick survey indicated that environmental flows were considered to be of greatest importance, followed by water quality and biodiversity. Blue-green algae were considered next most important, followed by impacts of introduced species. Other issues of interest were water supply, water conservation, floodplain interactions, nutrient inputs and carbon processes, and bank erosion.

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*MDFRC = Murray-Darling Freshwater Research Centre

Sampling fish with the electrofishing boat.
Photo: S Meredith

SideStream

MDBMC historic decision to allocate water to help the Murray

For the past two years the CRCFE has been working with the Murray-Darling Basin Commission (MDBC) and CSIRO Land and Water to assess the potential ecological benefits that could be achieved from a given range of environmental flow scenarios in the River Murray System. The hard work of our team became evident on 14 November when the Murray-Darling Basin Ministerial Council took a historic first-step decision to address the declining health of the River Murray system. The Council recognised that the health of the River Murray is important for maintaining biodiversity and the health and economic success of the human communities it supports. This first step marks the beginning of the Council's collective actions to return the River Murray to the status of a healthy working river. Six significant ecological assets have been selected as targets for rehabilitation efforts: Barmah-Millewa Forest; Gunbower and Koondrook-Perricoota Forests; Hattah Lakes; Chowilla Floodplain (including Lindsay-Wallpolla); the Murray Mouth, Coorong and Lower Lakes; and the River Murray channel.

New premises for Lower Basin Laboratory at Mildura

On 21 November, the new permanent home of the CRCFE's and MDFRC's Lower Basin Lab was officially opened at the La Trobe University campus at Mildura. The new purpose-built premises in the Brian Grogan Building are also close to the Sunraysia Institute of TAFE. Facilities at the laboratory include a microscope laboratory, controlled temperature room, wet lab and offices. The new building is named after Councillor Brian Grogan, in recognition of his contribution to both higher education and the water industry. It is largely due to Mr Grogan's work that the MDFRC and CRCFE have the Lower Basin Laboratory in Mildura today.

Awards

Michael Hammer, a PhD student with the CRCFE and University of Adelaide, has received the River Murray Catchment Water Management Board's Open Literary Award. The award is in recognition of the 'Recovery outline for the Southern Pygmy Perch in the Mount Lofty Ranges'; see www.nativefishsa.asn.au (research link).

Dr Anthony Scott and Ms Bronwyn Rennie of the CRCFE, and Ms Sarah Cartwright of the Murray-Darling Basin Commission, have together won the annual Chairman's Award of the CRCFE. The award recognises the team's work in coordinating the activities of the Living Murray Scientific Reference Panel and the Regional Evaluation Groups, their workshops, and assessments. They were also pivotal in the writing of the Panel's interim report on the Living Murray for the Murray-Darling Basin Ministerial Council this year.

Dr Anthony Scott and Ms Bronwyn Rennie of the CRCFE, and Ms Sarah Cartwright with Prof Gary Jones. Photo: S Nichols

At Albury, Dr Daryl Nielsen and Dr Gavin Rees have won Chief's Awards from the Chief of CSIRO Land and Water 'for consistent effort in lifting the profile of salinity research within Australia'.

Dr Ben Gawne, Director of the MDFRC, has been awarded the ASL Early Career Excellence Award at the Joint 42nd Australian Society for Limnology Congress and 36th Congress of the New Zealand Limnological Society held at Warrnambool, Victoria, 1–5 December.

The team that worked on Sustainable Diversion Limits project for the DSE in Victoria was awarded a High Commendation in the Institution of Engineers Excellence Awards ceremony in September. The CRCFE scientists in the team, which also included members of SKM consultants, were Prof. Sam Lake, Associate Profs Gerry Quinn and Martin Thoms, and Prof. Barry Hart.

New Partner for the CRCFE

The CRCFE is gaining a new partner. The South Australian Department of Water, Land and Biodiversity Conservation is joining us in the new year.

New Director of Research

The Board of CRCFE has approved the appointment of Prof. Stuart Bunn as the CRCFE's new Director of Research. Stuart will be providing leadership in the development and implementation of the CRCFE's new research portfolio.

New staff at Goondiwindi

During this year, the CRCFE Northern Laboratory at Goondiwindi has been joined by several new staff. We have already mentioned Ms Janey Adams (see last *WaterShed*). Other new members of staff are Dr Cassie James (Research Scientist), Ms Angelene Wright and Ms Melissa White (Research Assistants), and Drs Tariq and Minal Khan who are employed through Queensland Natural Resources and Mines' Biologist in the Bush program. Tariq and Minal will spend half of their time working on CRCFE research including the Narran Lakes and Dryland River Refugia projects.

New species of freshwater fish in Flinders Ranges

Scientists believe they may have discovered a new species of native fish in the Flinders Ranges, South Australia. Researchers found the freshwater species, which is just a few centimetres long, when exploring creeks just north of the Gammon Ranges National Park. Michael Hammer (CRCFE and University of Adelaide) says the find is part of ongoing work into the diversity of freshwater fish in South Australia and he is confident it is a new discovery.

New funding for post-doctoral fellowships

At its 30 September meeting in Adelaide, the CRCFE Board approved new strategic investment in key CRCFE research areas, including three new post-doctoral fellowships in ecological prediction & decisions systems, and landscape ecology & management. Other new projects or activities include a new community science project for the Northern Laboratory at Goondiwindi, a possible joint project with the northern MDB cotton industry on large scale river restoration, and scoping studies on the effects of the fire–flood–drought cycle and aquatic–terrestrial linkages.

Time to register for the next AUSRIVAS Online course

The next AUSRIVAS Online course begins in February 2004. The course teaches the methods of AUSRIVAS for rapid biological assessment of the condition of Australian rivers and streams. Any or all of the four online modules can be studied entirely over the Internet by distance. A fifth module, a 4-day workshop, is held in Canberra. For details and registration, see http://ausrivas.canberra.edu.au/Bioassessment/Macro invertebrates/Training/. The course costs $360 (+ GST) per module.

Successful Symposium on Urbanization and Stream Ecology

The three-day Symposium on Urbanization and Stream Ecology run by CRCFE, CRC for Catchment Hydrology, Melbourne Water and Water Year 2003, ran successfully in Melbourne on 8–10 December. Invited speakers from the USA — Prof. Judith Meyer (University of Georgia), Dr Cathy Tate (USGS), Dr Peter Groffman (Institute of Ecosystem Studies), Prof. Nancy Grimm (Arizona State University) and Assoc. Prof. Derek Booth (University of Washington, Seattle) — together with contributions from Japan, New Zealand, USA, France, Russia, UK, Brazil, Bangladesh, Zambia, Nepal, Germany and Nigeria, ensured that the urban ecology perspective was not just Australian. CRCFE staff and students presented eight papers, Prof. Gary Jones gave the opening address, and Dr Chris Walsh was keynote speaker.

ASL Congress at Warrnambool

CRCFE staff presented 28 papers and posters at the Joint 42nd Australian Society for Limnology Congress and 36th Congress of the NZ Limnological Society on 1–5 December.

Electronic *WaterShed*

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CRCFE web site:
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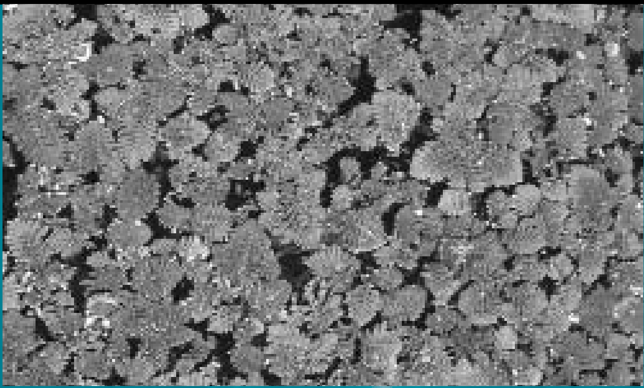

Feature plant

Azolla is the feature plant for this issue.

Family: Azollaceae
Genus: *Azolla*
Species: *Azolla filiculoides* or *Azolla pinnata*

Pacific azolla (*A. filiculoides*) or ferny azolla (*A. pinnata*) are perennial free-floating aquatic ferns with tiny fronds only 1–2 mm long. The whole plant is usually no bigger than 1–2.5 or 3 cm across. Azolla is found in stationary and slow-moving waterbodies and tends to occur in masses, sometimes covering the entire water surface. In full sun, and as they age, azolla plants turn a reddish colour. Being a fern, azolla has no flowers. At least one species of azolla occurs in each state or territory of Australia.

Areas mentioned in this issue.

Comments and ideas are welcome and can be sent to:

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