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Freshwater Ecology

Cooperative Research Centre for

annual report

2001 - 2002



COOPERATIVE RESEARCH CENTRE FOR
FRESHWATER ECOLOGY



Vision

The Cooperative Research Centre for Freshwater Ecology exists to improve the condition of Australia's inland waters.

Mission

The Cooperative Research Centre for Freshwater Ecology provides ecological understanding to improve and protect Australia's inland waters by collaborative research, education, resource management, policy advice and community liaison.

Objectives

To deliver high quality scientific research that contributes to the understanding of the ecology of aquatic ecosystems. With in-depth understanding, it is possible to predict how aquatic ecosystems react to different scenarios.

To develop and test ecological theory, through our research program.

To provide knowledge of the principles of ecology, so they can underpin management decisions and actions and address key management issues facing Australia's water industry.

To increase the capacity of Australia's water industry to predict the ecological consequences of management actions.

To produce methods and tools for assessing ecological conditions, to assist water managers to measure the effects of their actions.

To contribute an ecological perspective to policy debates within the water industry.

To maintain international linkages so our work is known internationally and to ensure our science is at the best possible standard.

To provide ongoing professional education to build up a capacity within the water industry to understand ecological issues.

To provide high quality postgraduate education and experiences that equip graduates with skills and knowledge appropriate to industry needs.





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THE COOPERATIVE RESEARCH CENTRE FOR FRESHWATER ECOLOGY IS A COLLABORATIVE VENTURE BETWEEN:

ACTEW Corporation • CSIRO Land and Water • Department of Land and Water Conservation, NSW • Department of Natural Resources and Environment, Victoria • Department of Natural Resources and Mines, Queensland • Environment ACT • Environment Protection Authority, NSW • Environment Protection Authority, Victoria • Goulburn-Murray Rural Water Authority • Griffith University • La Trobe University • Lower Murray Water • Melbourne Water • Monash University • Murray-Darling Basin Commission • Sunraysia Rural Water Authority • Sydney Catchment Authority • University of Adelaide • University of Canberra

SCOPE OF CRCFE RESEARCH:



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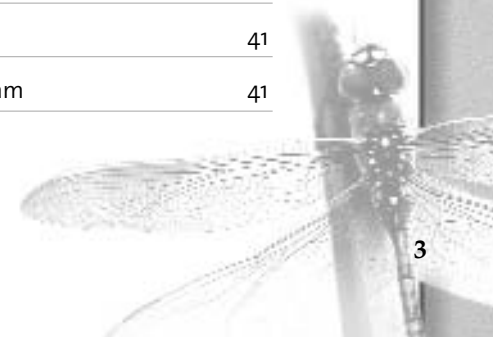
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CHAIRMAN'S FOREWORD	5
CHIEF EXECUTIVE'S REPORT	7
CHAPTER 1 STRUCTURE AND MANAGEMENT	9
1.1 Membership of the CRCFE	9
1.2 CRCFE Board	9
1.3 Board Committees	9
1.4 Organisational Structure	10
1.5 Program Advisory Committees	11
CHAPTER 2 RESEARCH	12
2.1 Research Overview	12
2.2 Program Advisory Committees	12
2.3 Program A – Flow-Related Ecological Processes	13
2.4 Program B – Restoration Ecology	16
2.5 Program C – Conservation Ecology	18
2.6 Program D – Water Quality and Ecological Assessment	21
2.7 List of Research Projects	25
CHAPTER 3 KNOWLEDGE EXCHANGE	27
3.1 Program Highlights	27
3.2 Cooperative Linkages	28
3.3 Specialist Advice	36
3.4 Publications	37
3.5 Conferences/Workshops Supported by the CRCFE	38
3.6 Public Awareness/Promotion	38
3.7 Media Coverage	38
CHAPTER 4 EDUCATION AND TRAINING	39
4.1 Postgraduate Education	39
4.2 Undergraduate Education	40
4.3 School Education	41
4.4 Future Directions for the Education Program	41



CHAPTER 5	STAFFING AND ADMINISTRATION	42
5.1	Specified Personnel	42
5.2	Staff Contributed by Partners	42
5.3	Staff Comings and Goings	42
5.4	Major Renovations and Purchases	42
5.5	Awards	42
5.6	Grants Held by CRCFE Researchers	43
CHAPTER 6	PERFORMANCE INDICATORS	44
6.1	Cooperative Arrangements	44
6.2	Research and Researchers	44
6.3	Education and Training	45
6.4	Applications of Research	45
6.5	Management and Budget	46
APPENDIX A	SCIENTIFIC PUBLICATIONS	47
A1.1	Books or Chapters in Books	47
A1.2	Refereed Journal Articles	47
A1.3	Non-Refereed Journal Articles	50
A1.4	Technical and External Contract Reports	50
A1.5	Brochures	52
A1.6	Electronic Publications	52
A1.7	Identification Guides	52
APPENDIX B	CONFERENCE AND WORKSHOP PAPERS AND PRESENTATIONS	53
APPENDIX C	STUDENTS IN THE CRCFE	56

Chairman's Foreword



The past year has seen a 'changing of the guard' with Ben Gawne replacing Terry Hillman as Director of the Murray-Darling Freshwater Research Centre, and Gary Jones replacing Peter Cullen as Chief Executive of the CRC for Freshwater Ecology from 1 July 2002 onwards.

Deciding on a new Chief Executive is the most important decision a board can make. The Board established a Selection Committee, which I chaired, to negotiate with the University of Canberra and initiate an international search after consultation with all Board members. The University of Canberra agreed to provide a tenured professorship for the Chief Executive, continuing the conditions that applied to the previous incumbent. Recognising the importance of the appointment to the University of Canberra, Professor Roger Dean, Vice Chancellor of the University joined the Selection Committee. Four candidates were short-listed and interviewed, including two international candidates. After careful deliberation the selection committee recommended the appointment of Professor Gary Jones, then Director of Knowledge Exchange with the CRC for Freshwater Ecology.

Gary brings considerable knowledge, skill, experience and enthusiasm to the position. He has a first class honours degree in science from Monash University majoring in aquatic botany, and a PhD in aquatic chemistry from the University of Melbourne. Subsequently Gary was awarded a Fulbright Post-Doctoral Fellowship to one of the world's leading aquatic chemistry laboratories at the MIT in Boston, USA, followed by an industry-funded Senior Research Fellowship to one of Britain's leading environmental microbiological laboratories at the University of Newcastle-on-Tyne.

Gary returned to Australia in 1989 to join CSIRO's Division of Water Resources as a research group leader. He was appointed as the ARMCANZ National Algal Manager in 1995, a position that gave Gary considerable exposure to the challenges facing Australia's land and water managers. In 2001 Gary was appointed as Director of Knowledge Exchange with the CRC for

Freshwater Ecology and as a professor at the University of Canberra. As chairman of the River Murray Expert Reference Panel on Environmental Flows and Water Quality he made an outstanding contribution to informing community stakeholders on the science of environmental flows in the Murray.

The Board is looking forward to Gary applying his considerable talents to shaping the future of the CRC for Freshwater Ecology.

Professor Peter Cullen, winner of the Prime Minister's Environmentalist of the Year Award, and 'Australia's most respected greenie', according to Senator Robert Hill, will be no mean act to follow. At this point I would like to pay tribute to Peter's outstanding contribution to the CRC for Freshwater Ecology and management of Australia's fresh waters.

Peter was the driving force behind the first bid for a CRC for Freshwater Ecology in 1991. Unfortunately the bid, while highly competitive, was unsuccessful. Peter showed great strength of character in overcoming the failure and developing a stronger and ultimately successful bid in 1992. The CRC for Freshwater Ecology was up and away with Peter as the inaugural Chief Executive. The record of the CRC stands as testament to Peter's abilities — an outstanding report from the 5th Year Review Panel, and a successful rebid including significant new partners, speak volumes.

Peter was appointed as President of the Federation of Australian Scientific and Technological Societies (FASTS), the peak body representing Australian scientific organisations. He presented the public face of Australian science through media interviews and presentations to scientific conferences and community meetings.



As President of FASTS, Peter gained a seat on the Prime Minister's Science, Engineering and Innovation Council (PMSEIC) and made significant contributions to the Council's deliberations on salinity and biodiversity.

One of Peter's greatest contributions lies in the area of communication. Explaining complex scientific concepts in ways that the community can understand is a daunting task. Peter is a master at it. Peter's own words, best expressed in a recent interview, describe his achievement:

'I believe my biggest personal contribution has been in the delivery of knowledge. We understood the need for media and communications to familiarise the public and the professions with what we were doing in the CRC, but this wasn't sufficient. We needed to better advise our stakeholders on a technical level, and this led to the evolution of the knowledge broker concept. This strengthened the links between the producers of the knowledge and the users of this knowledge. I believe this put the CRC ahead of the pack.'

How right he was! I would like to thank Peter on behalf of the Board for an outstanding contribution to the CRC for Freshwater Ecology, and to more sustainable management of Australia's freshwater resources.

I also thank my fellow Board members and the staff of the CRC for their contributions in what has been a particularly challenging year.

DR JOHN LANGFORD
Chairman of the Board

Chief Executive's Report

The 2001–02 year has been an exciting one for the CRC for Freshwater Ecology (CRCFE). Ecological issues are now firmly centre-stage in much of the decision-making with regard to water resources. The findings from the various research projects conducted over the nine years of our operations are now finding their way into management thinking.

The work we have done on assessing river health has led to the waterways condition report of the National Land and Water Resources Audit — an international first as a national approach to assessing river health. That assessment has also provided the *Snapshot of the Murray-Darling Basin River Condition* that was considered by the Murray-Darling Basin Ministerial Council at its April meeting, and that was a formative step in the Council moving forward on the Murray Environmental Flows project. This work, led by Associate Professor Richard Norris, has been the foundation for the next stage in the evolution of river health assessment, the Sustainable Rivers Audit that was developed specifically for the Murray-Darling Basin Commission and is now being trialled by them. It has taken us almost a decade to develop these techniques, to get governments to undertake the data collection, and for us to analyse and model the data to produce the various products now in regular use by governments.

The CRCFE continues to undertake fundamental work on the environmental allocations needed to maintain healthy rivers, and has contributed many ideas that are now guiding day-to-day decision-making by governments and community groups. Professor Gary Jones led the Murray Environmental Flows Project that is now providing the background for a major public consultation that will determine the sort of River Murray we live with in the future and leave for our children. Another major project, funded by the Murray-Darling Basin Commission, is to undertake an ecological study of the Narran lakes, a Ramsar-listed wetland that receives water from the Condamine-Balonne system.



This is my last Annual Report, since I am retiring from the CRC for Freshwater Ecology at the 30th June, and will retire from the University soon after that. The Board has appointed Professor Gary Jones as my successor, and I wish him well in this new role. Gary has been our Director of Knowledge Exchange for the last year, leading our team of five highly talented and committed knowledge brokers who deliver our science to our partner organisations and others.

The power of the CRC model is the ongoing relationship and trust that builds up between the research community and the industry users. It is not always an easy relationship, but over time the trust grows as we all realise we can achieve much more working together than we had been able to achieve in isolation. I think our CRC has been a great example of this.

I retire now with considerable pride in what we have achieved. We set as our Vision at the beginning of the CRC that we were here to make the waters better. Freshwater ecology is now a central plank in the knowledge needed to manage water resources in this country. Not only are we producing and delivering useful knowledge, but Ministers seek our advice on many issues as do agencies, the media and the community.

The CRC has some wonderfully talented scientists working within it, and what we have achieved has been due to their energy, their curiosity and their insights, as well as their preparedness to help us deliver the knowledge in various ways to those who need it. I am also greatly heartened by the quality and energy of those who are involved in the post-graduate program of the CRCFE across its various universities. Universities are finding it difficult to maintain their commitments to CRCs due to the financial stringencies



within which they operate, but the resources, the intellectual environments and the agency connections produced within the CRC program provide a post-graduate experience that is vastly superior to the experience the universities are able to provide themselves alone.

I would also like to pay particular tribute to Professor Barry Hart, who has decided to stand down as Director of Research of the CRCFE, although he will continue his research work in the CRC. Barry has provided strong scientific leadership to the CRCFE over the last decade and his contribution is greatly appreciated.

The CRCFE would not have achieved as much as it has without the committed governance provided by our Board, and in particular our Chairman, Dr John Langford. The Board has to reconcile many competing interests, and give a clear framework in which we can generate and deliver the scientific knowledge needed to manage our water resources. They have done a great job in this and their support and encouragement are appreciated by me and by staff and students throughout the CRC.

PROFESSOR PETER CULLEN

Chief Executive

Chapter 1

Structure & Management

1.1 Membership of the CRCFE

The Cooperative Research Centre for Freshwater Ecology (CRCFE) was formally established in July 1993 under the Commonwealth Government's CRC Program. In 1999, the CRC successfully applied for a further seven years of funding. The CRC is an unincorporated joint venture between:

- ACTEW Corporation
- CSIRO Land and Water
- Department of Land and Water Conservation, New South Wales (DLWC)
- Department of Natural Resources and Environment, Victoria (DNRE)
- Department of Natural Resources and Mines, Queensland (QNRM)
- Environment ACT
- Environment Protection Authority, New South Wales (EPA NSW)
- Environment Protection Authority, Victoria (EPA VIC)
- Goulburn-Murray Rural Water Authority
- Griffith University
- La Trobe University
- Lower Murray Water
- Melbourne Water
- Monash University
- Murray-Darling Basin Commission (MDBC)
- Sunraysia Rural Water Authority
- Sydney Catchment Authority
- University of Adelaide
- University of Canberra

1.2 CRCFE Board

The CRCFE is governed by a Board comprising the following members at June 30, 2002:

- Dr John Langford — Executive Director, Water Services Association of Australia (Independent Chair)

- Mr Don Blackmore — Chief Executive, Murray-Darling Basin Commission
- Mr Bruce Cooper — Director Ecosystem Management Branch, DLWC
- Dr Maxine Cooper — Executive Director, Environment ACT (Replaced Dr Colin Adrian)
- Mr Ron Dennis — Independent Board member
- Dr Jane Doolan — Waterways Unit, DNRE
- Prof. Mohamed Khadra — Pro-Vice Chancellor Science and Design, University of Canberra (replaced Prof. Alan Cripps)
- Prof. Nancy Millis — Independent Board member
- Dr Chris Moran — Program Manager, CSIRO
- Prof. Robert Norris — Dean, Faculty of Science, Monash University
- Prof. Roy Rickson — Dean Environmental Sciences, Griffith University (replaced Prof. Bill Hogarth)
- Mr Paul Shanahan — General Manager, Catchment Protection, Sydney Catchment Authority
- Mr Tom Vanderbyl — Manager Water Resources Planning, QNRM
- Mr Grant Wilson — General Manager, Waterways and Drainage, Melbourne Water

The Board meets on a quarterly basis.

1.3 Board Committees

The CRCFE activated two committees of the Board during the year: a Finance Committee and a Research Committee. The Finance Committee oversees the CRCFE's finances and makes recommendations to the Board. The Finance Committee meets on a quarterly basis. The Research Committee oversees the research undertaken, provides input into the new research program development and advises the Board.



Chapter 2

Research

2.1 Research Overview

The CRCFE's research portfolio seeks to generate new knowledge and combine this with the existing knowledge base to address the short- and longer-term issues facing Australia's river and catchment managers. The portfolio contains a mixture of large, longer-term, integrated field and laboratory projects addressing strategic priorities, and short-term projects addressing immediate needs and knowledge gaps.

Nine large multi-disciplinary projects currently form the core of the CRC's research portfolio. These projects use expertise from across the CRC to focus on problems at a range of geographic and time scales, combining field, laboratory and 'desk-top' research and development. With over 70 projects in total, the CRC is well positioned to make a real difference to sustainable water management in Australia. A list of core and associated projects is included at the end of this chapter.

The research is managed through the four research programs:

- Program A:** Flow-related Ecological Processes
(Program Leader: Associate Professor Gerry Quinn, Monash University)
- Program B:** Restoration Ecology (Program Leader: Professor Stuart Bunn, Griffith University)
- Program C:** Conservation Ecology (Program Leader: Dr Margaret Brock, NSW Department of Land & Water Conservation)
- Program D:** Water Quality and Ecological Assessment (Program Leader: Associate Professor Richard Norris, University of Canberra)

The CRC research portfolio addresses five key national issues:

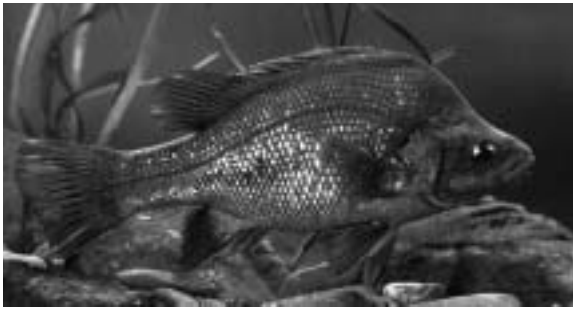
- the effects of regulation on our river systems, and the pressure for development of presently unregulated water resources;
- the serious degradation of many of our urban and rural aquatic systems and the lack of knowledge about how to rehabilitate these;
- the loss of ecosystems and biodiversity;
- the lack of detailed information about the condition (or health) of Australia's aquatic ecosystems;
- the lack of fundamental scientific understanding of the functioning of Australian inland aquatic systems, and how human actions affect biological communities and ecosystem processes.

All research projects undertaken within the CRC undergo a rigorous review process to ensure excellent quality science which is relevant and of benefit to our partners. To reinforce this, we have established a quality assurance manual that documents the review process that all research projects must undergo. The process has three levels:

- internal review of the science (by management committee);
- external review of the science (by national and international peers); and
- review of management relevance (by Program Advisory Committees).

2.2 Program Advisory Committees

The CRC consulted extensively with researchers and managers to develop its research portfolio, guided by the conviction that if truly multi-disciplinary and collaborative research is to be undertaken to achieve real benefits for the environment, researchers and managers must be involved in the planning of research projects.



A Macquarie perch, *Macquaria australasica*.
Project A210 is studying the needs of this native fish in relation to flow regimes.
Photo: Murray-Darling Basin Commission

In order to continue the involvement of land and water managers, Program Advisory Committees (PACs), which include industry representatives, have been established for each research program. The work of the PACs further ensures that the CRC's research is relevant to the water industry.

The PACs meet at least once per year and report their progress to the Board.

2.3 Program A — Flow-related Ecological Processes

Program Leader: Associate Professor Gerry Quinn

Deputy Program Leader: Associate Professor Martin Thoms

Australia's rivers and wetlands occupy a remarkably diverse range of geographic and climatic conditions, including the coastal fringe and inland, summer- and winter-rainfall regions, and temperate and arid zone systems. While these categories allow broad classification of flow regimes, the flow patterns in many of these systems are amongst the most unpredictable in the world. Regulation has resulted in many changes to these spatial and temporal patterns of flow. Total flow in most river systems has been reduced, the seasonal pattern of flow has often been reversed with water stored during the wetter months and released during the drier months for irrigation use, and much of the hydrological variability caused by extreme events (e.g. high flows) has been removed.

Our understanding of the effects of regulation on river ecosystems is limited. Nonetheless, we predict marked changes in habitat structure and availability, poorer

links between the main river channel and its floodplain, and ecological changes at a number of levels. For example, recruitment to plant and animal populations is altered, and there are changes in biodiversity and food web structure and loss of productivity.

This program is investigating how flow affects ecological processes in rivers and their floodplains. Its two themes address basic ecological issues (Theme A1) and relatively short-term management needs (Theme A2).

PROGRAM OBJECTIVES

- Determine the sensitivity of aquatic ecosystems to flow regulation and water abstraction.
- Determine how options for flow management will affect Australian aquatic ecosystems.
- Develop tools for assessing the success of environmental flow allocations.

Theme A1 — Role of flow in determining natural ecological processes in rivers and streams

We are examining selected ecological processes in river channels and their floodplains and wetlands. Based on the 'flood-pulse' hypothesis, we specifically consider the interactions and transfer of materials between these landscape components.

We are making progress towards quantifying links between key attributes of flow (particularly floods, but also droughts), representative biota and key ecological processes in rivers and their floodplains. Then we can begin to predict the outcomes of flow regime modifications.

Theme A2 — Flow manipulation in regulated lowland rivers

We are building upon the experience gained from the current Campaspe Environmental Flows project by continuing long-term flow manipulation experiments in winter-rainfall rivers and extending these studies to include summer-rainfall regulated rivers in northern NSW and southern Queensland. There is considerable scope to interact with the environmental flow allocation processes occurring in Victoria, NSW and Queensland.

We are quantifying relationships between different water release regimes and effects on target species or communities chosen to represent potential 'response' groups. These response groups are not only biota (e.g. fish, invertebrates, riparian and floodplain vegetation), but also ecological processes (e.g. fluxes of carbon and nutrients, nutrient spiralling) and food web dynamics.

PROGRAM SUMMARY

This program continues to advance our understanding of the role of flow in the ecology of river systems in Australia. Research on a number of lowland rivers in south-east Australia (e.g. the Murray, Ovens, Campaspe) has indicated that in-channel productivity may be a much more important driver of river ecosystems than was previously thought.

We have identified biotic indicators that we can use for detecting ecological responses to modified flow regimes. We have started quantifying crucial habitat for threatened species of fish in gravel-bed streams and how it relates to environmental flow releases. We continue to characterise flow regimes for summer- and winter-rainfall rivers and to survey the literature to link ecological changes to modifications in flow regimes.

A number of new initiatives will commence in 2002-03 that will directly address program milestones. One large project will examine the effects of flow regime and wetting and drying cycles on the Narran Lakes — a Ramsar-listed wetland in northern NSW. Other projects will involve designing monitoring programs to assess the ecological responses to environmental water allocations and flow regimes.

PROGRAM HIGHLIGHTS

Each of the core research projects has made major achievements in the past year.

- **Project A100 (Campaspe Flow Manipulation Experiment)** has identified key indicators of biotic response to modified flow regimes. These indicators include recruitment of native fish and, more importantly in terms of monitoring, abundances of some species of macroinvertebrates, especially shrimps. These data will allow significantly better monitoring and assessment of ecological outcomes from environmental flow regimes.



Luciano Serafini and Paul McInnery pulling fyke nets in the Broken River. The data from the Campaspe flow manipulation project could improve the assessment and monitoring of ecological outcomes from environmental flows. Photo: P Humphries



Maximising the ecological benefits of environmental flow releases for native fish in the Cotter River, ACT, is the ultimate aim of project A210. Photo taken at Bendora Dam, ACT by S Nichols.

- **Project A200 (The Effect of Flow on Lowland River Productivity)** has examined the responses of three large lowland rivers (Murray, Ovens and Broken) to flow events. There appear to be sufficient numbers of zooplankton resident in channel backwaters to support the recruitment and survival of juvenile fish. This goes against the traditional wisdom that the floodplain is the main source of carbon and biota for lowland rivers and drives the riverine food web from the bottom-up. In-channel processes seem to be much more important than previously thought, a result supported by fish recruitment data in the Campaspe River in project A100.
- **Project A210 (Environmental Flows and Ecosystem Response in Gravel-bed Streams)** has completed hydraulic modelling and hydraulic preference curves for a threatened species of native fish, the river blackfish. These curves will now be used to determine environmental flow regimes that will maximise suitable habitat for this species. They are providing information relevant to resource managers in upland streams who are trying to maintain populations of native fish species and overall river health.

SUMMARY OF PROGRAM A OUTCOMES

Program outcomes (From Schedule)	3 year milestones (From Schedule)	Progress at year 3
Better understanding of the link between flows, ecological processes and biodiversity in a range of river types	Improved conceptual and empirical understanding of the role of flow (floods and droughts) as a disturbance affecting ecological processes in rivers and streams	<ul style="list-style-type: none"> Final analysis of data from Lowland River project suggests that the Riverine Productivity Model is a better description of ecological functioning in the River Murray than either the Flood Pulse Concept or the River Continuum Concept. This is one of the few attempts to critically compare predictions from these conceptual models. Preliminary results from Project A200 (The Effect of Flow on Lowland River Productivity) indicate that there are substantial numbers of zooplankton resident in channel backwaters in three lowland rivers. These data suggest that biota coming from the floodplain are less important than previously suspected and the numbers of zooplankton in the river appear to be present in sufficient numbers to support the recruitment and survival of juvenile fish. Project A100 (Campaspe Flow Manipulation Experiment) has clearly demonstrated that irrigation releases, over periods when normally flows would have been low, have had marked effects on riverine biota in the Campaspe River. A scoping study reviewing the literature to quantify links between flow modification and ecological response was completed in June 2002.
New tools that will lead to improved recommendations for, and evaluations of, environmental water allocations	Ecological characterisation of flow regimes in rivers in Eastern Australia including both winter and summer rainfall systems	<ul style="list-style-type: none"> The flow regime in the Condamine-Balonne River system has been characterised via a range of univariate and multivariate analyses. There is a paper in press in <i>Regulated Rivers</i> on this work. Project A210 (Environmental Flows and Ecosystem Response in Gravel-bed Streams) has successfully completed hydrological characterisation of the Cotter River in the ACT, highlighting the differences between the original flow regime and the current modified flow regime. Small flow-pulses have been markedly reduced by the dams and their management. Project A100 (Campaspe Flow Manipulation Experiment) has identified key indicators of biotic response to modified flow regimes, especially shrimps and other macroinvertebrates.
Ability to predict the sensitivity of aquatic ecosystems to varying levels of flow regulation (or water abstraction) from models relating biotic patterns and ecological processes with flow attributes	Assessment and development of designs for: (i) monitoring the effects of environmental water allocations, (environmental flows) to rivers floodplains and wetlands, and (ii) experimentally testing, at realistic spatial and temporal scales, the causal links between attributes of flow regimes and specific ecological processes	<ul style="list-style-type: none"> The first environmental flows have been released from Lake Eppalock into the Campaspe River as part of project A100, allowing assessment of biotic responses to environmental flows. A project examining the effects of changing flow regimes and wetting and drying cycles on the Narran Lakes, a large terminal wetland system and Ramsar site in northern NSW, has been funded by the MDBC and will commence in 2003. A project designing a monitoring program for environmental flows in the Wimmera and Glenelg Rivers in Victoria will commence in 2002.
Develop and promote the adoption of flow restoration recommendations that could lead to measurable ecological benefits in degraded rivers	Development of interim flow restoration guidelines for lowland rivers that will lead to measurable ecological benefits in the main channel, the floodplain and associated wetlands	<ul style="list-style-type: none"> Project A100 (Campaspe Flow Manipulation Experiment) has clearly demonstrated that when devising environmental flow regimes, it is imperative that the timing of releases be considered as well as the quantity of those releases. The imposition of augmented flows during summer has been as damaging to river ecosystems as the loss of high flows and flooding in winter. Project A210 (Environmental Flows and Ecosystem Response in Gravel-bed Streams) has commenced 'flow typing' to map variations in the hydraulic character of the flow in the Cotter River and link these variations to the distribution of biota. The CRCFE was part of two project teams that developed environmental flow rules in Victoria. The first focused on sustainable diversion limits for unregulated streams and the second developed statewide guidelines for setting environmental flow rules more generally. Both have reported to Victorian DNRE.

2.4 Program B — Restoration Ecology

Program Leader: Professor Stuart Bunn

Deputy Program Leader: Dr Darren Baldwin

PROGRAM OBJECTIVES

Many of our streams, rivers and wetlands are in a degraded state and millions of dollars are spent each year on restoration. Unfortunately, little of the past restoration effort has been underpinned by a strong scientific base, and few attempts have been made to measure environmental benefits. The CRC for Freshwater Ecology has a vital role to play in providing the essential ecological knowledge that is needed to underpin and guide practical restoration measures.

The core research objective of Program B is *to understand the ecological processes that will facilitate the recovery of disturbed stream and river ecosystems*.

The program has four broad objectives:

- to understand the processes that will facilitate recovery of disturbed systems, and determine the resilience of restored systems to subsequent disturbances
- to develop innovative approaches for waterway restoration which integrate information across conventional disciplines to maximize environmental outcomes
- to establish several case studies with relevant management groups as adaptive stream rehabilitation experiments
- to facilitate the integration of river restoration practice into total catchment management.

To achieve these objectives, the Restoration Ecology Program has been organised around three broad research themes.

Theme B1 — Physical habitat restoration

A key assumption of most river and riparian restoration activities is that if you rebuild or recreate habitat then organisms will return and ecological condition will improve. This implies that recovery of degraded streams and rivers is largely constrained by the availability of suitable habitat.

Theme B2 — Mechanisms of recolonisation and recruitment

Successful stream and river restoration will not only depend on the availability of suitable habitat for aquatic organisms to survive in, but also on the ability of organisms to reach the new habitat via dispersal. Physical restoration of stream habitats will be pointless

if ecological recovery is constrained by the ability of aquatic plants and animals to recolonise disturbed sites. To be able to predict how quickly disturbed systems will recover, we need to know how aquatic organisms disperse (i.e. what mechanisms they use) and how far they can move.

Theme B3 — Indicators of success of restoration strategies

Much of the work aimed at developing and testing new methods for ecological assessment of the success of restoration is being undertaken in Program D. However, an important question to be addressed in the Restoration Ecology Program is whether it is possible to restore key ecosystem processes (e.g. primary production, nutrient cycling) without completely restoring all elements of the biological communities.

PROGRAM HIGHLIGHTS

- **Project B200 (Restoration Ecology in Degraded Rural Streams: the Granite Creeks Project)** has examined the ecological responses to installed timber structures in Creightons and Castle Creeks. The sleeper structures generated scour pools immediately downstream as predicted. The red gum structures themselves were rapidly colonised by both algae and invertebrates. Native fish showed a strong positive response to the restoration structures and scour pools, with the greatest response at the 4-structure sites. However, it is not clear if the response by native fish is due to aggregation of scattered individuals or due to recruitment.

A workshop on the importance of wood in streams was held in Melbourne, in collaboration with the CRC for Catchment Hydrology (CRCCH). The report is being prepared as a technical update of the Land and Water Australia *Riparian Technical Guidelines*.

- **Project B220 (Processes and Patterns: Restoration, Biodiversity and Ecological Functions)** is our first attempt to address the lack of knowledge about the linkage between biodiversity (particularly microbial diversity) and the movement of carbon and nutrients through aquatic ecosystems. Using a molecular technique adapted for this project (terminal-restriction fragment length polymorphism), the project has been able to show that a decrease in methane production as a consequence of acute salinisation in wetland sediments is coupled to a shift in the community structure of methane-producing bacteria.

- **Project B230 (Connectivity and Dispersal)** has shown that if sites in the water supply catchment areas for Sydney are to be restored, any recolonisation by the common stream shrimps could come only from within the same subcatchment, and in some subcatchments it could come only from within the same stream.

This highlights a potential mechanism by which ecological recovery of streams may be constrained by the ability of aquatic animals to recolonise disturbed sites. Several cryptic species within the described species *Paratya australiensis* have been discovered in the Nepean/Georges catchments.

SUMMARY OF PROGRAM B OUTCOMES

Program outcomes (From Schedule)	3 year milestones (From Schedule)	Progress at year 3
An improved understanding of the constraints to recovery of disturbed aquatic ecosystems and the processes that can facilitate rehabilitation	Development and validation of innovative and practical monitoring tools so that the success of rehabilitation of streams and rivers can be quantified in ecological terms	<ul style="list-style-type: none"> • Sampling techniques have been developed and tested for monitoring the recovery of large woody debris (LWD) habitats in degraded lowland streams. An experimental study has begun on the effects of LWD restoration in sand-affected streams (B200) in association with CRCCH. Associated projects have begun, studying the recovery of fish (B706) and the use of molecular markers to identify sources of colonists to restored habitats (E824). • A monitoring program has been designed and developed for riparian rehabilitation in SE Queensland as part of the SEQ Regional Water Quality Management Strategy (D721). It is currently being implemented as the regional Environmental Health Monitoring Program. • Population genetic tools are being used to estimate dispersal capability of common stream invertebrates in SE Qld and coastal Victorian streams (B703). Similar work has been completed in South Africa (B803). A core project is underway with a focus on water supply catchments in Sydney (B230). Additional information on dryland rivers is being collected as part of C200. • It is observed that there is a lack of recolonisation of benthic invertebrates on constructed riffle habitats in an urban stream after four years, indicating that other factors may constrain recovery (B705). • Two projects from CRCFE Mark I are now completed, on the understanding of nutrient cycling and ecosystem processes in streams, and how these relate to overall stream health (B110). • A new project has begun looking at the links between biodiversity and ecosystem processes, and the factors that may constrain recovery of processes (B220).
To ensure that public funds invested in restoration of degraded ecosystems result in the maximum environmental benefit possible. This will be achieved by: <ul style="list-style-type: none"> • developing guidelines for rehabilitation of streams, rivers and floodplain wetlands in both rural and urban settings, based on sound ecological principles • establishing demonstration sites to showcase ecologically-sensitive rehabilitation methods 	<p>Initiate demonstration sites aimed at showcasing practical, cost-effective and ecologically sound methods for the rehabilitation of rivers and wetlands</p> <p>Contribute to the development of 'best management practice' for the cost-effective and ecologically sound rehabilitation of rivers and wetlands</p>	<ul style="list-style-type: none"> • Several sites for riparian rehabilitation have been established and monitored in SE Queensland as part of the SE Queensland Regional Water Quality Management Strategy (SEQRWQMS) (D721, CRCCH 6.4). • Recommendations for riparian land management have been written into the SEQRWQMS (D721). • A snag demonstration project has been completed on the Murray (B704). • A new R&D project has been established as part of Phase 2 of the Land and Water Australia (L&WA) Riparian Lands Program (B708); it includes work on demonstration sites in SE Queensland and Victoria. • The program has contributed to the production of technical guidelines on Riparian Management (with CRCCH & L&WA). An update on the restoration of wood in streams is in progress for L&WA. • A working group on flow and habitat restoration (F310) has been established, and first reviews of the effects of altered flow regimes have been prepared.



The sleeper structures installed in Castle Creek for the Granite Creeks project created scour pools and were rapidly colonised by algae and invertebrates. Nick Bond, Bridgid Cowling and Annabel Carle sampling invertebrates from river red gum sleepers in Castle Creek. Photo: A Glaister



Alena Glaister and Bridgid Cowling sampling a River Red Gum sleeper for invertebrates in Castle Creek for the Granite Creeks project. Photo: K Cousins

2.5 Program C — Conservation Ecology

Program Leader: Dr Margaret Brock

Deputy Program Leader: Associate Professor
Jane Hughes

Biodiversity is important to our culture for the economic value that can be gained from the biota via materials and medicines, the ecological sustainability of human societies, and rich and varied opportunities in recreation and tourism. Loss of biodiversity continues to be one of our most serious environmental concerns. Whether we look at wetlands or salt marshes, mangroves or bushland, inland rivers or estuaries, the same story emerges. Degradation of habitat, the major source of biodiversity loss, is continuing at an alarming rate.

Definition of threats to biodiversity is the first step in conservation of freshwater biota and ecosystems. Decisions regarding appropriate responses often need to be made on a time-scale of the immediate to the very near future. An adaptive approach is appropriate, where intervention and research, including monitoring and evaluation, go hand in hand to achieve improved conservation outcomes. The principles of conservation ecology need to be better understood to underpin decisions for restoration and abatement of threats.

The CRC for Freshwater Ecology, by virtue of its strong industry linkages and its multi-disciplinary research capacity and knowledge base, is uniquely placed to provide leadership in research and in applying research to maintain or restore biodiversity values in a range of freshwater ecosystems.

PROGRAM OBJECTIVES

- To assess biodiversity and its distribution in freshwater ecosystems, and to gain insights into processes that regulate levels of biodiversity at various scales in space and time.
- To identify threats to biodiversity, to measure their impacts on biodiversity, and to undertake research leading to a greater understanding of the mechanisms by which they act.
- To develop responses to these human-induced pressures, to monitor the outcomes of those responses, and to evaluate the effectiveness of the responses.

This program is addressing these objectives through research organised around two themes: Biodiversity Assessment and Regulation (Theme C1) and Conserving Biodiversity (Theme C2).

Theme C1 — Biodiversity Assessment and Regulation

What do we have left? What of our natural freshwater biodiversity remains relatively intact; how do we measure it; and how is it distributed across the landscape? How does the system work? What are the factors that regulate biodiversity in natural and modified ecosystems? We are addressing these questions.

For instance we are designing and developing a long-term biodiversity monitoring program for the Sydney Catchment Authority which aims to a) effectively and efficiently measure and assess fish, macroinvertebrate and riparian vegetation biodiversity; b) identify locations of high conservation value based on their biodiversity characteristics; and c) monitor and assess biodiversity changes over time. Also, studies of the sustainable management of on-farm biodiversity in the rice-growing industry are contributing to our knowledge of the relationship between this farming system and biodiversity at farm and regional scales.

Theme C2 — Conserving Biodiversity

What can we do? How can we identify key threatening processes, manage their impacts, protect biodiversity values in natural and partially degraded systems, and conserve threatened species and communities? We are addressing these questions also. For instance we are studying the conservation biology and systematics of individual species or groups such as mountain galaxias, mayflies, crayfish and frogs.

PROGRAM SUMMARY

There has been significant progress on these objectives through projects and external influences. The CRCFE has expanded its influence in the conservation of biodiversity through National and State forums and by participating in discussions of the national needs to conserve biodiversity in all ecosystem types. The program continues to contribute to these debates, both directly through outcomes of its projects and

indirectly through activities such as calls on our increasing knowledge to guide decisions about the listing of threatened species, communities and key threatening processes. For example, 'Alteration of natural flow regimes of rivers and streams and their floodplains and wetlands' and 'Clearing of native vegetation' have been listed as Key Threatening Processes in NSW under the Threatened Species Conservation Act, providing major legislative recognition of threats to aquatic ecosystems and their biodiversity.

In addition, we have produced and distributed the outcomes of the Fenner Conference on the Environment 2001: Biodiversity Conservation in Freshwaters, in *Biodiversity in Inland Waters — Priorities for its Protection and Management* by A. Georges and P. Cottingham, CRCFE Technical Report 1/2002.

Another product of CRCFE work on conservation ecology is the booklet *Conserving Natural Rivers: A Guide for Catchment Managers*, CRCFE River Management Series Part 1, that has been written by Peter Cullen and distributed during early 2002.

PROGRAM HIGHLIGHTS

Our projects have made strong contributions to our objectives and themes during 2001–02.

- **Project C200 (Dryland River Refugia)** examines questions of fragmentation and connectivity of ecosystems. The project mainly is determining the importance of waterholes as refugia for



Sampling invertebrates in Little River, one of the sampling sites in the Sydney catchment area used by the CRCFE in the design of a long-term biodiversity monitoring program.



aquatic organisms in dryland river catchments, and identifying the biophysical processes that sustain biodiversity and ecosystem health in these refugia. This project is progressing well with large integrated data sets now being processed to answer these questions.

The first *Dryland River Refugia* newsletter has been designed for and sent to 200 rural land-holders, stakeholders and government agencies.

- **Project C210 (Adaptive Management in Restoration Ecology)** has completed its first phase during 2001–02 by simulating a cycle of introduction for re-introduction of trout cod.

Phase 2, which will refine this model, look at alternative approaches to monitoring and planning, and instigate an on-ground program for re-introduction with stakeholders, is about to begin.

- **Project C220 (Conservation Ecology and Systematics of the Mountain Galaxias)** has produced a short paper published in *Fishes of Sahul*, a general Australian journal on fishes: 'Kosciuszko galaxias — a story of confusion and imminent peril' by T.A. Raadik and R.H. Kuitert.

SUMMARY OF PROGRAM C OUTCOMES

Program outcomes (From Schedule)	3 year milestones (From Schedule)	Progress at year 3
New knowledge on the distribution, life history and conservation ecology of threatened freshwater biota	Organisation of a national forum on conservation of biodiversity in freshwater ecosystems, bringing together the range of perspectives from science and management	<ul style="list-style-type: none"> • Fenner Conference on the Environment to be hosted by the Australian Academy of Science and the CRCFE in July 2001. • Publication from this meeting, <i>Biodiversity in Inland Waters — Priorities for its protection and Management</i>, by A. Georges and P. Cottingham 2002.
Principles and recommendations for assessing the biodiversity values of freshwater systems	Design of experimental protocols for testing hypotheses on the processes that regulate biodiversity in natural and modified freshwater ecosystems	<ul style="list-style-type: none"> • First <i>Dryland River Refugia</i> newsletter produced, outlining outcomes in all aspects of the project. Species examined are capable of widespread dispersal among waterholes within a river system. • Development of a long term biodiversity monitoring program for the Sydney Catchment Authority.
Advice on the likely impacts of various human-induced disturbances on biodiversity in freshwater ecosystems and the spatial scales over which they are likely to be affected	Develop principles for the assessment of biodiversity in freshwater ecosystems	<ul style="list-style-type: none"> • Workshops on biodiversity assessment in freshwaters conducted for the Sydney Catchment Authority. • Development of a long term biodiversity monitoring program for the Sydney Catchment Authority.



Sorting invertebrates samples near Kowmung River, one of the sampling sites in the Sydney catchment area used by the CRCFE in the design of a long-term biodiversity monitoring program.

2.6 Program D —

Water Quality and Ecological Assessment

Program Leader: Associate Professor Richard Norris

Deputy Program Leader: Dr Chris Walsh

As Australian river-management agencies move towards more ecologically based management, biological assessment methods are becoming increasingly important for measuring the effectiveness of management processes. The CRCFE has been pivotal in the development and adoption of rapid biological assessment techniques, particularly AUSRIVAS under the National River Health Program.

Effective biological assessment methods should provide a rapid collection and analysis of data for management use on a regional basis. The methods should assess the degree of impact and present this in an easily interpretable form, using standardised methods of measurement and data presentation. Models underlying the assessment should respond in known ways to natural variability and be implemented with designs that meet statistical assumptions such as the need for independence of treatments being compared.

Furthermore, for research managers to choose the most effective restoration and conservation strategies, ecological assessment should include assessment of degrading processes and an understanding of causal links between the damaging agents and observed ecological condition.

Some of these requirements have been met in current and previous CRCFE projects, but further testing and development is required. There is a pressing need to complete further work if ecological assessment and monitoring are to be effectively implemented. Projects within Program D are addressing these needs.

PROGRAM OBJECTIVES

- To determine the ecological responses of rivers and related wetlands to stressors.
- To develop and test ecological risk assessment (ERA) procedures for application to freshwater systems.
- To develop the ecological basis for determining reference conditions against which comparisons to determine damage or change are often made.
- To determine the effectiveness of various bioassessment approaches in providing information on the condition of the aquatic communities and ecosystem processes.

PROGRAM HIGHLIGHTS

- **Project D200 (Assessment and Delivery of Methods for Determining River Health)** is comparing the performance of different biological assessment methods in situations of salinity and sedimentation gradients in three geographical regions. The sensitivity of biological methods in detecting change in community composition has not been thoroughly explored. Project D200 has used simulations based on modifications of known community compositions to characterise the capacities of different biological assessment methods to detect simulated changes, and to assess the representativeness of samples used in biological assessment. Preliminary analyses on AUSRIVAS data have quantified the loss of taxa associated with different condition scores, and provided a measure of the variability associated with the sampling procedure. This work will be extended to the other biological assessment methods.

The use of reference sites when judging the condition of sites has proved to be a powerful tool. However, its use has been hampered by the difficulty of identifying appropriate reference sites in regions that have been significantly modified, including urban areas. Part of project D200 (Assessment and Delivery of Methods for Determining River Health) has developed a new approach, using sites protected by good management practices as reference condition. Models using good management reference condition are to be compared with the outputs derived from using traditional reference condition sites. Preliminary results indicate that for urban regions, normally difficult to assess, the new approach has considerable promise.

- **Project D210 (Urbanisation and the Ecological Function of Streams)** is investigating a rural-urban gradient with an emphasis on stormwater drainage infrastructure. Project D210 has identified the efficiency of stormwater drainage infrastructure (connection) as the primary degrading process for a wide range of indicators of ecological condition in streams draining catchments of low-level urbanisation on the eastern fringe of Melbourne. The relationships between indicators of condition and drainage

connection will guide management priorities for stream restoration and conservation in urban areas, and provide a link to the emerging field of water-sensitive urban design, which primarily aims to reduce drainage connection.

- **Project D220 (Development of a Catchment-based Ecological Risk Assessment Framework for Aquatic Systems)** Increased ERA skills are being applied by CRCFE and partner-agency staff to several studies that are part of or are associated with project D220. These include an assessment of 'end-of-valley' salinity targets (with DLWC), development of suspended solids guidelines (with Victorian EPA), the impact of irrigation (Project D726, with Goulburn-Murray Water), management of macrophytes in urban lakes (with Melbourne Water) and control of algal blooms in Lake Yarrunga (with Sydney Catchment Authority).

The recent ANZECC/ARMCANZ *Guidelines for Fresh and Marine Water Quality* (2000) adopts a risk-based approach and mandates an ERA when 'trigger levels' are exceeded, after consideration of local mitigating factors. This requires the

development of expertise in risk assessment methods, especially in the agencies responsible for implementing the guidelines. These agencies have actively participated in workshops run as part of project D220.

- **Project D721 (The SEQ Regional Water Quality Management Strategy)** developed an integrated ecosystem-health monitoring program incorporating a list of 15 indicators of ecosystem processes and biotic and physical/chemical patterns. These indicators were selected from over 50 potential indicators as the most effective indicators along a gradient of catchment clearance. Several sites for riparian rehabilitation were established and monitored as part of project D721, in collaboration with the CRC for Catchment Hydrology. Riparian rehabilitation has been recognised in the 2001 SEQ Regional Water Quality Management Strategy (SEQR-WQMS) as a key management action to address sediment and nutrient problems in the region. An additional important outcome of the D721 project has been the adoption of a regional Ecosystem Health Monitoring Program for freshwaters in south-east Queensland.

*Surveying aquatic plants using quadrats, for project D200.
Photo: Queensland Natural Resources and Mines*



SUMMARY OF PROGRAM D OUTCOMES

Program outcomes (From Schedule)	3 year milestones (From Schedule)	Progress at year 3
Improved scientific knowledge on the ecological effects of damaging agents (including nutrients and pesticides) in Australian freshwater systems	Development of priority areas for research in ecological response to agents that damage freshwater ecosystems	<ul style="list-style-type: none"> • Nitrogen found to be the primary limiting nutrient SE Queensland. Nitrate and organic carbon are important for controlling denitrification and rates are insufficient to deal with current loads. Shading from the riparian zone is important for controlling stream productivity. • The scoping study on Macroinvertebrate Biomarkers: Links to Toxicosis and Changes in Populations or Communities is now complete. • A new catchment-scale indicator of urban storm-water impacts, 'drainage connection', found to be a strong predictor of degradation of in-stream community composition and of several ecological processes along an urban-rural gradient. Drainage connection found to be the primary degrading process for a threatened amphipod species. • The National Land and Water Resources Audit Report on River Condition identified the environmental conditions associated with degradation of the biota: particularly increased sediment, nutrients and salinity, and loss of riparian vegetation. This study has demonstrated the importance of integrated data and their spatial presentation. • Project D200 is currently assessing the ability of different biological assessment methods to detect a salinity gradient and a sand-load gradient. • <i>Snapshot of the Murray-Darling Basin River Condition</i> employed methods developed and data collected in the National Land and Water Resources Audit. That report was an important component contributing to the recent decision to provide more water to the Murray and Darling Rivers.
Improved and robust bioassessment methods that provide information on ecosystem health and assist in identifying degrading processes (including habitat modification)	Integration of AUSRIVAS with other techniques for assessment of river condition	<ul style="list-style-type: none"> • The scoping study 'Dirty water models' is completed and a draft paper has been prepared for submission. This pilot work has demonstrated the potential value of predictive models that enable scenario testing. • The SEQRWQMS methods comparison and study design are now complete and accepted by councils with new management structure. These methods are now being implemented throughout the region. • Biological assessment has become an important component of the Victorian State Environmental Protection Policies, Index of Stream Condition, Queensland Water Allocation Management Plans, NLWRA, the NSW Blueprints for catchment targets and catchment management plans. • A workshop has been held on design for comparison of methods, habitat assessment and information needs of partners for integration of biological methods into monitoring programs. • A National State of the Environment Report summary of the First National Assessment of River Health, with site assessments, basin summaries and state agency comments, is complete and has been submitted to Environment Australia.



SUMMARY OF PROGRAM D OUTCOMES, CONTINUED

Program outcomes (From Schedule)	3 year milestones (From Schedule)	Progress at year 3
		<ul style="list-style-type: none"> • The final report on physical and chemical methods for assessment of river condition for the National River Health Program has been accepted by Environment Australia. • A study design for a Sustainable Rivers Audit in the Murray-Darling Basin has been completed and is currently being implemented. This has involved the integration of physical, chemical and biological methods in an overall framework, interfaced with state agencies' current assessment programs. • A pilot study has established the requirements for a long-term biodiversity assessment program for the Sydney Catchment Authority. The program would include assessment of fish, riparian vegetation and macroinvertebrates. The design has been done in collaboration with the SCA and has been interfaced with the Authority's river health assessment program.
<p>New ecological risk assessment procedures and associated tools for use by water industries</p>	<p>Bring in expertise in ecological risk assessment (biota and processes with inputs to ecological risk assessment over a range of scales up to catchment level)</p>	<ul style="list-style-type: none"> • CRCFE and partner-agency staff are developing expertise in ERA through a series of workshops, case studies and associated projects. • An expert in ERA, Assoc. Prof. Mark Burgman, led two ERA workshops, and Dr Russell Millar led a workshop on Bayesian statistical methods. • CRCFE is playing a major role in the development and application of ERA approaches (e.g. through new Australian and New Zealand water quality guidelines and projects below). • CRCFE partners are applying ERA techniques in several studies including an assessment of 'end-of-valley' salinity targets (DLWC), the development of suspended solids guidelines (Victorian EPA) and the impact of irrigation (Goulburn-Murray Water). • Two ERA test cases have recently commenced — one with Melbourne Water, the other with the SCA. • A CRCFE panel reviewed Melbourne Water's waterway management strategy. As a result, a process has been put in place to design and implement a new ERA framework for the management of Melbourne Water's waterways.

*Identifying invertebrates and algae for the D200 project.
Photo: Queensland Natural Resources and Mines*



2.7 List of Research Projects

PROGRAM A: FLOW-RELATED ECOLOGICAL PROCESSES

Core projects

- A.100 Campaspe Flow Manipulation Project (continuing from CRCFE Mk1)
- A.200 The Effect of Flow on Lowland River Productivity
- A.210 Environmental Flows and Ecosystem Response in the Cotter River

Associated projects

- A.702 Billabong/River Interactions during High-flow in the mid-Murray
- A.703 Measuring the Effectiveness of Environmental Water Allocations
- A.708 The Effect of Water Regime on Wetland Ecology
- A.709 Environmental Flow Requirements for Australian Arid-zone Rivers
- A.710 Modelling Dry-season Flows and Predicting the Impact of Extraction on a Flagship Species
- A.711 Habitat Fragmentation and Environmental Flows in the Condamine River
- A.712 Importance of Flood Flows to Productivity of Dryland Rivers and their Floodplains
- A.713 Floodplain Inundation and Fish Dynamics
- A.714 The Occurrence and Significance of Photosynthetic Bacteria in Freshwater Ecosystems
- A.715 Dryland Floodplain Ecosystems: Influence of Flow Pattern on Fish Production



Brendan Ebner and colleague radio tracking Macquarie perch on the Cotter Dam, ACT, for project A210.

PROGRAM B: RESTORATION ECOLOGY

Core projects

- B.200 Restoration Ecology in Degraded Rural Streams: the Granite Creeks Project, North East Victoria
- B.220 Processes and Patterns: Restoration, Biodiversity and Ecological Functions
- B.230 Connectivity and Dispersal

Associated projects

- B.701 Storage, Production and Transfer of Carbon and Nutrients in the Condamine-Balonne River-system
- B.703 The Role of Dispersal and Recruitment in Structuring Stream Invertebrate Populations
- B.704 River Rehabilitation through Resnagging
- B.705 Experimental Assessment of Physical Habitat in Urban Streams: Limitations to Recruitment
- B.706 Restoration Ecology of Fish Assemblages in Degraded Rural Streams: The Granite Creeks Project.
- B.707 Rehabilitating Submerged Macrophytes Enhances Survival of Larval and Juvenile Fish.
- B.708 National Riparian Lands Program (Phase 2): In-stream Ecological Issues
- B.709 A Synthetic Analysis of the Scientific Basis of Ecological Restoration of Stream Ecosystems

PROGRAM C: CONSERVATION ECOLOGY

Core projects

- C.200 Dryland River Refugia
- C.210 Adaptive Management in Restoration Ecology
- C.220 Conservation Ecology and Systematics of the Mountain Galaxias

Associated projects

- C.702 Systematics of the Australian Mayflies (Ephemeroptera) of the Family Baetidae and Family Caenidae
- C.704 Conservation and Evolution of Freshwater Crayfish
- C.709 Endangered Species Survival Decision Tool
- C.710 Long-term Monitoring of the Littoral Fauna of Lake Pedder
- C.711 Sustainable Management of On-farm Biodiversity in the Rice-growing Industry: Vertebrate Wildlife Resources.
- C.712 The Ecological Distribution and Abundance of Green and Golden Bell Frogs on the Molonglo River Floodplain.



**PROGRAM D: WATER QUALITY AND ECOLOGICAL
ASSESSMENT**

Core projects

- D.200 Assessment and Delivery of Methods for Determining River Health
- D.201 Assessing River Health in the Northern Murray-Darling Basin. (Extension to Assessment and Delivery of Methods for Determining River Health (D200))
- D.210 Urbanisation and the Ecological Function of Streams
- D.220 Development of a Catchment-based Ecological Risk Assessment Framework for Aquatic Systems

Associated projects

- D.715 Algal Availability of Phosphorus Discharge from Different Catchment Sources
- D.717 National Land and Water Audit
- D.720 Support and Completion of Australia-wide Assessment of River Health Models
- D.721 South East Queensland Regional Water Quality Management Strategy (SEQRWQMS)
- D.722 Nutrient Cycling, Primary Production and Aquatic Food-webs in Coastal River Systems: Implications for Eutrophication Management
- D.723 Predicting the Ecological Consequences of Increasing Salinity on Wetland Sustainability
- D.724 Tooma River Study
- D.725 Robust Procedures for Measuring Metal Speciation and Bioavailability
- D.726 Ecological Risk Assessment of Irrigation Schemes

*Two-spined blackfish, *Gadopsis bispinosus*. Project A210 is providing valuable information to determine environmental flow release patterns that will maximise habitat for this threatened species in the Cotter River, ACT.
Photo courtesy of Murray-Darling Basin Commission*



Chapter 3

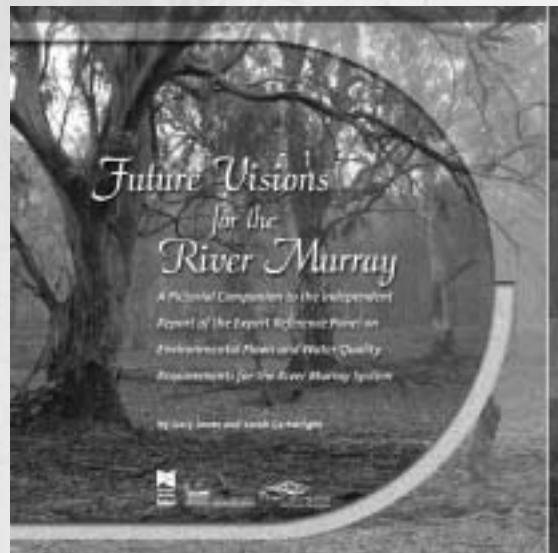
Knowledge Exchange

Program Leader: Professor Gary Jones

Knowledge is fundamental to the effective management of natural resources. The CRCFE sees the generation and exchange of knowledge as its core business.

3.1 Program Highlights

- Conducted and reported on the outcomes of an Expert Reference Panel on Environmental Flows and Water Quality for the River Murray.
- Produced the book *Future Visions for the River Murray*, a pictorial companion to the Expert Reference Panel's report, for the Murray-Darling Basin Ministerial Council.
- Coordinated Scientific Panel assessments of Victoria's Ovens and Broken rivers.
- Undertook a synoptic survey of aquatic biodiversity on behalf of the Sydney Catchment Authority.
- Described the environmental health of the rivers of the Murray-Darling Basin in a report titled *Snapshot of the Condition of the Rivers in the Murray-Darling Basin*.
- Facilitated a whole-of-water cycle benchmarking study workshop for ACTEW Corporation.
- Facilitated a workshop and produced a technical report reviewing the Scientific Panel approach to determining environmental flows.
- Produced two guides for regional catchment management organisations. Over 3500 have been distributed so far.
- Provided advice and information to 80 non-partner organisations, including government agencies, catchment management organisations, consultants, advocacy and industry groups.
- Undertook 28 contract projects for a range of clients, which generated an income of \$780,000 to the CRCFE.
- Produced 50 refereed journal articles, seven book chapters and two books, eight taxonomic identification guides, and 55 conference and workshop papers and presentations.
- Produced 19 media releases and 150 media hits.



The book Future Visions for the River Murray was produced as a pictorial companion to the Expert Reference Panel's Report for the Murray-Darling Basin Ministerial Council.

3.2 Cooperative Linkages

3.2.1 INTERNAL LINKAGES

The CRCFE has in place an internal communications strategy to ensure effective cooperation between sites and across research projects and programs.

Activity	Function	2001 - 2002
Board Meetings	Provide policy and direction to CRCFE. Ensure that activities meet the Centre's stated objectives	Met three times in the year
Executive Meetings	Chief Executive, Deputy Directors and Chief Administrator review progress of the CRCFE against objectives and outcomes	Met seven times
Management Committee	Executive, Program Leaders and Chief Ecologist develop proposals to present to the Board for approval	Bimonthly
Program Meetings	Coordinate the implementation of each research program and review progress	Ad hoc
Annual Staff Meeting	Sharing information	Albury, November
Postgraduate Workshop	Student presentations and discussions of education issues	Albury, November
Project Management System (PMS)	Lotus Notes provides a CRCFE-wide PMS	Ongoing
Seminar Series	Water Forum Seminar Series	Ad hoc
WaterShed	Newsletter that reports on CRCFE activities for internal and external stakeholders (distribution~3,000)	6 issues
CRCFE News	Electronic newsletter for staff	Weekly 2001-2002

3.2.2 PARTNER SUPPORT

ACTEW Corporation

- Facilitated ACTEW Corporation's Benchmarking Study Workshop (P. Cullen, I. Lawrence and J. Whittington)
- Supported the development of the Cotter-Gudgenby Catchment Resources Database (J. Whittington)
- Participated in the ACTEWAGL-sponsored Environmental Flows Workshop with ACTEW Corp., Environment ACT and CRCFE to determine the current state of knowledge about environmental flow releases in ACT rivers (J. Whittington, M. Thoms, F. Dyer, P. Liston, H. Chester)

CSIRO Land and Water

- Participated in the CSIRO workshop 'Towards a Predictive Quantitative Riverine Systems Model' (D. Baldwin, D. Nielsen, R. Oliver, B. Gawne and G. Rees)
- Participated in the development of a bid for a new irrigation CRC (P. Cullen)
- Participated in the development of CSIRO Flagship Project (B. Gawne)
- Provided design details and photographs of electrofishing boat design, CSIRO L&W Indooroopilly (A. Conallin)

Department of Land and Water Conservation, NSW (DLWC)

- Provided information on fish numbers and blue-green algae to Murray Region Office to assist Catchment Management Board's catchment target and benchmark setting (M. Bald)
- Provided advice on preservation methods and sampling techniques for assessing changes in the levels of dissolved organic carbon due to flow variation (A. Kotlash)
- Assisted DLWC by advising the Warragamba Catchment Joint Planning Group on catchment management targets for aquatic health in the catchment (A. Kotlash)
- Gave a presentation to the Resource Knowledge Group (Far West Region) on outcomes of scientific studies in the Barwon-Darling River (M. Thoms)
- Presented three seminars on Risk Assessment and Algal Blooms (M. Grace, A. Webb)
- Presented a seminar on predicting the ecological consequences of increasing salinity on wetland sustainability (D. Nielsen and M. Brock)
- Provided input to the preparation of the Darling Anabranch Management Plan (S. Meredith)
- Provided information via a presentation to a group of DLWC Resource Knowledge Managers on knowledge exchange and the role of knowledge brokers

- Commenced dialogue with a Resource Knowledge Manager from the Murray Region — Deniliquin, to assist him in developing a series of natural resource information workshops
- Met with a Sydney South Coast Region scientist to discuss and develop ways of improving the Draft Catchment Blueprints being developed for the region
- Attended a workshop on Snowy River Fish Rehabilitation and Barrier Study (T. Raadik)

Department of Natural Resources and Environment, Victoria (DNRE)

- Participated in a workshop with SKM and DNRE on the Victorian Environmental Flows Method for the Wimmera, Avoca and Glenelg Rivers Environmental Flows Project (G. Quinn)
- Undertook a scoping study to produce a rehabilitation plan for the Thomson and Macalister Rivers in collaboration with Melbourne University (P. Cottingham, B. Hart, T. Raadik, J. Barton, G. Quinn)
- Completed two Scientific Panel Reports: Ovens River — P. Cottingham, T. Hillman, L. Metzeling, J. Koehn with I. Rutherford (Melbourne University) and G. Hannan (Goulburn-Murray Water); and Broken River — P. Cottingham, T. Hillman, L. Metzeling, P. Humphries with M. Stewardson (Melbourne University) and G. Hannan (Goulburn-Murray Water) and Jane Roberts
- Liaised with NRE on aspects of the Euston weir pool drawdown trial
- Conducted a workshop for NRE to review the Scientific Panel approach to determine environmental flows (discussion paper, workshop, workshop report) (P. Cottingham)
- Was a member of the Steering Committee overseeing the Targeted Water Management Project (P. Cottingham)
- Provided design details and photographs of electrofishing boat design to NRE Heidelberg (A. Conallin)

Environment ACT

- Ongoing provision of advice in setting and implementing environmental flows for the Cotter River (R. Norris, J. Whittington, M. Thoms, F. Dyer, I. Lawrence)
- Chaired meeting of ACT Environment Advisory Committee (P. Cullen)
- Gave advice and support to Sullivans Creek Catchment Group on demonstration wetlands (I. Lawrence)



*An example of a drain using water sensitive urban design.
Photo: I Lawrence*

- Advised ACT Planning & Land Management Division on integrated urban land and water management principles and practices in relation to new sub-divisions (I. Lawrence)
- Developed Urban Sustainable Development (Water) principles and practices for urban residential development, for ACT Planning & Land Management (I. Lawrence)
- Advised on Lake Ginninderra Foreshore enhancement: water quality and ecology enhancement aspects, for ACT Planning & Land Management (I. Lawrence)
- Reviewed sustainability aspects of the Kingston Foreshore Development Plan (I. Lawrence)
- Advised ACT Government regarding sustainable urban land and water designs and management, including submission of selection and design guidelines, and planning principles. Series of 12 presentations to Minister, Chief Executive, Executive Directors, senior management and technical staff. Advice to consultants undertaking new sub-division designs (I. Lawrence)

- Assisted Canberra lakes management agencies, in preparing a submission to the NHMRC Review of the Recreational Use of Waters Guidelines (I. Lawrence).
- Provided advice on measures to ameliorate nuisance scum and odour problems associated with stormwater pipe discharges to Lake Ginninderra at Eastern Valley Way and Benjamin Way Basins (I. Lawrence)
- Discussed and advised on Lake Burley Griffin bacterial contamination event (I. Lawrence, G. Jones) and supported development of Faecal Coliform Confirmation R&D package (I. Lawrence)
- Participated in the ACTEWAGL-sponsored Environmental Flows Workshop with ACTEW Corp., ACT Environment and CRCFE to determine the current state of knowledge about environmental flow releases in ACT rivers (J. Whittington, M. Thoms, F. Dyer, P. Liston, H. Chester)

Environment Protection Authority, NSW

- Presented at and participated in State Water Monitoring Strategy development workshop for the development of a NSW Water Monitoring Strategy (J. Whittington, R. Norris, B. Hart, W. Maher)

Environment Protection Authority, Victoria

- Continued support of Envirolinx Council (P. Cottingham)
- Provided advice to and review of Shepparton Irrigation Region Drain Flow Data Interpretation Study (J. Whittington, P. Cullen)
- Provided publications

Goulburn-Murray Rural Water Authority

- On-going discussions regarding environmental flows in the Campaspe River (G. Quinn, P. Humphries)
- Provided publications

Griffith University

- Provided publications

La Trobe University

- Member, University Council (T. Hillman)
- Provided publications

Lower Murray Water

- Identified water plant in storage facilities and advised on control methods (M. Bald, O. Scholz)
- Participation in Regional Algal Coordinating Committee activities (MDFRC Lower Basin Laboratory Staff)
- Provided publications

Melbourne Water

- CRCCH Project 6.2: Optimising Urban Stream Rehabilitation Planning and Execution. Meeting of project team with Melbourne Water and CRCCH (G. Quinn)
- Provided advice on the Little Yarra resnagging project (G. Quinn)
- Provided advice and information related to reservoir management (Yan Yean and Greenvale reservoirs), and also performance data related to wetlands used to manage urban and agricultural run-off (P. Cottingham)
- Provided life history information on the blue-green alga *Phormidium* (P. Cottingham)
- Participated in wetland risk assessment framework workshop and provided information on approaches to evaluating wetland function (P. Cottingham)
- Conducted a review of the Melbourne Water Waterway Strategy (P. Cottingham)
- Hosted a workshop to facilitate inputs by Melbourne Water staff into Land & Water Australia's large woody debris guidelines (P. Cottingham)
- Reviewed the Melbourne Water decision support system STREAMS and identified opportunities for further refinement (2 workshops and report) (C. Walsh, P. Cottingham, A. Webb, M. Grace, B. Hart)
- Coordinated the 5th Yarra Forum for researchers and managers in the Melbourne area (P. Cottingham)
- Presented preliminary results from B7o6 to a meeting with Melbourne Water (N. Bond)
- Provided publications

Monash University

- Provided publications

Murray-Darling Basin Commission (MDBC)

- Conducted and reported Expert Reference Panel for assessment of environmental flows in the Murray and Lower Darling Rivers (A. Arthington, G. Jones, K. Walker, T. Hillman supported by J. Whittington and S. Cartwright) and presented this to various audiences including Community Advisory Committee (G. Jones)
- Undertook biological monitoring in the Upper Murray River for the MDBC (J. Hawking)
- Prepared and reviewed paper for the 2001 WWF MDB Visions Biodiversity Workshop, for Mr Clarrie Hillard, MDB Ministerial Council's Community Advisory Committee (P. Cottingham, A. Georges, G. Jones, G. Wilson)

- Completed *Snapshot of the Condition of the Rivers in the Murray-Darling Basin* (R. Norris, P. Liston, S. Linke, J. Coysh, N. Davies, F. Dyer (CRCFE), I. Prosser and B. Young (CSIRO))
- Provided advice to the Sustainable Rivers Audit for the Murray-Darling Basin Commission and attended Taskforce meetings (J. Whittington, R. Norris, I. Lawrence, B. Gawne, M. Thoms)
- Was a member of Weirpool draw-down trial steering committee (B. Gawne)
- Produced a book, *Future Visions for the River Murray (a Pictorial Companion to the Independent Report of the Expert Reference Panel on Environmental Flows and Water Quality Requirements for the River Murray System)* (G. Jones and S. Cartwright).
- Developed and provided Relative Flows Benefit Index to support flow options socio-economic assessment (G. Jones)
- Members of several projects steering committees (R. Norris, J. Whittington, B. Gawne, T. Hillman)
- Scientific panel presentation on environmental flows for the River Murray made to the April Ministerial Council Meeting (G. Jones)
- Presented the After Dinner Address to Corowa Centenary Celebration (P. Cullen)
- Gave a presentation on larval fish in the Lindsay River and Water Level Variability Workshop for Locks 9 and 10 (S. Meredith)
- MDFRC (Albury) hosted MDBC Sustainable Rivers Audit Fish Assessment training workshop 20-22 February 2002 (B. Gawne)
- Organised video footage of Border Rivers for MDBC video 12th April (G. Wilson)
- Provided advice regarding environmental flows in the Darling Anabranch (S. Meredith)
- Presentation on South East Queensland Regional Water Quality Management Strategy science to SEQ Regional Organisation of Councils — includes regional Mayors and Minister for Natural Resources, and to National Action Plan Community meeting, Ipswich (S. Bunn)
- Hosted workshop and provided advice and report 'Ecological Assessment of flow management scenarios for the Lower Balonne' (J. Whittington, S. Bunn, P. Cullen, G. Jones, M. Thoms, G. Quinn, K. Walker)
- Presentation to the Border Rivers Catchment Health Forum (G. Wilson)
- Discussion with DNR Goondiwindi on groundwater contributions to base flows, Dumaresq River (G. Wilson)
- Provided publications

Sunraysia Rural Water Authority

- Discussions on Euston weir pool trial (B. Gawne)
- Participation in Regional Algal Coordinating Committee activities (Lower Basin Laboratory Staff)
- Provided publications

Sydney Catchment Authority (SCA)

- Organised and ran a workshop to develop the synoptic surveys for the SCA's Aquatic Biodiversity Program involving CRCFE researchers, staff from the NSW EPA, and SCA staff (A. Kotlash, T. Raadik)
- Undertook the SCA's aquatic biodiversity synoptic surveys and reported findings. (A. Kotlash and many others)
- Involvement in the re-development of the SCA's web site (A. Kotlash)
- Provided ecological information to SCA staff to assist them in the preparation for their annual catchment audit (A. Kotlash)
- Provided knowledge about managing and monitoring carp (A. Kotlash)
- Provided advice to the Warragamba Catchment Joint Planning Group on setting appropriate catchment management targets for aquatic health in the catchment (A. Kotlash)
- Advice provided on environmental flows for the Woronora River (R. Norris, A. Kotlash, J. Harris and G. Quinn)
- Membership, SCA Expert Advisory Panel (G. Jones)
- Held a workshop to inform SCA, DLWC and EPA on progress of the Connectivity and Dispersal Project (B230) (J. Hughes, A. Baker, A. Kotlash)

Natural Resources and Mines, Queensland (QNRM)

- Input to Queensland WRPs: Pioneer Water Resource Plan, Albert/Logan Water Resource Plan, Mary Water Resource Plan (A. Arthington)
- Provided advice on ecological assessment in Lake Eyre Basin (S. Bunn)
- Gave a presentation to QNRM senior management on SEQRWQMS Science (S. Bunn)
- Advice on implementation of Physico-chemical health index (I. Lawrence)
- Commissioned to undertake environmental components of the Logan/Albert Water Resource Plan. (A. Arthington, M. Kennard, S. Mackay)
- Presentation of 'Implementation of DIBM3 as part of the proposed new Ecosystem Health Monitoring Program for Freshwaters' (S. Bunn)



- Held a workshop with Connectivity and Dispersal Project (B230) research team (J. Hughes, A. Baker, A. Kotlash), SCA, DLWC and EPA staff to discuss and decide on location of sampling sites and access.
- Provided a review of SCA draft wetland design guidelines, including participation in a review workshop (I. Lawrence)
- Support for Woronora Environmental Flows Scoping Study (A. Kotlash)
- Assisted in recruitment of Senior Water Scientist (A. Kotlash)
- Member of interview panel for new Catchment Information Manager (G. Jones)
- Attended workshop to develop assessment criteria for key functional aspects of catchment management for the SCA (G. Jones)
- Organised Ecological Risk Assessment planning workshop involving SCA, CSIRO and CRCFE staff (A. Kotlash, B. Hart, M. Grace)
- Organised and facilitated a workshop to assist the SCA to develop a fish biodiversity monitoring program. (A. Kotlash)
- Organised and facilitated a workshop to help the SCA develop a proposal for the letting of a contract to assess the impacts of the SCA's bulk water transfers operations (A. Kotlash, R. Norris, G. Quinn, J. Harris, J. Whittington)
- Organised and facilitated a meeting to further advance the development of the SCA's Aquatic Biodiversity Monitoring Program (A. Kotlash)
- Supplied publications

University of Adelaide

- Supplied publications

University of Canberra

- On behalf of UC, presented talk to Hawker College on 'Bugs and Computers' (R. Norris)
- Discussions and advice on development of UC-CRCFE business case (P. Cullen, G. Jones, C. Robinson)
- Supported development of UC-SCIDES marketing strategy (G. Jones)
- Presentation to UC SCIDES Senior Team Meeting 'Relations with External Communities' (G. Jones)
- Graduation Address (P. Cullen)
- Presented a seminar, 'Systematics and Conservation of the Mountain Galaxias (*Galaxias olidus*) Species Complex' (T. Raadik)
- Supplied publications
- Undergraduate Water Science lectures (G. Jones, J. Whittington, I. Lawrence)

3.2.3 EXTERNAL SUPPORT

Non-partner universities, government departments, agencies and funding bodies

Agriculture, Fisheries and Forestry – Australia, Clarence Valley & Coffs Harbour City Councils, Canada Health Services, Cotton CRC, Cotton RDC, Deakin University, Department Water Resources SA, Envirolinks VIC, Environment Australia, ERIS, Gippsland Water, Gold Coast City Council, Hornsby Shire Council, Land & Water Australia, Landcare Discovery Centre, Melbourne University, Mildura Rural City Council, Mildura TAFE, NSW Fisheries, NSW National Parks and Wildlife Service, Queensland Dept of Primary Industries, Queensland EPA, Queensland Murray-Darling Committee Inc., Queensland National Parks & Wildlife Services, SA Water, SA Environmental Protection Authority, SEQ Councils, SEQ Water Corp., Sunwater, Sunraysia TAFE, Sydney Water, University of Sydney, University of Waikato, URS Australia, WA Water Resources Commission.

Industry groups, professional organisations and NGOs

Support (advice, publications, etc.) was provided to the following industry groups, advocacy groups and professional organisations:

Australian Conservation Foundation, Australian Science Festival, Australian Water Association, Canberra Business Council, Condamine Balonne Water Committee, Cotton Australia, Federation of Australian Science and Technological Associations, Healthy Rivers Campaign Office, Inland Rivers Network, Institution of Engineers

Katoomba Creek, one of the sampling sites in the Sydney catchment area used by the CRCFE in the design of a long-term biodiversity monitoring program.





Australia, MDBC Community Advisory Committee, Murray-Darling Association, Murray Irrigation Limited, Murray Wetlands Working Group, National Farmers Federation, Queensland Conservation Council, Rice Growers Association, SmartRivers, St George–Dirranbandi Irrigators, Waterwatch, Wetland Care, World Wildlife Fund.

Redcliffs Apex Club, Regional Angling Clubs, Rotary Clubs of Lavington, Mildura & Goondiwindi, Waterwatch, Wetland Care Australia & Swan Reach.

Consultants

Support provided to:

- SKM — Review of Environmental Flows Assessment Approach (M. Thoms),
- SKM — Steering Committee for Project on Environmental Assessment of Water Trading in the MDBC (B. Gawne, T. Hillman, J. Whittington)
- URS Australia — Reference Group member for ‘MDBC Watermark Project — Managing Water Quality in Irrigated Areas’ (R. Norris)

Catchment Management Groups

The CRCFE provides newsletters, guides and other publications to over 285 groups. Additional support was also provided to:

Barwon-Darling Management Committee, Bookmark Biosphere Project, Border Rivers Catchment Management Association, East Gippsland Catchment Management Association, Environmental Flows Committee, Darling Anabranch Management Plan, Glenelg Catchment Management Authority (CMA), Goulburn-Broken CMA, Lower Murray Darling Catchment Management Board (CMB), Mallee CMA, Murray Unregulated River Management Committee, Murrumbidgee CMB, North East CMA, River Murray CMB, Sullivans Creek Catchment Group, Upper Brisbane Catchment Group.

Community Organisations

Support provided to:

Australian Acoustical Society, Bird Observers Club, Burnett Water For All Group, six secondary schools (work experience students), Landcare groups, National Water Week Committee,

Cooperation with other CRCs

The CRCFE is an active member of the CRC community. We seek opportunities for collaborative projects and activities with other CRCs. We undertake joint research projects, consulting and professional development programs with other CRCs.

CRC Association

- CRCFE hosted the CRC Communicators Workshop (L. Sealie/L. Regan), with presentations given by Knowledge Broker (J. Whittington) and Communications Manager (L. Sealie)
- Attendance at CRC Association Conference
- ‘Challenges for a Public Good CRC’: a talk presented to the CRC Committee (P. Cullen)

CRC Water Forum

The Water Forum comprises the CRCFE, the CRC for Water Quality and Treatment, the CRC for Catchment Hydrology, the CRC for Waste Management and Pollution Control, and the CRC for Coastal Zone, Estuary and Waterway Management.

- Water Forum seminar series — collaborative seminar series in several cities
- Joint display at Rivers Festival, Brisbane, 2001

3.2.4 INTERNATIONAL COLLABORATIONS

The CRC has an international strategy with four components:

Quality Assurance for our Research

The CRCFE ensures its research and education is world-class through peer reviewed publications in international journals, national and international peer review of research projects, presentations at and organisation of international conferences and through international collaborations with selected institutions and researchers.



International Collaborative Research Projects

Institution	Activity	Contact
Environment Bay of Plenty, NZ	Review of Urban Stormwater Report	B. Hart, I. Lawrence
Malaysian Dept Public Works & Klang River Basin Management Authority	Seminar & field inspection	I. Lawrence
Beijing City & Olympic Committee	Seminar: Urban pollution management	I. Lawrence
Lake Biwa Research Institute, Japan	Japanese Science and Technology Agency Fellowship to investigate cyanobacterial problems in Lake Biwa	R. Oliver
Knowledge Foundation, Sweden	Hosted delegation and discussed models for knowledge exchange	P. Cullen, J. Whittington
NIWA NZ	Joint research on riparian lands	S. Bunn
National Centre for Ecological Analysis and Synthesis, USA	Attended initial meeting for project 'Scientific basis of ecological restoration of stream ecosystems' at University of Maryland	P.S. Lake
Chinese Fisheries Institute	Hosted delegation and discussed CRCFE research	G. Jones
Scientific Committee for Water Research, France	Meeting Delegate	S. Bunn
Chinese Fisheries Institute	Hosted delegation	G. Jones

Helping Australia Meet its International Obligations

CRCFE activities inform and support the United Nations Convention on Biological Diversity, and the Ramsar Convention on Wetlands of International Importance. The CRCFE is investigating the impacts of water resource development on the ecology of the Narran Lakes, a Ramsar-listed wetland.

Raising Australia's Profile with Major International Organisations

The CRCFE aims to increase the international profile of Australian science and knowledge through helping organise, contributing to, participating in and attending international forums.

Forum	Contact
International Conference on Environmental Flows/4th Ecohydraulics Conference. Cape Town March 2002	A. Arthington and several others
Managing River Flows for Biodiversity, Nature Conservancy, USA	A. Arthington
6th Asian Fisheries Forum held in Taiwan	A. Arthington
North American Benthological Society, USA	Several
Worldwide Dragonfly Symposium	J. Hawking
International Phosphorus Transfer Workshop	D. Baldwin
International Symposium on Microbial Ecology	G. Rees
Netherlands Institute of Ecology	G. Rees

Ensuring International Best Practice is Available to Australia's Water Industry

The CRCFE seeks to assist our partners — government agencies, research institutions and the Australian water industry — more broadly with the development and implementation of best international practice in waterway management. The CRCFE has sponsored the visit of several international scientists. As part of their visit, international guests provide public seminars at one or more CRCFE sites.

International Visitors

CRCFE staff have organised meetings and visits from the following international visitors:

- Associate Professor Stephen Hamilton, Kellogg Biological Research Station, Michigan State University
- Ms Suzanne Sippel, Kellogg Biological Research Station, Michigan State University
- Associate Professor Timothy Moulton, Dept of Ecology, University of Rio de Janeiro, Brazil
- Professor Jim Thorp, University of Kansas
- Professor Geoff Petts, University of Birmingham, UK
- Dr Kit Rutherford, NIWA, NZ
- Ros Pontin and John Pontin, London Museum, UK
- Drs Bill Mathews and Edie Marsh-Mathews, Department of Zoology, University of Oklahoma
- Drs Robert Cashner and Martin O'Connell, Dept of Biological Sciences, University of New Orleans, USA
- Alan Covich, Dept of Fishery and Wildlife Biology, Colorado State University, USA
- Drs Jim Cooke and Graeme Inglis, NIWA, Hamilton, NZ
- Professor Scott Wissinger, Allegheny College, Pennsylvania
- Dr Gabriel Zwart, Netherlands Institute for Ecology, Centre for Limnology
- Dr James Gore, Department of Environmental Science and Public Health, Columbus State University, USA
- Professor Robert Cashner, Graduate School, University of New Orleans, USA
- Dr Ingrid Chorus, Federal Environmental Agency, Germany
- Professor Sergi Sabater, Department of Ecology, University of Barcelona, Spain
- Professor Peter Moyle, Department of Wildlife, Fish and Conservation Biology, University of California, Davis, USA
- Professor Anthony Ricciardi, Department of Biology, Dalhousie University, Halifax, Nova Scotia, Canada
- Professor Colin Townsend, Department of Zoology, University of Otago, Dunedin, NZ
- Dr Ian Maddock, University College Worcester, UK



A number of CRCFE staff presented workshops at the North American Benthological Society Conference, USA.

3.3 Specialist Advice

3.3.1 POLITICAL BRIEFINGS

- Briefing Senator Lynn Allison regarding Senate Inquiry into the Urban Water Industry (P. Cullen, I. Lawrence)
- Briefing to Water Resources Minister Brindle, SA, on CRCFE research in South Australia (P. Cullen, B. Gawne, J. Langford)
- Briefing to SA Environment and Conservation Minister, the Hon. John Hill, who is also Minister for the River Murray (G. Jones)
- Presentation to the Murray-Darling Ministerial Council on the outcomes of the Expert Reference Panel's Report on Environmental Flows and Water Quality Requirements for the River Murray System (G. Jones)
- Series of 12 presentations to ACT Environment Minister, Chief Executive, Executive Directors on sustainable urban land and water designs and management, including submission of selection and design guidelines, and planning principles (I. Lawrence)
- Met with Mr Lawrence Springborg MLA, Queensland State Member for the Southern Downs, and discussed the Northern Laboratory and its research activities (G. Wilson)
- Ms Sophie Panopoulos (Member for Indi) visited MDFRC and met with Dr Ben Gawne
- Senator Helen Coonan visited MDFRC and had discussions with Dr Darren Baldwin

3.3.2 COMMITTEE MEMBERSHIP AND EXPERT ADVISORY PANELS

Effective knowledge exchange is achieved by having CRCFE staff serving on various government and community committees.

CRCFE staff have chaired the following committees:

- ACT Environment Advisory Committee
- Lake Eyre Basin Scientific Advisory Panel
- Federation of Australian Scientific and Technological Societies (National)

CRCFE staff have been members of the following committees:

- PMSEIC Working Group on Natural Systems and Biodiversity
- State of the Environment Advisory Committee
- Murray Unregulated River Management Committee
- Border Rivers Catchment Management Association
- Scientific Reference Panel, Snowy River Rehabilitation Concept Trial Project
- Sullivans Creek Catchment Group Technical Advisory Committee
- ACT & Sub-region State of the Environment Advisory Group
- Albury Wodonga Regional Parklands Board
- River Murray Wetlands Technical Panel (South Australia)
- Environmental Flows Strategy Project Team, (South Australia)
- NSW Threatened Species Scientific Committee
- Worldwide Fund for Nature Specialist Advisory Committee
- Victorian River Health Strategy Scientific Panel
- Snowy Benchmarking Study Technical Reference Panel

CRCFE staff have been members of the following expert advisory panels:

- Expert Reference Panel on Environmental Flows and Water Quality Requirements for the River Murray System
- Ovens River Scientific Panel
- Broken River Scientific Panel

3.3.3 SMALL TO MEDIUM ENTERPRISES (SMEs)

The CRCFE services SMEs, such as relatively small water-retailers, consulting firms and Catchment Management Organisations, in a number of ways:

- Membership on Boards, Committees (see above)
- Advice and publications
- Supporting bids by consulting firms

3.3.4 EXTERNAL KNOWLEDGE EXCHANGE CONTRACT ACTIVITIES

External contract work has continued to be a significant knowledge exchange activity for the Centre. The income derived from this was lower than in recent years, while the number of projects increased from 2000–2001 (Figures 1 and 2). The CRC was able to meet client needs by accepting smaller contracts in a manner that did not unduly divert staff from their core research activities.

3.4 Publications

The CRCFE uses its publications and website to inform its partners, water managers, the science community, politicians, the media and the wider community about its work.

3.4.1 SCIENTIFIC PUBLICATIONS

During 2001–2002, the CRCFE produced:

- 7 chapters in books and 2 books,
- 50 articles in refereed journals,
- 5 articles in non-refereed journals,
- 8 identification guides,
- 44 external contract and technical reports,
- 55 conference and workshop papers and presentations.

For a detailed listing of these publications and presentations, please refer to Appendices A and B.

3.4.2 GENERAL PUBLICATIONS

During 2001–2002, the CRCFE produced:

Newsletters

- 6 issues of *WaterShed*,
- 3 issues of *Lower Basin Links*,
- 51 issues of the internal newsletter, CRCFE News,
- *Dryland River Refugia* Newsletter no.1 (May).

River Management Guides

- ‘Conserving Natural Rivers’ by Peter Cullen. River Management Series Part 1,
- ‘Assessing River Condition Using Existing Data’ by John Whittington. River Management Series Part 2.

The River Management Series is a new series of river management guides to explain the CRC for Freshwater Ecology’s scientific advice on key aspects of river management. The guides are aimed to inform regional catchment boards and authorities as they develop management plans. The River Management Guides

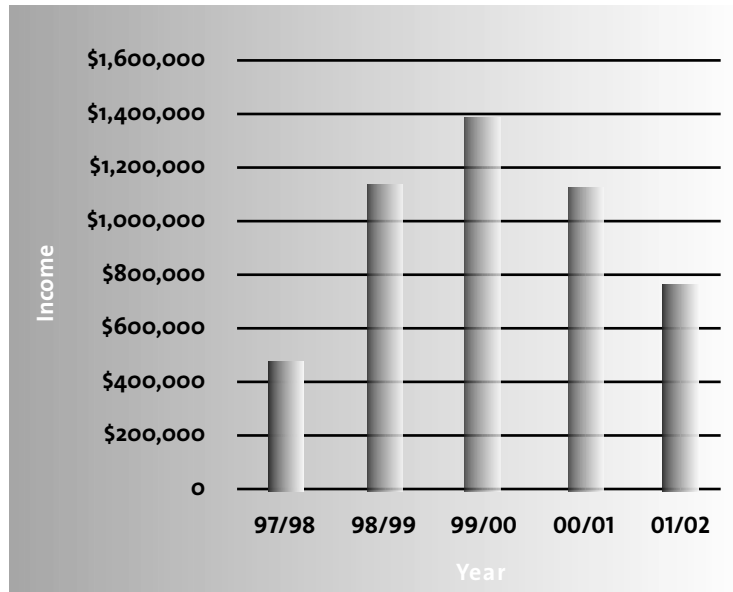


Figure 1: Annual income received from external knowledge exchange contracts

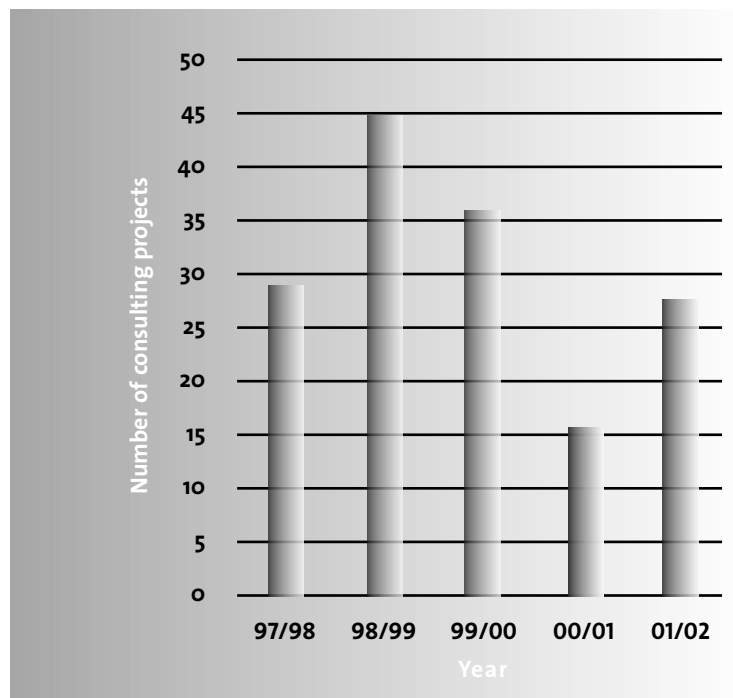


Figure 2: Number of external knowledge exchange contracts undertaken annually

have been produced and distributed via the *WaterShed* mailing list.

Brochures

- ‘Fish of the Menindee Lakes’ brochure,
- ‘Euston Weir — Trial Drawdown’ brochure (with the Murray Wetlands Working Group),
- Dryland River Refugia Fact Sheets 1 and 2.

Other publications and resources

- 7 portable rollup display units,
- a series of 6 fact sheet templates.

3.5 Conferences/Workshops Supported by CRCFE

CRCFE staff and students actively participate in conferences, workshops and public presentations as a way of informing and influencing the scientific community, water managers, the water industry, policy makers, catchment management organisations and the wider community.

- Workshop on the Use of Expert Panels in Determining Environmental Flows
- 'Biodiversity Conservation in Freshwaters': Fenner Conference on the Environment 2001
- Fifth International Conference on Toxic Cyanobacteria. Co-organised with CSIRO Land & Water
- 14th Annual Taxonomic Workshop, Albury
- Joint problem solving workshop for QNRM on Lower Balonne environmental flows
- Facilitated business 'Benchmarking' scoping workshop for ACTEW
- Scientific Panel Process review workshop held at DNRE Melbourne (with Melbourne Water)
- River Murray Health Outcomes workshop (for MDBC ERP project)
- Bayesian Statistics Course
- CRCFE Stakeholder Needs Workshop
- CRC Communicators conference organised by CRCFE
- SCA Ecological Assessment of Bulk Water Transfers

- LWA Large Woody Debris Workshop, facilitated by CRCFE
- Mildura Annual Youth Forum
- Planning meetings have commenced for hosting the Ninth International Symposium on Regulated Streams. The Organising Committee is chaired by Martin Thoms
- Joint Research Planning Meeting attended by CRC senior scientists, KE team and the Program Advisory Committee members
- Two workshops to review the Melbourne Water STREAMS decision support system
- Development of Suspended Solids Guidelines for Victorian Waters, with EPA Victoria.

3.6 Public Awareness/Promotion

CRCFE INFORMATION DISPLAYS

BasinLink: Natural Resources Management Communicators Conference, Canberra; CRC Leaders Forum, Brisbane; Aquafest, Canberra; CRCFE Annual General Meeting, Albury; Fenner Conference, Canberra; Focus on Business Exhibition, Canberra; Italian-Australian Technological Innovations Conference and Exhibition, Melbourne; Australian Science Festival, Canberra; University of Canberra Open Day; and the RiverSymposium, Brisbane.

3.7 Media Coverage

A total of 19 media releases and 150 media hits.

MEDIA HIGHLIGHTS

- The CRC is assisting an independent TV production company with the production of a series of TV specials on Wild Rivers of Australia.
- A feature story on aquatic ecology in the Sunraysia area was broadcast on Channel 10 TV's 'Totally Wild'.
- There was extensive media coverage of:
 - Heritage River Reserves,
 - 'Ten Next Steps in Natural Resources Management' written by Peter Cullen (including SBS TV's Insight program),
 - Mildura Laboratory's continued location in Mildura,
 - Lake Burley Griffin contamination,
 - River Murray Environmental Flows decision.
 - The potential sale of Cubbie Station (including Radio National and Channel 9 TV's *60 Minutes*).

The CRCFE held a workshop with representatives of key businesses from the Australian water industry to ensure that our research outcomes will deliver the knowledge needed by water related businesses.



Chapter 4

Education & Training

Program Leader: Debbie Heck

Deputy Program Leader: Associate Professor Bill Maher

The overarching objective of the CRCFE Education Program is to stimulate a broader education and training experience for its students, particularly in graduate programs. This is achieved through initiatives such as the active involvement of researchers from outside the higher education system, and by enhancing the employment prospects of students through involvement in our user-oriented research programs.

The program's specific objectives include:

- provision of postgraduate education that produces ecologists and aquatic scientists with high-level research skills that are sought after for work in the water industry,
- contribution to undergraduate education programs to ensure graduates have sound ecological knowledge and an appreciation of its application to water management, and that graduates are aware of opportunities and are employable within the water industry,
- assisting community groups to understand water related issues and help equip them to take an active role in land and water management,
- building community awareness of water ecology and related environmental issues through a program of public and school-based education.

The program seeks to meet the water industry's human resources training need for well-rounded graduates who have the academic, as well as the field, communication and technological, expertise to contribute to the workplace. We have five educational target groups: postgraduate; undergraduate; post-professional; schools; community. Postgraduate training is our primary focus.

4.1 Postgraduate Education

POSTGRADUATE SCHOLARSHIPS

Four CRCFE full postgraduate scholarships were awarded to Craig Boys and Amina Price (University of Canberra), Shane Perryman (Monash University) and Suman Sharma (Griffith University). Five Top-up scholarships were awarded to Melissa Barrett and Michael Hammer (University of Adelaide), Ernestine Harbott (Monash University), Ben Cook (Griffith University) and Victor Hughes (University of Canberra).

POSTGRADUATE STUDENT WORKSHOP

Sixteen new CRCFE students and staff gathered together for the annual induction program in Canberra on September 3-5. The program welcomed new staff and students into the CRCFE and reflected the CRC's commitment to provide professional development for its staff and students. The three-day program had three components:

- Introduction to the CRCFE program structure, operations, communications, and administration (1/2 day);
- Project management skills course (2 days); and
- Introductory media skills course (1 day).

The CRCFE was introduced by Gary Jones, Lynne Sealie and Charlie Robinson, and the project management course was run by Adam LaGood from Fundamental Training & Management. The media skills course, run by Lynne Sealie and Leane Regan with support from two media professionals, introduced writing for the print media, as well as providing experience in oral presentations and radio and TV interviews.

Participants also heard two special topic talks — one from Richard Norris on 'The First National Assessment



of River Condition' and one from Peter Cullen on 'The CRCFE's Business Environment'.

Exit surveys from students were positive, supporting the value of the training courses.

POSTGRADUATE COMPLETIONS

The following postgraduate students have completed their studies this year:

Stephen Balcombe (PhD)	La Trobe University
Glen Brown (PhD)	University of Canberra
Sean Doody (PhD)	University of Canberra
Jackie Griggs (PhD)	La Trobe University
Rebecca Hewlett (MSc)	La Trobe University
Alison Mitchell (PhD)	Charles Sturt
Melissa Parsons (PhD)	University of Canberra
Zenadia San Feleipe (PhD)	Monash
Niem Tri (PhD)	Monash



L to R, Glen Brown, Richard Norris and Melissa Parsons enjoy the University of Canberra graduation. Glen and Melissa completed their PhDs through the CRCFE. Photo: CRCFE

CONFERENCE/WORKSHOP ATTENDANCE

The CRCFE supported students to travel to and present papers and posters at the following national and international conferences and workshops:

- 3rd Australian Algal Workshop, Brisbane
- Macroinvertebrate Taxonomic Workshop, Albury
- Molecular Genetic Techniques for Plant and Animal Cell Biology, Monash
- North American Benthological Society 50th Annual Meeting, Pittsburgh, PA USA
- NABS statistical workshop
- Environmental Flows for River Systems, Cape Town, South Africa
- Multivariate Statistics Workshop, Sydney
- 9th International Symposium on the Interactions between Sediments and Water, Banff, Canada
- Australian Society for Limnology, Moama

4.2 Undergraduate Education

Undergraduate teaching takes place at Monash University, University of Canberra, La Trobe University and Griffith University, University of Adelaide and at other CRC sites, or at the request of other institutions.

The following undergraduate freshwater ecology and water science related units are offered at university partners as part of an associated degree. These often encourage students to further their studies by MSc or PhD in the water field within the CRCFE. Students are exposed to CRCFE research and researchers as much as possible, especially during their final year.

- Griffith University: BSc Ecology and Conservation Biology; BSc Environmental Science; Aquatic Ecology unit; Field Ecology
- La Trobe University: BSc in Environmental Management and Ecology; also an honours degree; Graduate Diploma in Environmental Management
- Monash University: units offered in the BSc degree, Freshwater Ecology unit; Aquatic Chemistry
- University of Adelaide: B Science and B Environmental Science
- University of Canberra: BSc Resource and Environment — Water Science unit

SUMMER RESEARCH SCHOLARSHIPS AND WORK EXPERIENCE

13 scholarships were offered for 8–10 weeks, with students submitting a final research report. Eleven summer scholarships were distributed as follows:

Monash University (2), University of Canberra (5), Griffith University (2), EPA Victoria (2), MDBC (1) with a further scholarship being shared between MDFRC staff and University of Adelaide.

INTERNATIONAL EDUCATION

- Prof. Sam Lake undertook a series of lectures, seminars and field excursions during his sabbatical leave in the USA.
- John Hawking gave lectures to students and academics at Uppsala University, Sweden, and the University of Technology Braunschweig, Braunschweig, Germany, called 'The ecology of Australian dragonflies: Survival strategies in a dry continent'.
- Dr Cath Meatheral, Dr Phil Suter and the third year Conservation Ecology students from La Trobe University Albury-Wodonga campus, were

joined by the Rotary exchange students from the USA to undertake marine ecology on Phillip Island.

4.3 School Education

The CRCFE is involved in school education at a number of levels, including:

- Association conferences,
- Presentations, class lessons and field work for specific schools,
- Work experience and career advice,
- 'Rotary Murray-Darling School of Freshwater Research', 'The Rotary Camp on River Health' (Mildura) and 'Upper Murray School'.

ROTARY MURRAY-DARLING SCHOOL OF FRESHWATER RESEARCH

The huge demand for places in the Rotary Murray-Darling School of Freshwater Research meant that for 2002 there were two schools convened: one at MDFRC and the other at Charles Sturt University. The participants from Year 11 worked in teams to solve an environmental problem, with support from leading scientists. The freshwater science focused on the Kiewa River from its source in the Bogong High Plains to its entry into the Murray, to determine river health. This program has prompted some students to direct their further studies and future career path towards freshwater ecology.

THE ROTARY CAMP ON RIVER HEALTH

The MDFRC Lower Basin Laboratory (Ben Gawne, Michelle Bald) and Rotary District 9520 hosted the 4th annual 'Health of the River System' forum at Lake Cullulleraine. Thirty-five Year 9 and 10 students from three states explored how river health affects our lives, concentrating on solutions to the problems confronting our river and wetlands. The social and economic importance of river systems was explored



Students from the 2002 Rotary Murray-Darling School of Freshwater Research in the Kiewa Valley. Photo: M Copland

via a 'role play' game of water allocation in a hypothetical catchment. Mentors and project leaders were recruited from MDFRC, Rotary, Murray Wetlands Working Group, the Mallee CMA and the Coomealla Anglers Club.

DEMONSTRATIONS TO SCHOOL AND TAFE GROUPS

Primary and secondary school students and their teachers continue to be made aware of a variety of environmental issues that affect their communities, particularly through the three regional laboratories. Interest in possible careers in the water industry is also developed.

4.4 Future Directions for the Education Program

The Education Program will be focusing on development across four main areas.

STUDENT FOCUS

It is essential that CRCFE students associate themselves with the CRCFE. Students will be involved as much as possible in the development of the education program.

DEVELOPING LEARNING PLANS

To develop students who are highly sought after by the water industry and research institutions, the CRCFE is considering a process of individual learning plans. Students will participate in workshops to think out their own learning plans and work with CRCFE education staff to identify their training needs. The scheme seeks to ensure the students complete their studies and develop their professional skills as required to enter the water industry.

DEVELOPING A MENTORING PROGRAM FOR STUDENTS

The development of a mentoring program between students and industry managers will strengthen the links between CRCFE students and industry. In the first instance the program will commence with a 'Students Meet Water Managers and Scientists' theme during the 2002 Annual General Meeting.

NETWORK OF UNDERGRADUATE-AQUATIC-SCIENCE EDUCATORS

Linking academics working in freshwater ecology at the CRCFE member institutions will be a key mechanism for the development of improved educational experiences for undergraduate students. This meeting will enable academics working with undergraduate students to share ideas and teaching and learning strategies.

Chapter 5

Staffing & Administration

5.1 Specified Personnel

There have been a number of changes to the Specified Personnel in the CRCFE during the year. The specified personnel for the year 2001–2002 are:

Prof. Peter Cullen

University of Canberra CEO 100%

Dr Ben Gawne (new)

MDFRC Director (Regional Laboratories) 100%

Prof. Sam Lake

Monash University Chief Ecologist 75%

Prof. Stuart Bunn

Griffith University Program Leader 75%

A/Prof. Richard Norris

University of Canberra Program Leader 75%

Dr Margaret Brock (new)

DLWC Program Leader 30%

A/Prof. Gerry Quinn

Monash University Program Leader 75%

There were the following changes to the specified personnel during 2001–2002:

Dr Terry Hillman was replaced by Dr Ben Gawne. A/Prof. Arthur Georges was replaced by Dr Margaret Brock. Prof. Barry Hart has not yet been replaced as Director of Research.

5.2 Staff Contributed by Partners

Staff contributed to the CRCFE are detailed in the Financial and Staffing Report (separate document).

5.3 Staff Comings and Goings

Ian Lawrence retired from the CRCFE. Dr Terry Hillman retired as Director of the Murray-Darling Freshwater Research Centre. Dr Ben Gawne was appointed as Director in his place.

5.4 Major Renovations and Purchases

No renovations to buildings were undertaken in the year. Major purchases during the year were related to the research effort of the CRCFE. Major purchases were:

Multiprobe — water analysis	\$12,000
Electrofisher	\$25,000
Microscope camera	\$20,000
Gel analysis portable darkroom	\$15,700
Three FWD vehicles	\$99,000

5.5 Awards

John Beardall: The paper by Giordano, M., Kansiz, M., Heraud, P., Beardall, J., Wood, B. and McNaughton, D. (2001) entitled 'FT-IR spectroscopy as a novel tool to investigate changes in intracellular macromolecular pools in the marine microalga *Chaetoceros muellerii*' (*J. Phycol.* 37(2), 271–279) won the Phycological Society of America Provasoli award in 2002 for the best paper published in *Journal of Phycology* during 2001.

Sam Lake: presented with the Award of Excellence 2002 from the North American Benthological Society.

Sarah Cartwright: best Honours presentation at the 40th ASL Congress at Moama in October 2001.

Alison King and David Crook: best PhD presentations at the 40th ASL Congress at Moama in October 2001.

5.6 Grants Held by CRCFE Researchers

Researcher	Organisation	Project	Funding Source	Period	Total Funding
John Beardall	Monash University	Effects of environmental stress on the susceptibility of microalgae to damage by UV radiation	ARC Discovery	2001-2003	\$207,031
Stuart Bunn	Griffith University	Riparian Lands Phase 2	L&W Australia	2001-2004	\$228,500
Stuart Bunn	Griffith University	Ecological & Geomorphological Assessment for the Georgina-Diamantina River Catchment	QNRM	2002	\$38,642
Stuart Bunn	Griffith University	Implementation arrangements for a stream health monitoring program in SEQ	Healthy Waterways partnership	2001-2002	\$125,000
Stuart Bunn	Griffith University	Importance of Flood Flows to Productivity of Dryland Rivers and their Floodplains	Environment Australia	2001-2002	\$127,252
Roger Croome	La Trobe University	The phytoplankton of the Daly River and its major tributaries	Environment Australia via the NT Dept of Infrastructure, Planning and Environment	Jul 2000-Sept 2001	\$45,000
Ross Hyne	NSW EPA	Development of a passive sampler device for polar pesticides	Rural Industries Research & Development Corporation	2001-2002	\$55,580
Paul Humphries	Monash University	Campaspe Flows	Environment Australia	2001-2002	\$500,000
Sam Lake	Monash University	Restoration ecology of fish populations in degraded rural streams	AFFA	2002	\$65,000
Martin Thoms	University of Canberra	Habitat and the distribution of native fish habitat in the Darling and Paroo systems	AFFA	2001	\$360,000
Martin Thoms	University of Canberra	Water management targets for the Narran Lakes	Natural Heritage Trust	2002	\$72,000
Martin Thoms	University of Canberra	The character and hydrology of wetlands around the Barwon-Darling River	Natural Heritage Trust	2002	\$65,000 in collaboration with NSW DLWC)
Glenn Wilson	MDFRC	Influence of water resources development on the functioning of floodplain anabranch ecosystems in the Border Rivers Catchment	Border Rivers Catchment Management Association	2002-2003	\$6,250
Glenn Wilson	MDFRC	Use of SIMS to model environmental histories in a dryland river fish, the spangled perch (<i>Leiopotherapon unicolor</i>)	Australian Institute for Nuclear Science and Engineering	Jan 2002-Dec 2002	\$12,000

Chapter 6

Performance Indicators

6.1 Cooperative Arrangements

6.1.1 ACTIVITIES OF THE CENTRE SEEN BY STAKEHOLDERS AS MAKING A DIFFERENCE TO WATER MANAGEMENT

Convened and led the Expert Reference Panel on Environmental Flows and Water Quality Requirements for the River Murray System, for the MDBEC. The CRC provided a key technical report supporting the April 2002 Ministerial Council decision to continue development of River Murray environmental flows allocations.

Described the environmental health of the rivers of the Murray-Darling Basin in a report to the MDBEC titled *Snapshot of the Murray-Darling Basin River Condition*.

Coordinated Scientific Panel assessments for Victoria's Ovens River and Broken River, and produced a technical report reviewing the Scientific Panel approach to determining environmental flows for DNRE Victoria.

Undertook a major Aquatic Biodiversity Assessment Pilot Study on behalf of the Sydney Catchment Authority.

Facilitated a whole-of-water cycle benchmarking study workshop for ACTEW Corporation.

Undertook assessment of proposed management scenarios for the Lower Balonne River system for DNRM Queensland.

Produced two river management guides for regional catchment management organisations that were distributed to over 3500 stakeholders. There has been strong demand for these guides. See Chapter 3, Knowledge Exchange, for more detailed information.

6.1.2 MOST RESEARCH UNDERTAKEN IN LARGE MULTI-DISCIPLINARY PROJECTS MANAGED IN AN INTEGRATED WAY

Nine large multi-disciplinary projects currently form the core of the CRC's research portfolio. These projects use expertise from across the CRC to focus on problems at an appropriate field scale.

The CRC's research portfolio is guided by a conviction that if truly multi-disciplinary and collaborative research is to be undertaken, the researchers and managers must be involved from the start in developing the projects. We continue to invest in leadership training to help staff work in these integrated projects.

6.1.3 MAINTAINING A STRONG PARTNER BASE

The partner base has been strengthened with the inclusion of the University of Adelaide and discussions are underway with another prospective partner.

6.2 Research and Researchers

6.2.1 RESEARCH PORTFOLIO APPROPRIATE TO SHORT- AND LONGER-TERM ISSUES FOR THE WATER INDUSTRY

Our research portfolio targets both short and long-term issues facing the water industry. As such we have a range of projects varying from large, integrated three to six year projects looking at scientific questions underpinning sustainable water resources management, to short-term 6–12 month projects addressing immediate needs and knowledge gaps. Additional targeted funding is provided through government and industry-funded research grants.

We believe that most benefit will be gained if research projects are developed as collaborative partnerships between researchers and managers.

To ensure the relevance of our projects for the water industry, Program

Advisory Committees (PACs) have been established for each research program to formalise the involvement of industry staff in research planning and activities. The PACs meet at least once per year and report their progress to the Board.

6.2.2 RESEARCH IS OF AN EXCELLENT STANDARD AND IS PUBLISHED IN REFEREED LITERATURE

All research projects undertaken within the CRC undergo a rigorous review process to ensure excellent quality science which is relevant and of benefit to our partners. To reinforce this, we have established a quality assurance manual which documents the review process that all research projects must undergo. This has three levels:

- internal review of the science (by management committee);
- external review of the science (by peers); and
- review of management relevance (by PACs).

All research projects are subject to national and international peer review, and must be approved by the Board of the CRC for Freshwater Ecology.

One of the ways in which the CRC ensures its research is world-class is through international collaborations with selected institutions and researchers. These linkages enrich the research generated by both parties and benefit the broader water science community in Australia as CRC researchers share their knowledge.

Fifty articles were published in refereed journals during the year.

6.2.3 EFFECTIVE PROJECT MANAGEMENT WITH REGULAR REPORTING TO BOARD

The CRCFE Project Management System tracks the achievement of milestones for individual projects. All staff access the Project Management System through the secure CRCFE intranet web site. Reasons for missed milestones are provided by the Project Leader and these form part of the Exceptions Report to the Board.

6.3 Education and Training

6.3.1 NUMBER OF POSTGRADUATE STUDENTS ENROLLED AND WORKING WITH THE CRC AND DEGREES CONFERRED

Forty-seven postgraduate (PhD and MSc) students are formally affiliated with the CRCFE.

Seven PhD degrees and one MSc degree were conferred to CRCFE students in 2001-2002.

6.3.2 INVOLVEMENT OF NON-UNIVERSITY STAFF IN TEACHING POSTGRADUATE COURSES AND RESEARCH SUPERVISION

Ten CRCFE postgraduate students have non-university staff as supervisors. Additionally, several students are involved in collaborative projects with non-university partners of the CRCFE and benefit from feedback and advice they receive from them.

6.3.3 SHORT COURSES AND WORKSHOPS DEVELOPED AND PRESENTED

Seventeen research planning, joint problem solving or communications workshops were organized in 2001-2002. See Chapter 3, Knowledge Exchange, for details.

6.4 Applications of Research

6.4.1 ADOPTION OF RESEARCH BY PARTNERS

- River health assessment methods (Sydney Catchment Authority (SCA), MDBC, QNRM, DNRE, DLWC, Environment Protection Authorities (EPAs))
- Completion of waterway condition assessment for National Land and Water Resources Audit
- Integrated urban land and water management (ACT Government)
- Urban stream rehabilitation (ACT Government)
- Biodiversity assessment methods (SCA)
- Environmental flows assessment and setting (MDBC, DNRE, SCA, QNRM)
- Taxonomic guides (DNRE, QNRM, DLWC, EPAs)

6.4.2 ADVICE AND CONSULTANCIES PROVIDED TO INDUSTRY PARTNERS AND OTHERS, AND

6.4.3 APPLIED RESEARCH, INVESTIGATION AND CONSULTING CONTRACTS WITH NON-PARTICIPATING AGENCIES

Completed 28 contracts generating income of \$780,000 (see Chapter 3, Knowledge Exchange, for details).

6.4.4 PRODUCTION OF TECHNICAL PUBLICATIONS APPROPRIATE FOR END-USERS AND DEVELOPMENT OF OTHER VEHICLES FOR REACHING THESE GROUPS

Twelve technical reports were produced for end-users. To broaden the access to these publications, most technical reports are available in PDF format on the CRC website. A number of 'plain-English' brochures on research findings are also produced for community groups and other stakeholders.



The CRC uses a variety of communication strategies to reach end users, including seminars, workshops, conferences, consultative and business meetings, international visits, committees and training sessions.

6.4.5 CENTRE STAFF INVOLVEMENT IN GOVERNMENT AND OTHER ADVISORY BODIES

CRCFE staff chaired three committees and served as members on 14 committees and three expert advisory panels during 2001–2002. See Chapter 3, Knowledge Exchange, for details.

6.4.6 MEDIA EXPOSURE BY CENTRE

The CRC's work was covered by a variety of mass media outlets as well as industry and community email newsletters. One media highlight was the coverage of Peter Cullen winning the Prime Minister's Environmentalist of the Year Award and Ian Lawrence winning the Banksia Environmental Foundation Award for Outstanding Individual Achievement for their outstanding contributions to the environment. These awards prompted coverage by national, regional, government and industry media.

The CRC's involvement in the *Australian* newspaper's 'Save the Murray' campaign reached many thousands of readers. Another highlight was the ABC TV *Four Corners* program 'Water Pressure'. An after-show, on-line forum for the general public received 920 responses, one of the busiest ABC forums ever.

Staff of the CRC generated 150 media hits. See Chapter 3, Knowledge Exchange, for details.

6.5 Management and Budget

6.5.1 EFFECTIVENESS OF BOARD IN SETTING RESEARCH DIRECTIONS AND PROVIDING OVERALL POLICIES FOR THE CENTRE

The Board has been very involved with developing the current research portfolio and with setting other policies for the CRCFE. During 2001–2002 the Board established a Research Committee to enable timely feedback on research project matters to the Executive and senior research staff.

6.5.2 REPORTING PROGRESS TO THE BOARD AND TO THE COMMONWEALTH

The CRCFE Board receives financial information on a quarterly basis and research progress reports at each Board meeting.

The Commonwealth is advised of the financial position of the CRC each quarter.

6.5.3 ACCURATE MONITORING OF AGREED PERFORMANCE INDICATORS

The CRCFE has a project management system in place, which tracks the completion of milestones for the research component. The other performance indicators are monitored through the CRCFE Information Management System.

6.5.4 DELIVER INDUCTION PROGRAM SO THAT ALL NEW ENTRANTS TO THE CENTRE HAVE AN UNDERSTANDING OF THE ORGANISATION, ITS OPERATIONS AND RESOURCES

An induction program is carried out annually as part of the project management course for new students and staff. The postgraduate student manual outlines funding opportunities, applications, and other administrative procedures.

6.5.5 PROVIDE APPROPRIATE STAFF DEVELOPMENT OPPORTUNITIES WITHIN THE CENTRE

Staff are provided with opportunities to expand their scientific and managerial skills through CRCFE-funded attendance at national and international conferences and workshops, plus national scientific and managerial development training courses. The CRCFE provides substantial annual funding (in excess of \$50,000) for this purpose.

6.5.6 SIGNIFICANTLY INCREASE REVENUES FROM OUTSIDE SOURCES DURING THE LIFE OF THE CENTRE

The CRC completed 28 external contracts during the year, generating income of \$780,000.

Appendix A

Scientific Publications

A1.1 Books or Chapters in Books

Bunn, S., Abal, E., Dennison, B. and Greenfield, P. 2001. Making the connection between healthy waterways and healthy catchments: synthesis and recommendations. In: *Healthy Waterways — Healthy Catchments: Synthesis of Scientific Research of the SEQ Study*. Healthy Waterways Partnership, Brisbane.

Dennison, B., Abal, E., Bunn, S. and Greenfield, P. 2001. Setting the scene. In: *Healthy Waterways — Healthy Catchments: Synthesis of Scientific Research of the SEQ Study*. Healthy Waterways Partnership, Brisbane.

Downes, B.J., Barmuta, L.A., Fairweather, P.G., Faith, D.P., Keough, M.J., Lake, P.S., Mapstone, B.D. and Quinn, G.P. 2002. *Monitoring Ecological Impacts: Concepts and Practice in Flowing Waters*. Cambridge University Press.

Hunter, H.M., Sologin, S.J., Choy, S.C., Hooper, A.R., Allen, W.S., Raymond, M.A.A. & Peeters, J. 2001. *Water Management in the Johnstone Basin*. Queensland Government and Natural Heritage Trust, 105 pp.

Mackay, S.J., Arthington, A.H. and Werren, G. 2001. Ecological impact of weirs in the Pioneer Catchment, Queensland. In: Blanch S. (ed.) *The Way Forward on Weirs*. Inland Rivers Network, NSW, pp. 39–58.

Smith, M., Storey, A. and Bunn, S. 2001. Developing the tools for assessing the health of rivers and streams. In: *Healthy Waterways — Healthy Catchments: Synthesis of Scientific Research of the SEQ Study*. Healthy Waterways Partnership, Brisbane.

Udy, J., Bunn, S., Hunter, H. and Dennison, B. 2001. Nutrient cycling in SEQ waterways: nitrogen plays a key role. In: *Healthy Waterways — Healthy Catchments: Synthesis of Scientific Research of the SEQ Study*. Healthy Waterways Partnership, Brisbane.

Wilson, G.G., Gawne, B. and McCarthy, B. 2001. Development of experimental design and monitoring for a weir drawdown trial to determine the nature of ecological benefits. In: *Seeking Knowledge Gaps for Sustainable Communities, Landscapes, Rivers — Murray-Darling Basin Commission Forum 2001*. Murray-Darling Basin Commission, Canberra, pp. 99–100.

Wilson, G.G., Gawne, B., Walker, K.F., Lloyd, P. and Harriss, D. 2001. Weir pool drawdown as a management option for the Murray. In: Blanch, S. (ed.) *The Way Forward on Weirs*. Inland rivers Network, NSW, pp. 77–87.

A1.2 Refereed Journal Articles

Barmuta, L.A., McKenny, C.E.A. and Swain, R. 2001. The responses of a lotic mayfly *Nousia* sp. (Ephemeroptera: Leptophlebiidae) to moving water and light of different wavelengths. *Freshwater Biology* **46**, 567–573.

Bourne, D.G., Riddles, P., Jones, G.J., Smith, W. and Blakeley, R.L. 2001. Characterisation of a gene cluster involved in bacterial degradation of the cyanobacterial toxin microcystin LR. *Env. Toxicol.* **16**, 523–534.

Brookes, J.D. and Ganf, G.G. 2001. Variations in the buoyancy response of *Microcystis aeruginosa* to nitrogen, phosphorus and light. *J. Plankton Res.* **23**, 1399–1411.

Capon, S. 2001. Flood for thought: relationships between flow and vegetation dynamics in large arid floodplains. *Proceedings Third Australian Stream Management Conference*, 27–29 August 2001, Brisbane, Queensland. Volume 1, pp. 115–119.

- Cenzato, D. and Ganf, G.G. 2001. A comparison of the growth response between two species of *Potamogeton* with contrasting canopy architecture. *Aquatic Botany* **70**, 53–66.
- Choy, S.C. & Marquet, G. 2002. Biodiversity and zoo-geography of Atyid shrimps (Crustacea: Decapoda: Natantia) of New Caledonia. *Memoir of the National Museum of Natural History, Paris* **187**, 17–32.
- Choy, S.C., Thomson, C.B. and Marshall, J.C. 2002. Ecological condition of central Australian arid-zone rivers. *Water Science and Technology (UK)* **45**, 217–224.
- Cooling, M.P., Ganf, G.G. and Walker, K.F. 2001. Leaf recruitment and elongation: an adaptive response to flooding in *Villarsia reniformis*. *Aquatic Botany* **70**, 281–294.
- Cottingham, P., Thoms, M.C. and Quinn, G.P. 2002. Scientific panels and their use in environmental flow assessment in Australia. *Aust. J. Water Resources* **5**, 103–111.
- Crook, D.A., Robertson, A.I., King, A.J. and Humphries, P. 2001. The influence of spatial scale and habitat arrangement on diel patterns of habitat use by two lowland river fishes. *Oecologia* **129**, 525–533.
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- Hart, B.T., Davies, P.E., Humphrey, C.L., Norris, R.H., Sudaryanti, S. and Trihadiningrum, Y. 2001. Application of the Australian River Bioassessment System (AUSRIVAS) in the Brantas River, East Java, Indonesia. *J. Environmental Management* **62**, 93–100.
- Hillman, T.J. and Quinn, G.P. 2002. Temporal changes in macroinvertebrate assemblages of permanent and temporary wetlands in a floodplain forest. *River Research and Applications* **18**, 137–154.
- Houng, H., Rieknagel, F., Marshall, J.M. & Choy, S.C. 2001. Predictive modelling of macroinvertebrate assemblages for stream habitat assessment in Queensland (Australia). *Ecological Modelling* **195**, 195–206.
- Hurwood, D.A. and Hughes, J.M. 2001. Nested clade analysis of the freshwater shrimp, *Caridina zebra* (Decapoda: Atyidae), from northeastern Australia. *Molecular Ecology* **10**, 113–126.
- Hurwood, D.A. and J.M. Hughes 2001. Historical interdrainage dispersal of eastern rainbowfish (*Melanotaenia splendida splendida*) from the Atherton Tableland, northeastern Australia. *Journal of Fish Biology* **58**, 1125–1136.
- Jones, G.J. and Chorus, I. 2001. Toxic cyanobacteria — towards a global perspective. *Env. Toxicol.* **16**, 456–459.
- King, A.J. and Crook, D.A. 2002. Evaluation of a sweep net electrofishing method for the collection of small fish and shrimp in lotic freshwater environments. *Hydrobiologia* **472**, 223–233.
- Kong, Y.H., Beer, M., Seviour, R.J., Lindrea, K.C. and Rees, G.N. 2001. Structure and functional analysis of the microbial community in an aerobic:anaerobic sequencing batch reactor with no phosphorus removal. *Systematic and Applied Microbiology* **24**, 597–609.
- Lake, P.S. 2001. On the maturing of restoration: linking ecological research and restoration. *Ecological Management & Restoration* **2**, 110–115.
- Langley, J.M., Shiel, R.J., Nielsen, D.L. and Green, J.D. 2001. Hatching from the sediment egg-bank, or aerially-dispersed? — the use of mesocosms in assessing rotifer biodiversity. *Hydrobiologia* **446**, 203–211.
- Marchant, R. 2002. Do rare species have any place in multivariate analysis for bioassessment? *Journal of the North American Benthological Society* **21**, 311–313.
- Marchant, R. and Hehir, G. 2002. The use of AUSRIVAS predictive models to assess the response of lotic macroinvertebrates to dams in south-east Australia. *Freshwater Biology* **47**, 1033–1050.
- McGlashan, D.J. and Hughes, J.M. 2001. Genetic evidence for historical connectivity among populations of the Australian freshwater fish *Craterocephalus stercusmuscarum* (Atherinidae) east and west of the Great Dividing Range. *Journal of Fish Biology* **59**, 55–67.
- McGlashan, D.J. and Hughes, J.M. 2001. Low levels of mitochondrial DNA and allozyme variation among populations of freshwater fish *Hypseleotris compressa* (Gobiidae: Eleotridinae): implications for its biology, populations connectivity and history. *Heredity* **86**, 222–233.
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- Raadik, T.A. and Kuitert, R.H. 2002. Kosciuszko Galaxias: a story of confusion and imminent peril. *Fishes of Sahul* **16**, 830–835.
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Appendix B

Conference & Workshop Papers & Presentations

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Choy, S., Thomson, C. and Marshall, J. 2001. Ecological condition of central Australian arid-zone rivers. Fourth International River Management Symposium, Brisbane, 29-31 August 2001.

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Cook, B., Choy, S. and Davie, J. 2001. Potential ecological impacts of translocating redclaw crayfish *Cherax quadricarinatus*. Fifth International Crustacean Congress, Melbourne, 9-13 July, 2001.

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Cullen, P. 2001. Living on Floodplains. Presented at the Second Victorian Floodplain conference, Traralgon, October.

Cullen, P. 2001. The Salinity Challenge, ACCI, Adelaide, October.

Cullen, P. 2001. Knowledge Needs for Catchment Management. Presented to the Victorian Catchment Management Forum, Hamilton.

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Cullen, P. 2002. Background and Futures for the National Action Plan. Presented at the Big Picture Conference, DNRE, Bendigo, March.

Cullen, P. 2002. Conserving Natural Rivers. Presented at the Rivers Forum — Protecting our Rivers. Canberra, Land & Water Australia, March.

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Cullen, Peter 2002. Environmental Aspects of Sustainability. Transitions to Sustainability Symposium. Australian Academy of Science. Canberra.

Fellows, C. 2002. Benthic metabolism of turbid waterholes in a dryland river catchment, Cooper Creek, Australia. North American Benthological Society. Pittsburgh, June.

Grace, M. 2001. Assessment of ecological risk associated with irrigation systems in the Goulburn-Broken catchment. ASL 40th Annual Congress, Moama, NSW, September 2001.

Grace, M. 2001. Ecological risk assessment. EPA Sedimentation Workshop, Queenscliff, September 2001.

Harris, J.H. (In press) Fish passage in Australia: experience, challenges and projections. Keynote address. In: R. Keller (ed.) *Proceedings of the Third Australian Technical Workshop on Fishways*. Monash University, Melbourne.

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Koehn, J.D. (2000). Radiotracking the legendary Murray cod in Australia. In: Eiler, J.H., Alcorn, D.J. and Neuman, M.R. (eds). *Biotelemetry 15*. Proceedings of the 15th International Symposium on Biotelemetry. Juneau, Alaska, 10–15 May 1999. Pp. 3–8. International Society on Biotelemetry, Wageningen, The Netherlands.

Koehn, J. 2001. Ecological impacts of cold water releases on fish and ecosystem processes. In: Phillips, B. (ed.) *Thermal Pollution of the Murray-Darling Waterways: Workshop held at Lake Hume, 18–19 June 2001*: Statement and recommendations plus supporting papers. Pp. 7–11. Inland Rivers Network and World Wide Fund for Nature.

Lake, P.S. (2001–2002). Seminars on restoration ecology and the Granite Creeks Project, given at the Academy of Natural Sciences, Philadelphia, Pennsylvania in May 2002; at University of Maryland; and at University of Wisconsin.

Lake, P.S. 2002. Scape ecology, perturbations and restoration ecology in streams. Presented at Award of Excellence Presentation, 50th Annual Conference of the North American Benthological Society at Pittsburgh, May 2002.

Lawrence, I. 2001. Integrated Approaches to Urban Land and Water Management. *Proceedings Royal Australian Planning Institute National Congress*, Canberra 2001.

Lawrence, I. 2001. A strategic review of Australian urban water BMPs, *Proceedings United Engineering Foundation Conference: Linking Stormwater BMP Designs and Receiving Water Impact Mitigation*, August 2001, Colorado.

Lawrence, I. 2002. Integrated Land and Water Management Decision Support Tools. *Proceedings International Water Association World Water Congress 2002*, Melbourne.

Lawrence, I. 2002. Contextual factors guiding the selection and design of Gross Pollutant Traps. Gross Pollutant Trap Workshop, May 2002. Sydney Water.

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Marshall, J., Choy, S. *et al.* 2001. Relationship between the ecological condition of rivers and modifications to their flow regime: an integrated study using multiple indicators. Third Australian Stream Management Conference — The Value of Healthy Streams, Brisbane, 27–29 August 2001. Vol. II, pp. 413–419.

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fish in the Broken River. Australian Society for Limnology 40th Congress, Moama, NSW.

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Nielsen, D.L., Brock, M., Healey, M., Jarosinski, I. and Harris, K. 2001. Salt — a health risk for zooplankton communities. Australian Society of Limnology, Moama, NSW.

Rees, G.N., Mitchell, A. and Baldwin, D.S. 2001. Interaction of anaerobic nutrient cycles in freshwater sediments. International Symposium of Microbial Ecology.

Sellens, C. 2001. A reference condition defined by good management practice for river protection. Australian Society for Limnology 40th Congress, Moama, NSW.

Sellens, C. 2002. A reference condition defined by good management practice for river protection. North American Benthological Society Conference. Pittsburgh, June 2002.

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Tsyrlin, E., Walsh, C.J. and Breen, P.F. 2001. An experimental assessment of physical habitat restoration in urban streams (We built it but they still won't come). 40th Australian Society for Limnology Congress, Moama, Sep 2001.

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Watts, K.E.N. 2001. Sand slugs: the hidden biogeochemistry within them. Australian Society of Limnology Conference, Moama, NSW.

Watts, K.E.N. 2002. Biogeochemical interactions within the hyporheic zone of a degraded rural stream. 9th International Symposium on the Interactions Between Sediments and Water, Banff, Alberta, Canada, 5–10 May 2002.

Watts, K.E.N., Hart, B.T. and Grace, M.R. 2001. Biogeochemistry of a sand slug stream. In: *Proceedings of the Third Australian Stream Management Conference*, 27–29 August 2001, Brisbane, pp. 639–645.

Wilson, G.G. 2002. Fish otolith microstructure as a tool for defining environmental flow requirements in freshwater ecosystems. *Environmental Flows for River Systems Conference*, Cape Town, South Africa, March 2002.



Appendix C

Students in the CRCFE

Name	Began	University	Supervisor	Topic	Funding	Graduate Employment
Masters Continuing						
CURMI, Tim	1/3/99	La Trobe	Suter (La Trobe)	The Health of the Lachlan River	NHT	-
HOGAN, Fiona	1/7/01	Monash	Hart (Monash)	Comparison of Different Methods for Measuring Denitrification Activity in Urban Streams	Self funded	
Masters Completed						
HEWLETT, Rebecca	22/4/98	La Trobe	P Suter (La Trobe) L Metzeling (EPA Vic)	Classification of Victorian streams: implications of taxonomic resolution, sample habitat and sample season	La Trobe EPA	
PhD Commencing						
BARRETT Melissa	01/07/02	Adelaide	Walker (Adelaide) Ganf (Adelaide)	Distributions and implications of C ₃ , C ₄ , CAM/SAM species in the Murray Darling Basin as a response to resources/stress limitations of water, nutrients and salinity	APA + CRCFE Top up	
BOYS Craig	01/08/01	University of Canberra	Thoms (UC)	Habitat used by riverine fish communities in semi-arid regions during low flow	CRCFE full scholarship	
COOK Ben	01/10/01	Griffith	Hughes (Griffith) Bunn (Griffith)	Recovery and recruitment of aquatic fauna to rehabilitate streams in south-eastern Australia	APA + CRCFE Top up	
HAMMER Michael	01/02/02	Adelaide	Walker (Adelaide)	Setting a framework for conservation: molecular systematics and conservation biology of small fishes of the Murray Darling Basin	APA + CRCFE Top up	
HARBOTT Ernestine	01/03/02	Monash	Hart (Monash) Grace (Monash)	Use of enzyme activity for characterising organic carbon in Australian freshwater streams	APA + CRCFE Top up	
HUGHES Victor	01/02/02	University of Canberra	Thoms (UC)	Hydraulic habitat of inland rivers: the role of large woody debris	APA + CRCFE Top up	
PERRYMAN Shane	01/03/02	Monash	Hart (Monash) Grace (Monash)	Nitrogen cycling and bacterial bio-diversity in urban Australian streams	CRCFE full scholarship	
PRICE Amina	01/07/02	University of Canberra	Thoms (UC) Wilson (MDFRC)	Influence of hydrology on the recruitment of native fishes to the Narran Lakes, north-western New South Wales	CRCFE full scholarship	
SHARMA Suman	01/03/02	Griffith	Hughes (Griffith)	Genetic structure of aquatic fauna in coastal streams in S.E. Queensland: evidence for past drainage changes	CRCFE Full scholarship	
PhD Continuing						
BALLINGER, Andrea	24/2/00	Biological Sciences, Monash	MacNally (Monash) Lake (Monash)	Invertebrate biodiversity of coarse woody debris on floodplains	MDBC CRCFE Top Up	
BOWEN, Trish	1/07/01	University of Canberra	Williams (UC)	Flow Effects on Cycling of Carbon from Lowland River Macrophytes	LWA + CRCFE Associated Project Student	

Name	Began	University	Supervisor	Topic	Funding	Graduate Employment
BUTCHER, Rhonda	28/3/96	Biological Sciences, Monash	Lake (Monash) Marchant (Museum of Victoria)	Conservation assessment of Victorian wetlands using invertebrates.	APA + CRCFE Top up (expired)	
CAPON, Samantha	1/2/00	Griffith	Bunn (Griffith) Brock (DLWC)	Flow related response of vegetation in arid inland floodplains	LWRRDC	
CONWAY, Carol	7/3/01	University of Canberra	Maher (UC)	Reactivity of organic carbon under anaerobic conditions and its role in sediment nutrient dynamics.	APA + CRCFE Top up	
CARINI, Giovannella	28/08/01	Griffith	Hughes (Griffith)	The Role of Flooding in the Maintenance of Genetic Diversity in Four Floodplain Invertebrates	Griffith and CRCFE Associated Project	
CHOTIPUNTU, Piayapong	1/02/00	Monash	Cullen (UC)	Aspects of sub-lethal salinity on the early life stages of an Australian native freshwater fish, Murray cod (<i>Maccullochella peelii</i> Mitchell 1838)	Overseas Scholarship and CRCFE Associated Project	
DRIVER, Patrick	27/2/95	University of Canberra	Harris (NSW Fisheries) Norris (UC) Closs (Otago)	Impact of carp on macrophytes and water quality	CRCFE scholarship (expired)	DLWC
EBNER, Brendan	3/3/97	La Trobe	Suter (La Trobe) Gawne (MDFRC)	Introphic interactions between zooplankton and fish.	La Trobe (expired) Scholarship	
EVANS, Lisa	24/7/95	University of Canberra	Williams (UC) Thoms(UC)	Riparian vegetation development and disturbance along the Upper Murray and Murrumbidgee rivers.	APA + CRCFE Top Up (expired)	
FOSTER, John	16/7/01	University of Canberra	Thoms (UC)	Inland river floodplains: the role of sediment and nutrient exchanges	APA + CRCFE Top up	
FRANCIS, Cathy	3/3/97	University of Canberra	Thoms (UC) Gawne (MDFRC)	The effects of flow regulation on carbon and nutrient cycle in temporary wetlands of the Murray River.	APA + CRCFE Top up	
FRASER, Ian	4/10/96	Water Studies Centre, Monash	Hart (Monash) Barling (SKM)	Development of a predictive model for algal growth in Cairn Curran Reservoir.	Goulburn Murray-Water	
GEHRIG, Susan	1/5/01	Adelaide	Walker (Adelaide)	The ecology of Riparian Willows on the River Murray	APA + CRCFE Top up	
GEORGE, Amy	1/04/01	Adelaide	Walker (Adelaide)	Population Dynamics and Recruitment of Eucalypts on the Lower Murray Floodplain	Adelaide and CRCFE associated project	
HOWITT, Julia	29/3/99	Monash	Baldwin (MDFRC) Rees (MDFRC)	Photochemistry of Aquatic Substances.	APA + CRCFE top up	
HUNTER, David	2/7/01	University of Canberra	Osborne (UC)	Life history of declining and non declining frogs in the Southern highlands of NSW.	APA + CRCFE	
KELLAR, Claudette	1/3/00	Monash	Quinn (Monash) Lake (Monash)	Community Dynamics in temporary pools	CRCFE	
KENNARD, Mark	1/3/00	Griffith	Arthington (Griffith) Pusey (Griffith)	A quantitative basis for the use of fish as indicators of river condition	Associated project	
KING, Alison	30/3/98	Biological Sciences, Monash	Lake (Monash) Humphries (MDFRC)	Identification and quantification of the nursery habitats of Murray Darling freshwater fish larvae.	CRCFE Scholarship	
MACKAY, Stephen	1/8/01	Griffith	Arthington (Griffith) Mosisch (Griffith)	Flow requirements of aquatic macrophytes in south-east Queensland streams	CRCFE	
McGINNES, Heather	10/07/00	Canberra	Thoms (UC)	Connectivity and Fragmentation of Floodplain-River Exchanges in a Semi-arid, Anabranching Floodplain River System	APA + CRCFE top up	

Name	Began	University	Supervisor	Topic	Funding	Graduate Employment
McKENNY, Claire	24/1/00	Griffith	Bunn (Griffith) Proctor (Griffith)	The relationship between ecosystem processes and community structure in south east Queensland rivers	APA	
McNEIL, Dale	4/3/96	La Trobe	Lawler (LaTrobe) Hillman (MDFRC) Closs (Otago) Gehrke (NSW Fisheries)	Fish, zooplankton and algae dynamics in Murray River billabongs.	APA + CRCFE top up (expired)	
MEDERIOS, Elvio	1/01/01	Griffith	Arthington (Griffith) Wilson (MDFRC)	Variation on Diet Composition of Fish in Dryland Refugia.	International Scholarship and Associated Project	
NICOL, Jason	25/7/01	Adelaide	Walker (Griffith) Ganf (Adelaide) Gawne (UC)	Ecology and Management of deflation Basin Lakes	MDBC Associated Project	
OSWALD, Louisa	20/11/95	University of Canberra	Norris (UC) Maher (UC)	In situ toxicity testing of water quality.	APA + CRCFE Top up (expired)	
PETERSON, Kylie	3/3/97	University of Canberra	Kearney (UC) Thoms (UC) Humphries (MDFRC)	Age, growth and survival of larval fish in the Murray-Darling Basin.	APA + CRCFE Top Up (expired)	EA
SELLENS, Claire	1/5/00	University of Canberra	Norris (UC)	Defining the reference condition: implications for biological assessment	CRCFE	
SIEBENTRITT, Mark	1/99	Adelaide	Walker (Adelaide) Ganf (Adelaide)	Effects of water regime on wetland plants	Bookmark Biosphere Trust + CRCFE Top-up	
SMITH, Ben	1/4/01	Adelaide	Walker (Adelaide)	Observations on the early life history of carp, <i>Cyprinus carpio</i> : fecundity, spawning and tolerance of eggs to salinity and dehydration.	APA + CRCFE Top up	
SONNERMAN, Jason	1/7/97	Water Studies Centre, Monash	Kershaw (Monash) Breen (Melb Water)	The development of rapid bioassessment protocol for the use of diatoms as water quality indicators.	APA + CRCFE Top Up	WSC-Monash
STOJKOVIC-TADIC, Slobodanka	1/2/01	Monash	Beardall (Monash)	Interactions between nutrient status and UVB in microalgae	APA + Top up	
TREADWELL, Simon	2/9/96	Biological Sciences, Monash	Lake (Monash) MacNally (Monash) Campbell (Monash)	Role of snags in carbon dynamics in lowland rivers.	CRCFE Scholarship (expired)	
VANDERKROK, Kellie	19/06/00	Monash	Hart (Monash) Grace (Monash)	Biogeochemistry of nutrients in a sand slug stream, Creightons Creek, Victoria	APA + CRCFE Top up	
WISHART, Marcus	1/3/98	Griffith	Hughes (Griffith) Bunn (Griffith) Davies (Griffith)	Dispersal of aquatic insects and the implications for river conservation in southern Africa	Associated Project	
PhD Submitted						
ASSEMI, Shoeleh	19/1/95	Water Studies Centre, Monash	Beckett (Monash) Hart (Monash)	Characterisation of humic substances and its role in phosphorus speciation in natural waters.	CRCFE Top Up (expired)	
BALCOMBE, Stephen	27/8/95	La Trobe	Lawler (La Trobe) Humphries (MDFRC) Closs (Otago)	Resource use by <i>Hypseleotris</i> (Pisces: Gobiidae) in the littoral macrophytes of a floodplain billabong.	La Trobe Scholarship (expired)	
BEATTIE, Gillian	31/3/96	Water Studies Centre, Monash	Hart (Monash) Beardall (Monash)	The role of algae and bacteria in nutrient cycling in lowland rivers.	Monash CRCFE top up (expired)	
CROOK, David	1/3/98	Charles Sturt University	Humphries (MDFRC)	Habitat use and movement of golden perch and carp in a lowland river.	CSU + CRCFE Top up	

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JENKINS, Kim	16/3/98	University of New England	Boulton (UNE) Brock (DLWC)	Flood frequency and community dynamics of invertebrates emerging from reflooded sediments of dry lakes in south-western NSW.	Menindee Project Scholarship (expired)	
PhD Completed						
BROWN, Glen	1/6/98	University of Canberra	Norris (UC) Maher (UC)	Relationships between nutrients, algae and invertebrates in the Thredbo River.	Kosciusko Thredbo Top up (expired)	DNR - QLD
DOODY, Sean	20/2/96	University of Canberra	Georges (UC) Osborne (UC)	Effects of nest site selection and fluctuating temperatures of <i>Carettochelys insculpta</i> .	CRCFE Scholarship (expired)	
GRIGGS, Jackie	4/1/95	La Trobe	Croome (La Trobe) Shiel (MDFRC)	Taxonomy, biogeography and ecology of Chydoridae in Australia.	ABRS+ CRCFE top up (expired)	Tasmania's HECS
PARSONS, Melissa	12/9/95	University of Canberra	Norris (UC) Thoms (UC)	Compositional patterns of lotic benthic macroinvertebrates: Relationship to habitat and the scale of measurement.	APA + CRCFE Top up (expired)	South Africa
MITCHELL, Alison	09/03/98	Charles Sturt	Baldwin (MDFRC)	Anaerobic Nutrient Cycles in Freshwater Sediments	CRCFE Full	
SAN FELEIPE, Zenadia	19/07/99	Monash	Beckett (Monash)	Ecological Risk Assessment in Derwent Estuary, Tasmania, Australia	CRCFE Associated Student	
TRI, Niem	1/04/98	Monash	Beckett (Monash)	Characterisation of Aquatic Particles and Cells Using Thin Channel Fractionation Methods	APA + CRCFE Top up (expired)	







