RIPRAP
RIVER AND RIPARIAN LANDS MANAGEMENT NEWSLETTER

INLAND RIVERS and riparian zones

Australia's inland rivers occur across the vast, predominantly arid regions of the continent, comprising 70 per cent of its land area. The management of inland river systems is emerging as a significant challenge for the Australian community. These systems have highly variable flows, they come and go, flood large terminal wetlands or lakes, wet vast floodplains, create diverging and converging channels, dissect new watercourses, and dry out to meandering braided channels, billabongs and waterholes. We need to develop specialist policies on which to make decisions concerning inland river management. While our present knowledge may appear inadequate, the demand is urgent and we must respond to pressing management issues now.

continued page 3

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CONtents

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Land & Water Australia's mission is to provide national leadership in utilising R&D to improve the long-term productive capacity, sustainable use, management and conservation of Australia's land, water and vegetation resources. The Corporation will establish directed, integrated and focused programs where there is clear justification for additional public funding to expand or enhance the contribution of R&D to sustainable management of natural resources.

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RIPArian lands:

WHERE LAND AND WATER MEET

From the Editor

Welcome to 2001 and another year of *RipRap*! In 2001 and beyond, *RipRap* is being expanded to become Land & Water Australia's river and riparian newsletter. This will see the themes for *RipRap* expanded to move beyond the riparian zone, with this edition on 'Inland Rivers and Riparian Zones' the first of these 'broadened' *RipRap*s. The format for *RipRap* will stay the same, and I am sure readers will enjoy the range of topics we cover this year. This edition is a terrific one, with four great articles by some of the researchers working on Australia's unique inland rivers systems, as well as some fantastic colour photographs. We also have a good 'wrap up' of the work going on in inland rivers across the States and Territories. I hope you enjoy reading this edition and, remember, if you have an idea for a *RipRap* theme, don't hesitate to drop me a line!

INLAND RIVERS and riparian zones

(continued from page 1)

By Brendan Edgar

Inland rivers also have a range of characteristics that make them unique within Australia and across the world. These characteristics, such as highly variable flows and the landscape scale at which they function, mean that new and innovative approaches are required for management. The following article discusses these characteristics and links them to the principles required to manage inland rivers. It also notes the research that is being undertaken to fill in our knowledge gaps about these unique systems.

Inland river characteristics

Variability

Inland rivers are characterised by highly variable flows. In many rivers, flows are commonly very low or there is no flow, with flow regimes dominated by occasional large flows produced by high rainfall events. Northern draining rivers have highly seasonal flows driven by monsoonal rains in the wet season and no rain in the dry season.

Scale

Inland river systems function at a landscape scale and are influenced by geography, time, distance, and the extensive nature of flood events. River flows and floodplain wetting can occur over great distances and with long lag times from where the rain originally fell.

Biodiversity

Biodiversity exhibits boom and bust cycles, coinciding with flood and drought. Biota are equipped to deal with such variability and respond rapidly to water. Diversity of habitats, from saline to freshwater, variability of flows, high temperatures, and plenty of sunlight results in high abundance and diversity of plants and animals on rivers and their floodplains.

Management

Inland river systems span State and Territory borders, however, implementing effective management arrangements is difficult in the absence of formal agreements between these jurisdictions. Recent progress has been made with the signing of the Lake Eyre Basin Inter-governmental Agreement. Institutional arrangements are not well developed, with the responsibility, capacity and legislative basis to act. Management regimes generally operate at a local or regional scale.

Water resource development

Diversions, regulation and floodplain development, including off-stream storage and interception of overland flows, are increasingly moving out into previously unregulated inland river systems. Property and development rights, as well as impacts on downstream users and the environment are major issues.

Land use

Pastoralism and rangeland grazing are the most extensive land uses, with the most productive areas located on the floodplains. Indigenous lands, oil and gas extraction, mining and tourism are also major owners and land users.

Community

Inland Australia has low population densities with people living on remote rural properties and stations, or in scattered settlements and towns. Interestingly, the Australian community living outside the region exercises a strong influence on policies affecting inland river systems.

Society

Inland rivers are strongly ingrained in Australian culture. Aboriginal land management and culture, droving, paddle steamers, Burke and Wills, Clancy of the Overflow and pastoralism, among others, evoke emotion and influence how people feel about the management of inland rivers.

Research

Until recently, little research had been conducted on inland river systems and how they function. Contemporary ecosystem theories derived from temperate, perennial streams, do not apply to inland rivers. Answers are needed that are specific to the management needs of these systems.

Principles for inland river management

A set of principles for inland river management may assist the community, policy makers and managers to make decisions for a sustainable future. The principles upon which to base inland river management and policies could recognise that:

1. Naturally variable flow regimes, the dry phase, and the maintenance of water quality are fundamental to the health of inland river eco-systems.
2. Flooding is essential to floodplain ecosystem processes and makes a significant contribution to pastoral activities.
3. Structures such as dams, weirs and levees can have a significant impact on the connectivity along rivers and between the river and its floodplain. Solutions are needed to either minimise these impacts or find alternatives.
4. Water is essential to rural industries and communities who have the responsibility at the local level to manage water resources.
5. Catchment management and integrated surface and groundwater management, are important concepts that need to be put into practice.
6. Sufficient knowledge exists to ensure that water resource allocation decisions are made on a sustainable basis. A strong commitment is needed to access and utilise best available scientific information.
7. New developments should be undertaken only after appraisal indicates they are economically viable and ecologically sustainable. Promoting greater water efficiency is essential to achieving sustainable industries.
8. High conservation value rivers and floodplains need to be identified, and in some cases, protected in an un-regulated state.
9. Stressed rivers need to be identified, and priorities established for their rehabilitation.
10. Improved institutional and legal frameworks are needed to meet community river management aspirations.
11. With all parties making a commitment to work together, management regimes can be developed that are ecologically, economically, socially and culturally sustainable.

Coongie Lake wetland, Cooper Creek system, SA. Photo by Roger Charlton.

Research gaps

Achieving a sustainable balance between water allocations for river health and for consumptive use requires an understanding of ecological processes. It is equally important to make knowledge accessible to all parties in order to achieve lasting decisions with broad community ownership. High priority areas of research include:

Whole system management

An essential aspect of our understanding of inland rivers functioning is the need to quantify the links between the different components of the system (wetland, river channel, floodplain). Relative contributions from each component under different flow regimes, and how the overall ecology depends on these interactions need to be investigated in view of potential changes in flow regulation.

Social/ institutional factors

Natural resource management is complex, and the factors that influence the adoption of research results are often social, legal, economic, policy and institutional. It is important to understand the community's relationship to inland rivers and the nature of the drivers for change; socially, politically and economically. We need to know more about the institutions that implement change, and what capacity building within communities is required to move forward to a sustainable future.

Understanding variability

Hydrologic variability may be associated with increased habitat and food web complexity. It is likely that the persistence of many species in dryland rivers relies on maintenance of intermittency, although there is little information to support this hypothesis. The variable flow of rivers promote a diversity of physical and chemical conditions and these, in turn, lead to habitat patchiness and increased biodiversity.

Understanding flood pulse

Each river has a flood pulse with unique patterns of stage, amplitude, flood timing, flood duration, rate of flood rise and fall, and flood frequency, and may differ in ways that have diverse biological consequences. An understanding of flow history is needed to identify independent measures of hydrological variability, each with biological significance, and including the ecological ramifications of the hydrological features of the flood pulse.

INLAND RIVERS and riparian zones

Managing flows

We need to understand how flow and climate variability relates to indicators of river health. By integrating the climatic, hydrological and river health aspects of the system we can determine better operating decisions on water releases for agriculture and the environment. The development of sophisticated flow management regimes is needed in regulated systems with environmental allocations. An experimental and adaptive management approach is needed — testing the performance of management systems as we go.

Understanding wetlands

Dependant wetlands are a critical component of inland river systems. They are often most affected by river regulation and diversions, and an improved understanding of their role in river ecology is needed.

Floodplain management

What are the floodplain processes that drive inland river ecosystems? How do grazing, nutrients and contaminants affect floodplain and river processes, and what are the most effective management options for a sustainable future?

Coolibah tree, Coongie Lake, part of the Cooper Creek system, SA. Photo by Roger Charlton.

Many of the questions and issues raised in this article will be covered at a National Workshop on Inland Rivers, see below.

National Workshop on Inland Rivers

The National Rivers Consortium, comprising Land & Water Australia, the Murray-Darling Basin Commission, CSIRO Land and Water and the WA Water and Rivers Commission, in conjunction with the World Wide Fund for Nature (WWF) and Environment Australia, are hosting a major workshop on Australia's Inland Rivers.

The workshop, to be held in Alice Springs on the 27–28 March 2001, will:

- bring together a select group of Australian scientists, policy makers, landholders and representatives from the community and industry
- review the status of existing scientific knowledge about the driving forces behind Australia's inland river systems;
- draw out the management principles that should be adopted in setting policies for inland rivers, and in evaluating development proposals;
- identify key information gaps and how they can be best incorporated into the design of an integrated program of research and development on inland river systems; and
- raise national awareness of the importance of these river systems.

For further information on the workshop, or on the issues raised in this article, contact

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Policemans Waterhole, Cooper Creek, Innamincka, SA. Photo by Roger Charlton.

MANAGEMENT of our inland rivers — a matter of choice

By Richard Kingsford

Most people know that much (70%) of Australia is arid, but how do we characterise the inland rivers that flow through this landscape? It is remarkable that our Macquarie Dictionary defines a river as a 'considerable natural stream of water flowing in a definite course, or channels, or series of diverging and converging channels'. Would the Paroo or Diamantina Rivers qualify? These rivers do not often carry high volumes of water and, in many places, may not even have a definite course or channel. One of the most important desert river systems in the world is Cooper Creek, whose name hardly reflects this distinction (!). The Cooper can cover 100 000 km^2 of floodplain when it is in flood. These inland rivers flood over extensive floodplains and often end in what is called a terminal lake system, with the Cooper and Diamantina terminating in Lake Eyre, and the Paroo nearly always ending in the Paroo overflow lakes.

The other distinction that our inland rivers have is high variability. Years may pass with no flooding, and then a huge flood can inundate vast areas of the catchment. The characteristic 'boom' and 'bust' cycles of our inland rivers is distinctive and the ecology follows the hydrology. As a result, during floods tremendous bursts of life occur as invertebrates build up populations — fish breed and frogs colonise and breed, with the birds following the 'boom' cycles of their prey. Soon after the Diamantina River started to fill Lake Eyre, banded stilts established a colony as their crustacean prey became abundant. Australian pelicans followed soon afterwards. Elsewhere on Cooper Creek, Australian pelicans, straw-necked ibis and cormorants bred in large colonies.

As our knowledge of the hydrology and ecology of inland rivers grows, however, so does the pressure to turn these waters to 'productive' use. Australia is the driest inhabited continent and our arid regions probably have some of the lowest densities of human populations anywhere in the world, however, there is still tremendous pressure to use the water in the rivers that course through the centre of our continent for irrigation. The argument goes that rural communities will prosper and the export dollars will 'flow', but Australia is probably in a unique global position as the flow of many of our desert rivers remains uninterrupted by dams or diversions. The Cooper, Diamantina-Georgina, Fitzroy and Paroo are all rivers that go through tremendous floods that are inevitably followed by droughts. Currently, we are being asked to make choices about these rivers, with the next

***This page**: Inundated coolibahs (Eucalyptus coolabah) on the western shore of Lake Goolangirie on lower Cooper Creek during the 1990 flood. Photo by Jim Puckridge.*

***Opposite**: Riparian redgums (Eucalyptus camaldulensis) on the Northwest Branch of lower Cooper Creek. Photo by Jim Puckridge.*

MANAGEMENT of our inland rivers

50 years illustrating the impacts of those choices. Will they be developed or will they be left alone? It is a question of choice.

Before making decisions that could have long-term negative impacts, we must consider the ecological costs arising from development of these water resources if particular decisions are made. To do this, we have to look elsewhere and use the body of knowledge that exists about the impacts of water diversions and dams on river systems in Australia and around the world.

With few exceptions, management of most rivers in the Murray-Darling Basin have followed a well trodden path of resource development. For many of the southern rivers (for example Murray, Murrumbidgee), governments built major dams in their catchments (for example Hume, Burrinjuck, Blowering) and then delivered water to downstream irrigation areas. Government water agencies started life as 'Water Conservation' agencies around the turn of the century when 'conservation' meant conserving water in dams. The dams stored water that would have otherwise flowed onto the floodplains of our major rivers or out to sea.

There have been major ecological prices to pay for this development. Large and important floodplain wetlands such as the Macquarie Marshes and the Gwydir, as well as forests such as Barmah-Millewa, have shrunk as water was denied them. Their margins were colonised by terrestrial plants, and fish and waterbirds declined in diversity and numbers with these changes. Graziers, who paid premium price for the land, owned most of the floodplains and they relied on the regular flooding of the rivers to produce the nutritious grass for their cattle.

Much of this water resource development has occurred over the last 50–100 years. The last major river to be developed in the Murray-Darling Basin was the Condamine-Balonne River. Over a period of little more than ten years, flows to the Narran Lakes, which lies at the end of this system, have been reduced by 75%. Such declines in flows have been followed by major long-term declines of biodiversity on the Macquarie, Gwydir, Murray and Murrumbidgee Rivers. There are also less well-known ecological costs that have come with water resource development of inland rivers — these can include increasing salinity, blue-green algal blooms and increasing levels of pesticides.

Elsewhere in the world, the impacts of water resource development are even more dramatic. In Asia, many rivers have their flows tapped during the drier part of the year. The Aral Sea, one of the greatest ecological disasters of the 20th century, is the starkest reminder of the consequences of removing water from inflowing rivers. Over a 27-year period from 1960–87, diversion of water caused water levels in this huge inland sea (68 000 km^2) to drop by 13 m, with the wetland area decreasing by 40% and having severe impacts on biodiversity. More than 80% of

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Will we continue to make the same mistakes that were made in the Murray-Darling Basin for our remaining rivers? Or will we take our acquired knowledge and ensure that the rivers that make Australia unique will still respond to the highs and lows of our erratic climate?

native fish species disappeared, and a fishing industry employing 60 000 people and catching 48 000 tonnes in 1957, collapsed to zero. Only 38 of the original 173 species that lived in the deltas survive. Deltaic vegetation has decreased considerably. Salts from the dry lake bed are mobilised by dust storms and deposited across 200 000 km^2. Wetlands have shrunk by 85%.

The impacts on human health have also been severe. In China, the lower parts of the Huang-Ho (Yellow River) have dried for 70 days per year in the ten years before 1996, including 122 days in 1995. Water levels in Qinghai Hu have dropped 10 m, with a direct impact on salinity (although causes or their ecological consequences are not yet well understood). In India, diversions from the Ganges means it no longer reaches the sea for all or part of the year, and in 1988 resulted in a 75% reduction in flow to Bangladesh, increasing salt-water intrusion of mangroves.

These international examples are reminders of the choices we now face when it comes to management of our inland rivers. Our governments will make decisions based on the evidence put before them and be informed by the current development culture of the day. Sometimes, the 'ecological' part of the equation will not even be considered. It has seldom played a significant part in the past until it is too late. Everyone now acknowledges the Murray-Darling Basin rivers are in poor health; our Federal system devolves responsibility for land and water management to the States which means that upstream States can still largely determine what happens on the rivers with little input from downstream users.

It is hoped that the Lake Eyre Basin can benefit from the experience of the Murray-Darling Basin, with the Lake Eyre Basin Agreement forging new partnerships that are founded in ecology. There is new understanding amongst the Lake Eyre Basin community and this is being translated into new policy initiatives. However, governments and communities can change and it will be interesting to see what path our generation will choose and how it will impact on future generations. Will we continue to make the same mistakes that were made in the Murray-Darling Basin for our remaining rivers? Or will we take our acquired knowledge and ensure that the rivers that make Australia unique will still respond to the highs and lows of our erratic climate?

In Cooper Country

By Jock Douglas

This is Queensland's Channel Country, where inland rivers radiate;
the counterpoint to Barrier Reef; twin wonder of the State.
Here the sandhills and the floodplains shift in furnaced summer blast,
Until a northern 'wet' can send cool waters down at last.
Then the slow spread of this lifeblood across alluviums deep and rare
restarts a verdant cycle, all the way down to Lake Eyre.

It's a place of glorious contrast, of aridity and mud,
of broad horizon beauty, and recurring rainless flood;
where wide rivers are called creeks, with infrequent inland flows;
when a patient landscape flourishes, revegetates and grows.
It's a place to know the very soul of Australian earth and sky;
Where human intervention has luckily passed by.

The flooding creates green from brown and all life multiplies.
The bare earth sprouts a billion plants and birds congest the skies.
The pelicans, the black cockatoos, the pink and grey galahs,
compete for space with wheeling clouds of green budgerigars;
while native sorghum, river couch and nutritious Cooper clover
with coolibahs and bellalies give a paradised changeover.

This unequalled inland country has a profound history:
a sad saga of Burke and Wills and their fateful "dig" tree.
Cattlemen have since followed, led by Conrick and Durack
to the finest cattle grazing lands in Australia's vast outback.
They respond to nature's rhythms and its seasonality.
Channel Country management's a speciality.

Now come the kings of cotton with their dollars and their clout.
The Murray-Darling's conquered, so they're moving further out
with their dozers and their graders and their chemicals, to show
how to vanquish Channel Country and exploit the Cooper flow;
to transform this natural system from its treasured unspoiled state;
to dominate it and subdue it; to excavate and irrigate.

It's time now to decide how far "development" should go;
and if our culture values what local people know.
The decision made will truly test our wisdom and our sense.
It may bring such reaction that would change Governments.
And the ghosts of Cooper tribal chiefs say "Will you never learn?
This happened here before, to us — perhaps it's now your turn."

Land & Water AUSTRALIA
research • development • innovation

New Name and direction for major science funding body

One of Australia's key research funding organisations has a new name.

Land & Water Australia is the new name of the Land and Water Resources Research and Development Corporation (LWRRDC).

The Chairman of Land & Water Australia, Alex Campbell, announced the change at the organisation's 10th anniversary workshop at Trappers Hotel, in Goulburn, NSW.

Mr Campbell told the workshop, "the change isn't simply cosmetic. The new name also represents a change in direction for Land & Water Australia, which currently manages over $20 million of R&D investment each year".

Mr Campbell said "earlier projects tended to separate land, water and vegetation issues. Land & Water Australia is now taking a more integrated approach, considering these issues together at farm and catchment scales — just as landholders and communities have to. We are also placing more emphasis on the social and institutional dimensions of natural resource management, and on using the R&D we invest in".

Significant initiatives for 2001 include the Ord-Bonaparte program, a major joint venture in the Kimberley with the CSIRO, and Western Australian and Commonwealth agencies; important new work through the National Dryland Salinity Program; and major catchment projects through the National Rivers Consortium.

Mr Campbell said the announcement is timely. "The floods in NSW, Western Australia's drought and the recently announced figures on dryland salinity (based on Land & Water Australia supported R&D) all demonstrate the need for information to help those managing Australia's natural resources."

"Significantly, Land & Water Australia isn't simply looking at more research. We are placing more weight on the 'D' in R&D, developing useful management tools and options for anyone from landowners to policy makers."

For more information

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MORE INFORMATION on wetlands ...

Following the success of our 1997 publication 'Are there seeds in your wetland? Assessing wetland vegetation', two more booklets on wetland revegetation issues have been produced. They are:

~ 'Are there plants in your wetland? Revegetating wetlands' and

~ 'Does your wetland flood and dry? Water regime and wetland plants'.

The first booklet covers aspects such as: a survey of the wetland to assess its revegetation needs; sources of new vegetation; important considerations in revegetation; and potentially useful classes of wetland plants.

The second booklet explores the importance of water regime in wetlands, including: cycles of wet and dry — what is 'normal'?; relationship of water regime to diversity of plant communities; monitoring water regime (including how to measure underground water level); and the possibilities of returning water regimes to a more natural pattern if they have been modified.

All three booklets came directly from the results of Land & Water Australia-funded wetland research programs at the University of New England.

For copies
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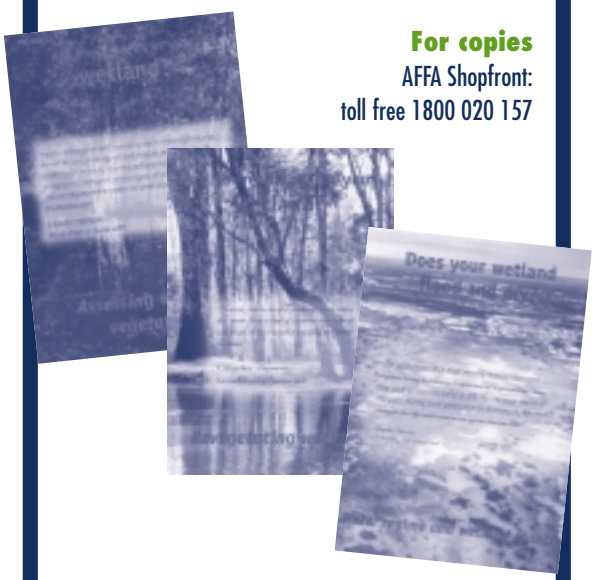

ARIDFLO —
Environmental flow requirements for Australian arid zone rivers

By Jim Puckridge, Justin Costelloe, Julian Reid, Michael Good and Vanessa Bailey

What is ARIDFLO and why is it important?

The *Environmental flow requirements for Australian arid zone rivers* project, or ARIDFLO, is a major two-year multi-disciplinary research project on selected rivers of the Lake Eyre Basin. It aims to develop an interactive predictive model of hydrology-biology relationships for Australian arid zone rivers.

Increasing interest by governments, communities and scientists in the rivers of inland Australia has meant that this project is of critical importance. It is especially so in the Lake Eyre Basin, which is the largest internally draining basin in Australia (Morton et al. 1995), and one where the rivers are largely untouched by development. The Lake Eyre Basin Regional Initiative is a community driven process working with governments and stakeholders towards economic and ecological sustainability in the Basin. The Catchment Committees and Coordinating Group established under that Initiative released their Strategic Plans on 21 October 2000. All of these plans include surface water management as a key natural resource management issue. On the same date, the Commonwealth, Queensland and South Australian Governments signed the Lake Eyre Basin Agreement. This Agreement sets out processes and structures for all governments to work together to address the management of water and related natural resources. In relation to ARIDFLO, the Agreement contains principles that refer to environmental flows and recognise the environmental values of the Basin. This situation provides opportunities for researchers to assist in informing communities and governments as they work toward sustainable management.

There is ample evidence that arid zone rivers are hydrologically, geomorphically and biologically different from rivers in more humid zones. They are hydrologically much more variable (Puckridge et al. 1998), their geomorphology is less stable, and many of their plants and animals are more opportunistic. Australian arid zone rivers show these characteristics to an extreme degree. It is essential then, that we base our management of such rivers on locally specific information, and not attempt to extrapolate from findings in rivers in wetter environments or from other continents.

Knowledge of the hydrology and ecology of the rivers of the arid zone is limited. This is due to the size and remoteness of the arid zone, the difficulty of attracting funding to an area considered largely undeveloped, and an historically held belief that rivers in the arid zone are nearly always dry. Hydrological cycles and corresponding biological responses take place over large temporal and spatial scales in arid zone rivers, and their study therefore requires expensive, long-term projects covering wide areas. The ARIDFLO model is intended to provide input to determining environmental flow requirements of Australian arid zone rivers, as well as to help prediction of the impacts that upstream water resource developments would have. The model will also have application to the restoration of the semi-arid rivers of the Murray-Darling Basin.

ARIDFLO — Environmental flow requirements for Australian arid zone rivers

What are the management issues ARIDFLO addresses?

There is very strong community and government interest in the management of inland rivers, especially in the Lake Eyre Basin. For example, proposals such as the Currareva cotton project for Cooper's Creek in Queensland (Walker et al. 1997), has confronted managers with the strength of community concern about water resource exploitation in these rivers, and highlighted the paucity of information relevant to the determination of environmental flows in such systems. The critical management issues that ARIDFLO addresses are the inadequacy of hydrological data, the more severe inadequacy of ecological data, and the very limited understanding of environmental flow requirements for Australian arid zone rivers.

Many Australian arid zone rivers, even some very large systems, are hydrologically ungauged or very sparsely gauged. The Diamantina, for example, which is over 1000 km long, has only one gauging station rated over the full range of flows. Further, many such rivers have complex geomorphology, high transmission losses and erratic spatial patterns of rainfall, so flood path prediction is extremely difficult. These are major issues for industries dependent on beneficial flooding, and also for managers trying to assess impacts of water resource use. The hydrologic methodology of ARIDFLO will describe flow regimes in arid floodplain rivers for which no long-term flow data exist. The methodology will achieve this by using satellite imagery, rainfall, climatic, hydrographic and geomorphological data, as well as local landowner's records. The ARIDFLO model will combine the outcomes of this approach with the results of biological sampling to provide improved understanding of the environmental flow requirements of arid zone rivers. It will also help managers predict the likely biological outcomes of water resource developments and provide a monitoring program to support adaptive management.

What is the science behind ARIDFLO — how will it assist management?

ARIDFLO is based on three premises:

1. That field data on hydrology and biology, collected at appropriate temporal and spatial scales and subjected to sophisticated modelling techniques, can be used successfully to develop models of hydrology–biology relations in large rivers. Such an approach cannot establish cause-effect relations with the certainty of experimental science, but experiments on large rivers are seldom feasible. As long as management is genuinely adaptive, such models are valuable inputs.
2. That knowledge of hydrology–biology relations in relatively unmodified rivers can inform the management and restoration of modified systems.
3. That in large, highly variable rivers, sampling design and analysis must be structured at many scales. The ARIDFLO project will therefore be stratified at four spatial scales — rivers (3), river reaches (5), waterbodies (35), sites within waterbodies (70), and three temporal scales — multidecadal (flow regime), multiannual (flow history) and subannual (flow pulse) (*sensu* Walker et al. 1995).

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Goyder's Lagoon Waterhole on the lower Diamantina River. Photo by Peter Hudson.

ARIDFLO — Environmental flow requirements for Australian arid zone rivers

ARIDFLO team members servicing fykenets in Fish Hole, on the Neales River. Photo by Peter Hudson.

Part of a breeding colony of Australian pelicans in wetlands of the Georgina River – Eyre Creek systems, SW Queensland, April 2000. Photo from the ARIDFLO project.

Although ARIDFLO will only be able to directly monitor responses over one year — an extremely short timespan for arid zone rivers — this year's data will be supplemented with data from a previous five-year study in this region (DRY/WET, Puckridge et al. 1999). ARIDFLO will also extend its window in time using remote sensing, rainfall data, landowners' records, and growth signals in fish otoliths.

The ARIDFLO project will use the hydrology–biology relations developed in the earlier DRY/WET model as hypotheses to be tested. ARIDFLO will test the predictions of DRY/WET against the new biological data collected in the one-year sampling program. The program will cover arid zone rivers in the Lake Eyre Basin in South Australia and Queensland, and will sample fish, macroinvertebrates, zooplankton, riparian plants and waterbirds. Flow, rainfall and patterns of wetland inundation will be monitored, and waterbody geomorphology described.

From the outcomes of the testing of DRY/WET, and in collaboration with pastoralists, industry representatives, interest groups, water resource managers and other wetlands experts, the first generally applicable model of relationships between flow regime, ecological processes and biological community structure for Australian arid zone rivers will be developed. Finally, an environmental monitoring program for the Lake Eyre Basin Rivers will be designed.

Preliminary results

Sampling

Fortuitously, the year 2000 has brought the biggest floods in the Lake Eyre Basin since 1990. This has provided ARIDFLO with the opportunity to sample from an extreme flood peak through the drawdown phase and, potentially, right to the drying phase in many waterbodies — thereby capturing biological responses to a wide spectrum of short-term events.

Sampling in April close to the flood peak was, unfortunately, hampered by flooded tracks. Nevertheless, 24 waterbodies in 5 river reaches were sampled. In August, most tracks were dry and 65 sites in 33 waterbodies and 5 river reaches were successfully sampled for all biological assemblages. In both April and August, aerial surveys of waterbirds covered not only these sites but ranged more widely over the wetlands of the Basin. The waterbodies sampled were chosen to cover a broad range of flood frequencies and drying times, and relating biological structures and processes to these long-term hydrologic parameters will be an important component of the ARIDFLO model.

Hydrology

Data from the Diamantina Lakes and Birdsville gauging stations on the Diamantina River were analysed to identify the scale of transmission

ARIDFLO — Environmental flow requirements for Australian arid zone rivers

***Inset**: The south shore of Lake Toontoowaranie on the lower Cooper Creek. Photo by Peter Hudson.*
***Left**: Inundated ephemeral vegetation in floodplain swamp at the junction of Cooper Creek and Whitula Creek floodplains, SW Queensland, March 2000. Photo from the ARIDFLO project.*

losses during flow events within this 330 km reach of river. Our analysis indicated that for flow pulses with total flow volumes at Diamantina Lakes of less than 1.2 GL, between 75–94% of the total flow volume did not arrive at the downstream gauging station at Birdsville. These extremely large decreases in discharge with downstream distance are typical of the rivers of the Lake Eyre Basin (c.f. Knighton & Nanson 1994) and their causes and effects are currently being investigated.

Eighteen automatic depth loggers and a salinity logger have been installed at key locations in the three river systems. The loggers on the Neales-Peake rivers are providing the only hydrographic data recorded for this system. On the lower Diamantina and lower Cooper, the logger data will be used to constrain transmission losses and the timing of flow events downstream of the gauging stations at Birdsville and Innamincka. Cross-sections and physicochemical depth profiles at depth logger sites will be used in the hydrological analyses of waterbody water regimes and will assist in the geomorphological classification of waterbodies.

The depth loggers indicate that water levels in the studied waterholes on the Neales and Peake rivers have remained very stable since the flow event in April, indicating that a long-sustained residual flow is still balancing water losses due to evapotranspiration. Around the Oodnadatta Track, the recession flow is responsible for rapid increases in salinity in some of the waterholes. This long, saline flow recession possibly indicates a contribution from saline groundwaters to the Neales-Peake river (see below, *Implications of water quality variation associated with flooding*).

"Transmission losses" are the water losses in a river reach due to evaporation, transpiration (vegetation uptake of water), seepage into the channel and floodplain, and ponding in terminal waterbodies.

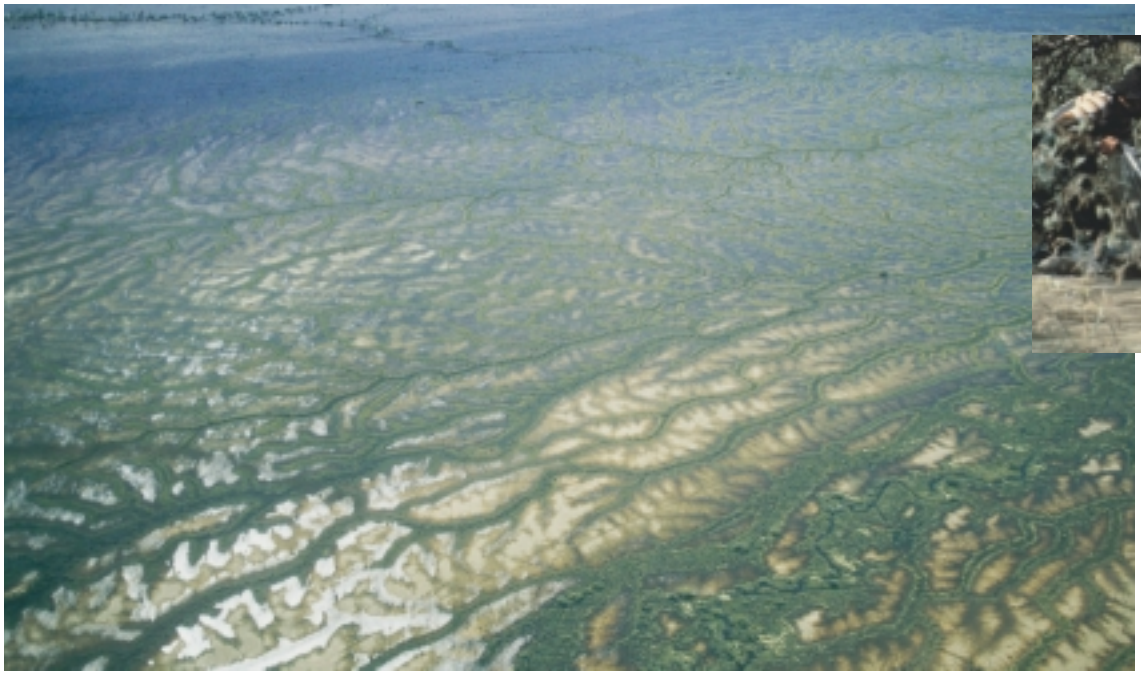
Biology

Biological responses to flooding

Zooplankton diversity in the Lake Eyre Basin rivers during flooding is unexpectedly high, and several new species have already been identified. The structures and composition of zooplankton and macroinvertebrate assemblages have also varied strikingly between waterbodies and between sampling times. It remains to be seen to what extent these variations are related to hydrology.

To optimize the contribution ARIDFLO can make, the sampling program of the project needs to be extended beyond its one-year timeframe. At the very least the sampling should encompass two calendar years, to provide replication over seasons, and to provide opportunity to follow the present flood conditions through drawdown to drought.

ARIDFLO — Environmental flow requirements for Australian arid zone rivers



Hauling a 2 metre larval fish seine net in the Northwest Branch channel of lower Cooper Creek. Photo by Jim Puckridge.

Inundated microchannels of the Cooper Creek floodplain, SW Queensland, April 2000. Photo from the ARIDFLO project.

Larvae and young juveniles of bony herring, desert rainbowfish and Lake Eyre hardyhead were abundant in both April and August. Such a protracted and aseasonal spawning is likely to be an opportunistic response to the February–April flooding, and suggests that the Lake Eyre Basin fish assemblage is unusually responsive to hydrological events.

A large tally of waterbird species and some very large numbers of individual species have been recorded on the 2000 flood event. We have established that at least 45 species of waterbird bred during the floods; significantly, many species have bred through the autumn-winter months, but we expect greater spring breeding activity along the Lower Cooper. Many of the waterbird colonies have not been previously documented scientifically. Initial estimates suggest that in August there were 250 000 waterbirds on Lake Gregory alone, and that the total waterbird population in the study region numbered in millions over April to August.

Finding the locations of many of the large mixed-species breeding colonies has relied on information provided by pastoralists and other residents. This demonstrates the knowledge and experience in the local community. Two large-scale geomorphological features — tributary junctions and river bends — appear to be crucial in providing sufficient water-residence time for the large colonial nesters to complete a successful breeding cycle.

Implications of water quality variation associated with flooding.

A widespread disease affecting most fish species and involving skin ulceration and fungal infection was apparent in April, and there were reports on the lower Cooper and upper Diamantina of large fish kills. In August, the incidence of this disease was greater and in the upper Diamantina in Queensland it was epidemic. The epidemic was accompanied by very low dissolved oxygen levels and evidence of stress even in healthy fish. The cause of this is being investigated.

Fish assemblage variability is apparent between waterbodies, particularly in the Neales River and its tributaries. This river, because of its smaller size and high gradients (compared to the Cooper and Diamantina), has a more rapid flood progress, so its waterbodies are connected for a relatively brief time. In addition, some of these waterbodies are subject to highly saline inflows during flood recession. Waterholes that become disconnected early in the flood recession can remain quite fresh while waterholes upstream and downstream become saline. The likely source of these saline inflows is the Great Artesian Basin, however, further work is required to confirm this. As a result of these features, the Neales is an extreme example of a spatially patchy aquatic system, in which refugia for freshwater-dependent species must be crucial. This patchiness is reflected in the dramatic variations in fish assemblages between waterbodies.

ARIDFLO — Environmental flow requirements for Australian arid zone rivers

A channel downstream of Stewart waterhole on the Neales River. Photo by Peter Hudson.

ARIDFLO and inland river water management

The management of Australia's inland rivers is subject to increasing community, government and scientific interest. The development and management of some river systems in Australia has left a legacy of salinity, poor water quality and massive loss of biodiversity. This has resulted in reduced economic and social opportunities as well as a huge loss of conservation values.

Australia's inland arid zone rivers are now among the last in the world of their type that are relatively untouched by development. Communities, governments and all stakeholders are in agreement that sustainable development in these arid river basins is a priority. The challenge for the scientific community is to work with communities and governments to develop our understanding of these rivers.

ARIDFLO is an important step in that process. The ARIDFLO model will be available as a predictive tool in the assessment, management and monitoring of water use projects in the arid zone, and in the restoration of arid zone rivers already affected by water resource use. It could be used to predict the likely outcomes of different water-allocation options. The model will be publicly released on CDROM (with a User's Guide) and in two versions — one for government / corporate agencies and one for landowners.

Beyond the lifespan of ARIDFLO there are two clear issues. First, it is essential that there is improved, ongoing collection of basic water quality and hydrologic data on all major rivers of the Lake Eyre Basin. Results of ARIDFLO will be able to identify river reaches where such data collection would be particularly beneficial. Secondly, if the community is to get value for money from investing in research it is important that the results of research are used in decision-making. This is more likely to happen when all key stakeholders have been consulted on the research, as they have been in the case of ARIDFLO.

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THE VALUE of Healthy Streams

The Third Australian Stream Management Conference

27–29 August 2001 Brisbane

Who will attend?

The conference is expected to attract people from catchment groups, academia, river-reliant industries and all levels of government across the country as well as internationally. Held every two years, the conference encourages scientists and practitioners to share their findings with a broad audience of researchers, educators, policy makers, regulators, advisors, community facilitators and stream users. The focus is on credible science and practical learnings in the fields of ecology, hydrology, geomorphology and socio-economics.

About the program

The theme of the conference is *The Value of Healthy Streams*, providing a focus on the technical aspects of the following major themes:

- Ecosystem service
- Hydrological connectivity
- Bio-physical integration
- Tools and techniques

Other associated events

The conference will be held in conjunction with the Brisbane RiverSymposium over 29–31 August, an annual event focused on social aspects of river management. The two events will be complementary, with the conference focused on the pure and applied science aspects of stream management, and the symposium focused on institutional and investment aspects. A common day, Wednesday 29 August, will link the two events and form a bridge for the change in themes.

The conference will also be associated with the Third Australian Fishways Technical Workshop to be held on 30–31 August. The workshop will address issues related to the design and operation of fishways to provide fish passage over stream barriers such as weirs and barrages.

Considering submitting a paper or poster?

Have you done something relevant to the conference themes recently, or do you have any views on these key subjects? If so, why not contribute a poster or paper to the conference? Please send to the Conference Convenor an abstract of what you would like to contribute. Abstracts must be less than 250 words in length. Based on these abstracts, the conference committee will invite authors to submit a full paper, either for oral presentation at the conference or to support a poster presentation at the conference. Selection will be based on the technical relevance of the abstract to one of the four key topics. The number of oral and poster presentations will be limited by available time and space at the conference so authors are urged to demonstrate how their paper will contribute to one of the four major themes. Also, while papers based on case studies are welcomed, authors need to emphasise in their paper the key technical lessons that can be learned from their experience.

Requirements for full papers and posters will be advised at time of invitation. All invited papers will be fully refereed and will be published in the conference proceedings. At least one author of each paper and poster is expected to be present at the conference. Papers presented at the conference will be 15 minutes in length, with 5 minutes for questions. Posters will be on display for the full length of the conference and a special session will be dedicated for viewing posters and discussion with their authors. Novel forms of presentation are encouraged, for example videos, GIS systems, etc.

What by when? Deadlines for authors

Receipt of abstracts	29 January
Invitation to submit full paper	26 February
Receipt of draft paper	23 April
Receipt of final paper	25 June
Receipt of poster	20 August
Presentation of paper/poster	27–28 August

For further information

For any issues, queries, or suggestions, please contact the conference convenor
Mr John Amprimo
Department of Natural Resources
GPO Box 2454
Brisbane QLD 4001
Tel: (07) 3224 7668
Fax: (07) 3224 8359
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Further details will also be published regularly on the Third Australian Stream Management Conference website at www.catchment.crc.org.au/streamconference

Please note: Papers regarding cultural, institutional and investment aspects of stream management should be directed to the RiverSymposium.

INVITATION to nominate for 2001
Thiess Services International and National River*prize*

29–31 August 2001 Brisbane

The Thiess Services $100 000 International and National $25 000 River*prize* acknowledges outstanding achievement in river management — both in Australia and anywhere in the world. The River*prize* is awarded each year as part of the International River*symposium* during Brisbane's River*festival*.

Who should enter?
If you are involved in river management or have contributed to successful river management initiatives, you are invited to nominate for the prestigious Thiess Services International and National River*prize*.

What is River*prize*?
River*prize* represents a serious commitment to improving river management and will be awarded as part of the Fourth International River Management Symposium in Brisbane from 29–31 August 2001. River*prize* showcases the world's best practice in river management and gives river managers an opportunity to examine and adopt more effective management practices.

How is it judged?
River*prize* is judged by an international panel comprising key river management figures and representatives of national and international organisations. The primary judging criteria is the ability to demonstrate progress and achievements in effecting real river management outcomes.

How do I enter?
Simply download the River*prize* nomination form from www.riverfestival.com.au and forward your submission to River*festival* River*prize* Nomination, PO Box 5696, West End Qld 4101.

When do nominations close?
Nominations for River*prize* close 20 April 2001.

Dates
The River*symposium* is part of River*festival* — Australia's major international river and water celebration. The 2001 River*symposium* will be conducted in association with the Australian Stream Management Conference 27–29 August.

For further information about Riverprize and the Fourth Internation River Management Symposium

River*festival*

River*symposium* Organiser,
Tel: (07) 3846 7444 Fax: (07) 3846 7660
Email symposium@riverfestival.com.au or visit our web site:
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Right: *2000 Riverprize award.* ***Below left***: *Riversymposium conference.* ***Below right***: *Peter Krause, Chairman Grand River Conservation Authority, Canada accepting 2000 Riverprize from Jim Soorley, Lord Mayor Brisbane and Martin Albrecht, Managing Director Theiss Services.*

Land & Water Australia is one of the main sponsors of the National River*prize* award.

UNDERSTANDING large floodplain ecosystems

By Martin Thoms, Ralph Ogden, Neil Sims, Heather McGinness and John Foster

Introduction

Large floodplain ecosystems are a feature of Australia's dryland rivers and generally contain extensive wetlands. There are 744 of these floodplain ecosystems listed in Australia as 'important', but only 263 of these are located in dryland regions. However, a glance at any map of Australia would suggest these numbers to be an underestimate. Floodplains are a vital part of any riverine ecosystem because their biota rely on them for refuge, breeding and replenishment of food resources. Floodplains are associated with a wide range of river types. In the drier regions of the country they are found adjacent to sinuous anabranching or distributary systems — those rivers that carry flow in more than one channel. Because of this, and the complex geomorphic history of these rivers, they contain a diverse array of physical habitats, including anabranches, floodplain backwaters, cutoffs, shallow floodways and flat plains. Floodplains are, therefore, areas of high biophysical diversity.

Floodplains are also sensitive to human disturbance. The character of many floodplains has been altered since European settlement by large-scale development and the loss of hydrological connectivity caused by flow regulation and the construction of levees. This is especially evident in many areas of the Murray-Darling Basin. In the Barwon-Darling, for example, approximately 23.9 million megalitres of water is stored in large dams — water that was originally important for the inundation of floodplains. Furthermore, water extractions for a variety of purposes can influence the hydrology of river systems. Water diversions are equivalent to over 60% of the natural flow at Menindee on the lower Darling River. Large areas of productive floodplains are now isolated from the river channel because of the construction of levees. There are over 10 000 km of floodplain levees in the New South Wales section of the Murray Darling Basin alone. As a result, the health of many floodplains has declined and there are concerns over the management of these important ecosystems.

Our understanding of the biophysical processes in these large complex systems is, however, relatively limited. In this article we describe the character of a large floodplain ecosystem, along with the consequences of altering its natural processes, functions, and connectivity.

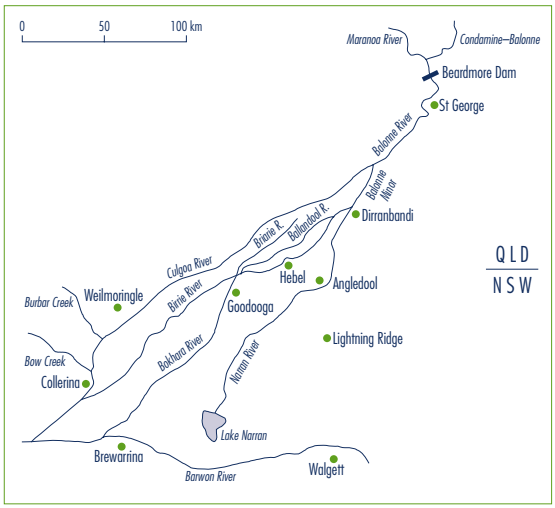

***Figure 1**: The Lower Balonne floodplain complex*

Ecosystem processes in the lower Balonne floodplain

The lower Balonne floodplain straddles the New South Wales and Queensland border downstream of St George (Figure 1). This large floodplain covers an area of approximately 19,880 km^2 and is typical of the many floodplains in the Murray-Darling Basin. Its integrity is maintained by hydrological connections between the floodplain and river channels of the region. This floodplain is fed with water, sediments and nutrients from the Condamine-Balonne catchment — which comprises 14 per cent of the Murray Darling Basin. Hydrological variability is a feature of this system, which is influenced by climatic conditions such as El Nino-Southern Oscillation (ENSO) events. This is evident because flows in the Condamine-Balonne correlate significantly with the Southern Oscillation Index (SOI). The long-term hydrograph of the Condamine Balonne is highly variable, with a large proportion of average flows occurring in very wet years and during major floods. Indeed, the coefficient of variation (CV) for flows in the Condamine-Balonne ranges from 1.35 to 2.78 , which is comparable to other dryland systems worldwide.

Associated with this highly variable flow regime is a dynamic wetting and drying cycle of the adjacent floodplain surface. The wetting and drying regime of floodplains is recognised as an

UNDERSTANDING large floodplain ecosystems

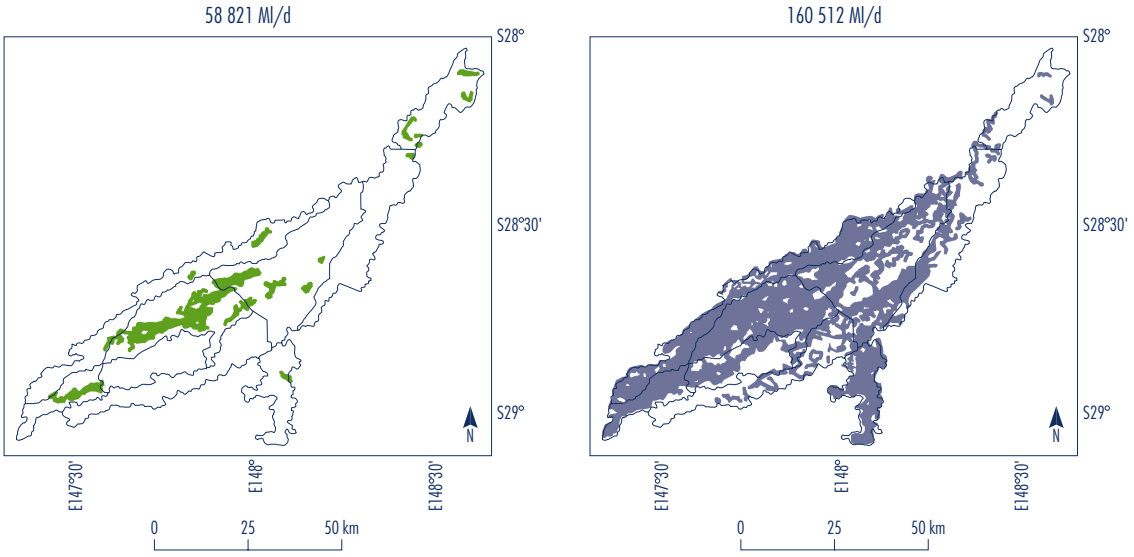

***Figure 2**: Remotely sensed images showing the area of floodplain inundated with various discharges.*

important factor in determining the distribution and structure of plants and animals, as well as controlling the exchange of nutrients and carbon between river channels and floodplains.

Remotely sensed images have enabled the investigation of large scale flooding patterns in the Lower Balonne floodplain. Landsat TM is an earth resources remote sensing satellite that measures the strength of sunlight that reflects off land surfaces. A series of remotely sensed images has been used to investigate the relationship between floods of different sizes and the extent of floodplain inundation (Figure 2). Using these images a detailed flooding map has been constructed for the Lower Balonne, that highlights the main flow paths across the floodplain and the areas most susceptible to inundation.

The distribution of floodwater strongly influences the distribution of floodplain vegetation communities across the lower Balonne floodplain. There are five main vegetation communities in the lower Balonne that tend to vary across the floodplain in response to distance from individual watercourses, and along the floodplain in response to how the region is flooded. Coolibah (*Eucalyptus microtheca*) and River Red Gum (*E. camaldulensis*) are located adjacent to watercourses, while lignum (*Muehlenbeckia cunninghamii*) and nutgrass (*Cyperus bifax*) can be found in areas of moderately high inundation frequency. Areas that are not watered as often (that is, that have a low inundation frequency) are dominated by open and dry grassland types, particularly Neverfail (*Eragrostis setifolia*), Lovegrasses (*Eragrostis spp*), Buffle Grass (*Cenchrus ciliaris*) and chenopods. The distribution of the various vegetation communities resembles a patch work quilt, with each patch having its own story of watering, supply of nutrients and how it came to be.

The landscape of the Lower Balonne floodplain is old. Approximately 65 million years ago, subtle movements in the earth's crust in central New South Wales and southern Queensland created a large depression downstream of St George. Into this, sediments and nutrients from the upper Condamine and Maranoa catchments were deposited. Over time, the area has experienced marked climatic changes resulting in a complex sequence of sediment deposition. As a result, the modern floodplain landscape is also complex (Figure 3). Downstream of St George, the Condamine Balonne River divides into six individual river channels; the Ballandool, Balonne Minor, Bokhara, Briarie, Culgoa, and

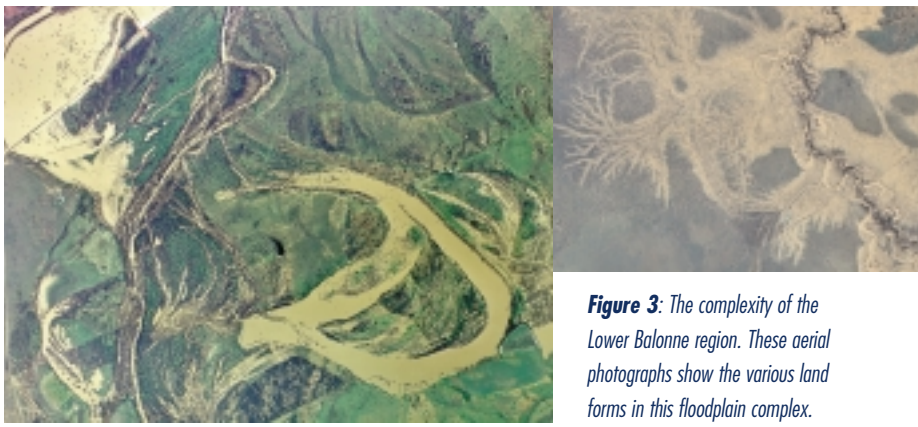

***Figure 3**: The complexity of the Lower Balonne region. These aerial photographs show the various land forms in this floodplain complex.*

For further information

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UNDERSTANDING large floodplain ecosystems

Narran. Each of these systems are different in their size, character, and how they convey water onto their adjacent floodplains. Indeed, the present floodplain ecosystem is comprised of a complex mosaic of different morphological units.

Recognition of the complexity of floodplain surfaces is important. Individual morphological units such as levees, billabongs and anabranch channels, have a unique set of physical, chemical and biological characteristics. Nutrients and carbon stored in floodplain soil are important for a range of biological activities. Our studies have shown that there are important differences in the content, or store, of nutrients and carbon in the different floodplain morphological units. On average, there is relatively more carbon in the morphological units closer to river channels compared to those at distance. These different morphological units also release nutrients and carbon at different rates during flooding (Figure 4). Importantly, morphological units located in the riparian zone or those associated with other anabranch channels, are relatively more reactive in terms of the release of nutrients and carbon in comparison to other floodplain morphological units.

Floodplains have been described as flat featureless tracts of land adjacent to river channels that are wet every now and then. This study of the lower Balonne would suggest otherwise. Regular inundation is important for the release of nutrients and carbon from floodplain soils and from any plant material that may be present on the surface. There is a pulse of nutrients and readily bioavailable carbon during flooding and this can cause a rapid increase of microbial activity and nutrient cycling processes that result in a highly fertile and productive system. Our studies suggest there are areas of floodplain that are relatively more productive that others — areas that, as a result, may require a higher management priority than others.

Ecosystem changes in the lower Balonne

Floodplain ecosystems like the lower Balonne have been subjected to the loss of hydrological connectivity as a result of water resource and large scale land development. Similarly, flows in the Condamine Balonne system have been modified by large-scale water abstractions for irrigation. A comparison of simulated (Integrated

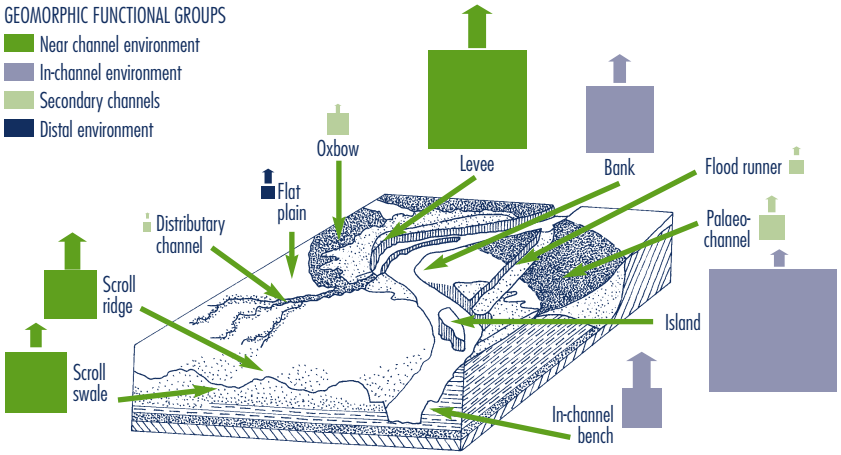

***Figure 4**: The storage and release of carbon between different geomorphic units of the Lower Balonne River Floodplain. Boxes are proportional to total carbon storage in surface sediments (%) and the arrows are proportional to dissolved organic carbon concentrations detected in overlying water after 24 hours of inundation (ppm).*

Quantity Quality Model data from the Queensland Department of Natural Resources) 'natural' and 'current' flow data illustrates the changed flow regime of the Condamine Balonne (Table 1). Median flows at St George have been reduced by nearly 30 % and there have been flow reductions over a range of flow magnitudes. These results are consistent with the impact of water resource development in other catchments of the Barwon-Darling. Between 1988 and 1994, there was a 32% increase in the amount of flow diverted from the upper Darling system.

***Table 1**: Hydrological change in the Condamine Balonne system at St George.*

Simulated flow data (IQQM) are given for the 1900–98 period.			
	Natural	Current	% change
Median annual (ML)	976 997	688 457	– 29.53%
1.5 ARI (MLD)	31 813	16 672	– 47.59%
2 ARI (MLD)	56 287	43 879	– 22.04%
5 ARI (MLD)	123 663	118 268	– 4.63%
10 ARI (MLD)	183 788	166 832	– 9.22%

Abstractions upstream of St George, combined with continued harvesting of water from the from the Lower Balonne floodplain, have the potential to significantly influence the long term ecological sustainability of the lower Balonne floodplain. Using a series of remote sensing images that date back over 15 years, the longer term vegetation response to inundation in the lower Balonne has been investigated. This has demonstrated that the vigour of floodplain vegetation increases dramatically during a 5 to 40 day period following a flood. However, between 1985 and 1999 there has been a slight but significant decline in the median Normalised Difference Vegetation Index (NDVI), a commonly used index of vegetation vigour, for the entire lower Balonne floodplain. This resulted from increased water stress associated with significant water resource and floodplain development in the region. Indeed, some floodplain regions experienced marked changes in NDVI, with noticeable declines since 1993.

UNDERSTANDING large floodplain ecosystems

There has also been a substantial loss of natural surfaces in the Lower Balonne floodplain (Table 2). This can have a significant influence on the transfer of carbon and nutrients between the floodplain and its river channel. In the lower Balonne, it has been calculated that reductions of up to 98 per cent in the potential supply of dissolved organic carbon from the lower Balonne floodplain during some flood events, have occurred.

***Table 2**: Floodplain development in the Condamine Balonne downstream of St George.*

	1988	1999
Cropped area (ha)	4 300	38 650
Dam storage capacity (ML)	54 750	592 500
Dam surface area (ha)	1 825	19 750
Total area (ha)	6 125	58 400

Sediments deposited in floodplains are indicative of the environment in which they were laid down. They provide historical records of material transported from the upstream catchment and of biota living within the floodplain river system. The physical, chemical and biological character of these sediments can be used to reconstruct the condition of floodplain rivers before and after the advent of human activities.

Sediments contained in cores extracted from the Lower Balonne floodplain system reveal how this floodplain has functioned over the last 1000 years and how it has changed in recent years. Figure 5 shows a typical sediment core extracted from the Lower Balonne floodplain. The stratigraphy (the study of the order and relative position of layers of sediments) of the sediment cores highlights a marked change in the nature of sediments being deposited in the Lower Balonne approximately 60–80 years ago.

The sediment core shows us that, prior to European settlement, the Lower Balonne received pulsed inputs of sediment, nutrients and carbon — a characteristic of dryland ecosystems. However, since European occupation the following has occurred.

~ Rates of sedimentation have increased by an order of magnitude (1.63 to 11.06 cm year^{-1}). Large quantities of sediment accumulate in flood plain areas because of increases in sediment supply resulting from upstream land use changes.

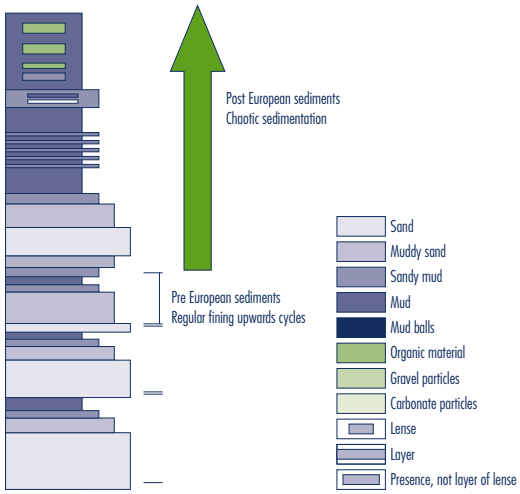

***Figure 5**: The stratigraphy of a sediment core extracted from the Lower Balonne. The Pre and Post European sedimentation periods are indicated.*

~ The texture and geochemistry of sediments has also changed, suggesting a different upstream source of sediments. It is pertinent to note that some of the sediment cores have high salinity levels. Mean salinity values range from 0.17 to 1.56 mS. Plant growth can be inhibited by high soil salinity. Levels of 0.6 mS can affect growth while levels >1.8 mS are detrimental to sensitive crops while levels >7.7 mS are detrimental to tolerant crops such as cotton. In parts of the Lower Balonne floodplain salinity levels are high (5.9 mS) at relatively shallow depths (~1m) and are detrimental to plant growth.

Summary

Australian floodplain ecosystems have a relatively short history of European occupation and development — impacts are generally less than 200 years old. Despite this, severe environmental degradation is evident in many places. Understanding the natural and modified response behaviour of these ecosystems is paramount for improved management.

It is important to recognise that river-floodplain ecosystems respond to disturbance over a range of levels — from organism-level responses, through population and community changes and, finally, ecosystem-level change. Observed responses will, therefore, depend on the organism, group of organisms or ecosystem in question. Additionally, there will be a lag time before an ecosystem response can be detected in floodplains, and the extent of this lag time will depend on the ecosystem level in question. For many of the more familiar organisms (fish, riparian trees), there would be a considerable lag time, with recent water resource and floodplain development taking decades to detect.

Floodplains are important ecotones between the land and water boundary that regulate interactions in riverine systems. Active management and restoration of these ecotones is a priority in many areas and has been the focus of recent research. Effective floodplain management requires an integrated approach in which both land and water issues are considered.

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A Rehabilitation Manual for Australian Streams ($25 plus P&H)

Volume 1: Concepts and planning. Volume 2: Rehabilitation tools
Rutherfurd, I., Jerie, K. & Marsh, N. 2000

This manual is designed to help those professional managers who are accepting the challenge of rehabilitating the physical and biological condition of Australian streams. It is based on an evolving set of ideas and contains gaps in our knowledge that need to be filled and it is hoped that the manual will grow and mature along with the infant stream rehabilitation industry.
Also available on the web at www.rivers.gov.au and www.lwa.gov.au

Stream Stabilisation for Rehabilitation in NE Queensland ($25 plus P&H)

Kapitzke, I. et al. 1998 ISBN: 0 642 267189

This manual identifies some of the primary problems and causes of river degradation as well as treatments and management techniques. It recognises that the sustainable use of streams depends on a range of factors such as geology, hydrology, climate, ecology, sociology, culture and economics.
As well, a free brochure accompanies the manual

THE PRODUCTS continue!!

Several *Demonstration and Evaluation of Riparian Restoration Final Reports* and *Associated Publications* can now be accessed via the Web!

The Reports cover work undertaken in the: Clarence Catchment, NSW; Bega Valley Catchment, NSW; Johnstone River Catchment, Qld; Regeneration and Recruitment of Native Riparian Species, Tas; and Large Woody Debris in Sandy River Systems, WA.

Each of the final reports has an easy to read introduction, with the report's contents broken up into sections that are easy to download in portable document format. In addition to the final reports, are information products arising from the demonstration projects: Repairing Farm Waterways: Blackwood Stories (see *It's a Wrap WA* for details); Myth Busters (Bega Valley); Riparian Restoration Case Studies (Bega Valley)

Full details of where you can get a hard copy of these publications is also provided, so go ahead and check them out at www.rivers.gov.au under the publications menu!

It's a WRAP

News from around Australia's States and Territories

Tasmania by Michael Askey-Doran

Rivercare support in Tasmania

Tasmania has recently established a Rivercare Technical Extension team to provide expert technical advice on river management and rehabilitation to groups developing Rivercare plans and conducting on-stream works. The team is jointly funded by the State and the Natural Heritage Trust (NHT), and represents a significant leap forward in river management within Tasmania. In the past, Tasmania has generally struggled to adequately resource such programs, and this now provides a great opportunity to improve the way in which rivers are managed.

The team brings together a diverse range of skills including vegetation management (native and introduced), aquatic and riparian ecology, engineering, geomorphology and Rivercare planning. The mix of the team reflects the need to approach river management in a holistic fashion, recognising that rivers are complex, integrated systems.

The Rivercare team will provide support to groups in a number of ways, with planning an integral part of the program. The team will work with groups and/or their consultants to develop plans that reflect both the needs of the groups and their river. The aim is to provide a catchment perspective that will enable groups to use the plans over a 5–10 year period. The Rivercare team will also provide direct support to groups undertaking works on streams, for example, willow and other weed removal, stabilising channels, revegetation and stock control. The team will also focus on protecting areas that are in good condition and restoring in-stream and riparian fauna habitat. Another important aspect of Tasmania's Rivercare program is putting in place suitable management and maintenance arrangements for life beyond NHT. The Rivercare team is working with the groups and local government to help establish such arrangements.

The team is based in Hobart and Launceston within the Department of Primary Industry, Water and the Environment's Land and Water Management Branch. The Inland Fisheries Service also has a fisheries extension officer who works closely with the team. Staff include:

- Team leader: Michael Askey-Doran (Hobart)
- Ecologist: Peter Cale (Hobart)
- Revegetation/weeds officer: Michael Noble (Launceston)
- Engineer: David Klye (Launceston)
- Geomorphologists: Guy Lampert (Launceston) and Sharon Cunial (Hobart)
- Inland Fisheries Extension Officer: Dave Jarvis (Hobart)

To contact the Tasmanian Rivercare team

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Where's the river gone? The Tasmanian Rivercare Team at work.

NEWS FLASH ABOUT THE MIGHTY MURRAY RIVER

Plans to improve national treasure

The Murray River Frontage Action Plans Project is a fantastic opportunity for everyone who uses, enjoys or lives near the Murray River to improve the condition of frontages, for the benefit of present and future generations. Frontage management is everyone's responsibility, as the entire community benefits from a healthy river system.

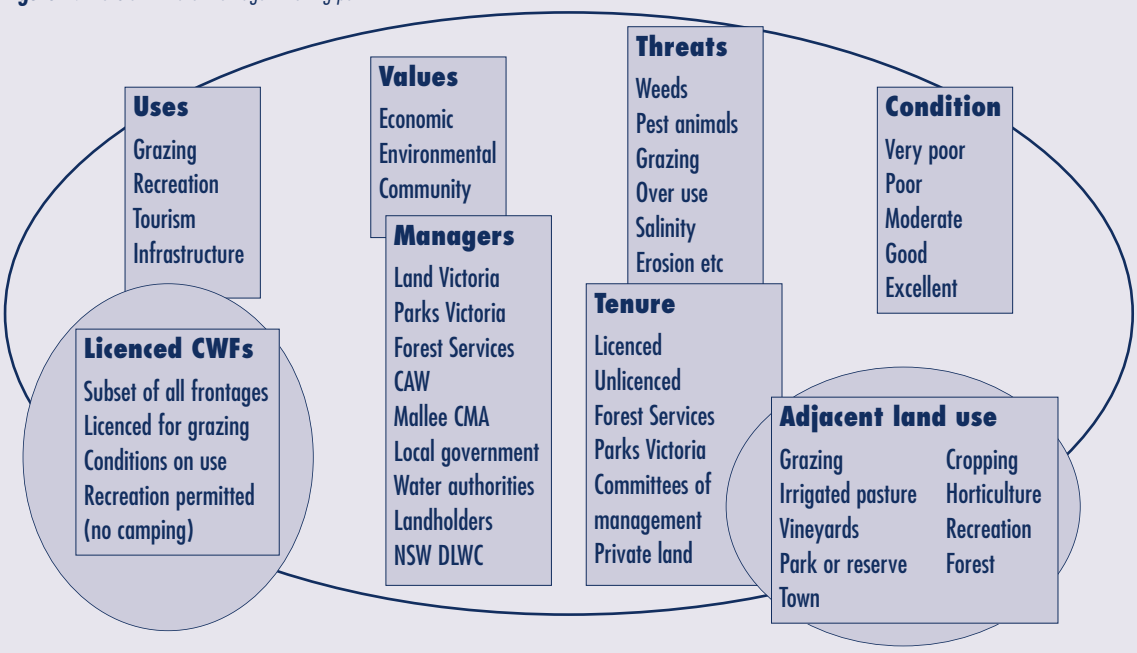
The Murray River Frontage Action Plans Project provides an opportunity for the Mallee community to give something back to the Murray River. The Project, set to spend 1.4 million dollars over the next three years, will see the Mallee Catchment Management Authority (CMA) link with Crown Water Frontage License-holders, natural resource management organisations and the wider Mallee community, in a drive to protect and enhance the valuable Murray River Frontage.

The concept behind the Frontage Action Plans resulted from outcomes of the Review of Crown Water Frontages conducted by the Mallee CMA in early 1999. The Review involved extensive community consultation, including public meetings at Sea Lake, Boundary Bend, Mildura and Cowra Station. It was discovered that management of Crown Water Frontage Licenses could not be accomplished in isolation from the rest of the frontage. Through community input, the idea of Frontage Action Plans was put forward to address outcomes of the Review and the Draft Mallee Waterway and Floodplain Management Strategies. The task was to take all values, uses, user groups and threats on the frontage and develop a simple and effective management system, see Figure 1.

The Project will see the development of Frontage Action Plans for three sections of the Murray River, from Nyah to Robinvale, Robinvale to Merbein and Merbein to the South Australian Border. Development of the plans is being driven by the Mallee CMA through a committee comprising license-holder representation, Mallee CMA, Natural Resources and Environment (NRE), Parks Victoria, Murray-Darling Freshwater Research Centre, Mildura Rural City Council, Swan Hill Rural City Council, NSW Department of Land and Water Conservation, Sunraysia Rural Water Authority and the North West Region Aboriginal Cultural Heritage Program.

Implementation of each Frontage Action Plan will be accompanied by the establishment of a range of demonstration sites. Community input and support has been essential for the consultation process for the Review of Crown Water Frontages and will continue to be essential to the success of the Murray River Frontage

***Figure 1**: The Crown Water frontage "melting pot"*



Action Plans. Interested land managers and community representatives in each area have been invited to join one of three working groups, for the three sections of the Murray River. In addition, there will be plenty of opportunity to be involved through activities including site visits to particular frontages, workshops to discuss issues and solutions and public meetings to discuss draft Plans.

The Murray is one of the only rivers world-wide that retains unimpeded access along the length of frontage located on the Victorian side. This frontage supports irrigation infrastructure, high recreation use, some grazing, biodiversity values and significant Aboriginal and European cultural values and sites of significance.

The planning process is due for completion in early January 2001 and will involve three community working groups for the three sections of the Murray River. Outcomes of the Plans may include upgrade of visitor facilities, track ripping, revegetation and an incentive program for license holders. It should be recognised that many license-holders have done a good job in protecting sections of the frontage, and now it is time for the rest of the Mallee community to do their bit.

Once Plans for the Murray are complete, it is anticipated that a similar process will be used for the Southern Creeks located in the Mallee Region. These include sections of the Lalbert, Tyrrell, Yarriambiak, Dunmunkle and Outlet Creeks.

In future it is likely that this process will be adopted by other Catchment Management Authorities with Murray River Frontage. It is the ultimate goal of the project to have a consistent process for the entire length of the Murray frontage (southern bank only) located in Victoria.

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mallee
catchment management authority

ACCV crew tree planting and track ripping as part of the Murray River Frontage Actions Plans Project. This site has been funded to the value of $37 000 to raise the profile during Plan development.

Land and Water Australia has identified eight good reasons to manage water frontages effectively. Reasons include; decreased erosion, greater bank stability; improved water quality, reduced algal growth; healthier land and water ecosystems; better stock management; increased capital values of properties; shade and shelter for livestock; lowered water tables, and; increased fish stocks. In short, good frontage management means a healthy and productive Mallee Region, both for us, our kids, downstream residents and all those people who travel to enjoy what the region has to offer.

The many values of the Murray frontage. Access management is an integral component of the project.

RiverReach — Implementing sustainable riverine management in the Queensland section of the Murray-Darling Basin

RiverReach

The Queensland section of the Murray-Darling Basin has a large catchment area of approximately 260 000 km^2. There are four major river catchments; the Condamine (24 500 km^2), Border Rivers (38 500 km^2), Maranoa Balonne (64 000 km^2) and the Warrego Paroo (130 500 km^2). The riverine styles are diverse, ranging from high mountainous rainforest streams along the Great Dividing Range in the east, to the braided streams, expansive floodplains and wetlands near the NSW Border in the west.

RiverReach

'Implementing Sustainable Riverine Management in the Queensland section of the Murray-Darling Basin' is a project jointly funded by the Natural Heritage Trust and the Queensland Government. The project is popularly known as 'RiverReach', and has a time frame of June 1998 to September 2001. At the start, the project faced a number of challenges, namely, the low level of community skills and understanding about riverine management; limited information and understanding of riverine condition and trend; prior river management intervention impacts; rural populations that are small and highly dispersed; the logistics of project delivery; and, poor knowledge of inland riverine management techniques.

To overcome these challenges, initial project planning identified three broad areas of investment:

1. increased education and awareness of riverine management issues;
2. promotion of community based on-ground works; and
3. the development of strategic riverine management plans.

Education and awareness

Community education and awareness raising about the issues associated with riverine management has been a central goal of RiverReach. This has occurred through a range of activities, for example, the provision of extension material, riverine planning workshops, field inspections and evaluations, skills enhancement through community involvement in project development, and demonstration works.

In addition, through RiverReach, technical staff have developed a river planning workshop module to facilitate delivery of educational material and to complement the process of project proposal development. The workshops are coupled with field inspections and enable local understanding and demonstration of riverine physical and ecological processes. The workshops also enable management practices to be examined in the light of theoretical application.

On-ground works

In order to undertake community based on-ground works, RiverReach advertised widely throughout the catchments for community groups to lodge Expressions of Interest (EOI) in riverine projects. Subsequently, over 220 organisations from 16 groupings including catchment management, landcare, water users such as agricultural producers, local government, River Trust, conservation, indigenous and educational groups were approached individually, as well as through newsletters and the printed press to register interest in planning riverine management projects.

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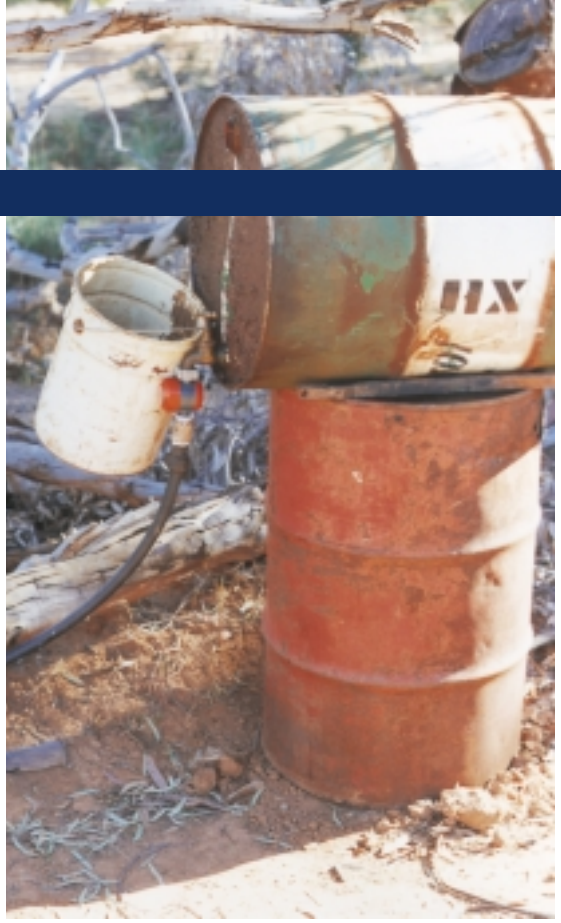
RiverReach on-ground works. Remote area watering system for seedling revegetation for the Moama Station revegetation project, north of Eulo and on Cookara Creek, tributary of the Paroo River. Generally revegetation is encouraged in semi-arid areas, however, in this situation revegetation will assist stabilisation of the creek bank, retard avulsion formation and reduce waterhole sedimentation.



On-ground works. 'Cup and saucer' off-stream watering point associated with stock managment fencing project adjacent to the Condamine River at Warra. Project undertaken by the Brigalow–Jimbour Floodplains Group Inc.

66 EOIs were received, and they covered a broad range of community organisations, themes, scales and scope. In all, 25 EOIs were received from Landcare or catchment groups, 11 from Shire Councils, 14 from individuals and 16 from community groups. The scope of proposals submitted encompassed urban and rural stream reaches and ranged widely from access to extension workshops, to catchment scale river management plans.

Proposals received during the calls were assessed and evaluated by the Project Management Committee and approvals were gained for 28 project proposals. Successful proposals included works involving riparian buffer strip stock management fencing, nuisance vegetation management, revegetation, provision of off-stream watering points and slump rehabilitation.

Planning

Throughout the catchments there are numerous natural resource strategic management plans, however, there is a dearth of information on riverine systems in the Basin. Accordingly, RiverReach is contributing to a number of planning initiatives including the State of the Rivers Survey and Report for the Maranoa / Balonne / Lower Condamine (completed in 1999 and currently in draft form) and the Strategic Riverine Enhancement Plan for the Dumaresq River / Macintyre Brook and Tributaries.

It has become apparent from the uptake of extension advice and materials during the past 24 months that there is increasing community awareness and a strong interest in extension advice on riverine management solutions in inland regions. Greater community support can be achieved through the methods already outlined, however, the completion of on-ground works will invigorate this interest within a wider community.

Future considerations

While there is a feeling that RiverReach is headed in an appropriate direction, there are fundamental chunks of information that are required to achieve a fully integrated approach to riverine management. There is a need for on-going research into the state of our rivers to improve our understanding of river systems. RiverReach is a community sponsored project directed at improving riverine management through enhancing community activities and skills. As such, it is not funded to conduct the riverine research required to prioritise subcatchments for riverine rehabilitation. For example, RiverReach cannot fund research into geomorphological and ecological aspects of stream reaches. This sort of information is required to ensure prioritisation processes protect first, and rehabilitate second.

RiverReach Planning. Recently formed avulsion on Redford Creek, which runs into the Maranoa River via Billin Creek. The extent of the river red gum root system is clearly evident. The photo was taken during the State of the Rivers Survey of the Maranoa–Balonne Lower Condamine.

Unfortunately, without a commitment to on-going funding, the current NHT initiative in the Queensland section of the Basin will not realise the longer-term outcomes so critically important to underpin sustainability in our riverine environments. Indeed, there will be significant unsatisfied expectations and demands arising from the initial RiverReach project should the initiative not continue past the life of RiverReach.

Conclusion

These are still early days in formulating any response to the problems derived from management practices over the past 150 years over this large area of the Basin. Challenges are numerous and compounding, however, it is felt that RiverReach is on the path to addressing many outstanding riverine management issues and problems in the Basin, albeit on a preliminary basis. There is an on-going need for riverine management education and awareness activities as well as fundamental research into riverine systems in the Queensland section of the Basin.

RiverReach extension. Primary school students observing river processes in a school sandpit model at Clintonvale State School. The school sandpit is a handy tool for demonstratng stream erosion and sedimentation processes.

New Water Law for Queensland

By John Amprimo

The Queensland Government recently passed the *Water Act 2000*, the first major revision of water law in the State since 1989. The revision was largely driven by the Council of Australian Government's Water Reform agenda of improved water resource planning and higher water use efficiency. Features of the Act that relate to riverine health include:

- process and criteria for the development of water resource plans, including setting environmental flow objectives;
- formalisation of water resource plans as subordinate legislation to 'lock in' the rules;
- allocation of river-related resources (water and quarry material) within the principles of ecologically sustainable development. [Note that the assessment of proposed works to access or take the allocated resource will become part of the State's whole-of-government Integrated Development Assessment System, allowing allocation and development issues to be clearly separated];
- ability to allocate overland flow water and regulate works that divert overland flow water in areas specified in a water resource plan, to ensure sufficient proportions of runoff and flood water reach or return to stream systems;
- process for setting and monitoring operating rules for rural water service providers, such as storage operation, irrigation water releases, etc; and
- control of activities that threaten the physical integrity of riverine areas, such as destroying native vegetation, excavating, or placing fill within the bed and banks.

Some parts of the Act become effective in the latter part of this year (for example, water resource planning and the separation of state irrigation assets into a corporatised body called SunWater) with the balance being implemented by March 2001 (for example, water licensing, riverine quarry material approvals, etc).

continued on next page

NATURAL RESOURCES Queensland

The inclusion of water resources developments into the Integrated Development Assessment System provides opportunity for other agencies (EPA, Fisheries Service) and local government to provide direct input to the assessment and approval of proposals. Any agency or local government that has jurisdiction to control a type of development through an existing approval process will have a power of veto over the proposal, as well as the right to impose conditions if collective approval is given. This will result in a more unified approach to development approval. In addition, the system provides for third party appeals on impact-assessed proposals, giving communities and interest groups an opportunity to input to the decisions.

There are no changes to riparian management powers in the new Act. Earlier riverine protection provisions have been retained "as is" but will be reviewed over the next 12 months to ensure they meet the State's objectives efficiently and effectively. Major issues requiring attention include: obligations of riparian landholders to manage their riverine lands; rights of riparian landholders to use riverine lands for certain purposes; suitability of riparian agro-forestry; clearer definition of a watercourse; control of land-use impacts on stream condition and ambient water quality; the use of stream improvement works to constrain natural processes; adjustments to land titles when stream boundaries move naturally; and, riparian vegetation management (including weeds).

In parallel with this review, a *Natural Rivers Policy* will be developed to identify key riverine values that must be considered as part of any future water resource planning process. The Queensland Government is concerned about the incremental loss of the State's natural river assets, as there is only a limited number of stream systems that have not been significantly modified by land use development or flow extraction, regulation or impoundment. These remaining systems are concentrated in the Gulf of Carpentaria and Cape York, with a few on the eastern coast and in the far west of the State. The new policy will facilitate an improved understanding of the significance of these natural values, including ecosystem services and social enjoyment, and set some broad State-wide objectives for the values. The natural values identified for a particular system could be used along with other inputs, such as socio-economic values and local community expectations, to make informed river development and management decisions.

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Australian Capital Territory

by John Feint

Riparian ACTion

As reported in Issue 17 of *RipRap*, the ACT has the Riparian ACTion program that complements the Bidgee Banks project in NSW. Riparian ACTion is an initiative of Environment ACT to conserve known remnant vegetation within the riparian zone along the Murrumbidgee River and its tributaries, and to ameliorate streambank erosion in the ACT.

At present, a total of $62 200 is available in devolved Natural Heritage Trust funding to land owners and managers to assist with fencing, materials, earthworks, tubestock, direct seeding and so on. This funding is to be matched by in-kind or monetary contributions by the applicant.

Projects are being targeted for funding on the basis of an assessment of local tributaries of the Murrumbidgee River on the basis of channel condition. This assessment has now produced a priority list of stream reaches for on-ground work. A field extension officer has been engaged for the project to approach the targeted landholders about initiating riparian restoration projects on the priority sites.

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AUSTRALIA

Natural Heritage Trust

Helping Communities Helping Australia

Turn over for more information on Bidgee Banks

Bidgee Banks

Bidgee Banks is a two-year, closely targeted financial incentive scheme aimed at improving the health of the Murrumbidgee River and its tributaries in NSW. It is funded by the Natural Heritage Trust through Murray-Darling 2001, and is managed by Greening Australia (ACT and SE Region). The project is also in partnership with the NSW Department of Land and Water Conservation (NSW DLWC).

Background

Various research reports have highlighted a number of issues in the Upper and Mid Murrumbidgee Catchments. One of these issues is gully and stream bank erosion, which is a key source of nutrient and sediment deposits in the Murrumbidgee River and its tributaries; another, is the decline of native riparian vegetation. In most cases the two are closely related. Numerous studies also recognise that bank stabilisation and the rehabilitation and protection of riparian environments, are critical for improving water quality, increasing biodiversity, providing habitat and improving aesthetic and capital values within the landscape.

Illalong Creek tributary. Micheal Grogan (land owner) and Lori Gould (Bidgee Banks project officer) discussing possibilities for rehabilitation of gully.

Objectives

The Bidgee Banks project is targeting these issues using a devolved grant system in the Upper and Mid Murrumbidgee Catchments. Funding is available to groups and individuals interested in contributing to the project. Major aims include:

- an increase in biodiversity of in-stream and surrounding riparian environments, resulting in habitat for both aquatic and terrestrial life and more functional ecosystems;
- a step towards improving water quality through a reduction in sediment and nutrient input; and,
- an increase in the value of land and water resources, along with the protection of infrastructure.

Funding and operational

A total of $680 500 is available for the Year 2000, stretched across the Upper and Mid Murrumbidgee Catchments, and a further $670 000 is anticipated for the year 2001. Two coordinators were employed to implement the project — one based in Wagga Wagga for the Mid Catchment, and one based in Canberra for the Upper Catchment. They are guided by a steering committee with representatives from Greening Australia, NSW DLWC, and community representatives from the Upper and Mid Murrumbidgee Catchments.

Bidgee Banks is open to all members of the community whether they are individuals, businesses or community groups. Assistance can be sought for fencing materials, tubestock, direct seeding, earthworks, materials such as rock, and alternate stock watering points. Applicant contributions include some materials, labour and site maintenance after works are undertaken.

Prioritisation of sites

In order to determine where funding is best spent, a priority system of sub-catchments has been adapted from the 'Stressed Rivers Assessment Report' (by Christoph Zierholz and John Scown, DLWC), based on erosion and conservation priorities. Under this blanket of sub-catchment priorities a number of other factors are taken into account on a case by case basis.

These factors include the return on investment, upstream and downstream status, links with intact reaches and other natural values within the landscape, placement in the sub-catchment, previous works undertaken, plans for the future, interest from the community, and educational, scientific and promotional values. This is all determined by site visits, maps and interviews with applicants. A rapid assessment approach has been adopted in order to get works on-ground works underway quickly.

Monitoring and evaluation

Formalised monitoring and evaluation of on-ground works will be undertaken by the Australian National University for the Upper Catchment, and Charles Sturt University, (Wagga Wagga Campus) for the Mid Catchment. A small amount of data will be collected from each site by the project coordinators also.

In addition to this, it is a requirement of the participants to take 'before' and 'after' photos of the site for a photo monitoring record. Sites will be mapped on a GIS database, and will relate to the photographs.

The project to date

On ground works began at the end of April 2000 and, to date, there has been interest throughout the Mid and Upper Catchments. There have been approximately 60 site visits, 30 applications approved (many with work started already), and 16 applications being waited upon.

Projects range in value from $150 to $19 000. One example, is a project on the upper part of the Yass River where a 5 kilometre stretch of river across 5 properties is being rehabilitated. It will be fenced from stock, revegetated with native species, undergo erosion works (a small amount of rock armouring) and priority (mid stream) willows will be controlled.

Another example, is the construction of a wetland in the upper Jugiong catchment to help minimise erosion by reducing the velocity of the water. In addition, the creek will be fenced from stock and remnant vegetation will be enhanced with additional plantings. The wetland will be fenced and planted with aquatic species.

These are two examples of approximately 30 projects funded by the Bidgee Banks project to date.

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Gundaroo Creek. Bidgee Banks funding has been approved to protect riparian vegetation from stock grazing planned for the near future. Has been de-stocked for 5 years.

Repairing Farm Waterways — Blackwood stories

Dead and dying trees, bare salt scalds and stream-bed scouring may not look very nice but it doesn't cost landholders money, at least not in the short to medium term.

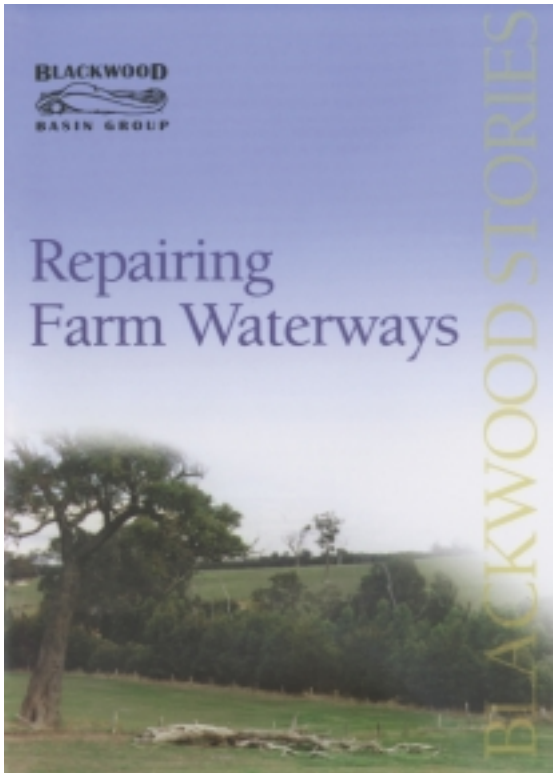
Not everything we do or invest in can be evaluated in cold hard cash, but that doesn't mean they are not often valuable, even essential, to good land management.

The Blackwood Basin Group has been working with 11 farmers in the Blackwood Basin to demonstrate and evaluate riparian restoration techniques. This Land & Water Australia sponsored project is demonstrating practical methods of rehabilitating three saline creek areas and assessing the costs and benefits of restoration on six other properties. The case studies contained in the booklet present the results of three years of monitoring.

This booklet takes a look at the reasons, both financial and non-market for spending time and money on restoring creeks and surrounding areas.

A study of landholder's views about riparian zone management is also documented in the booklet. Farmers from the middle Blackwood Basin were surveyed to assess attitudes to riparian management, and to gain a general view of the past and present condition of the river environment.

The 11 farmers involved in the project decided to do something about the degraded conditions of their own creeklines and river frontage. With financial assistance from Land & Water Australia, they each planned and carried out their own restoration activities including fencing, revegetation and trialing various site preparation techniques. The Blackwood Basin Group has monitored the results of these restoration activities since 1995 and economists from Agriculture Western Australia evaluated the financial costs and benefits of the restoration work.



You can also view the booklet at the www.rivers.gov.au website under the 'publications' menu item.

The farmers were motivated by a range of reasons for revegetating their creeklines and riverbanks. Although some of the revegetation options chosen may eventually yield a financial return, most of the motivation was driven by concern for the environment, biodiversity and natural beauty.

Copies of the booklet are available free to farmers in the Blackwood Basin and at a cost of $10 to others. For further information or to obtain a copy of "Repairing Farm Waterways — Blackwood Stories" contact:

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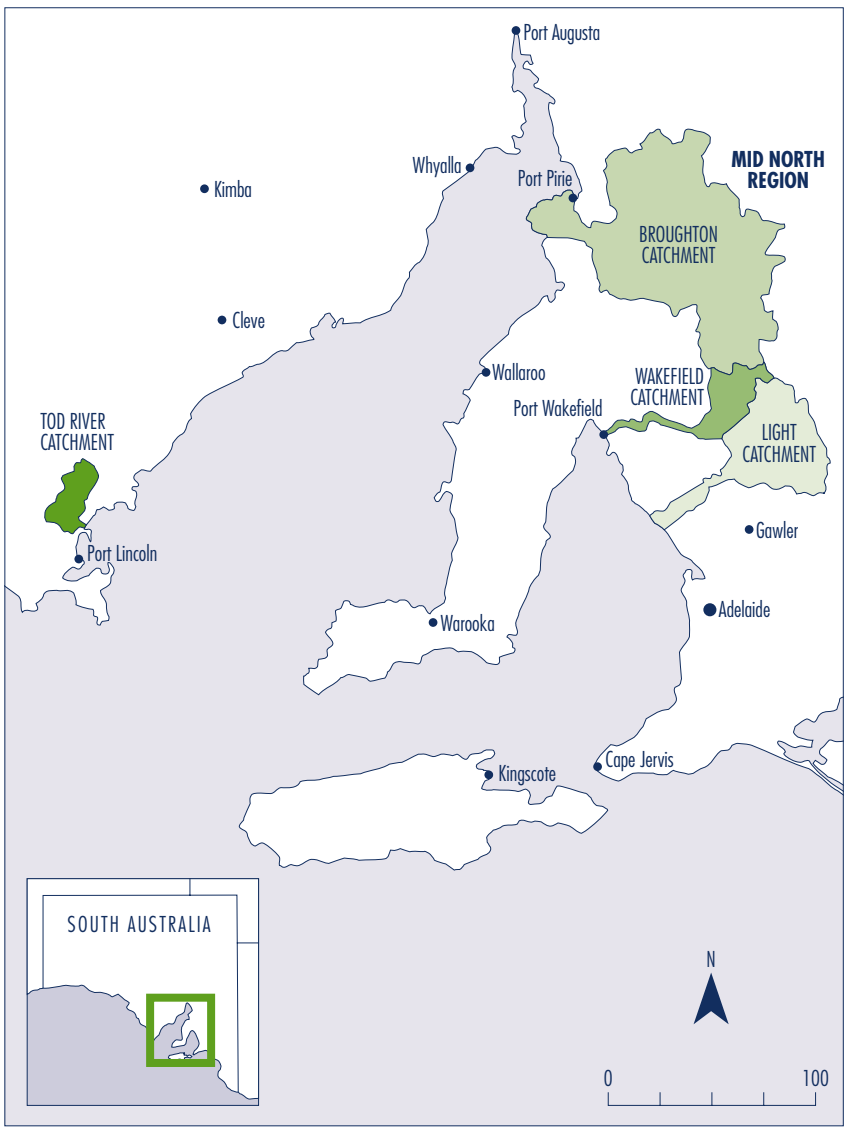
"You can't put a monetary value on restored land. It used to be a thorn in my side, seeing the sheep eroding the banks, but seeing it restored is peace of heart, peace of mind. I'm happy I made the move." *Trevor Sprigg (one of the farmers involved in the project)*

Managing semi-arid streams in South Australia

About the Healthy Rivers Unit

The Healthy Rivers Unit (HRU) is part of the Environment Protection Agency (EPA) of the SA Department for Environment and Heritage (DEH). In earlier days, riparian projects in SA were focused on the catchments of the Mount Lofty Ranges Watershed under the Riparian Zone Management Program (RZMP). Through this program, riparian surveys and community consultation meetings have been completed and management recommendation reports released for a number of areas. The latest of these reports *A Watercourse Survey and Management Recommendations for the Myponga River Catchment* by S. Kotz, D. Thomas and S. Rixon can be found at http://www.environment.sa.gov.au/epa/



The HRU now has a number of riparian management projects underway in semi-arid catchments of SA. In the last two years, we have moved into unchartered territory for SA riparian management — the semi arid systems of the Mid North Region and the Eyre Peninsula (Tod River catchment). Community interest in declining watercourse led to us initiating a range of riparian projects, as managing these semi-arid river systems presents a number of unique challenges, namely:

~ they have a highly variable hydrological regime;
~ there is a dependence by aquatic ecosystems on groundwater;
~ there is a lack of knowledge about these types of riverine environments;
~ there are difficulties with rehabilitating riparian vegetation; and
~ there is a lack of any catchment management administrative framework (for example, lack of Catchment Water Management Board).

Two of the riparian projects addressing these challenges in these semi arid area catchments are:

1. The Mid North Riverine Management Planning Project; and
2. Determining riparian vegetation for the Mid North Region Project.

The Mid North Riverine Management Planning Project

The Mid North Riverine Management Planning (MNRMPP) project was initiated by the EPA, in response to local community concerns about water resources and watercourse management issues in the Mid North Region of SA. The project commenced in May 1998 and is funded by the Natural Heritage Trust and DEH. It aims to achieve healthy rivers through planning for better watercourse management and by determining environmental water requirements. Over three years, the project will develop river management plans for the Wakefield, Broughton and Light river systems located north of Adelaide.

The specific objectives of the MNRMPP are:

~ to develop river management plans that incorporate recommendations for watercourse management and an assessment of environmental water requirements;

- to integrate watercourse management actions of landholders and key stakeholders;
- to integrate watercourse management and environmental water requirement issues into other regional and district planning and implementation strategies; and
- to increase community understanding of watercourse management and environmental water requirement issues.

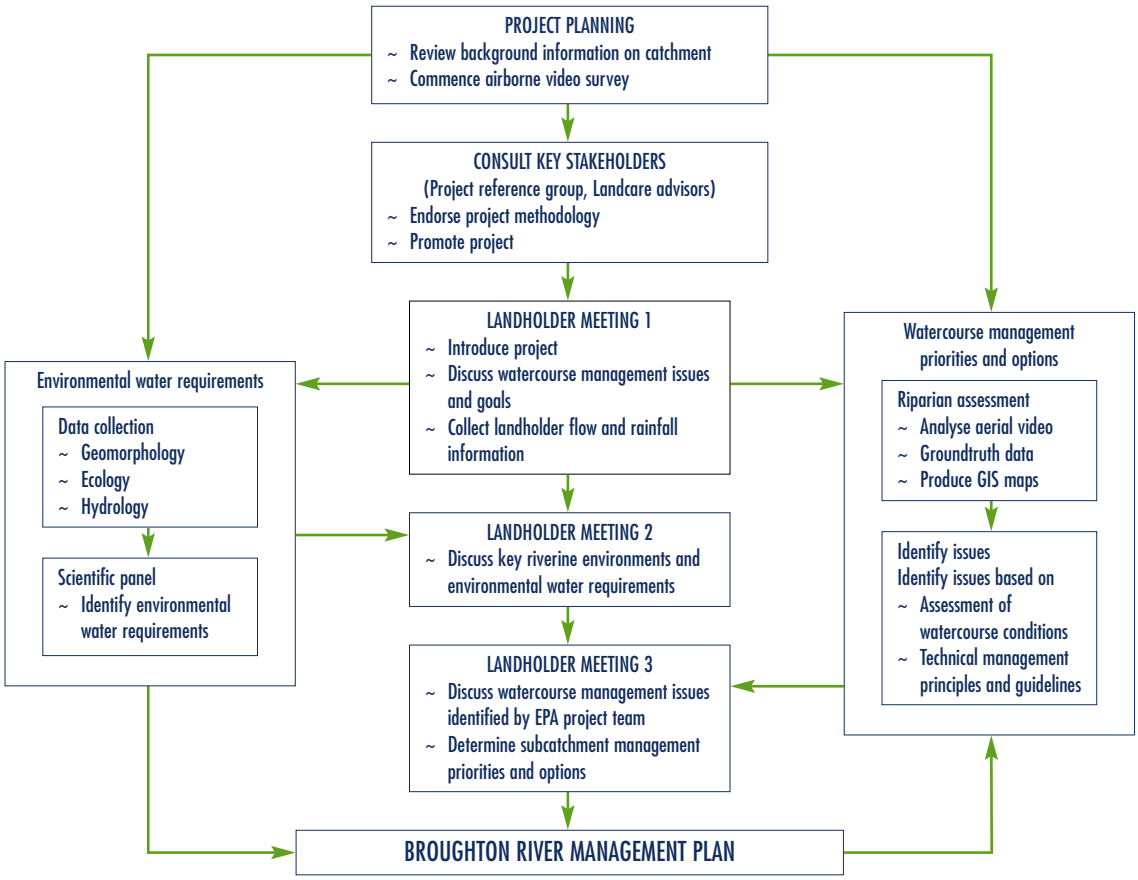
Regional stakeholders, through representation on the Project Reference group, provide a local advisory role to the EPA project staff and facilitate the integration of river management information into the plans and work programs of their organisations. The project has adopted a holistic approach to river management that considers environmental water requirements together with addressing riparian land management problems such as bed and bank erosion, stock and weed management and rehabilitation of riparian vegetation.

Assessment of watercourse condition and environmental water requirements runs more or less concurrently with a process of community consultation and involvement (Figure 1).

From left to right: Jane Bradley (Project team), Lance Lloyd (Consultant Ecologist), Bruce Murdoch, (Hydrologist), Paul McEvoy (Aquatic biologist) and Jason VanLaarhoven (Project team) inspect a Melaleuca brevifolia *habitat site on the Light River during the expert panel Broughton catchment field trip.*

Glen Scholz (Project team) setting a fyke net during the fish survey of the Wakefield River.

***Figure 1**: Overview of the river management planning process*



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***Above**: Watercourse Management Officers, Glen Scholz and Andrew Philpott taking a cross-section across an survey site on the Wakefield River.*

***Left**: On-ground works to rehabilitate Mid North watercourses face many challenges due to the seasonal and 'flashy' nature of the flows, severity of degradation and lack of trialed on-ground rehabilitation practices. At the site proposed for the Land & Water Australia SA erosion control trial, Anne Brown from Greening Australia inspects the watercourse to help EPA staff with identifying in-channel areas opportunities for revegetation using the draft riparian species list.*

Community meetings provide landholders with the opportunity to identify watercourse management problems and to participate in developing management solutions. This helps ensure that the plans have community ownership and heightens the prospect of plan implementation through on-ground action.

A rapid assessment method, based on aerial videography, is used to determine the current condition of watercourses. This data is used to produce maps for discussion at community meetings, to identify watercourse management issues and to select sites for assessment of environmental water requirements. Field studies involving habitat assessment, fish and macroinvertebrate sampling are undertaken at sites in different river geomorphic zones. This data, together with hydrological data and modelling, is analysed by a scientific panel who use their professional knowledge and expertise to determine the critical flow parameters for each river geomorphic zone.

A River Management Plan for the Wakefield Catchment (by D. Favier, S. Rixon, G. Scholz, EPA), released in May 2000, is the first of the three management plans to be produced by the Project. The plan contains important baseline information on the Wakefield River and its major tributaries, targets local and catchment wide watercourse management needs, and provides valuable information for water resource and development planning. The plan is available for viewing at the EPA website: www.epa.sa.gov.au

It is hoped that the long-term outcomes of this project for the Wakefield, Broughton and Light Rivers, include improved health and diversity of riverine ecosystems, reduced erosion and sedimentation, improved water quality and reduced stock and weed management problems.

Determining riparian vegetation for the Mid North Region

Throughout the Mid North catchments, the major watercourse management issue confronting landholders is a lack of native vegetation. Currently, there is very limited information on the present and Pre-European structure of riparian vegetation associations throughout the Mid North region. Community members have little information on what indigenous species to plant and where to establish appropriate vegetation. As a result, there is work being undertaken in the region to address this lack of information. For example, a Land & Water Australia funded demonstration/ evaluation project in the Mid North Rivers will focus on the use of riparian vegetation in bank stabilisation and other erosion control works. This project will also:

~ develop a practical watercourse management guide for Mid North landholders
~ develop and trial erosion control riparian rehabilitation works (inset photo).

Community representatives and organisations associated with land management in the Mid North region, have indicated that this vegetation information will be a valuable addition to their own natural resource programs. For example, this information can be used as a planning tool and technical reference for NHT funded community on-ground works programs currently under way in the Mid North. These programs are focusing on protecting and enhancing the riparian zones in the Broughton and Wakefield catchments through fencing and revegetation projects.

The HRU has developed a riparian vegetation assessment methodology and, through a consultancy, have had a vegetation inventory and condition assessment of selected riparian sites in the Mid North region undertaken. This will provide landholders and planners with a riparian vegetation reference list to enable them to determine the most appropriate vegetation for planting along localised areas of watercourse. The condition assessment of selected riparian sites will provide guidelines for the most cost-effective methods for site rehabilitation.

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