CRC AUSTRALIA

Cooperative Research Centre for Freshwater Ecology

Annual Report 1998/99

COOPERATIVE RESEARCH CENTRE FOR FRESHWATER ECOLOGY

Established under the Australian Government's Cooperative Research Centre Program

COOPERATIVE RESEARCH CENTRE FOR FRESHWATER ECOLOGY

Vision

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

Mission

The Cooperative Research Centre for Freshwater Ecology (CRCFE) provides ecological understanding to improve inland waters by collaborative research, education and resource management.

Objectives

To conduct high quality research that contributes to scientific understanding of aquatic ecosystems.

To provide stress-response relations for a variety of natural and human-induced disturbances on aquatic ecosystems.

To use research findings to provide better predictive tools and strategies for those using and managing land and water resources; to work collaboratively with managers in the conduct and implementation of our research.

To provide an avenue to international science to ensure relevant new approaches and techniques are available in Australia, and to contribute our work internationally.

To exploit the synergies available within the CRCFE from the range of scientific disciplines represented by conducting effective collaborative research that looks at whole ecosystems.

Cover image
The larvae of the aquatic water penny, *Sclerocyphon maculatus*, clings to rocks in streams and lakes. The adult beetle is short and broad.
Photo: J Hawking

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The Cooperative Research Centre for Freshwater Ecology is a collaborative venture between:

ACT Government
ACTEW Corporation
CSIRO Land and Water
Environment Protection Agency, Victoria
Goulburn-Murray Water
La Trobe University
Melbourne Water
Monash University
Murray-Darling Basin Commission
Murray-Darling Freshwater Research Centre
NSW Fisheries
Southern Rural Water
Sydney Water Corporation
University of Canberra
Wimmera-Mallee Rural Water

The Murray-Darling Freshwater Research Centre Lower Basin Laboratory is a collaborative venture between:

Cooperative Research Centre for Freshwater Ecology
Lower Murray Water
Sunraysia Rural Water Authority

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Wetlands in the Murray-Darling Basin that are of international importance & listed under the Ramsar Convention

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SA	1	Coorong and Lakes Alexandrina and Albert	140 500
	2	Riverland, including Chowilla Floodplain System	30 600
Vic	3	Hattah-Kulkyne Lakes	1 018
	4	Lake Albacutya	10 700
	5	Kerang Lakes	9 172
	6	Gunbower Forest	19 450
	7	Barmah Forest	28 500
NSW	8	Macquarie Marshes Nature Reserve	18 200
ACT	9	Ginini Flats, Namadgi National Park	125
Qld	10	Currawinya Lakes National Park	151 300

Important wetlands of 5 000 ha or more in extent (excluding the Ramsar sites)

State	No	Name, Location	Area in ha
NSW	11	Lake Goran, Liverpool Plains	6 000
	12	Lower Gwydir Wetlands, Lower Gwydir River and Gingham Watercourse	102 120
	13	Menindee Lakes, Lower Darling River, near Menindee	45 000
	14	Narran Lakes, Terminal drainage of Narran River	10 000
	15	Talyawalka Anabranch & Teryawynia Creek, Darling River between Wilcannia and Menindee	H / variable
	16	Paroo Overflow, Paroo-Warrego Riverine Plains	720 000
	17	Yantabulla Swamp, Paroo-Warrego Riverine Plains	37 200
	18	Darling Anabranch Lakes, Darling River Plains on Great Anabranch	269 000
	19	Lowbidgee Floodplain, Murrumbidgee River between Maude and Balranald	200 000
	20	Lake Cowal-Wilbertoy Wetlands, Lachlan River Floodplain between Forbes & West Wyalong	29 000
	21	Booligal Wetlands, Floodplains of Lachlan River distributaries	5 000
	22	Great Cumbung Swamp, Lachlan River Floodplain near Oxley	50 000
	23	Lachlan Swamp, Mid Lachlan River	6 600
	24	Lake Brewster, Lachlan River Floodplain	6 114
	25	Koondrook and Perricoota forests, River Murray, between Moama and Barham	31 150
	26	Millewa Forest, River Murray, between Tocumwal and Barmah	33 636
	27	Werai Forest, Along Edward and Niemur rivers	11 234
	28	Lake George, Between Canberra and Goulburn	15 000
Vic	29	Lake Hindmarsh, North-west of Jeparit	15 600
	30	Lake Tyrrell, North-west of Sea Lake	20 860
	31	Lindsay Island, Near Mildura	15 000
	32	Wallpolla Island, Near Mildura	9 200
	33	Lake Hume, Near Albury-Wodonga	18 465
	34	Lake Dartmouth, On Mitta Mitta River	5 990
	35	Lower Goulburn River Floodplain, Below Goulburn Weir	13 000

Source: ANCA 1996.

The Murray-Darling Basin

Chairman's Forword

Dr John Langford
Chairman

1998-1999 was a tough year for the Cooperative Research Centre for Freshwater Ecology. Not only were many research projects being finalised, published and disseminated to the water industry, but the Centre had to undergo its Five Year Review and the development of the new bid simultaneously. The enormous effort involved was only accomplished through the outstanding commitment of the Centre's staff and supporters. The successful outcomes of the review and the new bid stand as hallmarks of the maturity of the Cooperative Research Centre for Freshwater Ecology. The levels of teamwork and cooperation continue to increase each year as more people discover the power and enjoyment of working in collaborative, multi-disciplinary teams.

There is an increasing awareness in the Australian water industry that a strong ecological knowledge base is fundamental to sustainable management of our land and water resources. This is clearly demonstrated by the decisions of the Department of Natural Resources in Qld, the Department of Land and Water Conservation in NSW and the Department of Natural Resources and Environment in Victoria to join the new Cooperative Research Centre for Freshwater Ecology as full members. All these agencies are under considerable budgetary pressure, and it is exciting that they have seen the need to be part of the new Cooperative Research Centre for Freshwater Ecology (CRCFE). We are also delighted that the Sydney Catchment Authority and Griffith University have decided to join the new Centre. These organisations worked closely with other parties to develop the rebid proposal for the new Centre, which was granted funding for a further seven years.

The Cooperative Research Centre for Freshwater Ecology is developing a portfolio of integrated research projects to address the issues of flow-related ecological processes, restoration ecology, conservation ecology and ecological assessment.

Achievement of the Centre's vision of improving the condition of Australia's inland waters is supported by the development of specialist knowledge brokers using innovative approaches to disseminate knowledge. The knowledge brokers have expanded the Centre's capacity to deal with requests from partners and others. The future of the Centre is based on this ability to add value to our partners who both generate and use knowledge.

The Cooperative Research Centre for Freshwater Ecology has also developed its role as a contributor to public debates on water issues and works hard to raise the profile of water issues in Australia. The Centre attracts extensive media coverage, and is frequently sought after to provide comments on water issues. The Centre has also developed the capacity to advise Governments about water policy issues and provide ecological insights into the development of these policies.

The Cooperative Research Centre for Freshwater Ecology goes from strength to strength, generating valuable ecological knowledge to underpin sustainable water management in Australia, a country with big decisions to make about its water resources.

I would like to thank my fellow board members for their commitment and hard work during the year. The boundless energy, enthusiasm and leadership skills of the Director, Peter Cullen, have been vital in the success of the Cooperative Research Centre for Freshwater Ecology. As Board Chairman I would like to congratulate Peter on the success of the rebid: it was a great achievement. I would like to conclude with a special thank you to the staff of the Centre whose commitment and hard work have contributed so much.

Prof Peter Cullen
Director

This year was an exciting one for the CRCFE. Many of our research projects came to an end and were reported and transferred to our industry partners. Both the Five Year Review and the bid for a new CRC were highly successful, and we were delighted to welcome five new partners to the Centre.

The Five Year Review

Dr Gene Likens from the Institute of Ecosystem Studies in New York, Professor Colin Townsend from the University of Otago in New Zealand and Ms Christine Forster from the Land and Water Resources Research Development Corporation conducted the first stage of our Five Year Review. Three quotes from their report indicate the results of this international benchmarking:

'The CRCFE vision is to improve the condition of Australia's inland waters... It is the Panel's firm belief that the Centre is making major contributions toward its vision by conducting significant and relevant scientific studies, the results of which form the basis for all smart management, restoration and conservation efforts on critical freshwater resources.

(page 4)

...the Panel noted the following substantive outcomes of the research program:

- *improved understanding of how freshwater biota respond to flow variability*
- *indicators to measure ecosystem change in response to the provision of environmental flows*
- *understanding of the importance of flows linking rivers and floodplains*
- *understanding of the impact of river regulation on downstream communities*
- *improved understanding of reservoir processes and cyanobacteria blooms*
- *understanding of the important processes driving phosphorus release from sediments*
- *awareness of the 'health' of many of our aquatic ecosystems*

(page 14)

...We met with five PhD students...and were enormously impressed by their enthusiasm for their research and the esteem in which they held the CRCFE. They clearly benefited from being part of a vigorous and diverse network of researchers because of the breadth of skills, resources and data-rich study sites that are available to them. They valued the opportunity of being part of teams, where genuine team work and intellectual excitement are the norm.'

(page 12)

Mr Graeme Kelleher from Graeme Kelleher and Associates, Mr Peter Millington from Peter Millington and Associates and Dr Sue Meek from the Science and Technology Division of the WA Department of Commerce and Trade conducted the second stage of the Five Year Review in September 1998. Some quotes from this review include:

'This CRC is of immense importance to Australia, focussing as it does on the Murray-Darling Basin and two important urban river systems.

The Centre is assessed as being of a very high standard generally and outstanding in many respects, including the performance of integrated research, communication and collaboration, the development of leadership skills in its staff and public relations.'

(page 2)

These outstanding reviews confirmed that our collaborative research approach was working effectively. Everyone in the Centre made a great effort – both to deliver their research, and to help present it in ways that the panels could appreciate.

The New CRC for Freshwater Ecology

While the review was in process, we were developing the teams and concepts that would support a bid for a new CRC. We were delighted to have the three East Coast land and water management agencies, the Qld Department of Natural Resources, the NSW Department of Land and Water Conservation and the Victorian Department of Natural Resources and Environment, as well as Griffith University and the Sydney Water Corporation all join the CRCFE. The newly established Sydney Catchment Authority subsequently took up the Sydney Water Corporation membership following legislation changes in NSW. NSW Fisheries decided to withdraw from the CRCFE following the move of most of their freshwater staff to Port Stephens.

A number of teams worked hard to develop the new CRCFE research agenda that was presented in our submission and at interview. We were delighted to succeed in our bid, and look forward to building on the foundations we have already established.

Other Activities

During the year, the Lake Eyre community asked me to act as interim chair of the Lake Eyre Basin Coordinating Group. I was happy to help establish the group and find a suitable Chair, Mr Don Blesing. I have now reverted to my role as scientific adviser to the group.

As a member of the Prime Minister's Science, Engineering and Innovation Council (PMSEIC), I was invited to lead a working group looking at dryland salinity in Australia. The group's report has now been published and was presented to the PMSEIC. I am still involved looking at implementation options.

The CRCFE continues to support the CSIRO-BHERT training program on leadership of R&D teams and several staff have completed this program.

In Conclusion

It has been another busy and exciting year for the Centre. Our successes would not have been possible without the wisdom, experience and support of our Board and in particular, our Chair, Dr John Langford.

I would like to thank all the staff and students of the CRCFE for their commitment to complete the research projects. I greatly appreciate the energy, enthusiasm and unfailing good spirits shown by staff and students in the face of many demands, especially during the review and new bid process.

Acronyms used in this report

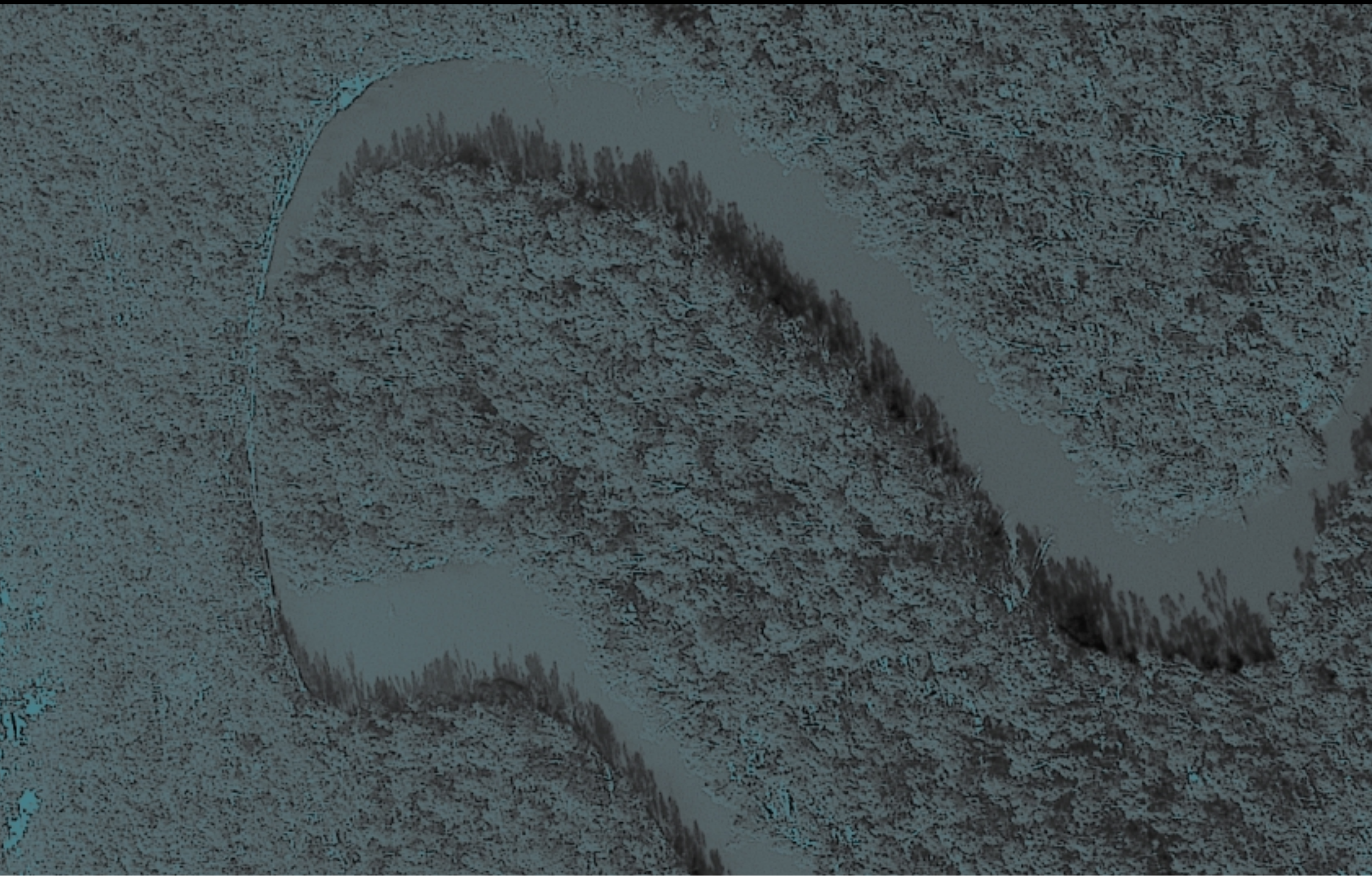
ABRS	Australian Bureau of Resource Science
ACRLGS	Australian Centre for Regional and Local Government Studies
ACTEW	ACT Electricity and Water
ANZECC	Australia and New Zealand Environmental
APA	Australia Postgraduate Awards
ARC	Australian Research Council
ASL	Australian Society for Limnology
AUSRIVAS	Australian River Assessment Scheme
AWQC (SA Water)	Australian Water Quality Centre
AWT	Australian Water Technologies
AWWA	Australian Water and Wastewater Association
CALM WA	Conservation and Land Management, Western Australia
CMA	Catchment Management Authority
CIT	Canberra Institute of Technology
CSIRO	Commonwealth Scientific and Industrial Research Organisation
BHERT	Business and Higher Education Round Table
COAG	Council of Australian Governments
CSU - Riverina	Charles Sturt University Riverina
CRC	Cooperative Research Centre
CRCCH	Cooperative Research Centre for Catchment Hydrology
CRCFE	Cooperative Research Centre for Freshwater Ecology
CRCWMPC	Cooperative Research Centre for Waste Management and Pollution Control
DIST	Department of Industry Science and Technology
DLWC	Department of Land and Water Conservation
DNR	Department of Natural Resources, Queensland
EA	Environment Australia
EPA NSW	Environment Protection Authority, NSW
EPA VIC	Environment Protection Authority, Victoria
ERISS	Environment Research Institute of the Supervising Scientist
FASTS	Federation of Australian Science and Technological Societies

Acronyms

Acronyms , continued

FRDC	Fisheries Research Development Corporation
FRP	Filterable reactive phosphorus
GASS	Great Australian Science Show
GHD	Guthrie, Haskins and Daley (consultants)
IMEF	Integrated Monitoring of Environmental Flows
LBL	Lower Basin Laboratory
LWRRDC	Land and Water Resources Research and Development Corporation
MDBC	Murray-Darling Basin Commission
MDFRC	Murray-Darling Freshwater Research Centre
MDFRC, LBL	Murray-Darling Freshwater Research Centre Lower Basin Laboratory (Mildura)
MRHI	Monitoring River Health Initiative
MW	Melbourne Water
NATA	The National Association of Testing Laboratories
NHT	National Heritage Trust
NRHP	National River Health Program
NRMS	Natural Resource Management Strategy
NSWFRI	NSW Fisheries Research Institute
QDNR	Queensland Department of Natural Resources
RIVPACS	River Invertebrate Prediction and Classification Scheme
SKM	Sinclair Knight Merz
SoE	State of the Environment
TCM	Total Catchment Management
TISA	Taylor Integrated Sampler
UC	University of Canberra
UWRAA	Urban Water Research Association of Australia
UNE	University of New England
UWS	University of Western Sydney
WAMP	Water Allocation Management Plan
WSAA	Water Services Association of Australia
WSC	Water Studies Centre, Monash University

1 Structure and Management



The management of the Cooperative Research Centre for Freshwater Ecology is designed to maximise the strengths of its member organisations. It does this by facilitating collaboration between staff across sites and research programs, and emphasising education, communication and knowledge exchange.

1.1 Membership of the Cooperative Research Centre for Freshwater Ecology

The Cooperative Research Centre for Freshwater Ecology (CRCFE) was formally established in July 1993 under the Commonwealth Government's CRC Program. It is an unincorporated joint venture between:

ACT Government
ACTEW Corporation
CSIRO Land and Water
Environment Protection Authority, Victoria
Goulburn-Murray Rural Water
La Trobe University
Melbourne Water
Monash University
Murray-Darling Basin Commission
Murray-Darling Freshwater Research Centre
NSW Fisheries
Southern Rural Water
Sydney Water Corporation
University of Canberra
Wimmera-Mallee Rural Water

1.2 The Board

The CRCFE is governed by a Board comprising the following members at June 30, 1999:

Dr John Langford (Chairman), Executive Director, Water Services Association of Australia

Professor Peter Cullen, (Director), Professor of Resource and Environmental Science, University of Canberra

Dr Colin Adrian, Executive Director, Environment ACT

Professor Allan Cripps, Dean of Applied Science, University of Canberra

Professor Ron Davies, Dean of Science, Monash University

Mr Ron Dennis, Chief Executive, Albury-Wodonga Development Corporation

Mr Paul O'Connor, Director of Research, NSW Fisheries Research Institute

Professor John Lovering, President, Murray-Darling Basin Commission

Professor Nancy Millis, University of Melbourne

Dr Graham Harris, Chief, CSIRO Land and Water

Mr Ross Young, General Manager, Waterways and Drainage, Melbourne Water

Table 1.1
Attendance at Board Meetings

	11 Sept 98	3 Dec 98	28 May 99	
Dr John Langford	●	●	●	
Professor Peter Cullen		●	●	●
Dr Colin Adrian		●	●	
Mr Peter Burnett	●			
Professor Allan Cripps				●
Ms Anne McMahon		●	●	
Professor Ron Davies			●	
Mr Ron Dennis	●	●	●	
Dr Graham Harris			●	
Dr Richard Davis	●			
Dr Steve Rogers		●		
Professor John Lovering		●	●	●
Professor Nancy Millis		●	●	
Dr Paul O'Connor				
Mr Ross Young	●			
Mr Kevin Wood		●		
Mr Graham Rooney				●

The Cooperative Research Centre: a centre with clear directions. Photo: D Eastburn

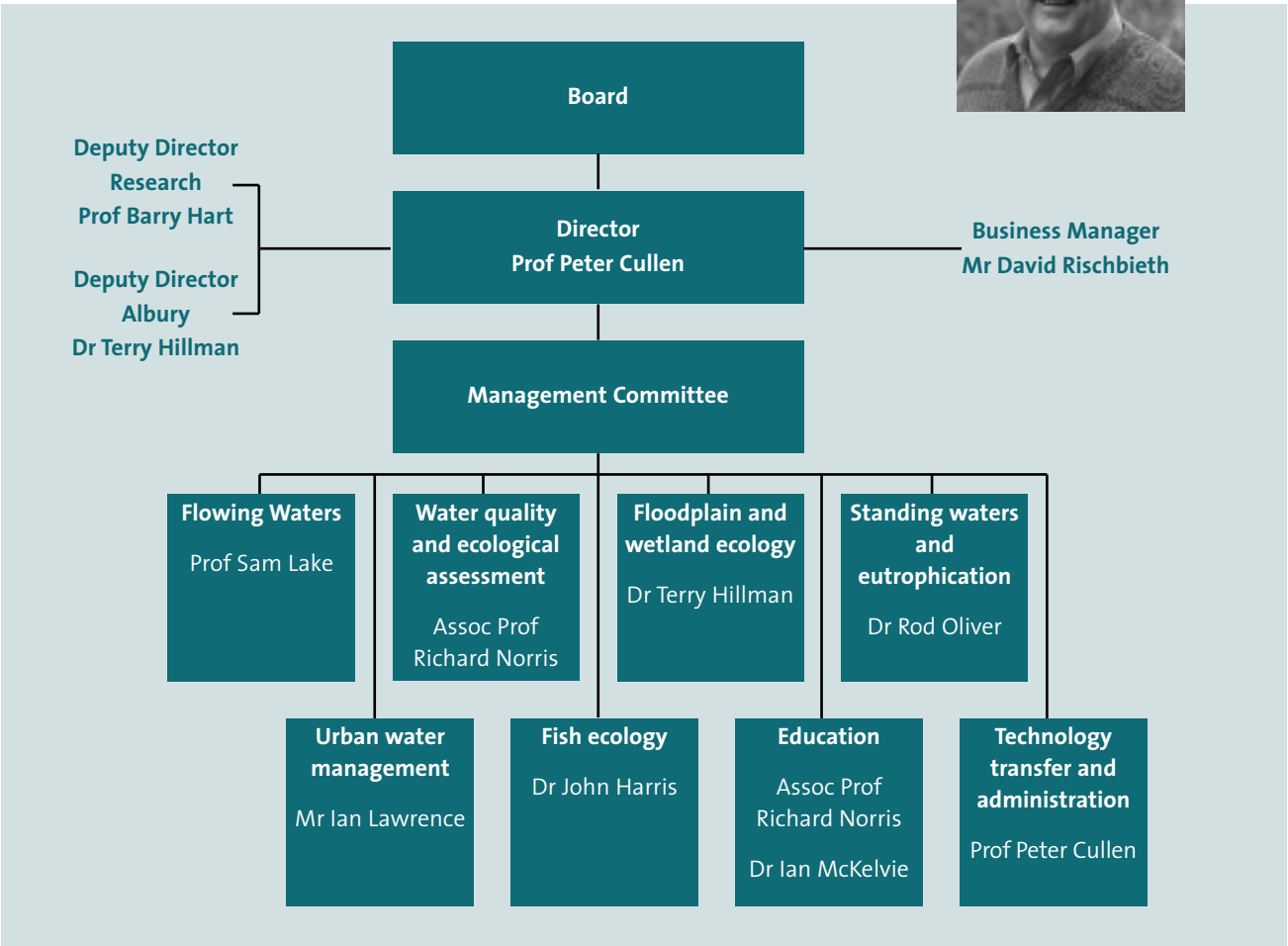
1.3 The Director and Deputy Directors

The Director, Professor Peter Cullen, carries executive responsibility for managing the Centre within the policy framework established by the Board. Professor Barry Hart as Deputy Director is responsible for coordinating and implementing the research program. Dr Terry Hillman as Deputy Director is responsible for managing the two regional laboratories: the Murray-Darling Freshwater Research Centre at Albury and the Lower Basin Laboratory at Mildura.

The Director, Deputy Directors and Business Manager form the CRCFE's Executive Committee.

Deputy Directors of the CRCFE, Prof Barry Hart (left) and Dr Terry Hillman Photos: K Markwort

1.4 Organisational structure



1.5 Research Programs

The Centre's six research programs are:

1 Flowing Waters
2 Standing Waters and Eutrophication
3 Water Quality and Ecological Assessment
4 Floodplain and Wetland Ecology
5 Urban Water Management
6 Fish Ecology

For details of the Centre's new Integrated Project Portfolio, please see chapter 3, *Research Programs*.

1.6 Working groups

Taxonomic Steering Group

The role of this committee is to coordinate and promote taxonomic activities within the CRCFE. Membership:

Dr Richard Marchant, Museum of Victoria (Chair)
Mr John Hawking, MDFRC
Dr Jane Growns, MDFRC
Ms Alena Glaister, Monash University
Assoc Prof Richard Norris, University of Canberra

Gibraltar Falls, ACT. The CRCFE exists to improve the condition of Australia's rivers, lakes and wetlands. Photo: K Markwort

The group organised the 11th annual taxonomic workshop at the Murray-Darling Freshwater Research Centre and produced seven new identification guides. The taxonomic workshop has become a major venue for disseminating taxonomic information to a wide range of non-specialist users. Taxonomic research and knowledge plays a crucial role in the CRCFE's research.

Sediment Working Group

The Sediment Working Group advises the Director of the CRCFE on:

a. the techniques and approaches for the study of sediment-nutrient interactions and
b. the coordination of sediment research activity across the programs.

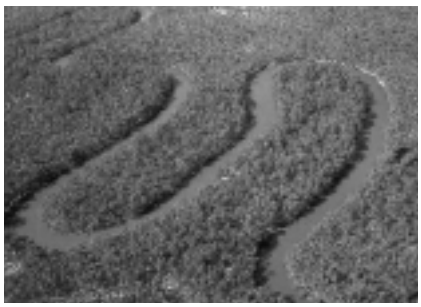
Membership:
Assoc Prof Bill Maher, University of Canberra (Chair)
Dr Ron Beckett, Monash University
Dr Darren Baldwin, MDFRC
Mr Ian Lawrence, ACT Government

The Sediment Working Group liaised closely with and provided technical support to the Integrated Project 'Sediment Nutrient Processes'.

Associate Projects Committee

The Associate Projects Committee advises the Management Committee on whether to accept a project that has been submitted as in-kind research.

Professor Sam Lake took out the Chairman's Award, presented by John Langford at the annual staff meeting. The Award recognises significant contributions to the Cooperative Research Centre for Freshwater Ecology. Photo: K Markwort



The River Murray flowing between the Barmah and Millewa Redgum Forest, Victoria. Each section of the river requires different management methods.
Photo: D Eastburn

Membership:
Dianne Flett, University of Canberra (Chair)
David Rischbieth, MDFRC
Sam Lake, Monash University
Terry Hillman, MDFRC
John Harris, NSW Fisheries

This committee meets two - three times a year to review all new in-kind research projects being undertaken by CRCFE researchers. The committee also reviews additions to existing in-kind projects and post-graduate projects. The committee only looks at new work; it does not consider the progress of existing projects, which are reviewed by the Management Committee and the Board.

1.7 Fifth Year Review

The first stage of the CRCFE's 5th Year Review was conducted at the Murray-Darling Freshwater Research Centre in Albury during August 1998. The panel included Prof Gene Likens from the Institute of Ecosystem Studies in New York; Prof Colin Townsend from the University of Otago, New Zealand; and Mrs Christine Forster from the Victorian Catchment Management Council. Algologist, Dr Barbara Bowles, the CRCFE Visitor, attended the review as an observer.

The panel reviewed progress across all programs against the Centre's performance indicators and the milestones set out in the Commonwealth Agreement. It also reviewed the implementation of the Third Year Review Stage One recommendations.

The panel was impressed with the presentation of the research program based on the three themes: Flow related ecosystem processes; Nutrient dynamics and eutrophication; Ecological assessment. This, the panel commented, reflected a high level of integration among the research projects and teams brought together by the CRCFE.

The panel commended the CRCFE's new research portfolio and its research capabilities.

The panel also looked at aspects of the Centre's Education Program and interviewed a number of the Centre's postgraduate students. It noted the cohesion of the post-graduate group and stated that it was impressed by the range and scope of the program.

The second stage of the Review took place at the CRCFE's University of Canberra laboratory during September 1998. The panel for the second stage of the Review was Professor Graeme Kelleher, Dr Sue Meek and Mr Peter Millington.

The Panel heard presentations on the management of the Centre, the communications and technology transfer activities as well as the Education Program. The Panel also met with groups of researchers and postgraduate students.

The Panel were impressed with the strong collaborative nature of the Centre. They commended the professionalism of its project management and communications activities. They were also impressed with the Centre's cutting-edge technology transfer activities.

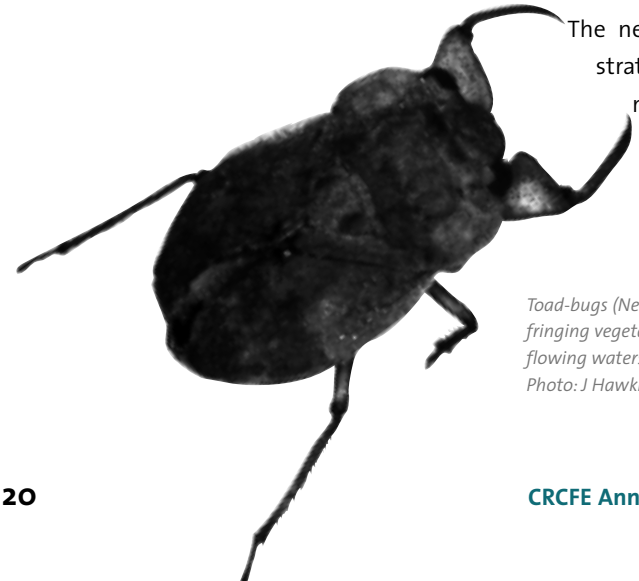
Overall, the Centre was rated very highly by both Panels.

1.8 Rebid for a New Cooperative Research Centre for Freshwater Ecology

The CRC for Freshwater Ecology's submission for a further seven years funding was delivered to the CRC Secretariat on September 29, 1998. This followed an extensive process to develop a high quality proposal. The Re-bid Committee, comprising existing Board members and representatives of interested new parties, met on several occasions, and together with researchers put together the basis for the proposal. 18 agencies participated in the successful bid. They included: the University of Canberra, the Murray-Darling Basin Commission, the Queensland Department of Natural Resources, Griffith University, NSW Department of Land and Water Conservation, the Environment Protection Authority (NSW), Environment ACT, ACTEW Corporation, CSIRO Land and Water, Monash University, the Environment Protection Authority (Vic), La Trobe University, the Victorian Department of Natural Resources and Environment, Lower Murray Water, Sunraysia Rural Water, Goulburn-Murray Water, Melbourne Water and the Sydney Catchment Authority.

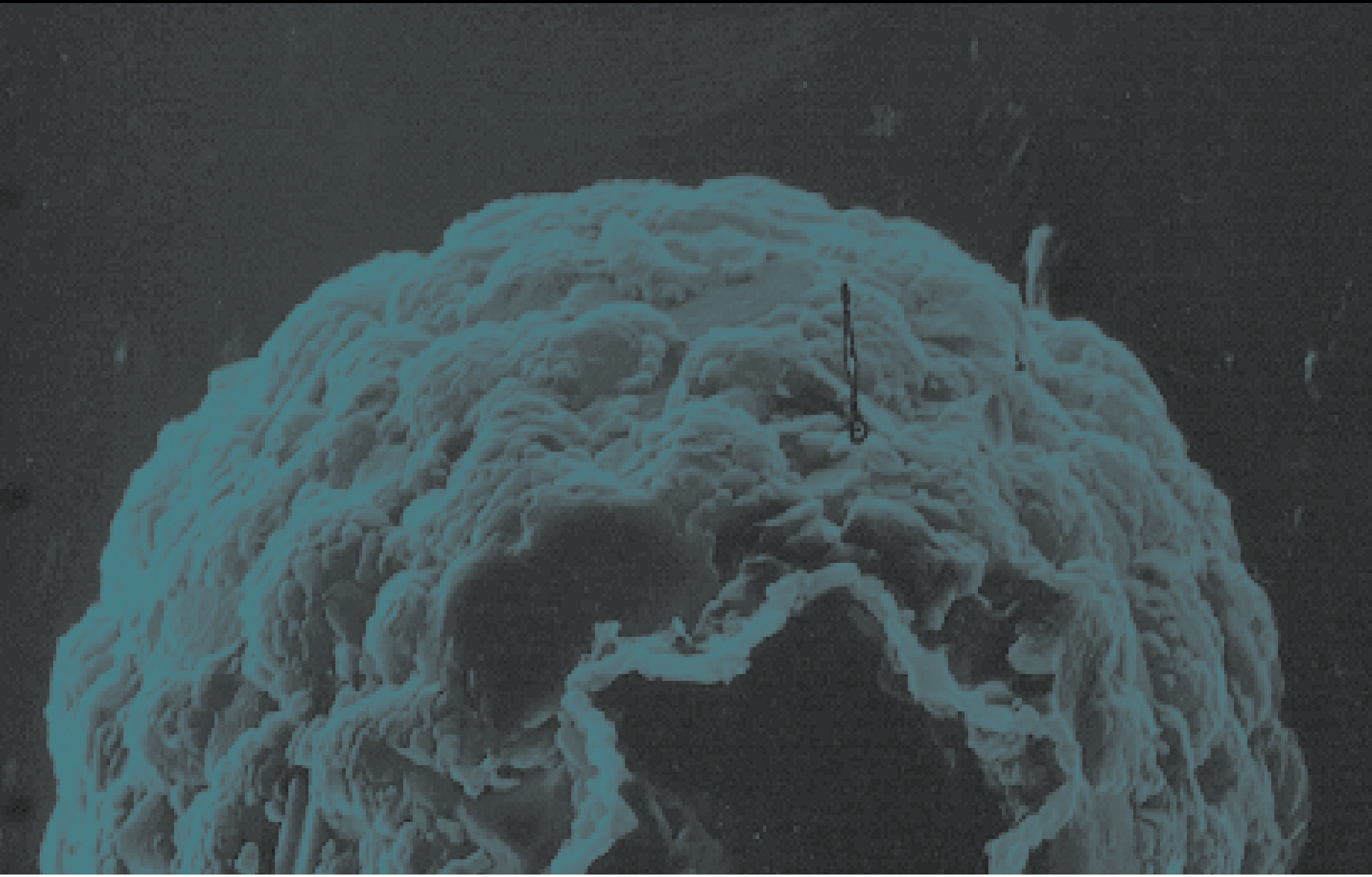
An interview was held during February 1999 before a Panel comprising Professor Graeme Kelleher, Dr John Keniry and Dr Jim Miller. In April 1999 the CRC was informed that it was one of 26 successful CRCs to be funded for a further 7 years. A combined meeting of the 'old' and 'new' Board was held on 28 May to begin the process of setting up the new CRCFE. This was followed by a busy period preparing the two official contracts: the Commonwealth Agreement signed by all parties plus the Commonwealth Government, and the Joint Venture Agreement, signed by all parties.

The new CRCFE will commence in July 1999, starting off with a strategic planning process to define the CRCFE's business over the next seven years.



Toad-bugs (Nerthra sp.) are found amongst fringing vegetation and detritus of still and flowing waters, and on muddy banks. Photo: J Hawking

2 Cooperative Links



Cooperative Links

The Cooperative Research Centre for Freshwater Ecology (CRCFE) is committed to achieving cooperation in all facets of its work. It recognises that collaboration and integration is fundamental to achieving its outcomes and has established strong links:

- Across CRCFE sites and disciplines
- With its fifteen member organisations
- With researchers outside the CRCFE
- With the CRC for Catchment Hydrology and the CRC for Water Quality and Treatment.

2.1 Internal cooperation

The CRCFE works hard to ensure that cooperation occurs between its six research programs and across its nine different sites. The following internal structures and activities are in place to facilitate this internal cooperation:

The Upper Snowy Expert Panel assessing flow requirements of the upper Snowy River below Munyang Power Station. Photo: J Harris

J Dean from EPA Victoria, C Humphrey from ERISS, with Cain and Peter, Rangers from the Djelk Community, sampling macro-invertebrates in Central Arnhem Land, NT. The Djelk Community Rangers are a special interest group within the Bawinanga Aboriginal Corporation with a strong connection to the Blyth-Liverpool wetlands. They are developing a wetland management plan. Photo: J Hawking

Table 2.1
Activities fostering internal collaboration

Activity	Function	Frequency
Staff meeting	Sharing and updating of information and knowledge in both a structured and social environment	Annual
Board meetings	Set CRCFE policy and direction. Ensure that activities meet the Centre's stated objectives	Three times a year
Executive meetings	Review progress of the CRCFE in terms of outcomes. Provides implementation plans on new initiatives as determined by the Board	Monthly
Management Committee	Review progress and revise activities accordingly. Act on policies set by the Board.	Quarterly
Program meetings	Review progress, develop plans and facilitate communication across sites. Consolidate project progress for feedback to the Management Committee and to the Board.	Half-yearly, depending upon need
Integrated Research Portfolio	The new research portfolio emphasises collaboration. Projects within this portfolio are multidisciplinary, involving researchers from different CRCFE sites. Project meetings are held regularly to coordinate and implement the research strategies.	Approx bimonthly, depending upon individual project
Watershed	Internal and external newsletter. In depth reporting of research issues. Readership of 3,000 includes land and water management organisations, government representatives, politicians, researchers, fishing clubs, journalists, other relevant CRCs, community groups.	4-6 times per year
Ripples	Internal newsletter. Informs staff and students of CRC activities and findings. Also provides information on water research in the wider scientific world.	Fortnightly

Table 2.1 continued

Activity	Function	Frequency
Project management	Project manager reviews progress and facilitates feedback to both the Management Committee and the Board.	Daily contact
Working groups	To advise Management and the Board on initiatives and directions for specific disciplines and operations. Facilitates cross-site and cross-program collaboration	As need dictates
Research working groups	Developing future research directions for a new life of the CRCFE. Nine working groups have been established with cross-site and cross-program representation.	As need dictates
Environmental flows working group	Representatives from a number of CRCFE sites drew together the activities conducted by the Centre in this area and to summarise our knowledge.	Several meetings throughout the year
Lotus Notes database	All CRCFE sites are now connected with each other electronically and may communicate via email and the World Wide Web. Lotus Notes, a projects management system, facilitates reporting and collaboration. It also keeps staff and students informed of CRCFE activities.	Ongoing
Seminar series	Each CRCFE site runs a seminar series, hosted by the parent organisation in collaboration with the CRCFE. These seminars enable staff and students to present their work to peers, including external researchers. Guest speakers also offer seminars.	Weekly or fortnightly, depending on site
Travel budget	The Centre maintains a budget to facilitate travel between sites.	Set on an annual basis

The exchange of knowledge between the Centre and Aboriginal Rangers in the Northern Territory is invaluable for both parties.

2.2 Cooperation with partners

Sharing of facilities

The Centre's new research portfolio emphasises cross-project and cross-site links. As a result, a number of projects share field sites and equipment. This not only reduces costs, but also ensures researchers are kept informed of activities in other projects. Staff and students have access to the following facilities across research sites:

- Experimental billabongs - Albury
- Chemistry laboratories - Albury, Canberra, Melbourne
- Instrumented water pollution control ponds - Canberra
- Ponds - Narrandera
- Curated flora and fauna collections - Canberra, Albury
- The NSW Fisheries electrofishing boat has been used for monitoring work on the Environmental Flows project being conducted from the MDFRC, Albury.
- The CRCFE in Canberra is using the MDFRC's chemical facilities to analyse samples gathered from work in the Snowy Mountains. It also shares chemical laboratory facilities with the Faculty of Applied Science at the University of Canberra.

ACT Government

The CRCFE and Environment ACT ran a one day course for ACT Landcare coordinators on catchment management at the University of Canberra, May.

Peter Cullen has undertaken the following activities for the ACT Government:

Chaired the assessment panel for the Natural Heritage Trust and ACT Environment grants, 11-12 May.

Facilitated a half day workshop on Environmental Flows in the ACT, 4 February.

Attended a meeting of the ACT Science & Technology Council, 30 July.

Attended meetings of the ACT Environment Advisory Committee and the Gungahlin Development Authority during the reporting period. Chaired an Environment Advisory Committee Meeting, 15 February.

Attended 3 meetings of the Gungahlin Development Authority, 18 February, 18 March, 15 April.

Chaired sessions and presented papers to the States Science and Technology meeting, 26-27 November.

Richard Norris has undertaken the following activities for the ACT Government:

Attended a meeting of the ACT Flora and Fauna Committee as a representative on water, 26 August.

Ran a 1 day workshop on AUSRIVAS assessment methods for community groups on behalf of ACT government, 20 January.

Ian Lawrence has undertaken the following activities for the ACT Government:

Provided advice and support on the drafting of ACT Environmental Flow Guidelines for Environment ACT

Provided advice and support on the upgrading of Tidbinbilla Nature Reserve Wetlands for Environment ACT

Provided advice and support on the drafting of Canberra Urban Lakes & Ponds Management Plan for ACT Dept Urban Services

Convened Urban Stormwater Management Workshops (2) for ACT Stormwater & Roads Branch and ACT Development Branch

Membership of Steering Group on drafting of ACT Integrated Catchment Management Plan.

Attended a meeting of the ACT Environmental Flows Working Group.

Dr T Hillman and F Smith studying aquatic insects in artificial billabongs. Photo: K Markwort

Martin Thoms assisted on a technical committee evaluating a fisheries restoration project for the ACT Government. A field visit was undertaken with Mark Lintermans, January.

ACT Electricity and Water Corporation (ACTEW)

Peter Cottingham and Ian Lawrence met with ACTEW to discuss knowledge exchange, September.

Peter Cottingham organised a workshop on the role of Nitrogen in waterways for ACTEW, Environment ACT and NSW EPA.

CSIRO Land and Water

Peter Gehrke established cooperative links with CSIRO Environmetrics unit to examine changes in river flow regimes.

Peter Cullen made a presentation to new CSIRO Project Leaders on Collaborative Models, July. Peter also attended a priority setting meeting at CSIRO Headquarters, November.

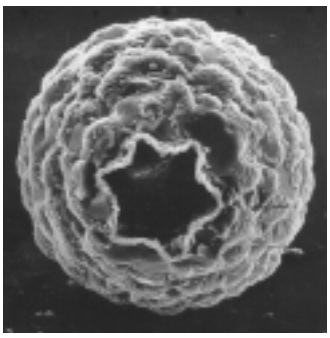
Senior CRCFE research staff met with Dr Richard Davis, Program Leader, Urban and Rural Water Management Program, CSIRO Land and Water and Dr Jon Olley, Project Leader, Environmental Hydrology to discuss cooperative links and water issues, June.

Senior CRCFE research staff met with Dr John Williams, Deputy Chief, CSIRO Land and Water, to discuss cooperative links and tour the laboratory, July.

Rhonda Sinclair participated in the Land and Water Communications Group meeting via a teleconference, July. Rhonda also provided input into InterActions, the group's newsletter, July and August editions.

The CRCFE hosted a visit by senior CSIRO Land and Water staff for a review of projects within the 'Riverine Ecology Project' within the Urban and Rural Water Management Program, September. Those attending were:

- Graham Harris (Chief)
- John Williams (Deputy Chief)
- Richard Davis (Program Leader: Urban and Rural Water Management)
- Chris Thurlow (Business and Operations Manager)
- Steve Rogers (Executive Assistant to the Chief)



An algae-eating rotifer that lives in billabongs, Brachionus novaezealandiae.
Photo: R Shiel

Darren Baldwin attended the Urban and Rural Water Management Research Group Leaders meeting, November.

A joint CSIRO, North East Catchment Management Authority and Murray Catchment Management Committee meeting was held at MDFRC to discuss the projects under the banner of 'Land Stewardship'. Towards the end of the meeting, discussion focussed on collaboration between the various players involved, December. A follow up meeting was convened in March.

Terry Hillman attended the Program Leaders' and Research Group Leaders' Planning Workshop (December) to discuss the sector priorities for the next triennium. Terry has also provided advice on the CSIRO Land and Water Sector Plan.

Terry Hillman attended an Urban and Rural Water Management meeting, March.

Terry Hillman is a member of the Organising Committee for the Biodiversity Conference to be held in Australia in April 2001. The Organising Committee consists of CSIRO staff from the Wildlife and Ecology, Entomology, Land and Water, Plant Industry, and Marine Divisions.

Environment Protection Authority, Victoria (EPA)

Peter Breen participated in a workshop on water and waterway research and management with visiting US scientist Professor James Perry, August.

Chris Walsh, Peter Breen and John Gooderham helped to develop an Urban RIVPACS model with EPA Victoria and the Museum of Victoria.

Peter Cottingham presented a technology transfer workshop to the EPA. The workshop was designed to assess the preferred type and form of information the EPA requires from the CRCFE.

Barry Hart attended a meeting of the EPA Scientific Advisory Committee, October.

Peter Cottingham met with the EPA to establish knowledge exchange links, July.

Goulburn-Murray Water (GMW)

Peter Breen participated in a Research and Development foresighting workshop for Goulburn- Murray Water, August.

Paul Humphries attended a Natural Resources Management Seminar, organised by GMW, June.

A number of CRCFE staff members attended the 1998 Jonathan Mann Memorial Lecture, 'Sharing the Murray: Sustainability and Providing Greater Certainty and Choice for Water Users', presented by Denis Flett, Chief Executive of GMW.

Ian Lawrence and Rod Oliver provided advice on Eildon Reservoir monitoring with SKM Melbourne.

Peter Breen, Ian Lawrence and Tony Wong participated in a workshop on the Use of Ponds and Wetlands for Stormwater Management, March.

La Trobe University

Terry Hillman attended the Regional Board meetings of the University in June and October and the graduation ceremony in March.

La Trobe University, together with DNRE, ID&A and the Wangaratta Centre for Adult Education Inc. held a short course in Stream Management Principles and Practices entitled 'Wise Water Ways'. Terry Hillman delivered the welcoming address and spoke at a Stream Ecology (macroinvertebrates) session. Over 50 people attended the course,18-22 October.

Melbourne Water

Chris Walsh, Jason Sonneman and Peter Cottingham participated in a review of the Melbourne Water and EPA biological monitoring programs.

Peter Cottingham prepared a briefing paper on heavy metals in waterways for Melbourne Water, March-April.

Peter Cottingham assumed responsibility for implementing the Melbourne Water Waterway and Environment technology transfer plan.

Peter Cottingham participated in a workshop on the Water Group and the Yarra Operations for Melbourne Water.

J Harris and J Matthews from NSW Fisheries gearing up to test drift-diving techniques as a survey method for eastern cod. Photo: NSW Fisheries

Dr P Newall sampling a Victorian stream for macroinvertebrates. Dr Newall is a CRCFE scientist from the EPA, Victoria. Photo: EPA, Victoria

Peter Cottingham met with representatives from Melbourne Water - Water Group to discuss knowledge exchange.

Peter Cottingham met with Melbourne Water representatives to consolidate the content of the Stormwater Management Course, October. Peter Breen also presented on this course.

Peter Cottingham organised a two-day field trip on Dandenong Creek. The field trip enabled Melbourne Water staff to collaborate with researchers from the CRCFE and CRCCH on how the environmental health of the stream could be improved. The field contingent featured a mix of disciplines (ecology, engineering and planning) and included Terry Hillman and Peter Breen (CRCFE), Tony Wong (Monash University, CRCCH) and Melbourne Water staff, December.

Peter Cottingham attended a workshop on ERAPSM (risk assessment model) at Melbourne Water, October.

Peter Breen and Prof. Tony Wong delivered the CRCFE/CRCCH Short Course on Stormwater Management to Melbourne Water Corporation, Monash University, 1-3 Dec. 98 and 1 May-1 June 99.

Peter Breen is involved in the Melbourne Water NHT Project *Port Phillip Bay Stormwater Quality Improvement (Coasts & Seas Program):*

Working Group meeting, January.
Works design meeting, February.
Wetland Concept Design Workshops, March.
Working Group meeting, April.

Peter Breen participated in the Melbourne Water Yarra Operations, Yarra River Stream Flow meeting, February.

Peter Breen participated in workshops to evaluate outputs from the CRCCH catchment load model FILTER and to develop remedial action scenarios for priority catchments identified using the FILTER model, April and May.

Murray-Darling Basin Commission

Peter Cullen attended meetings of the CAC MDBC, July, February.

The MDFRC's 'Review 1986 - 1997' has been completed and was discussed at the MDBC Meeting No. 48 in September. A small display of Technical Reports prepared by the CRCFE were also displayed.

Terry Hillman has been appointed a member of the Steering Committee for MDBC Project I8008 'Waterlines: Studies in Irrigation in the Basin'. The inaugural meeting was held at Narrabri in July.

Karen Markwort met with the Commission's Director, Natural Resources Evaluation and Communications, Rosemary Purdie, to discuss cooperative links.

Terry Hillman presented a paper on the 'Billabong-River interactions during floods' at the 4th Riverine Environment Research Forum, October.

Terry Hillman has been elected a member of the MDBC Riverine Issues Working Group, March and May.

Peter Cottingham led a scoping study by the CRCFE for MDBC. The project also involved Richard Norris.

Mike Copland presented to the MDBC Irrigation Conference, Tatura.

Mike Copland provided information and advice to participants in Special Forever, MDBC, Canberra.

Sydney Water Corporation

Peter Cottingham and Ian Lawrence presented a technology transfer workshop to assess the preferred type and form of information the Sydney Water requires from the CRCFE.

Peter Cullen and Terry Hillman facilitated a Workshop at Wingecarribee Swamp to further develop the Wingecarribee swamp trials program. The aim of the workshop was to establish a program of trials to augment the ongoing and long-term management of the swamp, April.

University of Canberra

John Whittington presented two lectures to Undergraduate Students, one on Eutrophication and the other on Chaffey Dam, August.

Dr Martin Thoms brought about 30 2nd year students from the University of Canberra course 'Catchment Processes' to the Centre in September. A number of staff from the Centre provided field and laboratory technical assistance for the group.

Peter Cullen gave the Graduation address on 18/12/98 in the Great Hall of Parliament house. Meredith Walton took out her degree at this graduation.

Peter Cullen participated in a two day Policy Workshop at Peppers Mt Broughton organised by Prof Bob Kearney and the Bureau of Resource Science. The aim of the workshop was to explore the interface between policy and science.

2.3 External cooperation

The CRCFE actively collaborates with more than 70 external organisations, including research funding bodies, universities, federal government departments and agencies and state government departments and agencies.

Professional organisations include – Australian Society for Limnology (ASL), Australian Water and Wastewater Association (AWWA), Federation of Australian Science and Technological Associations (FASTS), Australian Science Communicators (ASC), the Australian Society for Fish Biology, the Royal Australian Chemical Institute, Australian Academy of Science, Academy of Technological Sciences, Australian Biological Resources Study.

Community organisations include – Murray-Darling Association, Landcare, The Australian Conservation Foundation, Streamwatch, Water Watch, Albury Rotary Club, Lake Eyre Catchment Advisory Group, Murray-Darling Basin Community Advisory Committee, National Parks Association, Total Catchment Management Groups, other Rotary and Apex Clubs; Angling clubs, University of the Third Age, Renmark Irrigation Trust, Salt Action Groups, Probus Clubs.

Affiliates of the CRCFE

The CRCFE Affiliate Scheme was established to formalise links with researchers who are working with Centre Staff either in CRCFE projects or in other associated ways. There are now ten CRCFE affiliate members.

A Memorandum of Understanding has been signed with the University of Adelaide.

Links with other CRCs

The CRCFE is an active member of the CRC Program community.

- The CRC Association
  Four staff members attended and participated in the CRC Association's Annual Conference in March.

- The CRC Water Forum
  The Water Forum is comprised of the CRCFE, the CRC for Water Quality, Treatment, the CRC for Catchment Hydrology and the CRC for Waste Management and Pollution Control. The Forum meets quarterly to identify and implement joint programs and promotional activities.

- The CRC for Catchment Hydrology
  The CRCFE works collaboratively with the CRCCH on joint research conducted within the CRCFE's Urban Water Management program and the Campaspe environmental flows project. The CRCFE participated in the CRCCH's research agenda workshop.

The Murray Bridge-Onkaparinga pipeline is one of three pipelines that take water from the lower Murray to supplement Adelaide's supplies. Photo: D Eastburn

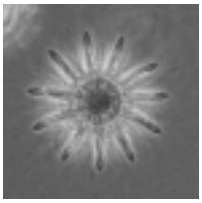
Dr John Langford is the independent chair for both the CRCFE and CRCCH

Collaborative links with other universities and government departments

In addition to its partner universities and government departments, CRCFE staff and students are collaborating widely with staff and students from universities and departments throughout Australia and the rest of the world. These collaborations, often wholly or part funded by the CRCFE, facilitate the exchange of ideas and ensure that staff and students are contributing to and participating in the international science and water industries.

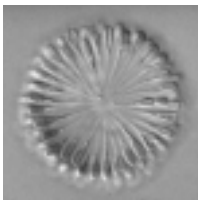
Table 2.2
Government Visitors

Visitor	Institution	Activity	CRC Centre visited
Senator Meg Lees	Leader of the Australian Democrats	Discussions with Terry and senior research staff and a brief tour of the laboratory	Murray-Darling Freshwater Research Centre
Senator Ian MacDonald	Parliamentary Secretary for the Environment	Launched two publications (not CRCFE) and then toured the laboratories and conversed with Paul Humphries (Campaspe), Darren Baldwin (Chaffey) and John Whittington (Floodplains and Chaffey)	Murray-Darling Freshwater Research Centre
Mrs Catherine Murphy	The Prime Ministers Science and Technology adviser	Visited for discussions about the CRC	CRCFE at University of Canberra
Mr Peter Cosier	Senator Hill's Office	Discuss the CRC view on how the activities in the States under the COAG reform might lead to useful environmental outcomes	University of Canberra



Helicopters were used to take CRCFE teams into remote sites in the upper Tooma River gorge, NSW. Photo: J Harris.

Griffith, a rural centre in southern NSW, was designed by American architect Walter Burley Griffin. Photo: D Eastburn



2.4 International activities

Table 2.3
Research Collaborations

CRCFE Member	Activity	Links
Dr R Beckett	Visited as leader of the Analytical Chemistry Subprogram of the Thai-Australia Science and Engineering Assistance Program (TASEAP)	Thailand
	Presented a workshop on Separation Science and Chromatography with G Jordan (Swinburne Uni Technology)	Thailand
	Presented a workshop on Atomic Absorption Spectrometry with J Schulze (Swinburne Uni Technology)	Thailand
Prof P Cullen	Attended the *Eighth Cary Conference* Institute of Ecosystem Studies	New York
Assoc. Prof. A Georges	Is collaborating with Professor Brad Shaffer on population genetics of freshwater turtles - impact of glaciation on patterns of population differentiation	University of California
Prof. B Hart	On sabbatical with Gene Likens	Institute of Ecosystem Studies, New York
Prof. S Lake	Collaborating in a project on the ecological dynamics of temporary Mediterranean streams	University of Vigo and the University of Palma, both in Spain
Assoc. Prof. R Norris	Participated in the New Zealand Macro-invertebrate Working Group.	Wellington, New Zealand
	Is part of a research team led by Professor Dave Allan, Ann Arbor undertaking a project on river assessment and rehabilitation	Michigan State University
	Collaborating with Professor Colin Townsend assessing spatial scales and invertebrates in the Taireri River	University of Otago, New Zealand
	Is co-authoring a book on the use of modelling approaches for assessment of water quality	Trefor Reynoldson (Canada Centre for Inland Waters) and Robert Bailey (University of Western Ontario)

Table 2.3
continued

CRCFE Member	Activity	Links
Assoc. Prof. R Norris	Invited as the keynote speaker to open the Environmental Indicators conference	Dunedin, New Zealand
Assoc. Prof. R Norris and J Coysh	Met with Eric Pyle about trialing the use of AUSRIVAS in New Zealand	New Zealand Ministry for the Environment
	Met on an AUSRIVAS pilot study on NZ data and other indicators	New Zealand Ministry for Environment and representatives of most NZ councils and NIWA (National Institute for Water and Atomospheric Research)
Dr R Shiel	Undertaking microfaunal consultancies or collaborative work with a range of national and international groups	University of Gent, Belgium; Netherlands; Academy of Sciences, Moscow; Institute of Zoology, Kosice; National University, Pusan; University of Waikato, New Zealand; Dartmouth College, Hanover; Charles University, Czech Republic; San Diego State University, USA; Milan, Italy; University of Hawaii, USA; University of Texas, USA and University of the Western Cape, South Africa
	Visited Dr L May to discuss collaborative work on Rotifera.	Institute for Freshwater Ecology, Penicuik, Scotland.
	Serving on the scientific advisory committee for the IXth International Rotifer Symposiu.	Thailand
	Project on the Salton Sea	University of California, San Diego
Assoc. Prof. M Thoms	Presented a seminar to the Southern African Ecological Society	Johannesburg
G Wilson	A collaborator on the international FishBase project	International Centre for Living Aquatic Resources Management, Manilla, The Phillippines

Table 2.3
continued

CRCFE Member	Activity	Links
Prof. B Hart and Assoc. Prof. M Thoms	Visited as part of the Metsi Consultants team conducting an in-stream flows assessment for the Lesotho Highlands Development Authority	Lesotho
Prof. B Hart, Assoc. Prof. R Norris, Dr P Davies, Dr C Humphries and J Simpson	Field trip to the Brantas River, and then ran a planning workshop in Surabaya Attended a Project Steering Committee meeting Contributed to a 1 day Bioassessment Seminar Ran a 3 day workshop on modelling aspects of the AUSRIVAS method	Surabaya, ITS, University of Brawijaya, Malang, Brantas River Indonesia
M Grace, S Sdraulig, Dr C Walsh and J Gooderham	Targeted Institutional Links (TIL) project - *Australian - Indonesia TIL Project - Environmental Science (Water Quality and Waste Treatment)* Ran an 8 day Water Quality and Ecological Assessment workshop	CRCFE (Monash University), Swinburne University of Technology, Institute of Technology Bandung, and Jember University, Indonesia Jember University, Indonesia
Prof. B Hart, Dr M Grace, J Gooderham, I Fraser, J Sonneman and G Beattie	Attended the TIL International Water Quality and Waste Management Symposium	Lombok, Indonesia
G Wilson and Dr Jill St.John	Providing advice on wild grouper populations for a project - Replenishment of wild grouper populations through hatchery rearing	Seikai National Fisheries Institute, Nagasaki and Okinawa, , Japan
Dr R Beckett, Dr I McKelvie and Dr K Grudpan	Workshops on Water Sampling and Analysis	Chang Mai University

Table 2.4
International visitors

Visitor	Institution	Activity	CRC Centre Visited
Prof. Brian Davies	South Africa	Presented a seminar and held discussions with Martin Thoms and Peter Cullen	University of Canberra
Mr Michael Dunbar	Institute of Hydrology, Centre for Ecology & Hydrology in the UK	Presented a seminar and discussed Environmental flows issues with Centre staff	MDFRC
Dr Shihua Fan	Institute of Applied Ecology, Shenyang, China	Working on FIA techniques for detection of peroxids and inositol phosphates	Monash University
Dr Stuart Findlay		To apply exoenzyme techniques to a range of aquatic samples of local interest and to develop procedures to apply the exoenzyme techniques to sediments	Albury
Prof. Charles Goldman	University of California, USA	Presented a seminar of emerging water quality problems	MDFRC
Dr John Green	University of Waikato, New Zealand	Working on ephemeral floodplain pools in the upper Murray catchment	MDFRC, September until July
Dr Chris Harfoot	University of Waikato, New Zealand	Working on the distribution of anaerobic photographic bacteria in wetlands	MDFRC
Dr Peter Keay	University of Luton, UK	Presented a seminar and discussed potential collaboration in micro-FIA development	WSC Monash University
Dr John Langley	Middlesex University, UK	Working on microfaunal recruitment into mesocosms	MDFRC
Dr James Perry	University of Minnesota, USA	Presented a seminar on environmental management	MDFRC
Prof Jim Warren	Monash Sunway Campus, Malaysia	Discuss possible research links with the CRCFE	Monash University

Table 2.4
continued

Visitor	Institution	Activity	CRC Centre Visited
Drs Claudia Ricci and Giulio Melone	University of Milan, Italy	Presented a seminar and working on rotifers and resistance to environmental stress	MDFRC
Dr Marcelo Alberto Danker, Director of the Campomar Foundation	Institute for Biochemical Research, Buenos Aires Agriculture and Biotechnology	The visit organised by the Australian Academy of Technological Sciences and Engineering	University of Canberra
4 delegates	Brawijaya University, LIPI, Limnology, Bapedalda EJ, ITS, Indonesia	A follow-up visit of people involved in the Ausaid study that is testing the applicability of AUSRIVAS biological assessment methods in Indonesia	University of Canberra, Monash University
A delegation of scientists	Malaysian	Discuss CRCs and research policy	University of Canberra

The snail, Glyptophysa gibbosa *grazes on water plants. Well camouflaged, they can be found amongst weed and algae of slow-flowing rivers, billabongs and lakes. Photo: J Hawking*

3 Research Program

The CRC for Freshwater Ecology undertakes research within six programs under four over-arching ecological themes. PhD research projects have made major contributions to research in all program areas. These projects are listed under Chapter 4, *Education and Training*.

During the past year, the CRCFE has benefited from the results being obtained in the new integrated projects developed during 1997/98. The latter half of 1998 saw the continuation of research development as ideas were put together for the proposal for a renewed Centre. With the approval of CRCFE II in April 1999, these research ideas were condensed into Schedule I for the Commonwealth Agreement. This contract sets out the research directions for the new Centre, commenced in July 1999.

The new research portfolio, outlined in Schedule I, has built on the research development undertaken during 1997/98. The new Centre will have research programs largely reflecting the research themes used in CRCFE I and outlined in the following chapter – they are, *Flow-related Ecosystem Processes, Restoration Ecology, Conservation Ecology and Water Quality and Ecological Assessment*.

Ibis at Lake Cowal-Wilbertoy Wetlands, NSW
Photo: W Lawler, NPWS

Dog rose, Bauera rubioides
Photo: J Hawking

Research Themes

Ecological assessment

Resource management and environmental protection agencies have an increasing need for high quality information relating to the ecological effects of their operations. Most river management agencies in Australia are moving towards more ecologically based management. However, there have been few useful techniques available that can be rapidly employed to assess the effectiveness of management processes. There is now renewed interest in the use of more qualitative techniques, primarily because of the high cost of quantitative approaches. The CRC for Freshwater Ecology is developing innovative methods for assessing river health particularly using macroinvertebrates, fish, microbes, algae and habitat.

Energy and nutrient dynamics

This research theme addresses a range of key processes in aquatic ecosystems. In its broadest terms it incorporates questions concerning the major sources of energy and nutrients in different aquatic systems, the flux of these resources through different components of the systems, their impact on trophic structure and food web inter-connections and the resulting changes in population dynamics and alterations in community structure.

Water regime and allocation

The extreme variability of rainfall in non-tropical Australia means that occasional large flows and long periods of low flows dominate our aquatic systems. Many of our management operations limit this variability in order to produce reliable water resources. CRCFE research seeks to understand how flow variability impacts freshwater ecosystems. Through understanding the impact of water regime - volume and variability - on ecological functions and attributes we are then able to study the impact of flow regulation on habitats, biota and ecological processes. A third and vital area of research is to measure ecosystem response to 'environmental flow' management.

Restoration and rehabilitation ecology

Most of Australia's freshwater ecosystems have been damaged by human interventions both at the catchment level and within water bodies. The causes of the damage have been both inadvertent and/or deliberate. The drive for restoration is building and this drive urgently needs sound ecological guidance. CRCFE research is providing guidance in areas such as the impact of nutrients and nutrient removal on aquatic ecosystems, re-instating natural flow regimes, re-instating more natural drainage systems in the case of urban drainage, impact of introduced species, conservation of endangered aquatic organisms, importance of riparian vegetation and improved understanding of the importance of floodplain and wetland ecosystems and the mechanisms whereby they interact with the river ecosystem to the benefit of both.

3.1 Flowing waters

Program Leader: Prof PS Lake

Professor Sam Lake, Program Leader for Flowing Waters Photo: K Markwort

Flowing waters, rivers and streams, are the lifeblood of this dry continent. They are the interactive channels by which materials and energy are stored and moved from terrestrial to aquatic systems. The levels of movement and retention of materials and energy in the river system affects the dynamics and structure of the rivers' populations and communities.

Australia has the greatest variability in river discharges amongst the world's inhabited continents. CRC research seeks to understand how the biota of our rivers have adapted to this variability and how biodiversity has been maintained. The impacts of flow regulation on river biota, notably invertebrates and fish (especially fish larvae) are being investigated in the Campaspe River below Eppalock Dam, with the Broken River being used as a reference river system.

Sustainable management of our rivers and streams requires an understanding of the major ecological processes and organisms involved. CRCFE research is describing the major ecological processes in a lowland river system ñ the Murray River. In particular, the role and fluxes of carbon between different components of the ecosystem are being measured across sites.

The application of knowledge from this program is being demonstrated in a restoration ecology project in the Granite Creeks area near Euroa. The project aims to describe the geomorphological and ecological state of creeks damaged by sand slugs from upstream erosion and to instrument restorative measures at the stream section scales.

Postgraduate research contributes significantly to work in this Program. Research on the impact of exotic fauna concentrated on an introduced snail from New Zealand. This research, now completed, identified abiotic and biotic factors responsible for the ecological success of the snail. Other research areas include a study showing the impacts of disturbance on predation by macroinvertebrates and a project forming part of the lowland rivers research, looking at the importance of large woody debris as a major substratum for primary production.

The salinity in the Murray-Darling Basin is a large and complex problem. It requires coordinated action by state and federal governments and community cooperation. Photo: D Eastburn

Research in the Flowing Waters Program falls into five main areas:

1. effects of flow variability on river biota
2. impacts of exotic fauna
3. the roles of nutrients in streams and rivers
4. taxonomy of stream fauna
5. restoration ecology

EFFECT OF FLOW MANIPULATION ON THE BIOTA OF A LOWLAND RIVER

Project leaders: Dr Paul Humphries and Dr Jane Growns

Project team: Prof PS Lake, Mr John Hawking, Mr Peter Hancock, Mr Luciano Serafini, Mr Garth Watson and Mr Daryl Nielsen

Sites: Campaspe and Broken rivers, Victoria.

Aims:

To investigate how biota respond to changes in flow regimes by altering the operation of Lake Eppalock to restore seasonality, variability and duration to the flows in the Campaspe River.

To provide, through consultation and collaboration with relevant community groups and other water management agencies, a model for future management of storages in large rivers.

Progress:

This project involves reinstating part of the natural hydrology of the lower Campaspe River by changing the way releases from Lake Eppalock occur. During the years of the experiment this will allow the downstream release of 25 per cent of in-flowing water. This is achieved by allowing the storage to fill over a longer period following the irrigation season. Currently the storage will fill following the first rains. This change in operation of Lake Eppalock will substantially increase flows during the winter months and, on average, reduce peak flow but extend duration allowing the responses of flow-related biological variables to be investigated.

Four years of adult and larval fish sampling have been completed and two and a half years of macroinvertebrate sampling. Following the change in operation of Lake Eppalock, possibly during 2001, and at the end of this large-scale experiment we will have a greater understanding of the ways in which flow regimes influence fish and invertebrates. If the project is successful, we will use similar river systems to test the methods developed for providing environmental flows.

ECOLOGICAL FUNCTIONING OF LOWLAND RIVER SYSTEMS

Project leader: Dr Ben Gawne

Project team: Dr Rod Oliver, A/Prof Martin Thoms, A/Prof Keith Walker, Dr David Williams, Dr Ian Webster, Dr Gavin Rees, Dr Darren Baldwin, Dr Chester Merrick, Ms Trish Bowen, Dr Ralph MacNally (DEEB, Monash University), Mr Simon Treadwell (PhD student), Ms Gillian Beattie (PhD student) and Prof Barry Hart.

Sites: The River Murray at Albury, Mathoura and Hattah.

Aims:

To determine the availability and the annual and seasonal inputs of organic carbon to lowland rivers.

To provide recommendations for the management of lowland river systems, with particular reference to riparian communities, snags, algal growth, the impact of floods on carbon and nutrient cycles and the impact of habitat modification on floodplain ecosystems.

Progress:

This large integrated project commenced in 1998. An essential step toward understanding the functioning of lowland rivers is to determine what carbon sources comprise the base of the food web. The major task confronting lowland river ecologists is to collect the data necessary to evaluate and refine the four existing models, each of which makes differing predictions concerning the primary source of carbon in lowland rivers. A first step in this process is to develop a heuristic model based on existing, published models and our own data from which we can develop testable hypotheses. The approach has generated two complementary models to deal with 1) the major sources of organic carbon in a single river reach and 2) the food web that relies on the various carbon sources. The models will allow us to make better predictions about how changes in management have affected our rivers.

Frog meets insect, part of the intricate food web supported by freshwater habitats

The dragonfly, Hemianax papuensis, *is found near ponds, still water and sluggish streams*
Photo: K Hawking

Egret chick
Photo: W Lawler, NPWS

The River Murray crayfish, Euastacus armatus, is becoming rare, even locally extinct in many sections of the lower River Murray where a chain of weirs has turned the river into a series of large, still pools
Photo: D Eastburn

The project has been divided into a number of manageable components, each of which will contribute data to the model. Some components are determining the amount of organic carbon contributed by the many different types of plants (algae, reeds, floodplain plants) which make up the base of the food web. Other components are looking at the way in which the plant material is decomposed or consumed by bacteria, fungi and invertebrates, and examining the relationship between invertebrates and fish. The study is being conducted at three sites along the River Murray, near Albury, Barmah and Mildura. By studying three sites we hope that we will be able to construct a model that can be applied to the entire river, rather than just a small section. Initial outcomes from the project and the detail of new methods developed for the project have been presented to an internal workshop and an information brochure has been produced for the project.

FLOW CHARACTERISATION

Project leader: Dr Jane Growns

Project team: Dr Ben Gawne, A/Prof Martin Thoms and Mr Nick Marsh, Prof Tom McMahon and Dr Rob Argent (CRCCH)

Aims:

To develop a comprehensive and ecologically relevant list of statistics to describe flow regimes.

To characterise natural flow regimes and determine how flows have been changed in response to water resource development.

Progress:

Using long-term data sets for 222 stream gauging locations in southeast Australia, we calculated 330 hydrological descriptor variables. This was then pared back to 91 relatively independent variables. These data have shown the highly variable affect that water resource development has had on flow in eastern Australian rivers. Both the purpose of the development and the climatic zone through which the river flows, result in different changes. However, some general effects were distinguished. These include: loss of extreme high and low components of natural flows, reduced variability, increased rates of change in flow, and alteration of the seasonality of minimum and maximum flows. Analysis of the data set distinguished intermittent from permanently flowing streams

and also flow-regulated and unregulated river reaches. Those sites where rivers had been regulated for irrigation were significantly different from unregulated sites in warm temperate regions.

The management implications from this work are many. As most water managers are aware, providing 'environmental flows' to rehabilitate rivers is going to be a complex task. The results presented in the final report for the project (a draft is being reviewed) show that each river must be considered separately, taking into account the natural flow regime of nearby rivers, the climatic zone in which it occurs and the main purpose for which it is regulated. However, we now have a framework on which to build. The hydrological differences between different types of sites described in this report could be used to develop hypotheses about the likely biological effects of these differences.

RESTORATION OF DEGRADED RURAL STREAMS: THE GRANITE CREEKS PROJECT, NORTH-EAST VICTORIA.

Project leader: Prof P. S. Lake

Project team: Dr. Jennifer Davis (CRCCH), Dr. Barbara Downes, Alena Glaister, Dr.Brian Finlayson (CRCCH), Ian Rutherfurd (CRCCH), members of Granite Creeks Landcare Group, plus casual assistance from several research staff and students.

T Peake and P Reich taking a profile of the stream bed in the Queanbeyan River, NSW

Sites: Streams in the area between Euroa and Avenel in north-central Victoria.

Aims:

To determine the levels of sediment input into selected streams from catchments of the Strathbogie Ranges, and the movements of such sediments within the streams.

To develop feasible and rigorous means to monitor and assess stream restoration in this area.

To assess the role of habitat structure in effective restoration and whether habitat fragmentation impedes restoration.

Progress:

We have selected five streams in the Granite Creeks Catchment, which represent both sand-affected and 'natural' clay streambeds, for comparison of their fauna, catchment condition, channel morphology, wood content, and hydrology. Jennifer Davis has reviewed the history of European settlement and land use practices for the Granite Creeks Catchment and has carried out an extensive geomorphological assessment, covering both the 'hill country' and the 'flats', describing the history of sediment dynamics and catchment erosion, the locations and extent of sediment degradation and aggradation, the current geomorphological condition of the creeks and the possible causes of sediment erosion and movement.

Murrumbidgee River, ACT

We have undertaken a sampling program to assess the distribution of fish species. In addition we have sampled invertebrates under high flow conditions to detect the major faunal differences between the impacted sand sections and the relatively unimpacted clay-based sections of the creeks. Also undertaken was an extensive survey of the log-dwelling fauna in both sand and clay section. This information will allow the setting of target biota for restoration and the selection of appropriate indicators. This faunal data, together with assessment of organic matter (ash-free dry weight), and other measured site parameters such as volume of woody debris are being analysed to help understand the complexities of sand impact on these stream systems.

A report has been compiled relating the history of European settlement and land use practices for the Granite Creeks and their catchments. Also, preliminary data has been analyzed and published in conference proceedings and student project reports.

ILLUSTRATED KEY TO THE NYMPHS OF THE AUSTRALIAN EPHEMEROPTERAN FAMILIES BAETIDAE AND CAENIDAE

Project leader: Dr Phil Suter

Sites: Nationwide

Aim:

To provide a common voucher system and illustrated keys for the mayfly families Baetidae and Caenidae using samples collected by the Monitoring River Health Program.

To describe new species as appropriate.

Progress:

Baetid and caenid mayflies are important constituents of streams yet their taxonomy has been rudimentary. This project has produced keys to the Baetidae and Caenidae. A distribution database has been created and provided to LWRRDC. This database is being regularly updated as more material is examined. Examination of the first Monitoring River Health Initiative sampling occasion identified at least five new species and the distribution of over 30 species has been extended.

Descriptions of a new genus and three new species of Caenid mayflies and one new species of Baetid mayfly have been published and *CRC Identification Guide No. 23* was presented at the Taxonomic Workshop on February 1999.

3.2 Standing waters and eutrophication

Program Leader: Dr Rod Oliver

Nutrient enrichment, or eutrophication, of standing waters may adversely impact water quality. An increase in nutrients frequently stimulates the production of aquatic plants and algae, which although not intrinsically problematic in natural systems is usually so in potable, industrial and agricultural water supplies. Of particular concern to the management of these water supplies are algal and cyanobacterial blooms, some of which may be toxic.

Dr Rod Oliver, Program Leader for Standing Waters and Eutrophication

Nitrogen and phosphorus are two nutrients considered to play a major role in eutrophication, with studies worldwide suggesting that phosphorus enrichment is particularly important in freshwaters while nitrogen enrichment is important in estuaries. In Australia, considerable debate continues as to the relative importance of nitrogen and phosphorus in stimulating the production of cyanobacterial blooms. Projects within this Program are addressing these issues and have shown that nitrogen limitation may be quite common in waters of the Murray-Darling Basin.

The conversion of nutrients into algal biomass, however, is not solely a function of nutrient availability, but is also dependent on physical conditions such as the extent of mixing, the water temperature and light penetration. Biological conditions such as the presence of algal grazers and food web interactions are also important. A major focus of this Program has been to develop techniques for assessing and describing these interactions in standing waters typical of the Murray-Darling Basin, which range in size from small, irrigation supply weirs on the river systems, to large storage reservoirs in the upper catchments. To address these issues the projects within this Program are focused in three major research areas:

1. developing and applying techniques for identifying environmental conditions conducive to algal growth;
2. assessing methods for managing algal growth by manipulating the chemical and physical environment; and the
3. appraisal of algal community structure as a biomonitoring tool.

PhD research has contributed significantly to this Program, in particular through providing integral research for the Chaffey Dam projects. In addition, a student research project developing a predictive model for algal growth complements other modelling work being undertaken within the program.

THE CHAFFEY DAM STUDY.

Project leaders: Dr Bradford Sherman and Dr Phillip Ford

Project team: Dr Rod Oliver, Dr John Whittington, Dr Ian Webster, Dr Darren Baldwin, Dr Ron Beckett, A/Prof Bill Maher, Mr Zygmunt Lorenz, Mr Pat Hatton, Mr Gary Miller and Mr Leigh Gray, Mr Damian Green and Mr Jason van Berkel (PhD students).

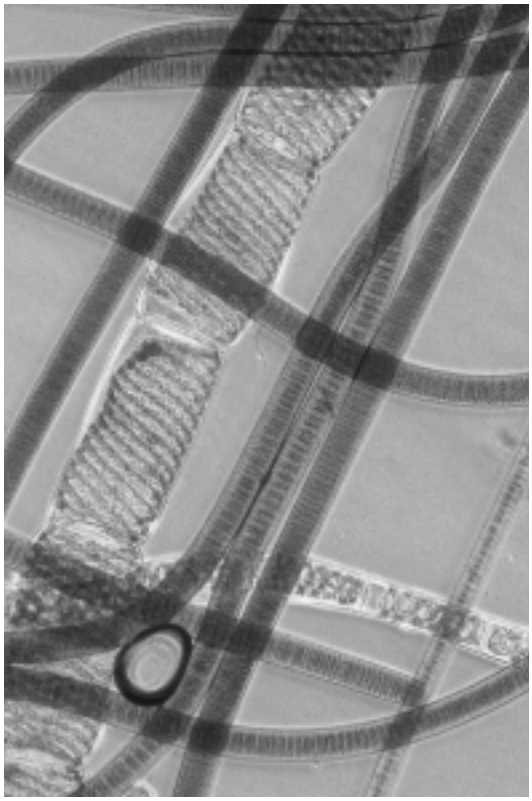
Site: Chaffey Dam on the Peel River near Tamworth, NSW

Aim:

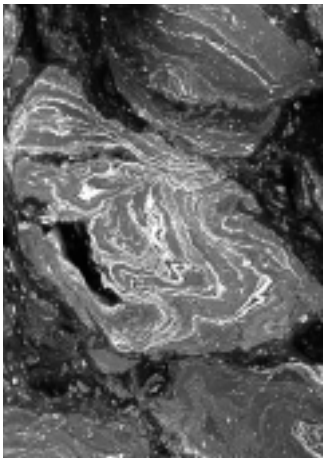
To understand the capabilities and limitations of bubble plume destratification systems in supplying oxygen to the sediments and in controlling the growth of bloom-forming cyanobacteria in reservoirs.

To investigate and define: the effect of sediment oxidation on sediment-phosphorus interactions and the bioavailability of P; the changing role colloids play as a consequence of changes in the oxygen status of the water column; and the effects these processes may have on cyanobacterial blooms in subtropical reservoirs.

Algae in a stream
Photo: J Sonneman



The green alga, Spirogyra, and the blue-green alga, Oscillatoria
Photo: J Sonneman



Blue-green algal scum. The giant algal bloom in the Darling River in 1991 reinforced the need for an integrated approach to natural resources management in the Murray-Darling Basin. Photo: D Eastburn

Progress:

Chaffey Reservoir is an example of a water storage where destratification has failed to live up to expectations. Despite the reduction in density stratification and the increased dissolved oxygen levels at depth produced by artificial destratification, the reservoir still suffered from massive blooms of the toxic cyanobacteria, *Anabaena* and *Microcystis*, which could occur at virtually any time of year.

The final report for this three-year study presents a detailed investigation of the physical, chemical and biological processes within Chaffey Reservoir that exert the greatest influence on the water column chemistry and the phytoplankton community. The project team utilised a whole-ecosystem approach to experimental design resulting in a comprehensive data set able to rigorously test complex reservoir water quality models. The ultimate objective is to identify the intrinsic limitations of artificial destratification and to provide sound advice to the Australian water industry on the most effective management strategies for the control of cyanobacteria and the transport of oxygen to the hypolimnion.

A draft of the technical report for this project is being reviewed and will be published in the near future. We have produced a brochure outlining the findings of this research.

SEDIMENT - NUTRIENT PROCESSES

Project leader: Dr Ron Beckett

Project team: Dr Ian Webster, A/Prof William Maher, Dr Phillip Ford, Dr Darren Baldwin, Dr Gavin Rees, Mr Ian Lawrence, Dr Jason van Berkel, Dr Soheyl Tadjiki.

Sites: Urban and rural rivers and ponds in South-East Australia.

Aims:

To test whether sediments (both bottom and suspended) play an integral and crucial role in determining nutrient concentrations and fluxes in Australian freshwater systems.

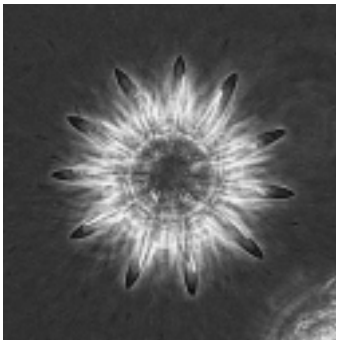
Progress:

This project is investigating various aspects of nutrient dynamics (P, N, C) within the sediment and between the sediment and overlying water column. Nutrient movement and transformations are extremely important components of ecosystem functioning, yet our understanding of the processes that drive nutrient cycling (particularly in the sediments) is still quite poor.

An intended outcome of this research is a predictive system model that will provide a useful management tool for simulating the consequence of manipulating environmental conditions on nutrient release and uptake from sediments. This extends to devising better catchment strategies and to improving the design of urban pollution control basins to achieve maximum nutrient retention, given knowledge of the character of the organic inputs.

The preliminary results from this work have been presented at an internal workshop.

PHYSICAL AND NUTRIENT FACTORS CONTROLLING ALGAL SUCCESSION AND BIOMASS IN BURRINJUCK RESERVOIR



Project leader: Mr Ian Lawrence

Project team: Prof Peter Cullen, A/Prof William Maher, Dr Rod Oliver, Dr Ian Webster, Dr Phillip Ford, Dr Bradford Sherman, Prof Graham Harris and Dr Miriam Bormans (CSIRO, Land and Water) and Dr Bob Wasson (ANU)

Sites: Burrinjuck Reservoir, NSW

Aims:

To identify the major determinants of water quality and algal biomass and their implications for catchment management.

To determine the role nitrogen plays in influencing algal growth and composition and to evaluate a eutrophication reduction scheme for removing nutrients from Canberra's sewage.

Progress:

This project utilised existing data sets collected for both the upper Murrumbidgee catchment and Burrinjuck Reservoir. These data provided the opportunity to 'manipulate' nutrient budgets for a whole system. We have compiled, validated and interpreted 22 years of physical, chemical and biological data for the Reservoir and its streams. Following analysis of this dataset we have advanced our understanding of the primary determinants of reservoir algal biomass and composition, including the role of internal nutrient loading. A Reservoir Managers Workshop has been held to present the research outcomes of this work and to explore potential management options. A final report is currently being produced.

VALIDATION OF THE NIFT (NUTRIENT INDUCED FLUORESCENCE TRANSIENT) ASSAY FOR IDENTIFYING NITROGEN AND PHOSPHORUS LIMITATION OF PHYTOPLANKTON GROWTH.

Project leader: Dr Rod Oliver

Project team: Ms Gosia Przybylska and Mr Zygmunt Lorenz

Sites: Murray Darling Freshwater Research Centre

Aims:

Confirm that the NIFT assays for nitrogen and phosphorus limitation are reliable when organisms are grown under nitrogen limited conditions.

Investigate whether prolonged dark incubation influences the outcome of the NIFT assay.

Measure the NIFT responses of a nitrogen fixing cyanobacterium grown without a source of combined inorganic nitrogen.

Lake Hume in low water
Photo: J Hawking

Progress:

This project investigated the hypothesis that cells with growth limited by nitrate-nitrogen would show NIFT responses to the addition of either ammonium or nitrate, whereas those growing on an ammoniun source would respond only to ammonium. This is based on the knowledge that cells taking up nitrate transform it into ammonium before use.

The results of the project were contrary to expectations. The blue-green alga, *Microcystis*, and the green alga *Scenedesmus* showed a NIFT response to the addition of ammonium but not to nitrate when grown in either ammonium or nitrate-N. In contrast, the diatom *Aulacoseira*, when limited by nitrate gave NIFT responses to the addition of either ammonium or nitrate. As expected, there was no NIFT response to additions of phosphate in either of these cases.

The study shows that the NIFT assay does reliably identify nitrogen or phosphorus limitation but does not identify the source of nitrogen limiting growth (ammonium or nitrate).

The nitrogen fixing cyanobacterium *Anabaena* when grown without a source of combined inorganic nitrogen did not respond to additions of nitrate or ammonium but at peak biomass did respond to phosphorus. This confirms that species using nitrogen fixation to sustain growth will not show a NIFT response to nitrogen.

ALGAL AVAILABILITY OF PHOSPHORUS DISCHARGED FROM DIFFERENT CATCHMENT SOURCES

Project leader: Dr Rod Oliver and Dr Ian Webster (CSIRO)

Project team: Mr Shane Perryman and Ms Helen King

Sites: Goulburn River, Victoria

Aims:

To determine the forms and bioavailability of phosphorus from three representative sources: an upland catchment, a sewage treatment plant and an irrigation return drain.

To determine how the forms of phosphorus change within the river.

To develop a sediment transport model that predicts the impact of the form of phosphorus entering the river and the changes occurring within the river, on downstream algal blooms.

Progress:

Historical monitoring data was used to identify periods of peak phosphorus loads entering the Goulburn River from each of the selected sources: the Acheron River (upland catchment), the Shepparton sewage treatment plant (STP) and Rodney Main Drain (irrigation return water). We have found distinct differences between the forms of

phosphorus at each of these sites and the role of particles in phosphorus dynamics. At the Acheron River site, suspended particles were in low concentration and their capability to adsorb phosphorus was relatively low. Consequently these suspended particles did not play a significant role in phosphorus dynamics. In comparison particles at the STP and Rodney Drain sites were in higher concentrations and had a greater capacity to exchange phosphorus. They played a more important role in phosphorus dynamics, and significant amounts of bioavailable phosphorus were attached to particles.

At the Acheron River site there was a significant contribution of resuspended benthic algae to the transport of material during high flows. This may be an important process for downstream transport of readily metabolised carbon and nutrients in these upland regions.

Over an annual cycle, our preliminary data suggests that the irrigation return drain is providing a larger load of bioavailable phosphorus to the Goulburn River than the upland catchment.

Continuing work in this project will measure the downstream changes in phosphorus forms and bioavailability for each of the three sources and estimate the loads of bioavailable phosphorus and the exchange of phosphorus between the bottom sediments and the overlying water. We will also develop and test a sediment transport model coupled to a phosphorus-speciation model to predict the effects of discharges on downstream phosphorus concentrations.

MODELLING THE GROWTH AND SUCCESSION OF PHYTOPLANKTON POPULATIONS

Project leader: Dr Rod Oliver

Project team: Mr Zygmunt Lorenz

Sites: Murray Darling Freshwater Research Centre

Aims:

Produce a process based computer model that summarises current knowledge on the environmental factors influencing the growth of phytoplankton.

Incorporate into the model detailed functions describing light and nutrient requirements of major phytoplankton groups.

Test the reliability of the model using long term data sets.

Progress:

We have developed a framework for the model and a preliminary version has been produced based on the light requirements of the blue-green alga, *Microcystis aeruginosa*. This initial program has been used to trial various procedures for modelling the responses

of algal populations and algal communities to variations in the light regime. We have found that to reliably predict algal growth, the model needs to track individual cells within populations and to account for vertical differences in environmental conditions and the movement of phytoplankton through these gradients.

The model relies on the following components:

- light conditions drive a photosynthesis model estimating carbon fixation over short time steps,
- carbon units are distributed between cellular compartments and used as the basis for calculating growth rates and respiration rates,
- other cell characteristics are combined with this structure to describe algal responses to a range of environmental conditions.

We intend to refine the capability of the model using a light-field component that accounts for temporal and spatial changes in the underwater light environment and the light responses of various algae as determined using active fluorescence techniques. A nutrient component is to be included to account for nitrogen and phosphorus conditions using literature information on nutrient requirements of major algal types.

3.3 Floodplain and wetland ecology

Program Leader: Dr Terry Hillman

Dr Terry Hillman, Program Leader for Floodplain and Wetland Ecology. Photo: K Markwort

Floodplain rivers, such as the Murray and its tributaries, are complex interactive systems. They are made up of the river channel (or main stream) and the floodplain which in turn is composed of a continuum of habitats ranging from permanently inundated wetlands and anabranches to rarely flooded (but still 'flood influenced') terrestrial systems. The ecology of a lowland river is the ecology of the floodplain and the river and the interaction of the two. It follows that fluxes between the two systems (water, nutrients, carbon, and biota) are vital to the survival of both.

Management of a floodplain river should be based on an understanding of both systems and their interaction since its long-term sustenance depends on such knowledge and its wise application. It is our intention that research in this program will guide the modification of management activities to the long-term benefit of the river system as a human and ecological resource. The heterogeneity of these systems and their consequent biodiversity represents a significant conservation issue.

The program continues to address three major research issues:

1. the role of aquatic and riparian plants;
2. the role of hydraulic factors in floodplain ecology; and
3. the ecology of key functions and species in floodplains.

Postgraduate projects have continued to make a major contribution to our under standing of the ecology of key species including Cladocera, amoebae, yabbies, European

The inland banjo frog
Photo: D Hunter

perch, turtles and frogs. PhD research has also contributed to our understanding of riparian vegetation, carbon and nutrient cycling on floodplains and biodiversity in wetlands. Where possible these projects have been associated with larger studies.

Scale, particularly spatial scale, remains an important issue in this Program. A tension exists between the difficulty of achieving meaningful replication at the large (management) scale - both logistically and in terms of the nature of the current ecosystem - and the risk of generalising from small-scale experimental studies. While not resolved, these difficulties have been addressed by paying particular attention to the design phase of research projects and by carrying out research at a range of scales from laboratory and mesocosm experiments to 'reach-based' studies in which the whole billabong is the experimental unit.

RIPARIAN VEGETATION – PRODUCTIVITY AND ECOLOGY

Project leader: Dr David Williams

Project team: Ms Judy Frankenberg, A/Prof Martin Thoms, Ms Lisa Evans (PhD student) and Mr Dan Mawer

Sites: Murrumbidgee River upstream from Burrinjuck Dam, River Murray upstream from Hume, Goodradigbee and Abercrombie Rivers

Aims:
A better understanding of the ecological and geomorphological factors which determine the composition of riparian vegetation along large rivers.

To quantify the seasonal contributions this vegetation makes to the total riverine organic matter.

The River Murray
Photo: D Eastburn

Progress:

Floodplain vegetation is potentially a significant source of carbon for the riverine food web. However, since the makeup of riverine plant communities is affected by inundation patterns, river management may change the yield of carbon derived from floodplain vegetation. In this project, changes in riparian vegetation are being associated with environmental variation following a field survey along the Goodradigbee, Abercrombie and upper Murrumbidgee Rivers.

We now know that the environmental variables most related to vegetation patterns are floodplain geomorphology, intensity of land use, substrate texture, height above the channel and lithology as it controls valley and channel form. The relationship between vegetation associations and height above, and distance from, the river channel, point to the importance of inundation patterns. Clear floristic and geomorphic/geologic differences were apparent between the Murrumbidgee and Murray Rivers. Through experiments, we have also determined the basic regeneration requirements of the main woody riparian species of the Upper Murrumbidgee River.

Publications are currently being produced from this work.

MEASURING THE EFFECTIVENESS OF ENVIRONMENTAL WATER ALLOCATIONS

Project leader: Dr Gerry Quinn

Project team: Dr Terry Hillman and Dr Michael Reid

Aim:

To develop monitoring programs to detect changes in response to environmental water allocations and proposed water management strategies within the Murray-Darling Basin.

Progress:

This project initially produced a monitoring program to test the effectiveness of proposed indicators. The second stage of this project is now underway. It will trial the monitoring programs and indicators recommended in Stage I.

BILLABONG – RIVER INTERACTIONS DURING HIGH FLOW

Project leaders: Dr Terry Hillman and Dr Gerry Quinn

Project team: Dr David Williams, Dr Russ Shiel, Ms Judy Frankenberg, Dr Rod Oliver, Mr Rob Cook, Mr John Hawking, Mr Daryl Nielsen, Mr Garth Watson, Mr Dale McNeil (PhD student), Dr Gerard Closs (University of Otago), Dr Cath Meathrel, Prof Alistar Robertson (CSU-Riverina), Dr Adrienne Burns (CSU-Riverina).

Sites: Six billabongs along the Murrumbidgee River near Wagga Wagga, NSW

Aims:

To assess the transfer of biota between the main river channel and the billabongs across the floodplain.

To determine whether the hydraulic connection between river and billabong during high flows, and the consequent flux of water, materials and biota between the two, results in the resetting of the billabong system and the inoculation of the riverine ecosystem with carbon, algae and microorganisms.

Progress:

Pre-flood measurements of experimental and control billabongs have been completed for phase two of the project. Instrumentation has been installed in the study billabongs and sampling protocols have been developed in preparation for high flows in the Murrumbidgee River. Physico-chemical, carbon/microbial, microinvertebrate, macroinvertebrate, and fish surveys have been completed. This project is now awaiting flows in the Murrumbidgee to reach sufficient levels to connect the billabongs. Sampling protocols have been developed to cope with the intensive observations that will be required during the 'connection' period.

IN-STREAM PROCESSES AND ENVIRONMENTAL FLOW REQUIREMENTS FOR THE BARWON-DARLING RIVER

Project leader: A/Prof Martin Thoms

Project team: Dr Fran Sheldon and Ms Margot Biggin, Mr Victor Hughes and Mr Oscar Mamalai (Honours students).

Sites: Barwon-Darling River between Walgett and Wentworth.

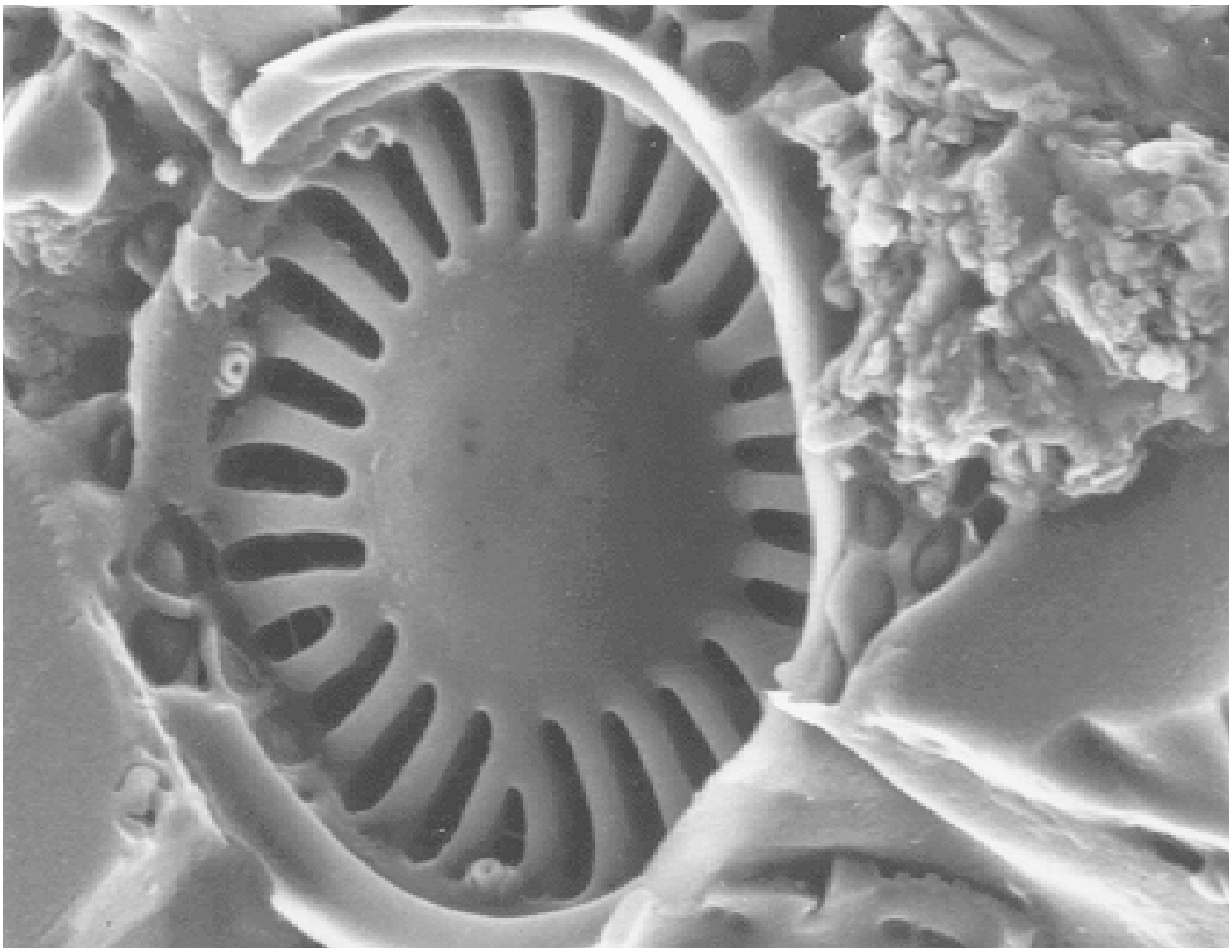
Aim:

To determine the in-channel flow requirements for the Barwon-Darling River for maintaining physical habitat complexity, organic carbon pathways and biological processes for dryland rivers.

Progress:

This project has recently completed and has provided indications of the impact of water resource development on the Barwon-Darling River system. The cross sectional morphology was described for over 2000 km of the Barwon-Darling River system between Boggabillia and Wentworth. Using a variety of cross sectional metrics, six distinct river zones were identified. These zones appear to be associated to the pattern of tributaries and anabranches. Furthermore, the presence of inset depositional benches is a feature of this dryland river channel. These reflect a highly variable flow and sediment transport regime. The oldest benches are >6,000 years with the youngest being <50 years,

containing contemporary material (such as plastic bags) at their base. This suggests a very dynamic process of internal channel formation. A common feature of each depositional area is the presence of numerous organic sediment layers. These organic layers are an important source of carbon. This highlights an important link between the physical structure of the river and ecological functioning.



Close-up of a Difflugia that has used diatom fragments to make its test.
Photo: R Shiel

The quantity of organic material (particulate and dissolved) released into the Darling on flooding of the various benches for the Wilcannia reach was modelled for 'Natural' and 'Current' levels of water resource development and the implications of development for carbon dynamics in the Darling hypothesised. Modelled hydrological data was then used to construct a series of hypothetical curves summarising ecological response to hydrological change ('benchmark' curves). The suitability of these response curves is then assessed using data from a seventh river, Cooper Creek - a relatively major pristine endoheric system in central Australia. The use of benchmark curves is then proposed as a methodology for assessing the likely ecological response of river systems to increased hydrological change.

FLOODPLAIN-WETLAND PROCESSES IN THE LOWER BALONNE RIVER SYSTEM

Project leader: A/Prof Martin Thoms

Project team: Dr Ralph Ogden, Mr Neil Sims (PhD student), Ms Heather McGinness and Mr Pat Levings (Honours students).

Sites: Lower Balonne River system downstream of St George (SW Queensland).

Aim:
To determine the role of different habitats in the Lower Balonne floodplain/wetland system in trapping carbon and nutrients from flood water and the extent of these exchanges during floods.

Progress:
Data collected from this study has been used to generate criteria for identifying key compartments, in terms of their storage, exchange and production of carbon and nutrients, in semi-arid lowland floodplain systems. The criteria will be used for land management and the setting of flow requirements.

The river and floodplain environments of the Lower Balonne system have been mapped and characterised. As a result, nine major floodplain regions have been recognised. For each of these regions, the long-term storage of carbon and other nutrients, the inundation character and how it has changed with water resource development, the effects of flooding on nutrient availability and how water resource development has influenced the transfer of carbon and nutrients between the river and the floodplain are all being examined. In order to do so, floodplain vegetation and sediments, erosion, discharge data, remotely sensed imagery and modelled hydrological data are all being utilised. The information obtained from this project will contribute to the Lower Balonne Floodplain Management Strategy.

MODELLING ECOLOGICAL RESPONSES TO WATER REGIMES OF ARID ZONE WETLANDS

Project leaders: A/Prof Keith Walker and Dr Jim Puckridge

Project team: Dr Justin Costelloe (University of Melbourne)

Sites: Coongie Lakes wetlands on the lower Cooper Creek, Lake Eyre Basin.

Aims:
Develop a discharge-water regime-biology model which allows prediction of both water regime change and biological trends in the Coongie Lakes wetlands, from changes in the Cooper Creek discharge regime.

To package the model as an interactive tool for use by resource managers, resource users and other stakeholders.

Progress:

This study is based in the Coongie Lakes wetlands on the lower Cooper Creek, a large arid zone floodplain river in the Lake Eyre Basin. The Cooper is unregulated, and retains a flourishing native biota, but is subject to proposals for irrigation development. Predicting the environmental effects of development on arid zone rivers is difficult because there are few long-term data sets relating flow regimes to biology. This problem is exacerbated by their extreme hydrological variability and complex floodplain morphologies.

Using data from a long-term study of the ecology and hydrology of the lower Cooper, we related wetland water regime and river flow to indices of fish, zooplankton and macroinvertebrate assemblage structure, fish behaviour and fish assemblage integrity. Neural networks were used to develop models which could predict biological responses to flow regime change.

These models are available on CD-ROM as DRY/WET, a program designed to help assess the ecological impacts of proposed water diversions from arid zone rivers. It may also help guide the restoration, management and monitoring of river systems already affected by diversions.

CONSERVATION OF AUSTRALIAN FRESHWATER TURTLES

Project leader: A/Prof Arthur Georges

Project team: Mr Sean Doody (PhD student), Ms Jeanne Young (Research Assistant), Mr David Judge (Honours student), Mr Scott Thomson (Masters student), Mr Mick Welsh (Honours student), Ms Kerry Beggs (Honours Student), Mr Mark Adams, Ms Jan Birrell and Dr Steve Donnellan (SA Museum), Dr Bradley Shaffer (University of California), Dr Bill McCord (East Fishkill Animal Hospital, New York).

Sites: Northern and South-eastern Australia

Aims:

To delineate species boundaries in Australian and southern chelid turtles.

To document patterns of genetic differentiation among populations of freshwater turtle.

Progress:

Research is conducted under two subprojects:

I. Taxonomy, systematics and evolution of Australian freshwater turtles (family Chelidae) with input to priorities for management and conservation.

II. Genetic differentiation among populations of freshwater turtle in eastern Australia, and its relationship to the history of population contraction and expansion in response to recent glacial events.

This body of research is producing valuable information for the setting of conservation priorities for Australian freshwater turtles, in collaboration with a range of organisations including the Parks and Wildlife Commission of the Northern Territory. A fully resolved 'family tree' has been produced for the side-necked turtles of Australia, South America, Africa and Madagascar using mitochondrial and nuclear gene sequences. An electrophoretic analysis of relationships among the long-necked chelid turtles of Australasia is complete and a new species of long-necked turtle from Arnhem Land has been described. The research team now have samples from all the major tributaries of the Murray-Darling Basin and the coastal rivers from Sydney to Princess Charlotte Bay. Preliminary analysis using mt DNA sequences is now being completed. Several manuscript have been produced from this work.

The Tortoise, Emydura sub. globosa, *found in the Murray-Darling Basin. Tortoises are long-lived animals with life spans similar to those of humans. They mature at 12 and can live to 70. Research suggests that as much as 95% of tortoise eggs are taken by foxes before they hatch.*

3.4 Water quality and ecological assessment

Program Leader: Associate Professor Richard Norris

The need to improve knowledge about the health of our rivers and lakes has focused attention on the methods used to monitor and assess water quality and how we make better use of this information for their management.

The CRCFE is working with Federal and State agencies to develop improved and cost-effective physical, chemical and biological assessment methods. It is a key player in the Monitoring River Health Initiative (MRHI), which is aimed at developing a coordinated national river bioassessment and prediction scheme.

Physical and chemical measures have long been the favoured methods for gathering information about water quality. However, these techniques have a number of deficiencies, not the least being that they only provide a snapshot of conditions in a waterbody representing the moment of sample collection.

Biological assessment techniques are increasingly being adopted by management agencies throughout Australia, as well as by community groups, because they provide an insight into events that may have occurred in the stream weeks or even months before the sampling. The CRC has a very active research program in the use of macroinvertebrates as biological indicators of stream health. In addition, bacteria, fish and algae are also being investigated as indicators of ecosystem health.

This program has two major aims:

To develop new cost effective approaches for assessing the ecological 'health' of Australian freshwater systems; and

To couple these approaches with new management support tools to assist with the ecologically sustainable management of the nation's freshwater resources.

Postgraduate research makes a major contribution to this program. Where possible, these projects have been associated with larger projects, in particular several PhDs support the biological assessment work through research on microbial populations, autocorrelation of benthic communities, responses of macroinvertebrates to toxins, relationships between habitat and macroinvertebrate communities and taxonomy of stoneflies and mayflied. The nutrient work has also been significantly advanced by postgraduate projects on bioavailable phosphorus, condensed phosphates, phosphorus speciation and determination, role of microbial production in carbon cycling, hydrolysis of phosphate esters, nutrient release from sediments and uptake of phosphorus by sediments. In addition, postgraduate research is being undertaken in the areas of aquatic and soil colloids and correlation of turbidity with environmental factors.

BIOLOGICAL ASSESSMENT OF RIVER HEALTH

Project leader: A/Prof Richard Norris.

Project team: Ms Sue Nichols, Mr Leon Metzeling, Dr Richard Marchant, Mr David Robinson, A/Prof Martin Thoms, Dr John Harris, Dr Peter Gehrke, Ms Rosanna Silviera, Mr Phil Sloane (Honours student).

Sites: South-eastern Australian Rivers

Aims:

Develop cost-effective approaches for assessing aquatic ecosystems using a range of ecological information (physical, chemical and biological).

Understand processes and links between components of an ecosystem and use these to develop appropriate guidelines for ecosystem protection.

Assoc Prof Richard Norris, Program Leader for Water Quality and Ecological Assessment
Photo: K Markwort

Progresss:

The CRCFE and the National River Health Program have developed predictive models for the biological assessment of river health. While these models provide useful information on water quality and the health of Australian rivers, little specific information is available on how the models may be affected by prevailing climatic conditions or how robust they are for assessing different types of impacts. This projects seeks to address these knowledge gaps.

The first part of the project investigates the responses of the outputs of the biological assessment models to common landuse impacts and also to methods of sampling. Sampling has been completed and the first round of samples processed and analysed. The data clearly demonstrate that single large kick-net samples provide an adequate representation of the fauna at a site. Using good independent trace metal data, the project has assessed the outputs of the models relative to a gradient of trace metals from Captains Flat. Clear representations were found between the level of contamination and the model outputs.

The second part of the project addresses the need to establish and examine long-term data on aquatic ecosystems. Long-term environmental variability may affect the interpretation of the outputs from predictive models. Data from the Thredbo, La Trobe, Wimmera and Yarra Rivers has been collated to provide datasets which will be examined as part of this project.

The third part of this project addresses the impact of dams and the ability of macroinvertebrate communities to cope with reduced discharges, the altered discharge regimes and reductions in water quality that result. Three field trips have been carried sampling sites below 19 dams ñ 7 in Victoria and 12 in southern NSW. Invertebrate

samples are being identified to the lowest taxonomic level and, combined with environmental data,will be run through appropriate predictive models.

The final part of this project is assessing the Index of Biotic Integrity (IBI). Metrics for the IBI using fish-community data were developed and refined. Data from the NSW Rivers Survey were used to produce IBI river-health scores for all of the 80 sites. Scores varied greatly across the range of geographic and river-type classifications, sites in the Murray ecological region were particularly low. The IBI model was validated using the repeatability of scores and independent comparison with results of the River Disturbance Index. Results of the project were published and work has begun on a practical manual to assist other scientists and agencies in applying the method widely for river-health assessments.

BIOLOGICAL ASSESSMENT PROJECTS

Project leader: A/Prof Richard Norris

Project team: Ms Sue Nichols, Ms Nerida Davies, Ms Gail Ransom and Ms Julie Coysh.

I. AUSRIVAS model development and refinement

Aims:
To test and refine the AUSRIVAS (Australian River Assessment System) models for all Australian states and territories.

Progress:
In this project, the CRCFE is liaising with MRHI lead agencies in each state and territory to obtain relevant macroinvertebrate and environmental data, and to determine the needs for model development and refinement. This includes visits to agency staff as needed to assist with training, data management and model development, ensuring that all agency staff are actively involved in site classification and decisions on site groups and familiar with modelling techniques.

II. Australian Alps Stream Health Monitoring Project

Aim:
To review previous water quality studies on alpine streams and develop a system for assessing alpine stream 'health' based on aquatic macroinvertebrate assemblages.

Progress:
The current status of knowledge of water quality and water quality monitoring in the Australian alpine area has been collated and summarised in a literature review. A sampling framework has been developed with 134 reference sites selected from the

national parks of the Australian alpine area. These sites will be sampled for aquatic macroinvertebrates and then used to develop an AUSRIVAS model for the Australian Alps.

III. AUSRIVAS Mapping and Reference Site Screening Module

Aims:

To develop a mapping and reference site screening module for AUSRIVAS.

To develop map-based outputs for both AUSRIVAS bioassessment results and catchment impact indices for use at a range of mapping scales with a consistent mapping and graphics framework.

To use and extend the Wild Rivers impact database to develop a standard framework for reporting and reference site condition and to aid reference site selection.

Progress:

This project is being undertaken with the Centre for Resource and Environmental Studies (ANU). AUSRIVAS outputs for test sites in the Upper Murrumbidgee Catchment were mapped together with the indices used in the Wild Rivers Project and good correlations were found between the two measures. These results suggest that there is value in combining the Wild Rivers mapping capabilities and indices with AUSRIVAS sites and outputs. Further investigations are being undertaken using data from New South Wales, South Australia and Victoria.

IV. AUSRIVAS/RIVPACS Trial for New Zealand

Aim:

To trial the use of AUSRIVAS in the Waikato Region with a view to introducing the approach nationally in New Zealand.

Progress:

The CRCFE has developed this project in conjunction with Environment Waikato, the New Zealand Ministry for the Environment, the Macroinvertebrate Working Group, regional councils and the New Zealand National Institute for Water and Atmosphere (NIWA). The trial has involved determining data requirements, key-sampling sites, guidelines for selection of reference sites, construction of models and a comparison of assessments. A final report to the Ministry for the Environment has been completed.

Manguika Stream, a reference site for the AUSRIVAS trial, NZ
Photo: R Norris

THE INFLUENCE OF TAXONOMIC RESOLUTION ON STREAM CLASSIFICATION AND PREDICTIVE MODELLING

Project leader: Mr Leon Metzeling

Project team: Ms Rebecca Hewlett (MSc student), Dr Richard Marchant, Mr David Tiller, A/Prof Richard Norris, Dr Phil Suter and Ms Nina Bate

Sites: Statewide in Victoria

Aims:
To assess the influence of taxonomic resolution on stream classification and predictive modelling.

Progress:
Macroinvertebrate data from 165 sites across Victoria, sampled under the National River Health Program between 1990 - 1996, have been used to assess the effect of different taxonomic levels on statewide classifications and predictive modelling. Numerical analysis has been completed to group sites across Victoria and to characterise these sites using environmental variables and macroinvertebrate taxa. Sites were classified using Ephemoptera / Plecoptera / Trichoptera (EPT) species, genus and family level data for riffle, edge and combined habitats as well as some comparison of seasonal data. In general interpretable results can be obtained for all the data examined at this broad scale, indicating substantial redundancy in the data sets. Further analysis is now being conducted to determine if these conclusions hold at a smaller spatial scale.

REGIONALISATION OF VICTORIAN STREAMS: AN ASSESSMENT OF ITS POTENTIAL FOR THE DEVELOPMENT OF ECOLOGICAL OBJECTIVES

Project leader: Mr Leon Metzeling

Project team: Dr Peter Newall, Ms Fiona Wells, Mr David Tiller, Mr David Robinson, Ms Jan Barton and Dr Richard Marchant

Sites: Statewide, Victoria.

Aims:
To classify Victorian streams into groups based on geographical regions and/or stream types and assess the potential of the classification for the development of ecological objectives.

Progress:
Our work in the past year has been within the framework of the five ecoregions defined in the first year of the program using invertebrate data collected under the National River

Health Program. We have examined the stream groupings within these regions to determine if they indicated different types of streams rather than sub-regional geographic groupings. Analyses to date indicate that the stream-typing approach is of limited applicability but this may also be an indication of the variables we had available for testing.

We have also assessed different approaches in setting ecological objectives within two of the ecoregions. We have built three AUSRIVAS models using data from each of these regions and preliminary assessments indicate that the regional models give better although very similar results to the statewide models.

BIOLOGICAL ASSESSMENT USING DIATOMS AS WATER QUALITY INDICATORS IN THE KIEWA RIVER SYSTEM

Project leader: Dr Peter Newall

Project team: Ms Nina Bate

Sites: Kiewa River and tributaries

Aims:

To develop rapid bioassessment techniques for diatoms and to compare them to invertebrates as indicators of nutrient status and other aspects of water quality or environmental change.

To develop a sampling and analysis protocol, and contribute towards an Australian temperate-zone database containing diatom and relevant environmental data.

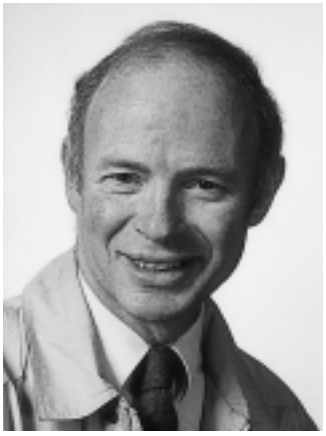
Progress:

Two components of this study have been completed and both published in the proceedings of the 15th International Diatom Symposium. The papers discuss (i) diatom data from the Kiewa River which was analysed in relation to water quality, and (ii) an assessment of the amount of information that is lost by reducing the size of diatom counts. The latter paper recommends a minimum number of valves to be counted for rapid bioassessment.

The Australian temperate zone (> 30 degrees south) diatom and water quality database is progressing well, with over 600 diatom samples collected simultaneously with macroinvertebrate and water quality samples (collected for the First National Assessment of River Health program) at stream sites around Victoria. These will be combined with samples taken in Tasmania, New South Wales, South Australia and Western Australia to complete the data base.

3.5 Urban water management

Program Leaders: Joint Program with CRC for Catchment Hydrology
Mr Ian Lawrence - CRC for Freshwater Ecology
Prof Tom McMahon - CRC for Catchment Hydrology



Ian Lawrence, Program Leader for Urban Water Management

There have been substantial advances in stormwater management across most States and Territories over the last 12 months, as water, regulatory and local government agencies implement catchment and stormwater management legislation requirements. There has been an associated increase in requests for information guiding the programs. At the international level, there have been concerns regarding the poor performance of some 'Best ' Management Practices, and a recognition of the need for improved selection and design of stormwater pollution control management measures.

There has been continued growth in community requests for information on how to be a more responsible citizen in environmental terms, and how to go about the restoration of local waterways and the development of wetlands. These trends place demands on agencies in respect to assessment of the health of urban waterways, and on the setting of realistic ecosystem targets for urban waterways.

Communities and governments are interested in securing the economic, environmental and social opportunities associated with a 'total water cycle' based approach to urban development. In such an approach the multiple uses and management objectives for stormwater, wastewater, water supply and groundwater are considered together.

The Urban Water Research Program, jointly undertaken with the CRC for Catchment Hydrology, aims to develop a better understanding of:

1. the catchments and their land use and rainfall-runoff and pollutant mobilisation processes and pathways, and how they might be modified;
2. the constructed waterways and the manner in which they influence the transport of runoff and pollutants, and opportunities for modifying them; and
3. the ecological and water quality responses of receiving waters to changing hydro logical, sediment and nutrient loading regimes, and their implications for stormwater design and management.

The advances in knowledge resulting from the urban research program have been an important source of information in the drafting of Stormwater Management Guidelines by Brisbane City Council, NSW EPA, Melbourne Water and Victorian EPA and a number of local government authorities. There has been strong growth in requests for information on urban pollution and management, restoration of urban waterways, and the selection and design of stormwater pollution control measures.

WATER POLLUTION CONTROL PONDS

Project leader: Mr Ian Lawrence

Project team: Dr Peter Breen, Dr Chris Gippel, A/Prof William Maher, Dr Phillip Ford and Dr Ian Webster

Sites: Stranger Pond, Canberra; Blackburn Lake, Melbourne; Lake Annan, Sydney

Aims:

To assess the long-term viability of pond sediments as sinks for stormwater pollutants.

To assess the validity of the ACT pollutant interception models where applied to different climatic and geochemistry contexts.

Progress:

The experimental work for this project has been completed and reports, guidelines and model published. The Pond and Wetland Design Guidelines (CRCFE, 1998) are a valuable output from this project, providing assistance to agencies, government departments and environmental consultants. A computer model for the design and performance assessment of ponds and wetlands has been developed and is being extensively used. They can be downloaded from the CRC home page ('freshwater.canberra.edu.au'). The models have been enhanced in association with users, to meet a wide range of applications. The CRCFE has convened 18 wetland design workshops across most states & territories to meet the demand for information from user groups. A number of these have been presented in association with CRC for Catchment Hydrology (CRCCH). We plan to continue supporting the uptake of this knowledge through support and development of models in response to user needs and consolidate the CRCFE and CRCCH pond and wetland guidelines into a single document.

An urban stormwater drain:
Sullivan's Creek ACT
Photo: I Lawrence

Shopping trolley in an urban waterway
in Giralang, ACT
Photo: K Markwort

YARRA RIVER ECOLOGICAL INVESTIGATION

Project leader: Dr Peter Breen

Project team: Dr Chris Walsh, Dr Mike Grace, Dr Sophie Bourgues, Prof Barry Hart and Dr Ron Beckett.

Sites: Yarra River, Melbourne.

Aim:
To evaluate spatial patterns in community structure and function in the lowland segments of the Yarra River and to evaluate the impact of urbanisation.

Progress:
This project commenced during 1998/99. The project will investigate the changes to the Yarra River brought about by urbanisation. The study focuses on three of the Yarra's five distinct segments: rural lowland (from Wesburn to the upper end of Warrandyte Gorge), gorge (Warrandyte Gorge to Fitzsimons Lane), and urban lowlands (from Fitzsimons Lane to Dights Falls). For each section, different parts of the food web are being investigated and ecosystem functioning assessed. Methods for community structure and function studies have been tested and documented. These were presented at an internal workshop during 1999. Where appropriate, methods are being compared with the Sediment-Nutrient Processes (Program B) and Ecological functioning of Lowland River Systems (Program A) projects.

Several water quality 'snapshots' have been undertaken and these have provided valuable insight into the nutrient dynamics of the river. A preliminary report on gross community respiration, primary productivity and microbial respiration has been completed, as well as preliminary report on benthic productivity/respiration and nutrient fluxes (benthic chamber studies).

At a larger scale, variation in sub-catchment area and sub-catchment impervious along the lowland Yarra River are being investigated. Preliminary assessment of variation in large woody debris (LWD) abundance and riparian cover has been undertaken. Variation in sub-catchment imperviousness along the lowland Yarra River independently explained variation in community composition commonly used as indicators of pollution. Despite sub-catchment area and sub-catchment imperviousness being highly inter-correlated, this statistical method was able to show that increases in catchment imperviousness explained biological patterns independently of longitudinal variation explained by catchment area alone. The power of these analyses will increase as data becomes available for more sites and at greater taxonomic resolution.

RIVPACS FOR URBAN STREAMS

Project leader: Dr Peter Breen

Project team: Dr Chris Walsh, Mr John Gooderham, A/Prof Richard Norris, Mr Leon Metzeling, Mr David Tiller and Mr Ian Lawrence.

Sites: 146 sites around Melbourne.

Aim:
To develop and test an urban RIVPACS model and protocol.

Progress:
Macroinvertebrate data from the CRCFE, Melbourne Water Corporation, and the Victorian EPA have been consolidated to produce a data set large enough for RIVPACS modelling. These data were collected using two different techniques: field sorting or full laboratory processing. Models have been developed and tested for these data and the results are being published in a final report.

3.6 Fish ecology

Program Leader: Dr John Harris

Knowledge of fish ecology is essential in understanding freshwater systems. Better understanding enables informed, reliable judgements about sustainable use of freshwater, including pressing issues such as: the degradation of freshwater habitats, loss of biodiversity, invasion by carp and declining fisheries.

Dr John Harris, Program Leader for Fish Ecology
Photo: K Markwort

The Program emphasises developing and assessing environmental flows, fishway design and effects of barriers to migration, studying the effects and control of carp and developing better tools for monitoring freshwater ecosystems and biodiversity.

Rivers are a seriously threatened component of Australia's natural resources, yet their ecology remains insufficiently understood, especially in relation to human-induced changes such as river regulation, alien species and catchment alteration. The Program therefore concentrates on the ecology of fish communities in river ecosystems.

Postgraduate research makes a significant contribution to this program. In particular, the research into control of carp is advanced by research on factors affecting carp population density and the effect of carp on macrophytes. The Index of Biotic Integrity has been successfully developed and validated for river-health assessment in NSW (Refer to Program D). A study of an electronic fishways monitor is progressing well. Broader ecological studies are benefiting from research on zooplanktivory by fishes.

BIOLOGICAL EFFECTS OF COLD WATER POLLUTION BELOW DAMS

Project leader: Dr John Harris and Dr Peter Gehrke

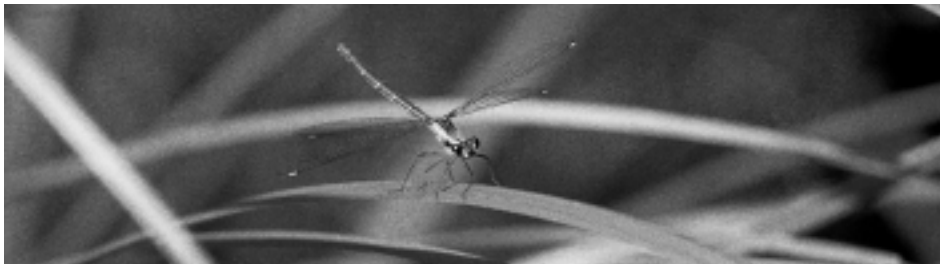
Project team: Ms Karen Astles and Mr Roy Winstanley

Sites: Macquarie River, Burrendong Dam

Aims:

Study the effects on native fish of cold irrigation flows downstream of dams.

Document the responses of fish and other biota to the range of water temperatures experienced in regulated rivers, including avoidance behaviour, feeding activity, growth, inter-species interactions and mortality.



Damselflies are a close relative of dragonflies. You can distinguish damselflies from dragonflies by the symmetrical wings of damselflies. Photo: J Hawking

Progress:

This project utilises a specially designed experimental facility located at Burrendong Dam. This facility is being used to study cold-water effects on biota using replicated, controlled-temperature channels. The channels allow us to measure the responses of fish and other biota to the range of water temperatures experienced in regulated rivers. In addition, distribution responses to cold water are being assessed using seasonal surveys of fish in the Macquarie River.

MEASURES AND BENEFITS OF ENVIRONMENTAL FLOWS

Project leader: Dr John Harris and Dr Peter Gehrke

Project team: Ms Karen Astles and Mr Roy Winstanley

Sites: 52 river sites throughout western New South Wales

Aims:

To develop a measure of river flow alteration that is comprehensive and ecologically relevant.

To develop a spatial model of responses of fish communities to changes in river flow regime and to predict changes in fish communities in response to changes in river management.

Progress:

Fish-community data from the *NSW Rivers Survey* are being used to generate a spatial model of fish community response to flow regime. The field sites for collecting validation data have been selected and sampled. Ongoing sampling will improve temporal predictive capacity of the model and will provide insights into spatial and temporal variability in fish communities. Hydrological data are being used to calculate changes in duration, magnitude, timing and rate of change of flow events as a result of alterations in river flow. The model will allow any changes in fish communities following the NSW Water Reforms to be assessed.

FISH PASSAGE DEVELOPMENT

Project leaders: Dr John Harris and Dr Peter Gehrke

Project Team: Mr Garry Thorncraft, Mr Dean Gilligan, Mr Matthew Barwick and Mr David McGill

Sites: Tallowa Dam, Shoalhaven River, Yarrawonga Weir, Nepean River, Tweed River, various fishway sites in New South Wales

Aims:

To develop low-cost fishways for Australian streams

To understand the migrations of freshwater fish

To assess the response of a native fish community to the installation of a fishway in the Crawford River

Progress:

This project brings together work on fishways across NSW. Fish migration is an essential part of the life history of native freshwater fish, and dams and weirs prevent this movement. Vertical-slot fishways have been built at eight sites and have performed well. A low-cost alternative - rock-ramp fishways ñ have been assessed on the Murrumbidgee, Nepean, Namoi and MacIntyre rivers. In addition, fishway designs were developed for the Edward and Murray rivers and fish passage is being studied at Tallowa Dam on the Shoalhaven River. This sub-project is examining the impact of Tallowa dam on fish communities and options for a high-level fishway. Surveys have shown the marked impact of the dam on the distribution of fish communities. Work at Yarrawonga Weir fish-lift is refining the automated operating procedures for the structure and assessing the structure's efficiency. Restoration of the fish community is being studied in Bomaderry Creek following removal of Bomaderry Weir and in the Crawford River following renovation of the fishway.

ANGLING CATCH DATABASE

Project Leader: Dr John Harris

Project Team: Mr Matthew Barwick

Sites: Various sites in the Hawkesbury, Hunter, Manning, Murray, Shoalhaven and Macquarie river systems

The Murray Cod, Maccullochella peeli, *Australia's largest native freshwater fish. Murray Cod lay eggs every year, but large numbers of their young die as hatchlings unless there is a flood. Photo: G Schmida.*

Aims:

Develop and maintain a standardised angling catch database for monitoring the quality and abundance of freshwater fish populations and the condition of aquatic habitats

Progress:

Angling fisheries dominate the use of fish resources in freshwater systems. Management of this resource requires monitoring the exploitation rate, angling quality and other aspects of fish catches. Cooperative research with the angling clubs provides the most direct data as well as directly involving the major user group. The project monitors the density and structure of fish populations, and community structure in some multi-species fisheries, thus it can provide an indicator of the condition of fish stocks and the environments that support them. The project also provides an efficient tool for assessing fisheries' responses to management. Standardised angling catch data are derived from cooperatively managed club competitions in specific recreational fisheries. The data include angling catch and effort, location and fish size. Data are independently verified during competitions. Feedback is provided to participating groups through annual seminars, and an annual workshop ensures opportunities are available for collaborating groups to participate actively in managing the project.

DRYING EFFECTS ON THE ECOLOGY OF THE MENINDEE LAKES

Project leader: Dr Ben Gawne

Project team: Dr Oliver Scholz, Ms Fiona Betts, Kim Jenkins (PhD student), Dr Andrew Boulton and Dr Margaret Brock (University of New England).

Sites: Menindee Lakes, NSW

Aims:

Examine changes in water quality, algal, zooplankton and fish communities during a drying event in the Menindee Lakes.

Progress:

The Menindee Lakes are an important natural resource, providing critical habitat for native fish and birds within the Darling River system. Management of Menindee Lakes needs to develop strategies that: i) optimise both water quality and availability for domestic and agricultural use, and ii) maintain the lake's environmental values. It has been suggested that storage in the lakes be rationalised in order to reduce evaporative losses, thereby increasing the amount of water available for other uses. This change in management practice would involve allowing some of the lakes to dry over summer. It is proposed that the introduction of a dry phase would both save water and, by restoring a more natural hydrological regime, improve the health and integrity of the wetlands.

Six of the Menindee Lakes (Malta, Balaka, Bijiji, Tandure, Menindee and Cawndilla) have been sampled seasonally. Additional sampling will coincide with episodic events, such as at the re-establishment of connection between lakes and river. As water regimes differ between each of the lakes, comparisons of flow-regime impacts on ecological processes between lakes will be possible. The work is being complemented by small-scale experiments that will help resolve the effect of drying on particular elements of the lake ecosystem, such as aquatic plants, invertebrates and fish.

The project has completed four seasonal sampling trips which has enabled the project team to document the lakes during a drying phase. Two of the lakes (Malta and Balaka) have now dried completely. Sediment has been collected and placed in mesocosms for a series of small-scale experiments during 1999. The experiments are helping to explain the mechanisms underlying patterns observed in the field survey.

A report has been completed for this study and a brochure outlining the main scientific findings has been produced.

CARP CONTROL METHODS

Project leader: Dr Craig Schiller

Project team: Mr David McGill and Mr Matthew McIntosh

Sites: Billabongs in the Murrumbidgee and Murray catchments.

Aims:

Develop and assess various methods for reducing carp abundance in enclosed water bodies

Assess the effects of reductions in densities of adult carp on the survival and growth of juvenile carp

Measure the responses of selected ecological parameters in waterbodies with different densities of adult and juvenile carp.

Progress:

This project focuses on carp removal, with research into development of large-scale carp harvesting methods being accompanied by studies of the potential impact of such harvesting on the growth and survival of juvenile carp and hence, in the longer-term, the ability of carp populations to recover from the harvest pressure applied. The project uses three study billabongs, two on the Murray River and one on the Murrumbidgee River, each partitioned into four smaller experimental units using fences supporting 1 cm mesh. The project will assess the effects of low and high densities of adult carp on the survival and growth of juvenile carp. Other issues being targeted by the study are: the impact of carp on turbidity, macrophytes, sediment reworking and growth of phytoplankton and zooplankton.

So far, over 165 wetland sites have been inspected and of these 21 were short-listed and have been electrofished and surveyed. The construction of large-scale nets and traps has been completed and the effectiveness of large-scale harvesting techniques (excluding electro-seine apparatus) has been tested in Lake Cargelligo. Three study billabongs have been partitioned and manipulation of carp populations is in progress. We will be monitoring the ecological changes associated with changes in carp density in the study billabongs and plan to conduct a second trial of large-scale carp harvesting techniques, including use of electro-seine apparatus.

THE DISTRIBUTION, ABUNDANCE AND MANAGEMENT OF THREATENED FISH IN THE MURRUMBIDGEE RIVER CATCHMENT WITH SPECIAL REFERENCE TO THE ENDANGERED TROUT COD

Project leaders: Dr Craig Schiller and Mr Mark Lintermans

Project team: Mr Ian Wooden, Mr Michael Rodgers and Mr Mark Jekabsons

Sites: Murrumbidgee River

Aims:

To determine the distribution and relative abundance of trout cod in relation to habitat and position in the river and to identify habitat preferences.

To develop trout cod management guidelines for State/Territory/Local government agencies and monitor the effectiveness of stocking and threatened species recovery programs.

Progress:

This project uses sample sites in the Murrumbidgee river between Burrinjuck Dam and Yanco Weir. Nine sites have been surveyed so far, providing a total of 587 fish, representing five families, nine genera and 10 species (excluding smaller species such as gudgeons and smelt). Of these carp represented 72%, and other species, in order of abundance, were golden perch, trout cod, trout species, river blackfish and Murray cod. A total of 48 trout cod were recorded in this sampling effort.

Although only 50% of field work has been completed, some trends are already apparent in trout cod habitat associations in the Murrumbidgee River and the project has recorded the smallest (and possibly youngest) sexually mature trout cod female found in the wild. Preliminary data analysis indicates strong trends in trout cod habitat associations. Evidence so far suggests that in the middle section of the Murrumbidgee River, smaller-size classes of trout cod are associated with high flow near single-stemmed, medium-to-large timber snags orientated in the same direction as water flow.

Further sampling will assess these preliminary findings, as well as elucidate trout cod distribution and habitat requirements currently limiting development of suitable management plans for this endangered species.

The Purple Spotted Gudgeon, Mogurnda adspersa, *a small native fish found in the Murray-Darling Basin. This fish is listed as uncommon and restricted, having suffered dramatic declines in numbers over the past 150 years. Photo: G Schmida*

DOWNSTREAM TRANSPORT OF LARVAL AND JUVENILE FISH

Project leader: Dr Craig Schiller

Project team: Mr Ian Wooden, Mr Michael Rodgers and Mr Keith Brehney

Sites: River Murray

Aims:

To assess the magnitude, spatial scale, timing and size compositions of downstream transport of larvae and juveniles for a number of fish species.

To produce a generic predictive model of downstream transport and predict which weirs will have significant impacts on movements of fish.

Progress:

This project is progressing well, with three rounds of field sampling successfully completed. To date over 320 field samples have been collected and approximately half have been processed. The second round of sampling during 1998/99 was highly successful, with catches 10 to 100 times greater than for Round one. Drifting larvae and juveniles have now been recorded for species, including Murray cod, golden perch, gudgeons and carp.

A preliminary data analysis has shown significant numbers (430) of Murray cod larvae and juveniles, plus a large number of eggs, present in the drift. This suggests, contrary to published literature, that this species does have a pelagic dispersal phase. The size range of drifting Murray cod larvae was 8 - 13 mm (mean 10 mm), suggesting that larvae enter the drift soon after hatching and disappear at 10-14 days of age. There is also a consistent pattern of low larval abundance immediately below weirs, with abundance increasing downstream of weirs, suggesting that weirs are affecting Murray cod drift and trapping the larvae in weir pools. Although based on incomplete data, these preliminary findings are important and contradict published data on this species. If supported by the complete project data set they will have important ramifications for future management of Murray cod.

Electrofishing with a backpack, Ellenborough, NSW.

Table 3.1
Diagram illustrating the relationship between research programs and projects

	flowing waters	standing waters & eutrophication	floodplain & wetland ecology
ecological assessment	Illustrated key to the nymphs of the Aust. ephemopteran families baetidae and caenidaae		
energy & nutrient dynamics	Ecological functioning of lowland rivers	The Chaffey Dam study Physical & nutrient factors controlling algal succession and biomass in Burrinjuck Reservoir Sediment-nutrient processes Algal availability of P discharged from different catchment sources Validation of the NIFT assay for N and P limitation	Riparian vegetation – productivity & ecology
water regime & allocation	Effect of flow manipulation on a lowland river (Campaspe River experiment) Flow characterisation		Billabong river interactions during high flow Instream processes and environmental flow requirements for the Barwon-Darling River Floodplain-wetland processes in the Lower Balonne River system Measuring the effectiveness of environmental water allocations Modelling ecological responses to water regimes of arid zone wetlands
restoration & rehab. ecology	Restoration of degraded rural streams: the Granite Creeks landcare project		Conservation of Australian freshwater turtles

water quality & ecological assessment	urban water management	fish ecology
Biological assessment: river health Biological assessment projects Biological assessment using diatoms as water quality indicators in the Kiewa R system Influence of taxonomic resolution on stream classification Regionalisation of Victorian streams: ecological objectives	RIVPACS for urban streams	Angling catch database
	Water pollution control ponds The Yarra River ecological investigation	
		Biological effects of cold water pollution below dams Measures and benefits of environmental flows Downstream transport of larval and juvenile fish Drying effects on the ecology of the Menindee lakes Fish passage developments
		Carp control methods Hydrologic manipulation as a potential carp control strategy Threatened fish in the Murrumbidgee River catchment: trout cod

HYDROLOGIC MANIPULATION AS A POTENTIAL CARP CONTROL STRATEGY

Project leader: Mr Glenn Wilson and Dr Ben Gawne

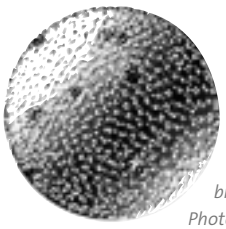
Project team: Mr Ben Smith

Sites: Menindee Lakes; wetland sites along the Murray River between Berri (SA) and Corowa (NSW); Murray, Darling and Macquarie rivers, NSW; 'Oakbank Station', Wentworth NSW.

Aims:
To evaluate the role of hydrological factors in determining the success or failure of recruitment of carp in the Murray-Darling Basin.

Progress:
Carp are widely believed to be a major agent of environmental degradation in Australia's lowland rivers. However, while there is broad community support for developing effective control measures, much of the required ecological information is not available. This project is designed to collect information on the age structure and spawning ecology of lowland carp populations. These data will be used to determine the environmental conditions that lead to successful carp recruitment, and assess the viability of hydrologic manipulation as a control technique. The findings will be used to develop management strategies to reduce carp numbers through minimising their reproductive success.

This project commenced in early 1998 and is divided into four parts: (i) sampling juveniles from Darling and Murray river wetland sites to enable spawning-timing profiles to be determined over varying spatial scales, (ii) collecting post-juvenile fish along Darling, Murray and Macquarie Rivers to examine patterns in annual age-structure, (iii) studies of the tolerance of eggs to salinity and desiccation, and (iv) establishing an experimental pond facility on the Darling Anabranch for examining mechanisms that limit carp recruitment. Field work has been undertaken to monitor carp spawning behaviour and timing and to sample post-juvenile carp from various sites. In the laboratory we have studied the tolerance of eggs to salinity and desiccation and an experimental pond facility is being constructed on 'Oakbank Station', Wentworth NSW. This facility will be used to examine the effect of single and multiple draw-down strategies on carp recruitment.



Volvox, a colonial flagellate, is a common phytoplankton found in billabongs and reservoirs
Photo: R Shiel

4 Education and Training

Dr Ian McKelvie, Program Leader for Education. Photo: K Markwort

Program leader: Assoc Prof Richard Norris
Dr Ian McKelvie (from January 1999)

The Cooperative Research Centre for Freshwater Ecology (CRCFE) provides high quality education at the postgraduate, undergraduate and community levels (including primary and secondary schools).

Specific program objectives include:

- To provide postgraduate education and professional experience that equips scientists with high level research skills. CRCFE graduates are sought after to work in the water industry.
- To contribute to undergraduate education programs such that graduates gain a sound ecological knowledge and an appreciation of its application to water management issues.
- To enhance the employability of students within the natural resource area.
- To raise student awareness of employment opportunities within the water industry.
- To assist community groups to understand water related issues, and equip them to take an active role in land and water management.
- To build community awareness of water ecology and related environmental issues through a program of public and school-based education.
- To contribute to the continuing development of professionals working in the water industry through programs that update their knowledge and skill base.

4.1 Postgraduate education

Highlights of the program this year include:

Ian McKelvie and Richard Norris held an information session with CRCFE students from Monash University Biological Sciences and Chemistry (Dec 3, 1998).

Melissa Parsons and Jackie Griggs completed the BHERT Leadership and Career Development training course.

Fourteen students at Monash University completed a media training course, conducted by Karen Markwort and Andrew Grieg (January 20/21).

Five CRCFE students at Canberra University completed a media training course, conducted by Karen Markwort and Andrew Grieg (Dec.).

Nine CRCFE students completed the Teaching and Learning Course run by the Monash Centre for Higher Education and Development (May 5, 12 and 19).

Six CRCFE students attended The Australian Aquatic Ecology Post Graduate Workshop at Pearl Beach NSW, 28-30 April 1999. This workshop, attended by 42 students from throughout Australia, provides a forum at which students can discuss ideas, problems and exchange expertise. The CRCFE was a major sponsor of this meeting.

The CRCFE supported 52 PhD students, 14 Masters students and 27 Honours students.

The CRCFE also provided support so students could attend relevant conferences and seminars. 19 students presented papers and posters at the Australian Society for Limnology's Annual Conference. Support was also provided to 6 PhD student to attend overseas conferences.

The CRCFE also provides postgraduate students with training opportunities. A Leadership and Career Development Workshop for PhD and Postdoctoral staff in CRCs was run through the CRC Association in August, and was attended by Melissa Parsons, a CRCFE student.

A formal workshop is held each year at the University of Canberra and Monash University to induct students into the CRCFE. The induction course helps new entrants to understand the CRCFE's operations, resources and facilities. All new students receive an induction manual.

Nine CRCFE students in Melbourne completed short courses on Tutoring and Demonstrating for Post Graduate Students run by Monash University's Centre for Higher Education Development (May).

Eighteen CRCFE students from Mildura, Albury, Adelaide, Canberra and Melbourne completed a three day Project Management course, conducted at Monash University on 28-30 June 1999.

CRCFE postgraduate students assessing river health. The Centre provides outstanding opportunities for postgraduate education and skills development. Photo: K Markwort

4.2 Undergraduate Education

Undergraduate teaching takes place at Monash University, University of Canberra and La Trobe University.

The CRCFE runs the Catchment Management Curriculum at University of Canberra. This cross-disciplinary course for third-year students draws on the CRCFE's wide range of expertise. The Catchment Management Course had 24 students enrolled in 1998, and 23 students in 1999.

Summer research scholarships and work experience

The CRCFE again sponsored several students to undertake professional placement over the summer academic break. Students were placed with organisations within the CRCFE, including:

- NSW Fisheries at Cronulla, Port Stephens and Narranderra
- MDFRC Lower Basin Laboratory, Mildura
- ACTEW, Canberra
- Monash University, Water Studies Centre
- Monash University, Biological Sciences
- MDFRC, Albury
- University of Canberra

Thirteen students participated in the CRCFE,s 1998/99 summer scholarship scheme. The scheme provides research experience for students who are likely to undertake Honours degrees. It also provides work experience in relevant laboratories and organisations. The work experience program is linked to a professional practice unit at the University of Canberra. The Lower Basin Laboratory has also taken on work experience students from the Sunraysia College of TAFE.

The value of the work experience program is illustrated by this comment from an ACTEW Corporation staff member who supervised a summer scholarship student:

> *"I have just returned from Melissa's brilliant presentation of her summer of GIS mapping of our water supply catchments. She has been a delight but, more importantly, has been keenly productive and enthusiastic. I suggest we might explore her availability for a short period were her studies to lend to an applied project."*

Primary school students collecting samples and learning about river health. The Centre has an active school education program.

4.3 School Education

Ian McKelvie and Mike Copland established contacts within the Victorian Ministry of Education Information Technology section which may enable input of CRCFE material to Victorian schools through the STEPS program.

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

- presentations at science exhibitions
- presentations and field work for specific schools
- curriculum development and teacher training.

Learning outcomes include:

- the excitement of science
- the relevance and importance of science to environmental problems
- an understanding of aquatic ecosystems and the organisms with which we work
- some appreciation of techniques

School curriculum materials

Mike Copland continues to provide schools with information, training and advice about the placement of CRCFE educational materials within the school program, including:

- The 'Freshwater Invertebrate' guide
- CRCFE posters
- Blue-green Algae teaching kits and
- 'Waterlines, the Barmah-Millewa Redgum Forest' CD Rom.

He is currently completing 'Waterlines - Cotton' CD Rom and Waterlines - Rice' CD Rom for release in March 2000.

In September, the CRCFE, along with other groups from Monash University, participated in the Victorian Education Ministry's Telematics Conference 1998: Teaching and Learning Over Distance. The Telematics Conference was a video conference, teacher in-service focussed on the role of new technologies in distance education.

Glenn Wilson supplied materials for use in developing new senior high school educational resources on the Murray-Darling Basin for Queensland School of the Air (Charters Towers) (July 1998).

School education activities - Mike Copland, MDFRC

Level	Activity	School
Primary	Class Lesson	Bandiana PS (110 kids) Wodonga PS (32) Melrose PS (150) Tawonga PS (25) Tumbaramba PS (24)
Primary	Field Trip	St Monica's PS (120) Bandiana PS (40) Wodonga PS (30)
Primary	Class lesson and field trip	Khancoban PS (25) Burrumbuttock PS (12) Wooragee PS (17)
Secondary	Class Lessons	Wodonga West SC (30) Tumbarumba HS (12) The Scots School (10)
Secondary	Field Trips	Catholic College Wod. (32) Wodonga West SC (21) The Scots School Albury(24)
Tertiary	Billabong lecture and field trip, Wagga, with Terry Hillman	Charles Sturt Uni, 2nd yr Agriculture students
Tertiary	Billabong field trip, Albury	ANU, 3rd yr Geography students (Albury)
Tertiary	Kiewa field trip, Kiewa Valley	Uni of Canberra, 2nd yr Applied Science students. Included natural history lecture by John Hawking.
Tertiary	2 Lectures and 3 field trips	La Trobe Uni, Grad Dip Education Students.

CRC - Rotary Easter School on the Murray-Darling Basin

- Rotary/CRCFE Easter School, Albury/Wodonga: 28 Year 11 students, 2 teachers, 2 Waterwatch coordinators, 2 Applied Science undergraduates from UC and 5 Graduate Diploma Education students from La Trobe, Wodonga. Organised by Mike Copland.
- Rotary/MDFRC River Health Student Forum, Lake Cullulleraine, 29 Year 10 students, 2 teachers, 1 Waterwatch coordinator and several Rotary Mentors. Organised by Ben Gawne.

Demonstrations to school groups

More than 25 schools in Albury/Wodonga have been introduced to freshwater environments through billabong and river field trips. The students have ranged from year four to year 11 and activities are geared to their interest levels. Post Graduate Diploma of Education students from La Trobe University became involved in this year's program. The interest (and understanding) of students from kindergarten up to Year 11 is high, with return visits showing a sound retention of knowledge.

Assistance is being provided to schools involved in "Murder Under the Microscope", an interactive World Wide Web educational activity conducted through Sydney University.

The Lower Basin Laboratory has also been very active with a schools outreach program. Bug collecting and identification field trips have been held for Mildura primary schools, as well as talks and demonstrations.

Barry Hart, Ron Beckett and Ian McKelvie presented a lecture for schools during Science Week. The presentation was subsequently adopted as the Royal Australian Chemical Institutes Hartung Youth Lecture, and presented to audiences at Glen Waverley Secondary College and Lowther Hall.

Teacher In-Services

- 130 participants addressed
- Victorian Science Teachers' Annual Conference, Melbourne -2 workshops
- Mitchell SC teachers, Albury - fieldtrip
- Riverina Science Teachers Annual Meeting, Albury - gave a talk
- Waterwatch Annual Conference, Adelaide - presented a workshop
- Key Learning Groups Conference, Wodonga - presented a workshop
- Communicating Across the Catchment Workshop, Albury - provision of resources

4.4 Other activities

Ian McKelvie attended the CRC Association Education meeting (April).

Other community education activities are included in chapters 8, *Communications*.

Table 4.1
Postgraduate students and topics, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
Honours Commenced						
AMINI, Nana	1/2/99	Water Studies Centre, Monash	McKelvie (Monash)	Development of rapid analytical methods by immobilised enzymes and flow injection analysis	-	
BRUNNER, Peter	1/2/99	University of Canberra	Thoms (UC)	River channel morphology within the lower Balonne River system	-	
DAVIES, Jennifer	2/2/99	Water Studies Centre, Monash	McKelvie (Monash)	Development of a flow injection technique for determination of acetate in anaerobic digestion processes	-	
GRAHAM, Nicholas	1/3/99	Biological Sciences, Monash.	Lake (Monash)	Hyporheos of a sand-bed stream: Creighton's Creek, Victoria	-	
HUBBERT, Elizabeth	1/5/99	Biological Sciences, Monash	Lake (Monash)	Shoreline refugia in a sand-bed stream: Creighton's Creek, Victoria	-	
KURUKULASURIYA , Srimali	1/2/99	Water Studies Centre, Monash	Beckett (Monash)	The speciation of pesticides in aquatic waters and sediments	-	
MOONEY, Angie	1/6/99	University of Canberra	Thoms (UC)	Sedimentation in the Murray Catchment South Coast Catchment Management Committee	-	
OSWALD, Kathryn	1/2/99	La Trobe	Suter (La Trobe) Scholz (MDFRC)	Benthic diatom communities of a temporary stream: Groundwater interactions and effects of nitrogen and phosphorus addition	La Trobe	
PINNER, Andrew	1/6/99	University of Canberra	Thoms (UC)	Heavy Metal storage in Floodplain systems- South Coast Management Committee	-	
SMITH, Ben	1/7/99	University of Adelaide	Walker (Adelaide) Wilson	Observations on the early life history of carp, *Cyprinus carpio*: fecundity, spawning and tolerance of eggs to salinity and dehydration Biophere.	-	
WATTS, Kellie	2/2/99	Water Studies Centre, Monash	Hart (Monash)	Investigation of Pond water phosphorus concentration in lowland river sediments	-	
Honours Continuing						
COCKAYNE, Bernard	1/2/98	La Trobe	Suter (La Trobe) Scholz (MDFRC)	Postdrought macroinvertebrate recolonisation of a temperate seasonally flowing temporary river: Rose River, VIC	La Trobe	MDFRC

Table 4.1
Postgraduate students and topics, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
COOK, Robert	1/7/98	La Trobe	Suter (La Trobe) Scholz (MDFRC)	Effect of shading on biofil biomass macroinvertebrate community structure in the Murray and Darling Rivers at Wentworth	La Trobe Scholarship	MDFRC
CHURCHILL, Ricci	1/2/98	La Trobe	Suter Meathrel (La Trobe)	A retrospective assessment of gold mining in the Reedy Creek subcatchment, North East Victoria, Australia	La Trobe	Dept of Natural Resources (QLD)
BIGGIN, Margo	1/2/98	University of Canberra	Thoms (UC)	Suspended sediment transport in a dryland river: The Barwon-Darling River system	-	
LYDDY-MEANY, Amanda	1/2/98	Water Studies Centre, Monash	McKelvie (Monash)	Determination of silica in Estuarine Waters by Flow Injection Analysis	-	
PEARSON, Melanie	1/7/98	La Trobe	Suter (La Trobe) Walker (Adelaide)	Habitat occupation of the Baetidae (Insecta: Ephemeroptera) in the Rose River, Victoria	La Trobe	
ROBERTS, Kate	1/7/98	University of Canberra	Norris (UC)	Drought: implications for macroinvertebrate recolonisation	Self-funded	
SIM, Lien	1/3/98	Biological Sciences, Monash	Lake/Beardall (Monash)	Interactions between Lake Myriophyllum (Myriophyllum salsugineum Orchard) and microalgae in Lake Purrumbete, Victoria	-	
Honours Completed						
COYSH, Julie	1/3/98	University of Canberra	Norris Thoms (UC)	Macroinvertebrate recolonisation pathways in a gravel bed river: implications of stream substratum complexity	Self-funded	CRCFE - University of Canberra
DAVIES, Nerida	1/3/98	University of Canberra	Norris Thoms (UC)	Prediction of local stream habitat features from catchment characteristics	Self-funded	CRCFE - University of Canberra
LEVINGS, Pat	1/2/98	University of Canberra	Thoms (UC)	The effects of flood frequency and flow-paths on floodplain soil structure and plant growth for two process zones in the Lower-Balonne, south-west Queensland	Bonlac/ DNRE/ WGCMA	
O'CONNELL, Matt	1/8/97	Charles Sturt University	Baldwin (MDFRC) Robertson/ Mitchell (CSU)	Bioavailability of dissolved organic carbon (DOC) derived from components of flood plain litter in a river red gum *(Eucalyptus camaldulensis)*	-	

Table 4.1
Postgraduate students and topics, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
GIARINO, Enzo	1/4/97	University of Canberra	Georges (UC)	Energetics and home range of the golden tree snake in riparian habitats	CSIRO	
MAMALAI, Oscar (JR)	1/2/98	University of Canberra	Thoms (UC)	River channel changes in a semi-arid river	-	MDBC
MCGINNESS, Heather	1/2/98	University of Canberra	Thoms (UC)	Carbon storage in floodplains	EA	University of Canberra
SMITH, Ben	1/7/99	University of Adelaide	Walker (Adelaide) Wilson	Observations on the early life history of carp, *Cyprinus carpio*: fecundity, spawning and tolerance of eggs to salinity and dehydration Biophere	-	
THYER, Jo Anne	1/7/98	University of Adelaide	Walker (Adelaide)	Ecology of the introduced snail *Potamopyrgust antipodarum* in South Australia	University of Adelaide, CRCFE	
WINGLER, Kylie	1/3/98	Biological Sciences, Monash	Lake (Monash)	Effect of small-scale and large-scale disturbances on the marcoinvertebrate fauna of Creighton's Creek, Victoria		WSL Consultants
WU, Sophie	1/2/98	Monash	Hart (Monash)	BAComparison of tow methods, FeOxide-strips and FeOxide-in-gel-, for determining bioavailable phosphorus concentration in natural waters	-	PhD, Uni. Of SA
Masters Commencing						
CURMI, Tim	1/3/99	La Trobe	Suter (La Trobe)	The Health of the Lachlan River	NHT	
HEWLETT, Rebecca	22/4/98	La Trobe	Suter (La Trobe) Metzeling (EPA Vic)	Classification of Victorian streams: Implications of taxonomic resolution, sample frequency and sample method	La Trobe /EPA	EPA, VIC
Masters Continuing						
ALLANSON, Matt	1/3/95	University of Canberra	Norris (UC)	Effects of land use on water quality in coastal freshwaters of New South Wales determined using rapid bioassessment	CRCFE	NSW Fisheries

Table 4.1
Postgraduate students and topics, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
COGHLAN, Jason	1/2/97	University of Canberra	Thoms/ Cho(UC)	Predicting the health of the riverine corridor	Hawkesbury Nepean Catchment Management Trust	
DAVIS, Nicole	6/3/96	University of Canberra	Apte (CSIRO) Maher (UC) Wade (ACTEW)	The fate of ammonia and the effects on the river system	ACTEW	
HARDWICK, Lorraine	4/2/94	Charles Sturt	Hillman (MDFRC)	Relationships between Macroinvertebrate Communities and Riparian Vegetation in Tarcutta Creek- a lowland tributary of the Murrumbidgee River, New South Wales.	Self-funded	
HUNTER, David	1/7/96	University of Canberra	Osborne Georges (UC)	Life history of declining and non declining frogs in the Southern highlands of NSW	Self Funded	
OWEN, Brendan	25/6/96	University of Melbourne	Harris (NSW Fisheries) Palaniswami (Melb)	Electronic monitoring of fishways	MDBC	
ROBERTS, Cherie	1/7/97	University of Western Sydney	Gehrke(NSW Fisheries)	Habitat and niche segregation among larval and juvenile fish in Hawkesbury River lagoon	University of Western Sydney	
THOMPSON, Scott	1/3/98	University of Canberra	Georges (UC)	Systematics of the long-necked turtles in the family Chelidae	ABRS	
TAN, Catherine	2/9/94	Monash	McKelvie (Monash)	Speciation of Mercury and Chromium in Sewage Sludge and Sludge Amended Soils	Self-funded	PhD, UNA
Masters completed						
ROSE, Teresa	30/6/97	University of Canberra	Norris (UC)	Effect of flow regulation on downstream physical habitat structures for macroinvertebrates in the Snowy River, Australia	NSW EPA	DLWC - Cooma
SWIREPIKE, Jody	1/2/95	University of Canberra	Williams (UC) Harris (NSW Fisheries)	Physical disturbance of *Potamogeton tricarinatus* and sediment by carp (*Cyprinus carpio*) in experimental ponds	NSW Fisheries	NSW EPA
JUDGE, David	16/3/98	University of Canberra	Georges (UC)	Reproductive ecology of *Emydura signata*	Nepean Heritage Trust	University lecturer

Table 4.1
Postgraduate students and topics, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
PhD Commencing						
HOWITT, Julia	29/3/99	Monash	Baldwin Rees(MDFRC)	Photochemistry of Aquatic Substances	APA CRCFE top up	
WARD, Jacqueline	1/3/99	La Trobe	Suter (La Trobe).	Ecology of the Murray River Crayfish	Self funded	
SMITH, Ben	1/7/98	University of Adelaide	Walker (Adelaide) Wilson (MDFRC)	Observations on the early life history of carp *Cyprinus carpio*: fecundity, spawning and tolerance of eggs to salinity and dehydration Biosphere	US trust	
WHITE, Lindsay	1/6/99	Monash	Harris (NSW Fisheries)	Hydraulics and fish behaviour in fishways	-	
PhD Continuing						
ASSEMI, Shoeleh	19/1/95	Water Studies Centre, Monash	Beckett Hart (Monash)	Characterisation of humic substances and its role in phosphorus speciation in natural waters	CRCFE Top Up	
BALCOMBE, Stephen	27/8/95	La Trobe	Humphries (MDFRC) Closs (Otago)	Spatial and temporal habitat use in billabongs by small fish assemblages	La Trobe Scholarship	
BEATTIE, Gillian	31/3/96	Water Studies Centre, Monash	Hart/Beardall (Monash)	The role of algae and bacteria in nutrient cycling in lowland rivers	Monash CRCFE top up	
BROWN, Glen	1/6/98	University of Canberra	Norris/Maher (UC)	Relationships between nutrients, algae and invertebrates in the Thredbo River	Kosciusko Thredbo Top up	DNR - QLD
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	
CHEN, Bailin	20/1/97	Monash	Beckett (Monash)	Development of field flow fractionation methods	APA	
CROOK, David	1/3/98	Charles Sturt University	Humphries (MDFRC)	Habitat use and movement of golden perch and carp in a lowland river	CSU	
DAVIS, Karen	1/12/97	University of NSW	Harris (NSW Fisheries)	Genetic variation of Carp *Cyprinus Carpio* in South-eastern Australia	Self funded	

Table 4.1
Postgraduate students and topics, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
DOODY, Sean	20/2/96	University of Canberra	Georges Osborne (UC)	Effects of nest site selection and fluctuating temperatures of *Carettochelys insculpta*	CRCFE Scholarship	
DRIESSEN, Jennifer	1/3/95	Water Studies Centre, Monash	Hart (Monash)	Carbon and nutrient cycling in lowland rivers	CRCFE Scholarship	
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	DLWC -
DUGGAN, Ian	1/3/96	Waikato	Shiel (MDFRC)/ Green Chapman (Waikato)	The ecology of New Zealand North Island Rotifers and their use as bioindicators	Waikato Jolly Fellowship	
EBNER, Brendan	3/3/97	La Trobe (La Trobe) Gawne (MDFRC)	Suter	Introphic interactions between zooplankton and fish	La Trobe Scholarship	
EVANS, Lisa	24/7/95	University of Canberra	Williams Thoms(UC)	Riparian vegetation development and disturbance along the Upper Murray and Murrumbidgee rivers	APA CRCFE Top Up	
FERDINANDS, Rod	1/1/95	Water Studies Centre, Monash	Hart (Monash) Finlayson Gippel (Melb)	Environmental indicators	Self Funded	
FINLAY, Kyla	1/8/96	Biological Sciences Monash	Campbell (Monash)	Taxonomy of freshwater invertebrates (Ephemeroptera)	CRCFE Scholarship	
FONSEKA, Chintha	1/8/92	Water Studies Centre, Monash	Beckett (Monash)	Characterisation of organic matter in wastewaters for optimal recycling and treatment	WSC(I)	
FRANCIS, Cathy	3/3/97	University of Canberra	Thoms Gawne(UC)	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	

Table 4.1
Postgraduate students and topics, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
GRAHAM, Sue	1/2/97	University of Adelaide	Walker (Adelaide)	Impact of water extraction on the endemic invertebrates of Artesian springs in the Lake Eyre Region	APA(1) Western Mining	
GRAY, Leigh	18/7/95	University of Canberra (CRCFE) Ford (CSIRO)	Maher (UC) Lawrence	Role of redox processes in the release of phosphorus from sediments	CRCFE Scholarship	
GREEN, Damian	15/9/95	University of Canberra	Harris (NSW Fisheries) Oliver (MDFRC) Cullen (UC)	Population dynamics and physiology of phytoplanktonin an artificially perturbed reservoir	CRCFE Scholarship	
GRIGGS, Jackie	4/1/95	La Trobe	Croome (La Trobe) Shiel (MDFRC)	Taxonomy, biogeography and ecology of Chydoridae in Australia	ABRS+ CRCFE top up	Tasmania's HECS
JENKINS, Kim	16/3/98	University of New England	Boulton Brock (UNE)	Flood frequency and community dynamics of invertebrates emerging from reflooded sediments of dry lakes in south-western NSW	Menindee Project Scholarship	
JONES, Sandra	1/1/95	University of Canberra	Osborne Williams (UC)	Conservation biology of the endangered legless lizard *Aprasia parapulchella* in the Molonglo catchment	ACTEW RPRA	
KHOSHMANESH, Aazam	1/1/97	Water Studies Centre, Monash	Hart/Beckett (Monash)	Study on biotic and abiotic uptake/release of phosphorus by sediment.	APA CRCFE Top up	
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.	LWRRDC Scholarship	
LLOYD, Natalie	21/8/95	Biological Sciences, Monash	Campbell MacNally (Monash)	Scales of spatial correlation in macroinvertebrate community structure	CRCFE Scholarship	
LOVELL, Belinda	1/5/98	Monash	McKelvie	Transport, Speciation and Bioavailability of Phosphorus in the La trobe River	Bonlac/ DNRE/ WGCMA	

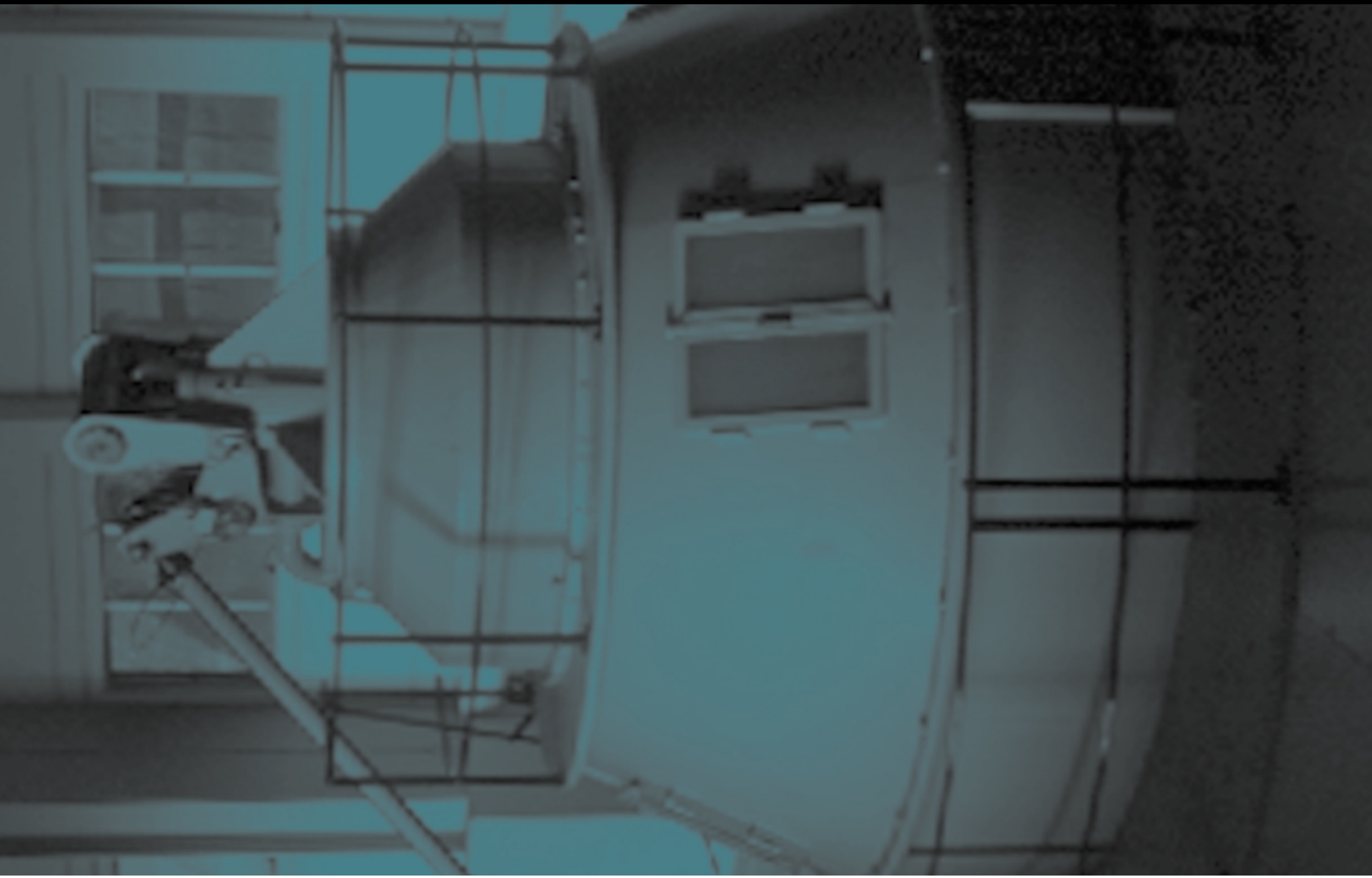
Table 4.1
Postgraduate students and topics, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
MCNEIL, Dale	4/3/96	La Trobe	Hillman (MDFRC) Closs (Otago) Gehrke (NSW Fisheries)	Fish, zooplankton and algae dynamics in Murray River billabongs	APA CRCFE top up	
MITCHELL, Alison	1/6/98	Charles Sturt University	Baldwin (MDFRC) Robertson (CSU) Rees (MDFRC)	The effects of hydrological regime on the potential for bacterially mediated phosphorus release from freshwater sediments	CRCFE	
NIELSEN, Daryl	1/7/94	Charles Sturt University	Shiel/Hillman Klomp (MDFRC)	The influence of flooding regimes on the ecology of billabongs: and experimental approach	LWRRDC	MDFRC
NIAS, Deborah	27/1/95	Biological Sciences, Monash Top up	Bailey (Monash)	Foodweb structure in an ephemeral floodplain wetland	Monash CRCFE	
OSWALD, Louisa	20/11/95	University of Canberra	Norris/Maher (UC)	In situ toxicity testing of water quality	.APA CRCFE Top up	
PARSONS, Melissa	12/9/95	University of Canberra	Norris/Thoms (UC)	Compositional patterns of lotic benthic macroinvertebrates: Relationship to habitat and the scale of measurement	APA CRCFE Top up	
PETERSON, Kylie	3/3/97	University of Canberra Humphries (MDFRC)	Kearney Thoms (UC)	Age, growth and survival of larval fish in the Murray-Darling Basin	APA CRCFE Top Up	
PUCKRIDGE, Jim	1/7/89	University of Adelaide	Walker (Adelaide) Australia	Flow variability and fish ecology in an arid zone floodplain river, Cooper Creek, Central	Self funded	
ROSE, Louise	5/12/97	University of Canberra	Gerritsen (UC)	Investigate management response and adaptations to coastal change in the face of increasing population and environmental stresses	-	

Table 4.1
Postgraduate students and topics, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
SCHREIBER,Sabine	1/4/94	Biological Sciences, Monash	Lake / Quinn (Monash)	Ecology of the introduced snail *Potamopyrgus antipodarum* and its effects on native fauna	CRCFE Scholarship	WSC - Monash
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	WSC-Monash
STOFFELS, Rick	1/2/98	La Trobe	Humphries (MDFRC)	Diet habitat associations of Midgley's gudgeon within and among floodplain billabongs: the role of their interaction with perch and mosquitofish	-	
TADJIKI, Soheyl	19/1/95	Water Studies Centre, Monash	Beckett (Monash)	The application of FFF techniques to the study of colloids	Monash Scholarship CRCFE top up	
THOMSON, Jim	1/7/94	Biological Sciences, Monash	Lake (Monash) Downes (Melbourne)	Influences of disturbance on predation in streams	APA	
TREADWELL, Simon	2/9/96	Biological Sciences, Monash	Lake MacNally Campbell (Monash)	Role of snags in carbon dynamics in lowland rivers	CRCFE Scholarship	
TSYRLIN, Edward	1/7/95	Biological Sciences, Monash	Campbell (Monash)	Taxonomy of the Plecoptera	CRCFE Scholarship LWRRDC	
VAN BERKEL, Jason	1/2/95	Water Studies Centre, Monash	Beckett (Monash)	Colloid characterisation and dynamics in reservoirs	CRCFE Scholarship	Self employed
PhD Completed						
INMAN, Mathew	1/2/96	University of Sydney	Baldwin (MDFRC)	Phosphate-ester hydrolysis mediated by mineral phases	ARC	Lyonnaise des Eaux (large water company) Kuala Lumpur
MINCHIN, Stuart	28/3/94	Water Studies Centre, Monash	McKelvie Hart (Monash)	Methods for the determination of bioavailable phosphorous using membrane immobilise enzymes	MGS CRCFE top up	DNRE - VIC

5 Knowledge Exchange



Knowledge is fundamental to the effective management of natural resources, and the CRC now sees the generation and exchange of knowledge as its core business. We now have two knowledge brokers whose specialist role is to interface with our partners and other stakeholders and provide a window to the ecological knowledge of the CRC. We also have a Communications Manager to deal with publications, newsletters, public communication and media activities.

The knowledge business that we operate has four key elements:

- Knowledge Strategy Development where we work with partners to identify knowledge needs
- Knowledge Generation ñ the research process by which new knowledge is created
- Knowledge Exchange by which knowledge is packaged and delivered to appropriate audiences, and dialogue is held to assess its usefulness
- Knowledge Management where we help develop systems that ensure knowledge is accessible as needed

The major elements in our knowledge exchange program are outlined below. They are organised around our major strategies:

- Providing members for various Government and Community Committees
- Support for Expert Panels on Flow Issues
- Specialist Seminars and advice
- Consultancies

The publications and media activities of the Centre are reported elsewhere.

5.1 Highlights

The CRCFE publication 'Living on Floodplains' was awarded the SA Ford Landcare Award for media.

Urban pond and wetland design principles have been published and promoted widely. The design principles were incorporated into best practice stormwater management guidelines developed by Melbourne Water, EPA Victoria and EPA NSW. The design principles were also included in a stormwater management course developed by Monash University, and were included in the design of a major wetland system as part of the Port Phillip Bay Stormwater Quality Initiative. The CRCFE in collaboration with the CRC for Catchment Hydrology held to a series of well-received and successful public seminars on urban wetland. Computer models to assist pond and wetland design are available on the CRCFE website.

Ecological aspects of stream restoration were widely promoted in a series of seminars with the CRC for Catchment Hydrology (now on video).

AUSRIVAS modelling continued, with its use in a statewide assessment using the Index of Stream Condition in Victoria, and interest in its use shown by Indonesia and New Zealand. The CRCFE continued to provide training in the use of AUSRIVAS across Australia.

The CRCFE played a major role in assisting the MDBC set future research directions as part of its Riverine SI&E program.

The Mildura lab continued to play a large role in promoting the need for continued research on the management of carp.

The CRCFE provided scientific advice that assisted in the development of a draft management plan for the Lake Eyre Basin

CRCFE expertise was sought and used widely for establishing environmental flows in regulated rivers across south-eastern Australia. This included representation on Healthy River Commission expert panels for the Shoalhaven, Woronora and Hawkesbury-Nepean Rivers in NSW, and the expert panel for the Snowy River.

Increasingly the CRCFE is seen as a provider of high quality, independent advice, which has resulted in a significant increase in consulting activities.

CRCFE undertook a major consultancy to identify the likely ecological outcomes of the COAG Water Reforms.

Brochure 'Sustainable Rivers: The Cap and Environmental Flows' produced by the CRCFE was launched by Federal Minister for the Environment, Senator Hill and well received across the Murray-Darling Basin.

John Whittington was awarded a Department of Science, Industry and Tourism funded Science Media Fellowship with the ABC.

The River Murray. Photo: D Eastburn

5.2 Membership of committees

One effective way to make our expertise available is to encourage staff to serve on Government and community committees.

Peter Cullen with other members of the Prime Minister's Science, Engineering and Innovation Council.
Photo: K Markwort

Peter Cullen

President, Federation of Australian Scientific and Technological Societies.
Member, Prime Ministers Science, Engineering & Innovation Council
Director, Landcare Australia Limited
Chair, ACT Environment Advisory Committee,
Member, ACT Science and Technology Council
Member, Gungahlin Development Authority,
Chair, National River Health Program Advisory Committee
Chair, ACT State Assessment Panel. National Heritage Trust.
Chair, Technical Advisory Committee, Gippsland Water
Member, Community Advisory Committee, Murray-Darling Ministerial Council,
Adviser, Lake Eyre Catchment Management Coordinating Group
Scientific Advisory Committee, Parks Victoria
Director, Water Research Foundation of Australia

Ben Gawne

Cardross Lakes Task Group
Mallee CMA Nutrient Management Steering Committee
Mallee CMA floodplain and waterway management Steering Committee
Murray & Lower-Darling Catchment Management Committee, NHT Technical Assessment Panel
Sunraysia Regional Algal Coordinating Committee
Mallee CMA Lindsey/Walpolla Reference Committee

Supply channel and waterwheel, Murrumbidgee Irrigation Area.
Photo: B van Aken, CSIRO Land and Water

A turbine-generator at Hume Dam

Barry Hart
Member, Catchment Management Council, Victoria
River Health Committee
Resource Assessment Committee
Chair, Victorian Water Quality Committee

Terry Hillman
Member, MDBC Riverine Issues Working Group
Member, North East Catchment Management Authority
Member, Faculty Honours Committee, Charles Sturt University
Member, NSW Murray Unregulated River Management Committee.
Member, NSW State Technical Advisory Committee examining Integrated monitoring of Environmental Flows (IMEF).
Member, Murray Lower Darling Community Reference Committee,

Sam Lake
Member, National River Health Program Advisory Committee

Ian Lawrence
Member, Steering Committee Canberra Urban Lakes Management Plan, Department of Urban Services, ACT
Member, Steering Committee Integrated Catchment Plan for the ACT, Environment Australia
Chair, National Urban Stormwater Management Working Group, Environment Australia

John Whittington
Murray Unregulated River Management Committee

Glen Wilson
Murray & Lower-Darling Catchment Management Committee, NHT Technical Assessment Panel
National Carp Taskforce
Member, Steering Committee Bookmark Biosphere Reserve wetland management project.

Supply channel flow and level control, Murrumbidgee Irrigation Area, NSW. Photo: B van Aken, CSIRO Land and Water

5.3 Support for Expert Panels on Flow Issues

One of the major issues in Australian water management is the provision of environmental allocations. A common approach pioneered by the CRC is the use of expert panels to make interim proposals for subsequent testing. Staff have participated in a number of such panels over the year.

Peter Gehrke

Barwon-Darling River Management Committee, Technical Adviser to set interim flow rules and water trading rules.

Cox's River Review, Member of Scientific Reference Panel

John Harris

Woronora River environmental flows expert panel, Healthy Rivers Commission Advice to Snowy Water Inquiry

Richard Norris, Peter Gehrke

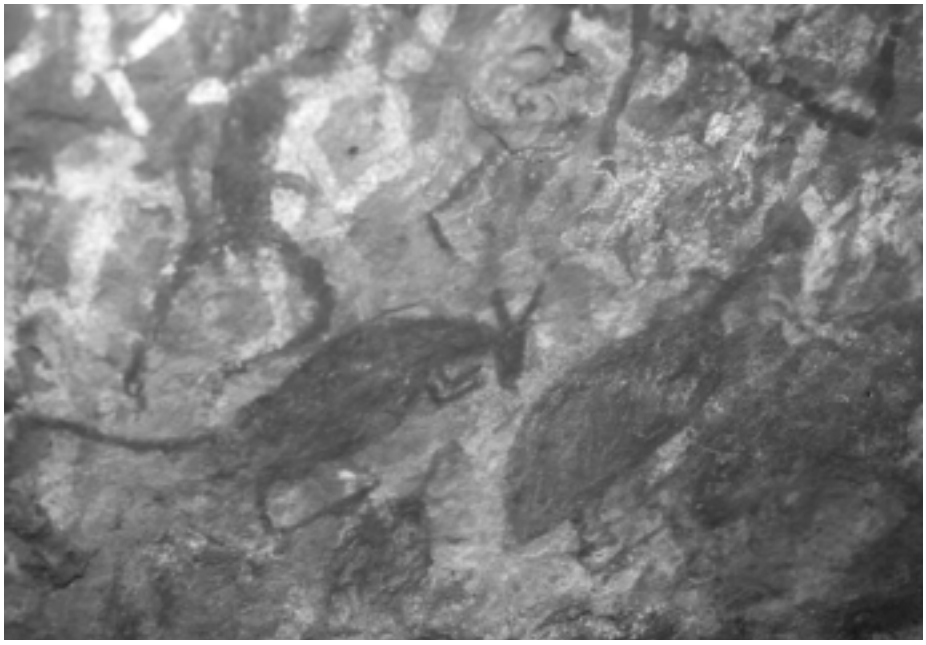
Expert Panel for Gosford-Wyong Councils Water Authority

Craig Schiller

Technical Advisory Panel on the Queensland Government's Water Allocation Management Plan for the Border Rivers and the Condamine-Balonne Rivers

Martin Thoms

Water allocation management plan (WAMP) for the Condamine-Balonne River system
Environmental flow regimes for the Wakefield and Gawler Rivers. SA Department of the Environment, Heritage and Aboriginal Affairs



Aboriginal cave paintings at Mt Grenfell near Cobar in western NSW. The Murray-Darling Basin has a rich Aboriginal art heritage. Cultural centres and keeping places in many parts of the region provide a focus for Aboriginal creativity and are valuable educational facilities for the wider community. Photo: David Eastburn

5.4 Specialist Seminars

Agency	Project/Activity	Staff involved
ACT Electricity & Water	Nitrogen management in ACT waterways	Ian Lawrence, Peter Cottingham
	Research outcomes and emerging management needs	Ian Lawrence, Bill Maher
Australian Institute for Environmental Health	Use of Constructed Wetlands for Wastewater Treatment	Peter Breen
Australian Water & Wastewater Association	Seminar on Chaffey Dam	John Whittington
	Address to the AWWA Mt Eliza Business School Executive Program	Peter Cottingham
	Seminar on Advances in ecological & water quality monitoring	Ian Lawrence
Charles Sturt University	Seminar at the Johnstone Centre on 'Determining Environmental Flows required in the Cardiangullong Creek below a newly established dam'	Terry Hillman and Rhonda Sinclair
Environment Australia	Presentation to representatives of ASEAN countries on Biological Assessment of Water Quality and the National River Health Program	Richard Norris
	Presentation on 'Science in Government'	Peter Cullen
	A one-day workshop looking at how States are defining Stressed Rivers	Peter Cullen (chair)
Australian National University	'Communicating Science' to Post Graduate Communication Students	Peter Cullen
Department of Urban Services, Canberra	Urban drainage seminar	Ian Lawrence
Goulburn-Murray Water Board, Tatura	Floodplains and their links to rivers	Terry Hillman

Agency	Project/Activity	Staff involved
Goulburn-Murray Water, Tatura	Environmental flows - the Campaspe experiment	P Humphries
Goulburn-Murray Water	Convened a Constructed Wetland Design Workshop	Ian Lawrence, Peter Breen and Tony Wong
Goulburn-Murray Water, Tatura	Eutrophication and algal management	Rod Oliver
Institution of Engineers	Presentation – Ecological effects of weirs, North Sydney	John Harris
International Erosion Control Assoc. Melbourne	Convened a Constructed Wetland Design Workshop	Ian Lawrence and Peter Adcock
Emergency Management Australia	'Algal Blooms' at a workshop on 'Planning for ecological emergencies: identifying ecological contingencies and uncertainties and framing planning and response'	John Whittington
NSW National Parks and Wildlife Service	Forum on allocation of environmental flows to the Macquarie Marshes	John Harris, Terry Hillman, Paul Humphries
North East Catchment Management Board Meeting, Lake Epalock	Campaspe Project	P Humphries
Office of Conservation seminars	NSW Rivers Survey and Index of Biotic Integrity	John Harris
CRC Catchment Hydrology	Stream Restoration Seminar	Sam Lake, Peter Breen and Ian Rutherford

5.5 Specialist Advice and Presentations

The CRCFE also makes presentations to a number of committees and organisations.

Organisation	Activity	Staff
Beulahdelah Anglers Club	Presentation of Angling Catch Database project	John Harris
Bicentennial Park Homebush	Scientific Panel meeting Contributed to Lake Belvedere Management Plan	John Harris
Catchment Management Authorities	Incorporation of AUSRIVAS model inputs into the revised Index of Stream Condition which is being applied across Victoria by CMA's	Leon Metzeling
Catchment Management Council, Victoria	Presented an overview of CRCFE ecological assessment activities to the Council	Richard Norris
Department of Natural Resources and Environment, Victoria	Victorian Best Practice Environmental Management Guidelines for Urban Stormwater, Technical Working group	Peter Cottingham Peter Breen
	Provided information on Lower Basin Laboratory Carp Research and Carp Management to department officers from Swan Hill	Glenn Wilson
	Provision of AUSRIVAS assessments and habitat data for statewide Index of Stream Condition assessments	Leon Metzeling
Environment ACT	Advice on environmental flow policies	Ian Lawrence
Environment Protection Authority NSW/Vic.	Provided comment on the occurrence of *Daphnia lumholtzi* in Australian Rivers to T Kobayashi	Russ Shiel
	Provided advice on the use of PET bottles for nutrient analyses and maintenance of live zooplankton in the laboratory setting	Russ Shiel
	Provided information on the CRCFE Menindee carp research to the water reform unit of the NSW EPA	Glen Wilson

5.5 Specialist Advice and Presentations, continued

Organisation	Activity	Staff
Environment Protection Authority NSW/Vic	Development of ecological objectives for the State Environment Protection Policy for the Western Port Bay and Catchment being revised by EPA Victoria	Leon Metzeling
Fletcher Challenge Paper	Provided guidelines for discharge of cooling water to Eight Mile Creek	John Hawking
Goulburn-Broken River Catchment Management Authority	Presentation on stream restoration and the Granite Creeks project to the Water Quality Committee of the Goulburn-Broken River CMC, Seymour	Sam Lake
Lachlan River Management Committee	Held discussions on Lower Basin Laboratory carp research and carp management in the Lachlan River	Glenn Wilson
Lower Murray Darling Catchment Management Committee	Drafted recommendations for local carp management and data needs for inclusion in the Lower Murray Darling Catchment Management Plan	Glenn Wilson
Land and Water Resources Research & Development Corporation	Attended a LWRRDC workshop on Research Initiatives in Melbourne, September	Barry Hart
	Member of a Reference Group for a LWRRDC funded consultancy: *Identifying and protecting high ecological value rivers*	Terry Hillman
	LWRRDC project review: Nutrient control in irrigation drainage systems using artificial wetlands, Brisbane	Peter Breen
	Participated in a LWRRDC workshop examining current and future directions for the River Restoration and Management R&D Program	Simon Treadwell

5.5 Specialist Advice and Presentations, continued

Organisation	Activity	Staff
Melbourne Water Corporation	CRC CH/FE Short Course on Stormwater Management delivered to Melbourne Water Corporation (with A. Prof. Tony Wong), Monash University	Peter Breen
	Field based talk to Melbourne Water officers on stream–floodplain interactions, Yarra River and Dandenong Creek floodplains	Peter Breen, Terry Hillman and Peter Cottingham
	Melbourne Water NHT Project: Port Phillip Bay Stormwater Quality Improvement (Coasts & Seas Program), Working Group and Design meetings	Peter Breen
	Victorian Best Practice Environmental Management Guidelines for Urban Stormwater, Technical Working Group	Peter Breen
	Melbourne Water Yarra Operations, Yarra River Stream Flow meeting	Peter Breen
	Workshop to evaluate outputs from the CRC CH catchment load model FILTER, Melbourne Water	Peter Breen
	Briefing note on the behaviour of heavy metals in waterways	Peter Cottingham
	Implementation of Melbourne Water – Waterway and Drainage Group internal technology transfer plan	Peter Cottingham
	Review of MW biological monitoring network approach	Chris Walsh, Peter Newall and Peter Cottingham

5.5 Specialist Advice and Presentations, continued

Organisation	Activity	Staff
NSW Nature Conservation Council	Water and Wetlands Management Conference. "Resolving Conflicts over Water"	Peter Cullen
	Gave advice on Walgett Weir proposal	Peter Gehrke
	Water and Wetlands Management conference presentation: 'Ecological Drivers for Change'	John Harris
NSW Water reforms	Policy and Technical Committee	John Harris
North East Catchment Management Authority	Gave two talks on carp impact and control to the Authority, Wodonga	Terry Hillman
NT Department of Lands, Environment and Planning	LWRRDC funded training project for Department staff in the use of Ausrivas for water quality monitoring	Richard Norris and Sue Nichols
Patawalonga Catchment Water Management Board	Review of Sturt River water quality (Heathfield WWTP licensing)	Ian Lawrence
Queensland Department of Natural Resources	Review of Queensland Stormwater re-use Strategy for DNR	Ian Lawrence
Stanwell Park	Presentation on Angling Catch Database	John Harris
State Fishways	Program meeting, Sydney, Fish passage strategy meeting, Port Stephens	
Sydney Water Corporation	Research outcmes and emerging management needs	Ian Lawrence
Victorian Catchment and Land Protection Council	Presentation on CRCFE ecological assessment activities to the Council	Richard Norris
Wagga Wagga City Council	Provided information on Carp control options with the council	Glen Wilson

5.5 Specialist Advice and Presentations, continued

Organisation	Activity	Staff
Walgett Shire Council	Advice to the Council on Walgett Weir proposal	Peter Gehrke
Wetland Care Australia	Supplied information on hydrologic manipulation as a carp control technique for South Australian sites	Glenn Wilson
Brisbane River Festival	Presented the Keynote Address to the Brisbane River Festival. 'River Restoration: Challenges for the Future'	Barry Hart
Brisbane River and Morton Bay Scientific Review Committee	Attended a Brisbane River and Morton Bay Scientific Review Committee Workshop, Brisbane	Barry Hart
Canberra Business Council	Presentation on 'Australia in a Competitive Global Environment'	Peter Cullen
Deans of Science	Presentation to a Deans of Science Meeting 'Some Futures for Science?'	Peter Cullen
Environment Institute of Australia	Presented an overview of the CRCFE, its role, activities and achievements to the Environment Institute of Australia at the Botanic Gardens, Canberra	Karen Markwort
Mallee Catchment Management Authority	Gave a talk to the Mallee CMA about laboratory research and the proposed Catchment Management School	Ben Gawne
Municipal Association of Victoria	Outlined CRCFE programs to the Association	Peter Cottingham
North Central Catchment Management Authority	Presented a session 'Modelling Algal Biomass in Cairn Curran Reservoir' at a Natural Resource Management Seminar	Ian Fraser

5.5 Specialist Advice and Presentations, continued

Organisation	Activity	Staff
North Central Catchment Management Authority	Presentation on 'Whole of Catchment Management for the control of sediment delivery: the case of the Eppalock Catchment'	Jenny Davis
	Presentation on the 'Campaspe Flow Manipulation Project'	Paul Humphries
Parliamentary Secretary for the Environment	Made a presentation to Senator Ian McDonald (Parliamentary Secretary for the Environment), Albury	Darren Baldwin
Riverwatch	Presented a talk on the Lower Basin Laboratories research program at the Riverwatch AGM in Dareton	Ben Gawne
Waterwatch	Presented sessions on biological assessment at the National Waterwatch Conference	Richard Norris

5.6 CRCFE Consulting activities

Consulting work has always been a significant part of the CRCFE's knowledge exchange activities. Consulting projects provide an opportunity to apply the knowledge and expertise generated by the CRCFE to aid informed decision making and to address specific issues. Consulting work is also a revenue source that assists with the wider knowledge exchange activities conducted by the CRCFE.

Major Consultancy projects

Environmental Scan of the Namoi River Terry Hillman

Environment Flows for Thomson Macalister, Victoria. Hart, Thoms, Hillman, Growns, Humphries, Cottingham West Gippsland Catchment Management Authority

Lake Cawndilla diversion assessment. Terry Hillman Department of Land and Water Conservation

Likely Ecological Outcomes of the COAG Water Reforms. Peter Cullen, John Whittington and Greg Fraser. Environment Australia

A stockpile of timber to fuel one of the irrigation pumps in the Riverland of South Australia, 1918. This is a typical example of one of the wood stacks maintained for steam-and-gas powered pumps in the Riverland and Sunraysia until the 1950s. Photo: South Australian Riverland Water Collection

Nathan Dam Review Peter Cullen and Terry Hillman Department of Natural Resources (Qld)

Riverine Management and Rehabilitation Scoping Study. Cottingham, Whittington, Hillman, Walker, Harris, Oliver, Norris, Hart, Cullen, Dugdale Murray Darling Basin Commission

Woronora River Environmental Flows Scoping Study. Hillman, Thoms, Harris, Growns, Quinn, Cottingham Sydney Water Corporation

Identification of microfaunal samples from Salinity Action Plan surveys. Russ Shiel Catchment & Land Management, WA

A summary of consulting activities is presented in the following figures. The number of consultancies, revenue received and revenue per consultancy all increased significantly in 1998/99, even though the CRCFE declined to accept a number of offers for additional work. This is indicative of the growing recognition of the CRCFE as a provider of high quality, independent advice to the water industries.

Figure 5.1:
Number of consultancies undertaken annually

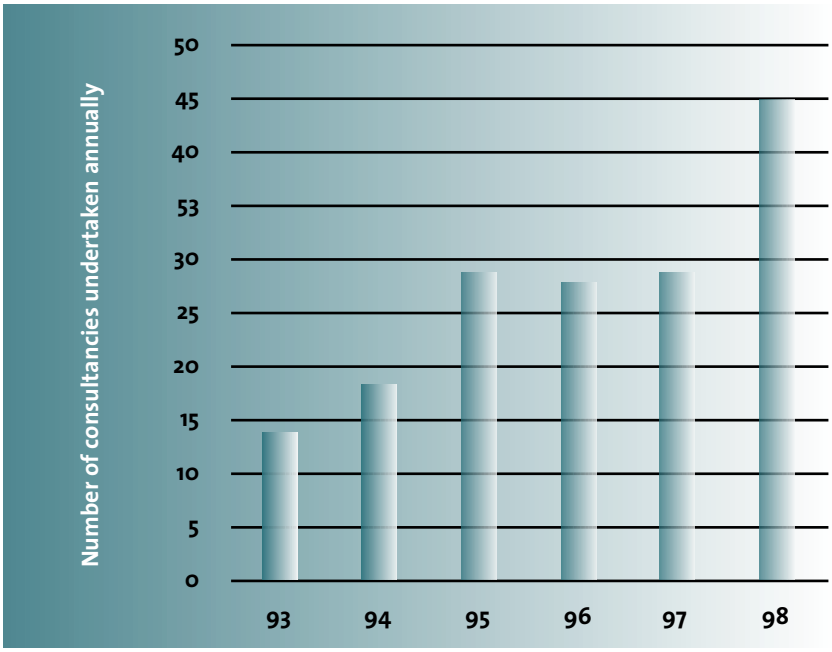
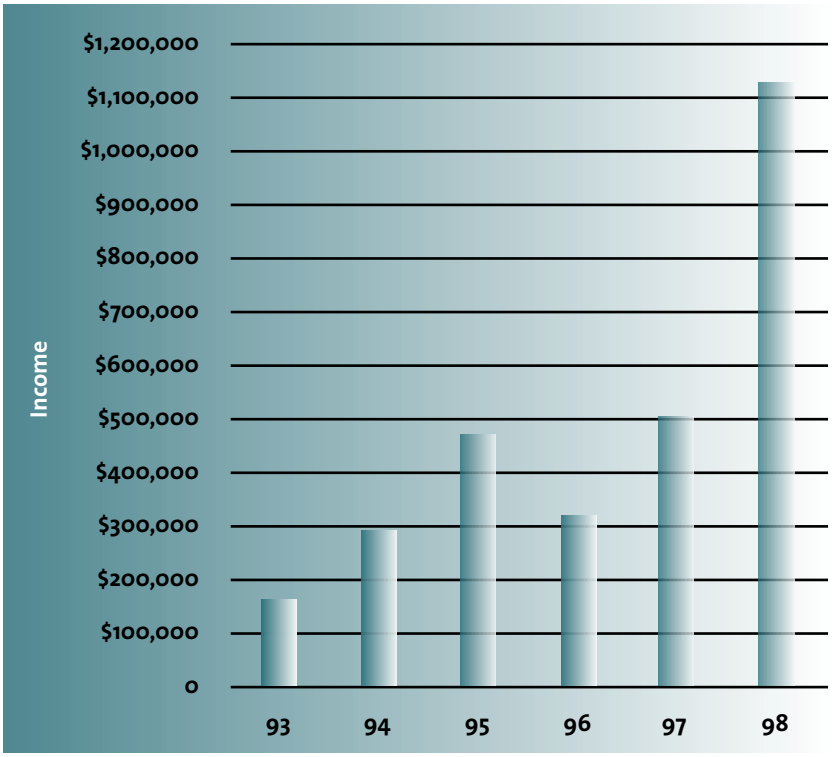


Figure 5.2:
Annual income received from consultancies



5.7 Technical support to consulting groups

In addition to undertaking consulting work directly or as a sub-consultant, the CRCFE also provides general advice to consultants undertaking natural resource projects.

Consultant	Activity/Project/Bid	Person
CMPSE	Met with CMPSE (Melbourne) to discuss potential technology exchange	Peter Cottingham
Gutteridge, Haskins & Davey Pty Ltd	Met with GH&D about conservation issues in the Mallee	Ben Gawne
Phillip Fox Associates	Briefing on Gum Bend Lake, Condoblin safety issues	Ian Lawrence
Sinclair Knight Merz	Brisbane: Review of Mango Hill Lake proposal	Ian Lawrence
	Provided advice to SKM for these projects: • Launceston Wetland Design Guidelines for SKM Melbourne • Stormwater Quality Interception Devices Strategy, Brisbane City Council, for SKM Toowoomba • Facilitation of field inspections: Murrumbidgee – River Catchment Management Committee – • Inspection of Canberra's stormwater management facilities.	Ian Lawrence
	Etiwanda Wetland Concept Plan development	Peter Breen
	Presented a technology transfer workshops in Sydney, Brisbane and Melbourne. The workshops were designed to assess what type and form of information the organisation requires from the CRCFE.	Ian Lawrence and Peter Cottingham
	Presented specialist workshop on the design of constructed wetlands, Brisbane, Sydney and Melbourne	Ian Lawrence

An old water-driven grain mill, Adelong NSW. Settlers used freshwater for many different purposes.
Photo: D Eastburn

Irrigated vineyards and citrus blocks near Mildura in the Sunraysia region of Victoria.

Technical support to consulting groups, continued

Consultant	Activity/Project/Bid	Person
Willing and Partners	Kingston Lodge wetland review report and presentation to Planning Review Board	Ian Lawrence
	Helensburgh Pond Review - final report submitted	Ian Lawrence
	Clarence Stormwater Management Strategy	Ian Lawrence
	Presented technology transfer workshops, Sydney and Canberra	Ian Lawrence and Peter Cottingham
	Presented specialist workshop on the design of constructed wetlands, Sydney and Canberra	Ian Lawrence

Salt crystals on remains of dead tree trunk at Quairading, WA Photo: B van Aken, CSIRO Land and Water

6 Staffing and Administration

The achievements of the Cooperative Research Centre for Freshwater Ecology are largely due to the hard work and commitment of its staff. The Centre's culture of working collaboratively and aiming for excellence has created an organisation where quality, vitality and goodwill are the norm.

6.1 Specified personnel

The specified personnel from Schedule 5 of the Commonwealth Agreement have not changed during the year and are as follows:

Prof Peter Cullen	University of Canberra	Director	100%
Dr John Harris	NSW Fisheries	Program Leader	80%
Prof Barry Hart	Monash University	Program Leader	75%
Dr Terry Hillman	MDFRC	Program Leader	100%
Prof Sam Lake	Monash University	Program Leader	75%
Assoc Prof Richard Norris	University of Canberra	Program Leader	75%
Dr Rod Oliver	MDFRC	Program Leader	100%

The annual staff meeting, held at the MDFRC, Albury. Photo: K Markwort

6.2 Staff commencing and departing

Staff commencing		
Name	**Position**	**Location**
Elizabeth Ash	Research Assistant	MDFRC
Barry Blythman	Technician	Monash-Water Studies Centre
Sophie Bourgues	Research Scientist	Monash-Water Studies Centre
Bernie Cockayne	Technician	MDFRC
Brett Cole	Research Assistant	Monash-Water Studies Centre
Anthony Conallin	Technician	MDFRC
Julie Coysh	Research Assistant	UC
Nerida Davies	Research Assistant	UC
Iain Ellis	Technician	MDFRC-Mildura
Graeme Esslemont	Research Scientist	UC
Mike Harper	Research Scientist	Monash-Water Studies Centre
Martin Lourey	Research Assistant	Monash-Water Studies Centre
Mary Luckin	Administration	Monash-Water Studies Centre
David McGill	Technician	NSW Fisheries\
Sue Nichols	Research Assistant	UC
Kristine Phan	Systems Administrator	UC
Claire Sellens	Research Assistant	Monash-Water Studies Centre
Soheyl Tadjiki	Research Scientist	Monash -Water Studies Centre
Claire Townsend	Admin Officer	UC
Leanne Whiley	Technician	NSW Fisheries

A beautifully restored paddle steamer on the Murray River.

Staff Departing Name	Position	Location
Johanna Berryman	Administration	UC
Fiona Betts	Technician	MDFRC-Mildura
Paul Blackman	System Administrator	UC
Karyn Davis	Research scientist	UC
Jannine Gibson	Administration	Monash-Water Studies Centre
John Gooderham	Research Assistant	Monash-Water Studies Centre
John Harris	Program (F) Leader and senior research scientist	NSW Fisheries
Simon Hogan	System Administrator	UC
Martin Lourey	Research Assistant	Monash-Water Studies Centre
Karen Markwort	Communications Manager	UC
Tim Marsden	Technician	NSW Fisheries
Oliver Scholz	Research Scientist	MDFRC-Mildura
Justen Simpson	Research Assistant	UC
Jason van Berkel	Research Scientist	Monash-Water Studies Centre
Meredith Walton	Admin Officer	UC

A stone sculpture by a Mexican sculptor in The Living Desert area near Broken Hill. Australian and international sculptors held an eight week sculpture symposium in The Living Desert to create this outdoor sculpture series. Photo: D Eastburn

6.3 Staff Development

Information Technology

Claire Townsend (UC) attended Lotus Notes training.

Estelle Oliver (MDFRC, Albury) attended a training course on searching Kinetica Web.

Estelle Oliver (MDFRC, Albury) attended the CSIRO Information Management & Technology Conference.

Kristine Phan(UC) attended Sun Systems Fundamentals of Solaris 2.X training.

First Aid

Simon Hartley, Tim Marsden, Dean Gilligan, Matthew Barwick (NSW Fisheries)

FWD Training Course

Zygmunt Lorenz, Shane Perryman, Trish Bowen and Chester Merrick (MDFRC Albury)

Simon Hartley, Tim Marsden, Dean Gilligan, Matthew

Barwick, Andrew Bruce (NSW Fisheries)

CSIRO/BHERT Leadership of Research and Development Teams
Peter Cottingham (Melbourne Water)

Rod Oliver (MDFRC)

Darren Baldwin (MDFRC)

CSIRO/BHERT Leadership and Career Development Course
Jackie Griggs (MDFRC)

Melissa Parsons (UC)

Mike Grace (Monash)

Communications Training
Helen King (MDFRC, Albury) and Glen Wilson (MDFRC, Mildura) attended a Media Skills Workshop for Scientists, run by Econnect.

Dianne Flett (UC) attended NLP Communications Training.

Karen Markwort (UC) attended the CRC Communicator's Conference.

Estelle Oliver (MDFRC, Albury) attended the Australian Copyright Council Melbourne, Copyright for Non-profit Libraries Seminars.

6.4 AWARDS

Goulburn Murray Water won an Institution of Engineers (Victoria), Engineering Excellence Award for the Muckatah Drainage Scheme Stage 1. The CRCFE (Dr P. Breen) and Neil Craigie and Associates Pty Ltd, in association with Sinclair Knight Merz Pty Ltd, provided the concept design for the system.

Dr Rod Oliver and Dr John Hawkings were awarded the "Certificate of Recognition" by NATA (National Association of Testing Authorities) as Assessors in the Field of Biological Testing.

Rhonda Butcher, a CRCFE PhD student, won the Australian Society for Limnology, 1998 Congress,

Student prize for an oral presentation. Rhonda is studying with Sam Lake at Monash University,

Prof Sam Lake won the 1998 Chairman's award.

Kerry Beggs,a CRCFE Honours student, won the 1998 University of Canberra Medal for outstanding academic Merit. Kerry is supervised by A/Prof Arthur Georges.

Sue Nichols identifying macroinvertebrates
Photo: K Markwort

6.5 Grants held by CRCFE researchers

Continuing Grants held by CRCFE Researchers					
Researcher	**Organisation**	**Project**	**Funding Source**	**Period**	**Total Funding**
Hillman	MDFRC	Billabong-river interactions during high flow in the mid-Murray region	NRMS	Sep95 - Aug98	$213,000
Hillman	MDFRC	Riverine and floodplain interactions during high floW	LWRRDC	Jul96 - Jun99	$278,000
Kearney	Uni of Canberra	Issues affecting the sustainability of Australia's freshwater fisheries resources and identification of research strategies	FRDC	Jul97 - Feb99	$228,000
Lake/ Humphries	Monash University/ MDFRC	Environmental flows on the Campaspe river	LWRRDC	Jul96 - Jun01	$696,000
Lawrence	ACT Government	Physical and nutrient factors controlling algal succession and biomass in Burrinjuck Reservoir	LWRRDC	Mar97 - Jun99	$100,000
Norris	Uni of Canberra	*In situ* toxicity testing	LWRRDC	Aug95 - Jul98	$ 87,000
Oliver	MDFRC	Variation in algal availability of phosphorus from different catchment sources	LWRRDC	Mar97 - Jun00	$289,000
Osborne	Uni of Canberra	Factors influencing pool habitat selection and tadpole survival by declining and non-declining amphibians of SE Australian waters	NSW NPWS	Jul97 - Dec99	$41,000
Schiller	NSW Fisheries	Downstream transport of larval and juvenile fish	NRMS	Jan97 - May00	$377,000
Thoms	Uni of Canberra	In-stream processes and environmental flow requirements for the Barwon-Darling River	LWRRDC	Mar95 - May99	$230,000
Copland	MDFRC	Waterlines: Studies in irrigation in the basin	NRMS	Sep97 - Aug00	$245.000
Gawne	MDFRC-Mildura	Drying effects on the ecology of Menindee lakes	NSW WMF	Jan98 - Dec98	$203,000
Gawne	MDFRC-Mildura	Hydrolic manipulation as a potential carp control strategy	NSW WMF	Jan98 - Dec99	$140,000

Continuing Grants held by CRCFE Researchers, continued					
Researcher	**Organisation**	**Project**	**Funding Source**	**Period**	**Total Funding**
Gawne	MDFRC-Mildura	The impact of flow regulation on carbon and nutrient cycles of floodplain wetlands of the River Murray	NSW DLWC	Mar97 - Feb00	$60,000
Georges	Uni of Canberra	Temperature dependent sex determination in reptiles the effect of fluctuating temperatures in natural nests	ARC	Jan96 - Dec98	$69,800
Georges	Uni of Canberra	Genetic differentiation among freshwater turtle populations and relationship to recent glacial events	ARC	Jan - Dec98	$30,000
Harris	NSW Fisheries	Regulated rivers and fisheries restoration	NSW WMF	Jan98 - Dec99	$415,000
Osborne/ Georges	Uni of Canberra	Potential impact of ultraviolet-B radiation on amphibians	ARC	Jan - Dec98	$30,000
Puckridge	Adelaide Uni	Modelling ecological responses to water regimes in arid zone wetlands	Environment Australia	Jan98 - Dec98	$99,000
Schiller	NSW Fisheries	Methods for carp control	NSW WMF	Jan98 - May00	$388,000
Thoms	Uni of Canberra	Storage, production and transfer of nutrients and carbon in lowland floodplain river systems: Condamine/ Balonne	Environment Australia/ QDNR	Jul97 - Jun00	$312,000

White water rafting in the headwaters of the Murray River. This is a popular sport during high flows, one of many recreational opportunities available in the Murray-Darling Basin. Photo: D Eastburn

New Grants held by CRCFE Researchers					
Researcher	**Organisation**	**Project**	**Funding Source**	**Period**	**Total Funding**
Thoms	Uni of Canberra	River Condition in the Namoi and Gywdir Valleys	NSW DLWC	One-off grant	$70,000
Osborne	Uni of Canberra	Research on Endangered Corroboree Frogs	NSW NPWS	One-off grant	$20,000
Thoms	Uni of Canberra	Lesotho Highlands Instream Flow Requirements Project	University of Cape Town, South Africa	One-off grant	$26,000
Beckett	Monash Uni	Development of thin channel separation methods and their use in pollutant speciation studies	ARC	Jan97 – Dec99	$120,000
Hart	Monash Uni	Nutrient release from river sediments: phase II	NEMP	Jul98 – Mar00	$219,000
Norris	Uni of Canberra	Final AUSRIVAS models for SA, NT, Qld	LWRRDC	Sep98 – Apr99	$21,000
Norris	Uni of Canberra	AUSRIVAS/Wild rivers mapping	LWRRDC	Feb99 – Jan00	$118,000
Norris	Uni of Canberra	New Zealand AUSRIVAS pilot study	NZ Ministry for the environment	Dec98 – Jun99	$29,000
Norris	Uni of Canberra	Australian Alps AUSRIVAS model	Alps liaison committee	Jan99 – Mar99	$12,000
Oliver	MDFRC	Validation of NIFT assay for identifying N and P limitation of phytoplankton growth	LWRRDC	Jan98 – Jan99	$36,000
Quinn	Monash Uni	Measuring the effectiveness of environmental water allocations phase II	Vic DNRE	Jul98 ñ Jun00	$156,000
Croome	La Trobe Uni	Extending the Rivers Phytoplankton Monitoring manual to Australian standing waters	NEMP	Oct98 ñ Jun99	$37,000
Thoms	Uni of Canberra	Environmental Flows R&D Needs Analysis	LWRRDC	One-off grant	$5,000

6.6 Major renovations and purchases

NSW Fisheries purchased a small research vessel for electrofishing and a FRV Pole Volt.

The Water Studies Centre moved into it's new premises at the Clayton campus, Monash University in November 1998. The new Centre was funded by Monash University.

7 Publications

7.1 Chapters in Books

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Stoffels R (1998). Diet Habitat Associations of Midgley's Gudgeon (*Hypseleotris* sp 4, undescribed) within and among Floodplain Billabongs: the role of their interaction with Perch (*Perca fluviatilis*) and mosquitofish (*Gambusia holbrooki*). Honours Thesis, Department of Environmental Management and Ecology, La Trobe University, Albury/Wodonga Campus.

Tan LW (1998). Taxonomy, microspatial and temporal variation of freshwater testate amoebai (Protozoa; Rhizopoda) on the submergent macrophyte *Vallisneria gigantea* in a River Murray Billabong. PhD Thesis, La Trobe University, Bundoora.

Thomson J (1998). Effects of Disturbance on the impact of invertebrate predators in stream benthic communities. Monash University.

7.9 Book reviews

Gehrke PC and Neira FJ (1998). Family Eleotridae. Gudgeons. In Neira FJ, Trnski T and Miskewicz AT (eds) *The Larvae of Temperate Australian Fishes*. University of Western Australia Press, p 383-385.

Gehrke PC, Schiller CB and Brown P (1999). Native fish and river flows: The Paroo perspective. In Kingsford RT (eds) *A free-flowing river: The ecology of the Paroo river,* p 201-222. (NSW National Parks and Wildlife Service, Sydney).

Halse SA, Shiel RJ and Williams WD (1998). The relationship between salinity, ionic composition and the invertebrate fauna of Lake Gregory. In Zheng M, Hurlbert SH and Williams WD (eds) Saline Lakes VI. *Hydrobiologia,* 381, p 15-29.

Harris JH, Thorncraft GA and Wem P (1998). Evaluation of rock-ramp fishways in Australia. In Jungwirth M, Schmutz S and Weiss S (eds) *Fish Migration and Fish Bypasses,* p 331-347. (Fishing News Books, Oxford).

Lake PS (1999). After the inundation:long-term changes in the fauna of Lake Pedder, Tasmania, Australia. In Davis JA and McComb AJ (eds) *Wetlands for the Future* Gleneagles Press, Adelaide, p 565-578.

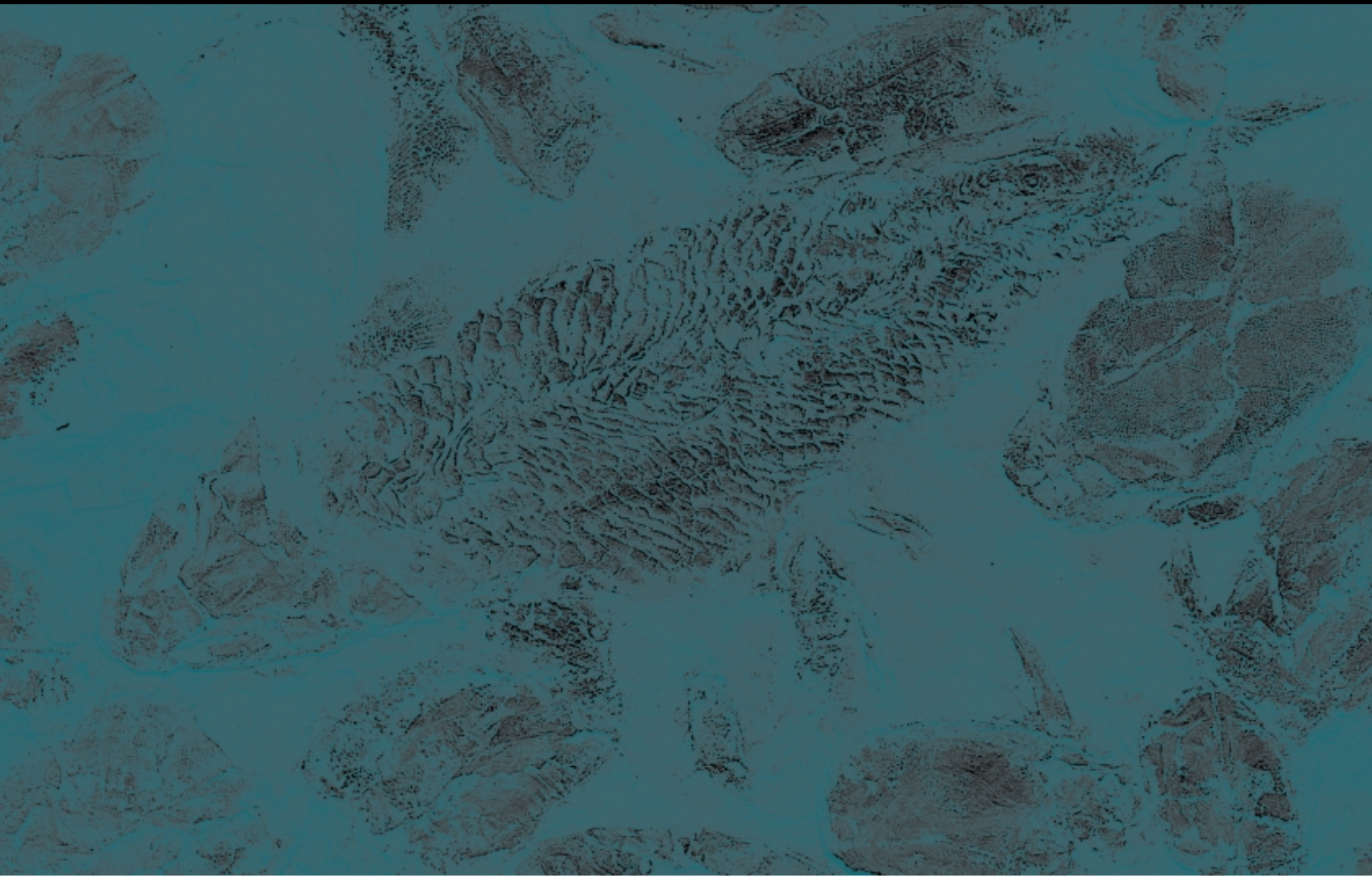
Oliver RL and Whittington J (1998). Using measurements of variable chlorophyll-a fluorescence to investigate the influence of water movement on the photo-chemistry of phytoplankton. In Imberger J (ed) *Physical processes in lakes and oceans, Coastal and Estuarine Studies* 54, p 517-534, American Geophysical Union.

7.10 Models and guidelines

Lawrence AI (1999). *Revision of Pond Model*. Upgrade of the denitrification sub-model and correction of some user difficulties. Ian Lawrence has taken a total of 40 service queries on Pond & Wetland models applications.

The wreck of the paddle steamer Hero at Boundary Bend, Victoria Photo: D Eastburn

8 Communications



The Cooperative Research Centre for Freshwater Ecology places a strong emphasis on communicating its work to a broad audience. The water industry, politicians, government agencies, the scientific community, the media and community organisations all recognise the Centre as an important source of information. Public awareness and understanding of water issues are also priorities for the Centre. To this end, Centre staff actively participate in a range of public forums and produce a variety of information materials and educational resources.

A group of Aboriginal children next to their artwork. Many Aboriginal communities live in the Murray-Darling Basin and have strong attachments to the rivers. Photo: D Eastburn

8.1 Communicating through the media

After five years of building relationships with the media, the Centre now receives numerous requests from the media for information and interviews. The Centre's policy of keeping the media informed about water issues helps to maintain the CRCFE's high profile.

113 media hits were recorded during the year:

Radio 30
Television 18
Newspaper 51
Newsletters/magazine1 4

Media releases issued

October 10	"Untangling carp breeding habits. Funding boost for local research."
December 3	"Water Studies Centre opens new complex".
December 8	"Assessing the potential impacts of irrigation".
December 14	"Thousands of fish to be released into Murrumbidgee".
December 18	"Australia to choose ...the high road or the low road".
December 21	Yarra River Project Press Release
January 21 1999	"The Yarra River under the microscope
March 19	"Sucking our rivers dry?"
March 1999	Study into algal blooms

In addition to media releases, journalists in both metropolitan and regional areas are regularly informed of the Centre's activities and research findings through the newsletters, Watershed and Lower Basin Links. Articles from these newsletters have subsequently been featured in regional and national newspapers, magazines and newsletters.

Two freelance photographers with the ABC TV Natural History Unit spent a week at the MDFRC filming time-lapse insect emergence. They are currently filming a documentary for the ABC TV, looking at the effect of drought on Australia's fauna and flora. Footage shot at MDFRC will be included in programs to air in late 1999.

Science Media Fellowship

Dr John Whittington was awarded a Department of Science, Industry and Tourism funded Science Media Fellowship with the ABC. The purpose of the Science Media Fellowship is to expose scientists to the media and the media to scientists.

John spent time with Radio National's Earthbeat and Science Shows and also with rural radio, particularly with the producers of Countrywide and the National Rural News. The partnerships he developed with ABC Radio will be ongoing.

ABC's Online Science Gateway, the LAB [www.abc.net.au/science] is an innovative, lively forum for disseminating information via the web. It attracts over 120,000 queries per week and the number is rising. John was directly involved with production, editing and concept development of material for the LAB. The CRCFE plans to look at possible links with this gateway. John also worked with television News, Current Affairs and Quantum.

The Fellowship provided the Centre with important information and contacts and provided the ABC with a greater understanding of the CRCFE.

8.2 Public awareness and understanding

General

The Centre's newsletters, Watershed and Lower Basin Links, are sent to large numbers of community groups, fishing clubs and individuals. Other Centre publications, such as brochures and manuals, also attract a broad readership.

Public displays

The Lower Basin Laboratory, Mildura, presented a display at the 1998 Wentworth Show.

The Lower Basin Laboratory held an Opening for the new laboratory.

John Harris participated in 'Exhibition of Rural Lives', Sydney – electrofishing boat technology and carp control.

Fish Ecology Program staff developed posters for NSW Fisheries Open Day, Port Stephens – NSW Rivers Survey, State Fishways program.

The CRCFE presented a display at the University of Canberra's Open Day.

The CRCFE presented a display at the University of Canberra's Environment Awareness Week.

The CRCFE presented a display at the Murray-Darling Basin Commission Wetlands launch.

The CRCFE presented displays at two CRC for Catchment Hydrology sponsored Industry seminars in Melbourne at which we made significant contributions. These were 'Stream Rehabilitation in Your Catchment ñ Priorities and Possibilities' and 'Constructed Stormwater Wetlands: from Design to Construction'. Sam Lake and Peter Breen made presentations on behalf of the CRCFE.

Other public activities

Australian Trust for Conservation Volunteers

Glenn Wilson used ATCV and Green Corps staff in field work to sample juvenile carp from wetlands along the Murray River, between Mildura and Corowa. (December 1998, February 1999).

Public Forum - National Carp Task Force

Glenn Wilson presented a seminar 'Hydrologic manipulation: a potential carp control strategy?' at the National Carp Task Force Forum, Mildura.

Public Forum - National Carp Task Force and North East Catchment Management Authority

Glen Wilson presented two seminars 'How should we control Australian carp: the need for an integrated approach' and 'Why are carp a problem: are anti-carp sentiments justified?' at the National Carp Task Force Forum, Wodonga.

Public Forum - Privatisation of ACT Electricity and Water (ACTEW)

Richard Norris took part in a public forum, 'The environmental and social risks of the proposed privatisation of ACTEW', hosted by the Conservation Council of the SouthEast Region and Canberra. Richard spoke on integrated management in the ACT and discussed the role of science in a water authority such as ACTEW.

Public Forum - Wet or Dry

John Harris presented a keynote address on 'Ecological Drivers for Change' in a session on 'Challenges for a New Millenium' at the Nature Conservation Council's public forum, the Water and Wetlands Management Conference titled 'Water: Wet or Dry'.

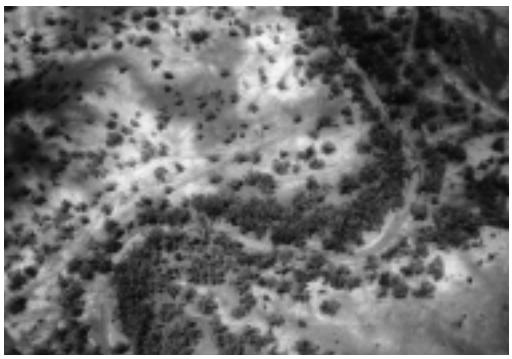
Public launch – DRY/WET Model

Public launch by the SA Environment Minister of the DRY/WET model (CRCFE affiliated project) at the University of Adelaide, December 1998

Anne Bell on motorbike, Coleambally, NSW. Communicating with people in rural communities is an important part of the Centre's role
Photo: D Eastburn

Schools and communities are making a valuable contribution to monitoring the health of our waterways through programs such as WaterWatch
Photo: D Eastburn

Fossils of fish that lived 360 million years ago, from Canowindra, NSW
Photo: D Eastburn



The Culgoa River near the Queensland–NSW border, reduced to a chain of waterholes during a drought
Photo: D Eastburn

Rotary Murray-Darling School of Freshwater Research

Murray-Darling Freshwater Research Centre staff and Mike Copland in particular, helped organise and contributed to the fourth Rotary Murray-Darling School of Freshwater Research in Albury environs from April 11-15 1999. For Year 11-12 students.

The Rotary Camp on River Health

Staff at the Lower Basin Laboratory played a major role in the Rotary Camp on River Health. For Year 9-10 students.

The World Wide Web

The Centre continues to upgrade its web site and plans to include more resources for students and the general public.

Urban Pond and Wetland Models developed as part of the Water Pollution Control Pond Research Project, have been placed on the CRCFE Web page. The Models have been progressively upgraded in response to user requests. There are currently some 200 users of the Models across Australia, New Zealand, Canada and the UK.

8.3 Federation of Australian Science and Technological Societies (FASTS) presidency

Through his presidency of the Federation of Australian Science and Technological Societies (FASTS), Peter Cullen has made major contributions to the general and political awareness of scientific issues in Australia. He has also been able to influence policy development at the highest levels in government. Media activities conducted through FASTS have raised the profile of scientific issues, such as dropping enrolments in science courses at tertiary-level, diminishing career opportunities for science graduates and funding for scientific research. The media coverage has generated flow-on benefits for the CRC for Freshwater Ecology.

8.4 Evaluation of communication activities

Survey of Watershed Readers

The CRCFE newsletter, Watershed has a distribution of 3,000. The Centre contracted consultants, Econnect, to survey Watershed readers. About 400 readers responded, all of which were quite complimentary. Readers were generally happy with the layout and approach and would like more contact information included in the publication.

Survey of Key Influencers

The CRCFE commissioned consultants, Roger James and Associates, to survey the Centre's 'key influencer' list. This list was established to build relationships with a range of valued stakeholders, including politicians, senior bureaucrats, directors of research organisations and prominent community representatives. The report was highly favourable, indicating that the CRCFE is communicating effectively with this group of stakeholders.

8.5 Workshops and seminars

Workshop/ Seminar /Conference	Presentation Topic	Sponsors	CRCFE Staff
AERG/CRCFE Seminar Series	Hydrologic manipulation: a potential strategy for lowland carp control?	AERG, CRCFE University of Canberra	G Wilson
ACRES	Interview with Graeme Jennings on Menindee Project		B Gawne
ASL Victorian Chapter	Presentation on Menindee Project, talk and lecture	ASL Victorian Chapter	B Gawne
Advanced Ordination Techniques in Ecology - 3 week course	Ordination Techniques	National Research Institute for the Amazon (INPA), Brazil	D Williams
Anabranch landholders meeting	Visit with John Harris	Lower Basin Laboratory (LBL)	B Gawne
Artist in Industry Committee Dinner	21 Artist Project	Artist in Industry Committee	B Gawne
Australia in a Competitive Global Environment	Australia's place in the global economy	Canberra Business Council, Questacon	P Cullen
Australia, the Environmental Future	Australia's environmental future	World Environment Day Forum, University of Melbourne	S Lake
Australian College of Seniors	Presentation on Murray R. (talk and lecture)	Australian College of Seniors	B Gawne
Australian Institute of Agriculture, Science and Technology meeting	The work of the CRC for Freshwater Ecology	CRCFE	P Cullen
Australian Institute of Agriculture, Science and Technology meeting	AUSRIVAS	CRCFE	R Norris
Australian National Algal Workshop	Algae	CRCFE, MDFRC	M Reid J Sonneman
Australian National Committee on Irrigation and Drainage, Brisbane	Bioavailability of phosphorus from irrigation drainage	Australian National Committee on Irrigation and Drainage	R Oliver
Billabongs - a neglected resource	The value of billabongs	Australian Freshwater Fishermen's Assembly	D Nielsen
Corowa and Howlong Angling Clubs' Meeting	Carp in Australia: history and control	Corowa and Howlong Angling Clubs	G Wilson
Combined CRCFE Projects Information Sharing Workshop	CRC integrated projects information sharing	CRCFE	Integrated projects staff
Community Catchment Management Course	Catchment management	ACT Landcare/ Environment ACT	M Thoms D Williams R Norris D Flett
Constructed Stormwater Wetlands - from Design to Construction (Melbourne, Canberra, Sydney, Brisbane)	Constructed stormwater wetlands	CRCFE, CRC Catchment Hydrology (CRCCH)	P Breen

8.5 Workshops and seminars, continued

Workshop/ Seminar /Conference	Presentation Topic	Sponsors	CRCFE Staff
Cooperative Research Centre Communicators' Workshop	Communication strategies	CRC Association	K Markwort
CRCFE/CRCCH Industry Seminar (Melbourne, Canberra, Sydney, Brisbane)	Rehabilitating Streams in Your Catchment - Priorities and Possibilities	CRCFE, CRCCH	S Lake, P Breen I Rutherford
Darling Anabranch Management Plan Executive (DAMP)	Presentation on flood research, talk and lecture	Darling Anabranch Management Plan	B Gawne
Darling Anabranch Management Plan Executive (DAMP) Meeting	Construction of Fishways	Darling Anabranch Management Plan Executive	B Gawne
Centre for Tropical Wetlands Management - seminar	Disturbance, patchiness and diversity in streams	Centre for Tropical Wetlands Management of the Northern Territory University	S Lake
Dominion University, Virginia, USA- seminar	Chaffey Dam Project	Dominion University, Virginia, USA	B Sherman
Ecological Assessment of Rivers -2 week workshop. Part of the Targeted Institutional Links Program		University of Jember, East Java, Indonesia	J Gooderham S Sdraulig C Walsh M Grace
Ecological Assessment of Rivers - for Thai academics. Federal TASEAP Program		Water Studies Centre, Monash	M Grace C Walsh
Ecological indicators for environmental flow		Lower Murray-Darling Community Reference Committee	T Hillman
Ecological Risk Assessment (ERA) Workshop	Ecological risk assessment	CRCFE, NSW EPA	B Hart
11th Taxonomic Workshop	Taxonomy	CRCFE, MDFRC	R Oliver P Suter J Hawking J Griggs K Finlay A Glaister E Tsyrlin
Environmental Assessment of Computer Modelling Output for Hume and Dartmouth Dams Operation Review	Environmental Assessment	Murray Darling Basin Commission	J Hawking C Schiller

8.5 Workshops and seminars, continued

Workshop/ Seminar /Conference	Presentation Topic	Sponsors	CRCFE Staff
Environmental Impact of Wiers	Ecological effects	Institution of Engineers	J Harris
Field Naturalists Club Meeting	Carp	Field Naturalists Club	B Gawne
FRDC Project Review Workshop	Research requirements for Australian freshwater fisheries	Fisheries Research and Development Corporation	R Kearney K Davis
Global Climate Change and Australian Limnology	The effects of global climate change on inland waterways	ASL	S Lake
Goulburn Murray Water R&D Foresighting Workshop	Development of R&D strategic direction	Goulburn Murray Water	P. Breen
Knowledge and Land Management: Building Learning Partnerships	Integration of science and land management	Landcare	P Cullen
LWRRDC Workshop on Riparian Issues and Future Research Agenda	Large woody debris in Australian riverine environments	LWRRDC	S Treadwell
Loxton-to-Bookpurnong Local Action Planning Committee AGM	Hydrologic manipulation: potential for lowland carp control?	Loxton-to-Bookpurnong Local Action Planning Committee	G Wilson
Managing Urban Stormwater Using Constructed Wetlands	Stormwater management	CRCFE, CRCCCH	P Breen
Marine and Freshwater Research Institute's Carp Workshop	Lower Basin Laboratory Carp Project	Marine and Freshwater Research Institute	G Wilson
Meeting - Craig Muir	Supplied info on introduced species	LBL	I Ellis
Meeting - Ken Vlatko	Supplied info on shrimp	LBL	I Ellis
Menindee Project Video	Production	TAFE, LBL	B Gawne O Scholz F Betts B Ebner
Mildura's Economic Development Officer	Talk about lab's research	LBL	B Gawne
Mildura South Rotary Club Meeting	Talk on Purple Spotted Gudgeon (talk and lecture)	Mildura South Rotary Club	B Gawne
Murray Wetlands Working Group Meeting	Menindee project (talk and lecture)	Murray Wetlands Working Group	O Scholz
Murray-Darling Association Meeting, Swan Hill	Lower Basin Laboratory Carp Project	M-D Association	G Wilson
National Land & Water Audit Committee, Melbourne	Development of indicators of catchment condition for Victoria.	National Land & Water Audit Committee	B Hart

8.5 Workshops and seminars, continued

Workshop/ Seminar /Conference	Presentation Topic	Sponsors	CRCFE Staff
NSW Department of Land and Water Conservation Seminar	CRCFE research activities	NSW Department of Land and Water Conservation	P Cullen M Thoms P Humphries R Oliver B Sherman D Baldwin J Whittington
NSW Fisheries Annual General Freshwater Research Meeting	Trout Cod Recovery Project	NSW Fisheries	C Schiller M Lintermans
NSW Health Department	Provided blue-green algal data	LBL	B Gawne
NSW Water Reform Flow Management Group	Presentation on LBL research	NSW Water Reform Flow Management Group	B Gawne
NHT Technical Assessment Panel	Reviewed submissions at meeting	NHT Technical Assessment Panel	B Gawne
Nitrogen in ACT Waterways	Regulation of Nitrogen in discharges to ACT waterways	ACTEW	P Cottingham R Oliver B Maher I Lawrence
North Central CMA	Talk about Carp Control (talk and lecture)	North Central CMA	B Gawne
Nutrient Coordinators Workshop, Halls Gap	Development of indicators of catchment condition for Victoria	Nutrient Coordinators	B Hart
Nutrient Management Strategy Scoping Study	Evaluation of tenders for	LBL	B Gawne
Office of Conservation Workshop	NSW Rivers Survey, Index of Biotic Integrity	NSW Fisheries Office of Conservation	J Harris
Postgraduate Workshop	Anaerobic Nutrient Cycles in Freshwater Sediments	CSU, Wagga Wagga	A Mitchell
Rehabilitation of rivers using environmental flows in the Murray-Darling Basin	River rehabilitation	CRCFE, MDFRC	J Growns
Science and Engineering to Address Environmental Problems.	Role of science and engineering in environmental solutions	ACT Environmental Engineering Society	P Cullen
Science in Government	Science policy and the role of science in government	Environment Australia	P Cullen
Sediments and Nutrients- A Dynamic Relationship	The relationship between sediments and nutrients	Applied Chemistry Department,RMIT University	M Grace

8.5 Workshops and seminars, continued

Workshop/ Seminar /Conference	Presentation Topic	Sponsors	CRCFE Staff
SKM Strategic Planning Workshop, Sydney	Research at the CRC for Freshwater Ecology	SKM	B Hart
Some Futures for Science?	Future directions for Science	Deans of Science Meeting, Canberra	P Cullen
State Government Ministers Civic Reception	Attended		B Gawne
Stormwater Management Short Courses x 2	Stormwater management	CRCFE, CRCCCH, Monash University	P Breen
TAFE Natural Resource Management Diploma Students	2 presentations on limnological field sampling techniques	TAFE	B Gawne
The Australian Aquatic Ecology Postgraduate Workshop	Spatial autocorrelation in two upland rivers		N Lloyd
The Australian Aquatic Ecology Postgraduate Workshop	The role of snags in the ecology of Australian lowland rivers		S Treadwell
The Campaspe project		Inland Fisheries Commission	P Humphries
The Challenge of Rehabilitating Australia's Streams – Conference	Stream rehabilitation	Dep't Environment, Heritage and Aboriginal Affairs; CRCFE; CRCCH; River Basin Management Society Inc	P Breen C Walsh
The Yarra River Ecological Study: progress to date	Waterway research and management	Melbourne Water, Waterways and Drainage	P Breen C Walsh M Grace S Bourgues
Tour of Lab and talk about research program to Peter Jackson, Mallee Wimmera Water	Tour of Lower Basin Lab, research program	LBL	B Gawne
Wetlands: how they operate	Wetlands	Belvoir-Wodonga Rotary Club	M Copland
Research planning, Communication and Technical Advice on Sediment Water Interactions for the Australian–German Sediment Research Alliance	Sediment water interactions	A DIST Federal Government Program	M Grace
Victorian Nutrient Coordinators Meeting, Wangaratta	Nutrient Research at the CRC for Freshwater Ecology	Victorian Nutrient Coordinators	B Hart

8.5 Workshops and seminars, continued

Workshop/ Seminar /Conference	Presentation Topic	Sponsors	CRCFE Staff
Virginia and the Tennessee Valley Authority, Tennessee, USA – seminar	Chaffey Dam Project	Virginia and the Tennessee Valley Authority, Tennessee	B Sherman
Water Industry and Health Workers Meeting	Blue-green algal blooms	Water Industry and Health Workers	B Gawne
Water Quality Guidelines Workshop, Geelong	Water quality guidelines philosophy		B Hart
Wetland Care Australia AGM	Hosted AGM and presented a talk on LBL wetland research	Wetland Care Australia	B Gawne
Wetlands Project Workshop, Bookmark Biosphere Reserve	Research advice		G Wilson
Workshop on the Use of Constructed Wetlands for Wastewater Treatment	Treatment of septic tank effluent	Australian Institute of Environmental Health	P Breen

Lake Mungo National Park, near Balranald in south-western NSW, is part of the Willandra Lakes World Heritage Area. Photo: D Eastburn

8.6 Conference presentations and lectures

Assemi S, Newcomb G, Hepplewhite C, Pelekani C, Snoeyink V and Beckett R (1998). Determination of size and molecular weight of humic substances using flow field-flow fractionation and SEC. Oral presentation, 9th International Meeting of the Humic Substances Society, Adelaide , September 20-25.

Assemi S, Hartley PG, Scales P, and Beckett R (1998). Investigation of adsorbed humic substances using atomic force microscopy. Poster presentation, 9th International Meeting of the Humic Substances Society, Adelaide, September 20-25.

Assemi S, Lead J, Wilkinson K, Cutak B, Larive C, Buffle J, Beckett R (1999). Study of the effect of solution pH and salt concentration on the diffusion coefficient of Swannee River fulvic acid. Poster presentation, FFF 99- Eighth International Symposium on Field-flow Fractionation, Paris, France, September 6-8.

Balcome F and Bunn S (1998). An experimental study of the effect of deprivation of particulate input on sediment respiration. Oral presentation, ASL 37th Congress, Peak Crossing, Queensland, July 3-6.

Baldwin DS and Mitchell A (1998). The chemistry of floods and drought on lowland river floodplains - a conceptual model. Oral presentation, ASL 37th Congress, Peak Crossing, Queensland, July 3-6.

Baldwin DS, Mitchell A and Rees G (1998). Evidence for bacterially mediated P release from anaerobic sediments. 8th Goldschmidt Conference, Toulouse, France, August 30–September 3.

Bate and Newall P (1998). The development of techniques for the use of diatoms in water quality assessment: how many valves? 15th International Diatom Symposium, Curtin University of Technology, Perth, September.

Beattie G, Hart B and Beardall J (1998). Bacterial production in lowland rivers: application of a new Thymidine method in Victorian Rivers. TIL Water Quality and Waste Management Symposium, Lombok, Indonesia, October 20-22.

Beckett R, Hart B and McKelvie I (1998). Presented the RACI Hartung Youth Lecture "Water, Water Everywhere, too green or brown to drink?" August 13 (Glen Waverley Secondary College) and 28 (Lowther Hall).

Betts F and Closs G (1998). Functional role of *Paratya australiensis* in billabong reed-bed communities. Oral presentation, ASL 37th Congress, Peak Crossing, Queensland, July 3-6.

Biggin M and Thoms M (1998). Suspended sediment transport in a dryland River: controlling factors in the Darling-Barwon river system. Poster presentation, ASL 37th Congress, Peak Crossing, Queensland, July 3-6.

Breen P and Walsh C (1998). Remediation in urban waterways. CRC for Catchment Hydrology Industry Seminar, Rehabilitating Streams in Your Catchment: Priorities and Possibilities. Leonda, Melbourne, September 4.

Butcher R (1998). Assessing biodiversity in wetlands: implications for design of wetland monitoring programs. Oral presentation, ASL 37th Congress, Peak Crossing, Queensland, July 3-6.

Coysh J, Norris R and Thoms M (1998). Macroinvertebrate recolonisation pathways following patch disturbance in a gravel bed river. Oral presentation, ASL 37th Congress, Peak Crossing, Queensland, July 3-6.

Cullen P (1998). Resolving conflicts over water. Water and Wetlands Management conference, NSW Nature Conservation Council, Centenary Theatre, St Leonard's, Sydney, 21 November.

Cullen P (1998). Science and Technological Advances. National Conference on Parks and Leisure, Australia, 20 October.

Cullen P (1998). Water and the Emerging Political Imperatives. 9th Jack Beale Water Resources Lecture, Australian National University, Canberra, 20 October.

Cullen P (1999). Synthesis of the Cary Conference on Urban Ecology Education. Institute of Ecosystem Studies, New York.

Cullen P (1999). The Journey of the CRC for Freshwater Ecology. CRC Association Annual Conference, Melbourne.

Cullen P (1999). Environment - Healthy Rivers - Myth or Must? National Engineering Forum, Cooma, April 19-21.

Cullen P (1999). The challenges of managing diffuse pollution. Keynote Address, International Conference on Diffuse Pollution, IAWQ, Perth.

Davies N, Norris R and Thoms M (1998). Predication of local stream habitat features from catchment characteristics. Poster presentation, ASL 37th Congress, Peak Crossing, Queensland, July 3-6.

Ebner B (1998). Fish menus and foreign cuisine. Oral presentation, ASL 37th Congress, Peak Crossing, Queensland, July 3-6.

Ebner B (1998). Appropriate sample sizes for a field study of food consumption. Australian Society for Fish Biology, Hobart September, 26-27.

Findlay K (1998). Construction and evaluation of a new laboratory system for rearing mayflies. 9th International Conference on Ephemeroptera, Tafi de Valle, Argentina, August 16-21.

Findlay K (1998). Success of a new rearing system for Australian ephemeroptera. Oral presentation, ASL 37th Congress, Peak Crossing, Queensland, July 3-6.

Findlay K (1998). Rearing leptophelbiid nymphs. Department of Biological Sciences, Monash University, August 7.

Fraser I, Hart B and Barling (1998). Determination of a nutrient budget for Cairn Curran Reservoir. TIL Water Quality and Waste Management Symposium, Lombok, Indonesia, October 20-22.

Gehrke PC, Schiller CB and Brown P (1998). Fish recruitment and river flows: expectations for Water Reform in NSW. Australian Society for Fish Biology Annual Conference, Hobart, September 26-27.

Georges A (1998). Reptile Management - symposium. Australasian Wildlife Management Society Conference, University of Queensland.

Grace M, Hart B, Ford P, Webster I and Tan Y (1998). Nutrient release from sediments: Measuring the key processes. Oral presentation, ASL 37th Congress, Peak Crossing, Queensland, July 3-6.

Grace M (1999). Sediment Research at the Water Studies Centre - A Review. Australian-German Sediment Research Symposium, Melbourne, February.

Grace M, Walsh C, Gooderham J & Sdraulig S (1998). Ecological assessment of the Kali Dinoyo, East Java. TIL Water Quality and Waste Management Symposium, Lombok, Indonesia, October 20-22.

Green JD and Shiel RJ (1998). Predation by the centropagid calanoid, *Boeckella major*, structuring microinvertebrate communities in the absence of fish. Oral presentation, XXVII SIL Congress, Dublin, August 8-14.

Green D, Oliver R and Whittington J (1998). The effect of light on phytoplankton population dynamics of Chaffey Dam with particular focus on the Cyanobacterium. Oral presentation, ASL 37th Congress, Peak Crossing, Queensland, July 3-6.

Green D, Oliver R and Whittington J (1998). Estimating the previous light history of the Cyanobacterium *Anabaena cirinalis* using chlorophyll floursecence. Oral presentation, ASL 37th Congress, Peak Crossing, Queensland, July 3-6.

Growns J (1998). Aquatic Mites as Bioindicators, with an Australian example. Tenth International Congress of Acarology, Canberra, July.

Growns J (1998). River regulation has increased macroinvertebrate diversity in a lowland river. XXVII SIL Congress, Dublin, August 8-14.

Growns J (1998). Rehabilitation of rivers using environmental flows in the Murray-Darling Basin. Seminar presented at the Institute of Freshwater Ecology River Laboratory, Dorset, UK, July.

Growns I and Growns J (1998). Habitat specific relationships of macroinvertebrates to hydrology in regulated and unregulated streams. XXVII SIL Congress, Dublin, August 8-14.

Harris J (1998). The Index of Biotic Integrity Using Fish Community Assessments of River Health. Oral presentation to the Australian Society of Fish Biology. Hobart, Tasmania, September 25-26.

Hart BT (1999). Biogeochemistry of phosphorus in Australian lowland rivers. Institute of Ecosystems Studies, Millbrook, New York, 14 May.

Hart BT (1999). East Java River Bioassessment Project ñ Final Assessment. National Bioassessment Conference, Brawijaya University, Malang, Indonesia, March 8-10.

Hart BT (1999). Environmental Science and River Restoration: The Challenge for the Future. Keynote Lecture, EnviroTox 99, Geelong, 8-10 February.

Hart BT (1998). Water Quality Management: A New Ecological Risk-Based Approach. First Taiwan-Australia Environmental Management Symposium, Science & Policy Working Together in Catchment Management, Taiwan National University, Taipei, 4-5 November.

Hart BT (1998). River Restoration: Challenges for the Future. Invited Keynote Presentation at Brisbane River Festival River Symposium, Brisbane, 29 September.

Hart BT (1998). Nutrient Release from Sediments: Key Processes in Australian Lowland Rivers. Oral presentation, ASL 37th Congress, Peak Crossing, Queensland, July 3-6.

Hart BT, Beckett R & McKelvie ID (1998). Water Chemistry and Algal Blooms. RACI Hartung Lecture, Lowther Hall, 26 August.

Hart BT, Beckett R. & McKelvie ID (1998). Water Chemistry and Algal Blooms. RACI Hartung Lecture, Glen Waverley Secondary College, 13 August.

Hart B, Grace M, Ford P, Webster I and Tan Y (1998). Nutrient release from sediments: Recent advances in understanding the key processes. Oral presentation, ASL 37th Congress, Peak Crossing, Queensland, July 3-6.

Hart BT, Maher W & Lawrence AI (1998). Ecological Risk-based Management of Water Quality. Keynote Address, International Conference on Water Quality and Waste Treatment, Lombok, Indonesia, October 19-22.

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Wilson GG (1998). The Lower Basin Laboratory carp research program. Tri-State Local Government Organisation Meeting. Renmark, September 28.

Wilson GG (1998). Hydrologic manipulation: a potential carp control strategy? Murray-Darling Association Annual Conference, Strathalbyn, SA, September 10-11.

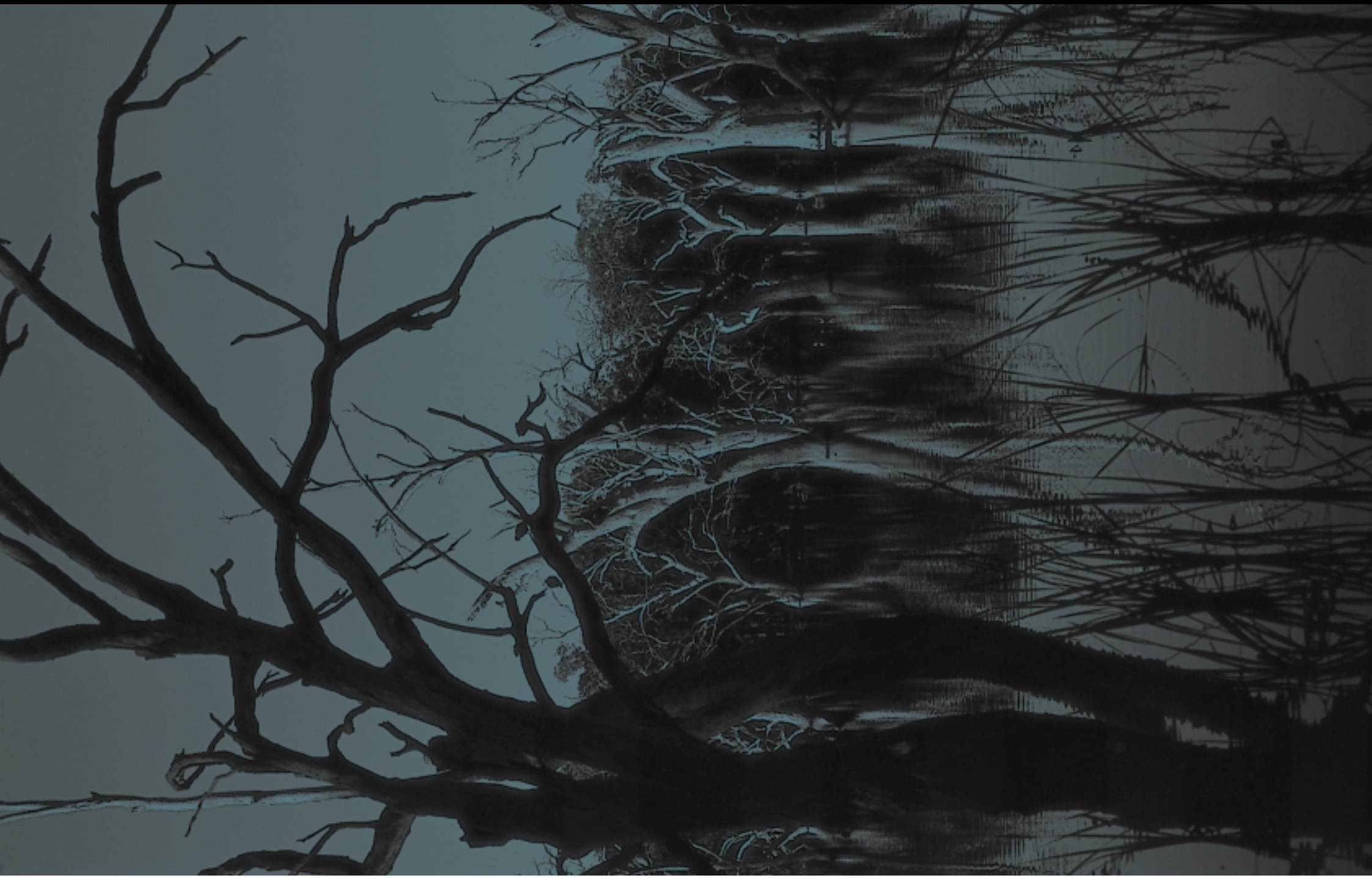
8.7 Other communication activities

Cubbie Station Visit

Martin Thoms and Karen Markwort visited Cubbie Station, a large cotton irrigation farm on the Condamine–Balonne river system. The station manager and owner met with them to discuss river management issues. Martin was granted access to the Station to conduct fieldwork as part of the *Floodplain–wetland processes in the Lower Balonne River System* project.

Bird life on a lower Murray wetland, Mannum, SA
Photo: D Eastburn

9 Performance Indicators



9.1 Cooperative arrangements

Involvement of partners in formulating research programs and setting priorities
The Board continues to select projects and set research directions and priorities. Agreements for each project specify the partner involved and resources committed.

Interaction with Australian and overseas industry and research groups
The CRCFE interacts with approximately 72 external national research and industry bodies as well as more than 39 international universities and other international institutions. For further information, please see Chapter 3, Cooperative Links.

Strength and number of links with land and water resource agencies
In addition to its partner organisations, the CRCFE maintains strong links with more than 28 land and water agencies. For further information, please see Chapter 6, Sharing Our Knowledge.

Hold an annual meeting with research managers from relevant funding bodies to discuss priorities and other aspects of research management.
Met with all partners to discuss priorities and other aspects of research management, as well as Environment Australia and LWRRDC.

Proportion of research projects involving substantial input of staff from more than one partner.
Over 50% of projects include cross-site collaboration.

9.2 Research and researchers

Papers in refereed journals
62 papers. For further information, please see Chapter 8, Publications.

Publication of books, book chapters, monographs, technical bulletins.
10 book chapters and identification guides. For further information, please see Chapter 8, Publications.

Flood-irrigated pastures, reclaimed from wetlands along the Murray River between Mannum and Wellington, support a large part of South Australia's dairy industry.

The Macquarie Marshes provide crucial breeding and feeding grounds for species from both land and water habitats. The Marshes are a wetland of international importance on the lower Macquarie River in NSW. Photo: D Eastburn

Number of papers delivered at research conferences

120 papers delivered at research conferences. For further information, please see Chapter 8, *Publications*.

Number of citations to published research results

Not available

Distinguished visitors, scientists and post graduate students from Australia and overseas attracted to the CRCFE

More than 27 overseas scientists and several delegations of government and industry representatives visited the CRCFE.

Deliver high quality research relevant to partners needs through the development of formal Project Agreements and effective reporting to the Management Committee and the Board on progress.

Formal agreements have been signed for all major CRCFE projects. Project reports are presented to each Management and Board meeting.

9.3 Education and training

Number of postgraduate students enrolled and working with the CRCFE and degrees conferred

The CRCFE has 52 PhD students and 14 Masters students.

Involvement of non-university staff in teaching postgraduate courses and research supervision

31 postgraduate projects are co-supervised by non-university staff.

Short courses and workshops developed and presented.

The CRCFE has presented more than 19 short courses and workshops throughout the year.

Teaching materials, curriculum and methods developed, software, manuals developed and distributed.

The CRCFE runs the Catchment Management Curriculum at University of Canberra. 24 students enrolled in 1998, and 23 students in 1999.

Two CD Roms due for completion 2000: 'Waterlines - Cotton' and Waterlines - Rice'.

CRCFE participated in the Victorian Education Ministry's Telematics Conference 1998: Teaching and Learning Over Distance, a video conference, teacher in-service.

CRCFE LBL supplied materials for new senior high school educational resources on the Murray-Darling Basin for Queensland School of the Air.

Rotary/CRCFE Easter School, Albury/Wodonga: 28 Year 11 students, 2 teachers.

Rotary/MDFRC River Health Student Forum, Lake Cullulleraine, 29 Year 10 students, 2 teachers.

Employment of graduates

Of the 17 PhD graduates since the inception of the CRCFE:

- 6 awarded post-doctoral positions
- 4 work for government departments
- 1 works as a consultant
- 1 works for a national consulting firm
- 1 works at La Trobe University
- 1 works for Lyonnaise des Eaux, a large water company, in Kuala Lumpur
- 3 unknown destination

Of the 3 Masters students who graduated in the reporting period:

- 1 lecturing at a university
- 1 works for EPA, NSW
- 1 works for DLWC, Cooma

9.4 Applications of research

Advice and consultancies provided to industry partners and others

The CRCFE provided advice to industry partners and others on more than 240 occasions.

Number of manuals of best practice distributed

Urban pond and wetland design principles have been published and promoted widely and incorporated into best practice guidelines by a number of resource management agencies and other major projects. Computer models to assist pond and wetland design are available on the CRCFE website.

AUSRIVAS modelling continued to be used extensively within Australia and interest in its use shown by Indonesia and New Zealand.

Advice given to public inquiries and briefings of politicians.
Peter Cullen is serving on the Prime Minister's Science, Engineering and Innovation Council and chaired a Working Group on salinity.

CRCFE expertise was sought and used widely on the Healthy River Commission expert panels for the Shoalhaven, Woronora and Hawkesbury-Nepean Rivers in NSW, and the expert panel for the Snowy River.

CRCFE undertook a major consultancy to identify the likely ecological outcomes of the COAG Water Reforms.

Applied research and investigation contracts and consulting with non-partner agencies
The CRCFE is increasingly seen as a reliable source of high quality, independent information and advice, which has resulted in a significant increase in consulting activities compared with the 1997-98 year.

42 consultancy reports were issued during the year.

Production of technical publications appropriate for end-users and use of other ways of reaching these groups (trade displays, electronic)
For information, please see Chapter 8, *Communications*, Chapter 5, *Knowledge Exchange* and Chapter 7, *Publications*.

Cost-benefit analysis of the application of materials developed by the CRCFE
Analysis has been done for the AUSRIVAS project.

CRCFE staff involvement in government and other advisory bodies
CRCFE staff are involved in 37 committees and government working groups and 8 expert panels.

Number of lectures given to professional workshops and conferences
Over 200 lectures have been given to professional workshops and conferences.

Involvement in mounting national conferences and workshops
The CRCFE sponsored or co-sponsored 13 national conferences and workshops.

9.5 Management and budget

Reporting progress to the Board and to the Commonwealth

Direct reports to the Board quarterly.

Annual report to the Commonwealth.

Accurate monitoring of agreed performance indicators

Project management system in place and accurate tracking of performance indicators conducted.

Annual Report of research, technology transfer and staff development.

Annual report produced and distributed to more than 2000 stakeholders.

Accurate recording and reporting of financial transactions

Quarterly reporting to the Board and Commonwealth.

Development of appropriate facilities for research and communication at all sites

Enhanced web capabilities of the computer network further boost cross-site communication. Further development of Lotus Notes to assist CRCFE communication and project management.

9.6 Human resource management

Deliver regular induction program so that all new entrants to the CRCFE have an understanding of the organisation, its operations and resources.

Induction programs undertaken at Monash University and the University of Canberra. Staff and students from other sites are supported to attend these programs.

Provide appropriate staff development opportunities.

During the year staff and students undertook training in various computer software programs, four-wheel-driving, First Aid, various safety courses, leadership skills, scientific writing, catchment management and media skills training.

Staff and students have also been supported to attend scientific conferences and seminars.

9.7 Communications

Ensure internal communication through fortnightly newsletter (Ripples), Annual Staff meeting and other means.

Ripples continues to be produced fortnightly and is available in both paper and electronic formats.

One major staff meeting conducted during the year.

Lotus Notes implemented and training programs held.

Project meetings conducted.

Travel budget continued.

Media exposure by CRCFE

More than 113 media 'hits' were recorded during the year. The Centre now receives regular requests from the media for interviews and information.

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