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Towards a national river classification scheme based on human values

by Gary Jones

There have been several attempts in recent years to establish a national system of river classification. Various methods have been proposed based on one or more of the hydrologic, geomorphic, chemical and biological features of river systems.

All such systems are 'envirocentric' in their approach. That is, the environmental attributes of the river systems are the starting and finishing point for the classification. This is probably reasonable if the classification is intended for purposes of river health assessment. But I suspect it does not well serve the broader and more diverse needs of those managing rivers from a government or community perspective.

I suggest that a human-centred (anthropocentric) approach is more likely to lead to wide acceptance of river management objectives and actions. A human-centred system would be based on the recognition, unashamedly pragmatic, that it is humans who make decisions about the conservation and management requirements of rivers. Hence, human needs and uses arguably should become the starting point for classification and management.

A human-centred approach to river classification may be the only practical way of reaching agreement on what are highly complex and vexed public policy decisions. We typically set social, economic and environmental goals for our rivers which are commendable in their aspirations, but which are, for many high-use rivers, unrealistic and unachievable. Such goals appear to be a recipe for irresolvable trade-offs and on-going disagreement.

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The Cooperative Research Centre for Freshwater Ecology develops ecological understanding to improve and protect Australia's inland waters.

The National Water Quality Management Strategy (NWQMS) guidelines for water quality use this kind of human-use approach. For water quality protection, they outline six 'designated use' categories: aquatic ecosystems, primary industries (including irrigation), recreation and aesthetics, drinking water, industrial water, and cultural and spiritual values. These then guide the development of water quality management appropriate for each designated use.

What might a national system of river classification look like if based on a balanced human- and environmental-needs framework? It might include the following categories:

- major classes that designate the Primary Use(s) of a river, and
- categories within classes, reflecting increasing ecological condition (or healthiness) for each Primary Use class.

While nearly all rivers are used in multiple ways, the proposal here is that just one use should be deemed to be predominant. For large rivers it could be possible to vary the Primary Use class along the length of the river. For example, a coastal river might primarily support irrigation in its upper and middle reaches, but receive drainage from a large coastal city in its lower reaches.

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

Managing such class transitions could be complex and probably should be considered very carefully before a multiple classification system could be adopted. In any case, there should always be only one Primary Use class at any point on a river.

Categories of ecological condition within each Primary Use would be specified by a set of ecological criteria. The criteria would recognise the structural and functional complexity of river systems (such as flow regime, habitat, water quality, and biodiversity or conservation attributes). They would be similar to the criteria set up for existing monitoring and assessment programs and they would have realistically achievable targets.

Realistic targets for the ecological condition categories would encourage river managers and community management groups to manage their section of river or catchment so it could move into a higher-ranked category. To help managers achieve their aspirations, national 'best ecological practice' guidelines would describe how to maintain or improve ecological assets within and between designated use classes and condition categories, and across different geo-climatic zones.

This potential classification system would allow river and catchment management to explicitly recognise and balance the needs of both humans and the environment, for a single river or stretch of river.

In some rivers the balance might be strongly towards environmental conservation. In others there could be agreement to allow some environmental attributes to be degraded or impaired in return for economic production and human well-being.

Nevertheless, sustainable management and water allocation policies are still required. This idea does *not* license the degradation or poor management of rivers, as some readers may fear. Rather, it suggests a management basis from which to attain the 'healthy working river' concept, written about in *Watershed* previously (May 2003).

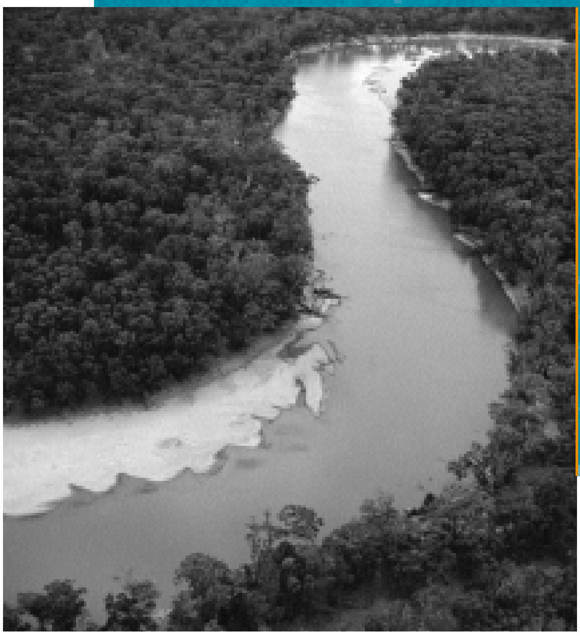
Human needs and uses arguably should become the starting point for classification and management

With some consolidation and re-focussing of the approach outlined in the NWQMS, the following Primary Use classes for rivers could be envisaged:

Primary Use	Designation	Description
National Heritage	H Class	Undammed rivers of high conservation value
Urban & Industrial	U Class	Rivers flowing through large cities or industrial areas that receive urban and industrial drainage
Drinking Water	D Class	Rivers (mostly upland with large dams) serving predominately drinking water supply purposes
Irrigation	I Class	Rivers supporting irrigation schemes, with or without large dams.

The ecological condition categories, and supporting criteria, would necessarily be tailored for each Primary Use class. However, generalised categories across all classes could be envisaged, with the concepts of 'best attainable' and 'moderate/poor' condition being developed through national agreement. For example the categories could be: 1) Best attainable condition in all river sections; 2) Best attainable condition in the majority of sections, with other sections moderate or better; 3) At least moderate condition in all sections; 4) Some sections poor; and 5) All sections poor.

Funding for river restoration activities might depend on maintaining or improving ecological condition via state or federal programs (such as the National Action Plan, or the Natural Heritage Trust). To maintain its category status a river would have to consistently meet all the ecological condition criteria (say, on a five-year running average basis). Minimum ecological condition categories could be written into legislation if required.



Large rivers might have several Primary Uses under a river classification scheme. Photo: A Tatnell

The U, D and I classes do not condone on-going environmental degradation and unsustainable water allocation policies. Instead, they recognise that, for those uses, there will be limitations to the 'best attainable' ecological condition. One cannot reasonably expect a river with large dams and major irrigation schemes to have the same ecological condition as a near-pristine heritage river. But best management practices can be applied equally to both.

This framework proposal is intended to stimulate discussion around a national river classification scheme, but it should not be seen as a final proposal. The underlying philosophy should be apparent. All stakeholders (not just scientists) should first agree on what type and level of human use is appropriate for a river. Then scientists and river managers could work with the community to achieve the best possible ecological outcomes. I believe that only through such a human-centred approach can we break the triple-bottom-line 'log jam' that appears to have tied up many rivers across the country.

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Online training for measuring river health with AUSRIVAS

Many readers will know of AUSRIVAS, the Australian River Assessment System, and its computer models developed by the CRC for Freshwater Ecology at the University of Canberra. AUSRIVAS is a set of methods and models for measuring the condition of rivers, using macroinvertebrates (such as freshwater insects and crustaceans) as indicators.

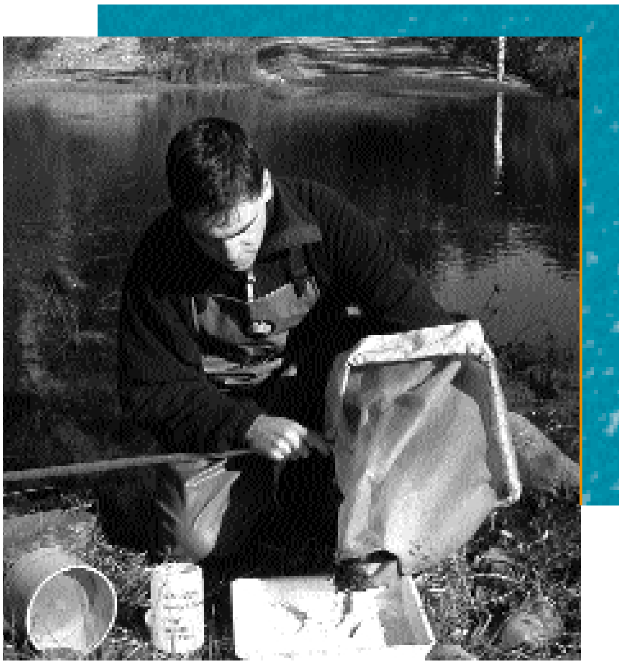
A new online course in AUSRIVAS has recently been released at the University of Canberra for Semester II, 2003. The modular course, developed with funding from Environment Australia, teaches the skills and knowledge needed to make a biological assessment of river health (to an acceptable standard) using AUSRIVAS methods. The course offers training that can lead to accreditation, although it is not an 'award' course (that is, it does not contribute to a university degree).

The theory of assessing river health with AUSRIVAS can be learnt entirely online. However, the student must attend a workshop in the final week of the course, to gain the practical skills required.

Isn't the student a bit isolated?

So that the online students are not isolated from the teaching staff and other students, the online course includes an email group consisting of staff and students and a discussion area (bulletin board). Staff and students keep in contact chiefly using interactive web pages, email, discussion groups, and interactive online tutorials.

To guide the new online student through the materials, the modules begin with a course outline and a learning plan. Several sections are presented in HTML, with hotlinks to relevant web sites and other learning components. Prescribed readings are available online through the university library's electronic-reserve. Discussion topics are linked to the readings and to tutorials run through the bulletin board in conjunction with a tutor. Step-through exercises are included, as well as examples of assessments. The assessment criteria explicitly reward critical thinking, integration and wider reading. Students can also track their own progress.



Field techniques are learnt in a 3 to 4 day workshop.
Photo: S Nichols

What do you learn?

The first module teaches you how to design an assessment study and what to look for when selecting the assessment sites. Next comes instruction so you can identify the habitats — living spaces — in which to look for macroinvertebrates. The third module describes how to sample biota to comply with the AUSRIVAS models, and how to process the samples. Lastly the student learns about data analysis and interpretation, using the AUSRIVAS models.

Laboratory and field techniques are taught during a three-to-four-day workshop, which the student attends at the University of Canberra.

Online delivery makes the course widely accessible.
Photo: B Rennie

First pass

Twenty-two students have begun work on the first online course, being run from 21 July to 18 September. Most of these students are personnel from water industry bodies, such as Environment ACT, Environment Australia, Natural Resources and Mines (Queensland), Primary Industries, Water and Environment (Tasmania), the Environment Protection Authorities of Victoria and South Australia, and the West Australian Water and Rivers Commission. The students are being assessed and are aiming to reach a standard acceptable for accreditation in their state or territory. They are also evaluating the course materials.

The next course will be run in October, if there is demand for it. At present, the cost is $300 per module plus $300 for the workshop (some students will not want all modules).

For further information, including how to register, look at What's New > Latest Reports and Activities, at http://freshwater.canberra.edu.au, or contact Associate Professor Richard Norris.

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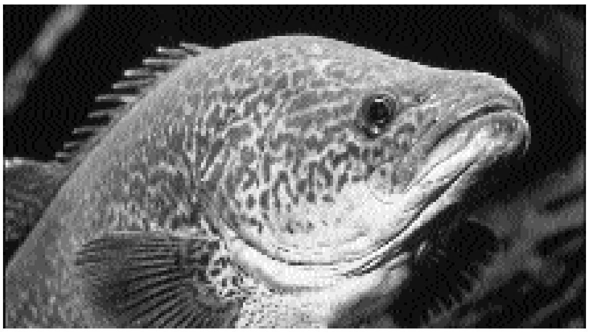
The creature feature for this issue is the Murray cod *Maccullochella peelii peelii* (Mitchell)

Family: Percichthyidae

The Murray cod is Australia's largest freshwater fish, occasionally reaching 1.8 m in length and weighing over 100 kg. Although much prized and still caught by anglers, it has suffered substantial declines in both range and abundance over the past 50 years and has recently been listed as a vulnerable species. The Murray cod is found only in freshwaters, mostly in relatively large, slow, turbid lowland rivers. Snags, overhanging riverbank vegetation, rocks and deep pools are important elements of cod habitat. The Murray cod starts its long lifespan by eating tiny freshwater plankton and insect larvae, but eventually consumes much larger prey, such as other fish (including carp), crustaceans, water birds, turtles, frogs, snails and some snakes and mice. It spawns in spring and early summer, laying anything from 10,000 to 200,000 eggs, generally on logs or hard surfaces.



Murray cod, Maccullochella peelii peelii, *Australia's largest freshwater fish. Photo: G Schmida*

Tapping into local knowledge

By Anthony Scott

People who live on the land have a huge body of knowledge about their area, and their observations may reveal much about the natural world and how it changes. Some scientists are now beginning to recognise that members of rural communities potentially can tell us a great deal about their local waterbodies and environment.

Many scientific studies cover a period of three to five years, and often miss the longer-term cycles of drought and flood, and cause and effect. Short-term studies may also not pick up the very slow degradation or improvements that can occur at time-scales of decades or centuries. Most scientific studies in Australia have taken place in the last twenty to thirty years. Although some studies have looked at the fossil record extending back thousands of years, only a few of them have collected the old paper and oral records available about the condition of our rivers and lakes 50 to 100 years ago. Also, the scientists generally do not live in the natural area they are studying, and they may not be able to see their results in their local context.

Historical and recent local information about the environment, whether oral or written, can provide useful evidence about long-term changes. For some regions, the memories of local residents who have lived in the area for, say, 70 years, or up to 100 years in some cases, can provide an excellent perspective on how things were, compared to how they are now. These people may also have photos or other documents that can be a valuable source of information. Other historical sources include reports of early surveyors, pioneers' diaries, reports written by natural history enthusiasts of the 19th century, and old newspapers, government records, maps, aerial photos and historical records of rainfall and river height.

Over the years, rural residents have seen the drastic effects on the environment caused by the cycle of drought and flood. Not only that, they may have first-hand experience of how large the floods can be and how severely a drought can affect wildlife and vegetation. They may have felt the unpleasant consequences of poor water quality, or recall changes in their river's channel at some time. During hunting or fishing trips, some will have noted bird breeding events and fluctuating fish populations, giving them valuable insights into population dynamics. Others may have observed slow changes in the species of water plants or riverside vegetation. Long-time landholders will probably have excellent records of farming practices and their consequences.

Much of this knowledge remains unrecognised by scientists unless we ask local people to teach us what they know, and to share with us their families' records, diaries and photos. In some cases, local knowledge in this form could reach back to the first settlers.

Recognising this potentially valuable source of information, the Narran Lakes project staff from the CRC for Freshwater Ecology (CRCFE) are hoping to work with the local community of the Lower Balonne Floodplain. The region was first settled in the 1860s, and has been the subject of a number of studies in the last 15–20 years. Now, in 2003, the CRCFE is running a major new study of the area, to learn about the structure and function of the lakes and the rivers, and the factors that influence their value to wildlife. If landholders and frequent visitors to the area are willing to contribute, the project may be able to tap into a rich stream of knowledge.

Although much local knowledge and historical information consists of observations and imprecise memories, and does not have the formality of a scientific approach, it still provides a useful *line of evidence*, particularly about rivers and catchments up to 150 years ago. Scientists can treat this information like any other scientific information, not regarding any single piece of data as conclusive but instead seeing it as one piece of evidence. When all the evidence tells the same story, then a strong argument can be formed. It is the corroboration provided by many different sources of information that provides the argument. In this sense, local and historical observations resemble scientific observations.

Environment researchers, including those of the CRCFE, have not so far made a practice of tapping into the local knowledge that exists within communities. However, we are beginning to do so in the Narran Lakes project. Already a community reference panel has been formed for the project. Also, we have set up a web site for the project at http://mooki.canberra.edu.au/narran, and are completing a living book for the site in which we invite people who know the area well to contribute their observations. CRCFE staff are exploring other proactive ways to bring local knowledge into science and management; for example, looking at existing models of community involvement such as Landcare and Waterwatch.

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Local residents often know a great deal about their river and its history.
Photo: M. Copland

Developing a northern river having learnt from the past

Young pig-nosed turtles, Carettochelys insculpta *Ramsay (1886). Photo: A Georges*

A CRCFE team has recommended that groundwater away from the river should be used for irrigation of proposed agricultural development in the Daly River basin, to protect surface water flows in the Daly River itself.

The Daly River in Northern Territory is part of the Daly Basin, an area that has been selected for major agricultural development. It is a big river, with an annual discharge of 4 million GL and year-round flow. By comparison, average annual discharge at the River Murray barrages in South Australia was 11,000 GL in the years before regulation and extraction, and is 3000 GL now. With no dams, and only two major towns in its catchment, the Daly River provides habitats for several threatened or uncommon species of fish and turtles, as well as recreational fishing for barramundi. It is also of great value to local indigenous people.

If the river basin is developed for agriculture, can the development balance the needs of agriculture, urban areas, indigenous values, recreation and tourism, and the environment? Can we avoid repeating the mistakes made on the rivers in the south?

A team from the CRC for Freshwater Ecology (CRCFE) at the University of Canberra, led by Arthur Georges and Martin Thoms, has been analysing the river flows and river ecology as part of a five-team study of the Daly River, to help answer that question. Overall, the study, commissioned by Environment Australia and the Northern Territory Government, has added to knowledge about the river flows, animals, vegetation both on the banks and in the river, and productivity, and is guiding future water extraction from the river.

Using a computer model they have built of the Daly River system, the CRCFE team has studied what could happen to the river and its ecology if river flows were reduced. To identify the effects of flow on ecology, the team has focused on the pig-nosed turtle (*Carettochelys insculpta*). This turtle is so dependent on the volume, timing and temperature of river flows that it can be used as a 'focal' or 'flagship' species in environmental studies. According to the focal species approach, the environmental conditions that suit a very sensitive species are highly likely to suit many other species in that environment as well.

The pig-nosed turtle is the last species of a family that was once found across a number of other countries including Australia. The Daly River contains the best remaining populations of the species. To help the species survive, several factors are necessary: suitable nest sites must be available; the eggs must be able to hatch successfully, with reasonable survival; there must be a suitable ratio of male to female hatchlings; and the turtles must be able to reach their food supply during the dry season.

Therefore, for the pig-nosed turtle, and many other river species, continuity of flow is important, as is timing of the annual wet-season floods. Unlike other turtles, this species cannot get out of the water and walk long distances. It is a large, heavy turtle with flippers and limited mobility on land. It cannot move from pool to pool when the river is shallower than 0.5 m, and the females cannot climb farther than 0.3–2 m above water level when looking for nest sites in sand banks. Hatching is triggered by wetness, usually from floods but sometimes from torrential rain. If flood or rain does not happen within a 30-day 'window', the potential hatchlings either run out of food (egg yolk) and die, or the sand bank and eggs are washed away in the wet season flood before the young are old enough to hatch.

From data provided by Northern Territory Government staff, the CRCFE study found that the flow of the Daly has varied from 8000 ML/s (megalitres per second) in summer 1998, to 2 ML/s in summer 1966. Median flow is 10 ML/s, and the team has defined high flow as >50 ML/s. In this very variable climate, rainfall has been as much as 2000 mm one year in the 19th century, and as low as 300 mm around 50 years ago. Generally it is in the range 600–800 mm per year.

Wet season runoff is the main source of water for the river, but much rain also soaks through the permeable soils to the groundwater and the local limestone and sandstone aquifers. Floods and high flows in the wet season also recharge the underground watertable and aquifers beside the rivers.

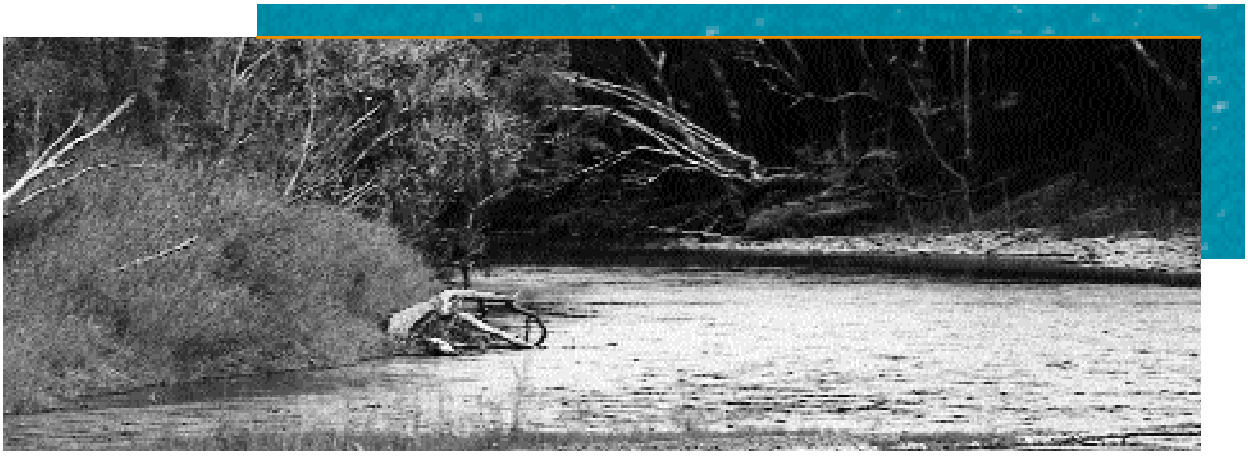
Soon after the wet season ends, groundwater becomes the main source of water for the Daly River and other rivers in the basin. This explains the way flow and water depths differ at different points along the river. For example, where the Oolloo Dollostone outcrops, it contributes a large volume of water, via fractures, springs, seepage zones and quicksands. Elsewhere, this aquifer is buried under impermeable claystone, and water can only enter the river from surface creeks and the shrinking watertable.

Places where the river is shallow are effectively walls dividing the river into a chain of pools, from the turtles' point of view. Early dry-season pools can be 20 to 35 km long and barely a constraint to turtle life and breeding. But late in the season, some pools may be only a few hundred metres long. In these conditions, the turtles are quite unlikely to be able to find suitable nest sites at the pool edge, and unless there is sufficient ribbonweed (*Vallisneria nana*) or other rooted aquatic plants in their pool to feed them through the dry season, they may also have difficulty in finding sufficient food.

Isn't there enough water to share?

Only 5–10% of dry seasons have high flows, while moderate flows (4–7 ML/s) are found 25–50% of the time, and 15% of dry seasons have very low flows (down to 2 ML/s). Turtles survive these variations under natural conditions. For the turtles, the wet years with high dry-season flows, roughly one year in every ten, are boom years in which the turtle populations do well, compensating for losses in the less favourable drier years.

If large volumes of water are extracted from the river itself and its local groundwater system, there is liable to be an effect on the ratio of high to low river flows in the dry seasons, making high flows less frequent and low flows more frequent. As a result, the turtle populations will have fewer high-flow years in which to recover from the low-flow conditions. If the volume of water extracted from river and local groundwater is the same every year, regardless of wet season rainfall, some dry season river flows will be lower than so far experienced historically. This could be catastrophic for the biota.



The Daly River is spring fed, and flows all year round. Photo: A Georges

Pig-nosed turtles need sand banks in which to lay their eggs.
Photo: A Georges

The volume of flow also affects water temperature. For the pig-nosed turtle, temperature controls the ratio of male to female hatchlings. To begin with, water temperature controls the timing of egg-laying. That timing in turn determines the sand temperature around the eggs in the nest in the increasingly warm weather at nesting (usually August–October). There is only 1˚C difference between 100% male hatchlings and 100% female hatchlings. If water extraction causes pools to be small because of low flow, the timing of egg-laying may be upset by water temperature so often that the turtles die out for lack of one or other gender.

So, can water extractions be managed so they don't mine and degrade the river but still provide adequate water for profitable agriculture?

The answer appears to be yes, provided water for agriculture is taken from the groundwater aquifers that have accumulated recharge over several years. Extracting water from aquifers at a distance of several kilometres from the river should achieve two objectives. First, it should not seriously affect the groundwater inflow into the Daly. Second, it should be possible to ensure a predictable water supply for irrigators. The volume of water in the aquifers is an accumulation of recharge during both wet and dry years, so should be less variable than surface river flow or rainfall.

The distance between river and pumps will have to be determined by further studies, as will the recharge processes and reliability of the groundwater stores, and the natural patterns of dry season flows.

And once extraction begins, the whole system will have to be managed adaptively, with continual audit of the volumes extracted and the dry season flows, to guide the level of the cap on extractions.

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The five-team study and its recommendations are summarised in: 'Recommended environmental water requirements for the Daly River, Northern Territory, based on ecological, hydrological and biological principles,' by WD Erskine, GW Begg, P Jolly, A Georges, A O'Grady, D Eamus, N Rea, P Dostine, S Townsend & A Padovan (2003), a report produced by NTDIPE by Supervising Scientist Division, Darwin NT, available at: http://www.ea.gov.au/ssd/publications/ssr/175.html.

This article is derived from 'Modelling dry season flows and predicting the impact of water extraction on a flagship species. Final Report to DLPE NT for Project ID 23045. Applied Ecology Research Group and CRC for Freshwater Ecology, University of Canberra', by A Georges, I Webster, E Guarino, M Thoms, P Jolley and JS Doody (2003). Available on our web site, http://freshwater.canberra.edu.au

SideStream

Symposium on Urbanization and Stream Ecology

The CRCFE is running a symposium on urbanization and stream ecology, on 8–10 December 2003 at the University of Melbourne. The aim is to advance knowledge and ideas about the effects of urban land-use on stream ecosystems and their restoration. For full details, see:
http://www.conferences.unimelb.edu.au/urbanization_and_stream_ecology. Early bird registration closes on 15 September 2003.

CRCFE and MDFRC Taxonomy and Ecology Workshop

The next Taxonomy and Ecology Workshop (15th in the series) run by the CRCFE and the Murray-Darling Freshwater Research Centre will be held at the Lake Hume Resort, Albury, NSW, on 10–11 February 2004. The workshop aims to train biologists in the identification and ecology of these freshwater invertebrates: mussels (Bivalvia), fairy shrimps (Anostraca), caddis flies (Trichoptera), lacewings and spongeflies (Neuroptera), dragonflies and damselflies (Odonata) and fish larvae. For information and registration please contact John Hawking at the MDFRC, phone (02) 6058 2340, email John.Hawking@csiro.au.

New knowledge exchange staff

We now have a senior community scientist, Janey Adams, at the Goondiwindi laboratory. Janey was previously in Adelaide, working as a private consultant in the water industry. In Canberra, our new knowledge broker is Ruth O'Connor. Ruth has previously worked in a wide variety of state agencies and research organisations including ***eriss***, NSW National Parks and Wildlife Service and the Blue Mountains Council.

Bill Maher appointed to Board of FASTS

Associate Professor Bill Maher (CRCFE and the University of Canberra) has been appointed to the board of FASTS (The Federation of Australian Scientific and Technological Societies). FASTS has a significant influence in the formulation of science and technology policy.

Goodiwindi laboratory official opening and new premises

The CRCFE's and MDFRC's northern laboratory at Goodiwindi was officially opened by Senator the Hon. Ian Macdonald (Federal Minister for Fisheries, Forestry and Conservation) on Wednesday 27 August in Goondiwindi.

The lab recently moved to premises in the main street of town. Its contact details now are: Northern Laboratory, MDFRC, CRC for Freshwater Ecology, 116 Marshall St (PO Box 1176), Goondiwindi, Queensland 4390. Telephone: 07 4671 4650 Fax: 07 4671 4858 Emails: gwilson@northernlab.net.au and jadams@northernlab.net.au.

Successful NISORS conference

The Ninth International Conference on River Research and Applications held in Albury, NSW, early in July attracted speakers from all over the world and Australia. The five-day conference, run by the CRCFE, addressed every facet of river variability. Keynote speakers emphasised, among other things, the value of adaptive management, and holistic approaches such as coupling habitat restoration with flow restoration rather than restoring each one separately. Improved integration of management and scientific outcomes was also discussed.

CRCFE urban input

Chris Walsh represented the CRCFE at a workshop on the comparative ecology of cities, on 20–22 July, hosted by the Australian Research Centre for Urban Ecology. The landscape-scale approaches to characterising urban impacts on streams, being developed at the CRCs for Freshwater Ecology and Catchment Hydrology, attracted strong interest.

Ian Lawrence of CRCFE has been involved in drafting several chapters of the manual Australian Runoff Quality, which describes existing best practice in the management of stormwater quality in Australia. The draft manual is available for comment, at http://www.eng.newcastle.edu.au/~ncwe/ncweARQ/arqSummary.htm

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

Feature Plant
by David Williams

Giant rush is the feature plant for this issue.

Family: Juncaceae
Species: *Juncus ingens*

The giant rush is a native emergent species (its stems extend above the water) which is commonly 2 m tall but may reach 5 m, making it probably the tallest *Juncus* in the world. It can grow in floodwater as deep as 1.5 m, provided the flood recedes in less than about 9 months, and appears to have increased in sites where flooding is now reduced. Giant rush forms dense stands along rivers and in floodplain wetlands of the central Murray region and along the Goulburn-Broken and Kiewa Rivers. It is dioecious (that is, it has separate male and female plants), which may explain why it often sets few seeds. However, the plants of this perennial species gradually expand sideways using rhizomes. Giant rush maintains green stems all year round. Its high stem density can protect banks and it provides nest sites for waterfowl such as ibis in some wetlands.

Areas mentioned in this issue.

Comments and ideas are welcome and can be sent to:

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