Annual Report 1999-2000

Cooperative Research Centre for Freshwater Ecology

Established under the Australian Government's Cooperative Research Centre Program

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 images
Trout Cod, *Macchullochella macquariensis*, an endangered native fish.
Photo: G Schmida

Purple swamphen (Western form).
Photo: A Tatnell

Paperbark swamp, Northern NSW.
Photo: A Tatnell

ISSN 1327 1342

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Cooperative Research Centre for
Freshwater Ecology

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

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

Edited by Lynne Sealie, CRCFE

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Contents

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

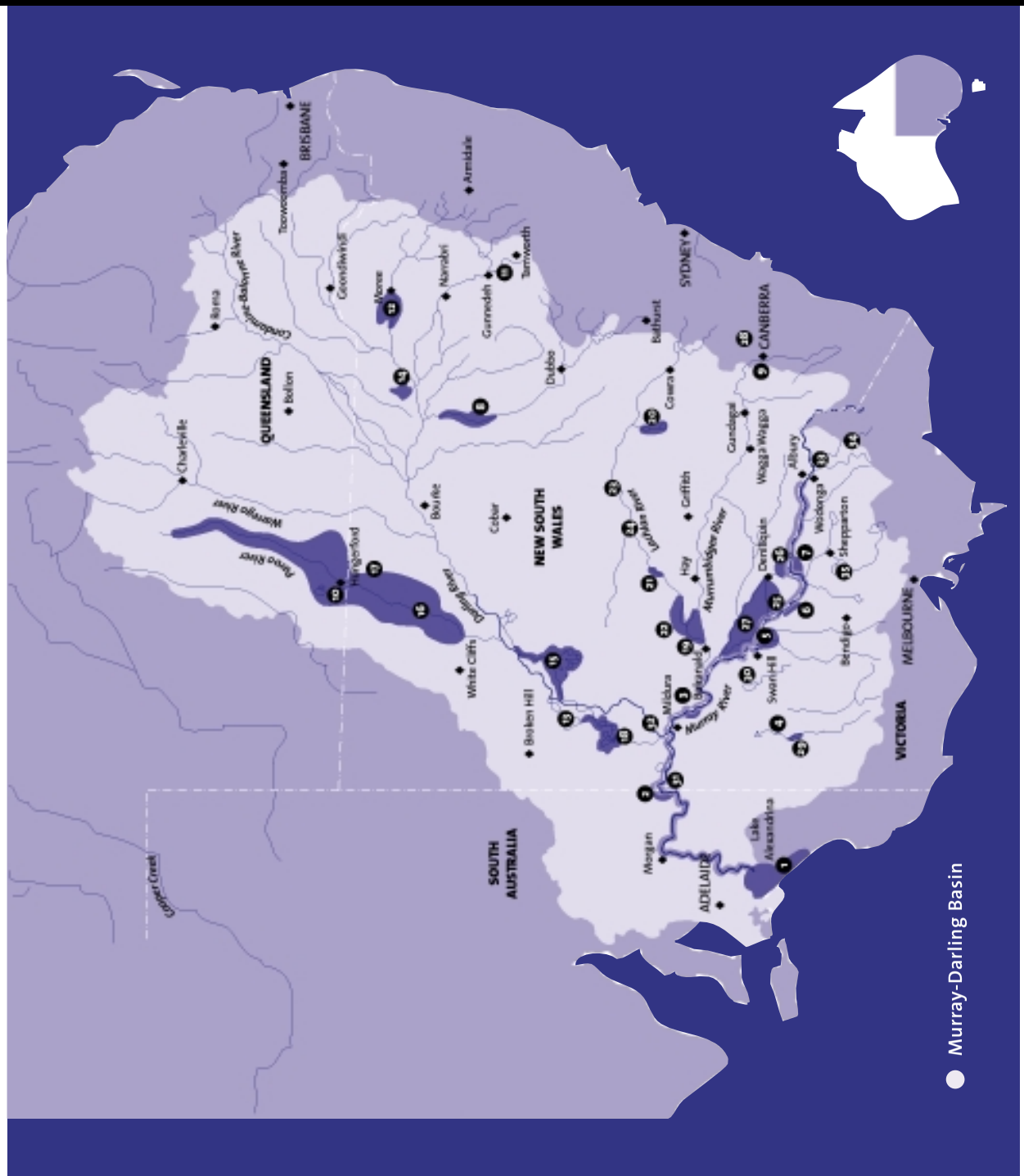
State	No	Wetland	Area in ha
SA	1	Coorong and Lakes Alexandrina and Albert	140 500
	2	Riverland, including Chowilla Floodplain System	30 600
Vic	3	Hattah-Kulkyne Lakes	1 018
	4	Lake Albacutya	10 700
	5	Kerang Lakes	9 172
	6	Gunbower Forest	19 450
	7	Barmah Forest	28 500
NSW	8	Macquarie Marshes Nature 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.

Regions of CRCFE Research



Chairman's Foreword

Dr John Langford
Chairman

Success in achieving another 7 years as a Cooperative Research Centre (CRC) brings with it the hard work of integrating the new partners with the existing partners, and developing a detailed set of research projects from the concepts set out in the first business plan. This has not been made any easier by shortening the life of the old CRC from 7 to 6 years. The ongoing research projects initiated by the existing partners flowed into the 1st year of the new CRC, restricting our ability to start new projects involving the new partners.

Developing a research program of significant integrated projects within the budget constraints, while at the same time meeting the needs of all the partners and making effective use of the in-kind resources contributed to the Centre is proving a challenge to us all. I am pleased at the open and cooperative spirit that prevails around the board table.

The Cooperative Research Centre for Freshwater Ecology continues to have a major input to national policy debates. The Centre has provided valuable input into evaluating the ecological outcomes of the COAG Water Reform Agenda; and the Murray Darling Cap on Diversions.

I would like to take this opportunity to thank Peter Cullen, the Chief Executive, for his commitment to the Centre and his outstanding contribution to the national debates on water policy. I would also like to thank the management team and staff who have supported Peter so ably during the difficult times of review, rebid and now initiating a new CRC and research portfolio with all the accompanying uncertainty.

I greatly appreciate the cooperative spirit of the Board members. Leadership starts at the top, and the cooperation of the Board members is an excellent example for the whole centre.

Finally, I would like to thank the students involved with the centre, both undergraduate and postgraduate; your vitality is an inspiration to us all.

Dr John Langford
Chairman of the Board

Prof Peter Cullen
Chief Executive

This year has been a transitional one for the Centre. We have been finalising a number of major research projects from the first CRC while planning in detail the new projects that will start in 2000. It has been a busy and stressful time for many staff. Many researchers are keen to start work on the exciting new projects we are considering. On the other hand, it is critical to our survival as a cooperative organisation that we develop a portfolio of projects that meet the short and longer-term needs of our industry partners.

We also have to try and use the range of skills that have been contributed to the centre. Most of our best researchers know they could deliver better science if they had more resources, and this is true. However our resources are constrained, and there are many competing opportunities. As a result, some people may be disappointed that they do not get the resources they believe they need.

The Board of the Centre has decided that around 20% of available resources should be allocated to knowledge exchange at this time. Our innovative knowledge exchange program is designed to deliver the knowledge we have to our industry partners in ways they can use to manage our water resources for the long term.

It has become apparent that there are a number of important outcomes from the research we undertake:

- New Knowledge - the results of our science that increases our understanding and might influence water management.
- Credibility - as significant generators of new knowledge we are listened to and respected by many interests.
- Graduate Students - building the future capacity of the water industry.
- Problem Solvers - by having groups of staff who operate at the cutting edge of their disciplines we are able to put together teams to help industry partners with a range of problems.

This problem-solving element has been one of the exciting developments in the last year or so as we and our industry partners have discovered the power of joint problem solving. This comes about where the industry partner is not really sure as to the question, but is aware of a general problem. We put together teams of people, roughly half from industry and half from the research community, to work through the issue and define the problem and develop solutions. We have used this approach with the Sydney Catchment Authority with Indicators for the Catchment Audit, the Queensland DNR with developing the WAMP process and with the MDBC on the Sustainable Rivers Audit. Each of these projects is managed and facilitated by one of our Knowledge Brokers – specialists who help synthesise and exchange knowledge with our industry partners.

Life continues to be difficult for our University partners, with the Government continuing its pressure to shift the costs of higher education on to students, and the costs of

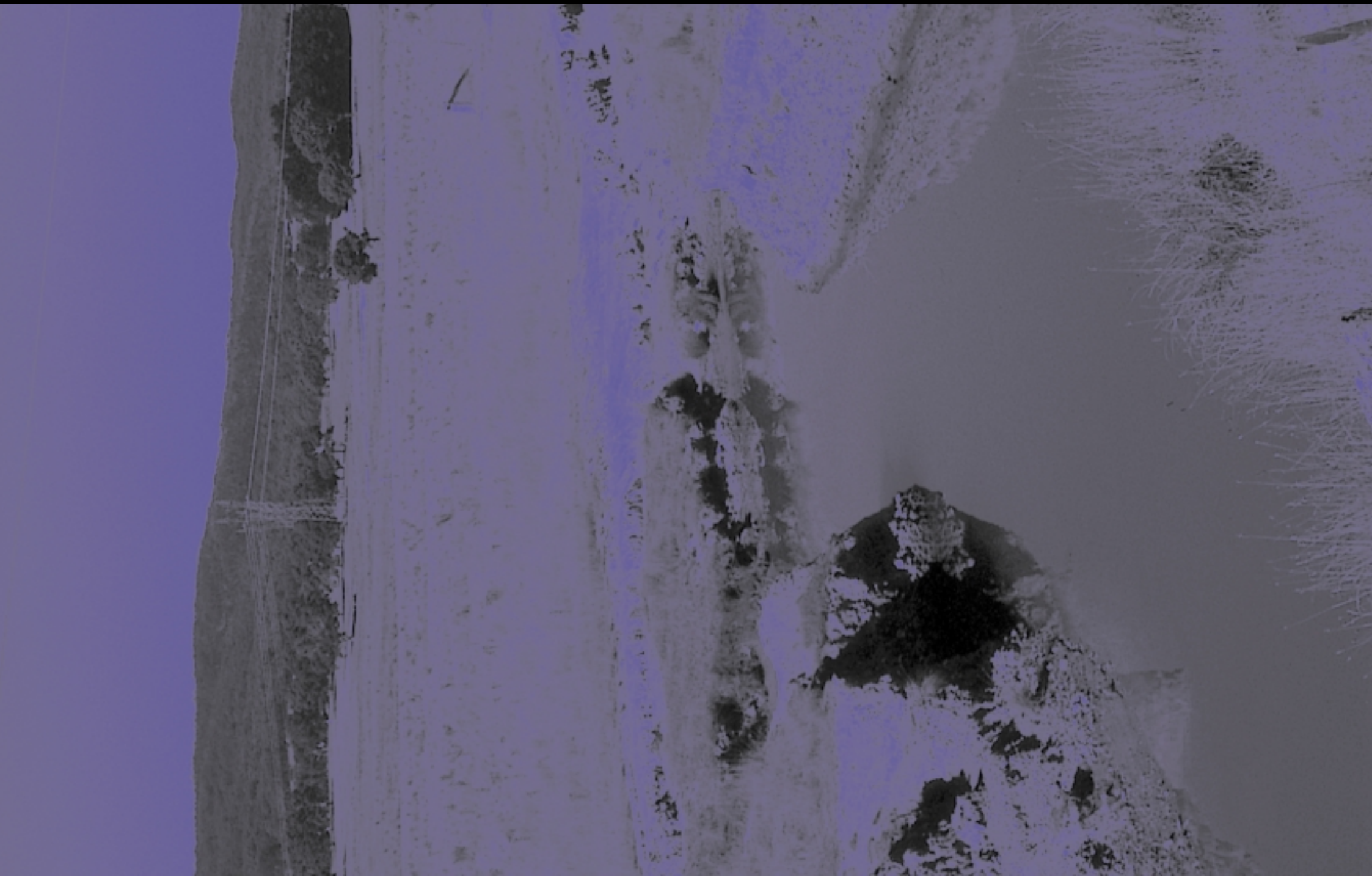
research to industry and students. The White Paper on research training offers some good initiatives that should help improve research training, but fails to provide the additional funds so desperately needed to replace ageing infrastructure, retain and attract top quality staff and make postgraduate work attractive to students. As the World becomes an ever more competitive information society this dumbing down of Australia is inexplicable and dangerous. It is even more puzzling when one realises that so many other countries with which we compete are dramatically increasing their investment in science and research.

The Centre continues to be an exciting and vibrant organisation, committed to making a difference. This comes about because of the energy, enthusiasm and talent of the staff and graduate students who have a commitment to collaborative research that can be used by the water industry. The good will of so many people has been critical in getting us through this start-up phase.

Special thanks must go to our Board and in particular our Chairman, Dr John Langford. Dr Langford has not only led the Board with distinction, but provided much wise counsel to me as Chief Executive. Board members have been able to provide wise and effective governance for the Centre as an organisation committed to improving the waterways of Australia.

Professor Peter Cullen
Chief Executive

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 CRC for Freshwater Ecology

The Cooperative Research Centre for Freshwater Ecology (CRCFE) was formally established in July 1993 under the Commonwealth Government's CRC Program. In 1999, the CRC successfully applied for a further 7 years of funding. It is an unincorporated joint venture between:

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

1.2 The Board

The CRCFE is governed by a Board comprising the following members at June 30, 2000:

Dr Colin Adrian, Executive Director, Environment ACT
Mr Don Blackmore, Chief Executive, Murray-Darling Basin Commission
Mr Greg Claydon, Department of Natural Resources, Qld
Mr Bruce Cooper, Director, Ecosystem Management Branch, Department of Land and Water Conservation, NSW
Professor Allan Cripps, Dean of Applied Science, University of Canberra
Professor Peter Cullen, (Chief Executive), Professor of Resource and Environmental Science, University of Canberra
Professor Ron Davies, Dean of Science until meeting 3/99, Prof Peter Darvall, Deputy Vice Chancellor Research & Development from meeting 1/00, Monash University
Mr Ron Dennis, Chief Executive, Albury-Wodonga Development Corporation
Dr Jane Doolan, Waterways Unit, Department of Natural Resources and Environment, VIC
Dr Graham Harris, Chief, CSIRO Land and Water
Professor Bill Hogarth, Dean of Environmental Sciences, Griffith University
Dr John Langford, (Chairman), Executive Director, Water Services Association of Australia
Professor Nancy Millis, University of Melbourne
Mr Jeff Wright, Chief Executive Officer, Sydney Catchment Authority
Mr Ross Young, General Manager, Waterways and Drainage, Melbourne Water

Table 1.1 Attendance at Board meetings

	10 Sept 99	18 Nov 99	3 Mar 00	23May 00
Dr John Langford	●	●	●	●
Prof. Peter Cullen	●	●	●	●
Dr Colin Adrian	●	●		
Mr Peter Burnett			●	●
Mr Don Blackmore	●	●		●
Mr Kevin Goss			●	
Mr Greg Claydon	●		●	●
Mr David Freebairn		●		
Mr Bruce Cooper	●		●	●
Prof. Allan Cripps				●
Dr George Cho	●			
Ms Anne McMahon		●	●	
Prof. Ron Davies	●			
Professor Grahame Coleman		●		
Professor Peter Darvall			●	●
Mr Ron Dennis	●	●	●	●
Dr Jane Doolan	●	●	●	●
Dr Graham Harris			●	●
Dr John Williams		●		
Prof. Bill Hogarth		●	●	●
Prof. Roger Kitching	●			
Prof. Nancy Millis	●	●	●	●
Mr Jeff Wright				
Mr Alan Dodds	●	●		
Mr Tony Paull			●	
Mr Paul Shannahan				●
Mr Ross Young		●	●	●
Mr Kevin Wood	●			

Goulburn, NSW.
Photo: A Mostead

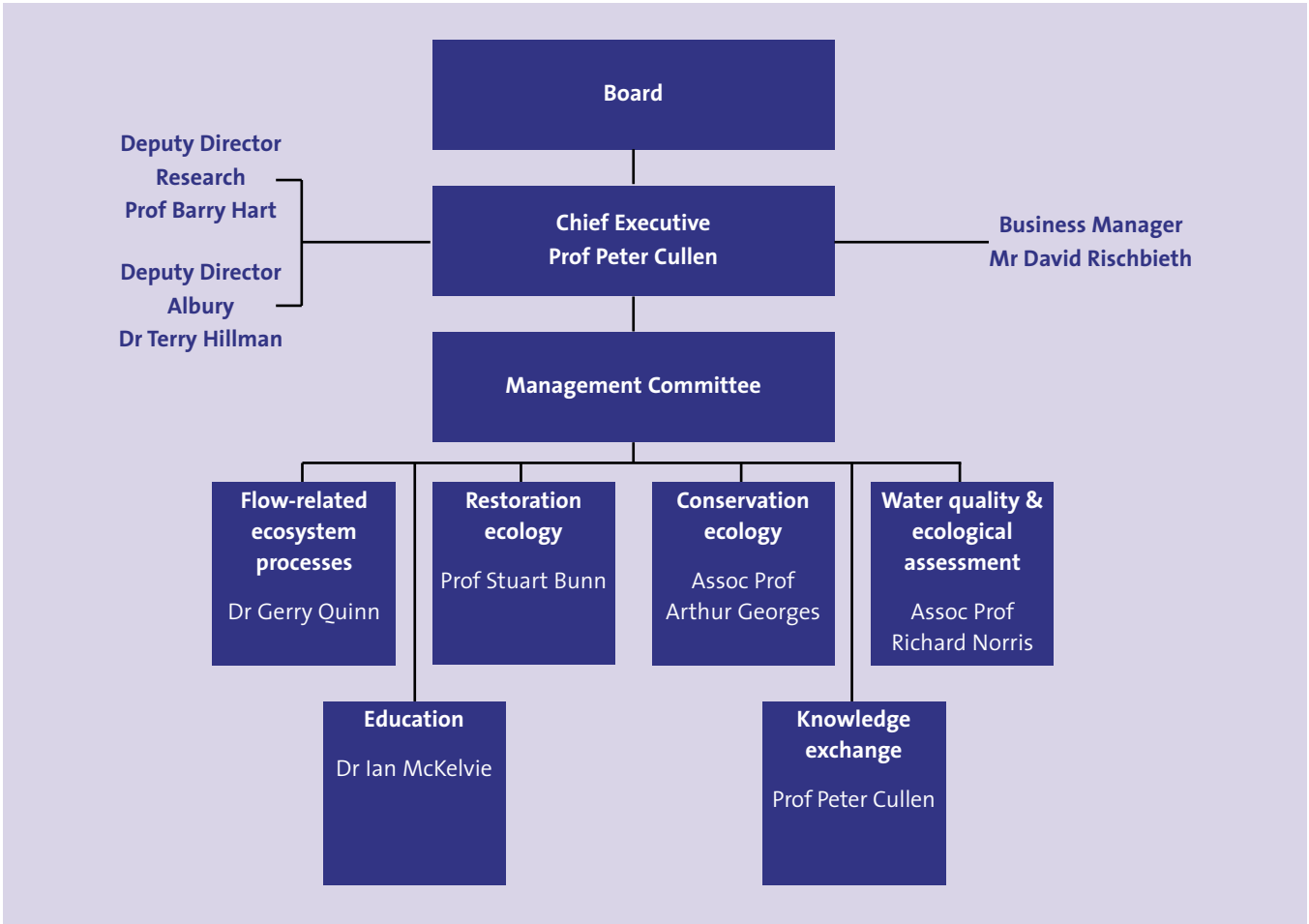
1.3 Organisational Structure

The Chief Executive, Professor Peter Cullen, carries executive responsibility for managing the Centre within the policy framework established by the Board. Two deputies support him - Professor Barry Hart is responsible for coordinating and implementing the research program. The second Deputy Director, Dr Terry Hillman, is responsible for managing the three regional laboratories: the Murray-Darling Freshwater Research Centre at Albury, the Lower Basin Laboratory at Mildura and the Northern Laboratory at Goondiwindi.

The Chief Executive, Deputy Directors and Business Manager form the centre's Executive Committee.

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

Figure 1.2 Organisational Structure



The New Northern Laboratory

The CRC for Freshwater Ecology has established the Northern Laboratory of the Murray-Darling Freshwater Research Centre in Goondiwindi, Queensland. It will compliment the activities of the other two MDFRC labs in Albury and Mildura. The Northern Laboratory will be a focal point for some of the developing research issues for the CRCFE. A Community Advisory Committee, chaired by Leith Boully, has been established and Glenn Wilson has been appointed as the research scientist in charge.

1.4 The Centre's Programs

The Centre's six programs consist of four research programs and an Education and Knowledge Exchange program:

A. Flow-related ecological processes
B. Restoration Ecology
C. Conservation Ecology
D. Water quality and ecological assessment
E. Education
F. Knowledge Exchange

1.5 Program Advisory Committees

Program Advisory Committees (PACs) have been established for each research program to strengthen the links between industry needs and the Centre's research programs. The four PACs have met and reported to the Board:

Di Flett
Executive Officer

Program A Advisory Committee, Flow Related Ecosystem Processes

Dr Gerry Quinn	CRCFE Program Leader
Dr Jane Doolan	DNRE
Mr Tony Paull	SCA
Mr Greg Raisin	DLWC
Mr Brian Wilkinson	Environment ACT

Program B Advisory Committee, Restoration Ecology

Prof Stuart Bunn	CRCFE Program Leader
Mr Peter Donnelly	Environment ACT
Dr Jane Doolan	DNRE
Mr Noel Kesby	DLWC
Ms Kate Lenertz	SCA
Mr Scott Seymour	MW

Program C Advisory Committee, Conservation Ecology

Assoc Prof Arthur Georges	CRCFE Program Leader
Mr Neal Forster	DLWC
Ms Mary Knowles	SCA
Mr Bill Logan	Environment ACT
Ms Julia Reed	DNRE

Program D Advisory Committee, Water Quality and Ecological Assessment

Assoc Prof Richard Norris	CRCFE Program Leader
Mr Bruce Cooper	DLWC
Mr Amir Deen	SCA
Ms Lisa Dixon	EPA
Mr Bob Neil	Environment ACT
Ms Peter Thompson	DNR

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
Ms Alena Glaister, Monash University
Assoc Prof Richard Norris, University of Canberra

The group organised the 12th annual taxonomic workshop at the Murray-Darling Freshwater Research Centre (8th & 9th Feb 2000) and presented 6 new identification guides. One of the major outcomes of the workshop was to identify knowledge gaps, helping to direct future taxonomic work of the Centre.

1.7 First Year Pastoral Visit

The First Year Visit to the CRC for Freshwater Ecology was held at the University of Canberra on 2 March 2000 by a visiting panel consisting of:

Chair	Prof Graeme Kelleher
CRC Visitor	Dr Barbara Bowles
Secretariat Support	Mr Vic Lawrentin

Mr David Rischbieth
Business Manager

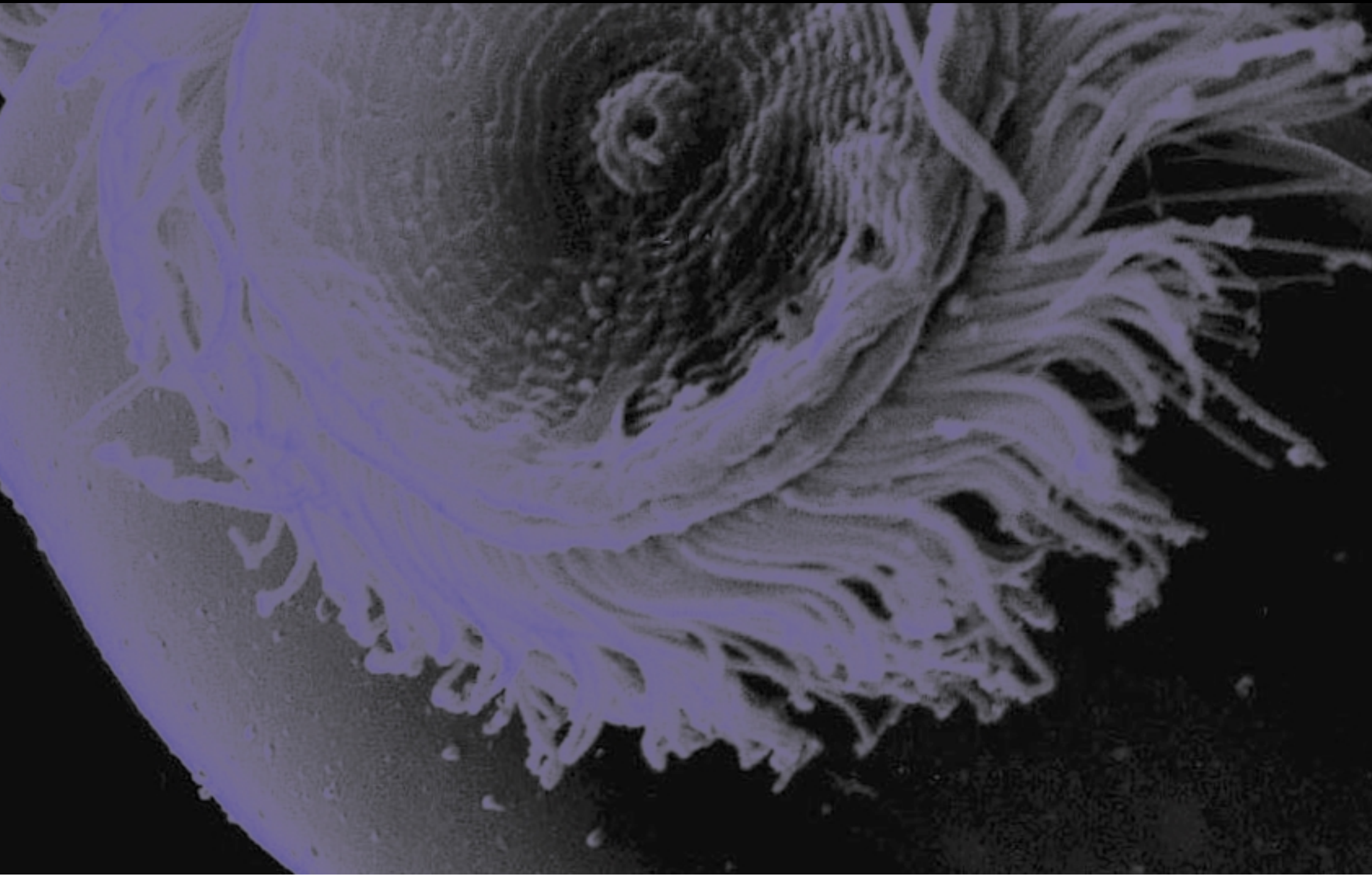
The Centre was represented by the

Chairman of the Board	Dr John Langford
CEO	Professor Peter Cullen
Business Manager	Mr David Rischbieth
Director of Research	Professor Barry Hart
Director of Regional Laboratories	Dr Terry Hillman
Chief Ecologist	Professor Sam Lake
Executive Officer	Ms Dianne Flett

The Centre received a very favourable report. The report stated that "The Centre is applying directly the experience and knowledge gained by its predecessor, it is already clearly focusing on and achieving all the 'evaluation criteria'.

This glowing report stands us in good stead for the first of our Centre reviews, expected to occur between years 2 and 3.

2 Cooperative Links



The strength of the Centre comes from joint problem solving, across disciplines and organisations. From its member organisations, the centre can bring people with diverse specialities together to work on joint research projects. The Centre recognises that collaboration is fundamental to achieving its outcomes and has established strong links:

- Across CRCFE sites and disciplines
- With its eighteen member organisations
- With researchers outside the centre
- With natural resource managers, government officials and community groups
- With the water industry
- With the four other water-related Centres in the Water Forum, including the CRC for Catchment Hydrology; the CRC for Water Quality and Treatment; the CRC for Waste Management and Pollution Control; and the CRC for Coastal Zone, Estuary and Waterway Management.

2.1 Internal cooperation

The Centre works hard to ensure that cooperation occurs between its four research programs and across its different sites. Internal structures and activities are in place to facilitate this internal cooperation:

Dr Terry Hillman receiving the Chairman's Award, presented by Prof Peter Cullen at the annual staff meeting. The award recognises significant contributions to the Centre. Photo: L Sealie

Table 2.1
Activities fostering internal collaboration

Activity	Function	Frequency
Board meetings	Set Centre policy and direction. Ensure that activities meet the Centre's stated objectives	4 times per year
Executive meetings	Review progress of the Centre in terms of outcomes. Provide implementation plans on new initiatives as determined by the Board	Monthly
Program Leader Meetings	Review and coordinate progress of research programs. Act on policies set by the Board.	Quarterly
Program meetings	Coordinate the implementation of each research program, review progress	Annual
Joint Program Leaders Meeting	CRCFE & CRCCH – opportunities for joint activities.	Annual
Project Management	Project manager reviews progress and facilitates feedback to the Program Leaders, Executive Committee and the Board	Regular contact
Staff Meeting	Sharing and updating of information	Annual
Postgraduate Workshop	CRCFE postgraduate students	Annual
Postgraduate Supervisors' Workshop	CRCFE postgraduate supervisors	Annual
Lotus Notes Database	Most CRCFE sites are connected with each other electronically. Lotus Notes , a projects management system, facilitates reporting and collaboration.	Ongoing
Seminar Series	Most CRCFE sites run a seminar series, hosted by the parent organisation in collaboration with the Centre	Variable

Table 2.1 continued

Activity	Function	Frequency
Watershed	Internal and external newsletter, reports on Centre's research. Readership of 3,000	6 times per year
Ripples	Internal newsletter	Fortnightly
Lower Basin Links	For the Lower Basin Laboratory (Mildura) stakeholders & community	3-4 per year

Sharing of facilities

The Centre's research portfolio emphasises cross-project and cross-site links. As a result, a number of projects share field sites and equipment. Staff and students have access to the following facilities across research sites:

- Experimental billabongs – Albury
- Chemistry laboratories – Albury, Canberra, Melbourne, Brisbane, Mildura, Goondiwindi
- Curated flora and fauna collections – Canberra, Albury

2.2 Cooperation with partners

ACT Electricity and Water Corporation

Design of Environmental Flow Monitoring Program: Cotter & Queanbeyan Rivers. Ian Lawrence, Richard Norris, Bill Maher, Martin Thoms, Mark Lintermans & Gerry Quinn undertook the development of a monitoring program for ACTEW. Final Report submitted 13th June.

Risk Assessment of Distributed Treatment Plant Strategy Study.Ian Lawrence, Richard Norris, Bill Maher & Peter Cottingham, in association with Monash Department of Epidemiology & Preventative Medicine, are undertaking a risk assessment of potential impacts of distributed treatment plant scenarios, as part of ACTEW strategy assessment. The study is scheduled for completion in August 2000.

Peter Cullen and Ian Lawrence met with ACTEW to advise on minimising impacts on urban streams from effluent discharge.

CSIRO Land and Water

CRCFE and CSIRO Land and Water have jointly entered into a partnership agreement to carry out a number of tasks relating to the waterway condition facet of the National Land and Water Audit.

Barry Hart and Mike Grace organised a workshop on nitrogen dynamics in collaboration with CSIRO Land and Water.

Stuart Bunn and colleagues from Griffith have worked closely with Dr Ian Prosser and Dr Peter Hairsine on the LWRRDC Riparian Lands Program.

The CSIRO Land and Water staff visited the MDFRC as part of a "Pastoral Visit".

Terry Hillman attended an Urban and Rural Water Management Program Research Group Leaders meeting in Canberra.

John Whittington participated in a video conference link for Component 1: National Water Reform for the CSIRO Land and Water Sector.

Rhonda Sinclair continues to provide articles for the Land and Water internal newsletter, *InterActions*, reporting on Centre activities.

Ian Lawrence and Gail Ransom worked with CSIRO Land and Water on the Burrinjuck Project.

John Harris, Terry Hillman, Peter Cullen worked with CSIRO Land and Water on a MDBC project "Rivers as Ecological Systems".

Department of Land and Water Conservation (NSW)
Martin Thoms worked with the DLWC on the Namoi Scoping Study.

Ben Gawne attended a meeting to review Water Quality monitoring in NSW, organised by DLWC.

Ben Gawne met with David Harris (DLWC) and Paul Lloyd (MWWG) to discuss Weir pool manipulation.

Stuart Bunn has been collaborating with Bruce Chessman and Doug Westhorpe on stable isotope analysis of biofilms. This forms part of DLWC's "Integrated Monitoring of Environmental Flows Methods Manual".

John Whittington attended a meeting of the Murray Unregulated River Management Committee in Khancoban, where interim flow access rules for the Billabong and Mannus Creeks were determined.

Terry Hillman attended numerous meetings of the Murray Lower Darling Community Reference Committee throughout NSW.

Stuart Bunn ran a workshop on Riparian Zone Management, with Dr Ian Prosser (CRCCH, CSIRO Land and Water), Dr Siwan Lovett (LWRRDC) and Dr Peter Davies (UWA), for DLWC staff in Coffs Harbour. Stuart Bunn provided expert advice on riparian issues.

Ben Gawne and Glenn Wilson collaborated with DLWC to organise a "Bug Day". 122 students from Mildura West Primary School attended.

Ian Lawrence, Rod Oliver, Gail Ransom (CRCFE) & Myriam Bormans, Brad Sherman, Phillip Ford (CSIRO) facilitated a Workshop for Reservoir Managers on Algal Management in Reservoirs, for DLWC, MDBC, ACTEW, Environment ACT, Goulburn Murray Water, DNR (Qld), Melb Water, DNRE (Vic)

Department of Natural Resources (Qld)

Peter Cullen led the Scientific Panel on the Western Rivers for Queensland Department of Natural Resources. A number of CRC scientists were involved (Stuart Bunn, John Harris, David Moffat and Jim Puckridge). The technical report *Scientific Forum on River Condition and Flow Management of the Moonie, Warrego, Paroo, Bulloo and Nebine River Basins*, edited by Peter Cottingham, provided to Queensland DNR.

Stuart Bunn ran a workshop on Riparian Zone Management, with Dr Ian Prosser (CRCCH, CSIRO Land and Water), Dr Siwan Lovett (LWRRDC) and Dr Peter Davies (UWA), for DNR Queensland staff in Kenilworth, (as well as local councils and EPA staff). Stuart Bunn provided expert advice on riparian issues.

Angela Arthington has served on the Technical Advisory Panels for the Logan, the Burnett and the Pioneer Water WAMPs (Water Allocation Management Plans). Technical reports on Vertebrates and Estuarine and Marine systems have been provided as part of WAMP documents.

Martin Thoms, Stuart Bunn and Angela Arthington continued to provide technical advice to the DNR on Environmental Flows.

At the request of the Queensland Minister Rod Welford, Peter Cullen led a team to review the ecological assessment processes used in the WAMP (Water Allocation Management Plan) developed by Queensland Department of Natural Resources. CRC staff involved included Angela Arthington, Stuart Bunn, John Harris, Terry Hillman, Richard Norris and Gerry Quinn. The technical report *Technical Review of Elements of the WAMP Process of the QDNR*, edited by John Whittington, provided to Queensland DNR.

Stuart Bunn was a member of the Technical Advisory Panel for the Fitzroy Basin Water Allocation and Management Plan:

- review of WAMP and advice to QDNR and the State Minister
- review of IAS on downstream effects of Nathan Dam on the Dawson River.

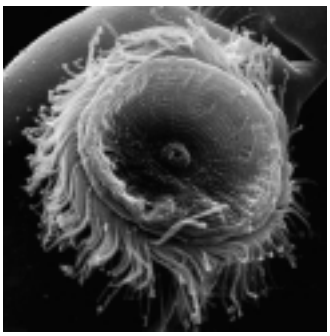
Angela Arthington provided a personal review of technical aspects of the Fitzroy Basin Water Allocation and Management Plan.

Stuart Bunn attended two meetings with the Program Management Committee of the LWRRDC Riparian Lands Program, which includes representatives from QDNR, DLWC and DNRE, and assisted in the development of R&D priorities for Phase 2.

Stuart Bunn has been actively involved in the SouthEast Queensland Regional Water Quality Management Strategy as Deputy Chair of the Scientific Expert Panel. QDNR is one of the partners of this (along with the EPA, BCC and 19 other councils). Angela Arthington deputises for Stuart on the Scientific Expert panel.

Department of Natural Resources and Environment (Vic)

Martin Thoms has been meeting with the DNRE to discuss snags and geomorphology.



A microinvertebrate, Trichodina diaptomi, *a single-celled ciliophoran (Protista) which lives on the surface of* Boeckella, *a copepod microcrustacean, in upper R. Murray billabongs. Photo: J Green (Univ. of Waikato) & R Shiel (MDFRC)*

Peter Cottingham attended steering committee meetings for a project developing a rapid economic appraisal of algal blooms for DNRE.

Peter Cottingham facilitated CRCFE feedback and contacts to Tom Ryan (DNRE) on proposed study of cold water effects on native fish.

Barry Hart and Peter Cottingham assisted Trish Geraghty in developing an outline of a scoping study to support the development of a rehabilitation plan for the Thomson and Macalister Rivers as part of the Stressed Rivers Program.

Environment ACT

Design of Environmental Flow Monitoring Program: Cotter & Queanbeyan Rivers. Ian Lawrence, Richard Norris, Bill Maher, Martin Thoms, Mark Lintermans & Gerry Quinn undertook the development of a monitoring program for ACTEW. Final Report submitted 13th June.

Integrated Catchment Management Framework for the ACT. Ian Lawrence was a member of the Steering Committee and assisted with drafting the Framework document.

National Water Audit: ACT analysis. Ian Lawrence provided advice and assistance to the Water Section of Environment ACT.

ACT Water Quality & Ecology Monitoring Program. Ian Lawrence, Richard Norris and Bill Maher undertook a review and report on Integrated Water Quality & Ecology Monitoring for Environment ACT. Ian Lawrence provided assistance on the ACT Water Quality 1999/2000 Report (March 2000) and a review of the draft Australian Water Quality Guidelines 'trigger values' for the ACT.

Environmental Flow Guidelines. Ian Lawrence assisted in the drafting of responses to comments on the draft Guidelines.

Advice on catchment management and wastewater licencing. Ian Lawrence provided a briefing on the findings of 'Analysis of factors determining algal levels & composition in Burrinjuck Reservoir' (LWRRDC & MDBC), and advice on methods for setting discharge licences.

Development of ACT related research program. Ian Lawrence undertook a compilation of ACT Water Research related information needs and assisted in development of ACT Water Research proposals for the new CRCFE research portfolio.

Sullivans Creek Catchment Coordination Committee. Ian Lawrence is a member of the Technical Advisory Group, and assisted in the development of the Catchment Management Strategy.

Warning!
Photo: P Sloane

Ian Lawrence provided draft material on the David St & Banksia St Wetlands Pilot Project Proposal.

Ginninderra Catchment Management Group. Ian Lawrence provided advice on the Emu Ridge Wetland proposal.

Review of ACT Cap Submission. John Whittington provided comments on the ACT Cap Submission.

Ian Lawrence advised Environment ACT on Water Audit analysis techniques.

Peter Cullen participated in a seminar organised by the Chief Minister's Department to assist groups developing bids for new CRCs.

Peter Cullen led a one-day planning workshop on environmental priorities for the ACT with the Environment Advisory Committee.

Peter Cullen attended two meetings of the ACT Science & Technology Council.

Peter Cullen chaired meetings of the Environment Advisory Committee.

Peter Cullen attended meetings of the Gungahlin Development Board.

Peter Cullen chaired the ACT Assessment panel for NHT and Environment Grants.

Environment Protection Authority (NSW)
Glenn Wilson discussed findings on carp control through drawdowns with NSW EPA staff (Justin Simpson), Mildura.

Ian Lawrence undertook a review of an EPA Report 'Comparison of Selected Models to estimate nutrient loadings' for the EPA.

Environment Protection Authority (Vic)

Peter Cullen participated in the Gippsland Environment Forum conducted by the EPA.

Barry Hart convened a workshop to explore the best available approach to determining the phosphorus load exported from the Macalister Irrigation District as part of local nutrient reduction strategies. Peter Cottingham and Ian Lawrence also attended the workshop.

The Victorian Minister for Environment and Conservation, Sherryl Garbutt, has invited Professor Hart to serve as a member of the Environment Protection Board for a three-year term.

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

Peter Cottingham joined the council of Envirolinx, convened by the EPA.

Goulburn-Murray Rural Water Authority

Barry Hart, Ian Lawrence and Mike Grace were invited participants in a technical review of the Lake Mokoan Cyanobacterial Blooms program.

Mike Grace, Peter Breen and Barry Hart met with Pat Feehan from Goulburn-Murray Water to discuss the development of a research proposal for the National Program for Irrigation Research and Development.

Peter Breen attended the Engineering Excellence Awards with Goulburn-Murray Water where the Muckatah ecologically sensitive drainage design won an award.

Ian Lawrence and Rod Oliver facilitated the Reservoir Management Workshop organised by Goulburn-Murray Water.

Pat Feehan from GMW attended the centre's organised workshops on nitrogen dynamics, and phosphorus export from the Macalister Irrigation District.

Griffith University

The Centre funded Angela Arthington's work on the distributions of freshwater fish in Queensland, through the Endemism Scoping Project.

Work on the Centre's Associated Project DIBM3/RR3 funded by SEQRWQMS, and discussions with Richard Norris re Project D2, have helped shape the research project of CRCFE PhD student Mark Kennard.

Several Centre members worked with Angela Arthington on the Review of the Ecological Benefits of State Responses to COAG, and on the Environmental Flows Advisory Panel and the Water Quality Think Tank (Environment Australia).

Dr James Udy attended the workshop on nitrogen dynamics organised by Barry Hart and Mike Grace.

Di Flett and David Rischbieth briefed Centre staff about Lotus Notes and accounting procedures.

Richard Norris has assisted in the development of the Griffith University Associated Project DIBM3/RR3, funded by the SEQRWQMS.

La Trobe University

Terry Hillman has been awarded the degree of Doctor of Science (honoris causa).

Terry Hillman attended numerous Board meetings during the year.

Terry Hillman presented a lecture on "Billabongs in the Murray Darling Basin" for the Graduate Diploma in Environmental Management students.

Lower Murray Water

Iain Ellis provided information to Lower Murray Water on local native fish and goldfish found in sewage treatment release ponds.

Ben Gawne met with CEO of Lower Murray Darling CMC regarding Thegoa Lagoon.

Melbourne Water

Peter Cottingham and John Koehn participated in Melbourne Water ISO 14000 training module on managing snags in waterways. John Whittinton, Peter Cottingham and Lynne Sealie drafted a brochure on the 'Ecological importance of snags' to support this session.

Tony Wong (CRCCH), Scott Seymour (Melbourne Water) and Peter Breen conducted a Constructed Wetland Tour in Melbourne. Tour attendees included rural and urban local government, catchment management authorities, drainage management authorities and commercial consultants.

Peter Cottingham prepared briefing material to staff at Melbourne Water on:

- The decline of amphibians in Australia.
- The ecology of avian botulism outbreaks.
- The impacts of highway runoff on waterways.
- Heavy metals in waterways.

Peter Cottingham facilitated arrangements for Scott Seymour (Melbourne Water) to give a seminar on management perspective of stream frontage management.

Mulga parrot, Psephotus varius.
Photo: A Tatnell

Peter Cottingham identified potential position papers of use to Melbourne Water.

Daryl Nielsen and Peter Cottingham supplied information on approaches to sampling zooplankton in the Patterson Lakes.

Peter Cottingham, Rod Oliver and John Whittington supplied opinions on the potential effects of using iron sulphate for the control of algae in reservoirs. Advice from the CRC for Water Quality and Waste Treatment and the WA Water and Rivers Commission was also sought.

Peter Cottingham assisted Graham Rooney with the formation of the Yarra Forum, which will provide opportunities to promote cooperation between researchers and managers undertaking work in the Yarra catchment.

Chris Walsh and Peter Breen briefed senior Melbourne Water Staff on urban stream research priorities, 6 August 1999.

Monash University

Peter Breen attended a project development meeting called by Prof Peter Kershaw, Palaeoenvironmental Change - with respect to contemporary management issues. Yarra River billabongs will be a major study site for this project.

Peter Breen participated in the presentation of a Stormwater Management short-course (with Assoc. Prof. Tony Wong, CRCCH).

Murray Darling Basin Commission

Terry Hillman attended numerous Riverine Issues Working Group meetings.

The Centre was invited to develop a framework for the Sustainable Rivers Audit (SRA) for the Murray-Darling Basin's waterways, proposed by the Murray-Darling Basin Ministerial Council. The Centre, in close consultation with water industry representatives, utilised its experience in water quality and ecological assessment to develop the SRA framework.

The Centre was contracted to produce a report "Ecological Sustainability of rivers of the Murray-Darling Basin" as an input to the "Review of the Operation of the Cap" undertaken by the Murray-Darling Basin Ministerial Council. Recommendations made in the Centre's report were adopted in the Ministerial Council's Review of the Operation of the Cap and are now being implemented.

The CRCFE and CRCCH are undertaking the scoping stage of a large river rehabilitation project funded through the Riverine program. Peter Cottingham and Sabine Schreiber provide CRCFE contributions, supported by advice from Gerry Quinn, Sam Lake and Terry Hillman.

Peter Cullen, Peter Cottingham and John Whittington commented on the MDBC Communication Strategy.

Terry Hillman, Rod Oliver, John Whittington, Mike Copland and Peter Cottingham attended the MDBC 1999 Strategic Investigations and Education Forum (Irrigation, Dryland and Riverine Sub-Programs Forum) in August, where both Rod and Peter presented papers. Peter's presentation of the 'MDBC Riverine Management Scoping Study' was awarded best paper in the Riverine sub-program.

Peter Cullen attended a Workshop on Dryland Salinity and Biodiversity jointly sponsored by Environment Australia and the MDBC. This led to a scoping study on the impacts of salinity on selected biota being done at the MDFRC by Terry Hillman and Daryl Neilsen.

Rod Oliver attended a meeting of authors for the MDBC Darling River book.

Lynne Sealie attended a workshop and commented on the MDBC Initiative documents.

Peter Cottingham assisted Lance Lloyd from the MDBC in evaluating project proposals for nutrient management as part of the MD2001 program.

Sunraysia Rural Water Authority

David Seamer and Iain Ellis provided information to Sunraysia Water on freshwater snails and algae.

Ben Gawne met with the CEO of Sunraysia Rural Water Authority to discuss the research program of the Lower Basin Laboratory.

Sydney Catchment Authority

Peter Cullen assisted SCA with selection of a Chief Scientist (March). He also took part in further discussions about Indicators of Catchment Health, relating to the inner catchment areas.

Peter Cottingham is assisting Tony Paull at the SCA in developing a monitoring and assessment program for future environmental flows from the Woronora River, supported with

advice from Gerry Quinn, Terry Hillman, Richard Norris, John Harris, Martin Thoms, Phil Sloane and Judy Frankenberg.

Scientists researching Wingecarribee Swamp, combined with ecologists from the Centre, met to develop a knowledge strategy for the swamp. A report on the "Management of Wingecarribee Swamp and Reservoir: Identification of Knowledge Gaps" was prepared for Sydney Catchment Authority.

Peter Cullen met with Sydney Water to develop an Environmental Impact Statement on Environmental Flows in the Sydney Region, for the Sydney Catchment Authority. It was not clear that the EIS was the best route to follow and the SCA has decided not to proceed down this path.

The Centre held a workshop for Sydney Catchment Authority on Indicators for Catchment Audits. Peter Cottingham and Peter Cullen prepared a report of the workshop. Peter Cottingham and Barry Hart provided advice on catchment indicators to be included in the SCA operating licence.

University of Canberra

Peter Cullen spoke at the University of Canberra Division of Science & Design Strategic Planning Workshop. "Reading the tea leaves - options, futures & threats." The White Paper on University Research.

Peter Cullen spoke to the Heads of Schools for the Vice Chancellor on "Developing a Research Culture". Peter Cullen presented a talk to Council of University of Canberra on the "Trends in Industry University Collaboration".

Peter Cullen spoke to a UC Seminar on "The CRC as a Knowledge Organisation".

Peter Cullen spoke to the UC Research Leaders Group outlining the green paper and the developing frameworks for industry-university collaborations.

Peter Cullen presented a talk to Council of University of Canberra on the "Trends in Industry University Collaboration".

Peter Cullen spoke on the Knowledge Business to a group of Venture capitalists visiting the ACT.

2.3 External cooperation

The Centre actively collaborates with more than 70 external organisations, including research funding bodies, universities, industry organisations, government departments, agencies and community organisations. These collaborations facilitate the exchange of ideas and ensure that staff and students are contributing to and participating in the science and water industries.

Universities, government departments, agencies and funding bodies include

Charles Sturt University, Bureau of Rural Sciences, Environment Australia, LWRRDC, NSW Department of Agriculture, Queensland EPA, Office of the ACT Commissioner for State of the Environment, Olympic Coordinating Authority, University of Adelaide, University of Western Australia, Northern Territory University, Water and Rivers Commission, WA and City of Newcastle, NSW, Department of Planning SA.

Professional organisations/societies include

Academy of Technological Sciences, Australian Academy of Science, Australian Biological Resources Study, Australian Science Communicators (ASC), Australian Society for Limnology (ASL), Australian Water Association, Ecological Society of Australia, Federation of Australian Science and Technological Associations (FASTS), Australian Society for Fish Biology, the Royal Australian Chemical Institute, Water Research Foundation.

Community organisations include

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

Bureau of Rural Sciences

Peter Cullen was invited to present a seminar to Bureau staff following meetings with the Director, Peter O'Brien, and our wish to develop closer collaboration between the Bureau and the Centre.

Environment Australia

Peter Cullen met with staff from the Water Quality section of Environment Australia to discuss the future of the National Water Quality Monitoring Program.

Peter Cullen chaired a meeting of the National River Health Program Advisory Committee considering research grants and provided advice on these proposals to Minister Hill.

The report, *The Likely Ecological Outcomes of the COAG Water Reforms*, has been completed and submitted to the Department.

CRCFE and CSIRO Land and Water have jointly entered into a partnership agreement with the National Land and Water Audit to carry out a number of tasks relating to the waterway condition facet of the Audit.

Peter Cullen serves on the State of Environment Advisory Committee and attended meetings to brief the consultant on the water chapter.

Peter Cullen attended a meeting of the Steering Committee of Waterways and Estuaries Project as part of the Land and Water Resources Audit. John Harris chaired the Committee.

Chris Walsh, Peter Breen and Mike Grace made presentations to the Urban River Health Workshop at Monash University Clayton on 8 Dec 1999, convened by Environment Australia, resulting in the Draft Urban River Health Strategic Framework.

Gippsland Water

Peter Cullen chaired the Technical Review Committee for Gippsland Water.

Olympic Coordinating Authority

Peter Cullen was asked to assist with a problem about weed growth in the Olympic Rowing Course at Penrith. He inspected the site to develop some approaches, then assisted with a workshop to develop a management strategy.

Wimmera-Mallee Rural Water

Peter Cullen met with WMRW to discuss its association with the centre and delivered a seminar on 'Balancing Economic & Environmental Demands for Water. The Balancing Act – Futures for Water Reform'.

2.4 Cooperation with other CRCs

The Centre looks for opportunities for collaborative projects and activities with other CRCs. It is an active member of the CRC Program community and many Centre staff members liaise with their counterparts in other CRCs. The Executive Officer, Business Manager and Communications Manager, for example, are part of an active network of information sharing with other CRCs on relevant areas of operation.

The CRC Association

Four staff members attended and participated in the CRC Association's Annual Conference in May.

The CRC Water Forum

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

CRCFE coordinated the production of a Water Forum brochure and display, to be used for joint communication activities, such as the Third International River Management Symposium.

CRC Water Quality & Treatment

Peter Cullen presented a talk to CRC for Water Quality & Treatment on 'Catchment Issues'.

The CRC for Freshwater Ecology's Rod Oliver is collaborating with the CRC for Water Quality and Treatment on the project "Artificial Mixing for Destratification and Control of Cyanobacterial Growth in Reservoirs". CSIRO Land and Water is also collaborating in this project.

The CRC for Catchment Hydrology

The CRCFE works collaboratively with the CRCCH on joint research conducted within the Centre's Urban Water Management program, the Granite Creeks restoration project, the Campaspe environmental flows project and the Characterisation of Flow project.

Stuart Bunn has led the ecological component of the LWRRDC research program on riparian lands, in collaboration with CRCCH, and is negotiating on behalf of the centre for involvement in Phase 2 of the Program.

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

The Chief Executive Officers of the Water Forum CRCs. (l to r) D Bursill (CRC WQ & T), P Cullen (CRCFE), R Mein (CRCCH), D Garman (CRCWM & PC) and R Shaw (CRC Coastal)

2.5 International Collaborations

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

Table 2.2 International Research Collaborations

CRCFE member	Activity	Links
Prof Angela Arthington	Involved in planning the International Conference on Best Practice Environmental Flows	To be held in Cape Town, South Africa, 2002
Prof. Stuart Bunn	River restoration techniques and workshops	Newbury Hydraulics, British Columbia.
Prof. Stuart Bunn	Collaborative research projects on riparian lands	National Institute of Water Atmospheric Research, New Zealand
Dr Ron Beckett, Dr Ian McKelvie	Continuing collaborative research	Chiang Mai University, Thailand
Prof Barry Hart	Continuing collaboration	Institute of Technology Bandung, Jember Univeristy, Indonesia
Prof Barry Hart, Assoc. Prof Richard Norris	"	University of Brawijaya, Malang
Prof Barry Hart, Assoc. Prof Martin Thoms	"	University of Capetown
Prof. Sam Lake	Collaborating in a project on the ecological condition and monitoring of Mediterranean rivers of Spain	Universidad de Vigo, Universidad de les Iles Balleares, Universities of Granada, Almeria, Murcia, Barcelona. All in Spain
Assoc Prof Richard Norris	Collaborating with Prof Allan on a large Waters and Waterways project	University of Michigan
	Met with the US Environmental Monitoring | and Assessment Group about study design for nationwide reporting	USEPA
Dr Russ Shiel	Collaborating with Dr John Langford and Assoc Prof John Green on Murray River billabong project	University of Waikato

Table 2.3

International Visitors

CRCFE site	Activity	Links
University of Canberra	Linda Thrift met with Peter Cullen	UK Office of Science & Technology
University of Canberra	Professor Jiri Marsalek met with Ian Lawrence & Peter Breen to discuss urban water research collaboration	National Water Research Institute, Burlington, Ontario, Canada
Griffith University	Hosted Professor Robert Naiman's attendance at the Riversymposium and discussed riparian research issues	University of Washington, USA
Griffith University	Stuart Bunn met with a delegation of water scientists and managers from Japan	River Ecology Research Group of Japan
Griffith University	International review of the LWRRDC riparian lands program (Phase 1)	Dr Rob Davies-Colley (NIWA) and Dr Jack Imhof (Ontario Ministry for Natural Resources, Canada)
Lower Basin Laboratory	Prof Digby Cyrus met with Ben Gawne Glen Wilson and Iain Ellis	University of Zululand and Board Member of Mhlathuze, South Africa
MDFRC	Mike Copland gave an overview of MDFRC activities	Japanese environmental scientists.
MDFRC	Mike Copland gave an overview of MDFRC activities to a study group of amateur and professional botanists	Canadian Botany Group
MDRFC	Visit to the Centre by delegation of officials organised by Mr Ron Dennis	China Department of Agriculture
MDFRC	Meeting for its international and Australian freshwater conservation staff to meet and explore Australian approaches to freshwater conservation	Delegates of the World Wide Fund International Freshwater Advisory Group River and Catchment Conservation Forum
Monash University	Delegation of Thai academics held discussions with Prof Barry Hart and Dr Ron Beckett about the CRC model and its relevance for Thailand	Burupha University, Chang Mai University, Ramkamhaeng , University, Ubon Ratchathani University, Suranaree University of Technology

3 Research Program

DIRECTOR OF RESEARCH: PROFESSOR BARRY HART

CHIEF ECOLOGIST: PROFESSOR SAM LAKE

Prof Sam Lake
Chief Ecologist

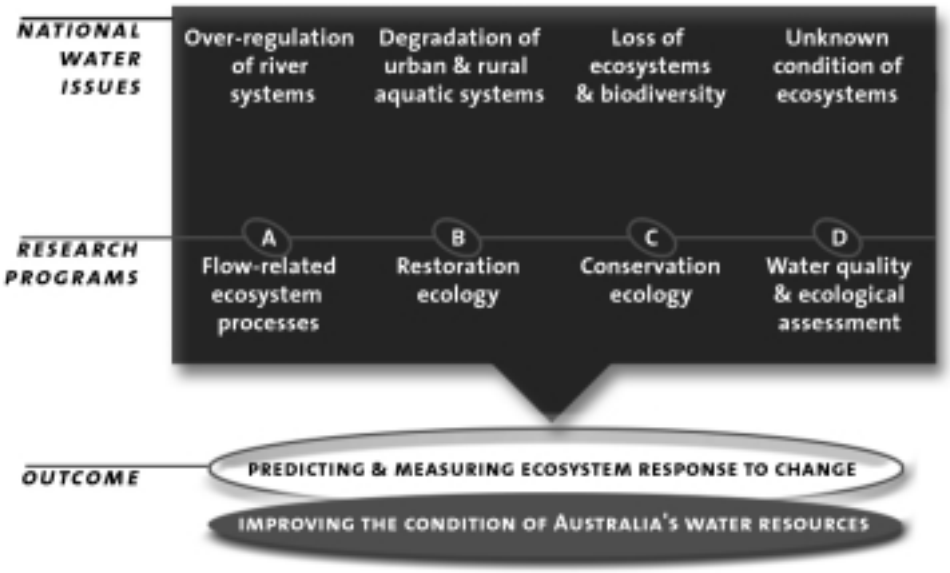
The CRC for Freshwater Ecology undertakes research within four research programs. During the past year, the Centre has undertaken two main activities within the research programs:

i) completion of the integrated projects developed during 1997/98;

ii) development of proposals for research over the next 3-6 years. These proposals will commence from July 2000.

PhD research projects have made major contributions to research in all program areas. These projects are listed under Chapter 4, Education and Training.

3.1 Links between Research Programs and national water issues



3.2 Program Advisory Committees

Program Advisory Committees (PACs) have been established for each research program to strengthen the links between industry needs and the Centre's research programs. The PACs have met and reported to the Board.

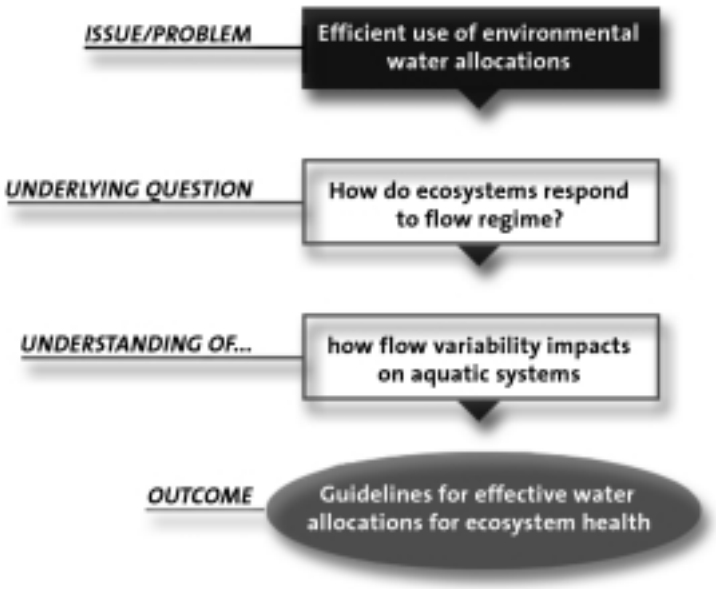
Previous page:
Collins Creek, a reference site for the AUSRIVAS models.
Photo: P Sloane

3.3 Program A Flow-Related Ecological Processes

Program Leader: Dr Gerry Quinn

The extreme variability of Australian rainfall 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. CRC research seeks to understand how flow variability impacts on 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 regulation on habitats, biota and ecological processes. A third and vital area of research is to measure ecosystem response to 'environmental flow' management.

Program Issues and Outcome



Dr Gerry Quinn
Program Leader

Program Objectives

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

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

ECOLOGY OF LOWLAND RIVERS

Project Leader: Dr Ben Gawne

Project Team: Prof Angela Arthington, Dr Darren Baldwin, Dr Bruce Cheesman, Mr Iain Ellis, Dr Ben Gawne, Dr Paul Humphries, Mr Zygmund Lorenz, A/ProfBill Maher, Mr Daryl Nielsen, Dr Rod Oliver, Dr Gavin Rees, Dr Russ Shiel, A/Prof Martin Thoms, Mr Garth Watson, Dr David Williams, Mr Ian Lawrence and Ms Helen King.

Aim:
To determine the sources of organic carbon to lowland rivers and provide recommendations for the management of lowland river systems.

Progress:
An essential step toward understanding the functioning of lowland rivers is to determine what carbon sources comprise the base of the food web. This project has generated a model of the major sources of organic carbon in a single reach of river. We have built the model from data on 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 of the project have contributed data on the way in which plant material is decomposed or consumed by bacteria, fungi and invertebrates, and examine the relationship between invertebrates and fish. We chose three sites along the River Murray, near Albury, Barmah and Mildura, in the hope that the model will apply to the entire river, rather than just a small section. The model will provide us with insights into the way lowland rivers function in order that we can make better predictions about how changes in management have affected our rivers.

A report is currently being prepared from this work.

A mayfly larvae, part of the food web in lowland rivers. Family: Baetidae.

IMPORTANCE OF FLOOD FLOWS TO THE PRODUCTIVITY OF DRYLAND RIVERS AND THEIR FLOODPLAINS.

Project Leader: Professor Stuart Bunn

Project Team: Mr Frank Walker, Dr Peter M. Davies, Prof Stuart E. Bunn, Thorsten Mosisch, Michelle Winning, Fiona Balcombe and Steve Balcombe

Aim:
To assess rates of primary production on floodplains of rivers of the Channel Country and compare these with known terrestrial rates of production in the surrounding landscape.

Progress:
This comparison will be used to determine how important this production is to both aquatic and terrestrial food webs and to estimate the importance of floodplain inundation for landscape-scale productivity. The project will also identify and produce a quantitative model on the likely consequences of changing patterns of floodplain inundation, occurring through water harvesting and other forms of flow regulation. A number of sites on the Paroo, Warrego, Cooper and Diamantina Rivers were sampled during the "dry" (November 1999) for soil samples and to assess suitability for access during the flood conditions. During March 2000, a significant flood in Cooper Creek resulted in floodplain inundation near Windorah. This flood event was sampled on two occasions. Measures of water quality and benthic and pelagic metabolism were taken, together with samples of invertebrates and fish for food web analysis. These preliminary data suggest that there is potential for substantial aquatic primary production on the floodplain (associated with the growth of planktonic and benthic algae). Given the extent of the floodplain, this may represent a substantial source of carbon for consumers. The on-going stable isotope analyses (C and N) will show have much of this production remains in floodplain soils and how much is distributed through the macroinvertebrate and fish food webs.

Researchers measuring aquatic primary production on the Cooper Creek floodplain. Photo: R Ashdown

Researcxhers dragging nets for work on food webs. Photo: R Ashdown

DOWNSTREAM TRANSPORT OF LARVAL AND JUVENILE FISH

Project Leader: Dr Craig Schiller (NSW Fisheries)

Project team: Mr Michael Rodgers (NSW Fisheries), Keith Brehney (NSW Fisheries) and Mr Ian Wooden (NSW Fisheries).

Aims:

To assess the transport of larvae and juveniles fish downstream in the Murray River.

To predict which weirs will have significant impacts on movements of fish.

Progress:
This project was undertaken on the River Murray. Drifting larvae and juveniles have now been recorded for a number of species, including Murray Cod, Golden Perch, Gudgeons and Carp.

We have found that significant numbers of Murray cod larvae and juveniles, plus a large number of eggs, were present in the drift. This suggests that, contrary to published literature, this species does have a pelagic dispersal phase. The drifting Murray cod larvae were 8 - 13 mm in size, suggesting that larvae enter the drift soon after hatching and disappear at 10-14 days of age. We observed low abundance of larvae immediately below weirs yet numbers increased downstream of weirs. This suggests that for Murray cod weirs are impacting on drift and trapping larvae in weir pools. These findings are highly significant and contradict published knowledge of the reproductive process and population dynamics of this species. The final analysis and reporting of these findings is now being undertaken. It is likely that these findings will have important ramifications for future management of Murray cod.

IN-STREAM PROCESSES IN THE BARWON-DARLING RIVER

Project Leader: Associate Professor Martin Thoms

Project Team: Dr Fran Sheldon, Vic Hughes

Aim:
To determine flow requirements for dryland rivers by investigating relationships between flow variability, habitat complexity and ecological functioning.

Progress:
Surveys of the Barwon-Darling have highlighted the complex nature of the river channel. The river is composed of a series of inset floodplains or benches. These features trap and store large quantities of organic material and once wet, release dissolved carbon into the water. We have determined the flows required to wet these surfaces and as a consequence have been able to determine the impact of water resource development on the natural wetting and drying processes. This information is then used to construct a series of hypothetical curves summarising ecological response to hydrological change. The use of 'benchmark curves' is then proposed as a methodology for assessing the likely ecological response of river systems to increased hydrological change.

This information is important in establishing environmental flow regimes for the Barwon-Darling River system. Journal articles and a summary report are available from this project.

FLOODPLAIN / WETLAND PROCESSES IN THE LOWER BALONNE RIVER SYSTEM

Project Leader: Associate Professor Martin Thoms

Project Team: Ms Heather McGuinness, Dr Fran Sheldon, John Foster and Ms Sarah Cartwright.

Aim:
To determine the role of different habitats in trapping carbon and nutrients from flood water.

Progress:
This study will generate criteria for identifying key habitats, 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 surveyed 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, remotely sensed imagery, discharge data, surface sediments and a series of sediment cores are being utilised. The information obtained from this project will contribute to the Lower Balonne Floodplain Management Strategy.

Further work in this area will be undertaken in the project, Habitat Fragmentation and Environmental Flows. This project will quantify the impact of water resource development on the Condamine-Balonne river by exploring the nature of habitat heterogeneity on the floodplain and how this influences floodplain carbon dynamics and invertebrate communities. The project will assist in identifying realistic environmental flow criteria for semi-arid zone rivers.

Scientific articles are available on the preliminary results from this study.

Great Egret in a billabong.
Photo: A Tatnell

RIPARIAN VEGETATION-PRODUCTIVITY AND ECOLOGY

Project Leaders: Dr David Williams and Ms Lisa Evans

Project Team: Ms Lisa Evans, Dr David Williams and A/Prof Martin Thoms

Aim:
To understand the factors which determine the composition of riparian vegetation along large rivers and to quantify the contribution this vegetation makes to the riverine organic matter.

Progress:
Riparian 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.

This project, based in the Murrumbidgee, Goodradigbee and Abercrombie Rivers, has examined the influence of inundation and flow on performance of the major plant species. Inundation period and current velocity have been found to affect plants – some species had a positive growth response to exposure to a period of flow compared to still water inundation. These results were found to correlate with the field distribution pattern of species. The duration of inundation was found to affect plant species in a similar way to velocity.

Hydrological analysis of a range of field sites has been conducted and will be used as input for a vegetation prediction model. So far it appears that variables relating to substrate, climate and hydrology will be the best predictors of vegetation distribution in these rivers.

These findings have implications for riparian vegetation rehabilitation in the matching of species to physical characteristics of the riparian zone, and for prediction of the impacts of engineering works that lead to changes in the flow regime.

Low flows in the Murrumbidgee.
Photo: K Markwort

A2 Flow manipulation in regulated lowland rivers

EFFECT OF FLOW MANIPULATION ON THE BIOTA OF A LOWLAND RIVER

Project Leader: Dr Paul Humphries

Project Team: Dr Paul Humphries, Dr Jane Growns, Mr Robert Cook, Mr Luciano Serafini, Mr Adam Richardson, Prof Sam Lake, DR Gerry Quinn, Mr John Hawking, Terry Court and Frank McKinley.

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.

Progress:
This project is investigating the response of fish, macroinvertebrates and habitat to an experimental flow change in the highly regulated Campaspe River. Current regulated flows provide little water for environmental purposes outside the irrigation season. The proposed flow change involves releasing 25% of incoming flow between May and October of each year, when a specified storage trigger level is reached. Comparisons with the less regulated Broken River will provide greater confidence that any responses detected are due to the experimental manipulation. The experimental flow change was initially due in May 1998, but due to the driest period in 100 years, this has been delayed until May 2001.

Western Chanda Perch, Ambassis castelnaui. *Photo: G Schmida*

We have now completed almost 5 years of fish and 3 years of macroinvertebrate sampling. Novel techniques for sampling fish larvae and macroinvertebrates have been developed and a new hypothesis for the relationship between flow and fish recruitment in lowland rivers has been established based on the work in the Campaspe and Broken Rivers. The state of the fish fauna in the Campaspe River is extremely poor, with dominance by introduced species evident. Macroinvertebrate communities have been found to be strongly influenced by the degree of flow regulation in the Campaspe River, with the upper section, which receives the bulk of irrigation water, effectively acting as an upland stream.

The project team have utilised the results from this research to input into allocation of flows for the environment in the Campaspe River through an expert panel and the Victorian Bulk Entitlement Process.

Scientific articles are available on the preliminary results and new methods from this study.

BILLABONG-RIVER INTERACTIONS DURING HIGH FLOW

Project Leader: Dr Terry Hillman

Project Team: Prof. Alistar Robertson, Dr Adriene Burns, Ms Helen King, Mr Garth Watson, Mr Daryl Nielsen and Dr Terry Hillman.

Aims:
To assess the transfer of biota between the river channel, billabongs and floodplain.
To determine whether the connection between river and billabong during floods resets the billabong ecosystem and inoculates the river with carbon, algae and microorganisms.

Progress:
This project was originally planned for billabongs on the Murrumbidgee River near Wagga Wagga, NSW. Background physico-chemical data and surveys of the biota were undertaken during dry periods. Because of the extended dry period we were unable to get sufficient flows to join the river and billabongs even after negotiating a 'top-up' release at the end of the irrigation season. As a last resort a second river system has been selected for the study — the Edward River. Manipulation of Stevens Weir is expected to produce appropriate flow conditions to join the river to selected billabongs during the study period. The Murrumbidgee Community Reference Committee on Environmental Flows had planned to use two years of its contingency water to 'create' the 'flood'. If environmental conditions are conducive, this discretionary allocation may still be used to create high flows in the Murrumbidgee and therefore allow the study to continue in both rivers.

MEASURING THE EFFECTIVENESS OF ENVIRONMENTAL WATER ALLOCATIONS

Project Leader: Dr Gerry Quinn

Project Team: Dr Michael Reid, Dr Gerry Quinn and Dr Terry Hillman

Aims:
To develop monitoring programs to detect changes in response to environmental water allocations.

Progress:
This project initially produced a monitoring program to test the effectiveness of proposed indicators. The second stage of this project is trialling the monitoring design and indicators developed in Stage 1 and will be complete by September 2000.

A report is available on the monitoring program developed for stage 1 of this study.

FLOW CHARACTERISATION

Project Leader: Dr Jane Growns

Project Team: Dr Ben Gawne, A/Prof Martin Thoms and Dr Paul Humphries

Aims:
To characterise natural flow regimes using ecologically relevant statistics.
To determine how flows have been changed in response to water resource development.

Progress:
This project used hydrological variables to characterise flow at 107 stream gauging stations in south-east Australia. We found differences in the data between intermittent and permanently flowing stations and between regulated and unregulated stations. The differences included much higher long-term maximum flows, 90th percentile flows and mean daily flows, and longer return intervals for the 2-year flood for regulated stations. Seasonality of flows was also different and several of the flow descriptors were less variable at regulated stations.

This work has important implications for allocating environmental flows — it should be possible to release water from dams in ways that minimise the differences in hydrology between regulated and unregulated rivers. We suggest that each river would need to be considered in the context of (i) the natural flow regimes of nearby rivers, (ii) the climatic zone in which it occurs, and (iii) the main purpose for which it is regulated.

A report is available from this work.

MEASURES AND BENEFITS OF ENVIRONMENTAL FLOWS

Project Leader: Dr Peter Gehrke

Project Team: Karen Astells and Roy Winstanley

Aims:
To develop a measure of river flow alteration that is ecologically relevant. To predict changes in fish communities in response to changes in river flow management.

Progress:
Analysis of hydrology data has identified differences between natural flow regimes and flows under current levels of water resource development. The proposed environmental flow rules in New South Wales provide a third hydrological environment. In this study we are looking at the likely changes in fish communities as a result of implementing the NSW environmental flow rules. We are constrained in our ability to model the impacts on fish communities because of a lack of temporal data on fish communities under sequential flow conditions. We are using, instead, spatial data from rivers with different flow regimes in order to predict temporal change. An important part of validating the model will be to assess the pitfalls and advantages of this approach.

Preliminary models suggest that environmental flow rules intended to create a more natural flow regime in rivers have created a hydrological condition that differs from both natural and developed hydrological conditions. It is difficult to predict with certainty how fish will respond to the new flow environment. Longer term fish data is required to determine trends in the responses of fish to changes in flow.

BIOLOGICAL EFFECTS OF COLD WATER RELEASES FROM DAMS

Project Leader: Dr Peter Gehrke

Project Team: Karen Astells and Roy Winstanley

Aims:
Document the responses of native and alien fish to cold water releases from dams.

Progress:
This project used controlled-temperature channels in a specially designed experimental facility at Burrendong Dam, NSW. We were able to measure the responses of fish to the range of water temperatures experienced in regulated rivers. In addition, the distribution of fish in relation to cold water has been assessed using seasonal surveys in the Macquarie and Bogan Rivers.

Our experiments show that the low temperature of water released from Burrendong Dam retards fish growth and causes high mortality in juvenile silver perch. This strongly suggests that cold water pollution from dam releases is having a major impact on growth and survival of juvenile silver perch and other native fish in rivers. Implementation of warm-water releases from dams for both irrigation and environmental flows is likely to be a critical factor in rehabilitating rivers and native fish communities.

ROTENONE IN STREAMS

Project Leader: Ms Jan Barton

Project Team: Dr Ben Gawne, Ms Jan Barton and Ms Rhonda Sinclair

Aims:
To assess the impact of rotenone treatment on benthic macroinvertebrate communties and to make management recommendations regarding the use of rotenone for conservation actions.

Progress:
This project was based in streams in the upper Goulburn catchment where Trout were removed with the chemical rotenone in order to conserve the endangered fish, *Galaxias fuscus*. Macroinvertebrate communities were sampled for three months before and two years after the rotenone was used. At least 60% of the macroinvertebrates were dead within 48 hours of rotenone treatment and all taxa seemed affected. The streams remained significantly impacted one month later, however, after nine months we were no longer able to observe any impact. It appears that hatching from eggs, apparently unaffected by rotenone, was important to recovery.

Guidelines for the use of rotenone have been established.

PROGRAM A: FLOW-RELATED ECOLOGICAL PROCESSES~OUTCOMES

Program outcomes	3 year milestones	Progress at the end of Year 1
Better understanding of the link between flows, ecological processes and biodiversity in a range ofriver types.	Improved conceptual and empirical understanding of the role of flow (floods and droughts) as a disturbance affecting ecological processes in rivers and streams	• Low flow recruitment hypotheis paper published andattracting much international attention • Modelling from lowland river project suggests that while floods are important they are not the dominant source of organic material to lowland rivers • Water column phytoplankton is a much more important component of lowland river ecosystems than previously thought • Conference on ecological effects of drought organised for February 2001
New tools that will lead to improved recommendations for, and evaluations of, environmental water allocations	Ecological characterisation of flow regimes in rivers in Eastern Australia including, both winter and summer rainfall systems	• Final draft of report from flow characterisation scoping study finished. • Project team for new flow characterisation project assembled and funding pending
Ability to predict the sensitivity of aquatic ecosystems to varying levels of flow regulation (or water abstraction) from models relating biotic patterns and ecological processes with flow attributes	Assessment and development of designs for (i) monitoring the effects of environmental water allocations (environmental flows) to rivers, floodplains and wetlands, and (ii) experimentally testing, at realistic spatial and temporal scales, the causal links between attributes of flow regimes and specific ecological processes	• Conceptual links between flow and habitat restoration, including monitoring, established as part of a new project to commence next year • Search for suitable flow and/or habitat restoration case studies underway. • Campaspe flow manipulation project proceeding but experimental component delayed due to lack of rainfall
Develop and promote the adoption of flow restoration recommendations that could lead to measurable ecological benefits in degraded rivers	Development of interim flow restoration guidelines for lowland rivers that will lead to measurable ecological benefits in the main channel, the floodplain and associated wetlands	• Will be developed within a new project to commence next year

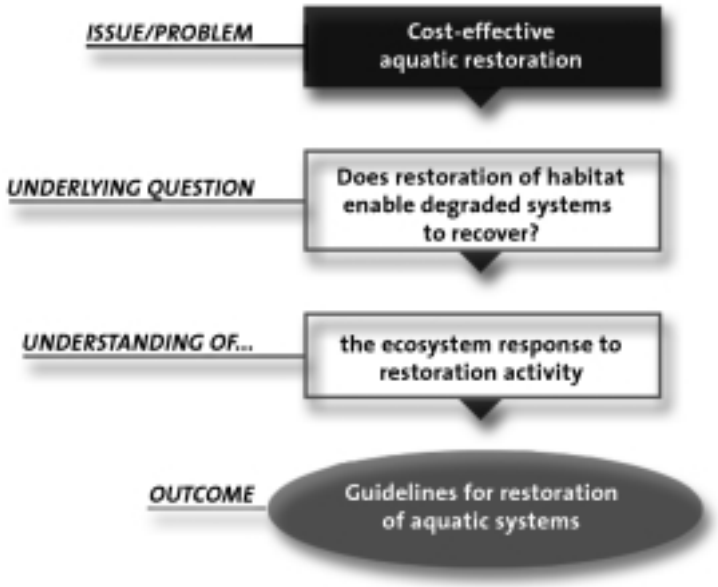
3.4 Program B
Restoration Ecology

Program Leader: Professor Stuart Bunn

Many of our streams, rivers and wetlands are in a degraded state and millions of dollars are spent each year on restoration. Unfortunately, little of the past restoration effort has been underpinned by a strong scientific base and few attempts have been made to measure environmental benefits. The core research objective of this Program is to understand the ecological processes that will facilitate the recovery of disturbed stream and river ecosystems. In doing so, we can ensure that future restoration projects are undertaken in ways that maximise the environmental benefits achieved for the money spent.

Prof Stuart Bunn
Program Leader

Program Issues and Outcome



Program Objectives

- Understand the processes that will facilitate recovery of disturbed systems.
- Develop innovative approaches to waterway restoration.
- Establish several case studies as adaptive stream rehabilitation experiments.
- Facilitate the integration of river restoration practice into total catchment management.

The Restoration Ecology Program addresses three broad themes:

B1 Physical habitat restoration
B2 Habitat fragmentation and connectivity
B3 Monitoring restoration success

B1. Physical habitat restoration

A key assumption of most river and riparian restoration activities is that if you rebuild or recreate habitat, then organisms will return and condition will improve. We will use rigorous scientific experiments to test whether recovery of degraded streams and rivers is constrained simply by the availability of suitable habitat. We will also capitalise on current or planned restoration activities to showcase practical and cost-effective methods for river and riparian rehabilitation.

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, Ms Alena Glaister, Dr.Brian Finlayson (CRCCH), Dr Ian Rutherfurd (CRCCH), members of Granite Creeks Landcare Group, Justin Sheed and Wayne Tennant of Goulburn-Broken Catchment Management Authority, Mr Pat Feehan of Goulburn-Murray Water, plus casual assistance from several research staff and students.

Aims:

To determine the levels of sediment input into streams from catchments of the Strathbogie Ranges.

To assess the effectiveness of adding habitat structure (timber) in restoring degraded streams (notably sand-slugged streams), and whether distance from potential sources of colonists affects restoration.

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

Robyn Glaister mapping snags along Creighton's Creek using GPS

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

Progress:

We selected five streams in the Granite Creeks Catchment, which represent both sand-affected and unimpacted streambeds, for comparison of their fauna, catchment condition, channel morphology, wood amounts, 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 appraisal, covering both the "upland hill country" and the "flats". This assessment describes 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 probable causes of sediment erosion and movement. The widespread erosion in the catchments of the creeks appears to have been synchronised with European settlement of the area. The movement of the sediments onto the "flats" has lead to the development of slow-moving and extensive sand slugs. Her report stressed the necessities of preventing further erosion in the upland catchments and of providing habitat structure in the lowland sand-impacted sections.

The project team carried out a major sampling survey for invertebrates, both those dwelling in the sediments and those living on logs, across both sand-impacted and reference creeks. This exercise has revealed that for both species richness and total abundances levels did not differ significantly between creek sections in general, but that levels of both parameters were significantly lower in the upstream sand-impacted sections than in the downstream non-impacted sections. Note the difficulties in isolating the impacts of sand from possible upstream-downstream effects. Species composition of the benthos differs significantly between upstream sand and downstream clay sections. Measurements of oxygen concentrations over summer suggest that in the pools of the clay sections, the benthic fauna may be stressed by low oxygen levels.

Interestingly, the species richness and abundances of the log fauna did not differ between sanded and unimpacted sections, but there were significant differences in species composition. Thus for the invertebrates of the sanded sections, the aims of restoration are to increase species richness and faunal abundance in the sanded sections for the sediment benthos, and to achieve the successful colonization of added timber structures by log-dwelling invertebrates. For the fish, the aims are to increase the densities of native fish that dwell in very low densities in the sanded sections, and to prevent the invasion of exotic fish from the downstream clay sections.

Thus from the preliminary study, we now have extensive knowledge of the fauna in the sand-impacted and unimpacted sections of the creeks. Restoration work will now concentrate on two creeks. We (CRCFE, CRCCH and Goulburn-Broken CMA) intend to design and construct timber structures that will hopefully be resilient to the disturbance of shifting sand. These structures will be placed into sites in sandy stream sections. The sites

will be either close to already present wood accumulations or at varying distances from wood accumulations. Colonisation by fish and invertebrates will be monitored, as will the sand-dwelling benthos close to and far from the timber structures.

Achievements include a major report titled "Stream degradation and sand slug development: Granite Creeks, central Victoria" by Jennifer Davis and Brian Finlayson, being prepared for publication by the centre. For conference proceedings, please see chapter 7, Publications.

RIVER REHABILITATION THROUGH RE-SNAGGING

Project Leader: Mr Simon Nicol

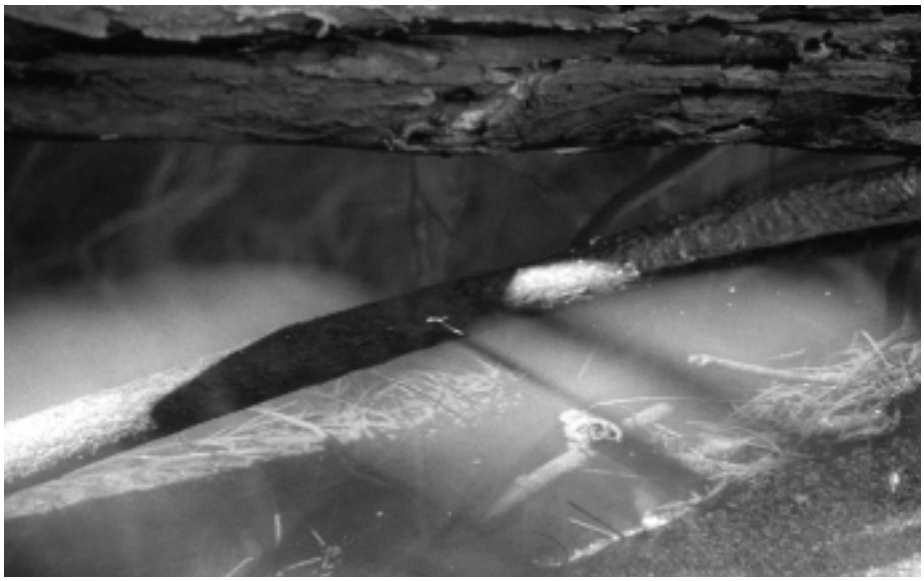
Project Team: ***DR*** John Koehn and Jason Lieschke.

Aims

Investigate the relationship between the degeneration of physical habitat and the biological condition of river systems; define measurable rehabilitation objectives and develop design criteria for re-snagging.

Progress:

In two past investigations into the ecology of large fish species in the Murray River, it has been identified that large woody debris is an important provider of physical habitat. Consequently, adding large woody debris to rivers (re-snagging) is currently considered a realistic option for providing physical habitat for many species. This project will provide information on the effectiveness of re-snagging for the rehabilitation of native fish populations and suggest ways in which such activities be undertaken.



Snags provide a variety of habitats for plants and animals. Photo: A Mostead

HYDROLOGIC MANIPULATION AS A POTENTIAL CARP CONTROL STRATEGY

Project Leaders: Dr Ben Gawne and Mr Glenn Wilson

Aim:
To evaluate the role of hydrological factors in determining the timing and success 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. This project is designed to collect information on the spawning ecology of carp 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 is divided into four parts: (i) sampling juveniles from the Darling and Murray River wetlands to determine spawning-timing profiles, (ii) collecting post-juvenile fish along Darling, Murray and Macquarie Rivers to examine patterns in 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.

The findings from this project show that hydrology influences the timing and success of carp spawning events. From this data we will make recommendations on the use of flow manipulation to control carp numbers.

A report is being prepared from this project.

Controlling carp in our rivers.

B2. Habitat fragmentation and connectivity

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

THE ROLE OF DISPERSAL AND RECRUITMENT IN STRUCTURING STREAM INVERTEBRATE POPULATIONS

Project Leader: Associate Professor Jane Hughes

Project Team: Prof Stuart Bunn, M. Hillyer and Dr Richard Marchant.

Aims:
To answer the questions: Are patterns of genetic differentiation among larval populations of insects the result of limited in-stream movement and recruitment resulting from only a few matings? Is adult flight an effective mechanism for large-scale dispersal of stream insects across areas where the terrestrial habitat is fragmented?

Progress:
Recent work on genetic variation in populations of stream invertebrates has challenged accepted views about dispersal and recruitment in streams – suggesting that recruitment is the result of only a few matings and in-stream movement is limited. This project will test these ideas by sampling streams where species have synchronous larval development and mass emergence of adults, and where in-stream movement (by drift) is thought to be high. The importance of aerial dispersal may have been over emphasised because past studies have focused on areas of continuous adult habitat. The effectiveness of aerial dispersal where the adult habitat is fragmented will also be determined.

B3. Monitoring restoration success

Most restoration projects are undertaken with the broad goal of improving "health" or "condition", and success can only be measured in terms of both biodiversity and key ecosystem processes. The Centre has an important role to play in the development of practical and cost-effective indicators of success of restoration activities. To a large extent, this work will be undertaken in Program D, as part of the overall goal of developing and testing new methods for ecological assessment. However, an important question to be addressed in the Restoration Ecology Program is whether it is possible to restore key ecosystem processes (e.g. primary production, nutrient cycling) without completely restoring all elements of the biological communities.

SEDIMENT - NUTRIENT PROCESSES

Project Leader: Dr Ron Beckett

Project Team: Mike Grace, Mike Harper, Bill Maher, Graeme Esslemont, N Hill, Gavin Rees and Darren Baldwin

Aim:
To test whether sediments play an integral role in determining nutrient concentrations and fluxes in Australian freshwater systems.

Progress:
The central hypothesis in this project is that suspended and bottom sediments have a pivotal role in determining nutrient concentrations and fluxes in freshwater ecosystems. In the project, we examined the importance of phosphate adsorption, particle coagulation and precipitation processes that occur in the water column, determined the rates of key microbial processes in sediments that lead to release of nutrients from sediments and the major factors involved in processing the carbon that drives sediment microbial process.

We showed that modelling water column adsorption processes requires only limited and relatively simple measurements of dissolved and total phosphorus measurements. Factors such as iron and organic carbon content cause a shift in the particle adsorption capacity. Novel techniques were developed to measure impact of shear on particles and subsequent settling rates. Anoxic conditions lead to a release of phosphate from sediments. The extent of release was variable with different sediments and could be strongly affected by type and concentration of carbon and sulfate and history of the sediment. We showed that typical rate constants could not be used to accurately model sediment processes, but would require the use of Monod-type kinetics. Reactivity studies on different plant litter showed that additional nutrients for degradation was dependent on the plant material. Reactivity studies also generated degradation rate constants necessary for modelling processes. Findings from this project, and refinements to established models, have been used in the development of a new quantitative model for sediment nutrient processes. The computer model is currently undergoing initial testing and validation.

A final report is being prepared for this project.

ECOLOGY OF THE YARRA RIVER

Project Leader: Dr Peter Breen

Project Team: Dr Chris Walsh, Dr Mike Grace and Dr Sophie Bourgues.

Aim:
To evaluate the impact of urbanisation on the Yarra River.

Progress:

This project has looked at the patterns occurring in the community structure of aquatic macroinvertebrates. We also looked at patterns in community function using indicators such as sediment denitrification potential, water column production and respiration, benthic production and respiration, and gross river production and respiration.

The patterns in the macroinvertebrate data suggest that impacts due to urbanisation can be observed above the natural downstream changes that occur in streams. We have found noticeable discontinuities in the data for community composition below tributaries that either deliver nutrients from wastewater treatment plants or runoff from highly urbanised catchments.

Dobsonfly larvae, an aquatic macroinvertebrate.

Denitrification potential was used as a measure of nutrient cycling in the Yarra River. In general the potential denitrification rates were high compared to literature values, the highest being measured in urbanised reaches. The potential rates at all sites appeared to be limited by nitrate. While nutrient cycling was not carbon limited, gross river primary production was generally low and appear to be limited by phosphorus in the rural sections and by light availability (e.g. turbidity) in the urban sections. Although water column production and respiration was very low, results from benthic enclosures indicate that production of benthic algal biofilms may be quite high and represent an important local source of primary production.

The results from this project are starting to build a picture of the relationship between community structure and function in the Yarra River. Importantly the project is also studying denitrification and evaluating if it can be managed in-stream to reduce nitrogen loads from urbanising catchments like the Yarra.

A final report is being prepared from this project.

PROGRAM B: RESTORATION ECOLOGY~OUTCOMES

Program Outcomes	3 year milestones	Progress at the end of Year 1
An improved understanding of the constraints to recovery of disturbed aquatic ecosystems and the processes that can facilitate rehabilitation	Development and validation of innovative and practical monitoring tools so that the success of rehabilitation of streams and rivers can be quantified in ecological terms	• Population genetic tools used to estimate dispersal capability of common stream invertebrates in SE Qld streams.Sampling of selected taxa in Victorian streams commenced. • Sampling techniques developed and tested for monitoring recovery of LWD habitats in degraded lowland streams • Commenced design and testing of a monitoring program for riparian rehabilitation in SE Qld as part of the SEQ Regional Water Quality Management Strategy
To ensure that public funds invested in restoration of degraded ecosystems result in the maximum environmental benefit possible	Initiate demonstration sites aimed at showcasing practical, cost-effective and ecologically sound methods for the rehabilitation of rivers and wetlands Contribute to the development of "best management practice" for the cost-effective and ecologically sound rehabilitation of rivers and wetlands	• Contribution to the production of technical guidelines on Riparian Management (with CRCCH & LWRRDC). • Selection of potential study sites in SE Qld as part of the SEQ Regional Water Quality Management Strategy

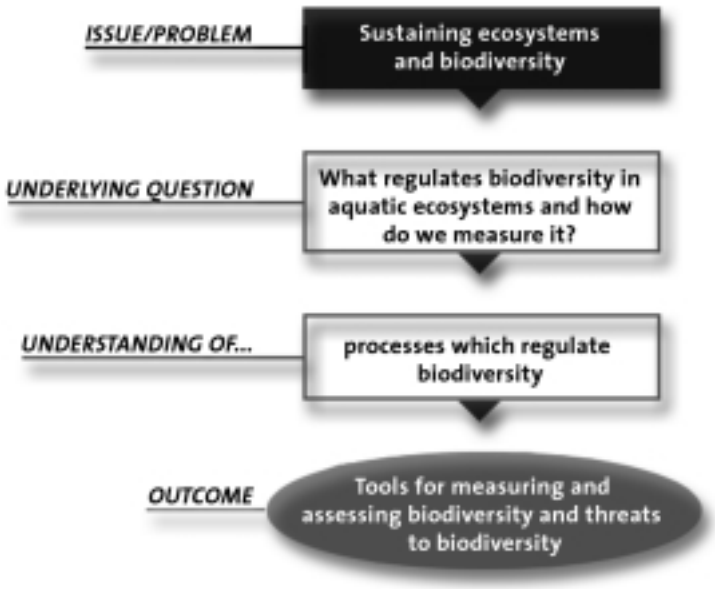
Snags provide important habitat for water birds such as these ibis. Photo: B van Aken, CSIRO Land and Water

3.5 Program C Conservation Ecology

Program Leader: Associate Professor Arthur Georges

Assoc Prof Arthur Georges
Program Leader

Program Issues and Outcome



Program Objectives

- To assess biodiversity in freshwater ecosystems and the processes that regulate it.
- To identify and understand threats to biodiversity.
- To develop and evaluate responses to human-induced pressures.

A Biodiversity Assessment and Regulation

B Conserving Biodiversity

ULTRAVIOLET RADIATION AND AMPHIBIAN DECLINES

Project Leader: Dr William Osborne

Project Team: Mr David Hunter, Dr Ken Green (National Parks and Wildlife Service)

Aim:
Examine sensitivity of amphibians to ambient levels of ultraviolet radiation.

Progress:

There is international concern that elevated levels of ultraviolet B radiation, resulting from ozone depletion, are likely to effect organisms living at high elevations. Organisms in the early stages of embryonic development that are confined to clear, shallow pools are most likely to be at risk. In the last decade there have been alarming losses to alpine frog populations, both in Australia and overseas. This project examines whether these concerns may be related to the sensitivity of declining species to increased UV-B radiation.

The project is located in the Snowy Mountains including the Murrumbidgee, Murray and Snowy River catchments. It is researching the reproductive and behavioural characteristics of declining and non-declining amphibians in natural water bodies that may make them more susceptible to UV-B radiation. The field work component of this research has been completed and results are being analysed prior to publication.

Journal articles are available from this work and results clearly indicate that a declining Alpine species, the Alpine Tree Frog, is highly sensitive to UV-B radiation.

CARP CONTROL METHODS

Project Leader: Dr Craig Schiller (NSW Fisheries)

Project Team: David McGill (NSW Fisheries) and Matthew McInttosh (NSW Fisheries)

Aim:

Develop methods for reducing carp abundance in enclosed water bodies; assess the effect of this on reduction in adult numbers on the survival and growth of juveniles.

Progress:

This project, based in billabongs in the Murrumbidgee and Murray catchments, focuses on carp removal and research into development of large-scale carp harvesting methods. We are also looking at what effect such harvesting has on the growth and survival of juvenile carp. This will provide an indication of the longer term impact of such methods.

Over 165 wetland sites have been inspected and of these 21 were surveyed using electrofishing. The effectiveness of large-scale harvesting techniques were tested in Lake Cargelligo. Three study billabongs, two on the Murray River and one on the Murrumbidgee River, have been partitioned into smaller experimental units and carp populations are being manipulated. Ecological changes associated with changes in carp density have been measured in the study billabongs. We are currently analysing the results from this work.

RECRUITMENT ECOLOGY OF NATIVE FISH

Project Leader: Dr Peter Gehrke

Project Team: Dr Craig Schiller and Mr Ian Wooden

Aim:
To develop a model of fish recruitment and criteria for managing nursery habitats.

Progress:
This work was undertaken on rivers, lakes, creeks and floodplains in the Paroo, Darling, Murrumbidgee and Murray catchments. We found that floodplains were the most common habitat used by recruiting fish, supporting the common perception of floodplains as nursery habitats. Stocking of floodplain habitats with large numbers of hatchery-reared larvae does not appear to enhance natural recruitment.

Golden Perch, Macquaria ambigua. *This project found that the recruitment of Golden Perch declined because of changes to flow.*
Photo: P Humphries

The report on this project shows that fish recruitment is impacted by flow management. There are few high flows in the Darling River and therefore floodplain habitats downstream of Menindee are not inundated regularly - this limits opportunities for native fish recruitment in this area. We found that the recruitment of Golden perch and Bony herring declined because of changes to flow however carp recruitment increased.

Carp recruitment was strong in all catchments. Temporary creek and floodplain habitats consistently provided stronger recruitment than permanent river or lake habitats. Carp are therefore likely to benefit from increased floodplain inundation frequency in a similar way to native fish species.

The Paroo River. Photo: A Tatnell

Development of water resources in the Murray-Darling Basin has not been ecologically sustainable in the context of maintaining biodiversity. This provides strong ecological support for the MDBMC cap on diversions and for NSW Water Reforms as a process for conserving biodiversity. Implementation of environmental flow regimes that mimic as closely as possible natural inundation patterns is recommended to maximise recruitment potential for native fish and to restore biodiversity.

A report is being finalised on the outcomes of this work.

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 (NSW Fisheries), Dr Mark Lintermans

Project Team: Mr Ian Wooden (NSW Fisheries), Mr Michael Rodgers (NSW Fisheries) and Mr Mark Jekabsons (Environment ACT).

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.

The field work has been completed and analysis has commenced. Early analysis indicates that mid-stream snags as well as bank snags are important. 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.

Most recent findings:

- Trout cod prefer higher flow areas (at micro & macro scales)
- Strong association with medium to large snags/large woody debris that occur singly (not in "clumps")
- Prefer snags in mid-stream (compared with shore-based snags)
- Linked with preference for higher flows
- Prefer snags oriented into flow (i.e. long axis of snag is at 0° to main flow)
- In middle Murrumbidgee, Trout cod are most abundant in stocked areas and regions with abundant suitable snags.

Trout Cod,
Macchullochella macquariensis,
an endangered native fish.
Photo: G Schmida

PROGRAM C: CONSERVATION ECOLOGY~OUTCOMES

Program outcomes	3 year milestones	Progress at the end of Year 1
New knowledge on the distribution, life history and conservation ecology of threatened freshwater biota	Organisation of a national forum on conservation of biodiversity in freshwater ecosystems, bringing together the range of perspectives from science and management	Funding to support Fenner Conference approved. Conference to run in July 2001
Advice on the likely impacts of various human-induced disturbances on biodiversity in freshwater ecosystems and the spatial scales over which they are likely to be affected	Design of experimental protocols for testing hypotheses on the processes that regulate biodiversity in natural and modified freshwater ecosystems	Project to address the issue of connectivity in dryland systems has been approved
Advice on the possible ecological effects of invasive species on native flora and fauna	Identification of primary threatening processes for aquatic biodiversity	Symposium on invasive species to be included as key element in Fenner Conference
Principles and recommendations for assessing the biodiversity values of freshwater systems	Develop principles for the assessment of biodiversity in freshwater ecosystems	Project to address this milestone under development in collaboration with Sydney Catchment Authority

High flows in the Murrumbidgee River, ACT. Photo: K Markwort

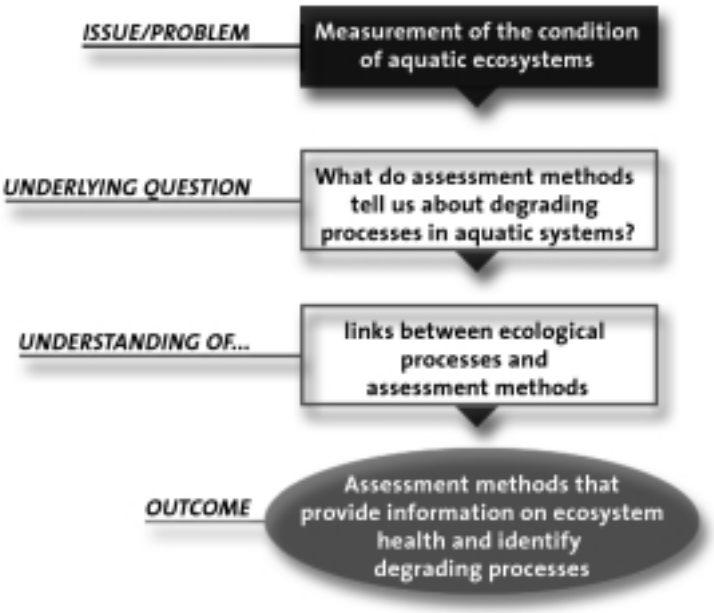
3.6 Program D: Water Quality and Ecological Assessment

Assoc Prof Richard Norris
Program Leader

Program Leader: Associate Professor Richard Norris

Resource management and environmental protection agencies have an increasing need for high quality information relating to the ecological effects of their operation. 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 the management process. There is now renewed interest in the use of more qualitative techniques, primarily because of the high cost of quantitative approaches. The centre is developing innovative methods for assessing river health particularly using macroinvertebrates, fish, microbes, algae and habitat.

Program Issues and Outcome



Program Objectives

- To determine the ecological response of rivers and related wetlands to stressors.
- To develop and test ecological risk assessment procedures for application to fresh water systems.
- To develop the ecological basis for determining reference conditions against which comparisons to determine damage or change are often made.
- To determine the effectiveness of various bioassessment approaches to provide information on the condition of the aquatic communities and ecosystem processes.
- To determine the relationships between ecological processes and outputs from bioassessment methods.

D1 Ecological response to damaging agents

ALGAL SUCCESSION AND BIOMASS IN BURRINJUCK RESERVOIR

Project Leader: Mr Ian Lawrence

Project Team: Ms Myriam Bormans (CSIRO Land and Water), Dr Rod Oliver, Ms Gail Ransom, Dr Brad Sherman, Dr Phillip Ford (CSIRO Land and Water), Dr Bob Wasson (Centre for Resource and Environment Studies, ANU).

Aim:
To identify factors determining algal growth and composition in reservoirs.

Progress:
This research has established that the phosphorus which is driving the algal growth in Burrinjuck Reservoir is derived predominantly from internal sources. This occurs because organic loading to the reservoir, from external sources, creates reducing conditions in the bottom waters. When the reservoir is low due to increased drawdown, the transfer of the nutrient rich bottom waters to the surface waters, where it is available to algae, is significantly increased. The form of nitrogen discharged to the inflows to the reservoir may also substantially modify the reducing conditions, and is a key determinant of algal composition.

These findings have implications for the management of water abstraction, rate of draw-down, and management of inlets to reservoirs. In addition, reduction in the discharges of organic material and specific forms of nitrogen from the catchment will assist in managing algal blooms.

We have held a series of workshops with reservoir and catchment managers to explore the range of techniques and information needs to better manage algae in reservoirs.

The final report from this project and the report from the Reservoir Manager's workshops are available at http://freshwater.canberra.edu.au

THE NIFT ASSAY FOR IDENTIFYING LIMITATION OF PHYTOPLANKTON GROWTH

Project Leader: Dr Rod Oliver

Project Team: Ms Gosia Przybylfka and Mr Zygmunt Lorenz

Aim:
Confirm that the NIFT (Nutrient Induced Fluorescence Transient) assays for nitrogen and phosphorus limitation are reliable and test the suitability of commonly used fluorometers for performing the assay.

Blue-green algae in Burrinjuck Reservoir. Photo courtesy DLWC

Progress:

This project investigated the hypothesis that cell growth limited by nitrate-nitrogen would show NIFT responses to the addition of either ammonium or nitrate, whereas those growing on an ammonium 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 cyanobacterium, *Microcystis*, showed a NIFT response to the addition of ammonium but not to nitrate when grown with either ammonium or nitrate-N. In contrast, the diatom *Aulacoseira*, gave NIFT responses to the addition of either ammonium or nitrate irrespective of the form of nitrogen. As expected, nitrogen fixing *Anabaena* did not give a NIFT response for nitrogen limitation despite the absence of combined inorganic nitrogen. This study shows that the NIFT assay does not readily identify the source of nitrogen (ammonium or nitrate) being utilised.

Testing of the effects of sample storage on the NIFT response were undertaken so that appropriate sampling regimes could be recommended. During sample storage in the dark the NIFT responses changed at different rates and it was concluded that measurements are most reliable if made immediately on fresh samples.

The results confirmed that although nitrogen limited algae from the major groups gave different NIFT response patterns to nitrate additions, the technique could still reliably distinguish between nitrogen and phosphorus limitation.

ALGAL AVAILABILITY OF PHOSPHORUS

Project leader: Dr Rod Oliver

Project Team: Mr Shane Perryman, Ms Helen Gigney and Mr Zygmunt Lorenz

Aim:

To determine the bioavailability of phosphorus from different sources; to develop a sediment transport model that predicts the impact of the form of phosphorus on downstream algal blooms.

Progress:

Nutrient measurements and flow data were used to calculate the loads of the various forms of phosphorus from an upland catchment, a sewage treatment plant (STP) and an irrigation return drain in the Goulburn River, Victoria. The largest cumulative load was from the STP plant despite long periods without discharge. Conventional wisdom is that nutrients released from STP plants are in forms readily available for algal uptake. This is not the case with the Shepparton STP where more than 75% of the phosphorus is in particulate form. This is a result of the long retention in treatment ponds prior to release, which allows algae and other aquatic organisms to grow in the effluent.

Annual total phosphorus loads from the Acheron River and Rodney Drain were of similar magnitude to each other and about one quarter that of the STP. Due to fluctuations in discharge and resulting differences in the forms of phosphorus delivered by the sources, a distinct periodicity was evident in loadings to the river. This will be important if available forms of phosphorus are being delivered at times when environmental conditions are suitable for algal growth.

The impact of these loadings on the downstream reach depends on whether phosphorus is accumulated within or transported through the reach. The first component of a combined transport and P-speciation model has been developed to estimate the changes in exchangeable phosphorus concentrations downstream of a source. The model combines the phosphorus input from a source with the upstream phosphorus concentrations and calculates the resultant concentration of the various phosphorus forms. The exchange between suspended particles and the dissolved phosphorus pool is estimated using a partitioning coefficient derived from adsorption-desorption isotherm experiments. This is used in conjunction with the suspended solids measurements to derive the dissolved phosphorus concentration. The dissolved phosphorus concentration is then used to estimate the exchange of dissolved phosphorus with the bed.

D2 Innovative bioassessment methods

BIOLOGICAL ASSESSMENT OF RIVER HEALTH

Project leader: Associate Professor Richard Norris

Aims:

- Investigate AUSRIVAS O/E taxa response to varying the sample size (i.e. amount of habitat sampled).
- Investigate responses of biological assessment outputs to common impacts e.g. mining (ACT at Captains Flat), sewage effluent, forestry, urbanisation, agriculture (NSW South Coast) and dams.
- Evaluate effects of invertebrate sorting methods (Lab-sort vs Live-pick) on AUSRIVAS model predictions.
- Provide supporting research on long-term variability of invertebrate assemblages in rivers.

Progress:

Component: Responses of biological assessment outputs to common impacts and sorting methods.

Project team: Ms Sue Nichols

Bioassessment precision using macroinvertebrates: effects of area sampled and replication.

The assumption underpinning many biological assessment programs is that a macroinvertebrate sample will provide representation of the macroinvertebrate assemblage at a site, which is adequate to make an accurate site assessment compared to reference sites and is also appropriate for the intended analytical methods. The AUSRIVAS model is one such rapid biological assessment method developed for Australia's National River Health Program.

This study investigates the differences in taxa numbers and composition between replicated macroinvertebrate samples from 5, 10 and 20m riffle transects of a site in the Thredbo River and assesses the adequacy of a 10m transect for biomonitoring. Replicated macroinvertebrate samples from a 10m x 0.35m collection area only, at both trace-metal affected and reference sites, on the Molonglo and Queanbeyan Rivers, were used to assess the precision and accuracy of predictive model results.

Sue Nichols collecting macroinvertebrate samples from a site impacted by mining on Coppers Creek.

There were no significant differences in the average number of taxa recovered from the 5, 10 or 20m x 0.35m collection areas at either family- or species-level taxonomic resolution. The average number of macroinvertebrate families and species found in any one collection from the Thredbo River site was 60% and 46% (respectively) of total taxa recovered from all collections. The species-level abundance data conveyed the most information about the macroinvertebrate assemblage and family-level presence/absence the least. The 5m samples often clustered together indicating that they were somewhat different from the others. However, the overall differences were small and the predictive model used for biological assessment of river condition was robust to the observed difference in taxonomic composition. All but one of the 15 collections from the Thredbo River site provided an identical AUSRIVAS site assessment.

There was little difference between total abundance estimates regardless of collection area. Lower Oligochaeta numbers in the collections from the larger areas and that total abundance estimates were most variable in the 20m collections, may indicate that

animals were escaping capture. Despite frequent washing of the net during collection, net-clogging rather than the area sampled may be controlling sampling effort (and thus number of individuals collected). The use of a larger net or mesh size may help alleviate the problem.

Predictive model results had good accuracy and precision (overall O/E taxa SE = 0.04). On most occasions a single macroinvertebrate sample collected from 10m of habitat accurately assessed the biological condition of both test and reference sites.

In a suitably homogeneous section of river a 5m collection may adequately replace a 10m sample for biological site-assessments. However, since most of the differences detected between the various areas sampled showed that the 5m collections varied from the 10 and 20m collections, a 10m transect is recommended.

River bioassessment: effects of field live-pick and laboratory sub-sampling of invertebrates.

The aim is to determine if there are significant differences between the site assessments provided by different models which were created from data derived from either lab-sorting or live-picking. This study will not attempt to establish a relationship between the magnitude of the impact and the degree of biological impairment as assessed by the models. The findings will have particular implication for 'across-border' monitoring programs were different invertebrate sub-sampling methods have been used and also provide an indication of model robustness to the effects of sampling methods (i.e., can a valid

Live-pick and lab-sorting sub-campling of macroinvertebrates

assessment of site condition be provided by using lab-sort data in a live-pick model). The evaluation of the predictive models will provide useful information to aid the development of the most sensitive method for detecting and assessing human influence on our waterways.

Some analysis is still required before writing up is complete but preliminary findings indicate that live-pick and lab-sort methods do not produce significantly different O/E taxa ratios when run in the appropriate models. However, models are sensitive to the methods i.e., lab-sort data cannot be run in live-pick models. The models detected a range of impacts of varying magnitudes but the lab-sort O/E taxa ratio range was greater than the live-pick range, possibly indicating greater sensitivity of the lab-sort method.

Mining adit at Captain's Flat, NSW, flows into the Molonglo River. Photo: P Sloane

Component: Bioassessment: are predictive model outputs related to a pollution gradient?

Project team: Mr Philip Sloane

Along with good independent trace metal data, this work assesses the O/E model outputs relative to a gradient of trace metals from Captains Flat. Under this component of the project Philip Sloane has his honours project written up ready for publication submission.

Component: Impacts of dams on water quality

Project team: Dr Richard Marchant and Genevieve Hehir

Sites immediately below nineteen dams in Victoria and NSW were sampled for macroinvertebrates using rapid bioassessment protocols. Specimens were identified to the lowest taxonomic level. The AUSRIVAS predictive models (combined seasons) for macroinvertebrate composition were applied to the results and O/E scores calculated. The mean O/E score for Vic was 0.46 for the genus model and 0.63 for the family model; for NSW the mean score at the family level was 0.57. There was no significant difference between family level scores in the two states. Many of the same taxa (that were predicted to occur) were missing at all sites and there was no correlation between O/E score and degree of hydrological deviation below the dam; nor was there any association between the score and whether the dam released surface or bottom water. Thus these dams all seemed to cause much the same disruption to the fauna with only certain taxa able to recolonise the reaches below dam walls. The limited recolonisation may well be caused by dams acting as barriers to drift, a prominent route for invertebrate colonists.

Component: Temporal stability in benthic invertebrate communities in south-eastern Australian streams and implications for the use of predictive models.

P***roject team:*** Mr Leon Metzeling, Mr David Robinson, Dr Stephen Perriss, A/Prof Richard Norris, Ms Sue Nichols, Dr Ken Thomas and Dr Richard Marchant

Analyses have been completed on long term data sets of benthic invertebrates from four catchments in south-eastern Australia. The data sets were of two types - semi-regular sampling over time (Wimmera and Thredbo) or intensive periods of sampling separated by more than a decade (Latrobe and Yarra). In each case, the samples were collected using the same equipment throughout, with the exception of the Thredbo where there was a change in sampling method in 1994. Most sites were considered to be reference sites with little change to their catchments over the sampling period.

The results indicate significant changes over time for most sites when using species level, qualitative data but show little change over time when using family level, binary data. Changes in species taxonomy could lead to some of these differences but these have been accounted for in the data sets wherever possible. Natural variability or changes in response to large-scale climate features (eg. ENSO or flow regimes) could both contribute to the observed changes. The comparative temporal stability of the family level data, which is similar to the type of data used in predictive models such as AUSRIVAS, raises questions as to the use of old reference site data in such models.

BIOLOGICAL ASSESSMENT USING DIATOMS

Project leader: Dr Peter Newall

Project Team: Ms Nina Bate

Aim:
To assess techniques for using diatoms to indicate nutrient status, water quality or environmental change; to contribute to a national diatom database and sampling protocol.

Progress:
This project has resulted in papers on the use of diatoms as biological indicators and has contributed to the "Illustrated Guide to Common Stream Diatom Species from Temperate Australia" (CRCFE). This follows on from a guide to the common genera published in 1999 and will be of great benefit to water resource agencies intending to use diatoms in water quality assessment. We have recommended a minimum number of valves (200) to be counted for rapid bioassessment and this should assist in the use of diatoms as water quality indicators. We have compared macroinvertebrate and diatom species assemblages in characterising water quality across several sites in the Kiewa River, Victoria.

Publications and guides are available on this work.

RIVPACS FOR URBAN STREAMS

Project Leader: Dr Peter Breen

Project Team: Dr Chris Walsh, Ms Sue Nichols, A/Prof Richard Norris, Mr Leon Metzeling and John Gooderham

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

Progress:
The project has demonstrated that successful urban AUSRIVAS models can be constructed. The models were however limited by the availability of reference sites and results were no better than those from the Victorian regional model. The project has highlighted some issues about data compatibility, but more importantly about the problem of reference sites for urban streams.

A final report is being prepared for this project.

BIOLOGICAL ASSESSMENT PROJECTS

Project leader: Associate Professor Richard Norris

Sue Nichols testing alkalinity of water samples for AUSRIVAS models.
Photo: P Sloane

Project team: Ms Sue Nichols, Ms Nerida Davies, Ms Julie Coysh, Ms Gail Ransom, Centre for Resource and Environmental Studies, ANU (Janet Stein, John Stein, Henry Nix)

I. Support and completion of Australia-wide assessment of river health models.

Aim:
To test and refine AUSRIVAS models for all states and territories in Australia.

Progress:
The centre has been liaising with all NRHP agencies in Australia to obtain relevant macroinvertebrate and environmental data and to determine the needs for model development and refinement. Significant interaction with agency staff to assist with training, data management and model development has ensured that all agency staff are actively involved in site classification, decisions on site groups and familiar with modeling techniques. Phase 1 of the project has resulted in construction of 6 new models for the ACT, Victoria and Tasmania and production of sampling documentation, now available on the AUSRIVAS website. Phase 2 of the project will result in new models and documentation for Queensland, Northern Territory, New South Wales, South Australia and Western Australia.

Nerida Davies taking water samples for the Alps project. Photo: P Sloane

II. Australian Alps Stream Health Monitoring Project

Aims:

To sample macroinvertebrates at approximately 95 sites across the Alps.

To carry out the Index of Stream Condition at these sites.

To develop an AUSRIVAS model for the Australian Alps.

To design an ongoing monitoring program for Alps Streams.

Progress:

The macroinvertebrate fauna and a wide range of habitat features were sampled and measured at 95 sites within the national parks of the Australian Alps in January and February 2000. Seventy-nine reference (minimally impacted) sites were used to provide baseline conditions against which test sites can be compared and assessed. Sixteen test sites (with suspected or known impacts) were sampled and assessed using AUSRIVAS. The habitat and macroinvertebrate data collected from the reference sites was used to develop an Alps summer riffle AUSRIVAS predictive model. The Alps summer riffle AUSRIVAS predictive model and a description of the methods is available on the Internet (Coysh et al. 2000, http://ausrivas.canberra.edu.au/ausrivas). The findings of the project including model development and the Index of Stream Condition are discussed in the final report.

III. AUSRIVAS Mapping and Reference Site Screening Module

Aims:

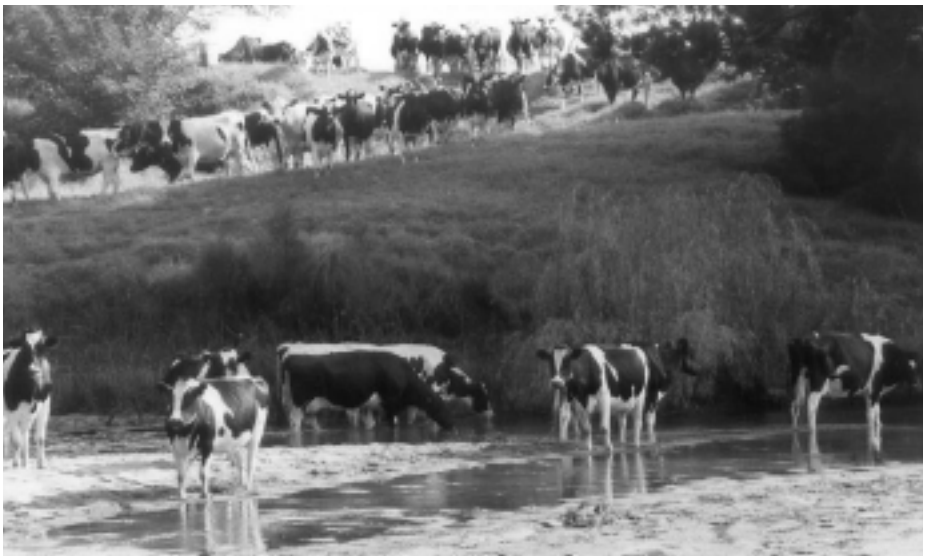
To develop a mapping and reference site screening module for AUSRIVAS.

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:

Many of the programming requirements for this mapping project have been completed such as designing and implementing the data and map request server, designing and implementing the http server and developing the methods for running ArcView from scripts and developing the method for remotely running ArcView. The programming associated with producing maps from ArcView, converting Wild Rivers data to a format readable by ArcView and designing the user interface are currently being investigated. This will enable the user to produce maps through the Internet that may include sites, streams, Wild Rivers indices and AUSRIVAS Bioassessment outputs.



Cattle: one of the possible impacts on catchments.

IV. AUSRIVAS software enhancement

Aims:

To complete the development of AUSRIVAS software and GUI platform to include additional functionality, interactive and interpretive aids.

To complete the development of the AUSRIVAS website, appropriate links and support to assist in establishing the permanent AUSRIVAS site.

Progress:

Phase 1 of this project is now complete and has resulted in a list of proposed modifications, survey of users to determine internet access needs, design of solutions to problems based on survey results, implementation of an alternative HTTP server, design of a new AUSRIVAS internal file structure and investigation of video formats for the web based manual. Phase 2 will address implementation of proposed changes and solutions to current problems, integration with the Mapping module, and completion of modifications to the WWW site.

V. First National Assessment of River Health (FNARH)

Aim:

To produce a comprehensive assessment of water quality in the Upper Murrumbidgee River catchment.

Progress:

The ACT component of the First National Assessment of River Health is now complete, with 162 test sites and 14 reference sites assessed using the ACT autumn, spring and combined autumn/spring AUSRIVAS models. Rivers and streams in the Upper Murrumbidgee River catchment exhibited biological conditions that ranged from severely impaired (Band D)

to richer than reference condition (Band X), however, the majority of sites indicated some form of impact. The major impacts affecting test sites within the Upper Murrumbidgee River catchment appear to be chemical pollutants, trace metal contamination, nutrient enrichment, rural runoff, habitat degradation, sedimentation and river regulation. AUSRIVAS was found to be a valuable tool for highlighting biologically impacted sites along the rivers and streams of the Upper Murrumbidgee River catchment.

Additional Projects

TAXONOMIC RESOLUTION AND STREAM CLASSIFICATION

Project Leader: Mr Leon Metzeling

Aims:
To assess the influence of taxonomic resolution, habitat and season on stream classification.

Progress:
Macroinvertebrate data from 165 reference sites across Victoria, sampled under the National River Health Program (NRHP) between 1990-96, have been used to assess the interaction of different taxonomic levels, sampling seasons and habitat on stream classifications. These comparisons have also been carried out at different scales — statewide, regional and single catchment.

Environmental parameters was used to characterise groupings of macroinvertebrates at each site. In general the same interpretions were obtained for all the data sets examined at the statewide and regional scales, indicating substantial redundancy in the data sets. Within the single catchment, the patterns were less consistent with greater discrepancy between the family, genus and species groups and their subsequent characterisation. These results confirm the applicability of family level data like that used in the NRHP for broad scale classifications but such data needs to be viewed more cautiously when working within a single river system.

REGIONALISATION OF VICTORIAN STREAMS

Project leader: Mr Leon Metzeling

Project Team: Dr Peter Newall and Fiona Wells

Aim:
To classify Victorian streams into groups based on geographical regions and assess the potential of the classification for the development of biological objectives.

Progress:

Our work in the past year has been using the five regions delineated from the invertebrate data collected under the NRHP. We used the reference site data within each region to assess the options for several indicators and for developing biological objectives. The indicators we considered were regional AUSRIVAS models, the SIGNAL biotic index, number of families, number of key families and number of EPT families (mayflies, stoneflies and caddisflies).

We built AUSRIVAS models for four of the regions and derived objective values for the other indicators based on the statistical distribution of scores within the reference sites for each region. These indicators and objectives will be incorporated into the State environment protection policy covering all surface waters in Victoria.

NATIONAL ASSESSMENT OF RIVER CONDITION

Project leader: Associate Professor Richard Norris

Principal Investigators: Assoc Prof. Martin Thoms, Dr. William Young (CSIRO Land and Water)

Project team: Dr Peter Liston, Dr Fiona Dyer, Ms Nerida Davies, Mr Simon Linke, Mr Nick Bauer

Poor riparian habitat, Goodradigbee River at Wee Jasper, NSW. Photo: P Sloane

Aims:

The principal aim of the project is to develop an Australia-wide assessment of waterway condition which integrates biological, morphological, water quality, catchment and hydrological components. The Assessment of River Condition (ARC) project will provide an overarching view of the quality of rivers across Australia. It is intended to be used as both a measure of river condition and as a tool to identify management options for rivers.

This project will form a component of the National Land and Water Resources Audit (NLWRA) currently being compiled by the Federal Government, and the information will be made available through the Australian Natural Resources Atlas.

Progress:

The major project outputs will be:

- a system for assessment of river condition applicable Australia-wide.
- an Australia-wide assessment of waterway condition which contributes to the Australian Natural Resources Atlas.
- an interpretation of the results of the assessment for all major drainages, including relative priorities for management action in river systems.

The ARC will be derived from five indices based on a model of river function in which catchment characteristics affect hydrology and habitat features, which in turn influences the aquatic biota.

1. Aquatic Biota Index
2. Catchment Condition Index
3. Water Quality Index
4. Hydrology Index
5. Physical Habitat Index

The reporting unit for this project, the river reach, has been defined on a geomorphological basis and reaches are currently being determined for catchments across Australia. Data for compilation of the five indices is being derived from a range of sources; spatial remote sensed data, field sampled data and modelled values where data is lacking. Much of the data has been acquired though in some areas this project is being hampered by dependencies on other NLWRA projects that are not yet completed.

The second major component of the project is the modelling of biotic integrity for reaches in which the biota has not been sampled. This task has commenced, a modelling approach similar to the AUSRIVAS approach has been developed and is being trialed.

The project commenced in November 1999 is to be finalised by March 2001. The first two milestones of the project have been completed. The final report and third milestone, due March 2001, will comprise the completed assessment of river condition for the approximately 14,000 river reaches that will be identified across Australia.

D3 Ecological risk assessment

ECOLOGICAL EFFECTS OF DRYLAND SALINITY

Project Leader: Dr Daryl Nielsen

Project Team: Dr Terry Hillman

Recent reports have highlighted the rapidly increasing influence of dryland salinity in the salinisation of aquatic systems. In response to this issue, the centre sponsored a one-day workshop bringing together water resource managers and researchers to explore research requirements in the face of increased salinisation. Knowledge gaps were identified during an examination of past and current research. Important amongst these was the lack of information regarding sub-lethal salinity effects and their influence on ecosystem structure and functions over time.

The workshop suggested six areas of research to address these issues: a data-base of existing data-sets linking salinity and biological data; survey wetland types to assess their current condition in terms of salinity and biological integrity; investigate the relationships between salinity and survival, growth and recruitment of biota; assess the response of ecosystems to increasing salinity; establish experimental sites for experiments linking salinity with ecosystem structure and process; identify key taxa on which to focus future research and assessment.

Outputs from this workshop are being incorporated in the development of the Ecological Risk Assessment Project.

Dryland salinity. Photo: B van Aken, CSIRO Land and Water

PROGRAM D: WATER QUALITY AND ECOLOGICAL ASSESSMENT~OUTCOMES

Program outcomes	3 year milestones	Progress at the end of Year 1
Improved scientific knowledge on the ecological effects of damaging agents (including nutrients and pesticides) in Australian freshwater systems.	Development of priority areas for research in ecological response to agents that damage freshwater ecosystems.	• Research projects developed and reviewed for the assessment of nutrient processing inurban streams. • Project under consideration for the assessment of pesticides in agricultural areas. • Project developed, reviewed and accepted for funding for testing biological methods to assess ecological responses.
Improved and robust bioassess–ment methods that provide information on ecosystem health and assist in identifying the degrading processes (including habitat modification).	Integration of AUSRIVAS with other techniques for assessment of river condition.	• Project developed, reviewed and accepted for funding for comparing biological assessment methods and integrating them into monitoring programs.
New ecological risk assessment procedures and associated tools for use by water industries.	Bring in expertise in ecological risk assessment (biota and processes with inputs to ecological risk assessment over a range of scales up to catchment level).	• Project on ERA developed and reviewed. Currently being refined for final consideration for funding. • Associated project for large scale ERA is currently under consideration.

4 Education and Training

Dr Ian McKelvie, Program Leader

PROGRAM LEADER: DR IAN McKELVIE

The Centre's Education Program provides high quality education at the postgraduate, undergraduate, school and community levels with the aim of providing a strong comprehensive ecological framework for the sustainable management of freshwater resources.

Its specific objectives include:

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

4.1 Postgraduate education

Postgraduate teaching

Professor Sam Lake taught a postgraduate course entitled " Ecological Status of Surface Waters: Monitoring and Management of Rivers" at the Centro Internacional de Altos Estudios Agronomicos Mediterraneos at Zaragoza, Spain, May 8-12.

First Postgraduate Student Workshop

The first CRCFE Postgraduate Student Workshop was held in October 1999 as a satellite meeting of the annual staff meeting of the CRCFE. The meeting provided a number of postgraduate students with an opportunity to present papers

The presentations were followed by discussion on the CRC Postgraduate program. Melissa Parsons and Brendan Ebner subsequently prepared a working paper entitled "The CRCFE Postgraduate Program in the Next 7 Years".

Postgraduate Completions

Postgraduate students who have completed their studies this year include:

Azaam Khosmanesh (PhD)	WSC, Chemistry (Monash)
Stuart Minchin (PhD)	WSC, Chemistry (Monash)
Daryl Nielsen (PhD)	MDFRC/Charles Sturt University
Sabine Schreiber (PhD)	Biological Sciences (Monash)
Soheyl Tajiki (PhD)	WSC, Chemistry (Monash)
Catherine Tan (M App Sc)	WSC, Chemistry (Monash)
Jason Van Berkel (PhD)	WSC, Chemistry (Monash)

Previous page:
Mayfly larvae, Family Baetidae.

Postgraduate Recruitment

Three CRCFE full postgraduate scholarships were awarded to Claire Sellens (Univ Canberra), Adrian Kelleher (Monash Univ), and Claudette Kellar (Monash Univ). Top Up scholarships were awarded to Heather McGuiness (Univ Canberra), Claire McKenny (Griffith Univ), Kellie Watts (Monash Univ) and Niem Tri (Monash Univ).

A postgraduate student induction manual has been prepared and distributed to all new students, and has been placed on the CRCFE student web site.

Postgraduate Training

PhD candidates Alison King and Cathy Francis undertook the week-long CRC Leadership and Career Development Course. The course was run by the Melbourne Business School sponsored by the Federal Government's CRC Program and the Business/Higher Education Round Table.

A number of CRC postgraduate students participated in a 14 day Statistics and Experimental Design course presented by Dr Gerry Quinn (CRCFE, Monash) and Dr M. Keogh (University of Melbourne).

Writing Award

A new three-month Writing Award was introduced to encourage students to submit within a three-year period.

Supervisor Training

Another new initiative was the introduction of a supervisor training day held in conjunction with the Annual Meeting. Thirteen participants from both university and non-university CRC partners attended this workshop.

Bruno David, summer scholarship student, electrofishing in clay section of Castle Creek for the Granite Creeks project.

Conference Attendance

The Centre has supported student travel to present papers and posters at a number of national and international conferences and workshops.

CHEN, Bailin	8th International Sediment-Water Interactions Conference, Beijing
CROOK, David	Australian Society for Fish Biology, Bendigo
EVANS, Lisa	Australian Society for Limnology,NZ
FINLAY, Kyla	Australian Society for Limnology, NZ
FRASER, Ian	Australian Society for Limnology, NZ
GRAHAM, Sue	Australian Society for Limnology, NZ
JENKINS, Kim	Australian Society for Limnology, NZ
KING, Alison	Australian Society for Fish Biology, Bendigo
LOVELL, Belinda	American Society for Limnology and Oceanography (Copenhagen)
McNEIL, Dale	Australian Society for Limnology, NZ
McNEIL, Dale	Australian Society for Fish Biology, Bendigo
OSWALD, Louisa	Australian Society for Limnology, NZ
OSWALD, Louisa	SETAC (Philadelphia)
TREADWELL, Simon	Australian Society for Limnology, NZ
TRI, Niem	FFF Conference, Paris

Ms Rhonda Butcher was selected to represent the Centre at the Young Water Scientist of the Year Award.

4.2 Undergraduate education

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

- Ian Lawrence gave a lecture on Catchment pollutant export processes to 3rd year students at University of Canberra.
- Ian Lawrence gave a lecture on Landscape design: integrated land and water management to 3rd year students at University of Canberra.
- Chester Merick (MDFRC) gave a lecture and field trip to 2nd year students at Charles Sturt University, Wagga Wagga on River and lake dynamics and water quality indicators.
- John Whittington (MDFRC) gave a lecture on Eutrophication to 3rd year students at University of Canberra.
- Paul Humphries (MDFRC) gave one lecture and one tutorial to students at the University of Canberra in July 1999.
- John Whittington (MDFRC) gave a lecture on Cap on MDBC flows to Riverina TAFE Natural Resource Management students.

Water Science students at Tharwa Bridge on the Murrumbidgee River. Photo: P Sloane

- Terry Hillman presented a lecture on "Billabongs in the Murray Darling Basin" for the Graduate Diploma in Environmental Management, La Trobe University, students on 31 August 1999.
- Mr Glenn Wilson (Mildura) ran TAFE Natural Resource Management laboratory classes.
- Mr Glenn Wilson (Mildura) presented Koori TAFE Conservation and Resource Management classes.

Summer research scholarships and work experience

Twelve summer scholarships of $3000 were available for distribution among the sites. These were allocated to University of Canberra (3), Monash WSC and Biology (3), Griffith University (2), MDFRC (2), La Trobe University -Wodonga (1), and the Lower Basin Laboratory, Mildura (1). The scholarships are offered for 8-10 weeks at $300 per week (tax payable). Students are required to submit a final report.

4.3 School Education

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

- presentations at science exhibitions and Teachers' Association conferences.
- presentations, class lessons and field work for specific schools.
- curriculum development and teacher training (including the Diploma of Education at La Trobe University).
- development of gifted students/high achievers extension program.
- work experience and career advice.
- "Easter School", "Riverine School" (at Mildura) and "Upper Murray School" in conjunction with Rotary.

Learning outcomes for school students include:

- the excitement of science and some appreciation of techniques,
- the relevance and importance of science to environmental problems,
- an understanding of aquatic ecosystems, and
- possible career paths

School curriculum materials

Mike Copland continues to provide schools with information and advice about the inclusion of CRCFE educational materials within the school program.

As was proposed in last year's Report, the Centre has become involved in the satellite broadcasts to Victorian Schools in the STEPs project.

Rotary Murray-Darling School of Freshwater Research

The fifth Rotary Murray-Darling School of Freshwater Research was held in and around Albury from 16 to 20 April. The School enables high quality science students to work with the scientists of the centre, so that they may better understand and appreciate the issues relevant to freshwater ecology. The participants this year included 26 students from as far away as Berri, Cobar, Nambucca Heads and Mudgee; a local Waterwatch coordinator; and 3 Graduate Diploma of Education students from La Trobe University (Wodonga). Organised by Mike Copland.

Students sample fish at Lake Cullulleraine

The Rotary Camp on River Health

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 have been introduced to freshwater environments through billabong and river field trips, ranging from year four to year 11. Post Graduate Diploma of Education students from La Trobe University became involved in this year's program. The interest and understanding of students is high, with return visits showing a sound retention of knowledge.

Assistance continued to be provided to schools involved in "Murder Under the Microscope", an interactive World Wide Web educational activity conducted through Sydney University and to the Melbourne Zoo's "Communicating Across the Catchment" program.

The Lower Basin Laboratory has also been very active with a schools outreach program. Mike Copland has represented the Centre at a number of career nights for secondary students and at speech days/nights. The MDFRC presented its first Freshwater Ecology prize to a senior student at Murray High School. He also "presided" at two primary school Science Week presentations.

The Wirraminna Centre at Burrumbuttock has become a most valuable school and community ecological resource.

Table 4.1
CRCFE Students

Note: Honours students are not formally associated with the CRCFE, but are included by virtue of their supervision by CRCFE staff.

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
Honours						
BRICOUT, Jodie	1/3/00	University of Adelaide	Walker (Adelaide)	Effects of salinity on floodplain vegetation.		
CHURCHILL, Ricc	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	
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	
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	
DOOLANDS, Shannon	1/3/00	University of Adelaide	Walker (Adelaide)	Design of wetland inlet regulators to exclude carp.	NHT per Bookmark Biosphere Trust	
EDWARDS, Megan	1/3/00	Charles Sturt University	Baldwin (MDFRC) Roberson (CSU	The role of DOC in inhibiting macrophyte growth.		
GEISECKE, Jonathon	1/33/00	University of Adelaide	Walker (Adelaide)	Design of wetland inlet regulators to exclude carp.	NHT per Bookmark Biosphere Trust	
GRIBBEN, Deborah	2/2/99	LaTrobe	Rees (MDFRC), Croome (LaTrobe)	Normans Lagoon: an examination of its phytoplankton and photosynthetic bacterial populations.	La Trobe	
HAMMER, Michael	1/7/00	University of Adelaide	Walker (Adelaide)	Conservation biology of southern pygmy perch.	Apps pending	
HUBBERT, Elizabeth	1/5/99	Biological Sciences, Monash	Lake (Monash)	Shoreline refugia in a sand-bed stream: Creighton's Creek, Victoria.		
KELLER, Reuben		Monash	Lake (Monash)	The Ecological impact of the Oriental weatherloach in wetlands.		

Table 4.1
CRCFE Students, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
MITCHELL, Alison	1/6/98	Charles Sturt University	Baldwin (MDFRC) Robertson (CSU) Rees (MDFRC)	The interactionsof the anaerobic nutrient cycling processes in sediments.	CRCFE	
MOONEY, Angie	1/6/99	University of Canberra	Thoms (UC)	Sedimentation in the Murray Catchment South Coast Catchment Management Committee.		
MURCHLAND, David	1/3/00	University of Adelaide	Walker (Adelaide)	Design of wetland inlet regulators to exclude carp.	NHT per Bookmark Biosphere Trust	
PEARSON, Melanie	1/7/98	La Trobe	Suter (La Trobe)	Habitat occupation of the Baetidae (Insecta: Ephemeroptera) in the Rose River, Victoria.	La Trobe	
PINNER, Andrew	1/6/99	University of Canberra	Thoms (UC)	Heavy Metal storage in Floodplain systems – South Coast Management Committee.		
SCOTT, Kane	1/3/00	University of Adelaide	Walker (Adelaide)	Design of wetland inlet regulators to exclude carp.	NHT per Bookmark Biosphere Trust	
SIMPSON, Lisa	1/3/00	University of Canberra	Norris (UC), Thoms (UC)	Effects of grazing on streams in the Australian alpine parks	Self funded	
STEGGLES, Tracey	1/7/00	University of Adelaide	Walker (Adelaide)	Distribution of spiders on Murray floodplain.		
SUTHERLAND, Lachlan	31/2/00	Charles Sturt University	Robertson (CSU), Nielsen (CSU)	Response of the micro-invertebrate egg bank in temporary wetlands to disturbance by livestock.		
YIAW, Hui Loi	1/3/00	University of Adelaide	Walker (Adelaide)	Effects of salinity on floodplain vegetation.		
YOUNG, Wendy	1/3/00	University of Adelaide	Walker (Adelaide)	Effects of salinity on floodplain vegetation.		
ZUTOWSKI, Sylvia	1/7/00	University of Adelaide	Walker (Adelaide)	Life history of freshwater mussels.		

Table 4.1
CRCFE Students, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
Honours Completed						
BIGGIN, Margo	1/2/98	University of Canberra	Thoms (UC)	Suspended sediment transport in a dryland river: The Barwon-Darling River system.		
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.		
KURUKULASURIYA, Srimali	1/2/99	Water Studies Centre, Monash	Beckett (Monash)	The speciation of pesticides in aquatic waters and sediments.		
MCINERNEY, Paul	1/7/00	LaTrobe	Suter (LaTrobe)	Impact of Inter basin transfer of water from the Snowy River to the Murray River on stream macroinvertebrates.		
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	
ROBERTS, Kate	1/7/98	University of Canberra	Norris (UC) Thoms (UC)	The effect of drought on community structure of stream macroinvertebrates.	Environmental Division of Urban Services (ACT)	Environmental Division of Urban Services (ACT)
RATAJCZYK, Paul	1/7/00	LaTrobe	Suter (LaTrobe)	The distribution of mayflies communities along the Kiewa River.		
SMITH, Ben	1/7/98	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.	Bookmark Biosphere Trust	Queensland Fisheries
WATTS, Kellie	2/2/99	Water Studies Centre, Monash	Hart (Monash)	Investigation of pore water phosphorus concentrations in lowland river sediments.		
WEDDERBURN, Scott	1/7/99	University of Adelaide	Walker (Adelaide)	Conservation status of small fish in the River Murray, SA.		

Table 4.1
CRCFE Students, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
Masters						
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
COGHLAN, Jason	1/2/97	University of Canberra	Thoms / Cho (UC)	Predicting the health of the riverine corridor.	Hawkesbury Nepean Catchment Management Trust	
CURMI, Tim	1/3/99	La Trobe	Suter (La Trobe)	The Health of the Lachlan River.	NHT	
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	
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
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	Habitat and niche segregation among larval and juvenile fish Fisheries).	University of Western Sydney in Hawkesbury River lagoons.	
THOMPSON, Scott	1/3/98	University of Canberra	Georges (UC)	Systematics of the long-necked turtles in the family Chelidae.	ABRS	

Table 4.1
CRCFE Students, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
Masters completed						
AMINI, Nana	1/2/99	Water Studies Centre, Monash	McKelvie (Monash)	Development of rapid analytical methods by immobilised enzymes and flow injection analysis.		
GREENWOOD, Ashley	1/7/99	University of Adelaide	Walker (Adelaide)	Inter-annual variability in climate and streamflow in the Lower Murray-Darling Basin: An environmental perspective.		
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	
PhD Commencing						
BALLINGER, Andrea	24/2/00	Biological Sciences, Monash	Mac Nally (Monash) Lake (Monash)	Invertebrate biodiversity of coarse woody debris on floodplains.	MDBC CRCFE Top Up	
CAPON, Samantha	1/2/00	Griffith University	Bunn (GU), Brock (DLWC)	Flow related response of vegetation in arid inland floodplains.	LWRRDC	
KELLAR, Claudet	1/3/00	Monash	Quinn (Monash) Lake (Monash)	Community Dynamics in temporary pools.		
LYDDY-MEANY, Amanda	1/2/00	Water Studies Centre, Monash	McKelvie (Monash)	Determination of silica in Estuarine Waters by Flow Injection Analysis.		
SELLENS, Claire	1/5/00	University of	Norris (UC) Canberra	Defining the reference condition: implications for biological assessment.	CRCFE	
WATTS, Kellie	1/3/00	Monash	Hart (Monash)	Biogeochemical cycling of nutrients in sand bedLowland rivers		

Table 4.1
CRCFE Students, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
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	Lawler (LaTrobe) 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	Development of field flow fractionation (Monash)	APA methods.	
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	Genetic variation of Carp Cyprinus Fisheries)	Self funded	Carpio in South-Eastern Australia.
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	

Table 4.1
CRCFE Students, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
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 -
EBNER, Brendan	3/3/97	La Trobe	Suter (La Trobe) Gawne (MDFRC)	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 waste waters 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	
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	Maher (UC) Lawrence (CRCFE) Ford (CSIRO)	Role of redox processes in the release of phosphorus from sediments.	CRCFE Scholarship	

Table 4.1
CRCFE Students, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
GREEN, Damian	15/9/95	University of Canberra	Harris (NSW Fisheries) Oliver (MDFRC) Cullen (UC)	Population dynamics and physiology of phytoplankton in 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
HOWITT, Julia	29/3/99	Monash	Baldwin Rees(MDFRC)	Photochemistry of Aquatic Substances.	APA, CRCFE top up	
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	
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 Latrobe River.	Bonlac/ DNRE/ WGCMA	
MCNEIL, Dale	4/3/96	La Trobe	Lawler (LaTrobe) Hillman (MDFRC) Closs (Otago) Gehrke (NSW Fisheries)	Fish, zooplankton and algae dynamics in Murray River billabongs.	APA CRCFE top up	

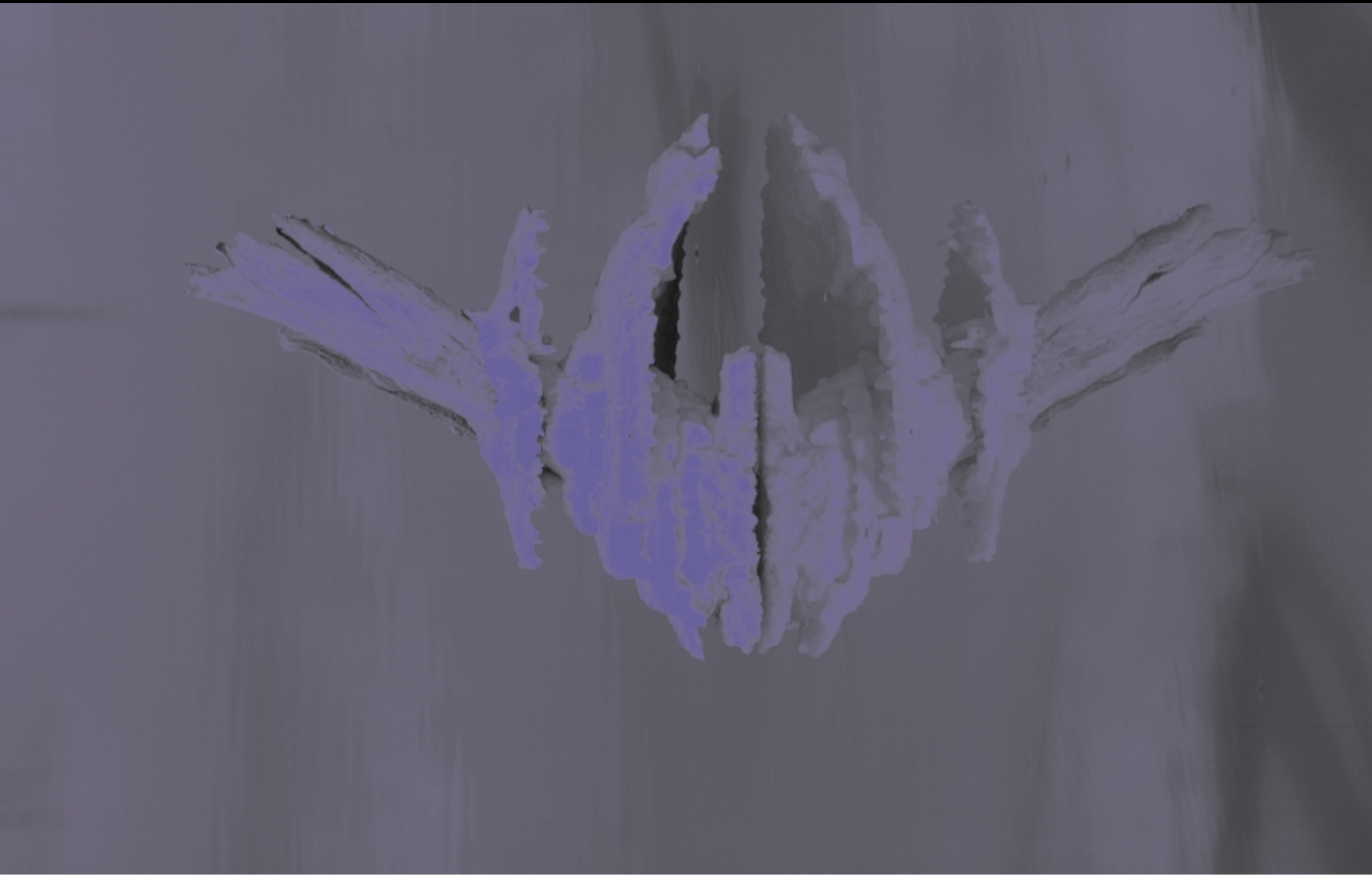
Table 4.1
CRCFE Students, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
NIAS, Deborah	27/1/95	Biological Sciences, Monash	Bailey (Monash)	Foodweb structure in an ephemeral floodplain wetland.	Monash CRCFE Top up	
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	Kearney Thoms (UC) Humphries (MDFRC)	Age, growth and survival of larval fish in the Murray-Darling Basin.	APA CRCFE Top Up	
ROSE, Louise	5/12/97	University of Canberra	Gerritsen (UC)	I nvestigate management response and adaptations to coastal change inthe face of increasing population and environmental stresses.		
SIEBENTRITT, Mark	1/1/99	University of Adelaide	Walker (Adelaide) Ganf (Adelaide)	Effects of water regime on wetland plants	Bookmark Biosphere Trust, CRCFE top-up app pending	
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	University of Otago		Diet habitat associations of Midgley's gudgeon within and among floodplain billabongs: the role of their interaction with perch and mosquitofish.		
TREADWELL, Simon	2/9/96	Biological Sciences, Monash	Lake MacNally Campbell (Monash)	Role of snags in carbon dynamics in lowland rivers.	CRCFE Scholarship	

Table 4.1
CRCFE Students, continued

Name	Commenced	University	Supervisor	Topic	Funding	Graduate Employment
TSYRLIN, Edward	1/7/95	Biological Sciences, Monash	Campbell (Monash)	Taxonomy of the Plecoptera.	CRCFE Scholarship LWRRDC	
WARD, Jacqueline	1/3/99	La Trobe	Suter (La Trobe)	Ecology of the Murray River Crayfish.	Self funded	
WHITE, Lindsay	1/6/99	Monash	Harris (NSW Fisheries)	Hydraulics and fish behaviour in fishways.		
PhD Completed						
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	
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	
NIELSEN, Daryl	1/7/94	Charles Stuart University	Shiel / Hillman Klomp (MDFRC)	The influence of flooding regimes on the ecology of billabongs: and experimental approach.	LWRRDC	MDFRC
PUCKRIDGE, Jim	1/7/89	University of Adelaide	Walker (Adelaide)	Flow variability and fish ecology in an arid zone floodplain river, Cooper Creek, Central Australia.		Visiting Research Fellow, Univ Adelaide
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	Institut fur Gewosser–kologieund Binnenfishcerei in Berlin, Germany
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	Post Doc fellow at WSC
THOMSON, Jim	1/7/94	Biological Sciences, Monash	Lake (Monash) Downes (Melbourne)	Influences of disturbance on predation in streams.	APA	
VAN BERKEL, Jason	1/2/95	Water Studies Centre, Monash	Beckett (Monash)	Colloid characterisation and dynamics in reservoirs.	CRCFE Scholarship	Self employed

5 Knowledge Exchange



5.1 Introduction

The Centre's goal is to improve the health of inland waters through improving the sustainable management of land and water resources. The application of the Centre's research to support sustainable management is a fundamental measure of the centre's success. To this end, the Centre affords a high priority to knowledge exchange.

A knowledge exchange strategy has been developed to guide the Centre's knowledge exchange activities. The strategy seeks to assist Centre members by providing appropriate information to land and water managers and decision-makers at all levels, and by contributing an ecological perspective to policy debates within the water industry. Future knowledge exchange will be delivered via knowledge exchange plans developed for each of the CRC research programs, while specific technology transfer plans will be developed to help promote the findings of selected projects. The synthesis and promotion of previous research outcomes, with emphasis on the implications for water resource management, is a major component of the CRC knowledge exchange strategy.

Peter Cottingham, Knowledge Broker.

A knowledge exchange team has been convened to implement the knowledge exchange strategy and help coordinate knowledge exchange activities. The team includes the Chief Executive, Knowledge Brokers and the Communications Manager. The Knowledge Brokers' specialist role is to provide a window to the ecological knowledge of the CRC for partners and other stakeholders. The team has developed links with the CRC research program and the CRCCH Communication and Adoption Program.

5.2 Major achievements

John Whittington, Knowledge Broker.

- The Centre completed a report for Environment Australia to identify the ecological outcomes of the Council of Australian Governments (COAG) water reforms. The report documents state and territory government progress and assesses the likely ecological benefits of these actions. This information, along with the consideration of emerging issues will aid further development and implementation of the COAG Water Resources Policy.
- The Centre developed a framework for the Sustainable Rivers Audit (SRA) on behalf of the Murray-Darling Basin Ministerial Council. The Centre, in close consultation with water industry representatives, utilised its experience in water quality and ecological assessment to develop the SRA framework, which will be a significant part of future reporting on river health and the implementation of the Cap on diversions in the Murray Darling Basin.
- The Centre was contracted to produce a report "Ecological Sustainability of Rivers of the Murray-Darling Basin" as an input to the "Review of the Operation of the Cap" undertaken by the Murray-Darling Basin Ministerial Council. Recommendations made in the Centre's reports were adopted in the Ministerial Council's Review of the Operation of the Cap and are now being implemented.
- The Centre has produced two reports that document the outcomes of workshops facilitated by the CRC for the Queensland Department of Natural Resources. The workshops and associated reports were undertaken to improve the input of environmental science to the Water Allocation and Management Planning process.

Previous page:
Salt crystals on remains of dead tree at Quairading, WA. Photo: B van Aken

- AUSRIVAS models and their application continued, with their inclusion in a statewide assessment using the Index of Stream Condition in Victoria, and interest in its use shown by Indonesia and New Zealand. The Centre continued to provide training in the use of AUSRIVAS across Australia and is developing training workshops and materials for agency personnel. The Centre has also liaised with the lead agencies responsible for AUSRIVAS in each state to finalise models for the AUSRIVAS internet site. These models will be widely available for the assessment of river condition around Australia.

Measuring stream velocity for assessing river health using the AUSRIVAS model. Photo: P Sloane

Nerida Davies calculating alkalinity for assessing river health using the AUSRIVAS model. Photo: P Sloane

Dan Mawer collecting an edge sample at Micalong Creek for assessing river health using the AUSRIVAS model. Photo: P Sloane

- CRCFE expertise was called on by the Prime Minister, the Minister for the Environment, the Minister for Science, Resources and Industry and the Minister for Agriculture, Fisheries and Forestry, to provide expert advice on water issues.
- CRCFE expertise was sought by the Olympic Coordinating Authority to advise on plant growth in the Olympic Rowing Course.
- The new ANZECC/ARMCANZ Water Quality Guidelines were released to the public for comment. Centre staff contributed extensive drafting material, including the proposal to shift to a risk based – ecosystem assessment approach, and participated in workshops in all capital cities around Australia to disseminate the new philosophy and approach of the guidelines..
- The ANZECC/ARMCANZ National Water Quality Monitoring Guidelines were released to the public for comment. Centre staff played a major part in the restructuring and development of the Guidelines.
- The ANZECC/ARMCANZ National Guidelines for Urban Stormwater Management were released for public comment. Centre staff played a major part in the revision of these Guidelines.

- The Centre continues to be seen as a provider of high quality, independent advice; resulting in significant consulting activity with an annual income of $1.4 M.

* Recommendations about the design of stormwater wetlands contained in the CRCFE stormwater pond and wetland design guidelines (Lawrence & Breen 1998) and the joint CRCFE-CRCCH Industry Report (1999 Managing Urban Stormwater using Constructed Wetlands) are being adopted by Melbourne Water in a major stormwater management project to reduce nitrogen loads to Port Phillip Bay. The project is jointly funded by Melbourne Water and the Natural Heritage Trust.

- Knowledge generated from the Centre's urban stream research has underpinned and supported Melbourne Water Corporation initiatives to promote Water Sensitive Urban Design to the land development industry. Melbourne Water Corporation has supported an Urban Land Corporation project to develop a Water Sensitive Design precinct in a commercial land development. The success of the project will be evaluated by CRCCH.
- Members of the Burrinjuck project team conducted two Reservoir Managers' workshops, presenting knowledge gained from the Burrinjuck project and other Australian reservoirs and its implications for reservoir management. The workshops were designed to facilitate productive discussion between the research team and all the participants. A report documenting the workshops was produced; please see section 7.6 for report reference.

Algae in Burrinjuck Reservoir. Photo courtesy DLWC

5.3 Federal Political Briefings

The Centre was highly successful at providing independent advice to Government on science and water issues.

Peter Cullen briefed:

- The Prime Minister on water reform issues.
- The Minister for the Environment, Senator Hill on dilution and salinity in the Lower Murray, in collaboration with Professor Tom McMahon and with assistance from the MDBC.
- Minister for Science, Resources and Industry, Senator Nick Minchin on water issues and science policy.
- The Minister for Agriculture, Fisheries and Forestry, Mr Warren Truss on the PMSEIC Salinity report.
- The Parliamentary Secretary, Sharman Stone on the salinity issue.
- Members of the Labour Science and Technology Committee on science policy issues.
- A group of Labour Shadow Ministers on appropriate responses to salinity.

John Whittington and Terry Hillman discussed water issues with Ms Peta Seaton MP (NSW Shadow Minister for the Environment) and Mr Ian Glachan (Member for Albury) during their visit to MDFRC.

Ben Gawne and other staff discussed water issues with Mr John Forest, Federal Member for Mallee during their visit to the Lower Basin Laboratory.

Ben Gawne and other staff discussed water issues with Senator Lyn Allison during their visit to the Lower Basin Laboratory.

Through his presidency of the Federation of Australian Science and Technological Societies (FASTS), Peter Cullen has been able to influence policy development at the highest levels in government. His last major activity as FASTS President was to lead the 'Science Meets Parliament' day, where 180 scientists had scheduled meetings with 140 parliamentarians. This included six CRCFE staff members. The day was thought to be a great success, and the Speaker and Minister have both indicated it should become an annual event. Terry Hillman, Ben Gawne, Richard Norris, John Whittington and Peter Cottingham also attended and made representations to ten parliamentarians.

5.4 Membership of committees

One effective way of making the Centre's expertise available is by staff serving on Government and community committees. Most staff members actively contribute to committees; the list below covers Management Committee members only.

Prof Stuart Bunn
Member, Scientific Committee for Water Research, International Council for Science. Director, Land and Water Resources R&D Corporation; Member of Communications

Committee, Program Management Committee, Remnant Vegetation Program, and Rivers Policy Group
Deputy Chair, Scientific Expert Panel, SouthEast Queensland Regional Water Quality Management Strategy
Member, River Symposium Advisory Committee
Member, Technical Advisory Panel on Environmental Flows in the Fitzroy Basin for Qld DNR
Member, Editorial Board, Journal of Marine and Freshwater Research
Member, Editorial Board, Ecological Management and Restoration
Member, School Committee, Australian Environmental Studies, Griffith University
Member, Advisory Committee, MDFRC Northern Laboratory

The Murray River, a priceless natural resource that crosses State boundaries. Photo: B van Aken, CSIRO Land and Water

Prof Peter Cullen

President, Federation of Australian Scientific and Technological Societies (until November 1999)
Member, Prime Minister's Science, Engineering & Innovation Council (until November 1999)
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 (until April 2000)
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

Assoc Prof Arthur Georges
Member, ACT Environmental Advisory Committee
Chair, ACT Nature Conservation and Namadgi Sub-committee
Member, Office of the Commissioner of the Environment, Biodiversity Reference Group

Prof Barry Hart
Board Member, Victorian Environment Protection Authority
Member, Victorian Catchment Management Council
Chair, Technical Advisory Group, Gippsland Water
Chair, Scientific Panel, Victorian River Health Strategy
Member, Scientific Advisory Panel, Environmental Flow Monitoring Committee, NSW Department of Land & Water Conservation
Chair, Victorian Nutrient Management Strategy Implementation Committee
Chair, Victorian Environmental Water Quality Management Committee,
Member, Scientific Advisory Panel to Victorian EPA, Member

Dr Terry Hillman
Member, Lower Balonne Floodplain Project Steering Committee
Member, Off Allocation Water Value Subgroup, MLDCRC
Member, Monitoring Working Group, MLDCRC
Member, Waterlines Steering Committee
Member, Lower Kiewa Revegetation Corridor Steering Committee
Member, Murray Corridor Floodplain Rehabilitation Consultative Committee
Member, North East/Goulburn-Broken Water Co-ordination Committee
Member, Expert Assessment Panel Funding Applications for Fish Rehabilitation Program (AFFA)
Member, Advisory Group on Hume to Yarrawonga Waterway Management
Member, La Trobe University Regional Board
Member, Charles Sturt University Johnstone Centre Advisory Board
Member, National Executive of the Murray Darling Association
Alternate member for the NSW Murray Unregulated River Management Committee
Board Member, North East Catchment Management Authority
Specialist Adviser, Wetland Care
Member, Murray-Lower Darling Community Reference Committee

Assoc Prof Richard Norris
Chairman, Canberra Region State of the Environment Reporting Committee
Member, ACT Flora and Fauna Committee

Dr Gerry Quinn
Member, State Technical Advisory Committee (STAC) for DLWC's IMEF (Integrated Monitoring of Environmental Flows) Program.

5.5 Support for Expert Panels

An approach pioneered by the Centre is the use of expert panels to provide expertise and make recommendations on water issues. Staff have participated in a number of such panels over the year.

Prof Angela Arthington
Member, Technical Advisory Panels for the Logan, Burnett and Pioneer Basin WAMPs for the Departments of Natural Resources, Queensland.

Scientific Expert Panel for South-east Queensland Regional Water Quality Management Strategy

Scientific Expert Advisor to the River Monitoring Committee, Lower Clarence County Council, NSW.

Prof Stuart Bunn
Scientific Expert Panel for South -east Queensland Regional Water Quality Management Strategy

Technical Advisory Panel for the Fitzroy Basin Water Allocation and Management Plan for the Department of Natural Resources, Queensland

Prof Peter Cullen
Landscape and Open Space Expert Advisory Panel for the Olympic Coordinating Authority

Dr Terry Hillman
Chairman of an Expert Panel on the "Health of the Murrumbidgee River to DLWC and the Murrumbidgee Agribusiness Forum

Dr Bill Maher
ACTEW Expert Panel on Trade Waste

Assoc Prof Richard Norris
Expert Panel on Strategies for the Implementation, Management and Monitoring of Environmental Flows in the Gosford/Wyong Shires.

Assoc Prof Martin Thoms
Queensland Department of Natural Resources, Technical Advisory Panel for Condamine-Balonne and Border Rivers WAMP

Victoria Department of Natural Resources and Environment, River Murray Scientific Panel

5.6 Specialist advice, workshops, seminars and presentations

Over the last year, the Centre provided expertise through workshops, seminars and presentations for over eighty industry users and other organisations. Chapter 2, Cooperative Links contains more detail about the knowledge exchange activities for our partners.

5.7 Small to medium sized enterprises

Many of the Centre's clients and partners are SMEs. In addition to its regular knowledge exchange activities with SMEs, the CRC is developing an associate scheme, tailored specifically to allow SMEs more systematic access to its ecological expertise.

5.8 International committees and activities

Knowledge exchange in international forums is essential to ensure the Centre and the Australian water industry are abreast of the best knowledge from overseas and that the Centre's work is informing international research and practise.

Committee/activity	Country	CRC staff
Member, International EcologyInstitute (ECI)	Various, based in Germany	Peter Cullen
Academy of Technological Sciences & Engineering - Meeting on Foresighting.	Delegation from UK and New Zealand	Peter Cullen
Attended the Binnington Geomorphology Symposium	Various	Martin Thoms
Lecture	Faculty de Ciencias, Universidad de Vigo, Spain	Sam Lake
Inspection of sites and discussions of data interpretation, part of a arge integrated project on the ecological condition of Mediterranean rivers	Universidad de Vigo and Universidad de les Iles Balleares, Spain	Sam Lake
Attended a workshop on ecological monitoring of Mediterranean rivers	Universities of Granada, Almeria, Murcia, Barcelona, Vigo and the Balearic islands, Spain	Sam Lake
Presented four papers at the IXth International Rotifer Symposium, Thailand	Various	Russ Shiel
Presented papers at the annual meeting of the North American Benthological Society (NABS)	Various	Richard Norris, Peter Davies and Stuart Bunn
Provided lectures and advice to visiting Thai academics from arange of institutions, brought to Australia under the TASEAP program.	Thailand	Mike Grace and John Whittington
Attended a workshop with the USEPA	USA	Richard Norris
Scientific Committee for Water Research meeting, International Council of Science	Various	Stuart Bunn

5.8 International committees and activities continued

Committee/activity	Country	CRC staff
Participated in two Workshops of SCOPE (the Scientific Committee on Problems of the Environment)	Various	Sam Lake
Identified microfaunal samples	USA	Russ Shiel
Involved in planning the International Conference on Best Practice Environmental Flows, to be held in Cape Town, 2002	South Africa	Angela Arthington
Presented two papers at XV International Symposium of Odonatology	New York State, USA	John Hawking
Participated in Minnesota Dragonfly Survey	Minnesota, USA	John Hawking

5.9 CRCFE consulting activities

Consulting work continued as a significant part of the centre'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.

Examples of major consultancy and contract projects

Project	Client	Coordinator
Australian Alps Stream Health Monitoring Project	Alps Liaison Committee	R Norris
First National Assessment of River Health	ACT Government, EA	R Norris
Perisher Resorts Biological Monitoring	NSW Parks & Wildlife Service	R Norris
AUSRIVAS Development and Training (various projects)	EA/LWRRDC	R Norris
National Land & Water Audit	LWRRDC	R Norris, M Thoms
Development of Experimental Design & Monitoring for a Weir Draw Down Trial	MDBC	G Wilson
Review of the Ecological Sustainability of the CAP	MDBC	J Whittington
Scope of the Sustainable Rivers Audit	MDBC	J Whittington
Western Rivers Scientific Forum	QDNR	P Cullen
Likely Ecological Outcomes of the COAG Water Reforms	EA	P Cullen, J Whittington
Assessment of Distributed Wastewater Treatment Plant Effluent Standards	ACTEW	I Lawrence
Technical Review of Elements of the WAMP Process of the Queensland DNR	DNR	P Cullen

Examples of major consultancy andcontract project, continued

Project	Client	Coordinator
Namoi River Environmental Scan	DLWC	P Cottingham
Thomson Macalister Environmental Flows	West Gippsland CMA, Victoria	B Hart
Woronora River Environmental Flow Monitoring Program Development	SCA	P Cottingham
Review of Lake Wollumboola Catchment Development	L.Wollomboola Support Group	B Maher
Operation Analysis of the Northern Water Feature, Homebush Bay	SOCOG	I Lawrence, Willings
Advice on Stormwater Pollution Control Retrofitting, Development of Wetland Designs, Ellenbrook WA	Water and Rivers Commission, WA	I Lawrence, P Breen
National Water Quality Monitoring Guidelines	EA	Maher
Design of Carrs Park Wetland, Kogorah	Kogarah City Council	Kinhill, I Lawrence
Design of Smithfield Lake, Cairns	Lester Firth	Willings, I Lawrence
Murrumbidgee Environmental Flows Assessment	DLWC	T Hillman
Review of Newcastle Stormwater Management Practice	Newcastle City Council	I Lawrence
Review of Nutrient Export Model	NSW EPA	I Lawrence
Review of Waterway Design	ANU	Kiah Environmental Designers, I Lawrence
Review of SoE Report on Inland Waters, and Brisbane City Council SoE Report	EA/BCC	A Arthington
Monitoring of Fletcher Challenge Paper Cooling Water Discharge to Eight Mile Creek	Fletcher Challenge Paper	J Hawking
Biological monitoring of the Upper Murray	MDBC	J Hawking

A summary of consulting activities is presented in the figures on the following page. The revenue received and revenue per consultancy all increased significantly in 1999/2000, even though the total number of consultancies fell from 1998/99 levels and the Centre declined to accept a number of offers for additional work. These figures reflect the recognition of the Centre as a provider of high quality, independent advice to the water industries.

Figure 5.1:
Number of consultancies undertaken annually

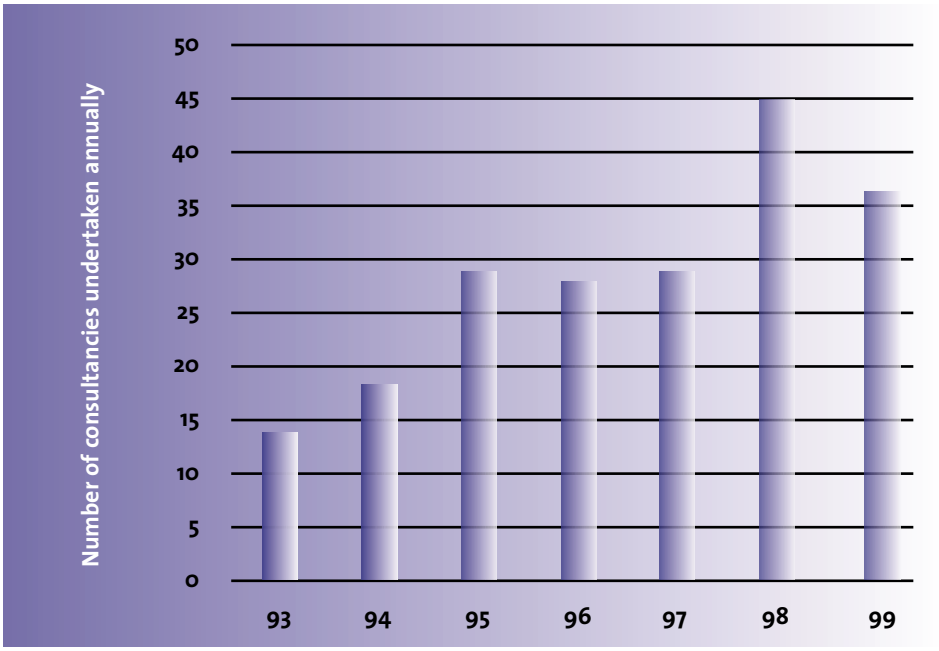
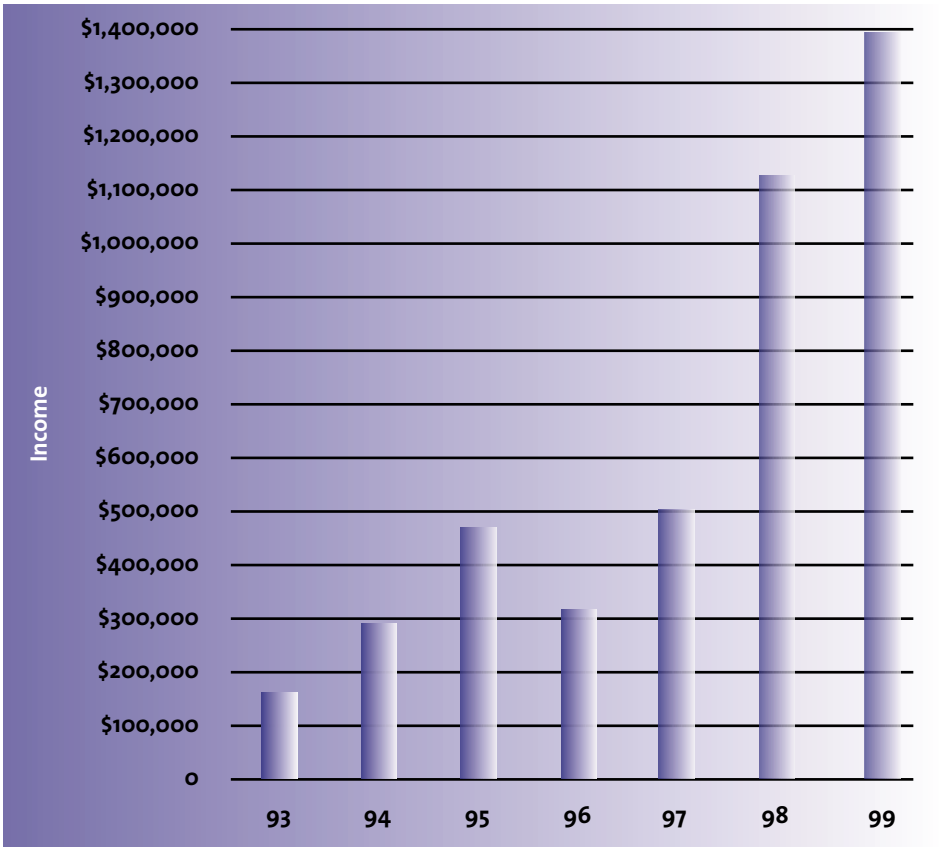


Figure 5.2:
Annual income received from consultancies



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

Encountering brumbies in Koszciusko National Park for the Alps Project. Photo: P Sloane

Transferring edge sample into container for the First National Assessment of River Health.

Measuring stream velocity using a flow meter for the First National Assessment of River Health.

5.10 Associated Projects

A number of externally funded projects are now included in the knowledge exchange program. The projects cover areas such as the development of resource assessment and communication tools, and the provision of training for the use the AUSRIVAS models for stream health assessment.

Associated projects include:

- The status of fish in the upper Murrumbidgee catchments (M Lintermans)
- Field guide to aquatic and riparian fauna of the southern tablelands (M Lintermans)
- Fish stocking in the Murray-Darling Basin (J Harris)
- Guide to invertebrates of Australian inland waters (J Hawking)
- National land and water audit. Waterway condition: biological assessment and overall integration (R Norris, M Thoms)
- AUSRIVAS training and accreditation (R Marchant, R Norris, J Hawking)
- AUSRIVAS mapping and reference sites screening module (R Norris)
- NRHP - AUSRIVAS software enhancement (R Norris)
- AUSRIVAS physical and chemical assessment module (M Thoms)
- Griffith University contributions to research projects on biological monitoring (Projects DIBM3 and RR3) for the SEQRWQMS

A reference site for the AUSRIVAS model. Photo: P Sloane

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	CEO	100%
Prof Barry Hart	Monash University	Director (Research)	85%
Dr Terry Hillman	MDFRC	Director (Regional Laboratories)	100%
Prof Sam Lake	Monash University	Chief Ecologist	75%
Prof Stuart Bunn	Griffith University	Program Leader	60%
Assoc Prof Richard Norris	University of Canberra	Program Leader	75%
Assoc Prof Arthur Georges	University of Canberra	Program Leader	75%
Dr Gerry Quinn	Monash University	Program Leader	75%

Staff of the Centre's Lower Basin Laboratory. Photo: L Sealie

Previous page:
Sue Nichols completing habitat data sheets for AUSRIVAS models. Photo: P Sloane

6.2 Staff commencing

Name	Position	Location
Abawi, Yahya	Research Scientist	DNR Qld
Arthington, Angela	Research Scientist	Griffith Uni
Arthur, Michael	Research Scientist	Griffith Uni
Avery, Estelle	Research Scientist	DLWC
Beardall, John	Research Scientist	Monash Uni
Bowling, Lee	Research Scientist	DLWC
Brock, Margaret	Research Scientist	DLWC
Bunn, Stuart	Research Scientist	Griffith Uni
Burden, Frank	Research Scientist	Monash Uni
Chessman, Bruce	Research Scientist	DLWC
Choy, Satish	Research Scientist	DNR Qld
Cousins, Katrina	Research Officer	UC
Dyer, Fiona	Research Scientist	UC
Ford, Cathy	Accounts Officer	MDFRC
Harris, John	Senior Ecologist	
Heck, Debbie	Research Scientist	Griffith Uni
Helen Missen	Admin Officer	MDFRC - Lower Basin Laboratory
Hughes, Jane	Research Scientist	Griffith Uni
Hyne, Ross	Research Scientist	EPA NSW
Koehn, John	Research Scientist	DNRE Vic
Linke, Simon	Research Officer	UC
Liston, Peter	Research Scientist	UC
Lubczenko, Vera	Research Scientist	DNRE Vic
Moffat, David	Research Scientist	DNR Qld
Moller, Glen	Research Scientist	DNR Qld
Muschal, Monika	Research Scientist	DLWC
Nicol, Simon	Research Scientist	DNRE Vic
O'Brien, Tim	Research Scientist	DNRE Vic
Outhet, David	Research Scientist	DLWC
Parsons, Melissa	Research Officer	UC
Pearson, Melanie	Research Assistant	MDFRC
Perris, Stephen	Research Scientist	EPA Vic

6.2 Staff commencing, continued

Name	Position	Location
Proctor, Heather	Research Scientist	Griffith Uni
Raadik, Tarmo	Research Scientist	DNRE Vic
Ransom, Gail	Software Engineer	UC
Richardson, Adam	Technical Officer	MDFRC
Saxinger, Melanie	Admin Officer	UC
Sealie, Lynne	Communications Manager	UC
Thompson, Jim	Research Officer	UC
Titmarsh, Geoffrey	Research Scientist	DNR Qld
Westhorpe, Doug	Research Scientist	DLWC

6.2 Staff leaving

Name	Position	Location
Blytham, Barry	Technician	Monash Uni
Boyall, Janelle	Research Officer	Monash Uni
Cole, Brett	Research Officer	Monash Uni
Dickinson, Pam	Centre Manager	Monash Uni
Esselmont, Graeme	Research Scientist	UC
Hancock, Peter	Research Assistant	MDFRC
Hedge, David	Administration	MDFRC
Hotzel, Gertroud		La Trobe Uni
Sellens, Claire	Research Officer	Monash Uni
Thompson, Jim	Research Officer	UC

6.3 Staff Development

Information Technology

Melanie Saxinger (UC) attended Lotus Notes training.

Four Wheel Drive Training

Nerida Davies, Phillip Sloane (UC).

CSIRO/BHERT Leadership of Research and Development Teams

Ian McKelvie (Monash), Arthur Georges (UC), Rod Oliver (MDFRC), Stuart Bunn (GU), Terry Hillman (MDFRC), Margaret Brock (DLWC) have all completed or are on course with the BHERT/CSIRO Achievement Through Teams Leadership in Innovation course.

CSIRO/BHERT Leadership and Career Development Course

PhD candidates Alison King and Cathy Francis attended the CRC Leadership and Career Development Course.

First Aid Training

Rosie Busuttil, Zygmunt Lorenz, Bev Chapman, Rob Cook and Adam Richardson completed the Red Cross Senior First Aid course. Gavin Rees, Daryl Nielsen and John Pengelly completed a Red Cross First Aid refresher course.

General

Alena Glaister (Monash) attended a workshop on "Setting and Managing Priorities" run by the Personnel Services Division, Monash University.

Alison Mitchell (Albury) gained a Certificate in Workplace Training and Assessment.

Claire Townsend (UC) attended Management Development for the Executive Assistant, run by the Institute of Administration, at the University of New South Wales.

6.4 Awards

Sabine Schreiber, a CRCFE PhD student, won the ASL student prize at the joint annual Conference of New Zealand Limnology Society and Australian Society for Limnology, Taupo, 1999 Congress.

Russ Shiel was the invited plenary speaker for the Hilary Jolly Memorial Lecture where he was awarded the inaugural (1999) Australian Medal for Limnology, for excellence in research, education and communication.

Dr Terry Hillman won the 1999 Chairman's Award for his contribution to the Murray Darling Freshwater Research Centre and the CRC as a whole.

Professor Peter Cullen was awarded a Highly Commended in the Outstanding Individual Achievement category of the Prime Minister's Environment Awards.

Associate Professor Keith Walker at the University of Adelaide has been recognised as the "Unsung Hero of South Australian Science" for his contributions to understanding of the Murray River.

Rhonda Butcher was nominated for the Young Water Scientist of the Year Award 2000.

6.5 Grants held by CRCFE Researchers

Researcher	Organisation	Project	Funding Source	Period	Total Funding
CONTINUING GRANTS					
Lake/ Humphries	Monash University/ MDFRC	Environmental flows on the Campaspe River	LWRRDC	Jul96 - Jun01	$696,000
Brock	DLWC/UNE	Wetlands & Water Regime	National Wetlands R & D program	97 - 00	$250,000
Oliver	MDFRC	Variation in algal availability of phosphorus from different catchment sources	LWRRDC	Mar97 - Jun00	$289,000
Osborne	UC	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
Hughes/ Bunn	Griffith University	Importance of dispersal and recruitment in stream invertebrate populations	Australian Research Council	Jan99 - Dec 02	$110,000
Bunn/ Udy/ Hunter	Griffith University/ QDNR	Nutrient cycling, primary production and aquatic food webs in coastal river systems: implications for eutrophication management	Australian Research Council (SPIRT) & SEQRWQMS	Jan99 - Dec 02	$419,000
Bunn	Griffith University	Rehabilitation and Management of Riparian Zones: Program B Ecological Issues	LWRRDC	Jan94 - Dec 99	$1,225
Copland	MDFRC	Waterlines: Studies in irrigation in the basin	NRMS	Sep97 - Aug00	$245,000
Gawne	MDFRC-Mildura	Hydrolic manipulation as a potential carp control strategy	NSW WMF	Jan98 - Dec99	$140,000
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
Harris	NSW Fisheries	Regulated rivers and fisheries restoration	NSW WMF	Jan98 - Dec99	$415,000
Schiller	NSW Fisheries	Methods for carp control	NSW WMF	Jan98 - May00	$388,000

6.5 Grants held by CRCFE Researchers, continued

Researcher	Organisation	Project	Funding Source	Period	Total Funding
Hart	Monash Uni	Nutrient release from river sediments: phase II	NEMP	Jul98 - Mar00	$219,000
Norris	Uni of Canberra	AUSRIVAS Mapping Module	LWRRDC	Feb99 - Jan01	$118,217
Norris	Uni of Canberra	AUSRIVAS Software Enhancement	EA	Dec99 - Jan00 Phase 1	$35,889
Quinn	Monash Uni	Measuring the effectiveness of environmental water allocations phase II	VIC DNRE	Jul98 - Jun00	$156,000
Nicol	DNRE	River rehabilitation through re - snagging	EA NHT	Oct 96 - Dec 01	$390,000
Thoms	UC	Storage, production and transfer of nutrients and carbon in lowland floodplain river systems: Condamine/ Balonne	Environment Australia/ QDNR	Jul97 - Jun00	$312,000
NEW GRANTS					
Lake	Monash Uni	Restoration ecology of fish assemblages in degraded rural streams	AFFA	2000 - 2003	$196,000
Bunn/Smith	Griffith University	Development of integrated baseline monitoring program	SEQRWQMS	Jan 00 - Mar 01	$250,000
Bunn/ Davies/ Walker	Griffith University/ University of WA/ QDNR	Importance of Flood Flows to Productivity of Dryland Rivers and their Floodplains	Environment Australia	Jan 00 - Dec01	$275,000
Glaister	Monash Uni	Study of elmid fauna of South Australia	Sir Mark Mitchell Research Foundation	Feb 00 - Dec 00	$1,330
Harris		Fish Stocking in the Murray-Darling Basin	EA NHT	Feb 00 - Jan 01	$25,000
Norris	UC	AUSRIVAS training and accreditation	EA NHT NRHP	Feb 00 - Oct 00	$59,000
Croome	La Trobe	Occurrence and significance of photosynthetic bacteria in freshwater systems	ARC	Jul 99 - Jun 02	$12,000

6.5 Grants held by CRCFE Researchers, continued

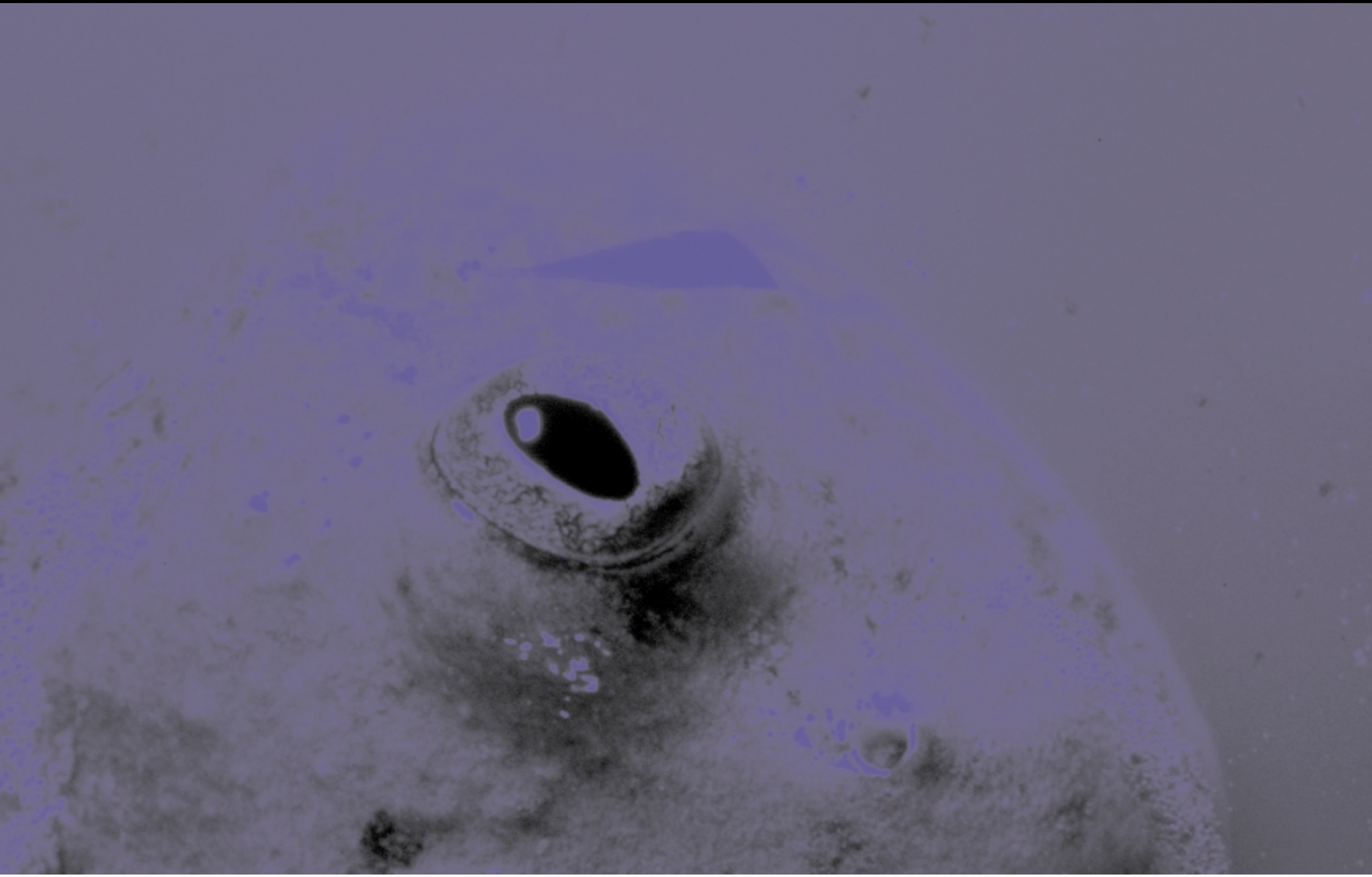
Researcher	Organisation	Project	Funding Source	Period	Total Funding
Thoms	UC	AUSRIVAS physical and chemical assessment module	EA NHT NRHP	Jan 00 - Jan 01	$130,000
Hughes/ Bunn	GUT	The role and dispersal and recruitment in structuring stream invertebrate populations	ARC	1999 - 2001	$114,000
Thoms	UC	Habitat fragmentation and environmental flows, Condamine Balonne River	ARC	1999 - 2001	$183,000
Hyne	NSW EPA	Relationship between pesticides in passive samplers to riverwater concentrations and macroinvertebrate populations	Cotton RDC	–	$402,000
Koehn	DNRE	Endangered species survival decision tool	EA NHT	Oct 98 - Dec 01	$142,500
Harris		Floodplain inundation and fish dynamics	EA NHT	May 00 - Feb 01	$20,000

6.6 Major renovations and purchases

A new Toyota FWD Utility was purchased for field work at the University of Canberra site. In early July 1999 the staff of the Lower Basin Laboratory moved to new premises located in the Mildura Base Hospital.

Heath Chester crossing a stream, one of the challenges of researching for the CRCFE.

7 Publications



7.1 Chapters in books

Bond, P.L. and Rees, G.N. 1999. Microbiological aspects of phosphorus removal in activated sludge systems. In: Serviour, R.J. and Blackall, L. (eds) *Microbiology of Activated Sludge*. Kluwer Academic Publishers.

Boulton, A.J., Sheldon, F., Thoms, M.C. and Stanley, E.H. 2000. Problems and constraints in managing rivers with variable flow regimes. In: Davies, B.R. and Petts, G.E. (eds) Global *Perspectives on River Conservation: Science, Policy and Practice*, Wiley, Chichester, pp414-426.

Boulton, A.J. and Brock, M. 1999. Australian Freshwater Ecology: Processes and Management. CRCFE.

Bunn, S.E. and Davies, P.M. (1999). Aquatic food webs in turbid, arid zone rivers: Preliminary data from Cooper Creek, Queensland. In: R.T. Kingsford (ed). *Free-flowing river: the ecology of the Paroo River*. New South Wales National Parks and Wildlife Service, Sydney. pp 67-76. ISBN 0 7313 6022 2.

Cullen, P. 2000. Perspective's on the Future of Urban Ecosystem Education: A Summary of Cary Conference VIII In Alan Berkowitz, Karen Hollweg and Charles Nilon, editors. *Understanding Urban Ecosystems: A New Frontier for Science and Education*. Springer-Verlag Inc. New York.

Davies, B.R., Snaddon, C.D., Wishart, M., Thoms, M.C. and Meador, M. 2000. A biogeographical approach to inter-basin water transfers: Implications for river conservation. In: Boon, P.J., Davies, B.R. and Petts, G.E. (eds) *Global Perspectives on River Conservation: Science, Policy and Practice*, Wiley, Chester.

Georges, A. and Legler, J.M. 1999. *Emydura sp*. (Fraser Island Short-neck) In: Pritchard, P.C.H. and Rhodin, A. (eds). *The Conservation Biology of Freshwater Turtles*. IUCN Publications, Gland, Switzerland.

Lake, P.S. 1999. After the inundation: long-term changes in the fauna of Lake Pedder, Tasmania, Australia. In *Wetlands for the Future* (eds., A.J.McComb and J.A.Davis) Gleneagles Publishing, Adelaide, pp 565-578.

Schofield, N.J., Collier, K.J., Quinn, J., Sheldon, F. and Thoms, M.C. 2000. River conservation in Australia and New Zealand. In: Boon, P.J., Davies, B.R. and Petts, G.E. (eds) Global *Perspectives on River Conservation: Science, Policy and Practice*, Wiley, Chichester.

Thoms, M.C., Parker, C.R. and Simons, M. 1999. The dispersal and startage of trace metals in the Hawkesbury River Valley. In: Finlayson, B.R. and Brizga, S.A. (eds) *River Management in Australia*, Wiley, Chichester.

Walker, K.F. 1999. A provisional guide to the freshwater mussels (Hyriidae, Unionidae) of Australia. In: Gunn, B., Cranston, P.S., Dimitriadis, S. and Trueman, J.W.H. (eds) *Interactive Guide to Australian Aquatic Invertebrates 2nd Edition,* CSIRO Division of Entomology, Melbourne.

Walker, K.F., Bryne, M., Hickey, C.W. and Roper, D.S. 1999. Freshwater mussels (Hyriidae, Unionidae) of Australia. In: Bauer, G. and Wachtel, K. (eds) *Ecology and Evolutionary Biology of the Fresh-water Mussels* (Unionoidea), Springer.

Previous page:
Water-holding frog,
Cyclorana platycephala
Photo: R Ashdown

7.2 Refereed journal articles

Allanson, M. and Georges, A. 1999. Diet of a sibling species pair of freshwater turtles, *Elseya purvisi* and *Elseya georgesi (Testudinata: chelidae),* from eastern Australia. *Chelonian Conservation and Biology,* Vol 3, No. 3, pp 473-476.

Arthington, A.H. and Marshal, C.J. 1999. Diet of the exotic Mosquitofish, *Gambusia holbrooki*, in an Australia lake and potential for competition with indigenous fish species. *Asian Fisheries Science*, Vol 12, No. 1, pp 1-8.

Baldwin, D.S. 1999. DOM and Dissolved P Leached from Fresh and Terrestrially -Aged River RedGum Leaves - Implications for Assessing River-Floodplain Interactions. *Freshwater Biology,* 41, 675-685

Blanch, S.J., Ganf, G.G. and Walker, K.F. 1999. Growth and resource allocation in responses to flooding in the emergent sedge *Bolboschoenus medianus*. *Aquatic Botany*, No. 63, pp 145-160.

Blanch, S.J., Maheshwari, B.L., Walker, K.F. and Ganf, G.G. 1999. An evaluation of the River Murray Hydraulic Model with regard for ecological research and environmental flow management. *Australian Journal of Water Resources,* No. 3, pp 107-120.

Blanch, S.J., Walker, K.F., Ganf, G.G. 1999. Water regime preferences of plants in four weir pools of the River Murray, Australia. *Regulated Rivers: Research and Management* (Lowland Rivers Issue).

Broomhall,S.D., Osborne, W.S. and Cunningham, R.B. (2000). Comparative effects of ambient ultraviolet -B radiation on two sympatric species of Australian frogs. *Conservation Biology* 14, 420-427.

Bunn, S.E. and Davies, P.M. (2000). Biological processes in running waters and their implications for the assessment of ecological integrity. *Hydrobiologia* 422/423, 61-70.

Bunn, S.E., Davies, P.M., and Mosisch, T.D. (1999). Ecosystem measures of river health and their response to riparian and catchment degradation. *Freshwater Biology* 41, 333-345.

Closs, G.P., Balcombe, S.R. and Shirley, M.J. 1999. Generalist predators, interaction strength and food-web stability. *Advances in Ecological Research* 28: 93-126.

Cottingham, P., Davies, T. and Hart, B. 1999. Aeration to promote nitrification in constructed wetlands. *Environmental Technology,* 20, pp. 69-75.

Crandall, K.A., Fetzner, J.W., Lawler, S.H., Kinnersley, M. and Austin, C. 1999. Phylogenetic relationships among the Australian and New Zealand genera of freshwater crayfish (Decapoda: Parastacidae). *Australian Journal of Zoology*, Vol 47, No. 2, pp 199-214.

Cullen, P., Norris, R., Resh, V., Trefor, B., Reynoldson, D., Rosenberg, D. and Barbour, M.T. 1999. Collaboration in Scientific Research: A Critical Need for Freshwater Ecology. *Freshwater Biology,* 42 pp131-142.

Davies, N.M., Norris, R.H. and Thoms, M.C. 2000. Prediction and assessment of local stream habitat features using large-scale catchment characteristics. *Freshwater Biology.*

Georges, A., Birrell, J., Saint, K., McCord, W.P. and Donnellan, S. 1999. A phylogeny for side-necked turtles (Chelonia: Pleurodira) based on mitochondrial and nuclear gene sequences. *Biological Journal of the Linnean Society.*

Green, J.D., Shiel, R.J. and Littler, R.A. 1999. *Boeckella major* (Copepoda: Calanoida): a predator in Australian ephemeral pools. *Arch. Hydrobiol*. 145, pp 181-196.

Green, J.D. and Shiel, R.J. 2000. Mouthpart morphology of three calanoid copepods from Australia temporary pools: evidence for carnivory. *NZ Journal Marine Freshwater Research, Special Issue*, 33(2).

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7.7 Brochures

1999 'Effects of a drying phase on the ecology of Menindee' was produced by John Whittington and Ben Gawne.

7.8 Theses

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Cooper Creek floodplain at Windorah. Photo: R Ashdown


WATER
CATCHMENT AREA
KEEP IT CLEAN

The CRC actively communicates its research to a broad range of people and organisations, from politicians to school children. Keeping the Centre's purpose clearly in mind, CRC staff provide ecological expertise and advice while building links with politicians, the water industry, and the general public. As a result, the Centre is recognised as an important source of independent and reliable information.

The Communications Manager was appointed in October 1999.

8.1 Major achievements

- WaterShed newsletter redesigned and distributed more frequently – 6 times per year.
- Lower Basin Links redesigned to provide readers with easier access to relevant articles.
- Two major displays for National Science Week. A large, interactive multi-media display featuring live frogs, fish, turtles and invertebrates in the Amazing World of Science Hall. This exhibition was run jointly with five other CRCs and the Faculty of Applied Science at UC. Approximately 8,400 visitors. The other display, a mini-billabong with turtles and plants in a prominent shop window in the main shopping centre in Canberra was very popular. Approximately 1,800 visitors.
- Over 250 organisations have ordered CRC publications. The storage, stocktake and ordering systems have been updated and streamlined, allowing more efficient retrieval and purchasing.
- Introduced a weekly electronic internal newsletter.
- The Lower Basin Laboratory's work with the Artists in Industry project culminated in a highly successful exhibition of the artists work at the Mildura Arts Centre, communicating the Laboratory's research to a broad general audience and attracting media coverage.
- Coordinated the submission for Peter Cullen's nomination for Outstanding Individual Achievement for the Prime Minister's Environment Awards. From a distinguished field, Peter was one of three finalists, being Highly Commended.

The Centre's display at the Australian Science Festival.

Previous page:
Cotter River catchment.
Photo: P Sloane

The good ship PLANKTN, part of the exhibition at Mildura Art Gallery for the Artists in Industry Project.

CRC staff and the Communications Manager use a variety of approaches to reach their diverse target audiences:

- Seminars and presentations
- Industry workshops
- Conferences
- Consultancies
- Technical reports and guidelines
- Committee membership and committee meetings
- Watershed and Lower Basin Links newsletters
- Brochures and other publications
- Displays, field days, exhibitions
- The web
- Electronic media
- Media activities
- Events

8.2 Workshops supported by the CRC

To promote its research findings, the CRC offers workshops to organisations and people who can apply the information to sustainable water management.

Conference/Workshop	Title	Sponsors	CRCFE Staff
Carp Biology	Two New Zealand carp biologists	CRCFE	Glenn Wilson
CRCFE combined projects (IP1, IP2 and Yarra) workshop	CRCFE combined projects (IP1, IP2 and Yarra)	CRCFE	Peter Cottingham
International Constructed Wetland Design Workshop	Expert advice	WA Water and Rivers Commission	Peter Breen
NEMP Workshop	Nutrient limitation of microalgae in freshwaters: An industry assessmentof new analytical techniques for incorporation into monitoring programs.	CRCFE	Rod Oliver
	Physical and nutrient factors controlling algal succession and biomass in reservoirs: An industry Workshop for Reservoir Managers	CRCFE & CSIRO	Ian Lawrence, Rod Oliver Gail Ransom (CRCFE) Myriam Bormans, Brad Sherman & Phillip Ford (CSIRO)
Salinity workshop	Identify knowledge gaps and potential research responses to the Ecological Effects of Dryland Salinity on Aquatic Ecosystems.	MDFRC, CRCFE	Daryl Nielsen, Terry Hillman
Specialist Workshop on Nitrogen Dynamics	Sources, Transformations, Effects and Management of Nitrogen in Freshwater Ecosystems	CRCFE, Monash University, NSW EPA, LWRRDC & CSIRO Land and Water	Barry Hart
Workshop	12th Taxonomic Workshop	CRCFE	Taxonomic working group
Workshop	Stream Habitat Assessment: Integrating Physical and Biological Approaches	Environment Australia	CRCFE University of Canberra staff and the Natural Heritage Trust

8.3 Presentations and lectures

In addition to Conference Proceedings listed in chapter 7, Publications.

The Joint Annual Conference of New Zealand Liminological Society and Australian Society for Limnology. 18 University of Canberra CRCFE students and researchers presented papers at the Conference. Russ Shiel was the invited plenary speaker for the Hilary Jolly Memorial Lecture where he was awarded the inaugural ASL Medal for excellence in research, education and communication.

Arthington, A. H. 1999. The growing awareness and significance of environmental flows as a determining factor in river basin planning and management. Keynote Address, "Rivers in Crisis - Offering Real Management Solutions". Brisbane RiverFestival.

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Davies, P.E. and Norris, R.H. 1999. Biological assessment of water quality: development of a national system in Australia. Annual meeting of the North American Benthological Society, Minnesota, USA.

Duggan, I.C., J.D. Green & R.J. Shiel. 1999. "Rotifer distribution in North Island, New Zealand, and their potential use as bioindicators of lake trophic state." NZSL/ASL joint conference, Lake Taupo, New Zealand.

Duggan, I.C., J.D. Green & R.J. Shiel. 2000. "Rotifer distribution in North Island, New Zealand, and their potential use as bioindicators of lake trophic state." IXth Int. Rotifer Symposium in Khon Kaen, Thailand.

Gawne, B. 1999. The reasons for conserving aquatic biodiversity at the "Biodiversity Conference Outback and Upfront".

Grace, M.R. 1999. Ecosystem Functions as Stream Health Indicators. Urban River Health Workshop, Monash University, Clayton.

Green, J.D. R.J. Shiel, J.M. Langley & D.L. Nielsen. 1999. "The influence of sediment flood history on microinvertebrate colonization of temporary waters". NZSL/ASL joint conference, Lake Taupo, New Zealand.

Green, D. 2000. PhD student at MDFRC/University of Canberra, delivered a seminar on his research at Chaffey Dam.

Harris J. 1999. Ecological drivers for change. Keynote address to the Water and Wetlands Management Conference, 'Water: Wet or Dry?' Nature Conservation Council of NSW Inc.

Hillman, T.J. 1999. Ecological linkages between wetlands and rivers. Wetland Care Australia, Canberra.

Hillman, T.J. 2000. Riverine Floodplain Interactions during periods of high flow. Murrumbidgee River Management Committee, Environmental Contingency Allocation Sub-Committee, Wagga Wagga.

Hillman, T. 1999. Presented a paper on "Stream Ecology (macroinvertebrates)" at the Wise Water Ways Workshop held at La Trobe University.

Lake, S. 2000. Evaluation in stream restoration and rehabilitation. Water 2000-LWRRDC Stream Restoration Workshop.

Lake, P.S, A. Glaister, J. Davis, B. Downes, B. Finlayson, R. Keller, A. Tucker, K. Swingler and B. David. 1999. Restoration ecology in streams inundated by sand slugs; the Granite Creeks project, Victoria, Australia. NZSL/ASL joint conference, Lake Taupo, New Zealand.

Langley, J.M., Shiel, R.J., Nielsen D.L. & Green J.D. 2000. "Mesocosms - an asset to rotifer biodiversity assessment?" IXth Int. Rotifer Symposium in Khon Kaen, Thailand.

Norris, R.H and. Davies P.E. 1999. Biological assessment of water quality: delivery of a national system in Australia. Annual meeting of the North American Benthological Society, Minnesota, USA.

Oliver, R. 1999. Presented a talk "Maintaining water health" to a community conference "Achieving the Balance". Upper Murray Catchment Network (NSW) and the Upper Murray Landcare Network (VIC).

Oliver, R. and Cottingham, P. 1999. Presented papers at the MDBC Strategic Investigations and Education Forum (Irrigation, Dryland and Riverine Sub-Programs Forum). Peter Cottinghams's paper received best presentation award (riverine program) and special commendation at Forum closing session.

Pinder, A.M., J.M. McRae, S.A. Halse, M. Pennifold & R.J. Shiel. 1999. "Aquatic invertebrate assemblages of the Wheatbelt region of Western Australia".

Pontin, R.M. & Shiel, R.J. 2000. "Further studies on rotifer communities of the aquatic macrophyte Myriophyllum" IXth Int. Rotifer Symposium in Khon Kaen, Thailand.

Puckridge JT, JF Costelloe, KF Walker. 1999. Responses of arid zone rivers to changes in flow-the DRY/WET model. Rivers for the Future (Land and Water Resources R&D Corporation, Canberra).

Shiel, R.J. 1999. "Microfauna". Monitoring Wetlands Workshop, Univ. of New England.

Shiel, R.J. 1999. Presented two papers at the Vth Int. Symposium on Cladocera, Max-Planck Inst., Ploen, Germany.

Shiel, R.J. & S.A. Halse. 2000 "Rotifer communities in salinizing habitats:comparisons from western and eastern Australia" IXth Int. Rotifer Symposium in Khon Kaen, Thailand.

Walsh, C. J. 1999. Melbourne's Troubled Waters: Stormwater's multiple insults to stream ecosystems in an urban landscape. Water Studies Centre, Monash University, Clayton.

Walsh, C. J. 1999. Ecological assessment of the small streams of Melbourne, an overview. Urban River Health Workshop, Monash University, Clayton.

Walker KF, Lambert MF. 1999. Reflections on 'the environment'. Environmental Challenges for the New Millennium. Conference on Post-Graduate Research on the Environment. Department of Civil & Environmental Engineering, University of Adelaide.

Whittington, J. 1999. Addressed the CSIRO Component 1 "National Water Reform" group on the research needs to implement water reforms in Australia.

Wilson, G. Presented his work on carp to the Murray Darling Association Fish conference.

8.4 Community workshops, meetings, presentations

One of the ways the Centre influences and educates the wider community about water issues is through representation at community forums and meetings.

Workshop/committee	Title	Sponsors	CRCFE staff
Albury Rotary	Presentation	MDFRC	Martin Thoms, Mike Copland
Artists in Industry	Meetings and display - PLANKTN	MDFRC LBL	Ben Gawne
Australian College of Seniors Group	Ecology of the Murray	Lower Basin Laboratory	Ben Gawne
Australian Trust Conservation Volunteers	Meeting		Ben Gawne
Bellbridge Rotary Club	Presentation on Billabong Flooding	MDFRC	Mike Copland
Bookmark	Advice on design of a limnology wet lab		Ben Gawne
Committee meeting, 10 winegrape growers	Irrigation issues		Ben Gawne
Ecological report for Adelaide Advertiser	Provided information and tour	MDFRC	John Whittington, Mike Copland
Inaugural Ecology Discussion Group	Freshwater Ecology	MDFRC LBL	Ben Gawne
Landcare, TCM	Participation in "Wirraminna Learnscape" video		Mike Copland
Mildura Business Centre	Blue Green Seminar	CRCFE	The Lower Basin Laboratory
Ministerial Tour of the District by John Anderson.	Meeting and tour		Ben Gawne
NSW TAFE (Albury)	Guest speaker at the Graduation Ceremony		Terry Hillman

Dam release at Captains Flat Reservoir. Flows require careful management to minimise possible damage to the freshwater environment downstream. Photo: P Sloane

8.4 Community workshops, meetings, presentations, continued

Workshop/committee	Title	Sponsors	CRCFE staff
Palimpsest - Art Meets Science Symposium	The meeting of Art and Science in Ecology	Mildura Arts Centre	Ben Gawne
The Albury/Wodonga Gateway Island project	Representation		Mike Copland
The "Lower Kiewa" project	Representation		Mike Copland
Presentation to 150 tourism stakeholders	'Why the environment needs flooding'	MDFRC	Mike Copland
Rutherglen Landcare Group Annual General Meeting	Floodplains and Billabongs: "how we affect their life and health"		Terry Hillman
Seminar for 10 Albury businessmen	River interpretation	MDFRC	Mike Copland
Submission to Albury City Council, Wadonga Wetlands Group	MDFRC		Mike Copland
Talk to Victorian Fly Fishers Association	The Health of our Rivers		Peter Cullen
Water Week	Spoke to groups of children and helped organise National Water Bug Survey Day	Lower Basin Laboratory, DLWC	Ben Gawne and Iain Ellis
Workshop 'The causes and control of blue-green algae'	Algal availability of phosphorus discharged from different catchment sources	LWRRDC & MDBC	Rod Oliver

Blue-green algal bloom on Chaffey Dam, one of the many issues Centre staff inform and advise the public about. Photo: B Sherman

8.5 Newsletters, brochures etc.

The Centre's newsletters, WaterShed and Lower Basin Links, were redesigned, leading to an increase in readership. Watershed is published every two months and sent to over 3,000 readers, both in Australia and overseas. Lower Basin Links is published quarterly and sent to over 500 readers, mostly in the Mildura region. Other Centre publications, such as brochures, attract a broad readership. Most of the Centre's newsletters and technical reports are also available on its website.

Over the last year, over 250 organisations have ordered CRC publications. The storage, stocktake and ordering systems have been updated and streamlined, allowing more efficient and reliable retrieval and purchasing.

An electronic weekly internal newsletter was introduced and will be informally evaluated using a survey sample. The newsletter Ripples was published fourteen times.

The brochure - 'Effects of a drying phase on the ecology of Menindee' was produced by John Whittington and Ben Gawne.

8.6 Displays and exhibitions

The Amazing World of Science, Australian Science Festival

A large, interactive multi-media display with live frogs, fish, turtles and invertebrates in the Amazing World of Science Hall. This exhibition was run jointly with five other CRCs and the Faculty of Applied Science at UC. Approximately 8,400 visitors.

Science Comedy Show, National Science Week

Information display at the science comedy show by Adam Spencer and Dr Karl Kruzcelnicki. 580 visitors.

Science in the City, Australian Science Festival

Featured live turtles in a mini-billabong - launched in a shop window in Canberra's main shopping centre in Canberra. Approximately 1,800 visitors.

Provided educational materials for Frog Week during National Biodiversity month at Healesville Sanctuary Education Section.

Presented a display at the University of Canberra's Open Day.

Lower Basin Lab provided fish tanks for display at the Murray Darling Associations Fish conference.

The MDFRC participated in a photographic display, Trading Places: The River 99 Exhibition.

8.7 Communicating through the media

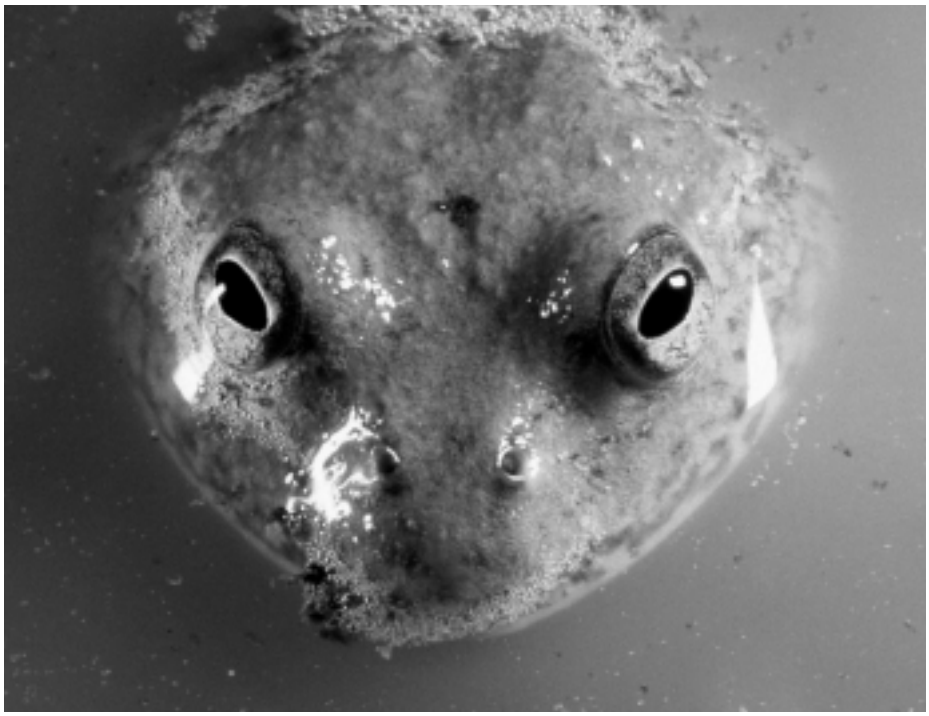
In addition to media releases, journalists are regularly informed of the Centre's activities and research findings through the newsletters, Watershed and Lower Basin Links. Articles from these newsletters have subsequently been featured in regional and national newspapers, magazines and newsletters. After five years of building relationships with the media, the Centre now receives numerous requests from the media for information and interviews.

103 media hits were recorded during the year:

Radio	28
Television	15
Newspaper	43
The Web	8
Newsletters/magazine	9

Media releases issued

'Pond experiment succeeds at reducing carp breeding'.	Glenn Wilson
'Irrigation Cap - vital for the Murray-Darling Basin'.(The Australian)	Whittington/ Cullen
'Prime Minister commends river health champion'.	Lynne Sealie



Water-holding frog, Cyclorana platycephala, in Cooper Creek. Photo: R Ashdown

8.8 Public awareness and understanding

John Whittington and Rhonda Sinclair organised Science in the Pub in Albury to help celebrate National Water Week. Hosted by the Australian Science Communicators and the MDFRC, the evening attracted around 110 locals to Sodens Hotel to hear Drs Paul Humphries and Andrew Sanger discuss Scales of injustice: feral fish fallacy?, looking at the introduction of feral fish into Australian waters. Compered by Dr Paul Willis (ABC) and Bernie Hobbs (ABC and Triple J), the evening was a huge success.

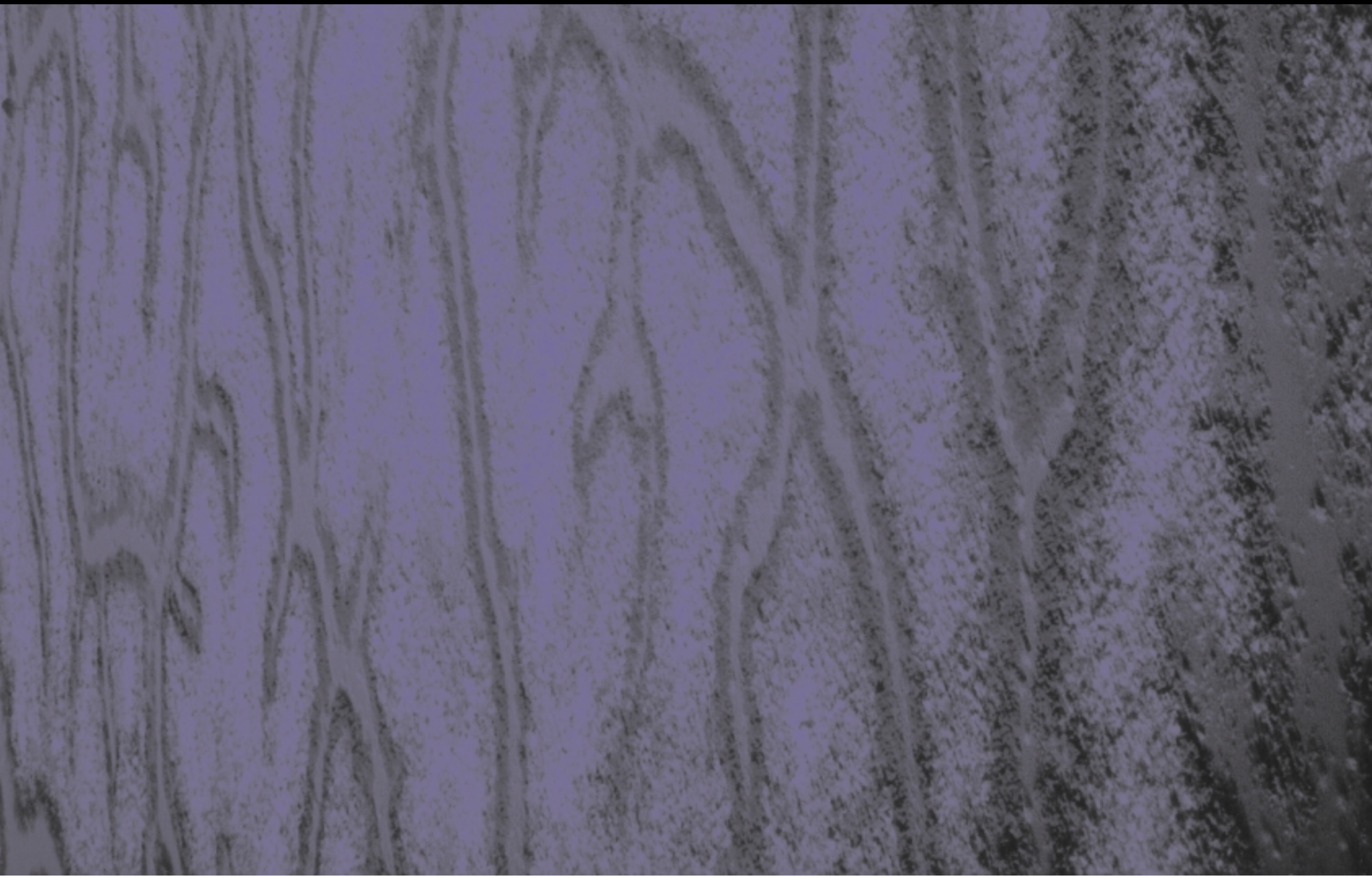
Federation of Australian Science and Technological Societies (FASTS) presidency

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. The media coverage has generated flow-on benefits for the CRC.

8.9 The World Wide Web

The Centre continues to use its website for disseminating information about its research to industry users and the broader public. The Communications Manager has prepared a development plan for the website so that information is layered to provide the level of detail required by the user. Material will be written to target specific audiences. Careful web site design and construction using clear navigation will allow users to find knowledge they require as they need it.

9 Performance Indicators



As indicated in Schedule 1 of the Commonwealth Agreement, the Centre has drafted a strategic plan that outlines key performance areas and links these to performance indicators. The key indicators that follow will be developed further as a part of the final Strategic Plan.

9.1 Cooperative arrangements

9.1.1 Activities of the Centre seen by stakeholders as making a difference to water management

The Centre's ability to improve water management is recognised by a wide range of stakeholders, as shown by the high demand for the Centre's expertise from community groups, the water industry, politicians, the media and the general public.

Many of the Centre's management recommendations have been adopted via consultancies, such as the workshops and reports for QDNR on the WAMP process, the framework for the Sustainable Rivers Audit for the MDBC and the Indicators for Catchment Health for the Sydney Catchment Authority. More detail is contained in Chapter 2, Cooperative Links and Chapter 5, Knowledge Exchange.

Stream bank erosion, one of the many management issues addressed by the CRCFE's research. Photo: P Sloane

9.1.2 Most research undertaken in large multi-disciplinary projects managed in an integrated way

Most of the projects documented in this report are multi-disciplinary; using expertise from across the CRC to focus on problems at an appropriate field scale. We continue to invest in leadership training to help staff work in these integrated projects.

Previous page:
Cooper creek floodplain at Windorah.
Photo: R Ashdown

9.1.3 Maintaining a strong partner base

The consultative processes used to formulate the research portfolio and develop a strategic plan have involved all the Centre's partners and served to strengthen the links between them. The Program Advisory Committees maintain a strong partner base by linking partners needs with the collaborative research programs.

9.2 Research and researchers

9.2.1 Research portfolio appropriate to short and longer term issues for the water industry.

Our new research portfolio, developed during 99/00, targets both short and long-term issues facing the water industry. As such we have a range of projects varying from six year projects looking at scientific questions underpinning the issues facing our industry, to short term 1-6 month projects addressing immediate needs and knowledge gaps.

Program Advisory Committees (PACs) have been established for each research program to strengthen the links between industry needs and the Centre's research programs. The PACs have met and reported to the Board.

Research assistant Phil Sloane collecting habitat characteristics on the Murrumbidgee River.

9.2.2 Research is of an excellent standard and is published in refereed literature.

- 43 publications in refereed journals during the year.
- All research projects undertaken within the CRC undergo a rigorous review process to ensure excellent quality science which is relevant and of benefit to our partners.

9.2.3 Effective project management with regular reporting to Board

- Project management reports have been presented to each Board meeting.
- Reporting is against milestones and any missed milestones are reported and acted on by the Board.

9.3 Education and training

9.3.1 Number of postgraduate students enrolled and working with the CRC and degrees conferred

The CRCFE has 51 PhD and 12 Masters students.

25 students approved as Associated Project students.

5 applications currently in progress from new PhD candidates.

There have been 3 Masters degrees and 8 PhDs conferred.

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

22 postgraduate students are co-supervised by non-university staff.

9.3.3 Short courses and workshops developed and presented.

The first CRCFE Postgraduate Student Workshop was held. A number of CRC postgraduate students participated in a 14 day Statistics and Experimental Design course.
A postgraduate student induction manual has been produced.

The first supervisors' training day registered 13 participants from both university and non-university CRC partners.

9.4 Applications of research

9.4.1 Adoption of research by partners

CRC research was adopted by partners for the development of stormwater management plans and guidelines, environmental monitoring and assessment programs, for the development of environmental policy, the identification of environmental flows in regulated and unregulated rivers, catchment management planning, fisheries management, lake and reservoir management, stream rehabilitation projects, and conservation programs.

9.4.2 Advice and consultancies provided to industry partners and others

CRC staff provided advice and contributed to science and resource management issues on more than 250 occasions at a diverse array of events, including seminars, workshops, conferences, consultative and business meetings, international visits, steering committees and training sessions.

The CRC undertook 36 consultancy projects that continued the rise in annual consulting income recorded in each year of the CRC's existence (see the Knowledge Exchange section in chapter 5 for more details). The 1999/00 income was achieved despite the fact that the CRC declined many requests to undertake consulting work. Priority was given to projects commissioned by industry partners and government agencies such as Environment Australia.

9.4.3 Applied research, investigation and consulting contracts with non-participating agencies

Applied research and consulting projects were undertaken for non-participating agencies where such work contributed to improved water resource management or the application of CRC research outcomes and tools. This included input to work related to stormwater management (e.g. stormwater management planning, pond and wetland design), tools for assessing river health (e.g. AUSRIVAS models and biological monitoring), and evaluation of government policy initiatives (e.g. COAG water reforms, review of the MDBC Cap on diversions).

9.4.4 Production of technical publications appropriate for end-users and develop other vehicles for reaching these groups

Seven technical reports were produced for end-users; a number of which have been reprinted to meet demand. To broaden the access to these publications, most technical reports are available in PDF format on the CRC website. A number of less technical brochures on research findings are also produced for end users.

9.4.5 Centre staff involvement in government and other advisory bodies

Most staff members actively contribute to government and other advisory bodies as an effective way of making the Centre's expertise available. The 7 members of the Management Committee alone are involved in 56 government and other advisory bodies. For further details, please see chapter 5, Knowledge Exchange.

9.4.6 Media exposure by Centre

103 media hits were recorded during the year. After five years of building relationships with the media, the Centre now receives numerous requests from the media for information and interviews.

9.5 Management and budget

9.5.1 Effectiveness of Board in setting research directions and providing overall policies for the Centre

The Board has identified priority areas for project development, and has then assessed the projects and selected those ready for funding. The Board has been closely involved with developing the Centre Strategic Plan and other operational plans.

9.5.2 Reporting progress to the Board and to the Commonwealth

Direct reports to the Board quarterly.

Annual report to the Secretariat.

The Centre received a favourable report from its first year 'pastoral' visit, organised by the CRC Secretariat. The report stated that the CRC had "no significant weaknesses" and "...is already clearly focusing on and achieving all the evaluation criteria".

9.5.3 Accurate monitoring of agreed performance indicators

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

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

An induction kit has been developed for students working in the CRC and this is available to all new students. Induction programs are offered as various sites as needed.

9.5.5 Provide appropriate staff development opportunities within the Centre

Staff and students have undertaken a variety of staff development training including information technology, leadership skills and first aid. Seminar programs are run at the Monash, Griffith and Canberra University sites, open to all CRCFE staff and students. Staff and students have also been supported to attend scientific conferences and workshops.

9.5.6 Significantl increase in revenues from outside sources during the life of the Centre

The revenue received and revenue per consultancy all increased significantly in 1999/2000, even though the total number of consultancies fell from 1998/99 levels and the CRCFE declined to accept a number of offers for additional work. $1,400,000 was received from consultancies.

These figures reflect the recognition of the CRCFE as a provider of high quality, independent advice to the water industry.

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
CIT	Canberra Institute of Technology
CSIRO	Commonwealth Scientific and Industrial Research Organisation
BHERT	Business and Higher Education Round Table
CSU	Charles Sturt University
CRC-WMPC	CRC for Waste Management and Pollution Control
DISR	Department of Industry, Science and Resources
DLWC	Department of Land and Water Conservation
EA	Environment Australia
EPA NSW	Environment Protection Authority, NSW
EPA Vic	Environment Protection Authority, Victoria
ERISS	Environmental Research Institute of the Supervising Scientist
FASTS	Federation of Australian Science and Technological Societies
FRDC	Fisheries Research Development Corporation
FRP	Filterable reactive phosphorus
GHD	Guthrie, Haskins and Daley (consultants)

Acronyms

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
MW	Melbourne Water
MRHI	Monitoring River Health Initiative
NATA	The National Association of Testing Laboratories
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

Cooperative Research Centre for Freshwater Ecology
University of Canberra site

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Notes

Cooper Creek in Flood.
Photo: R Ashdown

web site: http://freshwater.canberra.edu.au