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Land & Water Australia

RIPRAP
RIVER AND RIPARIAN LANDS MANAGEMENT NEWSLETTER
Edition 29, 2005

Environmental water allocation

The recent drought has accentuated the dependence of urban and rural communities on access to water. However, even without the drought, it has been clear for over a decade that some rivers, particularly those in the Murray-Darling Basin, are under great stress because of over-use of the available water. Many other rivers across Australia are now also approaching that point. The 1994 Council of Australian Government (CoAG) agreement on water reform emphasised that the best available scientific information should be brought to bear on helping to resolve these water allocation issues. The CoAG agreement also emphasised that environmental water needs had to be given priority in allocation decisions. A new Environmental Water Allocation Program has been established by Land & Water Australia to help inform these complex decisions.

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RIParian lands:

WHERE LAND AND WATER MEET

From the Editor

Well, a new 'look' to end 2005 and bring in 2006. As you can see, we have mixed the old with the new to create a new *RipRap* for you to enjoy. This edition of *RipRap* is on environmental water allocation, a topic that is at the forefront of people's minds as economic, environmental and social demands for water are being made in every region of Australia. The articles featured here show the scope and breadth of work being undertaken across the country, with the new Land & Water Australia Environmental Water Allocation Program now underway with six new projects, as well as work at CSIRO Land & Water and the Murray-Darling Basin Commission also being featured. 'It's a Wrap' provides a snapshot of projects across the states and territories and demonstrates the significance of this issue to rural and urban communities across Australia.

I hope you enjoy this edition of *RipRap*, our biggest one ever at 52 pages! I would also like to thank you for your continued support of *RipRap*, we value your interest and hope that we can continue to provide you with a useful source of information and inspiration for the work you do.

***Front cover**: Photo Peter Walton Photography.*

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Environmental water allocation

By Richard Davis

Later in this edition, the National Water Commission describes some of the initiatives underway to implement the National Water Initiative, *see page 36.*

The June 2004 Intergovernmental Agreement on a National Water Initiative identified a number of areas where lack of reliable knowledge is delaying the water reform process. These include:

- regional water accounts and assessment of availability through time and across catchments;
- changes to water availability from climate and land use change;
- interaction between surface and groundwater components of the water cycle;
- demonstrating ecological outcomes from environmental flow management;
- improvements in farm, irrigation system and catchment water use efficiency;
- catchment processes that impact on water quality;
- improvements in urban water use efficiency;
- studies into improved institutional arrangements for effective water markets; and
- independent reviews of the knowledge base.

The Environmental Water Allocation Program was established by Land & Water Australia (LWA) in July 2004 to help the National Water Initiative by providing improved knowledge about the water needs of the environment. As a result of extensive consultation with state and regional water managers, federal policy staff and researchers around the country, LWA identified four research themes around which activities in a new Program would be organised. The four themes are as follows.

Theme 1.
Improving, demonstrating and evaluating the benefits of environmental management of stressed rivers such as the Murray

The intergovernmental agreement to invest $500 million to recover water for environmental benefit in the River Murray illustrates how severe the problems are in that river. However, there are other rivers, within and outside the Murray-Darling Basin, where the pressures on water availability have led to degraded wetlands and floodplains, reductions in waterbird numbers, and losses of fish and invertebrates. For example, the flows in the Condamine–Balonne system have been reduced through irrigation abstraction to the point where they are affecting important downstream wetlands. The eWater Cooperative Research Centre (CRC) is studying these impacts at the Narran Lakes; this work is described in this issue on page 20.

These problems are now well known, and the need to provide more water for environmental benefits is widely accepted. The debate has shifted to identifying the specific environmental benefits to be obtained from delivering the additional water at different times and with different patterns. Under this theme, LWA will invest in models and other predictive tools that can be used by regional water resources managers to plan their water releases to maximise the environmental benefits. This model

Photo RipRap archives.

development needs to be based on sound science, so projects funded under this theme are likely to be part of larger research programs into environmental water allocations in these stressed systems. These projects will also have strong support from the management agencies that will use these predictive models.

Theme 2.
Research into environmental water allocation in poorly understood aquatic ecosystems across Australia

Research projects in this theme will focus on aquatic ecosystems where there is little knowledge or basic information about how they function. These ecosystems include rivers and associated systems in the less well studied portions of Australia (such as tropical rivers), groundwater dependent ecosystems and estuaries. There are a number of examples across Australia where groundwater dependent ecosystems have been affected by excessive pumping of groundwater. There are also examples where rising watertables, especially those affected by salt, have negatively impacted ecosystems. It has long been recognised that estuaries are dependent on freshwater inflows for their productivity and biodiversity. LWA will work with the Fisheries Research and Development Corporation to identify the research needed to understand what these dependencies are, and consequently, the flows that are needed to maintain estuarine health and productivity.

Theme 3.
Research into holistic water budgets of complete river systems

It is generally agreed by most scientists working in the natural resources management area that land use changes across catchments, combined with climate change, is significantly affecting the amount of water available in Australian rivers. For example, it is possible that vegetation change, increases in farm dams, increased groundwater use and climate change could reduce the flow in the River Murray by 2000 Gl/year by 2025 — a far greater effect than the 500 Gl/year currently being recovered for environmental use over the first five years of the Living Murray initiative (pages 23 and 27).

Research into these issues has tended to be done in isolation, however, under in this theme we hope to combine research teams so that a more holistic understanding of river requirements and, hence, water budgets can be gained.

Theme 4.
Research into the economic, social and institutional aspects

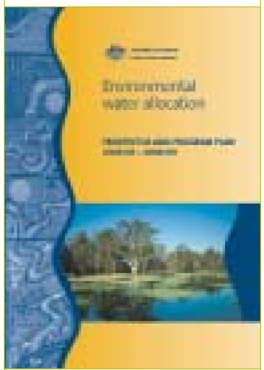
LWA has already funded a number of successful projects on the economic, social and institutional issues of water use through its Social and Institutional Research Program. The scope of these issues is large and complex, but fundamental to enabling the successful allocation of water between environmental and consumptive uses. The focus of this theme will be upon innovative approaches and emerging issues that are closely connected to environmental water and that are not covered by LWA's existing research portfolio.

Overall, six projects have now commenced in the new LWA Environmental Water Allocation Program; one under the first theme, four under the second theme and one under the last theme. These new investments are described in this issue, including their links to water resources management. A further three projects are under negotiation and, when finalised, will round out the initial portfolio of LWA research into environmental water allocation issues.

Photo MDBC.

Of equal importance to the research is the need to have managers involved in the design and conduct of the Program, as this is the best way of promoting adoption and use of the research findings. A Steering Committee and other consultative mechanisms are built into the Program to ensure that the research stays in touch with end-user needs. These projects join the research being funded by CRCs, CSIRO, universities and state government agencies into environmental water needs. Together, they will provide the basis on which a more rational allocation can be made of Australia's use of its surface and groundwater resources. ■

If you would like a copy of the Environmental Water Allocation Program Plan contact CanPrint Communications 1800 776 616 or visit the website www.rivers.gov.au



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Using 'buybacks' to secure water for environmental flows

By Michelle Scoccimarro and Drew Collins

'Buy-backs' of natural resource entitlements or rights are increasingly being used by governments to reallocate resources and promote conservation objectives (with recent applications in fisheries, biodiversity conservation and wetlands). Well designed buy-backs can target resources of high conservation value, reduce budget costs to governments and assist structural adjustment in resource dependent industries.

Australian governments have committed to the CoAG June 2004 *Intergovernmental agreement on addressing water over-allocation and achieving environmental objectives in the Murray-Darling Basin*, and indicated that a range of methods to source water for environmental purposes will be explored. To date, governments have tended to focus on obtaining water through infrastructure improvement projects such as lining irrigation channels, or installing pipelines that 'save' water by reducing evaporation and seepage losses. These water 'saving' options are attractive to governments as they can provide additional water without significantly impacting current users. However, viable and cost effective options are limited. Ultimately, governments will need to access water from consumptive users, and one way flagged in recent water policy statements is to "buy-back" water from irrigators.

Preliminary analysis by the Murray-Darling Basin Commission (MDBC) indicates that many environmental watering needs will vary significantly from year to year, and environmental managers will require additional water in an opportunistic fashion — for example, to supplement natural flood events. Water 'rights' currently traded on fledgling water markets in Australia provide access to water that is often poorly matched to environmental needs and, as a result, are unlikely to be the only attractive target of buy-back programs. Additionally, and perhaps more significantly, separate water rights may need to be specified and purchased by environmental managers through time-limited contracts. These new rights will need to be compatible with existing institutional arrangements that govern water entitlement and allocation across the states.

This approach, though seemingly complex, is not necessarily so, as 'derivatives' are a common feature of many established markets. For example, lease-back arrangements could be employed, low security allocations could be targeted, or options for the use of water under pre-determined conditions could be specified. These approaches have the benefit of allowing irrigators to maintain ownership of an entitlement, but enabling them to agree to the transfer of some water allocated under their entitlements on occasion, and on agreed terms. Contract periods could be structured to provide greater flexibility for adaptive management (as understandings of environmental needs improves) and to accommodate concurrent property right and water market reforms. Importantly, by only paying for water that is actually needed, tailored buy-back approaches will be more cost effective to governments, have less impact on irrigation

An example of an environmental asset, Koondrook forest, Murray-Darling Basin. Photo Toni Fuller, courtesy of the Murray-Darling Basin Commission.

communities, and be more effective in ensuring environmental needs are met. In addition, changes in the allocation and use of water may have significant third party impacts, such as in-stream salinity and the viability of irrigation infrastructure (the 'stranded assets' issue). Tailored buy-backs could take account of these broader impacts and seek to develop a portfolio of water rights that maximised overall gains.

The objectives of this project, which is jointly funded by LWA and the MDBC, are to review experiences with natural resource buy-backs, and to investigate alternative buy-back designs suitable for sourcing water from the irrigation sector for use as environmental flows. Buy-backs are prominent in the financial sector, and have been used on occasion by governments, including Australia, for guns, fishing licenses and biodiversity conservation. Interest in the use of competitive buy-back approaches for securing biodiversity outcomes on private land gained prominence following the successful *BushTender* pilot (Stoneham, Chaudhri, Ha & Strappazon 2002) in Victoria, and investigations within the Living Murray Initiative.

Our research team will investigate how buy-back instruments can be tailored to account for temporal differences so that we can find out when water is of greatest value to the environment and to irrigators. Our aim is to investigate how instruments can be designed to be consistent with prevailing institutional arrangements for water, but adaptive to future reforms. We will compare the likely cost to government of alternative buy-back designs compared to sourcing permanent entitlements, and investigate how third-party issues can be factored into purchasing strategies. We will also gauge the irrigation community's attitudes and interest in the use of these types of instruments.

To examine both the potential 'workability' and benefits of buy-back instruments in the water sector, case studies of two of the significant ecological assets under the Living Murray Initiative are being investigated. While the environmental demands proposed for these two sites are preliminary, they are sufficiently developed to be illustrative of the general nature of environmental watering needs.

We aim to contribute to the current policy discussion surrounding the use of these instruments to source water for environmental flows.

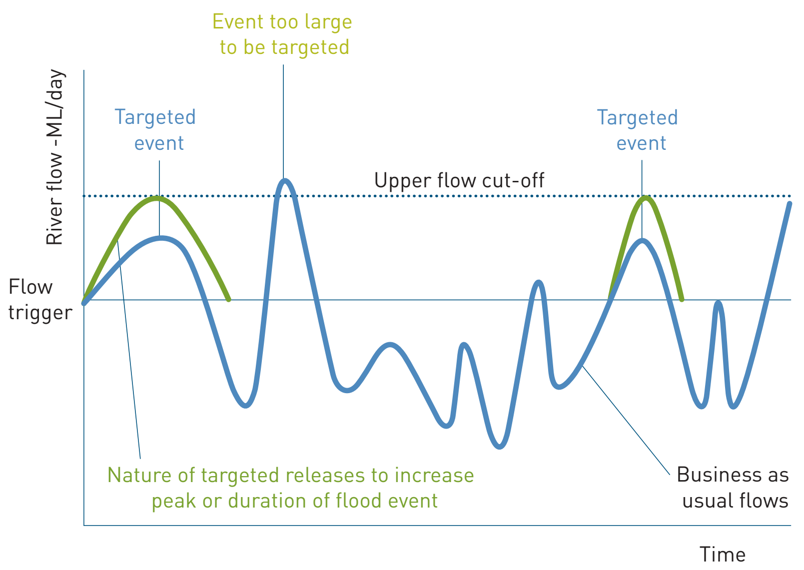

Figure 1: Stylised graph of how targeted environmental releases could be made to increase the peak or duration of flood events using a river flow trigger.

Figure 1 depicts a time series of business as usual (BAU) daily river flows, at a particular point along the river, just upstream of an environmental asset. The river flow trigger is defined as the flow level at which releases would be made to provide water to the environmental asset. In the diagram, under BAU flows, the trigger is met five times. The objective of the releases is to increase the peak or duration of natural flood events. The impact of the releases on river flow is shown by the green dotted lines in the figure above. There is also an upper flow cut-off. If this flow level is reached, no releases are made as at this flow level, the natural flood is so large that there would be no additional environmental benefit gained from the releases. In the diagram above, there is one such instance where this occurs.

This is just one of a number of triggers that is being investigated in the project. The objective is to be able to define triggers that deliver water at appropriate times to the environment and minimise impacts on the irrigators who are providing the water.

For this reason, our analysis will be illustrative of the pros and cons of these approaches, rather than provide a definitive answer. We hope the longer term outcome from the project will be heightened interest in buy-back instruments by those governments developing programs to source environmental water, as well as being able to provide guidance to key design issues. We believe that the successful use of these instruments will drive down the costs of providing environmental flows and be less disruptive to irrigation industries than if permanent irrigation entitlements were the focus of water sourcing. ■

Reference

Stoneham, Chaudhri, Ha and Strappazon 2002, *Auctions for conservation contracts: an empirical examination of Victoria's BushTender trial,* paper presented to the Environmental Economics Network Conference, ANU 2–3 May 2003, Canberra.

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Water use across a catchment and effects on estuarine health and productivity

By Christine Crawford

The extraction of freshwater from rivers and bores for irrigation, industrial use, town water supplies etc. is increasingly occurring across Australia, resulting in decreasing amounts of water reaching estuarine environments. Many state governments have recognised this issue, and are responding by implementing management plans for sustainable water resource use that attempt a whole-of-catchment approach to water management. However, although environmental flows in fresh-water systems have been investigated for many years, the requirements for freshwater inflows into estuaries to maintain estuarine health and aquaculture production are poorly understood. Similarly, there is limited information on the economic value of freshwater flows into estuaries. A new project is being funded by LWA and the Fisheries Research and Development Corporation to address this knowledge gap by investigating the value of water use across a catchment and assessing the importance of freshwater flows on estuarine health and production.

The research undertaken in this project aims to demonstrate the need for integrated economic and ecological investigations in the development of environmental flow regimes, and for this knowledge to underpin effective water management plans. Freshwater flow regimes that are essential to estuarine function will be examined using the Little Swanport catchment in Tasmania as a case study. Little Swanport was selected for detailed investigation because of the strong stakeholder and community involvement in the development of Water Catchment Management Plans. Ecological models to predict effects of different flow regimes on estuarine functions will be developed and then integrated with the economic study to examine the value of water usage between alternative users in the catchment. Based on this work, a generic economic evaluation framework will be developed that can be used by other groups making water allocation decisions.

As demands on water continue to expand, an ability to make informed decisions is an increasing challenge. However, assessing the value of non-income earning goods and services that are reliant on water resources with those that have a clear economic benefit (such as increased animal or crop production) has generally been fraught with difficulties. This project will further develop the concept of ecosystem services and societal benefits from the environment, shedding light on how they can best be recognised, valued and managed.

Little Swanport Estuary. Photo Christine Crawford.

For interest, see It's a Wrap Tasmania, page 44, to see the Little Swanport River as it begins its journey to here.

The specific objectives of this project are:

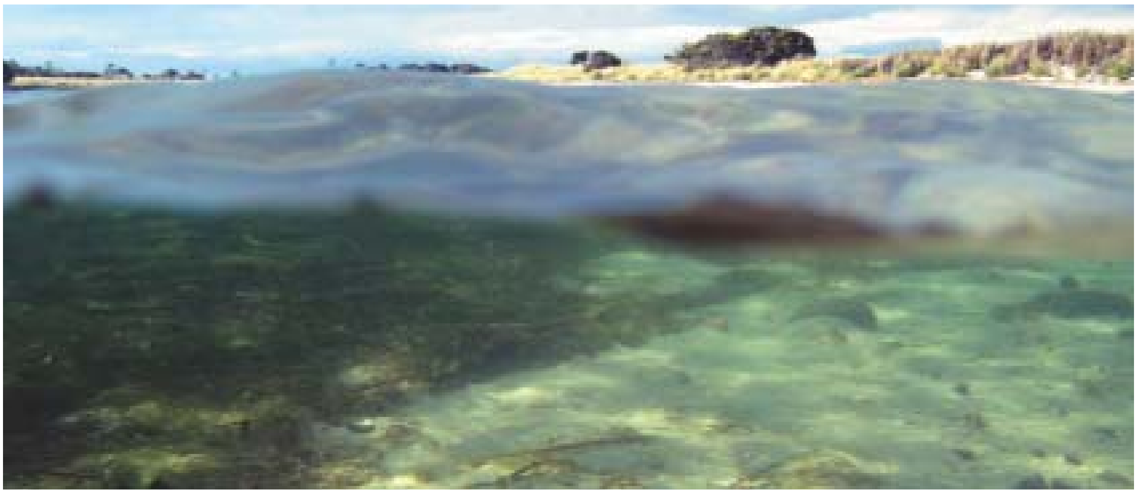
1. To complete an investigation of environmental flow regimes required to maintain the health and production of oysters from the Little Swanport Estuary through continued collection of environmental data under different flows and by the development of an estuarine model to predict the effects of different flow regimes.
2. To develop a set of economic accounts and an economic water evaluation framework and associated tools, using the Little Swanport catchment as a case study, to assess the value of freshwater to various users across the catchment, including upstream agriculture, estuarine shellfish farmers and fishers and for non-market goods and services.

Little Swanport Estuary case study

Studies to date on on the ecology of the estuary in relation to environmental flows have shown that freshwater flows into the estuary have a detectable and substantial effect on water quality — salinity, dissolved oxygen, nutrients, turbidity and vertical temperature profiles, especially in the upper reaches. In times of high freshwater flows nutrient levels can reach an order of magnitude higher than normal background levels. The zooplankton community of the mid-lower Little Swanport Estuary is typical of Tasmanian coastal regions. However, a small flood event appeared to cause a substantial shift in the zooplankton community structure. The larval fish assemblage contained families with several representatives that spawn in the estuary, including gobies, clinids (crested weedfishes), scorpaenids (scorpionfishes) and sparids (black bream).

Intensive fish surveys showed a diverse fish faunal community with 43 species. Many species had life cycles classified as estuarine/marine (i.e. could spawn either in estuaries or coastal waters). However, the most abundant fish caught in the estuary, black bream (*Acanthopagrus butcheri*), is a fully estuarine species and the estuary is a key spawning and nursery area for this important recreational species. The disappearance of black bream from sampling sites after a small flood indicates that the distribution of this species can be influenced by freshwater flows.

Top: *Aquaculture leases.* ***Above***: *Bream. Photos these pages Christine Crawford.*



Left: *Mouth of the estuary.*
Below left: *Sea grass and coastline.*

Field sampling of water quality and fauna and flora will continue during and after flood events and experiments will be conducted on the effects of freshwater flows, especially nutrient inputs, on phytoplankton communities and oyster growth and survival. At the same time, a predictive model of the effects of differing levels of freshwater flows on estuarine health and production will be developed.

A set of monetary accounts for water usage for the whole catchment will be developed based on an economic production function, e.g. the value of all inputs including water into crop and animal production, and the value of outputs (the market price), plus the monetary value of non-market goods and services such as the life-support function of the catchment and its biodiversity value. The non-market values will include the psychological benefits that residents enjoy from the presence of the river. This will be based on market and non-market economic modelling. The opportunity cost (value of production foregone) of different flow models will be based on agricultural production functions. Economic data will be obtained from the collection and analysis of existing secondary (land use) data, and supplemented by field work that will involve face-to-face interviews with producers and landholders in the catchment. Non-market values will be estimated by a range of techniques (e.g. travel cost, contingent valuation, hedonic pricing). The values identified will be refined after the biological modelling with the aim of extending the best (economic efficient) allocation of water to the various user industries and activities. ■

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Water regime dependence of fish in the . . . .

By Michael Douglas, Brad Pusey, Mark Kennard and Sue Jackson

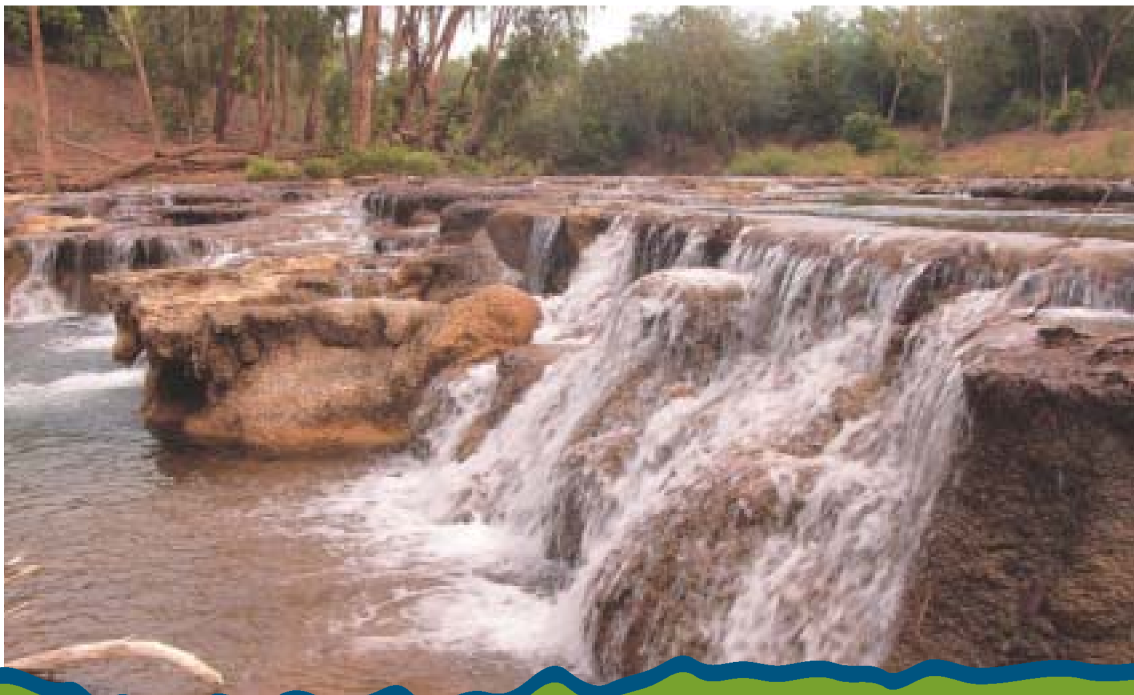
Australia's tropical rivers account for about 70% of the country's total runoff and with water becoming an increasingly valuable commodity in southern Australia, there is growing interest in the water resources of the north, particularly for irrigated agriculture. However, there is also recognition that the substantial runoff from tropical rivers helps to sustain the commercially important northern coastal fisheries, as well as underpinning the wealth of natural and cultural values associated with these rivers. Natural resource managers are faced with increasing pressure to develop the catchments and water resources in parts of northern Australia, but the ecological impacts of the likely changes in flow regimes are poorly understood, particularly for the wet-dry tropics. This means that there is a clear need for a better understanding of the environmental water requirements of wet-dry tropical rivers to ensure that water allocation processes maintain biodiversity and ecological processes.

The need to understand the environmental water requirements is particularly pressing in the Daly River Catchment in the Northern Territory. Most of the Northern Territory's current irrigation activity occurs in the Daly River Catchment, and because of its reliable groundwater reserves and relatively good soils, further agricultural development, land clearing and water extraction are proposed for the area. Importantly, the Daly River is also recognised for its high conservation values (Blanch et al. 2005).

Environmental water requirements of riparian vegetation, macrophytes, algae and the pig-nosed turtle have recently been examined in the Daly River (see Erskine et al. 2003). The Daly has the highest base-flow of any river in the Northern Territory and these studies identified the importance of sustained groundwater inputs during the dry season for maintaining these biota. Projected water resource use in the lower Daly River will, however, alter dry season flows more than any other facet of the overall flow regime.

The Daly River supports nearly 50 species of freshwater and estuarine fish, including the critically endangered Freshwater sawfish and the Freshwater whipray, which is listed as vulnerable. It is also held to be one of the country's best rivers for recreational barramundi fishing. Fish are also of great value to indigenous inhabitants of the catchment. However, despite their ecological, economic and cultural significance, the environmental flow requirements of freshwater fish in the Daly River has not been investigated and this is recognised as a significant knowledge gap (Erskine et al. 2003). In fact, fundamental knowledge of the ecology of fish in the Daly, such as their distribution within the catchment, habitat preferences, breeding phenology is lacking.

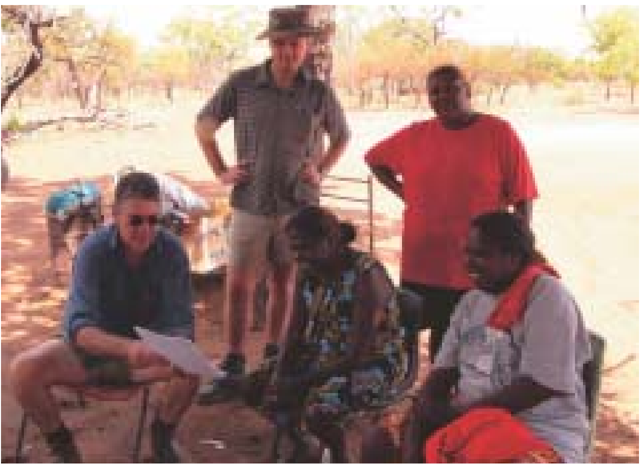
A project recently commenced under LWA's Environmental Water Allocation Program is aimed at addressing these knowledge gaps. The collaborative project involves researchers from Charles Darwin University, Griffith University,



A tufa dam on the Douglas River, NT. These are natural features caused by a build up of calcium carbonate and could pose a natural barrier to fish movement in the dry season. Photos throughout this article, Michael Douglas.

CSIRO Sustainable Ecosystems, the Northern Territory Government and the University of Wisconsin. The researchers are also working in collaboration with Aboriginal people from the Wagiman and Wardaman language groups. The broad aim of the project is to investigate variation in fish distribution and ecological requirements in the Daly River, as well as to document indigenous knowledge and learn about the cultural significance of fish. The research team will then draw on all knowledge gained from scientific and indigenous investigations to describe linkages between natural variation in fish communities with natural gradients in flow regime. The hydraulic habitat in the Daly River will also be studied so that the ecological consequences of flow regime changes under different water use scenarios can be predicted.

The perennially flowing Douglas River, a tributary of the Daly River, NT.



Brad Pusey, Mark Kennard (Griffith University), Brenda Huddleston, Elizabeth Sullivan and Verona Huddleston (Wagiman Guardagun Rangers) discuss methods for sampling fish in the upper Daly River.

The project has five components

1. Consultation with Aboriginal traditional owners and documenting indigenous knowledge.
2. Field sampling of freshwater fishes and habitats of the Daly River.
3. Derivation of ecological traits and examination of variation in species' distributions, assemblage composition, habitat use and other ecological traits across a natural gradient in dry season discharge.
4. Development of conceptual models relating fish ecology and flow, characterising the flow requirements of freshwater fishes of the Daly River.
5. Development of a Bayesian Belief Network model to aid government in water resource scenario testing.

Brad Pusey and Mark Kennard (Griffith University) surveying potential study sites on the Douglas River, a perennially flowing tributary of the Daly River, NT. Mark is indicating the average size of the fish in the study pool.

The focus of the project to date has been on consultation with the Aboriginal traditional owners of the upper and middle reaches of the Daly River and identifying potential study sites. Project staff met in Darwin in October for detailed planning and for the first meeting of the project steering committee. The committee brought together representatives from the key stakeholder groups to comment on the project's objectives, methods and outcomes. This was followed by a field trip to the Daly River Catchment to identify study sites and to meet with the Wagiman Guardagun Rangers. Fish sampling will begin in the dry season of 2006 and will continue until the end of the dry season in 2007.

In summary, this project addresses issues that are significant at a number of levels. It will be of great significance at the local community level where Aboriginal communities will benefit from the greater transfer and recording of indigenous knowledge, as well as being involved in the water resources planning processes. It will make a significant contribution to water allocation planning in the Daly River Basin, a system of recognised cultural, conservation and economic significance to the Northern Territory. The knowledge gained will also be directly applicable to other river systems in the Northern Territory and used in future planning processes. The increased knowledge of the habitat and flow requirements of fish will be of regional significance as it can be used to contribute to future water allocation planning throughout the wet-dry tropics of Australia. Finally, the proposed innovative methods of integrating knowledge from a variety of sources to develop conceptual and quantitative models to assist in water allocation planning will be a model for other parts of Australia to follow. ■

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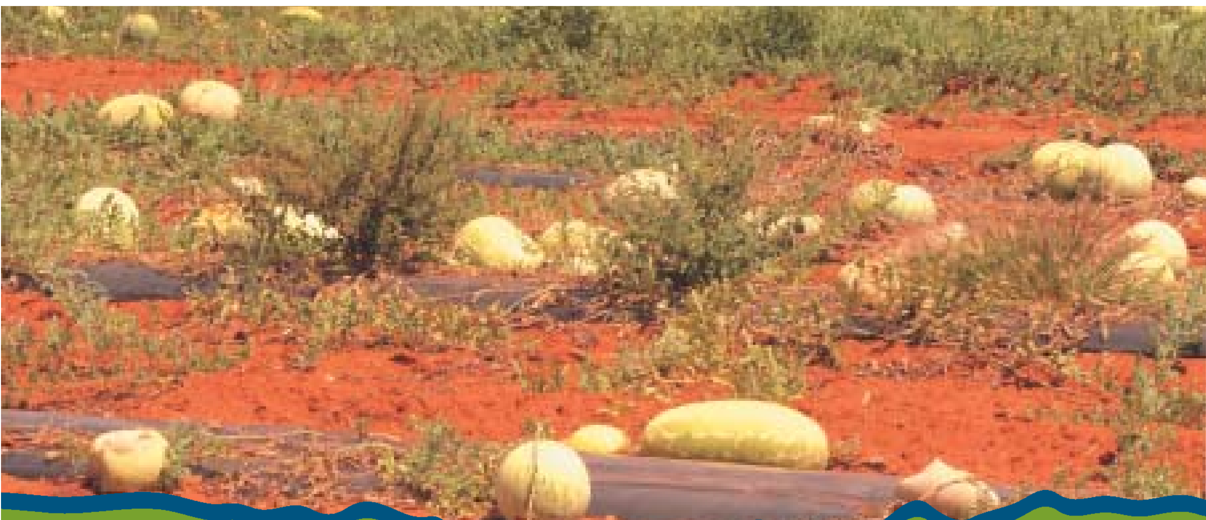


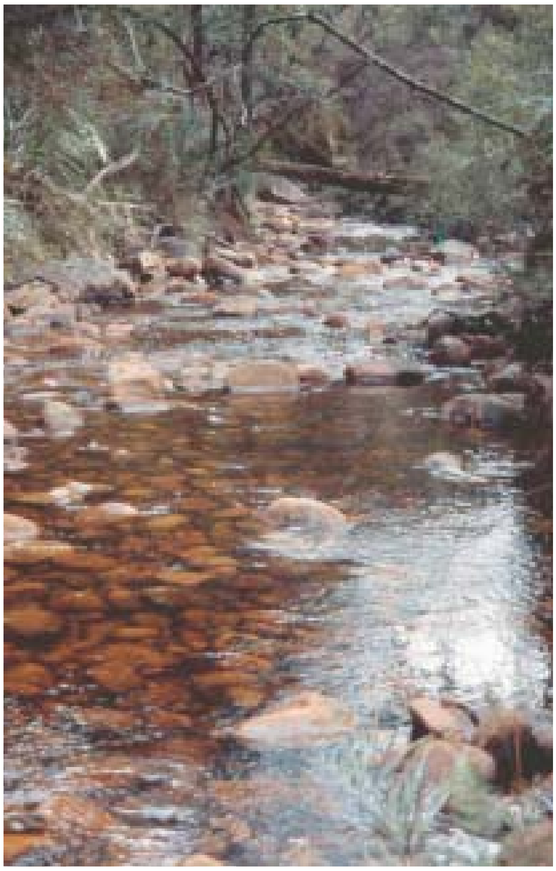
Fields of irrigated watermelons growing in the Daly River catchment.

Environmental water allocation required to sustain macroinvertebrate species in ephemeral streams

By Belinda Robson, Chris Austin and Ed Chester

Ephemeral streams and rivers are typical of the world's arid, semi-arid and Mediterranean climate regions. In Australia, ephemeral streams provide most of the water supply within these climatic zones, supporting large areas of dryland agriculture. For example, these streams provide the majority of water supply for stock animals via earthen dams constructed directly on the watercourse. Few ephemeral streams remain un-dammed and many have several earthen dams along their length. There are also major water supply schemes founded on ephemeral streams and rivers. The Wimmera-Mallee Stock and Domestic Supply System depends on ephemeral streams and rivers originating in the Grampians National Park in western Victoria. It supplies water to over 28,000 square kilometres of farmland, over 70,000 people and relies on major modifications to natural drainage systems, including dams, inter-basin transfers and the use of both artificial channels and river channels to transport water (Department of Water Resources, 1989).

Water extraction prolongs periods of zero flow in ephemeral streams and may also increase the frequency of stream drying, both inter-annually and within a year. These unpredictable patterns of wetting and drying may fragment river habitat, thereby affecting the survival of macroinvertebrate populations through reproductive isolation, blocking dispersal and local extinction. We also know little of the strategies used by stream animals to survive dry periods, or of how these are affected by modifications to stream flow regimes that increase drying. For example, if many species use perennial pools as a drought refuge, what is the consequence for species persistence if these pools are lost because stream drying is prolonged?



Left: *Fyans Creek, Grampians National Park was once perennially flowing but is now intermittent due to water extraction.* ***Right***: *Permanent pools of water provide a drought refuge for stream invertebrates. Photos throughout this article Belinda Robson.*

Grevillea Creek, an ephemeral stream in the Grampians National Park.

When extracting water from ephemeral streams, the assumption has always been that it does not matter how much water you take, because the plants and animals there are adapted to stream drying. However, despite the wide distribution of ephemeral streams, they are poorly studied. Consequently, the impact of water extraction on populations of animal species in intermittently-flowing (or ephemeral) rivers and streams are not known.

To address these knowledge gaps and provide a basis for assessing the water allocation needs of ephemeral streams, LWA has funded a project investigating the environmental water allocation required to sustain macroinvertebrate species in ephemeral streams. The project is based in streams in the Grampians National Park in western Victoria. Partners in the project include Deakin University, Glenelg-Hopkins Catchment Management Authority (CMA), the Wimmera CMA and the Corangamite CMA, who are all contributing funds and expertise.

Objectives

Specific objectives of the project are to:

- determine the key drought refuges used by macroinvertebrate species in intermittently-flowing streams and determine the level of threat to each refuge posed by prolonged drying and unpredictable flow regimes;
- determine the role played by different types of drought refuge in restocking macroinvertebrate populations in rivers and therefore the consequences for river communities if some refuges are lost or modified;
- determine the consequences of river habitat fragmentation caused by increased drying for the sustainability of macroinvertebrate populations by quantifying the effects on dispersal and the genetic structure of key aquatic species; and
- identify biodiversity hotspots among ephemeral stream communities and determine conservation priorities.

Approach and outcomes

The overall approach to the problem combines molecular genetics methods and experimental field ecology. Molecular genetics provides a means to assess the outcomes of all the processes affecting long-term population viability, and it also allows the identification of critically important ecological processes (for example population isolation and dispersal) that are very difficult to measure by other means. We have developed a series of field methods, including experiments, which can be used to examine the effects of water extraction on drought refuges. These methods can be enhanced by combining them with genetic analyses that show the longer-term consequences of ecological processes for stream biodiversity.

This project will determine the level of environmental risk posed by water extraction for the sustainability of stream macroinvertebrate populations. It will provide a knowledge-base to support decisions on environmental water allocations for ephemeral streams, thereby leading to improved management that protects drought refuges for river macroinvertebrates, their reproductive and dispersive potential. This should enhance the sustainability of their populations and consequently the biodiversity of ephemeral streams. ■

Reference

Department of Water Resources (1989) *Water Victoria: a resource handbook*. Department of Water Resources, Melbourne.

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SOCIAL AND INSTITUTIONAL RESEARCH PROGRAM

People, practice and policy

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1. Institutions and governance — what are the 'best' organisational arrangements to enable the regional delivery of NRM to be effective? What role is the National Water Initiative going to play over coming years? How can we build our organisational and human capacity to take on the challenges of regional NRM?
2. Policy instrument choice — can we use market based instruments to assist in the allocation of water? What role does regulation play in NRM? What are other countries doing in this area?
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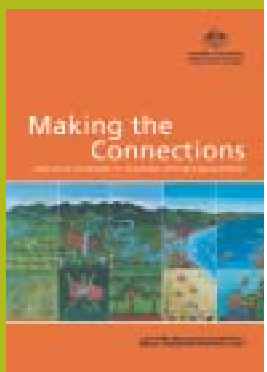

Veg Futures
The conference in the field | 06

You are invited to pack your bags and head to Albury-Wodonga from 19–23 March 2006 to take part in Veg Futures 2006, a national conference exploring the role of native vegetation in productive landscapes.

Veg Futures 2006 will ask the big questions about native vegetation management in Australia, and as the audience you will get an opportunity to answer them. Join leading lights in NRM including Professor David Lindenmayer, Dr Siwan Lovett, Leanne Liddle and Aaron Edmonds in plenary sessions, paddock sessions and workshops.

A particular highlight of Veg Futures 2006 will be Professor Ian Lowe AO, President of the Australian Conservation Foundation, speaking at the conference dinner.

The conference program at Veg Futures 2006 will be structured around five 'big' questions of native vegetation management:

1. What is the role and value of native vegetation in the regional landscape?
2. Who pays for native vegetation management?
3. How do we integrate conservation and production?
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5. How do we know if we are making a difference (monitoring and evaluation)?

Veg Futures 2006 is a practical conference that gives you the opportunity to share expertise and knowledge on how native vegetation can make a difference in productive landscapes.

For further information and details on how to register

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Water allocation to River Murray wetlands: a basin wide modelling approach

By George Ganf and Rod Oliver

Prior to regulation, the River Murray floodplain experienced periodic flood and draw-down, however, this natural regime has now been altered and as a result, the number of wetlands in the Murray system has decreased. Interestingly, there has been a disproportionate increase in permanent wetlands (e.g. 70% in South Australia) with a decrease in other wetland types. Through modelling, this project will assess the influence this change in wetland type has on the ecological character of the river system. The project links with CSIRO's Ecological Outcomes project via a floodplain inundation model that will enable us to predict the wetland types present under different flow conditions. Composite models predicting the development of plant communities under a range of water regimes and environmental conditions (e.g. soils) will provide a basis for assessing the influence that different water regimes have on wetland processes and diversity. These models will be used to identify optimal watering patterns for wetlands in order to maximise beneficial ecological outcomes. The project objectives are to:

1. compare and contrast wetland types present under different watering regimes using a floodplain inundation model;
2. assess changes in the proportions of wetland types due to regulation;
3. predict the floristic composition of natural and regulated wetlands via the known response of key species to water regimes in the Murray River (e.g. Blanch et al. 1999, 2000; Siebentritt 2003);
4. compare and contrast model predictions with selected wetlands in the Murray Basin either via information from existing wetland surveys or by further field work to ensure the complete range of wetland types are represented;
5. assess the influence of different wetland types on the ecology of the river system and predict how changes in the proportional representation of wetland types may impact upon the ecological character of the river; and
6. use this information as a base for water allocations in the River Murray Basin.

Nature of the problem

The allocation of water to improve the environmental condition of the River Murray and its floodplains is the basis of the Living Murray Initiative. A major challenge is how to distribute the environmental water allocation along the length of a large and complex river so as to maximise and sustain the environmental benefits generated. Further challenges include demonstrating the beneficial influences of environmental water allocations, and predicting the likely effectiveness of enhanced allocations.

Wetlands are critical components of the floodplain ecosystems of the Murray River, providing habitat and food resources for an array of terrestrial and aquatic animals. However, their influence is not restricted to the floodplain. During flood events, materials and organisms are exchanged between the river channel and wetlands. The river channel is one of six Significant Ecological Assets (SEAs) in the Living Murray, and while floodplain SEAs fall within particular state jurisdictions and have limited and defined areas, the river channel passes through three states and changing geological, climatic and hydrological conditions. It is apparent that a large-scale approach is necessary to assess the integrated influence of longitudinal and lateral variations in wetland types on the ecological condition of the river-floodplain system.

Similarly the floodplain SEAs require integrated management because of their reliance on water delivery along the river and their cumulative contributions to the ecological condition of the river system. To date, the only attempt to provide a broad scale understanding of such interactions has been through the Murray Flows Assessment Tool. This was designed to provide genera information on the benefits of environmental flows but is of insufficient resolution to predict benefits with the level of precision desired by managers. Improved models are urgently required by river managers to better predict the ecological benefits of environmental water allocations. There is a need to assess the efficacy of delivering allocations as specific environmental flows or in conjunction with irrigation flows or natural flows, but this can only be determined once watering requirements have been identified.

Conversely, for wetlands that have become permanently inundated, information on appropriate watering regimes is required to help target management strategies aimed at re-establishing wetting and drying patterns that sustain particular wetland types. Wetlands form a mosaic of environments across the floodplain, with characteristics determined by their environmental setting and the wetting and drying cycles that define their water regime. The growth of wetland vegetation is influenced by many factors including floodplain attributes such as soil types and topography, but despite this, the patterns of wetland vegetation appear to be strongly influenced by flooding regimes. Attempts to predict wetland vegetation from simple considerations of flooding frequency have been problematic, probably because water regimes are comprised of complex characteristics including the depth, duration and frequency of flooding, and the timing and predictability of filling and drying. Efforts to describe the spatial and temporal extent of water regimes across the floodplain are still in their infancy, but are crucial to understanding the longitudinal and lateral distribution of wetland types, and their different vegetation dynamics. Comparisons between wetland vegetation and water regimes, both spatially and through time, should provide an effective means of developing conceptual and empirical vegetation response models that can be used to predict the influence of watering patterns on the distribution of wetland vegetation.

There is no doubt that water regime and flow management plays a pivotal role in the floristic composition of aquatic plant communities in the MDB. Nevertheless, in the Murray (e.g. The Living Murray) and elsewhere (e.g. Gwydir Wetlands) evidence suggests that the influence of water regime is dampened by other factors. In some cases, water regime only explains a fraction of the variability that occurs in plant communities. Whether this variation is a function of abiotic factors (water regime, resources), biotic factors (viability/presence of the seed bank, life cycle stage) or a combination of both remains a mystery. Until this mystery is solved the focus will remain on water regime as the principal factor and a major management tool governing aquatic communities.

This project aims to progress our current understanding of how water regimes interact with other abiotic and biotic factors to determine the distribution of wetland types and the vegetation communities that they support. The development of such understanding is necessary if water allocations and their delivery in the Murray River are to be effectively targeted to provide appropriate areas and mixes of wetland habitats along the river system. This information will also guide the management of wetlands where persistent inundation needs to be addressed by providing improved wetting and drying cycles.

This project is jointly funded by LWA, CSIRO Land and Water "Water for a Healthy Country", The Murray Wetlands Working Group and the University of Adelaide. ■

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Flows and aquatic plants: an historical and experimental approach

By Barbara Downes

We all know that water has to be allocated both to protect and improve the condition of our rivers, but one of our biggest problems is knowing what sizes and what kinds of improvement in environmental health we might expect. Many environmental flow allocations are small relative to typical flows in many rivers, and the plants and animals that live there show lots of change over time and space in response to natural sources of change, like droughts or floods. This means there is a great concern that any environmental benefit arising directly from an allocation of flows for the environment will be undetectable against this very 'noisy' background. Collectively, this uncertainty means we may not be able to demonstrate to the community much direct benefit for environmental flow allocations.

Part of the key to solving this problem lies in understanding the size of the 'normal envelope of variability'. That envelope reflects natural variation and is the key to understanding what values of ecosystem measures (like measures of diversity) fall outside the natural range; it gives us both a measure of environmental stress for impacted rivers and also sensible targets for restoration or rehabilitation activities. Additionally, commonly used indicators of ecosystem health (e.g. macroinvertebrate diversity) are notoriously variable whereas other organisms — like aquatic plants — have rarely been examined.

In this project staff, and students at the University of Melbourne (A/Professor Barbara Downes, A/Professor Ian Rutherfurd, Ms Jane Catford) and the Herbarium at the Botanic Gardens in Sydney (Dr Tim Entwisle, Ms Lucy Nairn) will collaborate. The purpose of this research is to test whether aquatic plants, like reeds, mosses and algae, can be used to demonstrate the benefits of environmental flow allocations. In doing so, we will use a new approach for examining pre-existing data to review the hypotheses behind ecological benefits from environmental flows. Herbaria around Australia have been placing their records on an electronic data base, meaning that much of this information will be searchable and amenable to analysis for the first time. We will collate records across south-eastern Australia to see what we can learn about the 'envelope of variability' for plants in systems currently unstressed by water extraction and damming. Particularly useful will be data that provide some historical record of change in rivers, as this will also help with deciding what range of variability can be described as 'natural'. Following this, we will use a new method for combining evidence from different data sets to set new benchmarks for drawing conclusions about the connections between flow and environmental benefit. In the final phase of the project, we will test some general ecological hypotheses in the field that will be applicable to systems beyond those of the specific experimental sites.

The potential outcomes are:

1. improved understanding of the conceptual basis for the connections between flow and environmental benefits;
2. new standards for evidence of the latter; and
3. new suggestions for potential ecological indicators of environmental flows. ■

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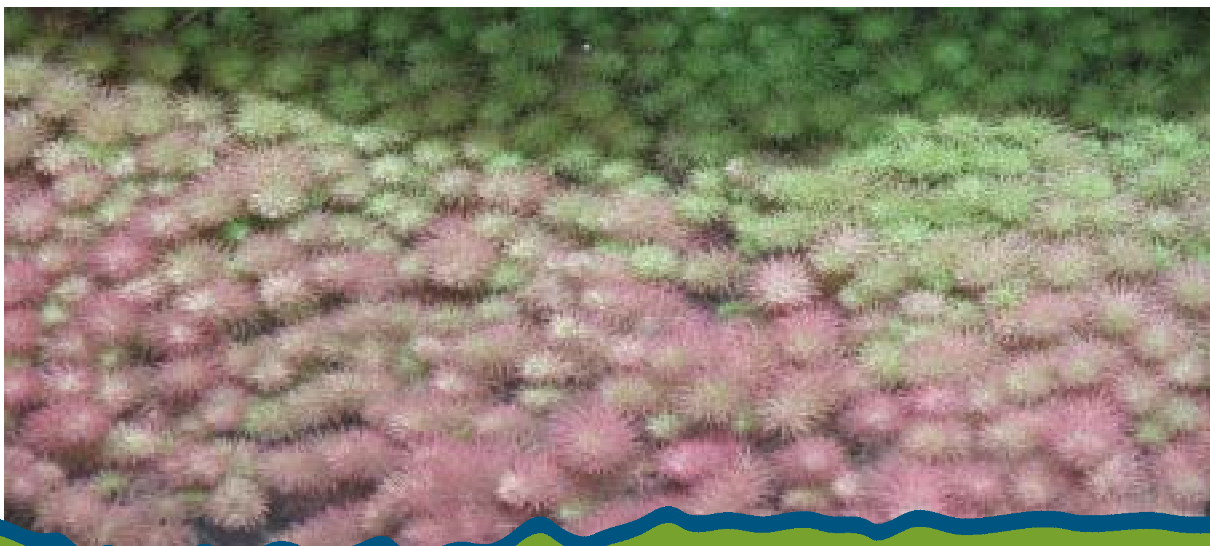

A species of Myriophyllum (Water-milfoil). Photo Chris Cameron, 'Snowgrass', Tel: (02) 6290 0747, E-mail: snowgrass@bigpond.com

The wetting and drying of a floodplain-wetland

By Martin Thoms, Scott Rayburg, Orla Murray, Sam Capon and Cassandra James

Martin Thoms, Scott Rayburg and Orla Murray are based at the University of Canberra. Sam Capon at Monash University and Cassandra James at Griffith University

In partnership with the Murray-Darling Basin Commission, a team of eWater CRC researchers led by Associate Professor Martin Thoms, is undertaking a study of the effects of variable wetting and drying regimes in the Narran Lakes floodplain-wetland ecosystem. The Narran Lakes are a terminal floodplain-wetland complex in southwest Queensland and northwest New South Wales, a portion of which is a Ramsar-listed wetland of international significance to migratory waterbirds. The Narran Lakes ecosystem, fed by the Narran River, is comprised of four distinct bodies of water and an extensive floodplain area (Figure 1). The ecosystem has a complex flood history characterised by highly variable and unpredictable wet/dry cycles (Figure 2). When sufficient water is present under the right conditions, very large water bird breeding events occur at the Lakes; the highest recorded event reportedly comprised 200,000 breeding pairs of Straw-necked Ibis. Extensive water resource development upstream has significantly changed the hydrology of the Narran River and is currently perceived as a major threat to the ecological integrity of the Narran Lakes ecosystem.

An integral part of the project is an examination of the character of inundation. To do this a series of 69 Landsat MSS and TM images were acquired between 1972 and 2004 to determine the extent of flooding associated with a range of flood events. To illustrate the complex nature of flood expansion and contraction within the study area a detailed study of two floods has been undertaken. Here, 14 Landsat Thematic Mapper (TM5) images were used for the December 1995 to February 1997 event and for a flow event that occurred between February and December 2004. A spatial pattern analysis has been used to examine the wetted portions of the ecosystem, and in particular to analyse the number, surface area, shape and proximity of each inundated patch. The expansion and contraction of floodwaters produced a complex response in the size of the inundated floodplain area, the number of inundated patches and the richness of their sizes, shapes and proximities to each other during the two floods (Figure 3). These two flood events resulted in 12,000 and 2500 hectares of the Narran Lakes ecosystem being inundated respectively. During each flood a mosaic of inundated patches of different sizes, shapes and proximities to one another was produced. In addition, inundated patch character changed greatly over time with the expansion and contraction phases, thereby creating a complex physical environment, which is an important driver of floodplain diversity.

This portion of the study has demonstrated how the spatial arrangement and character of inundated patches across a large floodplain-wetland complex change over time. This is an important step in guiding environmental water allocations for these systems. An ecosystems approach to determining environmental flow allocations advocates identifying flow bands that may provide the greatest ecosystem response in terms of habitat created or ecological service provided. Using this approach, floods that are managed within particular flow ranges will result in relatively larger spatial variations in the arrangement and diversity of floodplain inundated patches. It is important to note that floods resulting in a greater total inundated surface area pass through this critical range on both flooding and drawdown. This has implications for managing the drawdown of large floods because the fragmentation resulting from allowing floods to dissipate naturally may result in a greater diversity in patch character.

The relationship between discharge and the area of floodplain inundated have not yet been established for the Narran Lakes. However, once this is known, managers can better target both the temporal and spatial dimension of the flow regime to enable the dynamic mosaic of inundated patches to be maintained. This may be key to maintaining the biodiversity of such floodplain ecosystems. ■

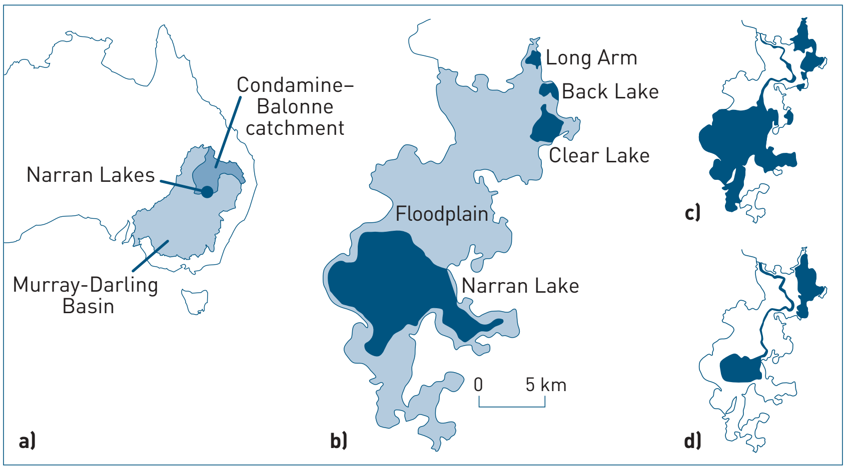

***Figure 1**. Location of the Narran Lakes ecosystem.*
***a)** Regional location of the Narran Lakes.*
***b)** The Narran Lakes ecosystem.*
***c)** Extent of the 1995–97 flood sequence (August 1996).*
***d)** Extent of the 2004 flood sequence (April 2004).*

complex

Figure 2. The Narran Lakes Ecosystem under wet and dry conditions. Photos courtesy of Narran Lakes Ecosystem Project.

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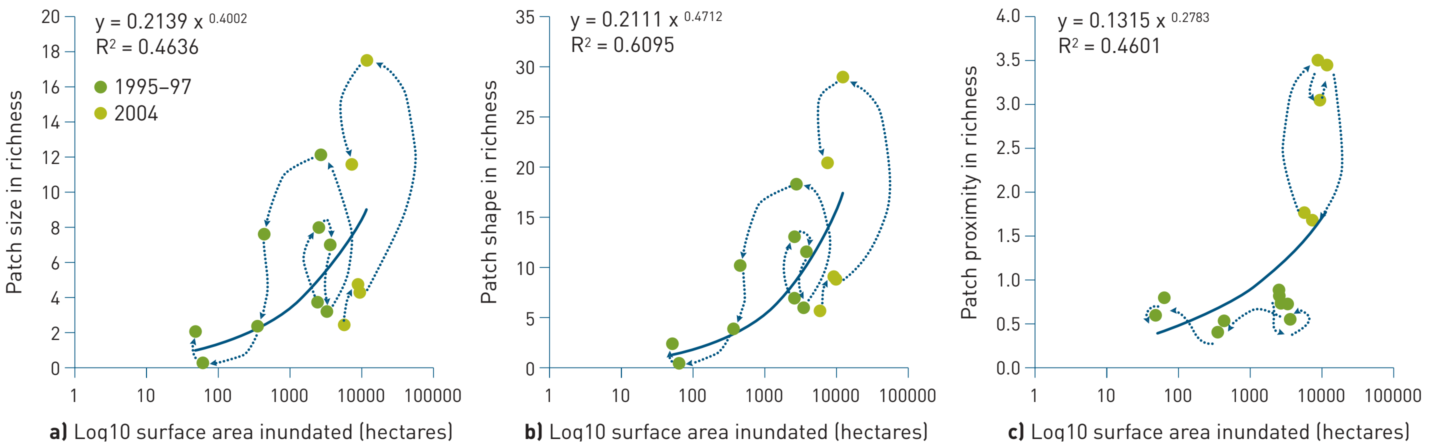
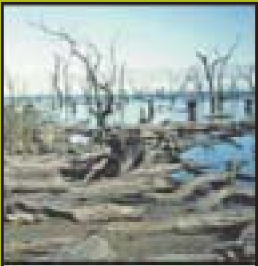
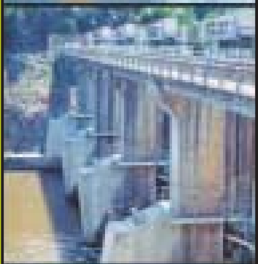
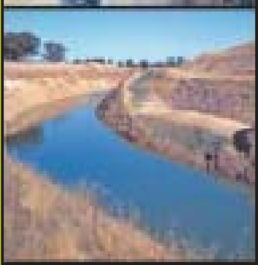
Figure 3. The character of inundated patches during two flood sequences (1995–97 and 2004) in the Narran Lakes ecosystem. ***a)*** *Richness of patch sizes.* ***b)*** *Richness of patch shape.* ***c)*** *Patch proximity. The solid lines are the line of best fit and the dashed lines trace the flood sequences for both flood events.*





Catchment and natural resource management 2006: learning to better manage our catchments

Thursday 23 February and Friday 24 February 2006
Albury Conference Centre, Albury NSW

A two-day national conference looking at the most recent developments in catchment and natural-resource management. The conference is organised by Hallmark Conferences + Events, publishers of the *Australian Journal of Environmental Management* (Journal of the EIANZ), *Water* (Journal of the Australian Water Association), *The Environmental Engineer* (Journal of the Society for Sustainability and Environmental Engineering), *Land & Water News* and *Environment Business*. The Conference Director is Professor Paul I Boon.

Focus on four themes

- Developments in policy and their implications for strategic direction and funding
- Ways to better manage water for improved environmental and social outcomes
- Improving our understanding and management of terrestrial vegetation
- How to use new and emerging technologies, maximise community engagement and ensure return on investment at the regional scale.

Topics include

- Recent policy developments at the federal and state level and their implications for strategic planning and investment
- Environmental water allocations in a hydrologically variable country
- Long-term shifts in terrestrial vegetation and forecasting likely changes over the coming decades
- Maximising environmental and economic returns while effectively managing terrestrial vegetation in agricultural landscapes;
- Critical decisions in providing the knowledge to underpin regional natural-resource management;
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- Integrating different disciplinary findings, taking the 'technical' and making it understandable by a wide range of audiences;
- Identifying target groups to develop appropriate strategies and extension courses to engage landholders; and
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Diverse range of speakers

- **Policy** — Federal National Water Commission, NSW Natural Resources Commission, Victorian Department of Sustainability and Environment, South Australian Centre for Natural Resource Management, and Glenelg-Hopkins CMA;
- **Water management** — Monash University, University of Melbourne, eWater CRC, WBM Pty Ltd, and Murray-Darling Basin Commission;
- **Terrestrial vegetation** — CSIRO Sustainable Ecosystems, Charles Sturt University, Arthur Rylah Institute, Trust for Nature, Talaheni (Yass); and
- **Technologies and community engagement** — Land & Water Australia, James Cook University, Bureau of Rural Sciences, Charles Sturt University, NSW Department of Primary Industries.

Cost

$675 including GST for the two days plus mid-conference wine tasting.

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Ecological outcomes for the Murray

By Sarah Ryan and Rod Oliver

Flood-dependent ecosystems along the Murray River will soon begin to receive additional environmental water under the Living Murray Initiative. Living Murray recognises that some of the ecological outcomes that people care about — red gums, waterbirds and fish — are declining in health and abundance, and that these declines are largely due to changes in water regimes. These changes revolve around how much water is received, when it is received and for how long.

In general, the processes that connect water regime to trees, birds and fish are known. It is well established that some waterbirds only breed over water and that a short flood duration limits breeding success, or that in other cases floods are needed to initiate establishment of red gum seedlings. The lack of freshwater flows in the southern Coorong leads to hypersalinity and a consequent decline in the water grass *Ruppia tuberosa*, this impacts on the migratory waterbirds that rely on it directly, or indirectly, as a food source.

For environmental water managers though, this understanding is not sufficient. There is now considerable pressure on catchment management and equivalent agencies to demonstrate to the community, and particularly to irrigators, that their applications of environmental water will result in ecological outcomes. They need to have that relationship quantified for the particular part of the floodplain, wetland or estuary that they are responsible for. Further, if the recovered environmental water will not adequately water the whole floodplain, they need to know spatially what regime will result in the best set of ecological outcomes. Along the Murray, issues of tradeoff will also arise. We need to be able to provide science and understanding so that decisions can be made to distribute the available environmental water to maximise outcomes across the system.

Red gum forest, lower Ovens River. Photo courtesy Healthy Country Flagship, CSIRO.

The scientific challenge

The scientific challenge is to increase our capacity to be predictive about the links between ecological outcomes and water regime at large spatial scales. This is a daunting challenge because the ecosystems are complex and the scale is large (the Murray is 2530 kilometres from its source to the sea). Science has contributed greatly to developing knowledge about floodplain-dependent processes, and has quantified them in particular places, but no-one has brought these disparate chunks of knowledge together. Knowledge on individual aspects and individual places is building at about 100 publications per year and must total well over 1000 by now, yet there is not one model or linked set of models that spatially codifies this knowledge for the whole floodplain and estuary system.

This is the challenge that our project, "Ecological outcomes in the Murray", has taken on in the Water for a Healthy Country Flagship. CSIRO's Flagship Programs aim to apply the multi-disciplinary expertise of CSIRO and collaborators to develop systems understandings and tools that will make a difference to issues of major national importance. A companion project "Coorong, Lower Lakes and Murray Mouth", is taking a similar approach in that region.

Conceptual model

Our approach begins with a simple conceptual model that emphasises the longitudinal and lateral links between water in the river and the floodplain, and the biophysical structures and processes that support healthy ecosystems (see Figure 1).

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Research

We divide our research into four components: floodplain water regimes; floodplain and wetland vegetation; channel production and fish; and responses to water manipulations. There is strong emphasis on the components being developed at similar spatial scales, in a standardised data management system and in common software frameworks like the eWater CRC toolkit, so that the final integrated analyses can be developed.

Floodplain water regimes

The spatial backbone of the whole project is a floodplain inundation model that predicts the water regime at any place on the floodplain. Built from a base of satellite imagery of past floods at known river flows, RiM-FIM (River Murray Flood Inundation Model) will work in linkage with the MDBC BigMod model of river flow to estimate

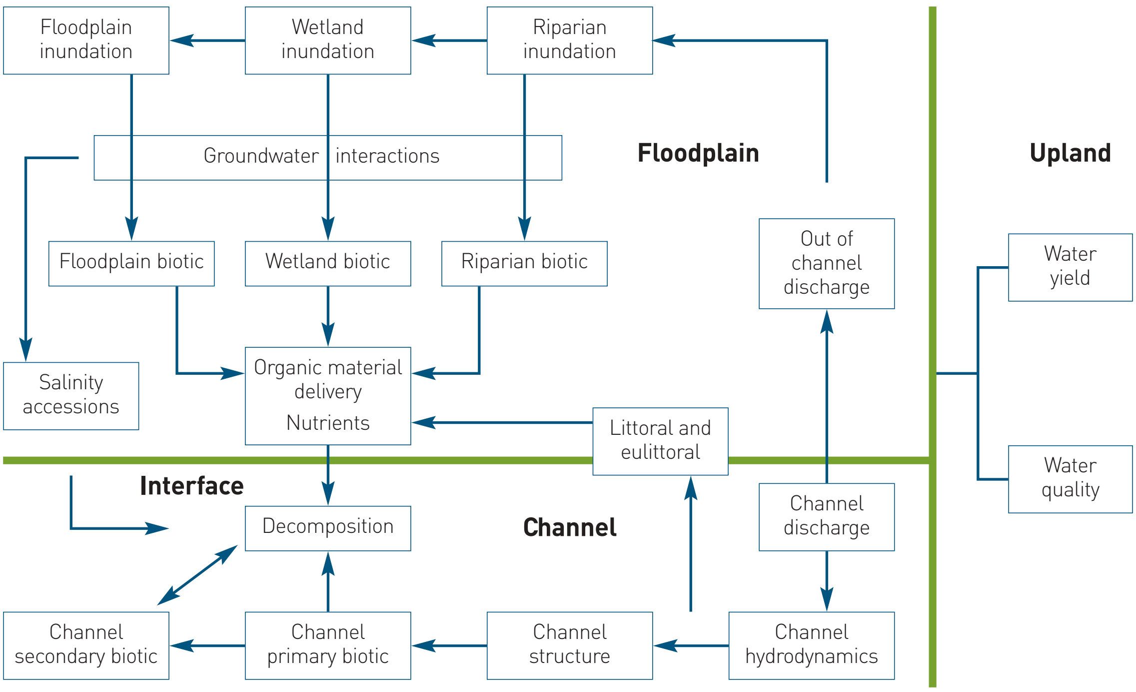
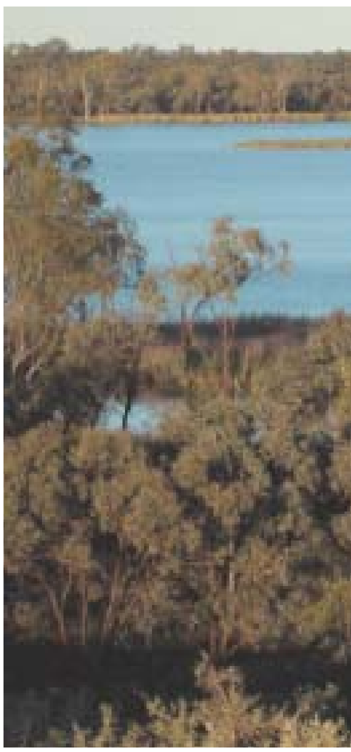
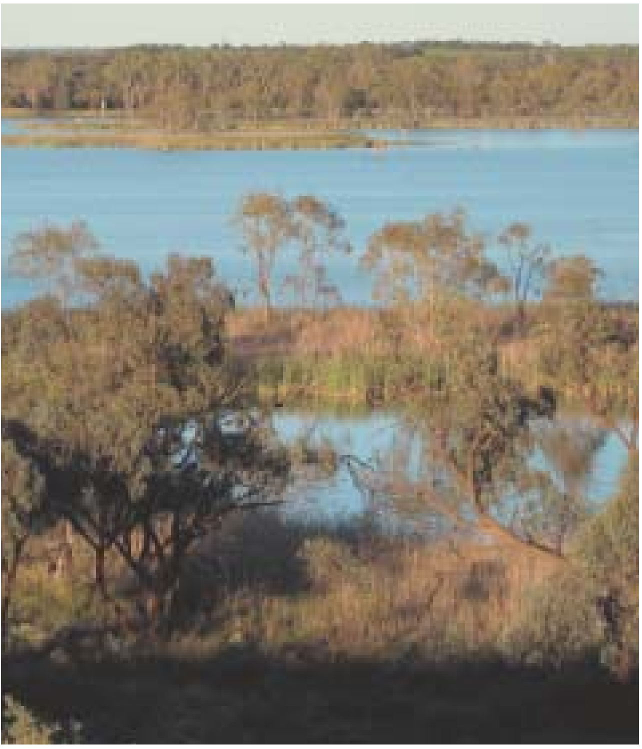


***Figure 1**. The conceptual model of key processes that will enable quantitative linking of water regime and ecological outcomes.*



which parts of the floodplain and its wetlands inundate at particular river flows. This work is nearly complete. When combined in the coming year with elevation data developed from LIDAR (LIght Detection And Ranging) images, the model will also be able to estimate volumes of water on the floodplain. Thus the full complement of water regime will be able to be estimated for any flood or watering at any place on the floodplain or any wetland (within the limits of the resolution which is currently 30 metres x 30 metres): the volume of water, its depth and its duration. Our approach is not to emulate the precision of full hydrodynamic modelling for particular places, but to produce reliable and consistent estimates of water regime along the length of the whole Murray River.



Both photos. *Kings billabong, Mildura, courtesy Healthy Country Flagship, CSIRO.*

Floodplain and wetland vegetation

The objective of this part of our work is to produce an integrated terrestrial vegetation map for the Murray Valley which, laid over the flood inundation map and combined with new knowledge about the response of individual species to water regimes, will provide estimates of vegetation responses to alternative watering plans. Progress to date includes assembly of taxonomic data from four herbaria into one consistent database (which indicates there are 1850 plant species native to the Murray floodplains); as well as compilation of data from major plant surveys and a dynamic floodplain vegetation model for the lower Goulburn. Further characterisation of wetland vegetation is being developed under a LWA project with collaborators at the University of Adelaide (see page 17). We are also exploring the potential to use LIDAR data to help distinguish community composition and remote sensing to pick up early signs of vegetation responses to water regimes. Other test work includes assessing invertebrate collections for their potential to complement the vegetation maps and build more complete pictures of the biotic responses to water regimes.

Broken Creek. Photo courtesy Healthy Country Flagship, CSIRO.

Channel production and fish

Fish are the key ecological outcome from the channel. They depend on food and habitat in the river, as well as being able to connect with flood-plains and wetlands for enhanced food resources and, in some cases enhanced breeding conditions. Our objective is to be able to predict the major characteristics of these interactions along the whole channel in order to link water regimes (floodplain and channel) to fish. Work in progress includes: measuring primary production in the river and validating a hydro-acoustic technique for quickly and accurately measuring fish numbers. Subsequent work will characterise channel morphology and habitat condition along the river, and link plant and fish production via foodwebs.

Responses to water manipulations

At a smaller scale, we are developing methodologies for assessing the impact of floodplain watering strategies that involve new structures such as regulators, pumps and fishways. These studies have immediate application and will also feed more detailed information about individual species responses into the whole-of-system modelling.

Linkages with water managers

Our research places utmost importance on designing tools and analyses that will support the roles of those implementing the Living Murray Initiative. The project is advised by a Reference Panel of MDBC and state representatives, and we have frequent contact with MDBC modelling staff to ensure that our models will interface with, and be complementary to, those used in practice. We also exchange data and ideas with environmental staff in catchment management agencies that are increasingly being charged with the responsibility to administer environmental water in their region. We acknowledge all these inputs, and those of research collaborators in universities and other places who have willingly shared data with us. We can only deliver appropriate, system-wide tools by bringing together the expert knowledge of many people who have spent long years studying and managing this river and its special places. ■

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Environmental water allocation and the living Murray

By Judy Haldane and Mark Siebentritt

Like most dryland river systems in Australia, the natural environment of the Murray is dynamic, it responds to fluctuations in flow through time. Before regulation, high flows occurred most often in winter/spring, and low flows were typical in summer/autumn. With development came the need to deliver more water during summer and autumn to satisfy peak demand. This was at a time when under natural conditions, the river system would be experiencing much lower flows. Regulation of the river system, along with other management practices has led to long-term ecological decline. Scientific advice tells us that if we do nothing the river's health will get worse. This will affect our irrigation and other industries, our native plants and animals and our communities.

In early 2002, the Murray-Darling Basin Ministerial Council established the Living Murray initiative in response to substantial evidence that the health of the River Murray system was in decline. Following this, Council agreed that the Living Murray should be underpinned by high-level principles and made the First Step decision — marking the beginning of a practical step forward in returning the River Murray to the status of a healthy working river.

The initial focus of the First Step decision is on achieving outcomes at the significant ecological assets complemented by water recovery projects and an environmental works and measures program.

Significant ecological assets

The ecological assets were identified on the basis of their high ecological value, for example, they are important breeding sites for waterbirds, and provide life-cycle habitat for fish, birds, vegetation and a variety of other river and floodplain plants and animals. The assets are:

- Barmah-Millewa Forest
- Gunbower, Koondrook–Pericoota Forests
- Hattah Lakes
- Chowilla Floodplain (& Lindsay-Wallpolla Islands)
- Murray Mouth, Coorong and Lower Lakes
- River Murray Channel

Each asset has an Asset Environmental Management Plan that describes the ecological objectives for the asset and identifies the volume and timing of environmental water and the structural works needed to achieve those objectives.

***Below**: Location of the significant ecological assets.*

For more detail on the Environmental Management Plan and the LMEWP go to: http://www.thelivingmurray.mdbc.gov.au/implementing

Goanna. The Barmah-Millewa Forest provides breeding habitat for a number of species including fish, frogs and reptiles. Photo Amy Webb.

Low level flooding of Barmah (Vic) and Moira Lakes (NSW), 4 November 2005. Photo Keith Ward, Goulburn Broken CMA.

Water recovery

Water recovery projects will address over-allocation of water resources, with the recovered 'environmental water' to be used to achieve environmental benefits at the significant ecological assets. The Living Murray Environmental Watering Plan (LMEWP) provides the framework for making decisions on the volume, timing and frequency of water to be provided to each of the assets.

Managing ecological assets — Reinvigoration at Barmah-Millewa Forest

The Barmah-Millewa Forest is the largest river red gum forest in Australia. It covers approximately 66,000 hectares of floodplain between the townships of Tocumwal, Deniliquin and Echuca. It is listed under migratory bird agreements with China and Japan and the Ramsar Convention on Wetlands. The Barmah-Millewa Forest is downstream of the Hume Dam and Yarrawonga Weir, which regulate River Murray flows. As a result, the natural pattern of river flows and flooding in the forest has altered significantly. There has been a decrease in medium-sized spring floods and an increase in low level, undesirable summer flooding. These changes to

Golden and Silver Perch eggs spawned during high river flows, 4 November 2005.
Photo Alison King, Arthur Rylah Institute.

the natural wetting and drying cycles of the forest have resulted in the decline of vegetation communities, and reduced waterbird breeding opportunities. River red gum forest is disappearing from higher elevation areas and moving to lower areas that were previously too wet.

From mid-October 2005 through to January 2006, up to 500 gigalitres* of environmental water is being made available by the Victorian and NSW governments through the Barmah-Millewa Forest Environmental Water Allocation. This will complement River Murray flows that have resulted from recent good rains.

While the Barmah-Millewa Forest Environmental Water Allocation does not form part of the water to be recovered under the Living Murray, it demonstrates the environmental benefits that can be achieved by applying such an allocation. Already, the forest is showing a strong response. More than half the Barmah-Millewa Forest wetland area has been inundated, and vegetation including the regionally significant Moira grass has started to respond. Careful monitoring has shown that Golden Perch, Silver Perch and other native fish, spawned during flow peaks. This event has provided information that improves our understanding of the spawning requirements of these and other native fish species. Colonies of waterbirds including Ibis and Egrets have also started breeding because of recent higher water levels in the forest.

The release of the Barmah-Millewa Environmental Water Allocation has also boosted flow levels along the length of the River Murray with additional water available to downstream wetland systems (Werai Forest, NSW). It is also being utilised to enhance the release from the Barrages into the internationally significant wetlands of the Coorong and Murray Mouth.

While much is known about how to achieve positive outcomes from environmental flows, there is no single best approach that can be applied free of uncertainty. Flows into the forest will continue to be managed carefully in the coming months to sustain bird and fish breeding and maximise environmental benefits. ■

**One gigalitre of water is equal to one billion litres or approximately the same volume of water as 1000 Olympic size swimming pools.*

For further information

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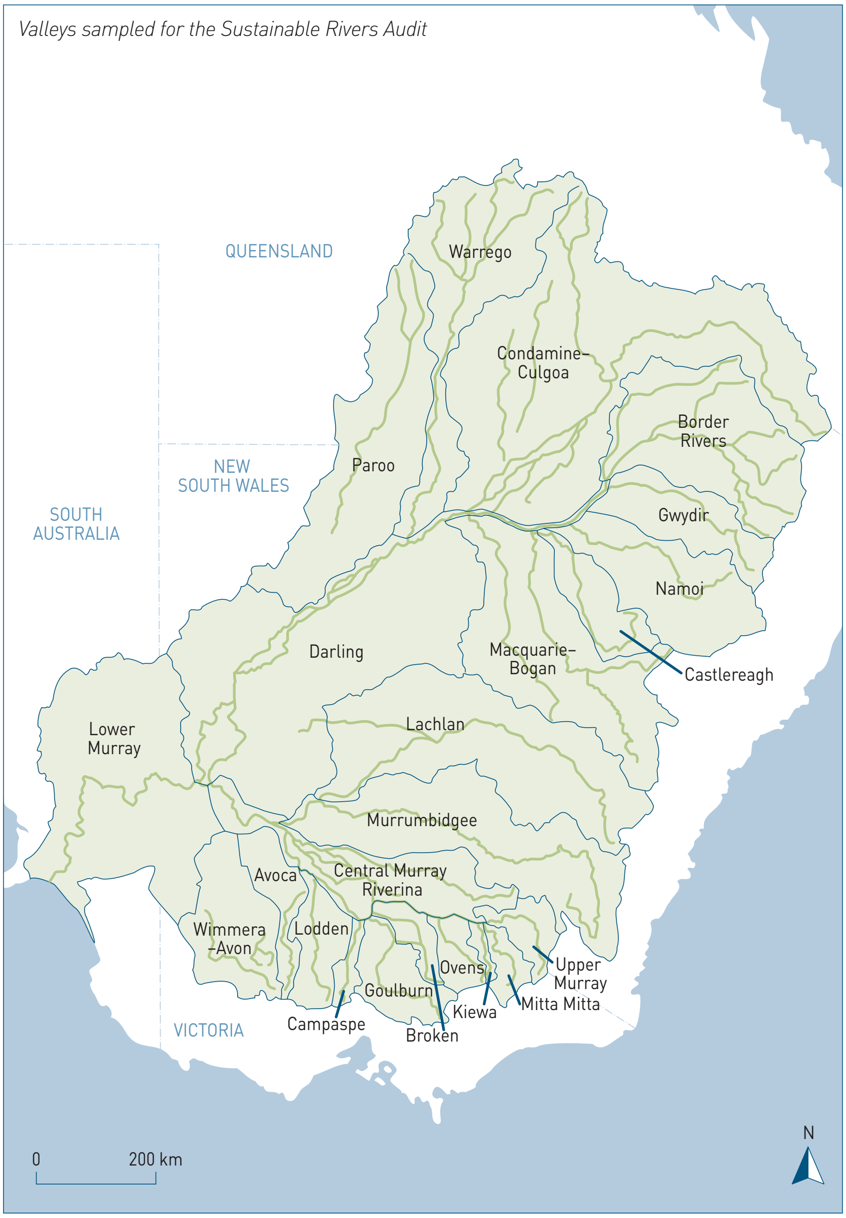
The Living Murray is an initiative of the Murray-Darling Basin Commission, which is a partnership of the Australian, New South Wales, Victorian, South Australian and Australian Capital Territory Governments.

Basin-wide river health audit underway

By Trudi Ryan

A comprehensive river health study will reveal the ecological condition of the Murray-Darling Basin and provide a benchmark for future monitoring studies. Known as the Sustainable Rivers Audit (SRA), the $10.6 million study is an initiative of the Murray-Darling Basin Commission (MDBC) and is supported by its partner agencies in each state and territory within the Basin. The SRA will operate over six years from 2004 to 2010 and data collection is currently underway throughout the 23 river valleys of the Murray-Darling Basin.



SRA sampling will be conducted at random sampling points within each of the 23 river valleys of the Murray-Darling Basin. The consistent sampling framework will allow for comparisons of river health both between valleys and over time.

A Basin-wide perspective

The six-year SRA will be the largest study of river health undertaken in the Murray-Darling Basin and the first time a standard framework has been applied to data collection on this scale. The project recognises the interconnected nature of the rivers in the Basin. It is hoped that by having a consistent approach to data collection, meaningful comparisons of river health between the 23 river valleys can be made. Once the framework is in place, these comparisons will be able to be done at different times, enabling changes in river health to be monitored. By 2007 all of the Basin's rivers will be sampled, giving a big picture view of river health which will be a tremendous resource for the entire catchment community.

The MDBC estimates that approximately 250,000 samples will be collected from thousands of study sites within the million square kilometre Basin over the six-year audit period. A rigorous study design developed by a panel of experts has been tested and refined during a pilot study process. The SRA will target key elements of river ecology that are known to be reliable indicators of overall ecosystem health. In the first instance, scientists will focus on three thematic indicators: fish communities, macroinvertebrate diversity and hydrological patterns. Three additional indicator themes are also in development and may be adopted during the second three-year phase of the SRA. These indicators focus on floodplain health, riparian vegetation and the physical form of rivers and streams to add a further perspective on river health across the Murray-Darling Basin.

Accounting for valley diversity

Data will be collected from randomly selected sites partitioned, where applicable, by four altitudinal zones in each of the river valleys. This design will account for diversity between lowland riverine (<200 metres above sea level [asl]), slope (200–400 metres asl), upland (400–700 metres asl) and montane (>700 metres asl) habitats. It will enable scientists to compare results for a given altitudinal zone across valleys as well as to determine the overall health of a given valley. River health will be compared against pre-European settlement condition, which will provide

a common benchmark and a point for comparison across the 23 valleys. Natural condition will not necessarily be a target for river management as the desired state of a river depends on the community's economic, social and ecological values and needs. The SRA provides the ecological report card on river condition but many other factors are incorporated into the water resource planning and management process.

Scientists from state and territory government agencies will use a range of techniques to investigate the indicator themes. Scientists sampling fish populations will use electrofishing and bait trap methods to assess the composition of fish communities at each sampling point. Scientists want to determine the number of different fish species populating the river networks and how these species make up the total fish community. For example, what is the relative abundance, by number of individuals and biomass, of native and introduced species and how well represented are species occupying different ecological niches? These patterns are indicative of such river health measures as water quality and the availability and distribution of habitat resources including food, shelter and breeding sites.

Similar investigations of macroinvertebrate diversity will be made across the Basin. The scientists are particularly interested in the distribution and composition of insect larvae, crustaceans and snail populations. Patterns and rates of flow will be investigated under the hydrology theme using data held by state and territory governments.

Introducing the Sustainable Rivers Audit (SRA)

- $10.6 million, six-year project (2004–10)
- Coordinated by MDBC and supported by its partner agencies.
- Biological and physical indicators will be assessed to determine river condition.
- Sampling will be conducted in each of the Basin's 23 river valleys.
- Consistent sampling framework will allow comparisons between river valleys and over time.
- Results will be independently analysed and reported by a team of experts, the Independent Sustainable Rivers Audit Group.
- SRA findings will inform future river management.

Healthy river ecosystems form the basis of biodiverse and productive catchments. The SRA will assess the river health of the 23 river valleys that make up the Murray-Darling Basin. Photo Arthur Mostead, sourced from the Murray-Darling Basin Commission.

MURRAY-DARLING BASIN COMMISSION

The composition of fish populations is indicative of river health. The ratio of native to introduced species and the relative abundance of different species will tell scientists a lot about water quality and the availability of habitat resources for breeding, shelter and foraging. Photo Arthur Mostead, sourced from the Murray-Darling Basin Commission.

The aims of the Sustainable Rivers Audit

- Determine the ecological condition of the rivers of the Murray-Darling Basin.
- Offer an insight into how river condition may vary across the 23 river valleys and change over time.
- Standardise river assessment programs across the state and territory boundaries of the Murray-Darling Basin.
- Provide scientific information to better inform community discussion about river management issues.
- Complement other river health initiatives and programs such as *The Living Murray, The Native Fish Strategy* and the 'Cap' on water diversions.
- Raise community awareness about the condition and importance of river health.

How will the data be analysed and reported?

Each year, the MDBC will collate the data collected by scientists from the state and territory government agencies for independent review by a panel of experts. This panel, known as the Independent Sustainable Rivers Audit Group (ISRAG) will analyse the data and provide an annual report to the Murray-Darling Basin Ministerial Council.

ISRAG will also prepare a more detailed report during the third and sixth years of the SRA detailing any changes in river health that have been detected during the monitoring process. ISRAG member Dr Terry Hillman said, "this information on the health of the Basin's river networks will inform future public discussion about the changing state of the rivers and will guide the long-term management of these critical riverine resources".

Contact

Further information on the Sustainable Rivers Audit including the SRA Program Report (2004) detailing metrics and indicators used for reporting river condition can be obtained from the website www.mdbc.com.au/sra ■

For further information

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Scientists use sweep-netting and other techniques to sample the number and relative abundance of different macroinvertebrate species living at a given sampling point. The results are indicative of river health attributes such as water quality, turbidity and the availability of habitat resources. Photo Arthur Mostead, sourced from the Murray-Darling Basin Commission.

Sustainable Rivers Audit — Sampling schedule

The sampling schedule for each river valley is outlined below. Sampling will reflect the main season of activity for the indicator groups across the broad climate zones of the Murray-Darling Basin. For example, macroinvertebrates are sampled in spring ( ) in the winter rainfall-dominant southern valleys while autumn ( ) sampling takes place in the summer rainfall-dominant northern valleys. Given the magnitude of the task of sampling 23 valleys for macroinvertebrates and fish in just 12 months, the Sustainable Rivers Audit spreads sampling over two years for macroinvertebrates and three years for fish.

			Fish						Bugs					
State	Valley	Possible zones in catchment	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
QLD/NSW	Paroo	2												
QLD/NSW	Warrego	3												
QLD/NSW	Condamine–Culgoa	5												
NSW/QLD	Border rivers (Moonie) NSW	4												
NSW	Gwydir	4												
NSW	Namoi	3												
NSW	Castlereagh	3												
NSW	Darling / Benanee	3												
NSW	Macquarie–Bogan	3												
NSW	Lachlan	3												
NSW/ACT	Murrumbidgee	4												
NSW	Murray–Riverina (Hume to Lock 9)	3												
VIC/NSW	Upper Murray (above Hume, NSW–VIC)	3												
VIC	Mitta	3												
VIC	Kiewa	3												
VIC	Ovens	3												
VIC	Broken	2												
VIC	Goulburn	3												
VIC	Campaspe	3												
VIC	Lodden	2												
VIC	Avoca	2												
VIC	Wimmera–Avon	2												
SA	Lower Murray (below Lock 9 / Mallee	3												

RAPt in rivers

National Riparian Lands R&D Program

Land & Water Australia's National Riparian Lands R&D Program has undertaken 11 years of research into how riparian areas function, how they can be better managed, and how to engage local communities in protecting, maintaining and rehabilitating these important parts of the landscape. At the end of the first phase of the Program, a series of workshops was held across Australia to disseminate research findings and to link people to the range of practical tools that had been developed. The second phase of the Program has now been completed, and it is timely to run these workshops again as new science, new products and new ways of thinking about how to work with communities have been developed. To date, workshops have been run in Queensland, South Australia and the ACT, as well as an extra one for Greening Australia facilitators. All the workshops have been well received and feature the scientists who have done the research talking about their findings. Professor Ian Rutherfurd, Professor Stuart Bunn, Professor Peter Davies, Dr Amy Jansen, Dr Andrew Brooks, Dr Don Thomson, Dr Phil Price and Dr Siwan Lovett are all involved. In February and March 2006, workshops will be held in Tasmania, Victoria, New South Wales, the Northern Territory and Western Australia. In each case, your state or territory NRM agency will be managing the workshop so look out for advertisements and secure your place early.

If you can't get to a workshop, don't despair as the next edition of *RipRap* will feature all the key findings from the Program, including information about the great new range of products that we are currently developing. ■

Dean Holland and Siwan Lovett. Photo James Morris.

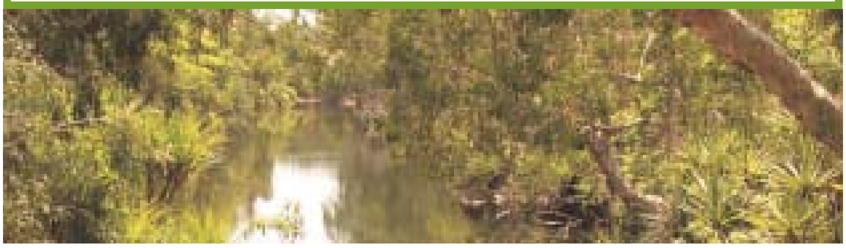
Call for projects ...

... Tropical Rivers Program, Social and Institutional Research Program, Native Vegetation and Biodiversity Program

In October 2005 proposals were sought for research and development (R&D) projects under three new programs. Integrated proposals that were innovative and collaborative across the three themes were also encouraged. The priority themes for the programs were:

- Tropical Rivers R&D Program
  - Ecosystem services of tropical rivers.
  - Understanding river and groundwater hydrology.
  - Research to support implementation of regional plans.
- Social & Institutional Research R&D Program
  - National Water Initiative social, market and institutional implementation.
  - Native vegetation regulations, incentives and institutions.
  - Market-based instruments mix, private sector leverage and institutions.
  - Regional NRM groups, institutions and governance arrangements.
- Native Vegetation & Biodiversity R&D Program
  - Understanding and valuing landscape processes.
  - Understanding risk and threatening processes.
  - Informing policy and management.

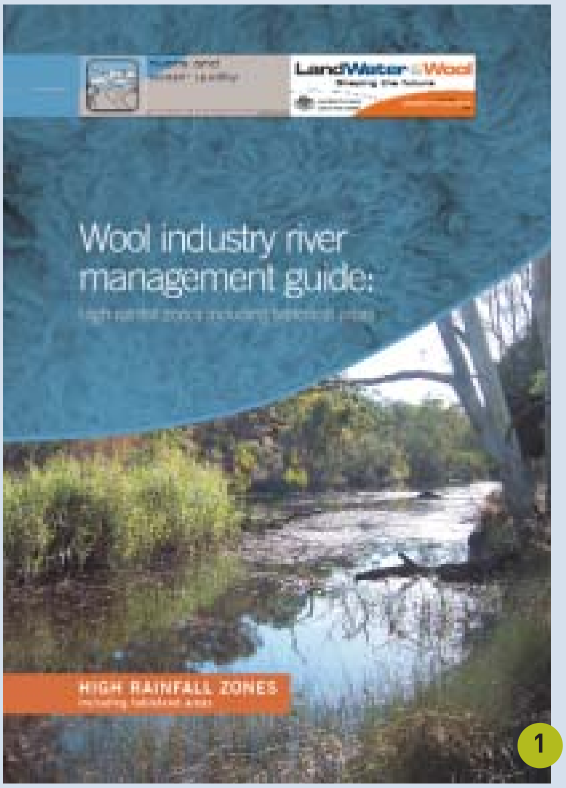
Successful projects are expected to be announced shortly with most projects expected to commence in early 2006. For further information contact Brendan Edgar, Acting Landscapes Manager at brendan.edgar@lwa.gov.au, or (02) 6263 6061.



Indigenous Projects Workshop

On 12–13 December 2005, Land & Water Australia hosted a workshop in Darwin for researchers involved in research and development projects with an indigenous focus. The meeting gave networking opportunities to assist research teams to develop project communication and adoption strategies; identified ways for LWA to support researchers and projects; and identified opportunities for communicating R&D outputs to target audiences. Further information is available from Stuart Pearson, Senior Knowledge Broker at stuart.pearson@lwa.gov.au, or (02) 6263 6008. ■

New river management information tailored for the wool industry



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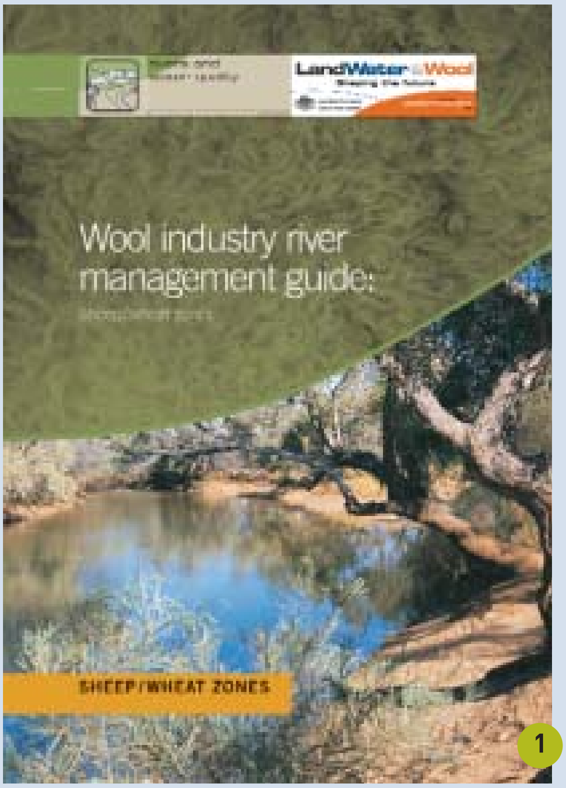

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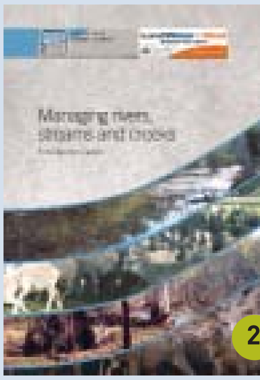

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Land, Water & Wool — Rivers and Water Quality has produced three complementary publications that are a must for anyone working in sheep growing regions of Australia. The first publication comprising two volumes is a comprehensive Wool Industry River Management Guide that brings together the latest science and recommended management practices for riparian areas within the context of a commercial wool growing property. The Guides are available for the high rainfall (above 600 mm) regions and sheep/wheat (300–600 mm) regions of Australia. Each book has more than 200 pages and is produced in full-colour.

The second publication — 'Managing rivers, streams and creeks: A woolgrowers guide' — is a summary of the key recommendations from the Guides and provides a friendly introduction to the river and riparian management issues on farm.

The final publication is 'Rivers Insights', featuring the stories of ten woolgrowers and what has motivated them to manage their rivers, creeks and streams in ways that make both economic and environmental sense.

These products will be available from CanPrint Communications on 1800 776 616 in hard copy (after February 2006) or can be downloaded from www.landwaterwool.gov.au or www.rivers.gov.au

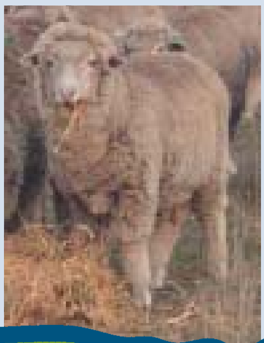


Photo Australian Wool Innovation.

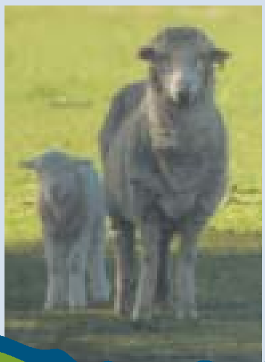


Photo Australian Wool Innovation.


Photo Australian Wool Innovation.


Photo Australian Wool Innovation.


Photo Jenny Sullivan.

Finding out about the National Water Initiative and the National Water Commission

Australia is improving the way it manages water. While states and territories remain the primary custodians of water resources, all levels of government are now working more cooperatively to deal with water as a national issue. This approach was formally adopted in 1994 when the state and territory governments, along with the Australian Government through the Council of Australian Governments (CoAG) agreed to a new national framework to minimise unsustainable use of water resources.

Much was progressed under this framework; however changes happened at very different rates across states and territories. To maintain the momentum for change and to further clarify water allocations and entitlements, CoAG last year reaffirmed its commitment to water reform by drawing up a long-term action plan called the National Water Initiative.

The Australian Government and all states and territories, with the exception of Western Australia, have signed on to the National Water Initiative.

Among the agreed actions of the signatory states and territories are commitments to:

- prepare water plans with provision for the environment;
- deal with over-allocated or stressed water systems;
- introduce registers of water rights, and standards for water accounting;
- reduce barriers to interstate water trade;
- improve pricing for water storage and delivery; and
- meet and manage urban water demands, for example, through the increased use of recycled water and stormwater.

To drive the national water reform, in March 2005 the Australian Government created the National Water Commission which advises the Prime Minister and CoAG on the progress of the reform process. The Government nominated three members to the Commission and the National Water Initiative state and territory partners also nominated three members. The Prime Minister appointed the Chairman to make up the final seven-member Commission. The Commission includes the Chairman Ken Matthews, Peter Corish, Dr Wally Cox, Peter Cullen, Chloe Munro, Dr John Radcliffe and David Trebeck. Commissioners were appointed for their expertise in an area relevant to the functions of the Commission, including water resource management; freshwater ecology or hydrology; resource economics; public sector governance; and the audit, evaluation or implementation of natural resource management programs.

***National Water Commissioners**. Pictured from left, Mr David Trebeck, Professor Peter Cullen, Mr Peter Corish, Dr John Radcliffe, Ms Chloe Munro, Dr Wally Cox and Chairman Ken Matthews.*

Australian Government
National Water Commission

The Commission has an additional role in advising the Prime Minister on financial assistance to be provided from two programs under the Australian Government's $2 billion Water Fund — the Water Smart Australia and Raising National Water Standards programs.

Projects that help to achieve the objectives, outcomes and actions of the National Water Initiative will be eligible to receive assistance from the Fund.

In its first six months of operation, the National Water Commission has, among many other activities:

- run one round in the Water Smart Australia program and is currently assessing project proposals;
- prepared guidelines for states and territories developing National Water Initiative implementation plans;
- started undertaking the 2005 National Competition Policy assessment of state and territory progress in implementing water reforms; and
- begun developing a baseline assessment of Australia's water resource and governance arrangements.

In coming years, the Commission will continue to progress the country's water agenda and press hard on areas critical to reform including water accounting and measurement, water access entitlements, water trading, ground water management and urban water reform.

For more information on the National Water Commission or any of its programs, visit www.nwc.gov.au or call (02) 6102 6000. ■

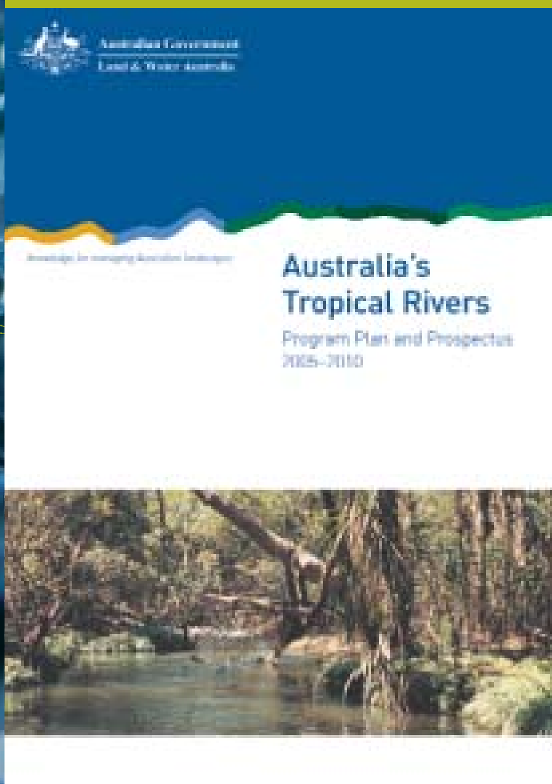
The full details of the National Water Initiative are available at www.nwc.gov.au/NWI/index.cfm

Australia's Tropical Rivers Program Plan and Prospectus

The Board of Land & Water Australia (LWA) has identified Australia's unique tropical rivers and associated catchments and estuaries as a priority area for a major investment over five years from July 2005. LWA is inviting expressions of interest from prospective investors interested in partnerships in research and development to improve the knowledge base for managing Australia's tropical rivers and associated catchments and estuaries.

The program is being managed through the National Rivers Consortium, a strategic collaboration between policy makers, river managers and scientists. Start-up funding for 2003/04 and 2004/05 has been secured from the Natural Heritage Trust, National Landcare Program and the National Rivers Consortium.

For a copy of the plan contact CanPrint Communications on 1800 776 616.



Absolutely RIPPing pix

We thought these images were particularly fabulous so wanted to show you some others. The full article begins on page 20.

The full article begins on page 20.

Narran Lakes. *Photos courtesy of Narran Lakes Ecosystem Project.*

New South Wales

by Alex Meehan

Returning water to the environment in NSW

There is a diversity of programs running in NSW to allocate water to the environment, all of which are aiming to improve the health of rivers and wetlands over the next ten years. The basis for these programs are the Water Sharing Plans (WSPs), which have delivered comprehensive environmental flow rules for many rivers in NSW. These WSPs are being complemented by several innovative schemes to recover water for critical wetlands, and will be evaluated by monitoring programs designed to ensure rigorous scientific assessment of environmental outcomes.

Sharing water between the environment and entitlement holders

The *Water Management Act 2000* put in place a system for setting the rules for allocating water, including the development of WSPs to cover surface and groundwater systems. There are currently 31 WSPs operating in NSW, with more in preparation. The water sharing rules within these plans are designed to provide for the environmental protection of the watersource, as well as directing how water will be allocated and shared among different water users. Each WSP contains a number of environmental water provisions, such as:

- diversion limits;
- provision of minimum flows at the down-stream ends of rivers; and
- release of water from dams to coincide with a reservoir inflow.

However, the most pertinent are environmental allocations, which create a bank of reservoir water specifically for environmental purposes, such as the flushing of algal blooms. Environmental allocations have been used since at least 1980; for example, in the Macquarie Marshes to sustain waterbird breeding, but they are now part of every WSP that covers a major regulated river. The plans will be reviewed after ten years, and several monitoring programs are now in place to determine their effectiveness (see below). In the meantime, others schemes are being developed to complement them.

Aquatic plants in Yarradda Lagoon, Murrumbidgee River, three months after environmental allocations.

Investing in innovative schemes to increase water efficiency

Delivery of environmental water by the WSPs is being achieved not only by changes in timing of releases and protection of flows at critical times, but also by reducing the volumes of water diverted to water users. While these limits are necessary to achieve sustainable water management, they have the potential to negatively impact rural communities, so it is important to find alternative strategies for recovering water.

The Wetland Recovery Plan (WRP) is one such initiative, designed to halt the decline of the internationally significant Macquarie Marshes and Gwydir River wetlands, by investing in water recovery and environmental management projects. The WRP works within the agreed WSPs for the Macquarie and Gwydir Rivers, but accentuates the environmental allocations by recovering additional water and delivering it more efficiently to critical wetlands. This way more water can be made available for the environment without adversely impacting farming productivity. The WRP includes projects that will:

- replace open channels with pipelines to minimise evaporation and leakage;
- modify flood barriers to enable a more effective distribution of flows into wetlands; and
- control the spread of invasive exotic weeds that would otherwise replace natural species benefiting from environmental flows.

Overarching management plans are being developed to guide such actions, which will be implemented over the next four years.

Evaluating benefits of environmental flows

Monitoring the effects of environmental water allocation is vital if we are to see whether the environment is reacting to changed flow regimes as expected. Two programs are already underway in the regulated rivers, and a new program is being developed for the unregulated rivers. These programs will be vital to measure the effectiveness of the WSPs when they are reviewed after ten years.

The Integrated Monitoring of Environmental Flows program measures changes in water levels, habitats and ecological processes after the release of environmental water. The program, which began in 1998, currently has over 20 studies running across NSW investigating

Egret rookery, Gwydir wetlands, after environmental water allocations in February 2005.

rivers, wetlands and even estuaries. To date, significant benefits to riparian wetlands have been measured in a number of valleys. For example, in the Murrumbidgee, environmental releases made in 2000 produced significant billabong filling, while similar releases in the Lachlan and Gwydir helped sustain large water-bird breeding events.

Environmental flows are also being released in stages to the Snowy River downstream of Jindabyne Dam to restore damage to the river's ecology caused by the construction of the Snowy Scheme over 37 years ago. The environmental allocations to the Snowy consist of:

- increased baseflows;
- a controlled flood release; and
- a return of seasonal flows.

The Snowy River Flow Response Monitoring project has been established to measure how these releases improve the river's ecological health. Indicators such as water quality, vegetation and fish are assessed over time, and in particular to see whether they are moving towards reference sites considered 'healthier'. The first environmental flow was released in August 2002, and baseline/post-flow results are currently being analysed.

For the unregulated rivers, a monitoring program is under development that will measure change in ecological condition over the lifespan of the WSPs. A major challenge for the new program will be to detect benefits of environmental flows, as in contrast to the Snowy and Murrumbidgee flow rules, those operating in unregulated WSPs are narrow, consisting mainly of pumping thresholds for license holders. To overcome this, conceptual models of ecosystem response to water extraction have been developed to focus the program on those indicators most responsive to changes in flow. Preliminary work undertaken in the Bega River suggests quantifying benefits is possible, provided that monitoring is concentrated in dry periods.

The new program is scheduled to begin in 2006. ■

For further information

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RARC version 2

The Rapid Appraisal of Riparian Condition (RARC) assesses the ecological condition of riparian habitats using indicators that reflect functional aspects of the physical, community and landscape features of the riparian zone.

Riparian condition refers to the degree to which human-altered ecosystems diverge from local semi-natural ecosystems in their ability to support a community of organisms and perform ecological functions.

This Technical Guideline is the second version of the RARC, and incorporates a simplified scoring system, additional indicators, and some adjustments to scoring of individual indicators.

The www.rivers.gov.au website now has a page dedicated to the RARC with the latest pdf and the excel spreadsheet to calculate scores available for easy downloading.

To obtain a copy contact

CanPrint Communications on 1800 776 616
or vist the website www.rivers.gov.au

Victoria by Jodi Braszell

An Environmental Water Reserve for the Thomson and Macalister rivers — implementing water recovery projects in Victoria

Extra water to maintain environmental condition will travel down the Thomson and Macalister Rivers through the recent establishment of an Environmental Water Reserve. As part of *Our Water Our Future*, Victoria is providing legal recognition to the water that rivers need to maintain their environmental health. This has been achieved by the establishment of a legal share of water for the environment — for all Victoria's river and aquifer systems. This water is called an Environmental Water Reserve.

The Thomson and the Macalister Rivers are two of West Gippsland's most significant waterways, supplying water to Melbourne and the Macalister Irrigation district (the largest irrigation area south of the Great Dividing Range in Victoria). The Thomson has also been designated a heritage river, with significant ecological, historical and recreational values. Both rivers provide freshwater flows into the Gippsland Lakes and regularly flood internationally recognised fringing wetlands.

Why were additional flows needed?

Flows in the Thomson and Macalister Rivers have been substantially altered by water resource development for irrigation and urban water supply. A large dam was built on the Thomson River in 1983. The Thomson Reservoir was constructed in order to safeguard Melbourne's water supply during drought. Lake Glenmaggie reservoir was built on the Macalister River in 1926, its water is used to supply irrigators in the district.

The impact of these dams on hydrological regimes in the Thomson and Macalister has been significant. The volume of flows is reduced, there is less variability in the natural seasonal pattern and, in the case of the Macalister, an actual reversal of the flow pattern. There has also been a dramatic reduction in the frequency and duration of some flow components. Scientific assessments indicate that the health of both rivers is declining and that flow needs, in particular, need to be addressed. For example, the abundance and distribution of native fish species (including the threatened Australian grayling) is declining, in-stream and riparian habitats are decreasing, and the abundance and distribution of exotic fish species is increasing.

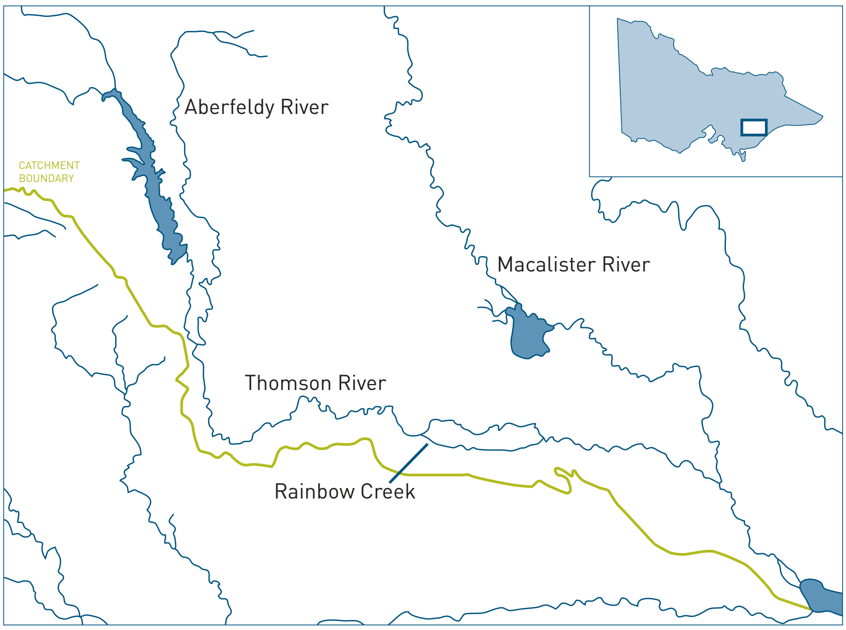
Addressing environmental condition issues in the Thomson and Macalister

As a result of these issues, the Victorian Minister for Water appointed the Thomson Macalister Environmental Flows Task Force in 2000 to assess the adequacy of the Environmental Water Reserve for Thomson and Macalister Rivers. On the Task Force were representatives from Southern Rural Water, the Department of Sustainability and Environment, the Department of Primary Industries, the West Gippsland Catchment Management Authority, Environment Victoria, Gippsland Coastal Board, Melbourne Water Corporation, and, importantly, community and irrigator representatives.

The Task Force commissioned environmental flow studies to assess the flow requirements of both rivers. Based on these studies, the Task Force recommended that the Environmental Water Reserve be increased in both the Thomson and Macalister Rivers to improve their ecological health. The Task Force also recommended a range of complementary river restoration activities such as fencing, nutrient reduction and bed and bank stabilisation.

In 2004, the State Government released its *Our Water Our Future* action plan, which sets out Victoria's strategies for securing water over the next 50 years. Using the recommendations from

The Environmental Water Reserve will provide a share of water to maintain rivers and aquifers, identified as a key component of whole-of-water cycle management.



the Task Force, *Our Water Our Future* committed 25,000 ML to enhance the Environmental Water Reserve for the Thomson and Macalister Rivers, to be delivered over a ten-year period.

The first stage has just been completed, with 10,000 ML provided to the Thomson River as a bulk entitlement for the environment. By the end of 2006, 5000 ML will be added to the Macalister River's Environmental Water Reserve. By 2014, the Thomson will have received a further 8000 ML and the Macalister a further 2000 ML.

The good news is that this process of enhancing the Environmental Water Reserve will not impact on the regional irrigation community. The water provided is coming from efficiencies made by both Melbourne's water saving efforts and recoveries from infrastructure upgrades in the Macalister Irrigation District.

The enhanced Environmental Water Reserve will be released strategically, targeting high priority ecological objectives. These objectives were identified through the environmental flow studies, which together with the Task Force report had a large amount of community input. Some of these objectives include providing triggers for fish spawning and migration, removing sedimentation and maintaining water quality. West Gippsland Catchment Management Authority (CMA) is responsible for the overarching management of these releases and is working with the community to achieve this.

To help manage the day-to-day releases of the Environmental Water Reserve, the West Gippsland CMA has developed Environmental Operating Strategies for both the Thomson and Macalister Rivers. These strategies decide how this extra water will be used and managed, by identifying the priority ecological objectives and the actions required to achieve these objectives.

One of the exciting advances in the adaptive management of the Environmental Water Reserve is the establishment of targeted monitoring programs across Victoria. The eWater CRC has recently developed the Victorian Monitoring Framework to provide river managers with the ability to assess the ecological responses of an enhanced Environmental Water Reserve. In particular, this Framework will allow us to provide river specific monitoring programs — the key to enabling the flexible management of the Environmental Water Reserve to optimise the ecological outcomes for these important rivers. ■

Top and bottom transects. Photos Jodi Braszell.

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RiverWays

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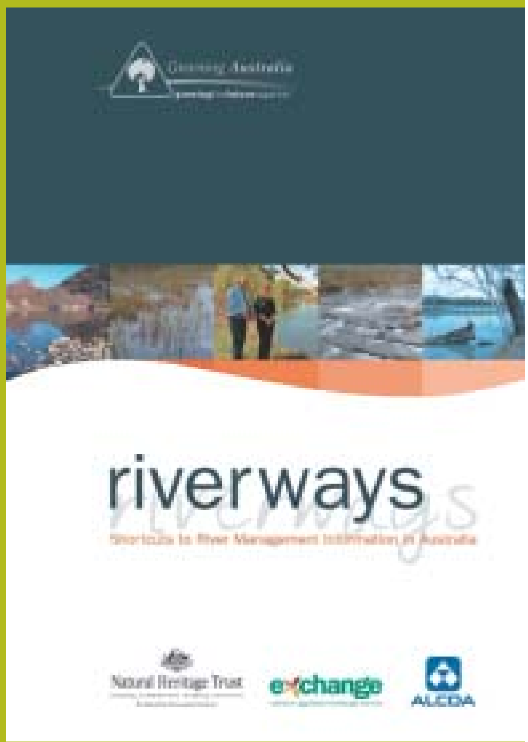

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Tasmania by Danielle Warfe

Environmental water allocation in Tasmania

Tasmanian water managers have most commonly used habitat-based assessments to determine how much water should be allocated, or retained, to meet environmental water requirements. These assessments involve constructing an hydraulic model of a representative reach, and using habitat-use curves to model the amount of habitat available for instream organisms under different discharges. The amount of habitat available, or the number of taxa that may be lost as discharge is reduced determines the level of risk to the system of maintaining that particular discharge. Thus, the minimum discharge of water required to maintain instream habitat at a specified level of risk can be recommended.

As in other states, there has been an increasing recognition that these methods only deal with one part of the entire flow regime, and only one component of the entire ecosystem. Recent assessments have become more holistic in their approach, incorporating the range of flow events present in a flow regime such as cease-to-flow, flush and flood events, as well as addressing the requirements of other ecosystem components such as riparian vegetation, floodplain wetlands, geomorphic features, and estuaries. These more holistic investigations have been conducted for a number of catchments in Tasmania, including the Lower Derwent, Coal, Elizabeth, Little Swanport and Welcome Rivers. The most extensive multi-disciplinary, holistic investigation has been conducted on the Gordon River under the monitoring program for Basslink, and incorporates geomorphic processes and karst, riparian vegetation, instream vegetation, macroinvertebrates and fish populations. Despite the increasing emphasis on holistic environmental flows, there has not been a consistent approach used for Tasmanian river catchments.

The Tasmanian Department of Primary Industries, Water and Environment (DPIWE) has recently completed a preliminary project (funded under the National Action Plan for Salinity and Water Quality) to develop a framework for determining holistic environmental water requirements. The framework is philosophically similar to other approaches which have been developed on the mainland, particularly the Flow Events Method, and relies on the Conservation of Freshwater Ecosystem Values database developed by DPIWE, and the River Analysis Package developed by the CRC for Catchment Hydrology to assist in defining relevant flow events.

Tasmania
DEPARTMENT *of* PRIMARY INDUSTRIES, WATER *and* ENVIRONMENT
WATER RESOURCES DIVISION

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Little Swanport River on Tasmania's east coast. Photo Danielle Warfe.

Flooded paperbark swamp forest on the Ringarooma River, northeast Tasmania. Photo Danielle Warfe.

This framework comprises four major steps:

1. Clearly identify the goals and objectives of the environmental flows. This includes a characterisation of the catchment's natural and current hydrology and potential water demands, establishing the condition of the catchment (land use, riparian condition, vegetation coverage etc.); consulting community stakeholders and interrogating the Conservation of Freshwater Ecosystem Values database; and deriving explicit objectives to be met by the environmental water allocations.
2. Conduct site assessments on representative sites and hydraulic modelling to determine relevant flow events for specific objectives (e.g. availability of spawning habitats, disturbance of riparian vegetation communities, inundation of geomorphic features). These assessments also characterise the physical heterogeneity (particularly the geomorphic and vegetative heterogeneity) of the system, and identify the flow events linked to different "disturbance patches". Where the flow requirements for specific objectives are not known, or do not address all components of the riverine system, these flow events are used to meet the more general objectives of maintaining/restoring physical heterogeneity through flow variability and disturbance.
3. Conduct hydrological analyses to define the occurrence of the flow events in terms of their magnitude, frequency, timing, duration and rate of change.
4. Define the recommended environmental flow regime according to the stated environmental flows objectives.

Consequently, this framework relies on the known flow requirements for specific objectives, and where these are not known, relies on the flow variability which maintains or restores the physical heterogeneity of the system.

This framework has been designed to provide guidance on how to assess, determine and recommend environmental flow regimes for Tasmanian catchments, and to ensure the transparency and objectivity of how such recommendations are reached. It is also hoped this framework will assist in communicating the importance of environmental flows to all stakeholders, and the consequences of providing or not providing them. The Tasmanian experience has shown that while scientific expertise is fundamental to the recommendation of appropriate environmental water allocations, an informed community is critical for successful implementation and management. ■

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South Australia by Glen Scholz

Water Dependant Ecosystem Risk Assessment Tool (Water – RAT)

Government of South Australia
Department of Water, Land and Biodiversity Conservation

One of the major issues in catchment management has been the lack of an integrated framework to give an open, accountable, standardised, and therefore defensible, set of decisions for setting priorities when allocating water resources, investing in on-ground works and for the protection of water dependant ecosystems. The South Australian State Water Plan (2000) requires that "All management and allocation of water resources must provide a process that places decisions about individual water resources development proposals in a total catchment context and take consideration of existing levels of development and the ecosystems that depend on the resource."

Within this catchment management and policy context a need was identified to develop a GIS tool to provide baseline information on spatial distribution and connectivity issues of significant water dependant ecosystems and associated development threats and risks. The application of a risk assessment methodology and the integrated use of environmental condition and process data, assessed through GIS, is now providing policy and program manage in SA with a transparent and defensible set of decision making tools. These tools allow them to identify assets and the threats that may degrade those assets, and to determine priorities based on risk of environmental degradation.

The use of the risk assessment framework provides a standard approach that can integrate scientific data at varying scales and level of detail and allow for interpretation of consequences when making difficult resource allocation decisions. Data is collected through a range of processes including aerial photography (farm dam mapping, swamp mapping), aerial videography (watercourse attributes), licence approvals and irrigation application estimates (groundwater use) and on-ground verification (e.g. Emu Wren habitat locations and Southern Fleurieu wetlands identification).

The following GIS covers are used to evaluate at the upstream/downstream connectivity issues and threat impacts to ecosystem assets (see map at right).

Baseline information
- Stream cover/order (Strahler)
- Digital elevation model
- Geology/groundwater flow systems
- Land parcels/titles

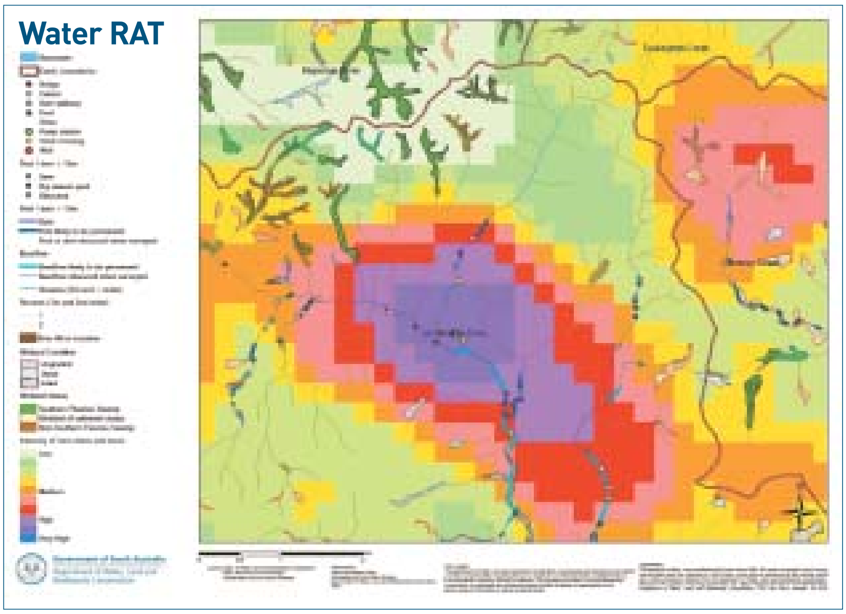
Assets
- Permanent baseflow
- Permanent pools (<15 metre point and >15 metre length)
- Southern Fleurieu wetlands, conditions: degraded, good, intact
- Southern Emu Wren habitat and location

Threats
- Farm dam capture, (spatial/intensity)
- Irrigation bore usage, (spatial/intensity)
- Instream structures, weirs, culverts, bridges, fords
- Onstream pumping stations
- On stream dams (length)
- Forestry cover (spatial)

Management/policy application

Recently, this tool has been used to develop a GIS planning policy coverage that will enable a preliminary assessment of the potential impact of a water affecting activity on a site to be made. This information will then be used to prescribe a level of assessment required by the proponent to ensure the activity will not have a negative

Asset threat map



Full citations were not provided for the references in this article, contact Glen Scholz if you require further details.

impact on significant ecosystems. For example, within the Mount Lofty Ranges the Southern Emu-wren is listed as endangered and the Southern Fleurieu Swamps are listed as a critically endangered under the *Environment Protection and Biodiversity Conservation Act 1999*, activities that have the potential to impact upon this species will now be able to be assessed and regulated accordingly.

The Water Dependent Ecosystem Risk Assessment Tool (Water RAT) developed by the SA Department of Water, Land and Biodiversity Conservation (DWLBC) has defined three risk categories for water affecting activities and incorporates a range of buffer zones that are used to protect these ecological assets. The buffer width zones are supported by the findings of Davies, P.M. and Lane, J.A.K. (1995).

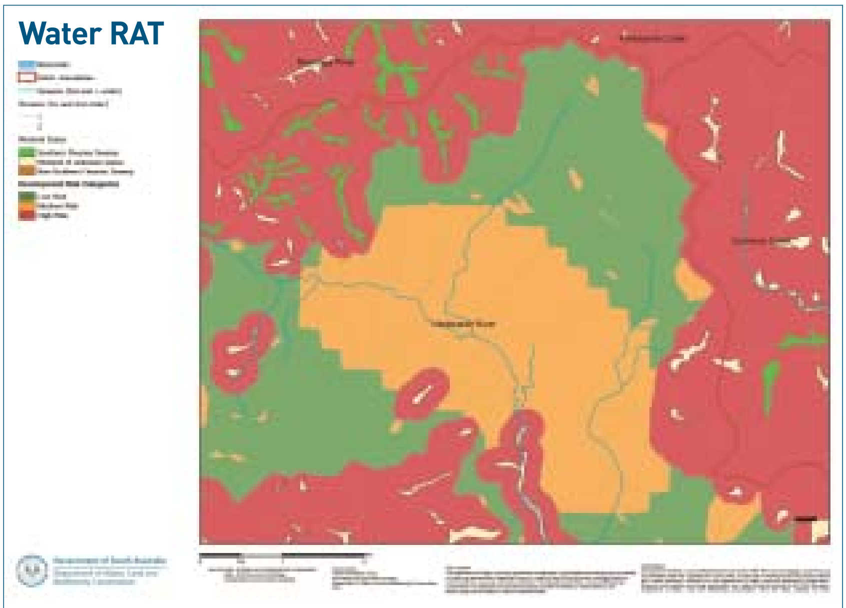
These three zones are used for determining risk posed by development.

Zone 1, Low: Green area

- Without a mapped wetland.
- Without a mapped permanent pool/base flow.
- Less than 20% of modelled runoff potentially used by farm dams or bore irrigation has not exceeded or reached sustainable use limits (State Water Plan, 2000).

Outcome: A proposal that has negligible impacts provided that it complies with pre-set conditions or a code of practice.

Development risk map



Zone 2, Medium: Orange area

- Greater than 20% modelled run off potentially used by farm dams or bore irrigation has exceeded or reached sustainable use limits (State Water Plan, 2000).
- With permanent pool/base flow.

Outcome: Proposals that may have significant on-site or off-site impacts that need to be assessed in a more rigorous manner and may include a site inspection.

Zone 3, High: Red area

This zone has been defined as containing high value ecosystems and possibly surface and groundwater stress.

- Upland Southern Fleurieu Swamps incorporate those areas that are reliant on a small watershed comprised of runoff and through flow from 1st and 2nd order streams. Most of these swamps have a watershed radius of less than 2 kilometres.
- Upland Southern Fleurieu Swamps have a minimum buffer zone of 100 metres.
- Isolated Southern Fleurieu Swamps incorporate those areas that are in 3rd order streams and higher. It is argued that as these swamps are further downstream, they are not solely dependant on flow generated in the immediately vicinity. Part of the flow regime for these swamps may be supplied from free flowing areas upstream. A buffer width of 200 metres has been applied to these areas.

Outcome: Proposals that present a high on-site or off-site impact and require a rigorous ecological/hydrological assessment including a site inspection.

The Water RAT was developed by DWLBC for the Mount Lofty Ranges area, but in the future may be applied to other regions as Natural Resource Management Boards take on more responsibility for the management of the state's natural resources. ■

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Western Australia by Jane Hammond

Flow Events Method favoured in WA for tropical and south west river systems

Western Australia is using the Flow Events Method supported by River Analysis Package software to model environmental flows for its river systems in a range of different climatic regions. The work will help ensure the ecological and social needs for water are met while accommodating the economic requirements for public water supply, irrigation and other water use in line with the Environmental Water Provision Policy for WA, 2000.

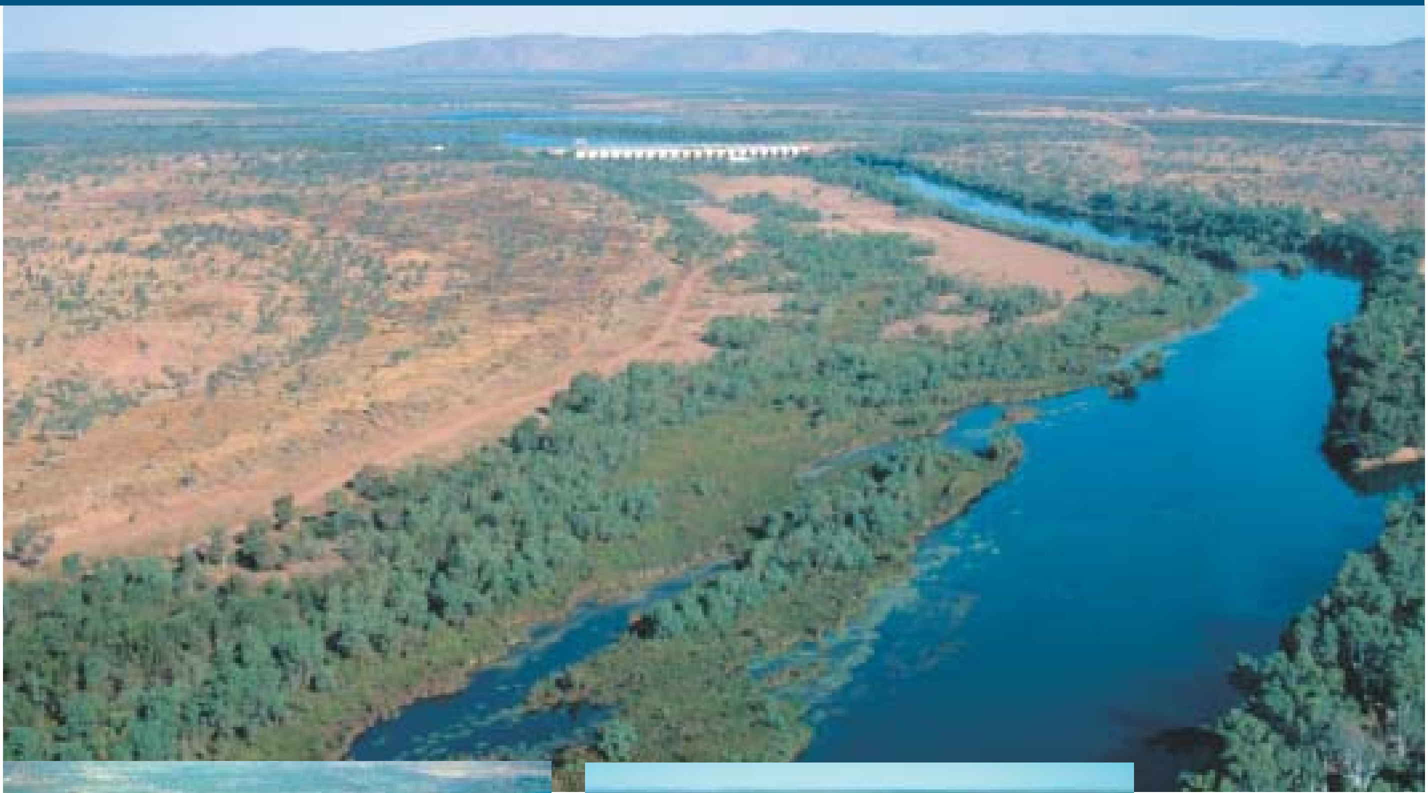
WA has been quick to adopt and adapt more holistic approaches to environmental flow assessment as they have developed in Australia and overseas. In the mid-1990s holistic approaches that took account of the ecosystem needs of the whole river system were used widely on the rivers of the south-west. From the tropical rivers of the Kimberley to the arid regions of the rangelands and the rivers of the temperate south west, the newly created State Department of Water is now using the Flow Events Method (FEM) to improve understanding of environmental water requirements and to support the management of the surface water resources of WA.

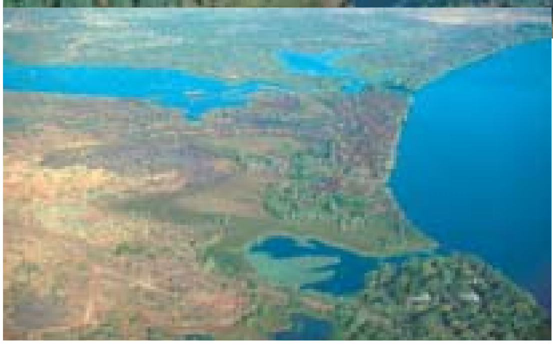
FEM was used for the first time in WA last year on the Hill River and Moore River, north of Perth. The rivers were chosen for the trial because they are simpler and smaller systems than many of the state's bigger rivers. The trials proved successful and FEM is now being applied to one of the nation's best known tropical rivers, the Ord, and with funds provided through the NAP for Salinity and Water Quality, to smaller river systems in the temperate south west of the state such as the Margaret River south of Bunbury.

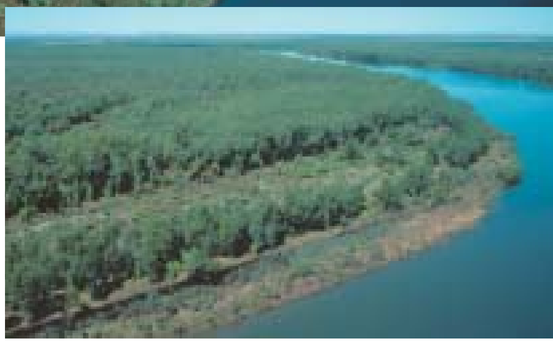
FEM is increasingly being used because it provides a useful way to link river ecology with the flow regime and takes into account the full range of flow variability over time. It is supported by an evolving software package (called the River Analysis Package or RAP). RAP provides an audit trail that records the decision-making process leading to an ecological water requirement. FEM continues to be developed by the University of Melbourne through the work of leading scientists, such as Dr Michael Stewardson.

In WA, the level of detail required to assess environmental flows depends on demand pressures on the resource. For rapid assessments in areas where consumptive pressures are low, hydrological approaches are still used for resource planning. For such systems in the south west sustainable yields are estimated to be 60% of historical mean annual flow with 40% retained for environmental needs.

Kimberley River Survey. Sundry shots of the Ord between the dams, wetlands and town. Close shots of vegetation on Ord below diversion dam. September 1997. All photos Dr Luke Pen.







Main image: *Kimberley trip, Film 14. Ord River looking back at diversion dam. June 1995.*

Inset left: *Kimberley River Survey. Sundry shots of the Ord between the dams, wetlands and town. Close shots of vegetation on Ord below diversion dam. September 1997.*

Inset right: *Kimberley trip, Film 13. Dense forest vegetation which has grown up along the impounded part of the Ord near mouth over the last 25 years, June 1995.*

More detailed holistic approaches are used to support resource planning in areas where demands are high or increasing rapidly. Holistic approaches such as the Building Block Method (BBM) have a long history of use in WA. Until very recently BBM was the approach normally used to identify ecological requirements and set limits on water allocations. Developed by Professor Peter Davies from the University of WA in the mid 1990s, the BBM was applied successfully to a number of systems such as the Dandalup River; and to set environmental flows below the Harris and Wellington Dams. The approach set the environmental flow as a monthly volume and specified the release of functionally important high flows as a frequency.

Hydraulic methods such as the wet perimeter approach have also been used in WA, including the Ord River in the Kimberley. Pressure to meet demands for water from competing users meant that the wet perimeter approach was used as an interim assessment method while the detailed scientific work needed to support a fuller analysis was underway. Extensive research on the ecology and flow characteristics of the Ord system has been carried out over the last five years through programs such as the Environmental Flows Initiative. This research provides a baseline to support environmental flow assessments and has highlighted the limitations of the wet perimeter approach to identifying ecological water requirements and allocation decisions.

WA will continue to invest in and adapt environmental flow methodologies such as BBM and FEM to protect aquatic ecology while providing water to meet current and future demands. The use of FEM in WA will result in: a better description of the flow regime needed to protect the state's river systems; better mimicking of the natural environment; and adaptation of environmental flows to a changing climate. ■

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Queensland by John Amprimo

Providing environmental flows in Queensland

The Queensland Government, under the *Water Act 2000*, can establish a Water Resource Plan (WRP) for a basin. A WRP formally establishes the strategic balance between consumptive and environmental water allocations across the basin.

The plans consider the flow requirements at a set of key points through an entire basin and across the flow regime. A numerical simulation model of daily flow within the basin is used in the development of each plan. This assists in the development of appropriate environmental flow strategies and the assessment of their relative benefits. Modelling flows over a long period is particularly important in river systems exhibiting high flow variability. Typically, the maximum extent of available rainfall and stream flow records is used in the modelling.

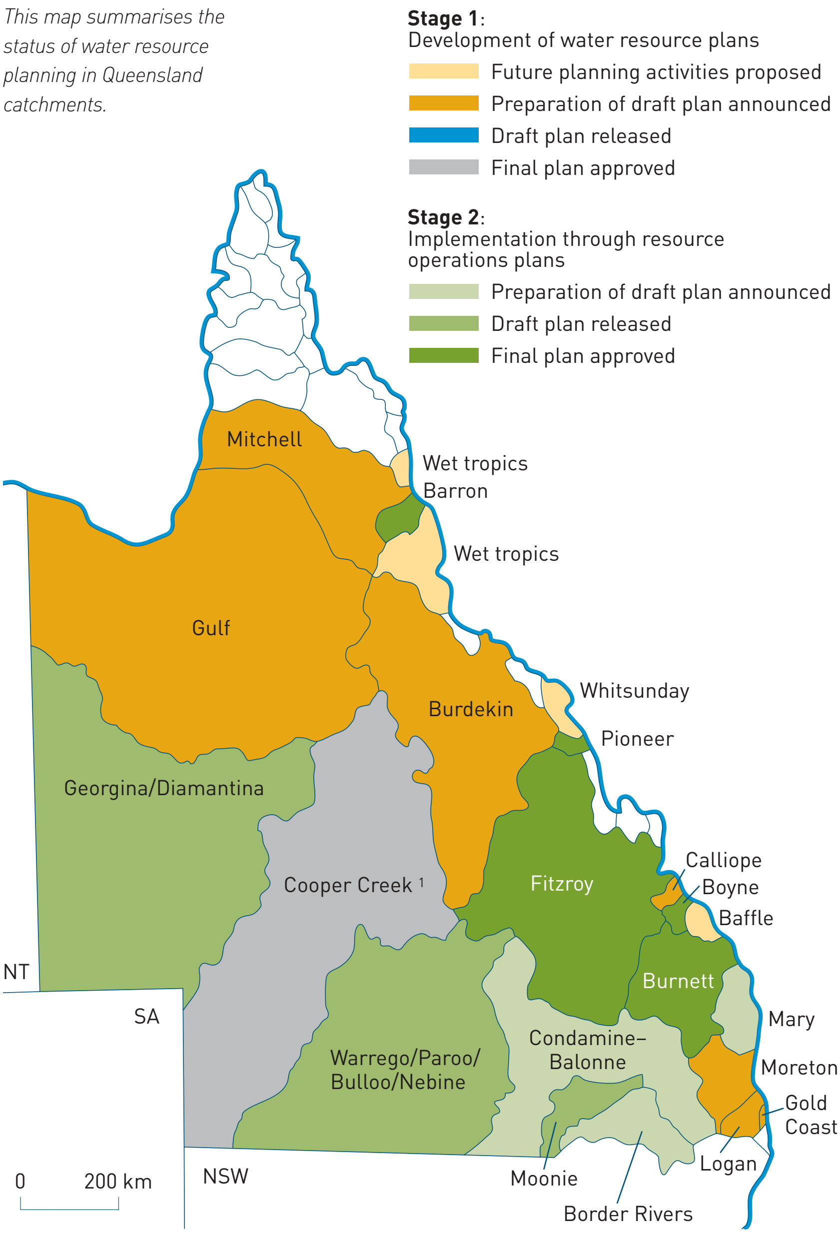
A key outcome of a WRP is the environmental flow objectives that ensure that the flow-related health of a catchment's streams and rivers is maintained through environmental flows. These flows are a means of managing water to mimic natural flow patterns. They are not a volume of water that is expressly reserved for the environment — more a case of how a particular type of flow, or part of a flow, should be managed or protected to support natural processes. In some streams, flows might not occur at all at certain times of the year, and an environmental flow strategy would strive to replicate this characteristic. WRPs propose strategies to cater for a number of flow attributes important for the river system's ecological health.

Environmental flow objectives define how far flow regimes are allowed to deviate from their pre-development levels. In simple terms, the more that flow regimes change, the greater the risk of impact on river health. The environmental flow objectives specified in a plan, therefore, define the acceptable level of risk and impact associated with a given level of water development and use.

To assess the environmental implications under different levels of water resource development, a Technical Advisory Panel (an independent group of experts in flow-related disciplines) is engaged to develop a set of performance measures that form the basis of performance indicators specified in each water resource plan. This work involves drawing on general scientific principles, panel members' experience, and benchmarking (comparison between a specific river reach and a set of reference reaches subject to varying degrees of flow regime change).

A more detailed Resource Operations Plan (ROP) is developed for each WRP to outline the 'rules' for the taking of water, providing environmental flows, trading of water entitlements, and for assessing the performance of the WRP in achieving its objectives. Flow release rules within a ROP dictate circumstances when a dam operator must release specific flows, usually to mimic an ecologically significant natural flow events. For example, in the Fitzroy system virtually all of the first major flow event of a wet season is to be 'passed' through storages to facilitate fish movement for spawning.

Photo courtesy of Peter Davies, Centre of Excellence in Natural Resource Management.



This map summarises the status of water resource planning in Queensland catchments.

WRPs exist for 11 basins in the State and another nine are presently under development, including extensive community consultation and socio-economic assessments. The completed WRPs represent 60% of the State area and the plans under development represent another 30%. For more details of the water resource planning process and progress with plans, visit the website www.nrm.qld.gov.au/wrp ■

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