Projects 6.1 - 6.7

RIVER RESTORATION

COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

River Restoration Program

Introduction to the River Restoration Program

River restoration (used synonymously with rehabilitation) aims to return natural, environmental values to streams. There is tremendous enthusiasm to rehabilitate Australian streams, with at least $50 million being spent on this activity in Australia each year. The Cooperative Research Centre (CRC) for Catchment Hydrology's River Restoration research program aims to provide stream managers with tools, and with understanding of stream processes, that will lead to more effective expenditure on restoration, and ultimately, healthier streams.

Stream health is often measured in terms of the organisms that live in streams, but the health of these organisms is often the result of physical processes. Thus, the strength that the CRC brings to stream restoration is in disciplines that relate to the physical processes: hydrology, hydraulics and geomorphology.

In 1999, during the initial round of the CRC for Catchment Hydrology, we completed a National Stream Rehabilitation Manual in cooperation with the Land and Water Resources Research and Development Corporation. Volume One of the manual described a planning procedure for river restoration and Volume Two detailed a set of tools for waterway managers (the manual is available through CanPrint, phone 02 6295 4444 or email lwa@canprint.com.au or it can be downloaded from http://www.rivers.gov.au). The current CRC's River Restoration research program, described in this brochure, aims to address some of the knowledge gaps identified in that manual in preparation for an updated edition.

As part of establishing the current CRC, land and water managers around Australia identified three priority areas for river restoration research:

1. In Australia, there has been almost no evaluation of either procedures for stream rehabilitation, or of the success of restoration projects themselves. The CRC's River Restoration Program has four projects designed to evaluate stream restoration planning and application (Projects 6.1, 6.2, 6.3 and 6.4)
2. There is insufficient understanding of how key river management tools impact on rivers. Examples include fishway design (Project 6.5), scour around objects in streams (Project 6.6) and environmental flow releases (Project 6.7)
3. Understanding the process of the natural recovery of streams (without intervention) is a foundation of efficient and effective river restoration. This area of research is incorporated into the CRC's Land-use Impacts on Rivers Program; Project 2.1 'Sediment movement, physical habitat and water quality in large river systems'. A separate information sheet on this project is available.

The following sections describe the seven research projects under the CRC's River Restoration Program. For more information, please visit the CRC web site at www.catchment.crc.org.au /riverrestoration, contact the Project Leaders listed after each section or contact the Program Leader:

Dr Ian Rutherfurd *CRC for Catchment Hydrology River Restoration Program Leader*
School of Anthropology, Geography and Environmental Studies, The University of Melbourne
Email: idruth@unimelb.edu.au • Tel: 03 8344 7123

Project 6.1 Developing criteria and concepts for planning the evaluation of stream rehabilitation projects

To assist both managers and researchers to successfully apply the principles outlined in the National Stream Rehabilitation Manual, the CRC for Catchment Hydrology and the CRC for Freshwater Ecology is producing three key documents:

Criteria for selecting sites for formal stream restoration experiments

Numerous groups, including parties in the CRC for Catchment Hydrology, are enthusiastic about establishing stream restoration experiments. However, we find that only a very few of these sites are appropriate for formal research. This document will set out the fundamentals of experimental design and the criteria that are required for a site to produce results that have a high level of confidence.

Methods for cheap and simple evaluation of stream restoration projects

Only a small proportion of projects can be evaluated scientifically. The majority require other procedures to evaluate them with different levels of confidence. In this project we are both developing these methods, as well as trialling them in the Goulburn Broken catchment. This document will target the stream management community and make a major difference to the practical application of stream restoration principles.

Assessing the recovery potential of stream reaches

The recovery of streams involves both recovery of physical processes and functions (eg. stable bed and banks), and the recovery of biological populations. Stream managers contemplating a stream restoration project have asked for documented guidance to assess the potential for recovery of their stream. Case studies for the projects will be drawn from five focus catchments around Australia, particularly the Goulburn catchment in Victoria.

Completion date: June 2002

Project Leader: Dr Mike Stewardson (The University of Melbourne)
Email: m.stewardson@civag.unimelb.edu.au • Tel: 03 8344 7733

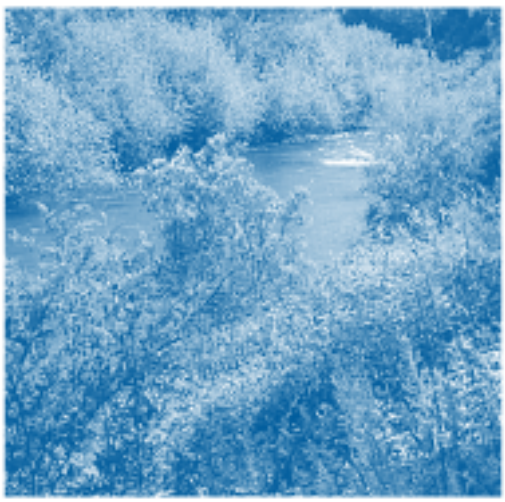
Researchers: Dr Ian Rutherfurd, Dr Barbara Downes, Michelle Ezzy (The University of Melbourne), Dr Gerry Quinn (CRC for Freshwater Ecology)

Participating Organisations: CRC for Freshwater Ecology • Goulburn Broken Catchment Management Authority • North East Catchment Management Authority • The University of Melbourne

Project 6.2 Optimising urban stream rehabilitation planning and execution

Stream managers embarking on a stream rehabilitation project often have low confidence that the project will achieve its planned outcomes, particularly in urban catchments where the pressures on streams are greatest. Project 6.2 encompasses the first trial of an urban stream rehabilitation planning approach at a catchment scale. It is analysing the costs and benefits of recommended actions, and an assessment of the viability of the plan as a whole relative to specific targets. The project has two parts:

1. Identifying constraints to urban stream restoration: a detention basin experiment



The health of urban streams is compromised by numerous factors, including changes in water quality, hydrology, hydraulics and habitat. To what level should stream managers address each of these impacts to produce a desired response in stream health? Research in Melbourne by the CRC for Freshwater Ecology demonstrated that providing habitat alone (ie. coarse substrate and riparian vegetation) does not produce a sustained improvement in biological condition. This experiment is investigating whether combining improved habitat and water quality with a more natural flow regime, will lead to improvement.

Changes to the hydrology of an urban stream will be achieved by retrofitting the outlet of a flood detention basin. Later, water quality will be improved by constructing a wetland in the basin. Physical and biological changes in the stream below the basin will be monitored over several years and compared with control sites. The results will have particular application in protecting streams in increasingly urbanised catchments from future damage.

2. Modelling the effectiveness and feasibility of a stream rehabilitation planning procedure

Stream managers, like Melbourne Water in Victoria, have sophisticated stream restoration plans with many millions of dollars of work planned. A major problem is how to assess the effectiveness of different options for proposed expenditure in the long term. Assessing a real multi-treatment project would take many decades of monitoring, and would yield unclear results.

This project is using a modelling approach to assess the viability of various targets in stream rehabilitation. We are developing a detailed restoration plan for a catchment in Melbourne, and then testing if the project can achieve the aims stated in detailed restoration targets. For example, the plan may call for maximum flow velocities of two metres per second, but modelling might show that this target is prohibitively expensive to implement. This project is closely linked to the CRC's Urban Stormwater Quality research program (Program 4), and the CRC for Freshwater Ecology's projects: 'Showcasing practical restoration methods' and 'Impacts of urbanisation on stream ecology'.

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Project Leader: Dr Tony Ladson (The University of Melbourne)
Email: t.ladson@eng.unimelb.edu.au • Tel: 03 8344 6646

Researchers: Dr Tim Fletcher (Monash University), Myriam Ghali (The University of Melbourne), Dr Peter Breen, Dr Chris Walsh (CRC for Freshwater Ecology)

Participating Organisations: Melbourne Water • CRC for Freshwater Ecology • The University of Melbourne

Project 6.3 Restoration ecology in the Granite Creeks, Victoria

The aim of Project 6.3 is to implement a rigorously planned, documented and evaluated stream restoration project. The project will be undertaken jointly by the CRC for Catchment Hydrology and the CRC for Freshwater Ecology, with assistance from the Goulburn Broken Catchment Management Authority.

A common and serious type of disturbance in Australian streams is excess sediment or sand slugs. Research in the Granite Creek systems of the Goulburn River in Victoria over the last two years has revealed information about the physical and biological processes operating in disturbed streams. One of the key findings was that the health of these systems is limited by the scarcity of large woody debris.

In this project we have built over 40 wooden habitat structures (simulating large woody debris) into the sand-slugged reaches of the Granite Creek streams. These are the type of structures that are now commonly being used by stream managers. In an intensive monitoring program, we are measuring the hydraulic, geomorphic, and biological response of the stream to the timber. The experiment will be used to test several hydraulic and scour-prediction models, as well as two ecological hypotheses regarding fish and invertebrates: the 'field of dreams' hypothesis, and the 'habitat halo' hypothesis. The results will demonstrate the effectiveness of these works to stream managers. This project is linked to the CRC for Catchment Hydrology Project 6.6 'Developing tools to predict scour of rehabilitation works' and to the CRC for Freshwater Ecology project 'Processes and patterns'.

Completion date: June 2003

Project Leader: Dr Ian Rutherfurd (The University of Melbourne)
Email: idruth@unimelb.edu.au • Tel: 03 8344 7123

Researchers: Prof. Sam Lake, Alena Glaister, Dr Nick Bond (CRC for Freshwater Ecology)

Participating Organisations: CRC for Freshwater Ecology • Goulburn Broken Catchment Management Authority • The University of Melbourne

Project 6.4 Evaluation of riparian revegetation in a south-east Queensland catchment

Riparian revegetation is the most common stream rehabilitation activity in Australia, however there has been little rigorous evaluation of the physical and biological effectiveness of this type of restoration. Project 6.4 involves the CRC for Catchment Hydrology, the CRC for Freshwater Ecology and other catchment based groups evaluating a whole-of-catchment riparian rehabilitation project. The Echidna Creek catchment north of Brisbane is now being revegetated so that we can assess the physical and biological changes that result. A monitoring network is in place to continuously measure water quality, and this is combined with monitoring for invertebrates and fish. The work and some of the monitoring will be carried out as part of the South East Queensland Regional Water Quality Management Strategy (SEQRWQMS) on the Brisbane River catchment.

In collaboration with CRC Project 2.1 'Sediment movement, physical habitat and water quality in large river systems', the outcome of this experiment will be a methodology to predict the effectiveness of riparian revegetation across the catchment of the Brisbane River and Moreton Bay.

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Project Leader: Prof. Stuart Bunn (Griffith University)
Email: S.Bunn@mailbox.gu.edu.au • Tel: 07 3875 7407

Researchers: Nick Marsh (Griffith University)

Participating Organisations: Melbourne Water • Natural Resources and Mines, Qld • South East Queensland Regional Water Quality Management Strategy • The University of Melbourne

Project 6.5 Hydraulics and performance of fishways in Australian streams

Rehabilitation of fish populations in Australian streams is severely restricted by the thousands of artificial barriers that restrict the passage of migratory fish. For example, there are at least 3600 artificial barriers to fish migration (weirs, culverts and other in-stream structures) in the Murray-Darling Basin, and less than 1% of these have effective artificial fishways.

Despite more than $1 million being spent on fishways nationally per annum, we have little appreciation of economical fishway design; once constructed, they are difficult and costly to modify. With adequate hydraulic and biological information we could design them correctly first time, and save many millions of dollars over the next decades.

There is considerable research on the unique biology of Australian migratory fish being undertaken, but very little on the detailed hydraulics of the fishway structures themselves. The CRC is well placed to make major advances in this area through our expertise in hydraulics. Project 6.5 concentrates on vertical slot fishways on the Murray River and will investigate:

- Detailed hydraulics (flow, velocity, turbulence) in existing fishways
- Conditions that attract native fish to fishway entrances
- Burst and sustained swimming ability of native and exotic fish
- The response of fish to local turbulence within fishways

The outcome of this research will be models of the hydraulics of vertical slot fishways that can be matched to fish swimming ability enabling managers to optimise the cost effectiveness of fishways. This work is being assisted by a grant from the Department of Agriculture, Fisheries and Forestry - Australia.

Completion date: June 2003

Project Leader: Assoc. Prof. Bob Keller (Monash University)
Email: bob.keller@eng.monash.edu.au • Tel: 03 9905 4946

Researchers: Lindsay White, Frank Winston (Monash University), Prof. Sam Lake, Dr John Harris (CRC for Freshwater Ecology)

Participating Organisations: CRC for Freshwater Ecology • Goulburn-Murray Water • Monash University • Murray-Darling Basin Commission

Project 6.6 Developing tools to predict scour of rehabilitation works

At the core of much of the physical rehabilitation of streams is the stability of the channel bed; recovery can only begin when the bed is stabilised. Vegetation can colonise the channel floor or margins naturally, or managers can attempt to accelerate the rate of recovery by encouraging vegetation, or by stabilising the bed with artificial structures. Although there is a large amount of research in the area of structural stability, it has not been distilled into a general planning tool for stream managers. For example, there are design rules for log sill construction, but little information to support a decision to use log sills or rock chutes. At present, tool selection is typically based on popularity and familiarity.

Project 6.6 addresses the key question in this issue - what structures, and what vegetation, will survive in a given stream, given the shear stresses present? The project will deliver a planning tool (probably a set of graphs that express failure as a factor of safety based on a probability of failure) that will assist managers in planning their stream restoration projects. The method will express the risk of failure in terms of probabilities based on the hydrological record. Typical questions that the method will answer include:

- Will log sills survive in this stream, or do I need to build rock chutes?
- How much anchoring will I need to use to stabilise this large woody debris?
- If I do nothing in this stream, will vegetation colonise and survive in the channel?

Outcomes of the project will be developed into computer programs.

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Project Leader: Assoc. Prof. Bob Keller (Monash University)
Email: bob.keller@eng.monash.edu.au • Tel: 03 9905 4946

Researchers: Dr Tony Ladson (The University of Melbourne), Wayne Tennant (Goulburn Broken Catchment Management Authority), Frank Winston (Monash University)

Participating Organisations: Department of Natural Resources and Environment, Victoria • • East Gippsland Catchment Management Authority • Monash University




The Cooperative Research Centre for Catchment Hydrology is a cooperative venture formed under the Commonwealth CRC Program between:

- Brisbane City Council
- Bureau of Meteorology
- CSIRO Land and Water
- Department of Land and Water Conservation, NSW
- Department of Natural Resources and Environment, Vic
- Goulburn-Murray Water
- Griffith University
- Melbourne Water
- Monash University
- Murray-Darling Basin Commission
- Natural Resources and Mines, Qld
- Southern Rural Water
- The University of Melbourne
- Wimmera Mallee Water

Associates:

- SA Water
- State Forests of NSW

Project 6.7 Developing an improved method for designing and optimising environmental flow

The design and provision of environmental flows is one of the most important areas of research in Australian hydrology, and is critical for stream restoration. This project capitalises on work by the initial CRC for Catchment Hydrology and the CRC for Freshwater Ecology. This collaborative research examined environmental flows in the Campaspe River, Victoria as part of a large experiment that led to a detailed understanding of the effect of hydraulics on biological processes. This work was also pioneered by Dr Mike Stewardson in his PhD.

Most environmental flow studies concentrate on how much flow the stream needs. The reality of most streams is that there is never as much water available as the system requires. The key question is: how we can make best use of the limited water that is available?

The method derived from our previous research identifies the key flow events for biological functions, and builds them into operating rules for the dam, or other aspects of a water resources scheme. In Project 6.7 we are developing this 'flow events' approach, and applying it to several case-studies. The project has two stages:

The first is to identify hydraulic flow events that trigger key ecological processes and link them to specific biological processes, or the life-cycles of organisms. Examples of such events include periods when:

- bed sediments are mobilised,
- large woody debris and backwaters are inundated
- the stream bed is exposed,
- benches and the floodplain are inundated.

The second stage of the project has two steps: (1) field surveys and (2) modelling. The purpose of this stage is to estimate the discharges corresponding to hydraulic events in a wide range of stream types. The flow assessment procedure will then be used to evaluate the environmental effects of historical changes in the flow regime of the river.

The flow events approach will also be used for assessing the environmental performance of a proposed water allocation model being developed as part of the CRC for Catchment Hydrology Project 3.1 'Integration of water balance, climatic and economic models'.

The outcome of the project for dam managers will be a procedure for assessing environmental flow regimes based on changes in the frequency and duration of the hydraulic flow events. A standard frequency-magnitude analysis will provide a simple and transparent approach to this problem. So far, the method has been trialled on the Snowy, Broken, Wimmera and Onkaparinga Rivers.

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Project Leader: Dr Mike Stewardson (The University of Melbourne)
Email: m.stewardson@civag.unimelb.edu.au • Tel: 03 8344 7733

Researchers: Dr Gerry Quinn (CRC for Freshwater Ecology), Dominic Blackham (The University of Melbourne)

Participating Organisations: Department of Natural Resources and Environment, Victoria • Goulburn Broken Catchment Management Authority • The University of Melbourne