Cooperative Research Centre for Sustainable Production Forestry

ANNUAL REPORT 98/99

Established and supported under the Australian Government's Cooperative Research Centre's program

CRC AUSTRALIA

Mission Statement

The CRC-SPF's role within the forestry sector is:

To sustain the productivity of and enhance the economic benefit from Australia's forests, through excellence in research, training and technology transfer.

Objectives

The CRC for Sustainable Production Forestry will provide the following benefits:

- Ensure the long term viability of Australia's forestry industry through high quality, relevant research in sustainable plantation forestry;
- Produce research outcomes which improve the competitiveness of industry partners, as well as being of interest to a wider range of stakeholders;
- Improve the efficiency and effectiveness of the applied research and development of industry partners through fostering and facilitating cooperative research;
- Provide an avenue to international science to ensure relevant new approaches and techniques are available in Australia;
- Provide innovative and relevant education and training that meets the skill formation needs of the forestry industry and the national forestry objectives;
- Ensure that all stake holders capture the benefits of Centre research through effective technology transfer.

Cooperative Research Centre
for Sustainable Production Forestry

ANNUAL REPORT 98/99

Established and supported
under the Australian Government's
Cooperative Research Centres Program

Australian Forest Growers

Australian National University

Australian Paper Plantations Pty Ltd

Boral Timber Tasmania Ltd

Bunnings Treefarms Pty Ltd

CSIRO Entomology

CSIRO Forestry and Forest Products

Forestry Tasmania

Fletcher Challenge Paper

Griffith University

North Forest Products Ltd

Primary Industries Corporation (Qld)

Silvagene Pty Ltd

Southern Cross University

Southern Tree Breeding Association Inc

The University of Queensland

University of Tasmania

Contents

Abbreviations

AFG	Australian Forest Growers	GU	Griffith University
ANU	Australian National University	NFP	North Forest Products
APP	Australian Paper Plantations	PIC	Primary Industries Corporation (QLD)
BTT	Boral Timber Tasmania	QFRI	Queensland Forestry Research Institute
BTf	Bunnings Tree Farms	RP	Resource Protection Program
CRC-HFPS	CRC for Hardwood Fibre and Paper Science	SCU	Southern Cross University
		SM	Sustainable Management Program
FT	Forestry Tasmania	STBA	Southern Tree Breeding Association
FCP	Fletcher Challenge Paper	UQ	The University of Queensland
GI	Genetic Improvement Program	UT	University of Tasmania

Chairman's Letter

CRC Secretariat
GPO Box 9839
Canberra City ACT 2601

Dear Sir

I am pleased to present to you the 1998/99 Annual Report of the Cooperative Research Centre for Sustainable Production Forestry.

The second year of the Centre has been one of great progress towards its scientific goals and objectives, as well as in the transfer of technology to its partners and other end users. This has occurred against a background of transition in the industry, with some companies reducing their own research programs and divesting themselves of ownership of their plantation estates. These changes only increased the importance of the CRC as a key provider of research and technology to plantation forestry, that will place the industry in a competitive position in the international market place.

The Centre has increased its contribution to training the next generation of foresters with skills which match the needs of industry. Staff are now teaching in more university courses and there has been a substantial increase in postgraduate student numbers. The Centre has also embarked on novel projects in the public domain, including a major textbook on natural vegetation and a project to encourage women into the forestry profession.

In addition, at the Annual Meeting of the Centre held in Burnie, it was clear that the necessary linkages were being made between geographic regions and between the scientific staff and industry to make this Centre a very successful one in the coming years.

Yours sincerely,

John Kerin
Chairman

Director's Report

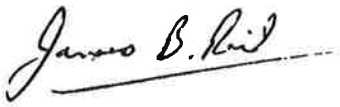
The CRC for Sustainable Production Forestry has firmly established itself as a key research provider to the plantation forestry sector in Australia. Industry has continued to take up the results of research from the Centre and modified their operations accordingly. This has resulted in industry (i) accepting a more efficient method for controlled crossing of eucalypts, (ii) improving their nutrient and herbicide regimes, (iii) advancing their management tools for plantation growth, and (iv) gaining an increased understanding of feeding preferences of vertebrate browsers.

The Centre now has staff located in six states and territories. The industry it serves is changing rapidly and several members have undergone restructuring during the past twelve months. Although this has required management flexibility, it has also provided significant opportunities as in-house research has been wound back. Under a new set of guidelines, the Board has accepted proposals for Associate Membership from Serve-Ag Pty Ltd and Forest Enterprises (Tasmania) Pty Ltd, and Supporting Membership from Private Forests Tasmania. Other major plantation growers have also indicated an interest in joining the Centre.

In the second year the Centre has continued to build links between partner organisations as well as fostering international linkages. For example, a successful Annual Meeting held in Burnie brought together research and operational staff of all seventeen partner organisations. The meeting was attended by 155 people and feedback suggested it was a valuable experience for all concerned. The success of the CRC at the international level was demonstrated by the strong international representation at a 'Molecular Genetics of *Eucalyptus*' symposium. This led to the establishment of significant international cooperation to develop a set of microsatellite markers to fingerprint eucalypts, an essential technology for quality control in breeding and deployment programs.

During 1998/99 the Centre has brought to fruition several projects which expand the horizons of the CRC and provide the public with basic information about forestry and vegetation management. The CRC was a key contributor, with the University of Tasmania and Forestry Tasmania, to a book entitled 'Vegetation of Tasmania' published by the Australian Biological Resources Study, a section of Environment Australia. This is the first book published which deals comprehensively with the biological, environmental and human interactions that have shaped the unique flora of Tasmania. The 'Women in Forestry' project also came to completion with the publication of a booklet which profiles many successful women involved in forestry and forest research. It has been enthusiastically received and distributed widely throughout Australia. These two projects indicate that the CRC has successfully advanced the understanding of forestry issues amongst the general public, in addition to continuing to build on its excellent research record.

There have been significant staffing changes within the Centre with Dr Clare McArthur replacing Dr Robert Floyd as Program Manager for Resource Protection and Dr Brad Potts replacing Dr Nuno Borralho as Program Manager for Genetic Improvement. At the Board level, Prof Andrew Glenn (University of Tasmania), and Mr Ron Beck (Primary Industries Corporation) have replaced Prof Allan Canty and Mr Peter Francis, respectively. Our graduates have continued to be eagerly sought by industry and this will be one of the major long-term contributions to our sector. In conclusion, this year has been productive and successful and I congratulate staff and students on a job well done.



Prof Jim Reid
Director

Management

The Board

The Board of Management of the Centre is comprised of an independent Chairman, Director and Deputy Director of the Centre, Chairman of the Advisory Panel and the Chief Executive or a nominee from each Core Partner. The Board determines policy and strategic direction, and sets guidelines for the effective operation and management of the Centre. The management structure and links are shown in Figure 1.

Operation of the Centre is facilitated through three committees:

Advisory Panel

The Advisory Panel has the role of providing scientific advice to the Board. The Panel includes Dr David de Little (Chairperson), three external scientific experts [Dr Peter Ades (University of Melbourne), Dr Roger Sands (University of Christchurch), Dr Tim New (Latrobe University)], and the chairperson of each Program Coordinating Committee.

Management Committee

This committee assists the Director in the day-to-day running of the Centre by implementing the policies set by the Board. The Committee includes:

Prof Jim Reid (Director)
Dr Russell Haines (Deputy Director)
Ms Corrine Condie (Business Manager)
Ms Jean Richmond (Secretary to the Director and the Board)

Program Managers
Dr Brad Potts (Genetic Improvement)
Dr Chris Beadle (Sustainable Management)
Dr Clare McArthur (Resource Protection)
Dr Neil Davidson
(Education and Technology Transfer)

CRC Board

Mr John Kerin
Chairman

Prof Jim Reid
Director

Mr Ron Beck
Manager, Production Division
Primary Industries
Corporation Qld

Prof Andrew Glenn
Pro-Vice Chancellor
(Research)
University of Tasmania

Mr John Cameron
Manager, General
Australian Paper Plantations

Mr Allan Jamieson
Manager
North Eucalypt Technologies

Dr Glen Kile
Chief
CSIRO Forestry and
Forest Products

Dr Hans Drielsma
General Manager
(Forest Management)
Forestry Tasmania

Mr Murray Vitlich
General Manager
Pulpwood Operations
Bunnings Treefarms

Prof Peter Baverstock
Dean, Graduate College
and Research
Southern Cross University

Mr Arnold Willems
General Manager
ANM Forest Management

Dr Ron King
Director, Office for
Research Griffith University

Program Coordinating Committees

The Program Coordinating Committees meet at least twice a year to review and preview research with regard to its scientific and technological merit, and to set and review research deliverables for each project. Each Committee is chaired by an industry partner representative and consists of the Director, the Program Manager, and at least three industry partner representatives. Project Leaders within the program are included as non-voting members and are therefore not listed below.

Genetic Improvement Program

Mr Peter Volker (Serve-Ag, Chair)
Prof Jim Reid (Director)
Dr Brad Potts (Program Manager)
Mr Ian Bail (Silvagene)
Ms Sandra Hetherington (FCP)
Mr Peter Kube (FT)
Dr David Pilbeam (BTf)
Dr Wayne Tibbits (NFP)
Dr Tony McRae (STBA)
Mr Ian Last (PIC)
Dr Neil Davidson (Program Manager Education and Technology Transfer)

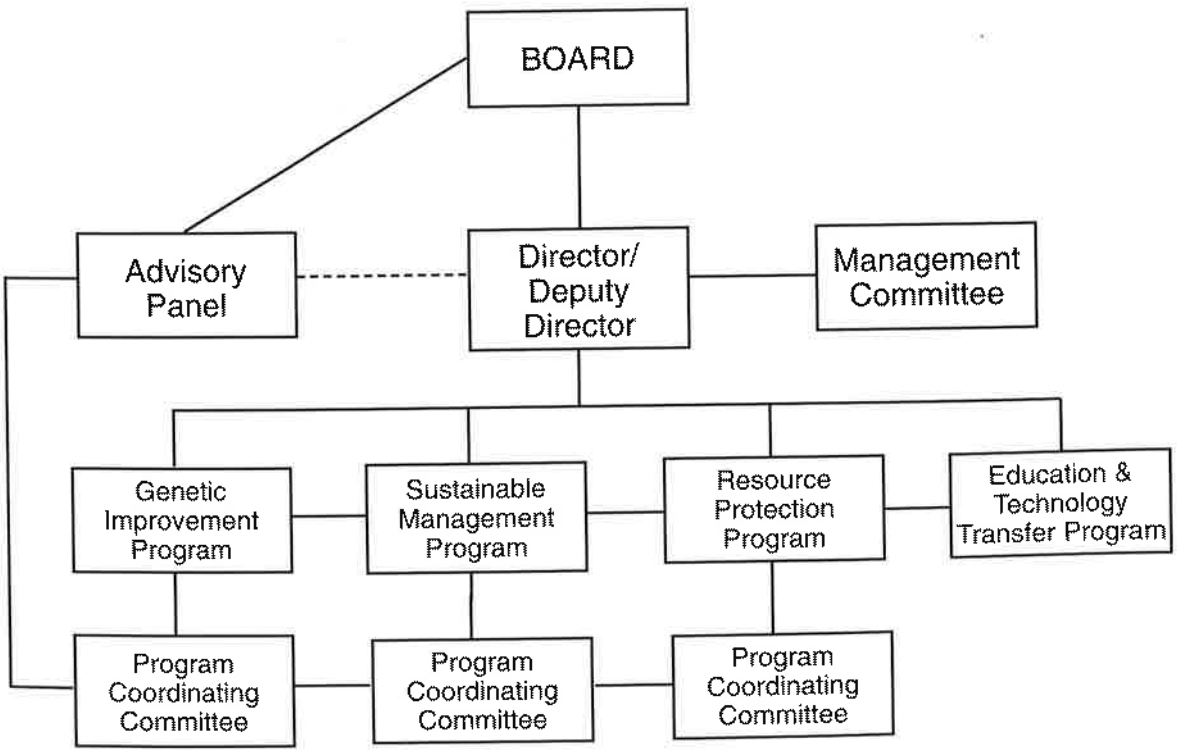
Sustainable Management Program

Ms Sandra Hetherington (FCP, Chair)
Prof Jim Reid (Director)
Dr Chris Beadle (Program Manager)
Mr Ian Last (PIC)
Dr Greg Holz (NFP)
Mr Bill Neilsen (FT)
Mr Richard Breidahl (BTf)
Mr Phil Whiteman (APP)
Mr Peter Naughton (BTT)
Dr Neil Davidson (Program Manager Education and Technology Transfer)

Resource Protection Program

Dr Humphrey Elliott (FT, Chair)
Prof Jim Reid (Director)
Dr Clare McArthur (Program Leader)
Dr David de Little (NET)
Mr Simon Hunter (BTf)
Mr Phil Whiteman (APP)
Ms Sandra Hetherington (FCP)
Dr Bill Foley (ANU)
Dr Ross Wylie (QFRI)
Ms Linda Maddern (BTf)
Dr John Madden (Hon. CRC Fellow)
Dr Neil Davidson (Program Manager Education and Technology Transfer)

Figure 1 Management Structure



MAJOR DEVELOPMENTS

Predicting browsing damage through indicator species

Browsing mammals have preferred food types. For instance, brushtail possums eat *Eucalyptus nitens* seedlings in preference to seedlings of *Acacia melanoxylon* and *Pinus radiata*. In collaboration with Forestry Tasmania, the CRC has developed a nonlinear model that describes intake (depletion) of one plant type on the basis of availability of another plant type.

Two examples of this relationship are shown in Figure 2. Possums show a strong preference for *E. nitens* seedlings over both *A. melanoxylon* and *P. radiata* but, as *E. nitens* seedlings become depleted, intake or depletion of the second seedling type increases rapidly. The straight line is a 1:1 relationship between consumption of the two food types (ie the relationship if two food types are equally favoured).

By modeling intake of one plant type on the basis of availability of another plant type, we offer a new perspective on analysing and understanding the complex interactions between plants as they influence feeding behaviour of herbivores. At the same time, we offer an approach to the applied problem of predicting damage to economically important seedlings in forestry. Depletion of an indicator species, one that is more preferred than plantation seedlings, for example, could be monitored to determine when a rapid increase in depletion (damage) to seedlings is likely to occur. For example, if *E. nitens* was the indicator species in Figure 2, the dotted line indicates the proportional depletion of *E. nitens* after which a rapid increase in damage to *A. melanoxylon* or *P. radiata* seedlings is expected. Indicator species need not be confined to those planted especially, but could be those growing naturally on plantations or even in regenerating forest.

Substantiation of this approach, using indicator species to anticipate damage, has one major implication for forestry. The use of 1080 could be reduced, by using it only in response to a site-specific measured risk of damage, instead of routinely.

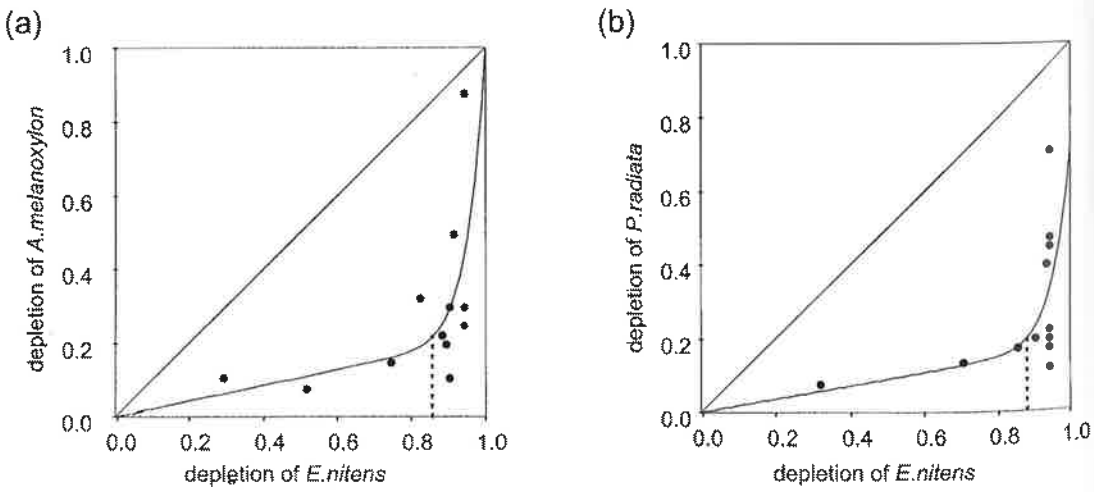


Figure 2
Nonlinear model of the proportional depletion of foliage from two seedling types by brushtail possums. Fig 2(a) shows *E. nitens* with *A. melanoxylon* and Fig 2(b) shows *E. nitens* with *P. radiata*. The more preferred plant type is on the x-axis. Straight line from (0,0) to (1,1) indicates no selection.

MAJOR DEVELOPMENTS

Phosphorus in forest plantations

Australia is renowned for soils of low phosphorus (P) availability. During the early history of plantation development, when plantations were being established almost entirely on land recently cleared of native forest, foresters observed remarkable growth responses in newly planted seedlings following applications of P fertiliser. In fact, P fertilisation was the difference between success and failure for some plantations, and P fertilisation became a standard practice. During the past decade, however, it has become much more common for plantations, particularly *E. globulus* and *E. nitens*, to be established on farmland with a history of P fertilisation ranging from a few years to several decades. Since many of these sites have a high P status, the need for P fertilisation has been reduced and may not be needed at all on many sites. There are many methods of analysing soils for P status but it is uncertain which, if any, of these methods reflect the P taken up by eucalypt roots. In response to this concern, CRC scientists have evaluated soil P availability at a wide range of eucalypt plantations of both species in southern Australia, and in glasshouse studies in Hobart.

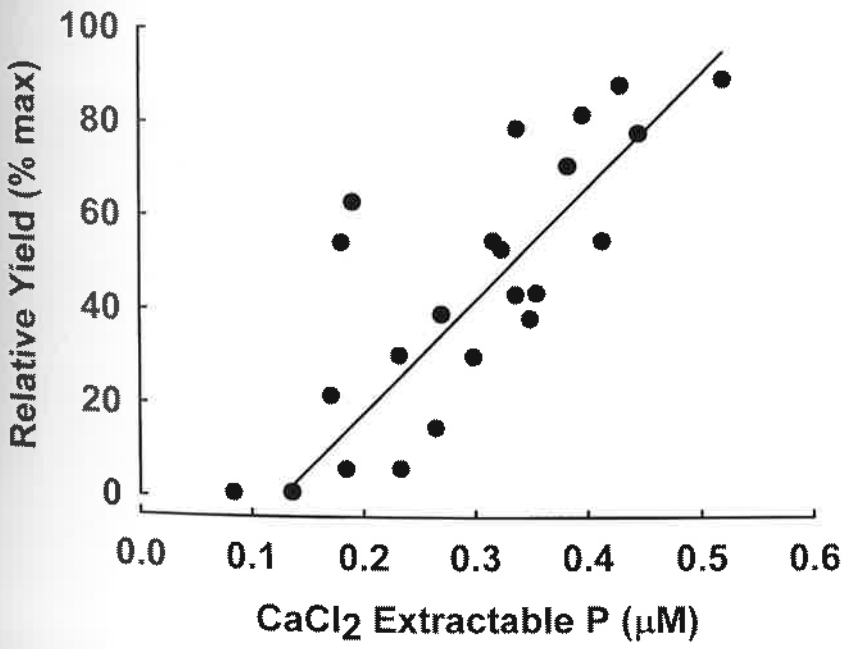


Figure 3
Relationship between the concentration of P as determined by calcium chloride ($CaCl_2$) extract and relative yield of unfertilised eucalypt trees, expressed as a percentage of the maximum growth obtained from fertilised trees at the same site. The data are from 23 eucalypt plantations in southern Australia.

During his PhD research, Daniel Mendham compared inorganic P concentrations in soil solution with the P-uptake ability of eucalypt roots. He showed:-

- There was a critical concentration of P in the soil (0.5 µM) above which responses to P fertiliser were unlikely or small (Fig. 3). Below this value P fertilisers were needed and responses were strong.
- The concentration in soil solution of P able to be taken up by eucalypt roots was best correlated with concentrations determined by a simple calcium chloride extract of soil.
- This result was consistent for the two eucalypt species, and across soils and scales of experimentation (ie excised roots, pot experiments, and field experiments), a relationship which previously had not been seen for any crop.
- An advantage of the calcium chloride extract over more widely used analyses, e.g. bicarbonate-P, was that the relationship with P-fertiliser response was not soil-type specific, allowing a common calibration to be used.
- Eucalypt roots were also shown to be able to take up P from solution at very low concentrations compared to many other species of plants.

The calcium chloride extract method of determining P will greatly improve the ability of growers to quantify the P status of soils in eucalypt plantations and allow them to be more selective with P fertilisation. The calcium chloride extract is now offered by at least two commercial laboratories. At current rates of planting on farmland, these advances represent a potential saving to industry of approximately $1.1 million per year.

MAJOR DEVELOPMENTS

Molecular Genetics of *Eucalyptus*

One of the major achievements of the CRC is the advancement of international collaboration on eucalypt genomics and the launching of the 'Eucalypt Genome Initiative'. This initiative unites major groups around the world mapping the eucalypt genome, and will provide a forum for cooperative research on molecular genetics, alignment of linkage maps and standardisation of gene and marker nomenclature.

This initiative was one outcome of the 'Molecular Genetics of *Eucalyptus*' Symposium organised by the Genetic Improvement program. The symposium was held in Hobart in early February 1999 and was extremely successful, judging from the quality and breadth of the presentations and excellent discussion. Most research groups working on the molecular genetics of *Eucalyptus* in Australia and overseas presented their latest results; eighty people attended the symposium, with delegates from Australia, South Africa, Brazil, France, New Zealand and Scotland. Students and researchers from throughout Australia attended, fulfilling an important educational objective. This symposium was the first specialist meeting in this field. The second is now planned for 2001 in Brazil. The symposium was preceded by a very well received pre-symposium course on molecular genetics which had 24 registrants. It was aimed at managers, breeders and researchers in industry requiring a basic knowledge of molecular genetics. The symposium was followed by the Eucalypt Genome Round-Table of key scientists that aimed to advance the level of international cooperation among research groups involved in eucalypt molecular genetics and to standardise nomenclature. The first international collaboration is being led by Dr Dario Grattapaglia (EMBRAPA, Brazil) and is already underway in laboratories in France, Brazil, South Africa and Australia. This experiment aims to develop a robust fingerprinting protocol for eucalypts and will result in a thoroughly tested set of microsatellites, perfect for fingerprinting and paternity analysis, that could be used by all researchers. A second international collaboration will see Dr Vaillancourt work in the molecular genetics laboratory of Dr Daniel Verhaegen (CIRAD Forêt) in Montpellier, France.

This symposium, together with the pre-symposium short course and the post-conference Eucalypt Genome Round-Table, were part of an integrated strategy to raise the profile of CRC molecular work and advance international collaboration. Both of these objectives have been achieved, and with continuing initiatives in this area we will firmly establish Australia in a central position internationally in eucalypt genome research.

Delegates at the 'Molecular Genetics of *Eucalyptus*' Symposium at the University of Tasmania.

MAJOR DEVELOPMENTS

Improved pollination procedures

A single-visit pollination procedure tested by CRC PhD student Dean Williams and Dr Brad Potts in 1996 is now set to significantly reduce the cost of controlled crossing of *E. globulus* in breeding and research programs across Australia. The traditional method of controlled pollination of *Eucalyptus* requires the tree to be visited three times: (i) to emasculate the flower at operculum shed and then isolate it with a bag to prevent contamination from other pollen; (ii) application of pollen approximately one week later, when the stigma is receptive and isolating the flower, again by enclosing it in a bag; and (iii) removal of the isolation bag 2-3 weeks later. These visits can become very expensive when the trees are a long way from the research headquarters or flowers are high in the canopy requiring the use of extension ladders or hydraulically operated platforms (e.g. cherry pickers). Controlled crossing may account for 30% of the operational costs of breeding *E. globulus*. The new technique has the potential to at least halve the cost of control crossing, resulting in substantial savings to large breeding organisations. This technique involves applying the pollen directly to the cut style at operculum shed and isolating the style with plastic tubing. This requires only a single visit to the flower.

Dean Williams demonstrating single-visit-pollination on *E. globulus*.

Similar technology has also been developed overseas by Shell International. The fact that seed could be obtained after pollinating the cut style of a eucalypt was first demonstrated in France over a decade ago by Bertrand Cauvin (AFOCEL) using *E. gunnii*, but the discovery has lain virtually dormant until recently. The single visit procedure has combined his discovery with the style isolation technique for *E. globulus* reported by Dr Liz Barber (CALM, Western Australia) in 1997.

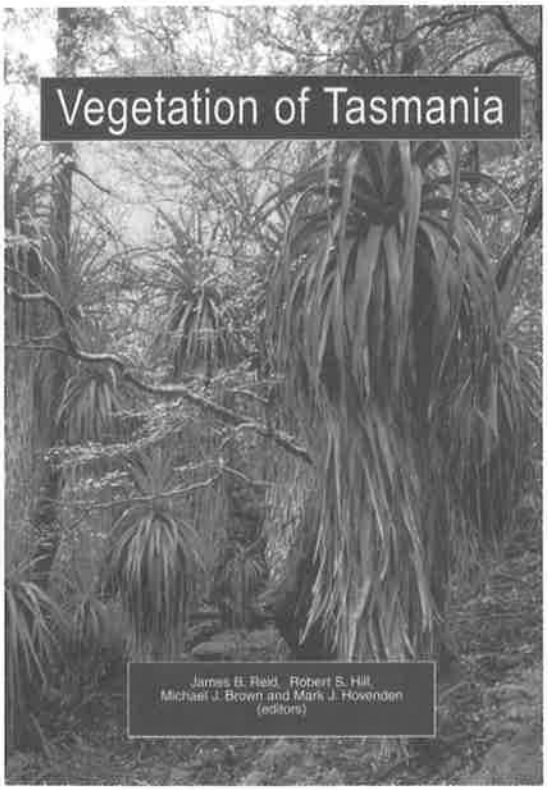
The cut style approach has been used in research crossing by the CRC for two years and has now been tested in operational crossing by several CRC partners. This year the STBA will produce 100% of their crosses with this technique. Surprisingly, not only is pollination successful when the stigma is removed, but there is even the possibility that seed set may be slightly increased with the new technique. While style cutting has not been successful to date with the more delicate flowers of *E. nitens*, the technique can no doubt be extended to a wide range of eucalypt species and other more efficient methods of reducing pollen contamination are currently being explored.

MAJOR DEVELOPMENTS

Public Education

Native Forest Systems

In conjunction with the University of Tasmania and Forestry Tasmania the CRC has produced a major text entitled 'Vegetation of Tasmania' which is a synthesis of the current ecological knowledge on Tasmania's forest systems. It was published by Environment Australia as part of the Flora of Australia series and chapters were contributed by the leading experts in the field including several CRC scientists. This is the first book to deal comprehensively with the biological, environmental and human interactions that have shaped Tasmania's unique flora. The book will be used as a textbook for Forest Ecology, a four-year special graduate course offered at the University of Tasmania and the CRC. It will also be a resource for foresters, ecologists and the wider community interested in managing or preserving native forest systems.



The role of women in forestry

Women are seriously under-represented in the forest industry. The reason for this appears to be their perception of the industry as destructive and macho. The reality of a forest industry moving towards sustainable production of a renewable resource with strong scientific and technological support appears not to be appreciated. In response to a CRC Review recommendation that we address the issue of gender imbalance in the forest industry, the CRC embarked on a project entitled 'Attracting Women to the Forest Sciences' funded by the Federal Government through the Science and Technology Awareness Program. The aim of the project was to dispel myths of a male oriented profession by providing positive female role models in the forest industry. The role models were drawn from female researchers, technicians, foresters and managers associated with the Centre. The project culminated in the CRC publishing the booklet *Her*storey, which is a compilation of the career histories of women working in the forest industry and photographs of each at work. The target audience for the booklet is school children up to the age of university entrance. However the booklet is also being distributed to forest managers.

The booklet has been very well received with requests from: the Australian Centre for International Agricultural Research (ACIAR) for 100 copies of *Her*storey to distribute at a forestry conference in Norway; Forestry Department (ANU) to use *Her*storey (350 copies) in promotion of forestry at schools in Canberra; and the Forest Education Foundation to distribute *Her*storey to Tasmanian schools in conjunction with their award winning teaching resource - 'Project Forests'. Approximately 3000 booklets will be distributed to schools throughout Australia.

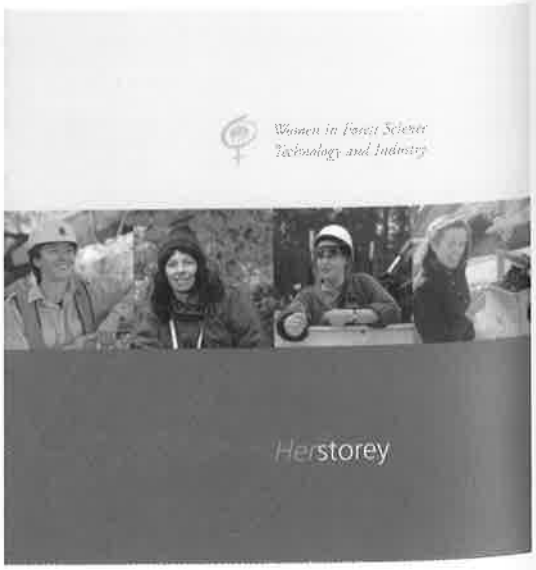


Table 1 Cooperative Linkages

Genetic Improvement Program

	CRC Staff	Collaborator	Research
International links			
Project A1: Genetics and reproductive biology	Dr B Potts Dr H Dungey	Prof T Whitham (UNA) USA Dr P Minchin (UL) USA	The effect of forest tree genetics on biodiversity.
Project A2: Breeding strategies	Mr G Dutkowski	Dr N Borralho (RAIZ) Portugal	Collaboration on tree breeding
Project A4: Molecular genetics of eucalypts	Dr D Steane Dr R Vaillancourt	Dr D Marshall and Dr J Russell (SCRI) UK	Developing microsatellite markers in *E. globulus*.
	Dr D Steane Dr R Vaillancourt Prof J Reid	Dr D Grattapaglia (EMBRAPA) Brazil Dr D Verhaegen (CIRAD) France Prof B Wingfield (CSIR) Sth Africa Dr D Marshall (SCRI) UK	Testing microsatellites for repeatability across many species.
	Dr R Vaillancourt Dr B Potts	Dr C Marques (RAIZ) Dr N Borralho (RAIZ) Portugal	Finding the origin of the Portuguese *E. globulus* landraces.
Project A6: Hybrid Breeding	Dr H Dungey Dr K Harding Dr M Dieters	Dr Bailian Li (NCSU) USA	Estimation of genetic parameters for wood properties in *P. elliotti* var *elliottii*, F_1 and F_2 hybrids.
Project A7: Molecular genetic improvement for tropical and subtropical production	Prof R Henry Dr M Shepherd	Dr C Williams (Texas A&M) USA	Genetic mapping in *Pinus* spp.
National Links			
Project A1: Genetics and reproductive biology	Dr B Potts Mr P Tilyard	Dr R Bereton (DELM)	Flowering patterns in *E. globulus* and their effect on the reproductive success of the swift parrot.
Project A2: Breeding strategies	Mr G Dutkowski	Dr A Gilmour (NSW Ag)	Improving quantitative genetic models
	Mr G Dutkowski Dr T McRae (STBA)	Dr H Graser (UNE) Dr R Kerr (UNE)	Breeding value prediction for tree breeding
	Mr G Dutkowski	Dr J Sasse (CFTT)	Spatial analysis for *Dothistroma pinii* damage in *P. radiata*.
Project A3: Molecular approaches to tree improvement	Dr G Moran Dr K Thamarus Ms K Groom Ms J Murrell Ms C Raymond (A5)	Dr S Read (U of M) Dr G Bossinger (U of M)	Mapping cambial specific sequences in *E. globulus*.
Project A4: Molecular genetics of eucalypts	Dr R Vaillancourt Dr B Potts Mr C Grosser Ms B Paterson	Prof M Sedgley (UA) Mr I Bail (Silvagene) Dr D Pilbeam (BTf) Mr P Gore (STBA)	Optimising seed orchards to achieve maximum genetic gain in eucalypt plantations.
Project A5: Wood quality	Ms C Raymond Ms L Nagy	S F NSW	Use of sound waves for non-destructive assessment of modulus of elasticity in standing trees.

	CRC Staff	Collaborator	Research
Project A6: Hybrid Breeding	Dr H Dungey Dr K Harding (QDPI)	Dr J Knight (QDPI) Dr P Kanowski (ANU) Hyne and Son	Breeding objectives for sawn timber in tropical pines.
	Dr H Dungey Dr M Dieters	Dr T McRae (STBA) QDPI Forestry	Production of *P. radiata x P. tecunumanii* and x *P. oocarpa* hybrids.
	Dr H Dungey Dr S Walker Dr M Dieters Dr Zhihong Xu	QDPI Forestry Griffith University	Use of carbon isotope discrimination to select *P. elliotti* var *elliottii* x *P. caribaea* var *hondurensis* clones.
Project A7: Molecular genetic improvement for tropical and subtropical production	Prof R Henry Dr M Shepherd	Dr Leslie Schoer (SF NSW)	Gene flow and genetic diversity of hardwood plantations in NSW.
	Dr M Shepherd Mr R Mellick	Ms A Specht (SCU)	Microsatellite markers in *Eucalyptus* spp.
Within Centre Links **Project A1: Genetics and Reproductive Biology**	Dr B Potts Mr G Dutkowski Mr A MacDonald Dr G Jordan	Mr M Powell (NFP) Dr W Tibbits (NFP)	Age to age correlations and genotype by environment interactions for growth in NFP *E. globulus* trials.
	Dr B Potts Mr A Mitchell	Mr P Gore (STBA) Dr D Pilbeam (BTf)	Genetic control of self incompatibility in *E. globulus*.
	Dr B Potts Mr G Dutkowski	Mr P Gore (STBA) Dr D Spencer (CSIRO) Dr W Tibbits (NFP) Dr D Pilbeam (BTf) Mr M Krygsman (APP)	Genetic control and estimation of breeding values for flowering time in *E. globulus*.
	Dr B Potts Mr G Dutkowski Mr P Tilyard Mr D Williams	Mr P Gore (STBA) Mr P Kube (FT) Ms S Hetherington (FCP)	Genetic variation in new base population trials of *E. nitens*.
	Mr D Williams Dr B Potts Prof J Reid	Dr P Smethurst (B1) Dr C Beadle (B3) Mr D Worledge (B3) Mr K Joyce (NFP) Mr M Powell (NFP) Mr P Kube (FT)	Environmental and silvicultural factors affecting the flowering of *E. nitens*.
Project A2: Breeding strategies	Mr G Dutkowski	Dr W Tibbits (NFP) Dr T McRae (STBA) Dr D Pilbeam (BTf)	Breeding value prediction. Breeding strategies.
	Mr G Dutkowski	Mr P Gore (STBA) Mr P Kube (FT) Ms S Hetherington (FCP)	Geographic variation in *E. globulus, E. nitens*.
	Mr G Dutkowski	Dr D Boomsma (STBA) Ms S Jarvis (STBA) Mr M Powell (NFP) Dr T McRae (STBA)	Data modelling for tree breeding.
Project A3: Molecular approaches to tree improvement	Dr G Moran Dr K Thamarus Ms K Groom Ms J Murrell	Ms C Raymond (A5)	QTL analyses for wood and fibre properties in *E. globulus*.

	CRC Staff	Collaborator	Research
Project A4: Molecular genetics of eucalypts	Dr R Vaillancourt Mr A Milgate	Dr C Mohammed (C5) Mr M Powell (NFP)	The genetic basis of *Mycosphaerella* resistance in *E. globulus*.
Project A5: Wood quality	Ms C Raymond	Mr P Whiteman (APP) Mr M Powell (NFP) Dr D Pilbeam (BTf)	Genotype by environment interaction for wood density, pilodyn penetration and predicting pulp yield in *E. globulus*.
	Ms C Raymond Ms L Nagy	Mr P Kube (FT) Ms S Hetherington (FCP)	Genotype by environment interactions for wood density, fibre length, fibre coarseness, cellulose content, microfibril angle and density variation in *E. nitens*.
Project A6: Hybrid Breeding	Dr M Deiters Dr H Dungey	Prof R Henry (A7) Dr M Shepherd (A7) Ms R Stokoe (A7) Mr L Scott (A7)	Molecular genetics of *E. cloeziana* and *A. cunninghamii*.
Project A7: Molecular genetic improvement for tropical and subtropical production	Prof R Henry Dr M Shepherd	Dr M Dieters (A6) Dr G Nikles (A6) Dr H Dungey (A6)	Genetic characterisation of commercial traits in hybrid pines.
	Prof R Henry Dr M Shepherd	Dr R Vaillancourt (A4)	Development of an enriched microsatellite library of *E. globulus* and *Pinus* spp.
	Prof R Henry Dr M Shepherd Ms R Stokoe	Dr B Potts (A1)	Investigation of putative inter-subgeneric *Eucalyptus* hybrids.

Sustainable Management Program

International Links			
Project B1: Site Productivity	Dr P Smethurst	Dr G Matschonat (UH) Germany	Solid-liquid phase partitioning of ammonium.
Project B2: Management of tropical soils	Assoc Prof P Saffigna	National NMR Centre Wuhan, PR China	Solid state NMR for characterisation of soil organic matter.
Project B4: Modelling plantation systems	Dr M Battaglia	Dr J Majaela (U of O) Spain	Seed germination modelling.
	Dr M Battaglia	Dr N Borralho (RAIZ)	Application of PROMOD.
	Dr P Sands	Dr E Voit (SCMU) USA	Applications of S-systems to forest growth modelling.
National Links			
Project B1: Site Productivity	Dr P Smethurst	Dr P Moody (QDPI) Ms J White (QDPI)	Effects of soil water content on K availability and uptake.
Project B3: Silvicultural systems Project	Dr C Beadle Mr M Savva	Dr H Keith (CSIRO)	National forest inventory.
	Dr C Beadle Mr M Savva	Mr A Lyons (PFT)	Growth of *P. radiata* on low rainfall sites.

Project B3: cont.	CRC Staff	Collaborator	Research
	Dr C Beadle Mr D Worledge	CRC-HFPS	Impacts of available water on wood quality of *E. globulus* and *E. nitens*.
	Dr C Beadle	Dr L Pinkard (FT) Mr G Britton (Britton Bros. sawmillers) Mr D Stackpole (CFTT) Mr A Warner (PFT) Mr T Bird (FFIC)	Silvicultural management of blackwood.
Project B4: Modelling plantation systems	Dr P Sands Dr M Battaglia	Mr B Rawlins (CSIRO)	Scheduling irrigation in the Murray-Darling Basin
	Dr M Battaglia	Mr P Pennington (CSIRO)	Analysis of native forest productivity
	Dr M Battaglia	Dr D White (CSIRO)	Water use by trees in WA
	Dr P Sands Mr P Ryan	Mr C Hackett (Plantsoft Services) Dr J Landsberg (Landsberg Consulting) Dr P West (SciWest Consulting)	Modelling growth and productivity
	Mr P Ryan	Mr T Burridge (QDPI) Mr K Montague (SF NSW)	Biomass data
	Dr M Lewty	Queensland Department of Natural Resources	Landscape modelling, spatial analysis
	Mr P Ryan	Mr T Thaung (UQ)	N nutrition of *E. cloeziana*.
Within Centre Links	Dr P Smethurst	Dr C Mohammed (C5)	N status and wood decay in pruned and unpruned trees.
Project B1: Site Productivity	Dr P Smethurst	Dr M Battaglia (B4)	Predication of LAI and growth responses to fertilisation.
Project B3: Silvicultural systems	Dr C Beadle Ms J Medhurst Ms M Cherry	Mr P Naughton (BTT)	Development of thinning regimes for *E. nitens* plantations.
	Dr C Beadle Mr D Worledge	Ms S Hetherington (FCP) Dr G Holz (NFP)	Scheduling irrigation in eucalypt plantations and impacts of irrigation on wood quality.
	Dr C Beadle Dr P Smethurst (B1) Mr P Adams	Dr N Mendham (UT)	Vegetation management
	Dr C Beadle Dr C Mohammed (C5)	Dr E Pinkard (FT)	Impact of green pruning on *E. globulus*.
Project B4: Modelling plantation systems	Dr P Sands	Dr C McArthur (C4)	Modelling animal behaviour and effects on browsing.
	Dr P Sands	Mr A Goodwin (FT)	Software development for ProMod and the Farm Forestry Tool Box.
	Dr M Battaglia	Mr S Candy (FT)	Relationship between site quality and defoliation by *C. bimaculata*.
	Dr M Battaglia	Mr S Candy (FT) Dr L Pinkard (FT)	Empirical growth model; modelling effects of pruning; site effects on

Project B4: cont.	CRC Staff	Collaborator	Research
		Mr T Smith (BTf) Mr B Walker (NFP)	productivity; productivity modelling.

Resource Protection Program

International Links **Project C1:** Biology, ecology and economic impact of pests.	Dr G Allen	Mr B Murphy (NZFRI) NZ	Biocontrol of leaf beetles using egg parasitoids.
	Dr M Steinbauer	Dr P Mitchell (WU) USA	Coreid research on restra lengths and their relationship to host plant.
	Dr R Floyd	Dr W Haojie (RISF)	Resistance of provenances and families of *A. mearnsii* to insect damage.
	Dr M Steinbauer	Dr H Brailovsky (UNA de M) Mexico	Taxonomy of Australian Coreidae.
Project C3: Resistance of planting stock to vertebrate browsers.	Dr C McArthur	Dr G Iason (MLURI) Scotland, UK	Review of role of plant secondary compounds in mammalian ecology.
Project C5: Strategies to minimise loss due to fungal attack.	Dr C Mohammed Ms K Barry	Dr R Pearce (U Birm.) UK Prof L Hall (U of Camb.) UK	Mechanisms of defence against decay in *E. nitens*.
National Links **Project C1:** Biology, ecology and economic impact of pests.	Mr B Howlett Mr Z Lukacs Ms T Simmul	Dr A Clarke (GU)	Ecology of eucalypt defoliators
	Dr M Steinbauer	Dr T Yonow (CRC- TPFM) Mr I Reid (ANIC)	Distribution modelling of coreids.
	Dr M Steinbauer	Dr R Cant (SF NSW)	Biogeography of Australian coreids.
	Dr M Steinbauer	Dr M Lacey and Dr T Bellas (CSIRO)	Pheromone analyses of autumn gum moth.
	Dr M Steinbauer	Dr S Schmidt (ANIC)	Egg parasitoids of autumn gum moth.
	Dr R Floyd	Mr R Bird (Ag Vic) Mr D Jamieson (ACT Forests) Mr P Mitchell (Harris Daishowa)	Resistance of provenances and families of *A. mearnsii* to insect damage.
	Dr R Floyd Dr M Steinbauer	Mr G Wall (Goulburn Valley Water) Mr P Ebner and Mr R Rhind (Lower Murray Water) Mr N Collett (CFTT) Mr D Jamieson (ACT Forests)	Quantification of impact of defoliation on short-term growth of trees.
	Dr R Floyd Dr M Steinbauer	Mr A Davey and Mr D Jamieson (ACT Forests) Mr K Nethercott (Auspine) Mr R Hescosk (APP) Mr R Pfitzner (Forestry SA) Ms J King (DPIE) Mr R Borschmann (Hancocks) Mr A Moore (Green Triangle Forest Products)	Biology and ecology of *Essigella californica*.

	CRC Staff	Collaborator	Research
Project C2: Insect control techniques and IPM.	Mr D Bashford	Mr L Hill (DPIWE)	Light trap monitoring of *E. globulus* plantations in south-western Australia
	Mr J Matthiessen	Western Australia Insect Pest Management Group	Surveillance and monitoring of *E. globulus* plantations in south-western Australia. Investigations of insecticidal control of African Black Beetle and spring beetle in *E. globulus*.
Project C3: Resistance of planting stock to vertebrate browsers.	Dr C McArthur Ms J O'Reilly	Dr W Foley (ANU)	NIR analysis of eucalypt leaves in relation to palatability.
	Dr C McArthur	Dr W Foley (ANU)	Review of role of plant secondary compounds in mammalian ecology.
Project C4: Strategies to reduce vertebrate browsing damage.	Dr C McArthur Ms K le Mar	Dr M Statham (DPIF)	Use of plantation and surrounding habitat by mammalian herbivores.
Project C5: Strategies to minimise loss due to fungal attack.	Dr C Mohammed Ms K Barry	Mr N Davies (UT) Mr E Peacock (UT)	Mechanisms of defence against decay in *E. nitens*.
Within Centre Links	Mr L Rapley Dr G Allen Dr M Hurley	Dr D de Little (NFP)	Feeding performance and diapause in autumn gum moth.
Project C1: Biology, ecology and economic impact of pests	Ms T Simmul Dr G Allen	Dr D de Little (NFP)	Biology of fireblight beetle.
	Mr Z Lukacs	Dr R Floyd (CSIRO)	Seasonal phenology of autumn gum moth.
	Ms G Brown Dr M Hurley	Dr D de Little (NFP)	Biology of *Heteronyx* beetles: effect on establishment of *E. nitens* plantations.
	Dr M Steinbauer	Mr H Lieshout and Mr M Krygsman (APP)	Trapping methodologies for autumn gum moth.
	Dr M Hurley	Mr P Naughton (BTT) Dr C McArthur (C4)	The impact of *Heteronyx* beetles on the establishment of *E. nitens* plantations.
	Dr J Elek Mr S Candy Ms N Beveridge	Ms S Hetherington (FCP) Forestry Tasmania staff	The impact of chrysomelids on growth of *E. regans* and *E. nitens* plantations.
	Dr J Madden Mr V Patel	Dr R Milner (CSIRO) Dr J Elek (FT)	Biological control of eucalypt feeding beetles with fungal entomopathogens.
Project C2: Insect control techniques and IPM	Mr J Matthiessen (CSIRO) Dr M Hurley (UT)	Dr D de Little (NFP) Mr R Breidahl (BTf)	Biology and management of insect establishment pests of plantations.

	CRC Staff	Collaborator	Research
Project C3: Resistance of planting stock to vertebrate browsers	Dr C McArthur Mr H Fitzgerald Mr S Paterson	Mr P Naughton (BTT)	Influence of seedling type and weeds on growth and damage to *E. nitens* seedlings in a plantation.
	Dr C McArthur	Dr M Hurley (C2) Mr P Naughton (BTT)	Comparison between insect and mammalian herbivore damage to eucalypt seedlings in plantations.
	Dr C McArthur	Ms N Marsh (FT)	Mammalian preferences for seedlings grown under different nursery conditions.
	Dr C McArthur Ms J O'Reilly	Dr B Potts (A1) Mr G Dutkowski (A2)	Genetic variability in resistance to browsing of *E. globulus* foliage.
Project C4: Strategies to reduce vertebrate browsing damage.	Dr C McArthur	Mr A Gibbons (CSIRO) Dr M Battaglia (B4)	Effect of thinning in *E. delegatensis* forest on plant and animal communities.
	Dr C McArthur Mr J Bulinski	Mr P Naughton (BTT) Ms S Hetherington (FCP) Dr D de Little (NFP) Dr H Elliott (FT)	Developing monitoring systems, quantifying and predicting browsing damage.
	Dr C McArthur Ms K le Mar	Dr D de Little (NFP) Mr I Blanden (NFP)	Use of plantation and surrounding habitat by mammalian herbivores.
Project C5: Strategies to minimise loss due to fungal attack.	Dr C Mohammed Ms K Barry Ms A Eyles Ms A Mollon	Dr C Beadle (B3) Dr P Smethurst (B1) Dr L Pinkard (FT) Mr W Neilsen (FT)	Mechanisms of defence against decay in *E. nitens* and *E. globulus*.
	Dr C Mohammed	Mr A Milgate (A4) Dr R Vaillancourt (A4) Dr D de Little (NFP) Dr B Potts (A1)	Determine the taxonomy of *Mycosphaerella* in Tasmania and its infection biology.
	Dr C Mohammed	Dr ZQ Yuan (UT) Dr R Taylor (FT) Mr T Wardlaw (FT) Ass Prof A Richardson (UT) Dr D de Little (NFP) Mr P Mineely (NFP)	Ecologically sustainable forest management: fungal and invertebrate biodiversity.

Education and Technology Transfer

National Links	CRC Staff		
	Dr N Davidson Ms J Burrell	Science Communicators from other CRCs	Interaction and coordination of science communication
	Dr N Davidson	Ms F Sugden (GA), Mr A Lyons (PFT)	'Trees for Dollars and Sense' Workshops
	Dr N Davidson Ms C Condie	Mr A Lyons (PFT) and all programs	Farm Forestry Fact Sheets
	Ms J Burrell Dr N Davidson	Mr D Hamilton, Mr D Vickers (Forest Education Foundation) Dr B Yaxley (Tas. Ed. Dept) Ms J Chambers (Kingston Primary School)	School Kits

	CRC Staff		
	Ms J Burrell Dr N Davidson	Ms C Hiller (UT) Mr D Hamilton, Mr D Vickers (Forest Education Foundation) Dr B Yaxley (Tas. Ed. Dept)	Women in forest science
	Ms J Burrell	Prof J Reid Dr M Brown (FT), Prof R Hill (UT) Dr M Hovenden (UT)	'Vegetation of Tasmania'
	Dr N Davidson	Mr M Castley (FT) Mr A Lyons (FT)	Agfest displays and launch of fact sheets
Within Centre Links	Ms J Burrell	all CRC staff	'Overstorey'
	Ms C Condie	all CRC staff	Monthly Report
	Dr N Davidson	all CRC staff	CRC web site

Abbreviations

DELM	Department of Environment and Land Management
CFTT	Centre for Forest Tree Technology
UM	University of Melbourne
UA	University of Adelaide
SF NSW	State Forests of New South Wales
(UNA) USA	University of North Arizona (USA)
(UL) USA	University of Louisiana (USA)
SCRI	Scottish Crop Research Institute
(NCSU) USA	North Carolina State University (USA)
(UH) Germany	University of Hohenhein
(SCMU) USA	South Carolina Medical University
CRC–TPM	CRC Tropical Pest Management
ANIC	Australian National Insect Collection
DPIWE	Department of Primary Industries, Wildlife and Environment
DPIF	Department of Primary Industries and Fisheries
DPIE	Department of Primary Industries and Environment
NZFRI	New Zealand Forest Research Institute
U of O	University of Ovido (Spain)
CSIR	Commonwealth Science and Industry Research (South Africa)
(WU) USA	Winthrop University (South Carolina, USA)
RISF	Research Institute of Subtropical Forestry
UNA de M	University National de Mexico
MLURI	Macauley Land Use Research Institute
(U Birm) UK	University of Birmingham
U Camb	University of Cambridge

RESEARCH

Genetic Improvement Program

Manager
Dr Brad Potts

Introduction

A major expansion of the plantation estate of eucalypts and pines is occurring throughout Australia with a vision to treble the estate by 2020. Improved genetic quality of the plantation stock is essential if Australia is to be competitive in international markets when this estate is harvested. Large tree breeding programs being run by CRC partners in both the tropical and temperate regions demonstrate the importance of breeding and aim to reduce the costs of plantation establishment, harvesting and processing, as well as to add value to pulp and timber.

The research undertaken in the Genetic Improvement Program aims to ensure that plantation stock is of the highest possible genetic quality. It aims to improve the efficiency of breeding and ensure the genetic gains are rapidly and efficiently transferred to Australia's increasing plantation estate. In brief, the program aims to:

- define appropriate breeding objectives for individual firms and the sector, from forest growers to industrial processors;
- identify selection criteria and methods for assessing wood quality, growth, pest and disease resistance, and other key traits, and statistical methods for their analysis;
- determine the molecular and quantitative genetic control of important traits, and how this changes with age, site and silvicultural treatment;
- improve strategies to select, breed and deploy elite genotypes;
- improve our ability to control and manipulate reproductive characteristics in order to optimise deployment systems;
- ensure rapid uptake of technological advances made in Australia and overseas, particularly in the rapidly changing field of molecular genetics; and
- provide training and education in forest genetics and breeding, and be a forum for discussion in Australia.

The research outcomes will directly assist breeders of pines, eucalypts, and other native species in our member organisations, as well as organisations multiplying and distributing improved seed.

Mr Gustavo Lopez assessing genetic variation in *E. globulus* control crosses.

Project 1

Leader
Dr Brad Potts

Staff
Mr Robert Barbour
Mr Greg Dutkowski
Mr Peter Gore
Mr Andrew Hingston
Mr Tim Jones
Dr Greg Jordan
Mr Kelsey Joyce
Mr Maarten Krygsman
Ms Rachel Lawrence
Mr Gustavo Lopez
Dr David Pilbeam
Mr Mike Powell
Prof Jim Reid
Dr Wayne Tibbits
Mr Paul Tilyard
Dr Rene Vaillancourt
Mr Peter Volker
Mr Dean Williams

Dr Wayne Tibbits shooting down a tree branch to collect seed.

Genetics and reproductive biology of eucalypts

Background

This project aims to provide the basic biological information necessary for effective exploitation of temperate eucalypt species. It will determine the extent to which traits of economic and biological importance are under genetic control and amenable to artificial selection and breeding. Such traits include growth, wood quality, pest and disease resistance and reproductive characteristics. Further, as cloning is no longer considered an economically viable means of deployment in Australia, the demand for improved seed is currently unprecedented. The project will study factors affecting sexual reproduction in order to optimise the quantity and quality of seed from eucalypt seed orchards. This project is closely linked to Project A4 (Molecular Genetics).

Outcomes

- Four and eight year growth data from NFP's five base population trials of *E. globulus* have shown extremely high age-age correlations (0.83-0.98). Racial differences and across-site genetic correlations increased with age.
- Marked genetic differentiation of the timing of the transition to adult foliage was demonstrated in *E. globulus*. The genetic relationship between growth rate and early transition to adult foliage was shown to be complex and change with site.
- A comparison of the insect and fungal community on the adult and juvenile foliage of *E. globulus*, *E. nitens* and their hybrids showed that developmental change has an enormous impact on dependent communities. This far exceeds the effect of genetic differences between the pure species and their hybrids. Pest communities will therefore undergo dramatic change as plantations mature.
- Defoliation of *E. globulus* trees by sawfly larvae *(Perga sp.)* over a 2-3 year period was shown to have a genetic basis and significantly reduce survival and growth.
- Significant genetic variation of *in vitro* rooting success has been demonstrated in *E. globulus* (h_2 between 0.16 and 0.27). Non-additive genetic effects for *in vitro* rooting were examined for the first time in this species and shown to be small.
- The effects of inbreeding and hybridising *E. globulus* and *E. ovata* were studied over ten years. Inbreeding depression was severe in both species, and increased with age. The F_1 hybrids initially grew well in the field but rapidly started dying after two years, cautioning against the extrapolation of the performance of hybrids from early field results.

Goals

To determine:

- the importance of non-additive genetic effects in *E. globulus* and *E. nitens*;
- the impact of inbreeding depression on growth and wood properties in *E. globulus*;
- the genetic control of flowering time and self-sterility in *E. globulus* and use this information to improve flowering synchrony and outcrossing rates in seed orchards;
- the mechanism of self-sterility in *E. globulus* and *E. nitens*;
- the effects of spacing, fertiliser and paclobutrazol on flowering and capsule production in *E. nitens*;
- the pollinators of *E. globulus* and *E. nitens*; and
- the performance and genetics of F_1 and advanced generation *E. nitens* x *E. globulus* hybrids.

Project 2

Leader
Mr Greg Dutkowski

Staff
Mr Paul Chambers
Mr Peter Gore
Dr Bruce Greaves
Ms Sandra Hetherington
Mr Peter Kube
Ms Michelle McGrananhan
Dr Tony McRae
Dr David Pilbeam
Mr Mike Powell
Dr Wayne Tibbits

Breeding Strategies

Background

Research in this project is aimed at developing 'state-of-the-art' strategies for selection, breeding and deployment which can be integrated into programs run by CRC partners. The project aims to:

- improve genetic models for estimating breeding values;
- improve selection by developing models which allow the integration of economic information into breeding value prediction;
- improve tree breeding decision-making by evaluating different breeding strategies; and
- support members (e.g. STBA) in the planning and implementation of their breeding and deployment programs.

This project is intimately linked with partner tree breeding and deployment programs. The manager of the STBA national eucalypt breeding program is located with this group in Hobart to ensure efficient technology transfer.

Outcomes

- Genetic variation within central Victorian *E. nitens* was shown to have an unexpected spatial structure. Parts of the previously identified provenances of Macalister, northern Toorongo and Rubicon *(sensu strictu)* are indistinguishable, but the Macalister locality of Connors Plain is quite different. All remaining southern localities are similar, but with an indication of an east-west discontinuity. Exclusion of *E. denticulata* types during seed collection has eliminated the correlation of early adult foliage with poor growth.
- Multi-stemming in *E. globulus* has a wide range of heritabilities and between-site correlations, which suggests some sites share common environmental stresses which lead to the expression of multi-stemming.
- Preliminary spatial analysis of defoliation of *P. radiata* by *Dothistroma pinii* showed this trait has a 'patchy' phenology and will benefit from spatial analysis.
- The algorithm developed to invert the additive relationship matrix which accounts for selfing has been used in the prediction of breeding values for *E. globulus*.
- A framework has been developed to compare the economic advantage of improving various tree characteristics. The framework has been applied to a hypothetical enterprise growing unpruned *P. radiata* for production of structural sawn-timber and packaging-grade liner-board. Kraft pulp yield and liner-board ring-crush had the highest effect on profitability.

Goals

To determine:

- improved models for breeding value estimation which better account for between- and within-site heterogeneity, tree pedigree, multi-stemming, competition, measurement age, and population structure;
- a race classification for *E. nitens* and the effect of incorporating race in models for predicting breeding values;
- models to incorporate risk traits such as frost, drought and disease resistance into breeding and deployment systems;
- whether the 'Rolling Front' strategy should be modified in the light of uncertain levels of genotype by environment interaction;
- an economic model for an enterprise producing sawn-timber and high-brightness newsprint from thermo-mechanical pulp; and
- the benefits of alternative breeding strategies, and assist with a review of the STBA breeding strategy.

Project 3

Leader
Dr Gavin Moran

Staff
Ms Kylie Groom
Ms Jan Murrell
Dr Karen Thamarus

Molecular approaches to tree improvement

Background

This project aims to study genes controlling commercial traits in *E. globulus* focusing on wood and fibre properties. It will:

- determine the number and location of QTL controlling wood and fibre properties and growth in *E. globulus*; and
- map and characterise candidate genes involved in wood and pulp properties.

This project works closely with Project A5 (Wood Quality). Two full-sib families from the CSIRO/NFP hybrid trial have had wood cores and DNA samples collected. Many of the wood and fibre properties assayed use technologies developed by the CRC-HFPS. A framework genetic linkage map for *E. globulus* is being completed using nearly 200 RFLP markers developed by CSIRO in *E. nitens* as well as 45 microsatellite and isozyme markers. In addition, candidate genes are being mapped. These include genes involved in lignin biosynthesis and cellulose biosynthesis, as well as 35 cambial specific copy DNA (cDNA) sequences developed by researchers at the University of Melbourne.

Dr Karen Thamarus in CSIRO molecular biology laboratory, Canberra.

Outcomes

- Pulp yield measurements (NIR analysis) are complete.
- RFLP, isozyme and microsatellite loci have been mapped in one family.
- Sixteen candidate genes have been mapped in one family to date: 4 lignin genes, 2 cellulose genes, 3 floral genes, and 7 cambial specific cDNA sequences.
- Preliminary QTL analyses of basic density and percent pulp yield are complete, with two putative QTLs identified for basic density ($p<0.0005$).

Goals

- Complete construction of genetic linkage map for *E. globulus*.
- Map and characterise the QTLs segregating for basic density, pulp yield, cellulose content, fibre length and microfibril angle.
- Map candidate genes, including cambial specific sequences, and evaluate the role of known genes as potential QTLs.
- Recommend strategies to incorporate molecular information for wood density and cellulose content into breeding and deployment programs.

Project 4

Leader
Dr René Vaillancourt

Staff
Mr Peter Bundock
Mr Carl Grosser
Mr Hamish Jackson
Mr Andrew Milgate
Ms Alexandra Mitchell
Dr Briony Patterson
Dr Brad Potts
Mr Mike Powell
Prof Jim Reid
Dr Dorothy Steane
Ms Claire Turner

Molecular genetics of eucalypts

Background

The rapidly changing field of molecular genetics is providing unprecedented insights into the genome and population structure of eucalypts and offers powerful tools for use by tree breeders. Already molecular markers are being used for fingerprinting for quality control, determining relatedness, paternity analysis and gene flow studies, as well as understanding the genetic control of quantitative traits.

This project focuses on eucalypts and aims to use molecular markers to:

- provide a better knowledge of inbreeding, heterosis and the role of genetic diversity in breeding and base populations of eucalypts;
- quantify the factors affecting outcrossing, gene flow, and contamination in seed orchards; and
- characterise the number and location of major genes (QTLs) affecting commercially important traits (e.g. growth, wood density, pest and disease resistance).

Dr Briony Patterson collecting seed for isozyme analysis.

Outcomes

- The 13 microsatellite markers (loci with numerous alleles, ideal for paternity and maternity analysis) developed as part of the CRC and SCRI (in Scotland) collaboration were used to survey variation in a range-wide collection of *E. globulus*. This information will form the foundation of a database for fingerprinting *E. globulus*.
- Two *E. globulus* genetic field trials were assessed for *Mycosphaerella* leaf infection. The results obtained confirmed the breeding values calculated for a previous generation (Dungey 1997) and clearly indicate that breeding for resistance is possible.
- New PCR-based markers for chloroplast DNA (cpDNA) of *E. globulus* were developed that reduced the time and expense involved in studying this variation. These markers may make it possible to trace the geographic origins of seedlots and landraces.
- Together with industrial partners, a research strategy was developed to study the factors affecting outcrossing rates, patterns of gene flow, and contamination of seed orchards.

Goals

- Determine the genetic control of resistance to *Mycosphaerella* infection in *E. globulus*.
- Complete linkage maps of an intraprovenance cross of *E. globulus* using RAPDs and microsatellites developed in temperate and tropical eucalypts. This will help align maps made in different species around the world, locate unlinked microsatellites for fingerprinting and gene flow studies, and be used for QTL detection.
- Use microsatellite and isozyme markers in gene flow studies, calculate outcrossing rates and undertake paternity analysis to optimise seed quality in seed orchards of *E. globulus* and *E. nitens*.
- Use molecular markers to monitor the efficiency and contamination levels of different pollination techniques in *E. globulus*.

Project 5

Leader
Ms Carolyn Raymond

Staff
Mr Alex Bradley
Mr Peter Kube
Mr Andrew MacDonald
Ms Laura Nagy

Wood quality

Background

Wood quality is one of the most important determinants of profitabilty, whether plantations are harvested for pulp, sawn timber or other solid wood products. However, wood property traits are expensive and difficult to measure and there is a poor understanding of their genetic control and relationships with breeding objectives. For these traits to be integrated into breeding and deployment programs it is essential to develop cost effective, non-destructive sampling techniques which can be used on a large scale.

Work in the Genetic Improvement Program is concentrating on:

- developing non-destructive sampling strategies for wood and fibre properties;
- defining relationships between wood, pulping and sawn timber properties;
- determining the magnitude and importance of genotype by environment interactions for wood properties; and
- developing breeding objectives for a range of wood products.

Ms Jacinta Lesek from Forestry Tasmania running cellulose content analysis in the CSIRO/CRC wood property laboratory, Hobart.

This project has very strong links to the CRC-HFPS, with some of the technologies developed in CRC-HFPS (SilviScan 2, cellulose content analysis and Near Infrared Reflectance Analysis) being implemented and applied to genetic material in the breeding programs for both *E. globulus* and *E. nitens*. Research is also conducted in collaboration with the pulping laboratories of the industrial partners.

Outcomes

- Genotype by environment interactions were found to be of little practical importance for basic density and predicted pulp yield in *E. globulus*.
- Very strong correlations (>0.8) were found in *E. nitens* for whole tree pulp yields with cellulose content of cores and predicted pulp yield determined by Near Infrared Reflectance Analysis.
- Data for basic density, predicted pulp yield, fibre length and fibre coarseness were provided for QTL studies in the Molecular Genetics Project A3.
- Near Infrared Reflectance Analysis appears promising as a rapid method for predicting cellulose content of ground wood. Models were developed for three sites for *E. globulus* using 30 samples per site selected to cover the range of predicted pulp yields. A 'blind' test for ten samples per site resulted in a very high correlation (>0.8) between predicted cellulose and laboratory cellulose content.
- The speed of sound wave transmission through wood was shown to be a poor predictor for basic density due to large errors.

Goals

- Determine genetic parameters and the level of genotype by environment interactions for traits relevant to solid timber - wood density variation and microfibril angle - in *E. nitens*.
- Determine genetic parameters and the level of genotype by environment interactions for traits relevant to pulp production - basic density, fibre length and cellulose content - in *E. nitens*.

Project 6

Leader
Dr Mark Dieters

Staff
Dr Heidi Dungey
Dr Kevin Harding
Mr Dominic Kain
Dr Garth Nikles

Hybrid breeding

Background

There is escalating interest in the use of hybrids in forestry in Australia and overseas. However, little is known about the genetics of hybrid populations and the most efficient means of breeding improved hybrids. Through its partner organisations, the CRC has one of the best genetic bases of artificial forest tree hybrids in the world. This project aims to:

- understand the genetics of hybrid populations, focusing on growth and wood properties; and
- develop or introduce into Australia the most advanced stategies for breeding hybrids.

The project focuses on the tropical pine species *(Pinus elliottii* and *P. caribaea* var *hondurensis)* and their hybrids being deployed by Queensland DPI. This project interacts closely with Project A7 (Molecular genetic improvement for tropical and subtropical production) and Project A1 (Genetics and reproductive biology of eucalypts).

Outcomes

- A literature review on the use of hybrids in forestry has been completed which indicated that genetic parameters for hybrid populations are rare, as are well designed experiments comparing hybrids with parental controls.

Dr Garth Nikles (left) and Dr David Lee (second from right) with QFRI staff in the nursery inspecting hybrid eucalypts.

- A survey of international organisations involved in hybrid breeding was undertaken to determine the species/hybrids planted, areas planted of each, rotation age, the use (timber or pulp) and future vision. The results are currently being collated.
- Heritability estimates for growth of hybrids between *P. caribaea* var *hondurensis* and both *P. tecunumanii* and *P. oocarpa* in Australia ranged from 0.06-0.29. Parental performance in pure and hybrid combinations were highly and positively correlated, showing a recurrent selection scheme would be effective for these hybrids.
- Analyses of *P. caribaea* var *hondurensis* and hybrids in international trials in Swaziland, Zimbabwe and Australia showed high genetic correlations of performance across sites within a country but this was only moderate across countries. Transfer of selections across countries may therefore result in less genetic gain than anticipated.

Goals

- Simulate different hybrid breeding strategies, including Reciprocal Recurrent Selection (selecting on general hybridising ability - GHA), Recurrent Selection (selecting on general combining ability of the pure species - GCA), and the use of a composite hybrid. This simulation will be used to recommend optimal hybrid breeding strategies.
- Complete analyses of pine hybrid wood samples using the X-ray densitometer at North Carolina State University, USA.
- Determine genetic parameters for growth and wood properties for *P. elliottii* x *P. caribaea* var *hondurensis* hybrids and use the estimates to evaluate deployment options, and optimise selection age.
- Determine the performance of hybrids of *P. caribaea* var *hondurensis* with both *P. tecunumanii* and *P. oocarpa* at ten years of age and compare the results with five year data.
- Determine the performance of *P. caribaea* var *hondurensis* inter-provenance hybrids and levels of additive and dominance variation for growth at seven years of age.
- Determine the performance of interprovenance hybrids of *Araucaria cunninghamii.*

Project 7

Leader
Prof Robert Henry

Staff
Mr Mike Cross
Dr Mark Dieters
Dr Russell Haines
Dr Kevin Harding
Mr Rohan Mellick
Mr Leon Scott
Dr Mervyn Shepherd
Ms Rhonda Stoke
Mr Paul Toon

Molecular genetic improvement for tropical and subtropical production

Background

This project will apply molecular genetic techniques to the improvement of tropical and sub-tropical forestry species, including *Pinus* hybrids, *Araucaria cunninghamii* (hoop pine) and *Eucalyptus cloeziana*. Investigations in progress include evaluation of inbreeding in natural populations and investigation of putative hybrids. Mapping and QTL analyses are being conducted to attain a greater understanding of key commercial traits in the *P. elliottii* var *elliottii* x *P. caribaea* var *hondurensis* F_1 hybrid which will allow the incorporation of marker-aided selection (MAS) into QFRI-QDPI breeding and propagation programs. The research strategy aims to:

- generate genetic maps for *P. elliottii* var *elliottii* and *P. caribaea* var *hondurensis* F_1 hybrids;
- generate new populations suitable for genetic mapping;
- perform marker-trait co-segregation analysis for growth, form and wood properties;
- examine QTL stability in a range of genetic backgrounds, across sites and different silvicultural conditions; and
- explore the use of MAS in the development of breeding and propagation populations, and its potential in a clonal forestry program.

Ms Geogia Pfennig (visitor) working in the molecular genetics laboratory, Hobart during the CRC's pre symposium course on Molecular Genetics.

Outcomes

- Establishment of *Pinus* hybrid mapping populations in a replicated field trial; and completion of sampling of *Pinus* hybrids for wood properties.
- Development of three microsatellite markers from *P. elliottii* and *P. caribaea*, preliminary evaluation of AFLP markers and identification and sequencing of a further 38 *Pinus* microsatellite loci for development. Evaluation of 39 microsatellite markers from other *Pinus* in *P. caribaea* and *P. elliottii*.
- Preliminary evaluation of a taxon-specific assay for verification of *Pinus* hybrid progeny in QFRI-QDPI's clonal testing program.
- Development of a robust methodology for the extraction of DNA from hoop pine and an innovative approach to recover microsatellites from poorly enriched libraries. Identification of 16 unique microsatellite loci as well as AFLP in hoop pine, the first in the genus *Araucaria*.
- Development of five SSR markers in *Eucalyptus* spp. and evaluation of transferability of nine microsatellites from other eucalypts to *E. cloeziana*. Microsatellite allele diversity was assessed in two southern populations.

Goals

- Develop further microsatellite and AFLP markers for *Pinus* species.
- Develop genetic maps for *P. elliottii* and *P. caribaea* individuals.
- Establish clonally replicated mapping populations of *Pinus* hybrids on a second site in south-east Queensland.
- Initiate research into recombination shrinkage in hybrid maps and the implications for hybrid breeding.
- For *Pinus* F_1 hybrids: analyse wood properties and search for QTLs for wood, growth and form traits.
- Assess propagation characteristics in *Pinus* F_1 and advanced generation hybrids.
- Generate genetic maps for select hoop pine individuals and commence genetic mapping of commercial traits.
- Complete sampling and genetic diversity analysis of southern and northern populations of *E. cloeziana*.

Sustainable Management

Manager
Dr Chris Beadle

Introduction

Plantations and farm forests, can be a sustainable resource if the factors necessary for production remain favourable over successive crop cycles. Management decisions and applications influence sustainability in a major way. This program examines the environmental factors and silvicultural practices that influence forest production, and casts these into a quantitative framework with the use of process-based models. We play a critical role in delivering the knowledge needed to ensure that practices implemented by forest managers in Australia are sustainable and subject to ongoing improvement in terms of economic and environmental performance. This provides a valuable adjunct to the work of other research organisations involved in the definition and development of criteria for sustainability.

In temperate Australia, the major research focus is on the expanding resource of eucalypt plantations which is likely to play a significant role in regional development. In subtropical Queensland, research concentrates on the existing coniferous plantation resource. Although the specific crops differ among regions, the basic soil and physiological processes which underlie productivity are the same and provide a unifying theme across the program.

In addition, we aim to produce outcomes of significant benefit to the community through the provision of high quality training for postgraduate students, and research which has the potential to enhance regional development.

Project 1

Leader
Dr Philip Smethurst

Staff
Mr Paul Adams
Mr Craig Baillie
Dr Chris Beadle
Ms Maria Cherry
Mr Keith Churchill
Ms Diane Connell
Mr Robin Cromer
Dr Neil Davidson
Ms Sandra Hetherington
Dr Greg Holz
Dr Martin Line
Dr Robert McCormack
Mr Daniel Mendham
Dr Rabi Misra
Mr Martin Moroni
Mr Bill Neilsen
Mr Peter Naughton
Ms Ruth Osborne
Ms Silvia Pongracic
Dr Chris Shedley
Ms Paulina Teixeira
Ms Ann Wilkinson

Site productivity

Background

The aims of this project are:

- to determine the extent to which nutrient and water supply can sustain high leaf areas and tree growth rates after canopy closure;
- to evaluate the effects of slash management strategies (during the inter-rotation period) on nutrient supply and other soil conditions that affect productivity; and
- to improve our understanding of water storage and access to it in relation to soil profile characteristics, rainfall, and ground water.

Outcomes

- Fertilisation increased leaf area index (LAI) of *E. nitens* at the Westfield plantation (mudstone-derived soil; 1580 mm annual rainfall), reaching very high values of 8 to 10 in plots receiving the highest rates of fertiliser (600 kg N at planting and repeated at 26 months). However, growth appeared to be maximised at an intermediate rate of fertiliser application (300 kg N ha^{-1} at planting and repeated at 26 months). Since excess canopy production is occurring at this site, it provides an opportunity to validate and improve theoretical predictions of optimum LAI for these conditions.
- Young eucalypt plantations on ex-forest sites are highly responsive to N fertiliser applications between 1 and 3 years after planting. Applications of 200-500 kg N ha^{-1} as urea led to stem volume increases of 10-25 m^3 ha^{-1} by five years of age (Fig. 4), and the responses will probably continue for several more years. These responses occurred at both the Tim Shea (mudstone-derived soil; 1580 mm annual rainfall) and Nunamara (basalt-derived soil; 1107 mm annual rainfall) sites.
- A further application of 400 kg N ha^{-1} at the Tim Shea and Nunamara sites at four years increased basal area by about 10% by 5.5 years, regardless of rates of previous fertilisation. Applications at five years of age are also being tested.
- Analyses of soils sampled around the time of planting were a good indication of the need for N fertilisation during the first three years; later sampling was needed for the diagnosis of older plantations.

- Urea, ammonium sulphate and ammonium nitrate increased concentrations of available N in soil when applied at the same rate of N in spring to a sand in a warm-dry climate in Western Australia. This suggests that there may be flexibility in the use of different forms of N fertiliser depending on their cost. This comparison needs to be repeated at several sites.

Goals

- Quantify the effect of weeds on the growth response to N fertilisation in 4- to 6-year old plantations of *E. globulus* and *E. nitens*.
- Compare the efficacy of urea and other forms of N fertiliser in increasing soil N status and uptake.
- Determine the relationship between LAI and growth in *E. nitens* plantations as affected by N fertilisation.
- Evaluate cation availability in soil as affected by N fertilisation in a high rainfall environment.
- Develop a micro-method for measuring magnesium uptake kinetics of eucalypt and pine roots.

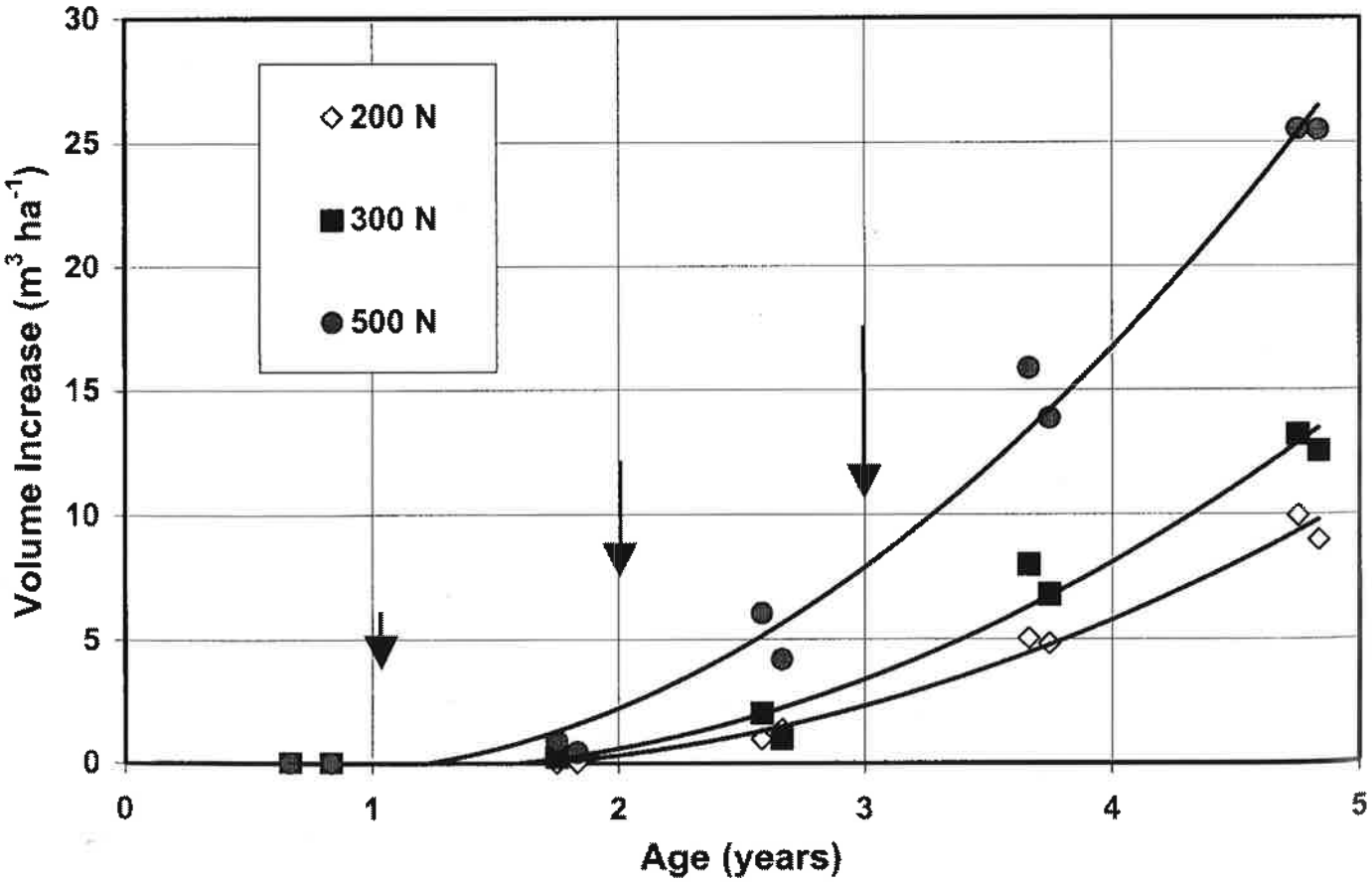


Figure 4
Increase in stem volume of *E. nitens* exposed to various rates of nitrogen fertiliser application (200, 300 & 500 kg ha $^{-1}$N as urea) between 1 and 3 years after planting at the Tim Shea and Nunamara sites. Volume increase was measured as growth in the fertilised treatments minus growth in the controls. A small dose of N and P was applied at planting to all treatments. Arrows indicate times of fertiliser application with the length of the shaft of the arrow indicating the relative amount applied on each occasion. Cumulative rates of N applied are indicated in the legend.

Project 2

Leader
Ass Prof Paul Saffigna

Staff
Dr Sue Berners-Price
Mr Tim Blumfield
Dr Ken Bubb
Mr Uldis Cakurs
Mr Paul Keay
Mr Trevor Leaman
Ms Nicole Mathers
Mr David Osborne
Dr Senake Perera
Dr Ian Phillips
Dr Nina Prasalova
Dr Guixin Pu
Prof Calvin Rose
Mr John Simpson
Dr Bofu Yu
Dr Xu Zhihong

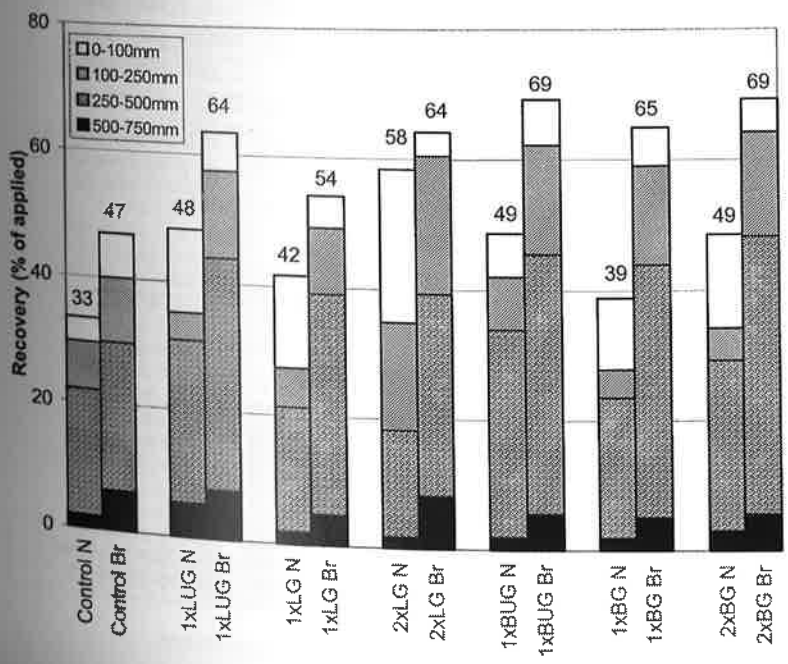
Management of tropical soils

Background

The aims of this project are:

- to evaluate the impacts of soil and stand management on both quantity and quality of soil organic matter in subtropical plantations;
- to develop effective soil organic matter management regimes for sustaining the productivity of these plantations;
- to evaluate the impacts of silvicultural practices on N pools and dynamics in hoop pine plantations;
- to quantify the effects of both silvicultural practices and environmental conditions on soil N availability and on plantation N demands;
- to quantify the effects of harvesting, site preparation practices and seasonal conditions on soil physical processes in subtropical pine plantations; and
- to quantify the relationships between surface condition, site hydrology, soil physical characteristics and leaching processes during the inter-rotation period of the pine plantations.

Figure 5
^{15}N and Br recovered from a soil profile 15 days after applying $^{15}NO_3$ under field conditions. The difference is the N loss due to denitrification.



Outcomes

- Prospects for characterising soil organic matter quality in hoop pine and exotic pine plantations were improved by developing an acid pre-treatment of samples to concentrate carbon prior to solid state ^{13}C nuclear magnetic resonance (NMR) spectroscopy.
- On average, 35% of the bromide applied to the surface soils in a one-year-old hoop pine plantation was leached below 50 cm after 15 days, and 50% of ^{15}N applied as nitrate was not recovered in the upper 50 cm of the soil. The additional 15% loss of ^{15}N over bromide (50-35%) was attributed to denitrification (Fig. 5).
- Analysis of seven years of rainfall, runoff, soil and nutrient data from an experiment at Imbil revealed that retention of plant debris reduced soil loss by 57-90%.

Goals

- Quantify denitrification, immobilisation and leaching of ^{15}N-labelled experiments under different slash (residue) management regimes during winter and summer months in hoop pine plantations.
- Develop and apply soil biological methods, particularly microbial biomass C and N assays, to characterise soil organic matter dynamics and N cycling in subtropical pine plantations.
- Further develop and apply ^{13}C and ^{15}N NMR methodologies to characterising soil organic matter quality in hoop pine and exotic pine plantations.
- Assess the suitability of existing data from long-term catchment studies for incorporation into a predictive model of soil loss from subtropical pine plantation catchments.
- Estimate infiltration parameters for selected sites and storm events using the rainfall-runoff model SRM.

Project 3

Leader
Dr Chris Beadle

Staff
Mr Paul Adams
Mr Chris Barnes
Dr Philip Brown
Ms Maria Cherry
Mr Keith Churchill
Prof Robert Clark
Mr Dugald Close
Mr Travers Collins
Dr Neil Davidson
Mr Paul Dargusch
Ms Amabel Fulton
Ms Sandra Hetherington
Dr Greg Holz
Dr Mark Hovenden
Dr Sarah Jennings
Mr Kelsey Joyce
Prof Peter Kanowski
Mr Dean Kearney
Mr Sven Ladiges
Dr S Mahendrarajah
Ms Linda Maddern
Ms Anna Matysek
Ms Jane Medhurst
Ms Alicia Mollon
Prof Robert Menary
Dr Neville Mendham
Mr Peter Naughton
Dr Libby Pinkard
Mr Digby Race
Ms Jackie Schirmer
Dr Chris Shedley
Dr Philip Smethurst
Mr Tim Tabart
Mr Doug Walch
Mr Grant Westphalen
Ms Ann Wilkinson
Mr Dale Worledge

Silvicultural systems

Background

The aims of this project are :

- to provide guidelines for the preparation and management of seedling stock during plantation establishment;
- to develop weed management systems which minimise the use of herbicides including the use of non-competing species as cover crops;
- to develop pruning, thinning and spacing systems which are suitable for converting industrial pulpwood plantations to clearwood regimes and for farm forestry; and
- to assess the benefits and costs of trees on farms, and the real or perceived barriers to the adoption of commercial forestry on part or all of the farm enterprise, and develop an enhanced understanding of the factors which determine regional timber supply.

Outcomes

- Landowners make the decision to adopt or not to adopt commercial farm forestry based on an evaluation of the optimal utilisation of their land. Factors influencing this 'utilisation decision' include considerations of the economic opportunity cost of land, effects of time before a return will be received from farm forestry, perceived effects of farm forestry on farm management, and preferences relating to the design of farm forestry systems. The results suggest a need for two strategies to increase adoption: improving information dissemination and expanding the range of farm forestry systems available to landowners.
- A review of economic modelling approaches for non-industrial private forestry as a source of timber has highlighted that an extension to the stated preference approach may be a workable means of analysing timber supply in this area.

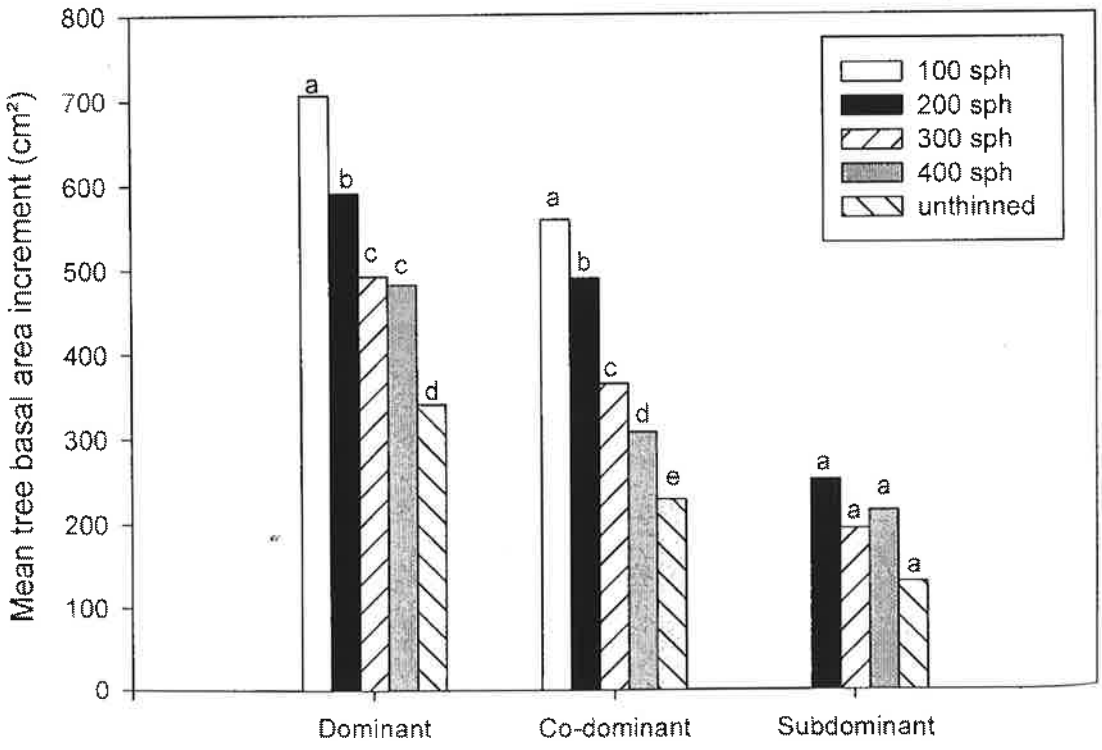


Figure 6
Mean basal area increment of *E. nitens* at Goulds Country, north-east Tasmania, over a seven year period of growth since an early thinning at age six years to 100, 200, 300 and 400 stems per hectare (sph). Letters in each dominance class indicate homogeneous groupings of thinning treatments (LSD = 0.05). Note the significant growth response of dominant and co-dominant trees but not sub-dominants.

- Diameter growth increased with increasing duration of weed-free conditions until a maximum was approached after approximately one year (the critical period of weed interference) of weed removal.
- Cover crops, especially fog grass, can suppress weeds and self-seeded pine seedlings given good site preparation and conditions for germination. However, more attention is needed to determine the requirements for establishment of legumes.
- Relationships between stem, leaf area and crown dimensions for 13 plantations of *E. nitens* (post-canopy closure) were independant of site, age and silvicultural treatment.
- Thinning induced changes in photosynthetic activity, particularly in the lower crown, and changes in the distribution of foliage in the crown of *E. nitens* in plantations. The growth of dominant and co-dominant trees responded to thinning. These responses suggest that the optimal final stocking is likely to be between 200-300 stems per hectare (Fig. 6).
- The use of cold-hardened and nutrient-starved seedlings reduced the effects of cold-induced photoinhibition, a major factor affecting establishment and growth of seedlings on many plantation sites in Tasmania.

Goals

- Develop strategies that can assist industry and government in the development of farm forestry.
- Evaluate the role of anthocyanins and other pigments as mechanisms for protecting leaves from photoinhibition.
- Determine the relative importance of competition from water and nutrients as factors underlying the effects of grass weeds on the growth of a tree crop.
- Model the effect of physiological responses to thinning.
- Provide a physiological basis for fertiliser-induced micronutrient deficiencies.
- Determine if altered microclimate at the edge of clearfelled areas affects biodiversity in wet sclerophyll forests.

Project 4

Leader
Dr Peter Sands

Staff
Dr Michael Battaglia
Dr Roger Braddock
Mr Alex Bradley
Dr Ken Bubb
Ms Maria Cherry
Dr David Doley
Dr Frieda Henskens
Mr Bruce Hogg
Ms Susan House
Dr Mark Hunt
Mr Eric Keady
Mr Keith Lamb
Mr Mike Lofts
Dr Mark Lewty
Mr Daryl Mummery
Ms Kate Murray
Ms Laura Nagy
Mr Mark Nestor
Mr David Osborne
Dr Simon Papps

Modelling production and wood quality

Background

The aims of this project are to:

- produce process-based models which enable the productivity of plantations to be predicted for specific management questions, and for which input data can be readily and cheaply obtained by forest managers;
- define the effects of site and climatic factors on wood properties, determine the feasibility of altering wood properties via silvicultural treatments, and develop tools for predicting response of wood properties to environmental factors; and
- develop decision support systems for plantation management.

Outcomes

- ProMod has been implemented as a user friendly software package using the Visual Basic programming language and incorporated into the Farm Forestry Toolbox sponsored by Private Forests Tasmania.
- Productivity maps for *E. globulus* in Tasmania have been produced that take into account enhanced spatial modelling of soil factors. Techniques were developed which account for and display the effects of the sensitivity of productivity estimates to variations in environmental factors. These were applied to show the effects on productivity across the State of variation in soil

Dr Libby Pinkard
Mr Rob Prydon
Ms Carolyn Raymond
Mr Andrew Rumley
Mr Paul Ryan
Mr Tony Smith

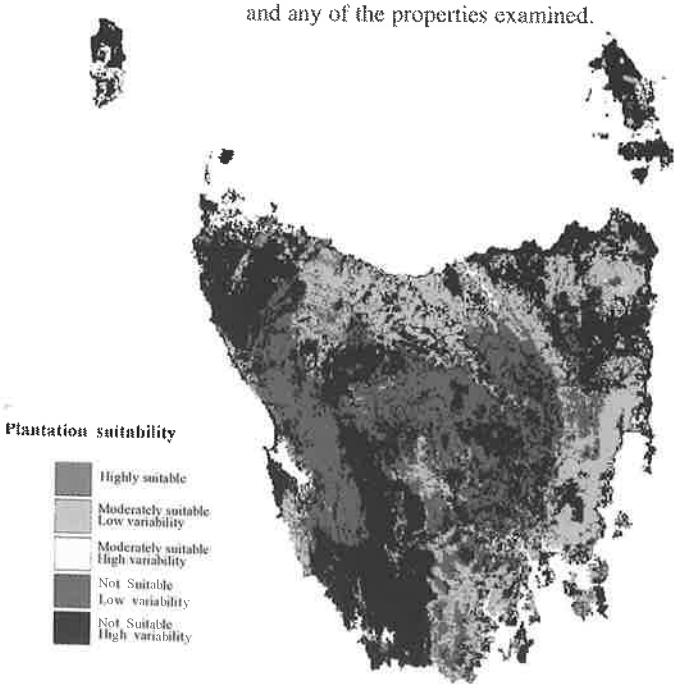
depth and nutritional status. The new maps show where there is a strong likelihood that suitable sites will be found, or where productivity is sensitive to site factors and accurate assessment is justified (Fig 7).

- The concepts of optimal foraging theory were applied to develop a model of biomass partitioning under steady-state conditions. The model adequately predicted canopy LAI (r^2=0.90) and current stem volume increment (r^2=0.86) for 34 *E. globulus* plots at sites in Tasmania, Victoria and Western Australia. It also predicted stand nitrogen demand and the distribution of biomass.

- ProMod was applied in collaboration with RAIZ to data from Portuguese plantations. After minor modifications, due to differences in stem taper between Tasmania and Portugal, excellent agreement between observed and predicted productivity was obtained.

- A literature survey of the response to silvicultural treatments of wood, pulping and paper properties in eucalypts showed that, despite large growth responses to silvicultural treatments, there were no adverse effects on these properties, with the possible exception of irrigation. In addition, no strong relationships were found between tree size and any of the properties examined.

Figure 7
Map of site suitability for plantations in Tasmania.



- Fertiliser applied at establishment did not adversely affect wood and fibre properties of *E. globulus* when rainfall was above 1000 mm. However, on drier sites, wood properties were adversely affected through changes in basic density, shorter fibres and lower predicted pulp yields. Changes in wood properties were not related to changes in growth rate.

- Basic density increased with increasing rainfall for both *E. globulus* and *E. nitens*.

Goals

- Modify a canopy photosynthesis model developed earlier in the CRC to directly take into account environmental effects on stomatal conductance.

- Develop and implement a dynamic submodel of biomass partitioning.

- Validate the *E. nitens* and *P. radiata* versions of ProMod, generate productivity maps of these species for Tasmania, and parameterise ProMod for *E. grandis*.

- Evaluate the effects of planting layout on photosynthetic activity, growth and form in *E. globulus*.

- Review existing Decision Support System and their operational requirements, and prepare data sets for their use.

- Determine allometric relationships, canopy architecture and above- and below-ground biomass distribution for 12-year-old *E. grandis* and 48-year-old *E. cloeziana*.

- Examine effects of rainfall on *E. globulus* wood properties across a rainfall gradient in Western Australia for the same seedlot and at the same age.

- Determine interactions between spacing and rainfall on wood properties in spacing trials (*E. nitens* in northern Tasmania; *E. globulus* in Western Australia).

- Determine empirical relationships for basic density and cellulose content for *E. globulus* in northern Tasmania in a joint project with Forestry Tasmania.

Resource Protection

Manager
Dr Clare McArthur

Introduction

The Resource Protection Program aims to develop a comprehensive understanding of the biology, ecology and impact of a number of key pests (insect and vertebrate) and diseases of eucalypt plantations in temperate Australia. Using this information, it also aims to develop management techniques and products to minimise the effects of pests and diseases on the quantity and quality of forest products. These techniques are being developed consistent with the principles of sustainable forest management.

The program aims to produce integrated pest management (IPM) strategies for a number of key pests such as the Tasmanian leaf beetles *(Chrysophtharta bimaculata* and *C. agricola)*, autumn gum moth *(Mnesampela privata)* and several marsupial herbivores. In addition, the biology, ecology and control of a number of other pest species, including some fungal pathogens, will be studied to provide the basis for future development of IPM strategies. In some regions, research will focus on establishing the identity and distribution of pest and disease species, as these details are not yet known. Finally, efficient and effective monitoring protocols are being developed for some of these pest and disease species to determine when and whether control actions are necessary.

Project 1

Leader
Dr Geoff Allen
Dr Rob Floyd

Staff
Mr Dick Bashford
Ms Natasha Beveridge
Mr Steven Candy
Ms Michelle Court
Dr David de Little
Mr John Dowse
Dr Jane Elek
Dr Humphrey Elliott
Dr Grant Farrell
Mr Bradley Howlett
Dr Marina Hurley
Mr Zoltan Lukacs
Dr John Madden
Ms Linda Maddern
Mr John Matthiessen
Ms Helen Nahrung
Mr Vin Patel
Mr Stephen Paterson
Mr Anthony Rice
Ms Tara Simmul
Dr Martin Steinbauer
Mr Rex Sutherland

Biology, ecology and economic impact of insect pests

This project aims to provide a strong foundation of basic research on the biology and ecology of the major insect species across various geographic regions so that Insect Pest Management (IPM) strategies can be developed. Particular emphasis in the project is centred upon *M. privata* (autumn gum moth) across all regions of southern Australia and the leaf beetles *C. agricola* and *C. bimaculata* in Tasmania. Other insect species currently under study include *Acacicola orphana* (fireblight beetle), *Heteronyx* spp. (Melolonthine scarab beetles) and *Heteronychus arator* (African black beetle). Areas of research include phenology, host-plant interactions, natural enemies, mating systems, monitoring protocols and impacts on tree growth.

Outcomes

- A model for the impact of *C. bimaculata* larvae on the growth of *E. nitens* has established a leaf occupancy of 0.2 immature stages (egg or first instar lavae) as the economic threshold for IPM.
- Monitoring of population phenologies of *C. agricola* and potential predators at three sites in Tasmania has shown consistent early population peaks for coccinellid predators and variable but later peaks for adult soldier beetles.
- Developmental temperature thresholds (temperature at which growth occurs at any stage of the life cycle) for *C. agricola* and *A. orphana* were established: *A. orphana* has a low average threshold of 4.6 ^{o}C.
- The relationship between family and provenance variation in *Acacia dealbata* and larval survival in *A. orphana* was quantified. Significant correlates to larval survival included moisture and to natural defoliation included foliage colour.
- Protection of *E. regnans* from insect attack for eight years tripled their wood volume; similar trends are emerging from protection of *E. nitens*.
- *M. privata* was found to have an oviposition preference for juvenile foliage over adult foliage.
- Initial sampling of *H. arator* in newly-established plantations has indicated that abundance is around three to five-fold greater within the planting mounds than in the undisturbed inter-rows.
- Leaf toughness significantly influenced the survival of neonate *M. privata* larvae. Consumption and growth of neonate *M. privata* larvae differed according to host species, but less so between host provenances grown under similar conditions.

Goals

- Model the impact of defoliation by adult chrysomelids on the growth of eucalypts.
- Validate the temperature development model for *C. agricola* in the field.
- Clarify the role of host vigour and resource abundance on oviposition preference of *M. privata*.
- Describe the flight behaviour of *M. privata* and determine the composition of its pheromone.
- Determine aspects of the biology and aphid-plant interactions of *Essigella californica*.
- Establish the distribution, abundance and impact of *Heteronyx* spp. within new eucalypt plantations.
- Determine the role of leaf surface waxes and interactions of conspecifics on the oviposition preference of *M. privata*.

Autumn Gum Moth Workshop, Mildura, August 1998: participants inspecting eucalypt plantations defoliated by autumn gum moth.

Project 2

Leader
Dr Geoff Allen
Dr Rob Floyd

Staff
Mr Dick Bashford
Ms Natasha Beveridge
Mr Steven Candy
Ms Michelle Court
Dr David de Little
Mr John Dowse
Dr Jane Elek
Dr Humphrey Elliott
Dr Grant Farrell
Mr Tim Hingston
Dr Marina Hurley
Dr John Madden
Mr John Matthiessen
Dr Richard Milner
Ms Helen Nahrung
Mr Vin Patel
Mr Stephen Paterson
Mr Anthony Rice
Dr Martin Steinbauer
Mr Rex Sutherland

Insect control techniques and IPM

Background

Forest managers are constantly looking for non-chemical options for insect control that are effective, environmentally friendly and economically viable. Individual non-chemical control approaches are generally not as efficacious as chemical insecticides and must be used in conjunction with other options in an IPM strategy to achieve adequate control. However, there are very few non-chemical options currently available to managers of eucalypt plantations in temperate Australia. This project will develop a number of non-chemical control options, as well as improve the use of chemical insecticides, for incorporation into IPM strategies.

Outcomes

- Work on the biological control agent Novodor [active ingredient: *Bacillus thuringiensis* var *tenebrionis* (Btt)], has established aerial spray techniques that are effective at preventing defoliation by young, but not older, chrysomelid larvae or adults, while having no significant effect on their principal natural enemies. Recent trials have demonstrated that 25% dilution has the same effectiveness as 100% Btt. At present, its effectiveness in the field is variable and it is not cost-effective for large-scale use.
- Appropriate dilution and application rates of a Bt-based control agent (Btk) for controlling *M. privata* have been determined.

- Laboratory testing indicates that a new systemic insecticide has effect in protecting seedlings against attack by *H. arator* and 'spring' beetles, but that dosages required may present economic problems.

Goals

- Establish the phenology of the tachinid flies attacking *C. agricola*.
- Assess the generational impact of natural enemies on the field survival of *C. agricola*.
- Develop protocols for monitoring chrysomelid populations using binoculars and trap trees.
- Determine appropriate doses of several new, more environmentally friendly insecticides and their effects on natural enemies of chrysomelids.
- Develop a standard protocol for the use of UV light traps in monitoring *M. privata* populations.
- Test the Bt-based control agent (Btk) for controlling autumn gum moth on field populations.
- Verify whether abundance of *H. arator* is consistently greater in planting mounds than in the inter-rows within new plantations, and investigate causes.
- Identify the 'spring' beetle species causing most damage in the establishment phase of Western Australian and Tasmanian plantations and determine their geographic distribution and abundance.
- Validate the efficacy of insecticide treatment for protection of seedlings from establishment pests.

Dr Martin Steinbauer inspects insects caught in a UV light trap used to monitor *Mnesampela privata*.

Project 3

Leader
Dr Clare McArthur

Staff
Mr James Bulinski
Mr Hugh Fitzgerald
Mr Peter Naughton
Ms Julianne O'Reilly
Mr Stephen Paterson

Resistance of planting stock to vertebrate browsers

Background

A key method for reducing browser damage to eucalypts is to produce more resistant trees. This may be achieved by genetic and phenotypic manipulation of trees. The aims of this project are to:

- investigate both the genetic basis of resistance of eucalypts, and the effects of environment on this resistance;
- determine whether resistance can be modelled as a function of leaf chemistry, mainly using near-infra-red spectroscopy (NIRS).

These aims rely on determining the relative damage to, and preferences for, various plant types by browsing herbivores. Results will be used to identify resistant genotypes, develop a rapid method for estimating susceptibility using leaf chemistry, and to predict susceptibility of seedlings as a function of their growth environment. These three aspects can be incorporated into an overall strategy for predicting and reducing browser damage of eucalypts at plantation establishment.

Brushtail possum

Outcomes

- Captive brushtail possums ate more (preferred) 'hardened' *E. nitens* seedlings (half-halves) than container stock seedlings (Lannin 121s, 63s, and 81s), indicating a strong influence of nursery growing conditions on palatability. In contrast, pademelons showed weak, variable preferences with an inconsistent relationship to growing conditions. Captive possums consistently ate more foliage than pademelons, and both herbivore species ate much more foliage than stem.
- In a preliminary analysis of a field trial (with the Genetic Improvement Program), there were large differences in mammal browsing damage sustained to foliage of different provenances of *E. globulus*. Provenances from the far northeast of Tasmania sustained much higher levels of damage than provenances from southern Tasmania and the Strzelecki Ranges.
- In a plantation in northern Tasmania, the growth of residual (two year-old) nursery stock of *E. nitens* was much slower than normal container stock, leaving them vulnerable to browsing for a longer period. This emphasises the importance of correct seedling choice to avoid increasing the cost of browsing.

Goals

- Quantify the genetic basis of palatability of *E. globulus* foliage using bioassays with brushtail possums and Tasmanian pademelons, both at the race and family level (with the Genetic Improvement Program).
- Determine the relationship between leaf chemistry, using NIRS, and intake by brushtail possums and pademelons.
- Determine the palatability of eucalypt seedlings grown under different fertiliser regimes and various nursery conditions.

Project 4

Leader
Dr Clare McArthur

Staff
Mr James Bulinski
Dr David de Little
Mr Hugh Fitzgerald
Ms Kirsten le Mar
Mr Peter Naughton
Mr Stephen Paterson

Strategies to reduce vertebrate browsing damage

Background

This project addresses the problem of reducing browsing damage to seedlings, using physical and vegetation characteristics of the environment (whole plantation and its surrounding habitat) as its framework. These environmental characteristics should have a significant influence on the browsers: how many browsers are present, and how they use plantations and other habitats as refuges and feeding areas. The aims of this project are to:

- understand this interaction between browsers and the environment, and the consequence of it on damage levels to seedlings;
- investigate the impact of introduced cover crops on browsing of seedlings;
- develop methods for monitoring damage and predicting risk and, finally, to design appropriate options to reduce browsing damage through various planting strategies.

Outcomes

- Two prototypes for monitoring browsing damage of newly planted seedlings in plantations have been described: one for use in research and one for operations.
- In an *E. nitens* plantation in northern Tasmania, mammalian herbivores reduced the absolute biomass of grasses and the relative proportion of grasses to forbs through grazing, thereby potentially reducing weed competition with eucalypt seedlings.
- In a patchy environment of *E. nitens* plantations, grasslands and native forest in north-western Tasmania, pademelons were the most abundant mammal species (1.46 animals ha^{-1}) followed by Bennett's wallabies (0.26 animals ha^{-1}). Estimated densities for brushtail possums and rabbits within this environment were extremely low (<0.04 animals ha^{-1}).
- Nocturnal densities of pademelons and Bennett's wallabies were signficantly higher in a newly established *E. nitens* plantation and grasslands than in native forest and 5-7 year-old plantations. Animals were not further attracted into the general area or coupe by planting.
- Immediately after 1080 poisoning on one plantation in north-western Tasmania, only target species were found dead. Many pademelons, some brushtail possums and few Bennett's wallabies (no large males) were found, but carcasses were very difficult to locate. All dead radio-collared animals were found within 85 m of the bait line (average distance: 33 m, 43% were found < 20 m from the bait line). The pademelon population was considerably reduced, but there was little detectable change in numbers of possums or Bennett's wallabies. Six weeks after poisoning, the pademelon population had recovered or possibly increased.

Goals

- Quantify the differences in growth and browsing damage of three types of seedlings: normal container stock, half-halves, and nutrient-starved two year-old container stock.
- Determine how individual browsing marsupials use a newly established plantation and its surrounding habitat, before and after seedlings are planted.

Ms Kirsten le Mar inside a browsing mammal exclosure at Surrey Hills, Tasmania.

Project 5

Leader
Dr Caroline Mohammed

Staff
Ms Karen Barry
Ms Alieta Eyles
Mr Andrew Milgate
Ms Alicia Mollon
Dr Yuan Zi Qing

Strategies to minimise loss due to fungal attack

Background

The objective of this project is to develop management tools to limit the impact of stem decay fungi and the leaf pathogen *Mycosphaerella*. The project will also investigate the sustainability of forest management by examining the biodiversity of decay fungal/invertebrate assemblages in different ecological niches (logs retained of different sizes). Studies of stem decay focus on defence mechanisms that trees use to restrict the spread of decay, especially in pruned and thinned *E. nitens* and *E. globulus* plantations destined for solid wood production.

Outcomes

- In contrast to other angiosperms and more comparable to conifers, the reaction zone (RZ, zone associated with decay) in *E. nitens* has lower moisture content than adjacent sapwood. Mineral elements (K, Ca, Mg and Mn), which could play a role in determining water content, are in lower concentrations in the reaction zone than in healthy sapwood or decayed wood.

Ms Karen Barry preparing an *E. nitens* seedling for NMR imaging for stem decay.

- The reaction zone has been characterised as containing a number of hydrolysable tannins including pedunculagin, telli-magrandin I and tetra-galloyl-glucose.
- An *in vitro* log-store experiment has demonstrated the enhanced durability of the RZ tissue compared to healthy sapwood. Bioassays clearly indicate that compounds in the RZ are antifungal.
- Five *Mycosphaerella* species and three species from *Mycosphaerella* anamorph genera have been isolated and identified from plantations in Tasmania; *M. nubilosa*, *M. cryptica*, *M. tasmaniensis*, *M. grandis*, *Sonderhenia eucalyptorum* and *M. vespa*, *Coniothyrium ovatum* and *Sonderhenia eucalypticola*.
- *M. cryptica* and *M. nubilosa* have the highest frequency of severe infections and have the greatest impact on juvenile eucalypt plantations in Tasmania.
- The internal transcribed spacer region of the ribosomal DNA has been sequenced for all the Tasmanian *Mycosphaerella* species, and molecular analysis support the morphological classification of species.
- Analyses of field data of disease assessment done within the Genetic Improvement Program indicate a clear genetic basis to observed resistance.
- Results of studies of genetic resistance to infection indicate that mycelium from *M. nubilosa* may have potential as an effective inoculum for a bioassay, whereas mycelium from *M. cryptica* and *M. vespa* do not.

Goals

- Carry out more detailed studies of the infection biology and epidemiology of *Mycosphaerella*.
- Develop a screening method to be used on very young plants to test the resistance of eucalypts to *Mycosphaerella*.
- Continue studies of antimicrobial defence mechanisms in eucalypts, including the role of kino and physiological and pathological responses to pruning in *E. nitens* and *E. globulus*.
- Identify the fungi associated with decay following severe pruning.
- Determine whether small trees, which could be left as a future decaying log habitat at the end of the rotation, are likely to follow the same successional pathways as larger logs, providing the full range of decay types and hence fungal and invertebrate biodiversity.

Education and Technology Transfer

Manager
Dr Neil Davidson

Staff
Ms Jane Burrell
Prof Rob Clark
Dr David Doley
Prof Robert Henry
Ms Gaye Johnson
Dr Greg Jordan
Prof Jim Reid
Dr Robert Wiltshire

Background

The Education and Technology Transfer Program coordinates:

- intake of postgraduate students across the three research programs and five university partners in the CRC, and involvement of CRC staff in education and training;
- transfer of technology from research programs to the industrial partners in the CRC and to small end-users of forest technology, particularly farmer groups; and
- activities to raise awareness in the various publics of the CRC's research in sustainable forestry, and to develop a CRC ethos.

The principal objectives are to:

- develop a national centre of excellence for postgraduate training with emphasis on training graduates relevant to the industry sector. This includes involving staff from partner organisations in teaching and supervision of university students;
- rapidly transfer the technology arising from research conducted at the Centre to the industrial partners and other end users;
- publish research of international quality so Australia and the CRC are seen as world leaders in plantation forestry; and
- raise community awareness of the CRC's activities and the value to Australia of a sustainably managed forest industry.

Outcomes

Education

- The Centre has 60 PhD, MSc and Honours students currently enrolled; 13 were attracted from industry, 11 are on scholarships with industry support (APA-I, FFIC, LWPRDC), and a further 13 are on competitive national scholarships (APA, AIDAB). Only ten are supported solely by CRC PhD scholarships. Four students have CRC top-ups to APA scholarships (see Tables 2 and 3 for details).
- Four students won awards this year; Ms J Medhurst won the Maxwell Ralph Jacobs Award for physiological research on thinned eucalypt plantations ($3000), Ms Y Setiawati won a travel award from CIRAD-Forêt to visit France (November 1998-January 1999) to study molecular aspects of genetic control of flowering in *A. cunninghamii* (hoop pine); Dr M Steinbauer won first prize for best student paper in the Australian Journal of Entomology for 1997/98; and Ms T Simmul was awarded best oral presentation at the Annual Conference of the Australian Entomology Society.
- Supervision of postgraduate and honours students is widely distributed amongst CRC partner institutions with 28 of the 56 supervisors of Honours, MSc and PhD projects being non university departmental staff (see Table 4 for details).
- There are seven CRC scientists, who are not staff of university departments, who contributed to university courses in fields allied to their research: Dr N Davidson in Physiological Plant Ecology, Dr P Smethurst in Soil Fertility, Dr B Potts in Genetics, Dr C McArthur in Vertebrate Zoology, Dr Z Xu in Soil Science, Dr M Steinbauer in Insect Management for Forestry and Dr M Hunt in Plantation Silviculture. Dr N Davidson coordinates a four-year undergraduate course, 'Forest Ecology', designed for students with an interest in forestry at UT. Dr N Davidson, Dr C McArthur, Dr M Battaglia, Dr C Beadle and Dr B Potts have also each been supervising third year students enrolled in a unit entitled 'Plant Science Research' where each student is conducting research on a topic in forest ecology at UT.
- Seven postdoctoral fellows worked with the Centre in 1998/9: Dr K Thamarus in molecular genetics (CSIRO-FFP, Canberra); Dr M Steinbauer in entomology (CSIRO Entomology); Dr M Shepherd in molecular biology (SCU); Dr H Dungey in forest genetics (QFRI); Dr N Prasalova in soil nutrition (GU),

Table 2: CRC Research Students

First Name	Last Name	Degree	Funding	Start	Inst	Topic	Scientific Supervisors	CRC Program
Paul	ADAMS	PhD	LWRDC	1996	UT	Sources of competition from weeds in plantations	Dr N Mendham, Dr C Beadle, Dr P Smethurst	SM
Robert	BARBOUR	Hons		1999	UT	Gene flow between plantations and native forest	Dr B Potts, Dr R Vaillancourt	GI
Karen	BARRY	PhD	APA-I	1997	UT	Defence mechanisms against decay in *E. nitens*	Dr C Mohammed	RP
Tim	BLUMFIELD	PhD	CRC	1999	GU	Carbon and nitrogen dynamics of hoop pine plantations	Ass Prof P Saffigna	SM
Georgina	BROWN	Hons		1999	UT	Preliminary investigations into the biology and ecology of *Heteronyx* spp. (*Scarabaeidae*)	Dr M Hurley, Dr D de Little	RP
James	BULINSKI	PhD	CRC	1994	UT	Quantifying and predicting mammalian herbivore damage in Tasmanian eucalypt plantations	Dr C McArthur	RP
Peter	BUNDOCK	PhD	APA	1995	UT	Genetic mapping and QTL analysis in *E. globulus*	Dr R Vaillancourt	GI
Uldis	CAKURS	PhD	APA/CRC	1999	GU	Effect of debris retention on run-off, soil loss and nutrient export in hoop pine plantations	Ass Prof P Saffigna, Dr B Xu	SM
Steven	CANDY	PhD		1993	UT	Mathematical models to support IPM of leaf beetles	Dr J Madden, Dr H Elliott	RP
Paul	CHAMBERS	PhD	APA-I	1995	UT	Quantitative genetics and the economic flow-ons from genetic gains	Dr B Greaves, Dr N Borralho	GI
Dugald	CLOSE	PhD	APA/CRC	1997	UT	Environmental constraints on early growth of seedlings in eucalypt plantations	Dr P Brown, Dr C Beadle, Dr G Holz, Dr M Hovenden	SM
Travers	COLLINS	Hons		1999	UT	Photosynthetic light response of *E. globulus* to nitrogen treatment	Dr N Davidson, Dr M Hovenden, Dr C Beadle	SM
Diane	CONNELL	PhD	CRC	1999	UT	Above-ground nitrogen dynamics in *E. nitens*	Dr P Smethurst	SM
Paul	DARGUSCH	MSc		1997	UT	Physical, social and economic barriers to the adaptation of farm forestry in NE Tasmania	Prof R Clark, Ms A Fulton	SM
Greg	DUTKOWSKI	PhD		1996	UT	Improvement of mixed models for prediction of breeding values in forestry	Dr B Potts, Dr A Gilmour	GI
Alieta	EYLES	PhD	APA/CRC	1999	UT	Role of kino in anti microbial defences of *E. globulus*	Dr C Mohammed, Prof R Pearce	RP
Andrew	GIBBONS	MSc	CSIRO	1998	UT	Effect of intensive forest management on understorey and fauna in *E. delegatensis*	Dr C McArthur, Dr M Battaglia	RP/SM
Carl	GROSSER	PhD	SPIRT	1999	UT	Seed orchard molecular biology	Dr R Vaillancourt, Dr B Potts	GI
Craig	HAWKINS	MSc		1998	UT	Response of *Brunonia australis* to forestry practices	Dr R Wiltshire, Dr P Barker	SM
Andrew	HINGSTON	PhD	APA	1998	UT	Pollination ecology of *E. globulus* and *E. nitens*	Dr B Potts, Dr P McQuillan	GI
Bradley	HOWLETT	PhD	FFIC	1993	UT	Host location by *Chrysophtharta bimaculata*	Dr J Madden, Dr A Clarke, Dr P McQuillan	RP
Tim	JONES	Hons		1999	UT	Genetic variation in insect resistance in *E. globulus*	Dr B Potts, Dr R Vaillancourt	GI
Amal	JOSEPH	MSc		1998	USC	Performance and genetics of *Pinus caribea* var. *hodurensis* interprovenance hybrids	Dr H Wallace, Dr M Dieters, Dr H Dungey	GI
Dominic	KAIN	PhD	FWPRDC	1998	ANU	Genetics of wood properties of *Pinus elliottii*, *P. caribea* and their hybrid	Prof P Kanowski, Dr K Harding, Dr M Dieters, Dr B Li	GI
Dean	KEARNEY	Hons		1999	ANU	Characterisation of branching patterns and changes caused by stocking	Dr R James	SM
Peter	KUBE	PhD		1996	UT	Breeding objectives for the production of sawlogs from plantation grown *E. nitens* and *E. globulus*	Ms C Raymond, Prof J Reid, Dr N Borralho	GI
Sven	LADIGES	PhD	CRC	1996	UT	Micronutrient deficiencies in eucalypts induced by excess application of N & P	Prof R Menary, Dr C Beadle	SM
Keith	LAMB	MSc		1997	ANU	Modelling environmental characterisitcs for steep country plantations	Prof P Kanowski	SM
Kirsten	LE MAR	PhD	APA/CRC	1996	UT	Comparison of eucalypt plantations use by three herbivorous marsupial species	Dr C McArthur, Dr D de Little, Dr M Statham	RP
Trevor	LEAMAN	PhD	APA	1998	GU	WUE and C^{13} in plantation forest in SE Qld	Ass Prof Saffigna, Dr Z Xu, Mr M Dieters, Mr M Hunt	SM
Gustav	LOPEZ	PhD	AIDAB	1998	UT	The importance of non-additive genetic effects in *E.globulus*	Dr B Potts, Dr R Vaillancourt	GI
Zoltan	LUKACS	PhD	APA	1994	UT	Biology of the autumn gum moth	Dr A Clarke, Dr J Madden, Dr R Floyd	RP
Nicole	MATHERS	PhD		1998	GU	C&N dynamics of forest soils using C^{13}, N^{15}	Ass Prof Saffigna, Dr Z Xu, Dr S Berners-Price	SM
Michelle	McGRANAHAN	PhD	APA	1996	UT	Genetic control of propagation ability in *Pinus radiata* and its use in breeding programs	Dr B Greaves, Dr B Potts, Dr N Borralho	GI
Jane	MEDHURST	PhD	FFIC	1996	UT	Thinning of *Eucalyptus nitens* stands	Dr C Beadle, Dr N Davidson	SM
Rohan	MELLICK	Hons		1998	SCU	Provenance variation in *E. pilularis* planted in Queensland	Dr A Specht, Dr D Lee, Dr H Dungey	GI
Andrew	MILGATE	PhD	APA-I	1997	UT	The genetic basis of resistance to *Mycosphaerella* in *Eucalyptus globulus*	Dr C Mohammed, Dr R Vaillancourt	GI/RP
Alexandra	MITCHELL	PhD	CRC	1995	UT	Reproductive biology and breeding systems for *E. globulus*	Dr B Potts, Dr R Vaillancourt	GI
Alicia	MOLLON	PhD	SPIRT	1999	UT	Pathology and physiology of pruned *E.globulus*	Dr C Mohammed, Prof R Pearce, Dr L Pinkard, Dr C Beadle	RP/SM
Martin	MORONI	PhD	APA-I	1995	UT	Nitrogen mineralisation	Dr P Smethurst, Prof R Menary	SM
Daryl	MUMMERY	MSc		1999	UT	Using landscape models to enhance plantation yield predictions	Dr E Bruce, Dr M Battaglia, Dr P Ryan	SM
Helen	NAHRUNG	PhD	APA	1999	UT	Ecology of *Chrysophtharta agricola*	Dr M Hurley	RP
Mark	NEYLAND	MSc		1998	UT	Alternative silvicultural systems for regenerating native forest	Dr N Davidson, Dr C Beadle, Mr J Hickey	SM
Ross	PEACOCK	PhD		1994	UT	Regeneration after cable logging	Dr N Davidson, Dr M Brown, Prof R Hill	SM

Table 2: CRC Research Students cont.

First Name	Last Name	Degree	Funding	Start	Inst	Topic	Scientific Supervisors	CRC Program
Digby	RACE	PhD		1998	ANU	Economic aspects of farm forestry development in regional Australia	Prof P Kanowski	SM
Anthony	RICE	PhD	APA	1999	UT	Biocontrol of leaf eating Chrysomelids	Dr G Allen	RP
Andrew	RUMLEY	Hons		1999	ANU	An investigation of the relationship between Leaf Area Index (LAI) and site factors for plantations	Dr R James	SM
Jackie	SCHIRMER	Hons		1999	ANU	Socio-economics of farm forestry in N.E. Tasmania	Prof P Kanowski	SM
Leon	SCOTT	PhD	CRC	1998	SCU	Molecular genetics of hoop pine	Dr M Shepherd, Prof R Henry, Dr M Dieters, Dr G Nikles	GI
Yetti	SETIAWATTI	PhD	AIDAB	1997	UQ	Enhancement of pollen production in *Araucaria cunninghamii* (hoop pine).	Dr D Doley, Dr M Dieters	GI
Tara	SIMMUL	PhD	APA-I	1996	UT	Biology of the fire blight beetle	Dr A Clarke	RP
Rhonda	STOKOE	PhD	CRC	1998	SCU	Molecular analysis of *Eucalyptus cloeziana*	Dr M Shepherd, Prof R Henry, Dr G Nikles, Dr D Lee	GI
Tim	TABART	MSc		1998	UT	Achieving sustainable economic development through collaborative community decision-making	Prof R Clarke, Ms A Fulton	SM
Paul	TOON	MSC		1998	USC	Family and provenance variation within *Pinus caribea* var. *bahamensis*.	Dr H Wallace, Dr M Dieters	GI
Claire	TURNER	Hons		1999	UT	Variation between populations within the *E. risdonii/tenuiramis* complex	Dr R Wiltshire, Dr B Potts, Dr R Vaillancourt	GI
Peter	VOLKER	PhD		1992	UT	Estimation of genetic parameters for eucalypt hybrids	Dr B Potts, Dr N Borralho	GI
Doug	WALCH	MSc		1997	ANU	Benefits of different designs of shelter belts in farm forestry	Prof P Kanowski	SM
Tim	WARDLAW	PhD		1994	UT	*Armillaria* butt and root rot of eucalypts	Dr C Mohammed, Dr G Kile	RP
Grant	WESTPHALEN	PhD	CRC	1996	UT	Indicator species for sustainibility in native forest systems	Dr M Brown, Dr N Davidson, Dr C Beadle	SM
Dean	WILLIAMS	PhD	CRC	1996	UT	Reproductive biology of *Eucalyptus*	Prof J Reid, Dr B Potts	GI

Table 3: Summary table of Student enrolments and funding sources

Number of Students

Total		60
Full/PartTime:	Full Time	47
	Part Time	13
Degree	Hons	9
	MSc	11
	PhD	40
CRC Programs	Genetic Improvement	22
	Sustainable Management	25
	Resource Protection	13

Funding

CRC Scholarship	10
APA Scholarship	11
CRC top-up of APA Scholarship	(4)
APA-I	5
SPIRT	2
FFIC	2
AIDAB	2
LWRDC	2

Dr F Henskens in canopy nitrogen dynamics (UT), and Dr A Loch in pest management of blue gums (CSIRO Entomology).

- There were six visiting scientists. Dr David Gwaze, Forestry Policy Coordinator with Forestry Commission Zimbabwe visited the Hybrid Breeding group at QFRI for ten weeks. He conducted research on quantitative genetics and breeding of tropical pines.

  Dr Dario Grattapaglia, who is internationally renowned for research on genome mapping of *Eucalyptus*, based in Brazil, visited the Genetic Improvement Program in Hobart from 1-5 February and an international collaborative research project was developed.

  Mr Brendan Murphy, PhD student from Canterbury University, NZ, worked with Resource Protection Program for three months studying chrysomelids in Tasmania.

  Dr Caroline Preston, Dept of Soil and Forest Science, University of British Columbia, USA, visited the tropical soils research group at Griffith University and QFRI for two weeks and contributed to research on ^{13}C and ^{15}N NMR technology in study of soil nutrition.

Some of the contributers to the Eucalypt Genome Round-Table. Back (left to right): Dr D Grattapaglia, Dr D Verhaegen, Prof C Marino, Dr M Shephers, Dr B Potts, Dr R Vaillancourt, Dr C do Valle. Front: Dr M Byrne, Dr D Marshall.

  Prof Don Field, University of Wisconsin, USA, visited Dr A Fulton's group in June 1999, to discuss aspects of rural sociology relating to forestry.

  Prof David Powlson, Soil Science Division, Rothamsted Experimental Station, UK, visited Griffith University to discuss soil nutrition and sustainability in agriculture and forestry.

  In addition the CRC had two FAO scholars, Mr Vinod Kumar and Mr Akshay Saxena who spent ten weeks with the CRC and partners.

  A high-level Chinese delegation visited the CRC in Hobart on September 19 1998, led by Madam Prof Tiang, sister to the President of China.

Technology transfer

- In the last year the program ran one symposium, 49 seminars (25 in the normal seminar series and 24 directed specifically at our end-users, denoted 'seminars*' in Table 5), 12 workshops, 3 short courses or field days, and produced 47 technical publications (7 in the CRC Technical Report series, 5 Farm Forestry Fact Sheets and 35 other reports) and 10 news sheets (Hot Off the Seed Bed, Beyond the Black Stump and Pest Off) (for details see Table 5).

- During 1998/99 there were 79 research papers published in refereed journals, 47 unrefereed articles produced, and 13 theses completed.

- There were 46 internodal visits in three months in 1998. If representative of traffic between partners in the CRC, visits would total 184 for 1998/99.

Major events designed to meet sectoral needs:

- In association with FT and PFT the CRC developed the Farm Forestry Toolbox, included in which is a model adapted from the CRC ProMod program for use by farmers. It was launched in May 1999.

- The 'Molecular Genetics of *Eucalyptus*' Symposium was held in Hobart in February 1999. This provided an important forum for developing national and international collaboration in the molecular genetics of eucalypts.

Table 4: Supervisors of CRC students and the number of students they supervise

Supervisors					
Dr G Allen Ag Sci UT	1	Dr B Greaves Plant Sci UT	2	Dr G Nikles* QFRI	2
Dr P Barker* NPWS	1	Dr K Harding* QFRI	1	Prof R Pearce Birmingham Uni (UK)	2
Dr M Battaglia* CSIRO FFP	1	Prof R Henry SCU	2	Dr E Pinkard* FT	1
Dr C Beadle* CSIRO FFP	8	Mr J Hickey* Forestry Tas	1	Dr B Potts* CRC	11
Dr S Berners-Price GU	1	Prof R Hill Plant Sci UT	1	Ms C Raymond* CSIRO-FFP	1
Dr N Borralho* CRC	4	Dr G Holz* NFP	1	Prof J Reid Plant Sci UT	2
Dr M Brown* Forestry Tas	2	Dr M Hovenden Plant Sci UT	2	Dr P Ryan CSIRO FFP	1
Dr P Brown Ag Sci UT	1	Dr M Hunt* QFRI	1	Ass Prof P Saffigna GU	4
Dr E Bruce Geog Env St UT	1	Dr M Hurley Ag Sci UT	2	Dr M Shepherd* CRC	2
Prof R Clark Ag Sci UT	2	Dr R James ANU	2	Dr P Smethurst* CSIRO FFP	3
Dr A Clarke UQ	3	Prof P Kanowski ANU	3	Dr A Specht SCU	1
Dr N Davidson* CRC	5	Dr G Kile* CSIRO-FFP	1	Dr M Statham* DPIF	3
Dr M Dieters* QFRI	3	Dr D Lee* QFRI	2	Dr R Vaillancourt Plant Sci UT	8
Dr D de Little* NFP	2	Dr B Li NCSU (USA)	1	Dr H Wallace USC	2
Dr D Doley UQ	1	Dr J Madden Ag Sci UT	3	Dr R Wiltshire Plant Sci UT	2
Dr H Dungey* QFRI	2	Dr C McArthur* CRC	3	Dr Z Xu* QFRI	5
Dr H Elliott* Forestry Tas	1	Dr P McQuillan Geography UT	2		
Dr R Floyd* CSIRO Ento	1	Prof R Menary Ag Sci UT	2		
Ms A Fulton Ag Sci UT	2	Dr N Mendham Ag Sci UT	1		
Dr A Gilmour* NSW Ag	1	Dr C Mohammed Ag Sci UT/CSIRO	5		

*Supervisors who are not university departmental staff.	= 28
International supervisors	= 2
University departmental supervisors	= 26
Total	= 56

- An Annual Meeting of the CRC was held in Burnie in November 1998. This was very successful, with the attendance of 155 staff and students of the CRC. It offered an opportunity for all CRC staff to meet and discuss research and develop links with programs, projects and industrial partners. Presentations were made on themes representing the major operational activities in plantation forestry: pre-establishment (site selection and quality, choice of stock, browsing); establishment (weed management, seedling quality, fertilising); stand management (genetics, nitrogen, water, insect pests); harvesting (impact on soils, slash management, transport costs); and wood quality (wood density, decay, pruning). On the last day CRC staff were divided into eight teams to compete in managing a simulated plantation grown, using a computer model. The exercise was realistic and it was very informative for scientific staff to see the financial consequences of daily decisions made by managers, and for managers to see the consequences of not adopting the best technology.

- Five Farm Forestry Fact Sheets (Farm shelter, Plant genetics and quality, Plan for tree planting, Pruning, Thinning) were produced by the CRC for PFT. These were launched by PFT and the CRC at Agfest in May 1999.

Mr Andy Warner (PFT), Mr Adrian Goodwin (FT) and Dr Michael Battaglia (CRC-SPF) at the launch of the Farm Forestry Toolbox.

Public awareness

- A major text entitled 'Vegetation of Tasmania', written and edited by the CRC in conjunction with UT and FT, was published by Environment Australia (for details see Major Developments).

- In response to a CRC review recommendation that the CRC embark on a project to address the gender imbalance in the forestry industry, the CRC has produced the booklet, '*Her*storey', which encourages women to see forestry as a career path (see Major Developments). The booklet will be distributed to Australian schools. The project was funded through a grant of $26,400 from the Science and Technology Awareness Program.

- Six teaching kits for high school children depicting research questions addressed by the CRC have been completed for distribution with the *Her*storey booklet. Six more kits have been drafted. All kits are being developed in cooperation with the Forest Education Foundation and address a learning activity identified in 'Project Forests'.

- A new CRC web page was launched (http\\www.forestry.crc.org.au).

- In the last year there have been 11 articles in newspapers and industry news-sheets, and 5 items in the electronic media relating to Centre Activities (see Media Activities p 69).

Goals

- Improve rate of adoption of CRC technology by appointing a Forestry Extension Officer to the program (October 1999) who will interact with CRC scientists, operational staff and managers to identify CRC technology most appropriate to each partner.

- Symposium on 'Insect-Eucalypt Interactions' in Canberra in February 2000.

- 'Farm Forestry' Colloquium in Canberra in March 2000.

- Symposium on 'Hybrid Breeding and Genetics' at Noosa, Queensland in April 2000.

- Produce a 'Farm Forestry Technical and Business Handbook', December 2000.

Utilisation and Application of Research

Strategy for the technology transfer program

The principal objective of the Technology Transfer Program is to transfer the technology rapidly to the industrial partners and other end-users. This involves the following steps:-

1. Involvement of industrial partners in planning research projects and running experiments

Most CRC research is conducted using company trials, or trials established on company land, so companies are involved at the outset with the planning and implementation of research projects and have ownership of them. Research plans for these experiments are lodged with the companies, and these include an agreed protocol for the research. The company partners allocate staff time (in-kind contributions) to CRC research projects so effective interaction can occur. The Program Coordination Committees of the CRC retain an overview of these research projects. They prioritise research and set 'deliverables' (research outcomes that can be directly used by industry).

2. Early transfer of results

The early transfer of results starts with informal interactions (phone, fax, E-mail and visits to company sites). Formal transfer starts with a faxed summary of the applications of recent research as an A4 page entitled 'Hot Off the Seedbed' (Genetic Improvement Program), 'Beyond the Black Stump' (Sustainable Management Program) or 'Pest Off' (Resource Protection Program). Company responses will then determine whether it is best to organise a seminar, workshop, short course or field day on the topic. Later stages of transfer are through technical reports, unrefereed papers and refereed journal papers. For details see Table 5.

3. Development of training courses in modern forestry techniques for company staff and other end-users of CRC research

- Examples of technical training courses run by the CRC this year include: a 'Molecular Genetics and Molecular Markers' course run by Dr R Vaillancourt, which was a pre-symposium course associated with the 'Molecular Genetics of *Eucalyptus*' Symposium; an 'Introduction to Arcview' course, run by Mr G Dutkowski; three ASREML workshops run by Mr G Dutkowski; a workshop on wildlife biology techniques run by Ms K le Mar; and a field day on nutrition of tropical soils run by Assoc Prof Paul Saffigna.

- Technology transfer also occurs through the training provided by the CRC to their postgraduates. Recent PhD graduates transfer new technology to their employer. There are eight company staff enrolled in PhD and MSc courses while still employed: Mr T Wardlaw (Forest Pathologist, FT); Mr S Candy (Statistician, FT); Mr P Kube (Tree Breeder, FT); Mr P Volker (Consultant, Serve-Ag); Mr R Peacock (Research Scientist, Dept Planning, NSW); Mr C Hawkins (Forester, BTT), Mr Daryl Mummery (Experimental Scientist, CSIRO-FFP), and Mr M Neyland (Research Officer, FT). Three resigned their positions to conduct research but intend returning to industry; Mr G Dutkowski (Technical Manager, BTf), Mr P Adams (Research Forester, SA DPI) and Ms J Medhurst (Project Officer, FT). Further, there are 11 of our students on scholarships supported by industry (see Table 3).

- The success of our students in obtaining employment in the forest industry was demonstrated by appointments over the last two years: Dr H Dungey (Geneticist, QFRI), Dr M Hunt (Silvicultural Officer, QFRI), Ms N Papworth (Botanist, Botanical Gardens), Dr L Pinkard (Communication Officer, FT), Dr D Mendham (Research Scientist, CSIRO-FFP, WA), Dr M Steinbauer (Postdoctoral fellow, CRC-SPF with CSIRO Entomology, Canberra), Ms N Marsh (Extension Officer, Biology and Conservation Branch, FT), Dr Xianming Wei (Postdoctoral fellow, CSIRO Plant Industry, Merbein, Victoria), and Ms J Dingle (Technical Officer, FT).

Table 5: Technology Transfer Activities

Date	Function	Topic	Reach	Pgm	Time (days)
1998					
July	Seminar* AFG SCU	Changes in productivity after pruning and thinning. J Medhurst, L Pinkard and C Beadle	120	SMP	1
July	Meetings	Eight meetings during the year with operations staff and TFGA on Browsing Damage Management. C McArthur	80	RPP	8
Aug	Workshops	Six farm forestry workshops presented in association with PFT and GA.	240	ETT	6
Aug	Seminar* NET	Just how diverse is Tasmanian blue gum. B Potts, G Dutkowski	15	GIP	0.5
Aug	Meeting	Discussion of progress of all projects. Northern Node meeting	30	SMP GIP	1
Sept	Workshop Gympie	ASREML Forestry Workshop. G Dutkowski	4	GIP	3
Sept	Seminar* SCU	Quantitative and molecular genetics of *E. globulus*. B Potts	23	GIP	
Sept	Seminar* N Tasmania	Browsing damage in plantations. J Bulinski	20	RPP	
Sept	Seminar* RWG 5	Use of process-based models for silviculture. M Battaglia, P Sands	20	SMP	
Sept	Seminar* CSIRO-FFP	Molecular approaches to population genetics of *E. globulus*. B Potts	25	GIP	
Sept	Seminar* QFRI	Exploitation of eucalypt base populations. B Potts	25	GIP	
Oct	Workshop Hobart	ASREML Forestry Workshop. G Dutkowski	4	GIP	2
Oct	Seminar* STBA	Genetics of multi-stemming in *E. globulus*. G Dutkowski	15	GIP	
Nov	Seminar*	Managing in a changing environment. R Haines	30	ETT	
Nov	CRC Annual Meeting	Meeting of all CRC staff to develop cross-program and cross-institutional links and cement links with industry.	155	ETT	3
Nov	Seminar* STBA	Breeding strategy for *E. globulus*. G Dutkowski	30	GIP	
Nov	Seminar* STBA	Geographic variation of *E. globulus*. G Dutkowski, B Potts	30	GIP	

Nov	Seminar* STBA	*E. globulus* base populations. P Gore, G Dutkowski	30	GIP	
Nov	Pest Off 2	Fire blight beetles on acacias. T Simmul, M Steinbauer	80	RPP	
Dec	Meeting	Presentations in N nutrition for Northern Node meeting	30	SMP	1
1999					
Jan	CRC Technical Reports	No. 10 Runoff, soil and nutrient losses. U Cakurs, B Yu			
		No. 11 Productivity predictions for drought prone WA. C Shedley, M Battaglia, C Baillie, P Smethurst			
		No. 6 GXE interactions for basic density. A Muneri, C Raymond			
		No. 7 Modelling timber supply. S Jennings, A Matysek			
Feb	Workshop Indooroopilly	The forest model 3-PG and its use.	35	SMP	2
Feb	Seminar* STBA	Distribution of the O'Connor *E. nitens* base pops. G Dutkowski	30	GIP	
Feb	Course	Molecular genetics and molecular markers. R Vaillancourt	24	GIP	1
Feb	Symposium	Molecular genetics of *Eucalyptus*.	80	GIP	2
Feb	International Collaboration	'Eucalypt genome initiative'. R Vaillancourt	20	GIP	1
Feb	Beyond the Black Stump	No. 11 Measurement of leaf area index in *E. nitens*. M Cherry	100	SMP	
Feb	Hot off the Seedbed	Phase change in blue gums. G Jordan, B Potts, R Wiltshire	100	GIP	
Feb	Field day	Nutrition of tropical soils.	35	SMP	
Feb	Seminar* STBA	Breeding strategy for *E. globulus*. G Dutkowski	15	GIP	
March	Launch	Launch of Farm Forestry Toolbox.	31	SMP	1
March	Workshop	Northern Node meeting at SCU.	30	SMP, GI	1
March	Beyond the Black Stump	No. 12 Soil P analyses guide fertiliser needs at planting. P Smethurst	100	SMP	
March	Beyond the Black Stump	No. 13 Hybrid model to schedule pruning. M Battaglia, L Pinkard	100	SMP	

March	Research Colloquium ANU	Presentations by ANU forestry researchers and collaborators	200	SMP	
March	Release	ProMod is released as part of Farm Forestry Toolbox CD	500	SMP	
March	CRC Technical Reports	No. 14 Trial establishment P Tilyard, B Potts, R Vaillancourt		GIP	
		No. 15 Antimicrobial defences in wood. K Barry, R Pearce, C Mohammed		RPP	
March	Seminar* NE Tasmania	Socioeconomics of commercial farm forestry. J Schirmer	120	SMP	1
April	Book	Vegetation of Tasmania	1000	ETT	
April	Fact Sheets	1. Farm shelter	500	SMP	
		2. Plant genetics and quality	500	GIP	
		3. Plan for tree planting	500	SMP	
		4. Pruning	500	SMP	
		5. Thinning	500	SMP	
April	Workshop	Wildlife biology techniques. K le Mar	55	RPP	3
April	Seminar* Ballarat	Browsing research in plantations. C. McArthur	40	RPP	
April	Seminars*	Research on mammal browsing. C McArthur. Effectiveness of poisoning. K le Mar	40	RPP	
May	Booklet	*Her*story, women in forestry	3000	ETT	
May	Open day	Discovery day at UT:-			
		Launch of *Her*storey. J Burrell	80	ETT	1
		Entomology in forestry. G Allen, T Simmul	70	RPP	
May	Display Agfest	Launch fact sheets on farm forestry, and showcase for Farm Forestry Toolbox CD. G Dutkowski, J Medhurst, M Cherry	200	GIP SMP	4
May	CRC Technical Report	No. 16 GXE interactions for pulp yield. C Raymond, L Schimleck, A Muneri, A Mitchell.		GIP	
May	Seminar* ABRI	Data models for tree breeding. G Dutkowski	3	GIP	2
May	Workshop Hobart	ASREML Forestry Workshop. G Dutkowski	30	GIP	1
May	Course Hobart	Introduction to Arcview. G Dutkowski	10	GIP	2
June	Hot off the Seed Bed	Single visit controlled pollination. D Williams, B Potts	100	GIP	

June	Beyond the Black stump	No. 13 Fertiliser placement and inclusion of K at planting. P Smethurst	100	SMP	
June	Beyond the Black stump	No. 14 N losses in hoop pine plantations. P Saffigna, G Pu	100	SMP	
June	Seminars* RWG	1. Managing access to native Australian gene resources. R Haines 2. Forest biotechnology. G Moran 3. Threats to native gene resources. B Potts 4. Wood properties. C Raymond 5. *E. nitens* breeding. W Tibbits 6. Issues in tree breeding. G Dutkowski	30	GIP	1
June	Meeting	Tasmanian forest entomologists	9	RPP	0.5
June	Seminar* TIAR	Forestry research. Launceston G Allen	140	RPP	0.5

Note: Seminar* are seminars conducted specifically for end users of CRC technology

Table 6: Major Technology Transfer Activities proposed for 1999/00

Date	Function	Topic	Reach	Pgm.	Time (days)
1999					
Sept	Workshop	Near infrared reflectance analysis	100	GIP	2
Oct	Conference	Institute of Foresters of Australia (CRC managed field day)	200	SMP	1
2000					
Feb	Symposium	'Eucalypt-insect interactions'	150	RPP	2
March	Forestry Colloquium	'Socio-economic research to create successful farm forestry'	200	SMP	3
April	Symposium	'Hybrid breeding and genetics'	150	GIP	5
May	Display	CRC display at Agfest	200	ETT	4
Dec	Handbook	'Business and technical handbook for farm foresters'	2000	ETT	

Industrial Uptake

In each program there have been new technologies developed which have been transferred to industrial partners and other end-users:

Genetic Improvement

- The new single visit pollination procedure developed for *E. globulus* by Mr D Williams and Dr B Potts is now in operational use in the STBA breeding program and will be tested in new seed production systems. This system could reduce the cost of controlled pollination by at least one half.
- Close collaboration with the STBA (which is the breeder for many CRC members) has been maintained and built upon by CRC staff and partners. Mr G Dutkowski, Ms S Hetherington and Mr R Breidahl were elected to the STBA Board.
- Genetic parameters estimated in Projects A1 and A3 are being used to guide the STBA breeding strategy.
- The racial classification developed by Mr G Dutkowski and Dr B Potts of the CRC has been used in breeding value prediction by BTf and NFP.

Research team from Bunnings Treefarms: Tony Smith , Mason Kucharski, Mike Booth, Julie Cox and David Pilbeam.

- Software developed by Mr G Dutkowski of the CRC which accounts for selfing in the creation and inversion of the additive relationship matrix has been used in the prediction of breeding values by BTf and NFP.
- Courses presented, or advice given, by Mr G Dutkowski of the CRC has resulted in the uptake, or increased usage, of the ASREML software by Dr W Tibbits (NFP), Mr P Kube (FT), Dr T McRae (STBA), Dr H Dungey (QFRI) and Ms C Raymond (CSIRO-FFP and Project A3).
- Forestry Tasmania regularly has a staff member running cellulose contents for *E. nitens* progeny using facilities in the CSIRO/CRC building in Hobart for collaborative projects.
- Cost benefit analyses for different sampling methods for wood density and pulp yield are being evaluated by STBA and industrial partners.
- A joint whole-tree pulping project with FT and NFP is being conducted to confirm the use of cellulose content and near infrared reflectance analysis of core samples as a reliable predictor of whole tree pulp yields.
- Genetic parameters were used to select clones for establishment of new clonal seed orchards to produce F_2 seed of *P. caribaea* var *hondurensis* x *P. tecunumanii* and x *P. oocarpa* hybrids. F_1 parents were selected on the basis of predicted breeding values that utilised genetic parameter estimates from the program. These orchards (1.5 ha of each hybrid) are planted at Kennedy, in far North Queensland, and contain 30 clones.
- Hybrid breeding values estimated for *P. elliottii* and *P. caribaea* var *hondurensis* have been used to rank families used in the operational family forestry programs with the *P. elliottii* x *P. caribaea* var *hondurensis* hybrid, and to guide the development of operational crossing progams to produce seed for future clonal tests and production of hybrid families for deployment on 'wet sites' in SE Queensland.

Sustainable Management Program

- Substantial uptake by industry is now occurring following recommendations based on previous research with:
  - Reduced use of deep ripping following the demonstration that it is not a routine requirement.
  - Phosphorus applications restricted to 'at-planting'.
  - Increased usage of N applications at 2-6 years in temperate eucalypt plantations.
  - Refinement of the use of herbicides to include strip or spot weed control options.
- The recommended calcium chloride extraction method for P analysis of soils to determine P-fertility 'at-planting' (see 1997/98 Annual Report and Major Developments in this Report) has been accepted by a number of partner organisations and is now being offered by two commercial laboratories.
- Permanent sampling plots established by the CRC for PFT are an integral part of growth and yield predictions in their new plantings of *P. radiata* on low rainfall sites.

Ms Jane Medhurst presents results from research on thinning of plantations for solid wood production to foresters at a field day in Southern Forests, Tasmania.

- Data from biomass harvests in *E. obliqua* forests are now being used by the Bureau of Resource Sciences as part of the development of biomass equations for the National Forest Inventory.
- PFT has included ProMod as a decision support system in its Farm Forestry Toolbox.
- Data exchange agreements with FT and NFP have been executed for the further development of ProMod for *P. radiata* and *E. nitens*.
- ProMod and work on pruning decay was used to develop pruning prescriptions for FT.
- A productivity prediction system for drought-prone regions of south-western Australia is being used by BTf.
- An empirical growth model developed for *E. globulus* in south-western Australia is being used by BTf.
- Expertise within the program has been used to produce technical information sheets for farmers in conjunction with PFT.

Resource Protection Program

- Planting of small blocks of tree species that are more attractive to chrysomelid leaf beetles (trap trees) has continued by FT in newly-established *E. nitens* and *E. globulus* plantations to reduce monitoring time, by using them for early warnings of high populations of leaf beetles.
- Forestry Tasmania has modified the monitoring system it uses for IPM of chrysomelid leaf beetles. This follows the recommendations of economic thresholds from models which relate population levels to damage and growth of trees.
- Systems for monitoring browsing damage in newly established eucalypt plantations are now being developed in FT, based in part on recommendations from CRC Technical Report No. 9.
- Forestry Tasmania is considering problems associated with decay when formulating pruning prescriptions.

Staffing and Administration

Staffing

During 1998/99 there have been a number of changes. On the Board, Prof Andrew Glenn has replaced Prof Allan Canty as the UT representative, and Mr Ron Beck has replaced Mr Peter Francis for PIC. A long standing partner with the CRC, ANM changed its name to Fletcher Challenge Paper (FCP). Ms Sandra Hetherington (FCP) is the new Chair of the Sustainable Management Program Coordinating Committee and replaces Ms Silvia Pongracic (APP). There have also been changes of partner representatives on all Program Coordinating Committees. There were two changes of Program Manager: Dr Clare McArthur was appointed as Program Manager of the Resource Protection Program to replace Dr Robert Floyd and Dr Brad Potts was appointed as Program Manager of the Genetic Improvement Program to replace Dr Nuno Borralho.

Amongst the scientific staff, Dr Guixin Pu was appointed research fellow at GU and Ms Anna Matysek commenced as part-time research assistant in the Sustainable Management Program at UT. Ms Ann Wilkinson, Mr Hugh Fitzgerald and Ms Julianne O'Reilly were appointed to the technical staff at the UT. Mr Paul Keay was appointed to the technical staff at QFRI and Mr Tim Blumfield spent time as administrative assistant at GU. Ms Jane Burrell left the Education and Technology Transfer Program in Hobart.

Four PhD students; Mark Hunt, Daniel Mendham, James Bulinski and Zoltan Lukacs, and nine honours students completed their degrees this year with the CRC.

Twelve new PhD/MSc students commenced this year; Mr Timothy Blumfield, Mr Uldis Cakurs, Ms Diane Connell, Ms Alieta Eyles, Mr Carl Grosser, Mr Craig Hawkins, Mr Amal Joseph, Mr Dominic Kane, Ms Alicia Mollon, Ms Helen Nahrung, Mr Anthony Rice, Mr Timothy Tabart and Mr Paul Toon.

Administration

The number of meetings held by the Board and other committees during 1998/9, were as follows:

Board of Management	3
Management Committee	10
Advisory Panel	2
Program Coordinating Committees	
Genetic Improvement	2
Sustainable Management	2
Resource Protection	3

SPECIFIED PERSONNEL

Title and Name	Contributing Organisation	% time in CRC	Role
Prof James Reid	University of Tasmania	50	Director
Dr Russell Haines	Primary Industries Corp (QFRI)	50	Deputy Director
Dr David de Little	North Forest Products Limited	30	Chair, Advisory Panel
			Program Managers
Dr Chris Beadle	CSIRO Forestry and Forest Products	80	Sustainable Management
Dr Clare McArthur	CRC/University of Tasmania	100	Resource Protection
Dr Brad Potts	CRC/University of Tasmania	100	Genetic Improvement
Dr Neil Davidson	CRC/University of Tasmania	100	Education & Technology Transfer

Publications

Genetic Improvement Program

Refereed Publications

Borralho, N.M.G. and Dutkowski, G.W. (1998). Comparison of rolling front and discrete generation breeding strategies for trees. Canadian Journal of Forest Research 7, 987-993.

Dutkowski, G.W. and Potts, B.M. (1999). Geographical patterns of genetic variation in *Eucalyptus globulus* ssp. *globulus* and a revised racial classification. Australian Journal of Botany 5, 237-263.

Hardner, C. and Tibbits, W. (1998). Inbreeding depression for growth and fecundity traits in *Eucalyptus nitens*. Forest Genetics 5, 11-20.

Jackson, H.D., Steane, D.A., Potts B.M., and Vaillancourt R.E. (1999). Chloroplast DNA evidence for reticulate evolution in *Eucalyptus* (Myrtaceae). Molecular Ecology 8, 739-751.

Jordan, G., Potts, B.M. and Wiltshire, R. (1999). Strong, independent quantitative genetic control of vegetative phase change and first flowering in *Eucalyptus globulus* ssp. *globulus*. Heredity 83, 179-187.

McKinnon, G.E., Steane, D.A., Potts, B.M. and Vaillancourt R.E. (1999). Incongruence between chloroplast and species phylogenies in *Eucalyptus* subgenus *Monocalyptus* (Myrtaceae). American Journal of Botany 86, 1038-1046.

Ruaud, J.N., Lawrence, N., Pepper, S., Potts, B.M. and Borralho, N.M.G. (1999). Genetic variation of *in vitro* rooting ability with time in *Eucalyptus globulus*. Silvae Genetica 48, 4-7.

Raymond, C.A., Banham, P. and MacDonald, A.C. (1998). Within tree variation and genetic control of basic density, fibre length and coarseness in *Eucalyptus regnans* in Tasmania. Appita 51, 299-305.

Raymond, C.A., Muneri, A. and MacDonald, A.C. (1998). Non-destructive sampling for basic density in *Eucalyptus globulus* and *E. nitens*. Appita 51, 224-228.

Schimleck, L.R., Michell, A.J., Raymond, C.A. and Muneri, A. (1998). Assessment of the pulpwood quality of standing trees using near-infrared spectroscopy. Journal of Near Infrared Spectroscopy 6(1-4), A117-A123.

Schimleck, L.R., Michell, A.J., Raymond, C.A. and Muneri, A. (1999). Estimation of basic density of *Eucalyptus globulus* using near-infrared spectroscopy. Canadian Journal of Forest Research 29(2), 194-201.

Shepherd, M. and Henry, R. (1998). Monitoring of fluorescence during DNA melting as a method for discrimination and detection of PCR products in variety identification. Molecular Breeding 4, 509-517.

Skabo, S., Vaillancourt, R.E. and Potts, B.M. (1998). Fine-scale genetic structure of *Eucalyptus globulus* ssp. *globulus* forest revealed by RAPDs. Australian Journal of Botany 46, 583-594.

Vaillancourt, R.E., Skabo, S. and Gore, P. (1998). Fingerprinting for quality control in breeding and deployment. Australian Forestry 61, 208-211.

Wei, X. and Borralho, N.M.G. (1998). Genetic control of growth traits of *Eucalyptus urophylla* Blake, S.T. in South East China. Silvae Genetica 47, 158-165.

Whitham, T.G., Martinsen, G.D., Floate, K.D., Dungey, H.S., Potts, B.M. and Keim, P. (1999). Plant hybrid zones affect biodiversity: Tools for a genetic-based understanding of community structure. Ecology 80, 416-428.

Williams, D.R., Ross, J.J., Reid, J.B. and Potts, B.M. (1999). Response of *Eucalyptus nitens* seedlings to gibberellin biosynthesis inhibitors. Plant Growth Regulation 27, 125-129.

In press

Chambers, P. (1999). A simple model to examine the impact of changes in wood traits on the costs of thermo-mechanical pulping and high brightness newsprint production with *Pinus radiata* D. Don. Canadian Journal of Forest Research.

Greaves, B.L., Borralho, N.M.G. and Raymond, C.A. (1999). Early selection for kraft pulp in plantation eucalypts. New Forests.

Muneri, A. and Raymond, C.A. (1999). Non-destructive sampling of *Eucalyptus globulus* and *E. nitens* for wood properties. II. Fibre length and coarseness. Wood Science and Technology.

Raymond, C.A. and Muneri, A. (1999). Non-destructive sampling of *Eucalyptus globulus* and *E.*

nitens for wood properties. 1. Basic density. Wood Science and Technology.

Raymond, C.A., Schimleck, L.R., Muneri, A. and Michell, A.J. (1999). Non-destructive sampling of *Eucalyptus globulus* and *E. nitens* for wood properties. III. Predicted pulp yield using near infrared reflectance analysis. Wood Science and Technology.

Shepherd, M., Chaparro, J.X. and Teasdale, R. (1999). Genetic mapping of monoterpene composition in an interspecific eucalypt hybrid. Theoretical and Applied Genetics.

Steane, D.A., McKinnon, G.E., Vaillancourt R.E. and Potts, B.M. (1999). *Eucalyptus* phylogeny derived from nuclear ribosomal ITS sequence data. Molecular Phylogenetics and Evolution.

Books chapters

Reid, J.B. and Potts, B.M. (1999). Chapter 9. Eucalypt Biology. In 'Vegetation of Tasmania - Flora of Australia Supplementary Series No. 8'. (Eds. J.B. Reid, R.S. Hill, M.J. Brown and M.J. Hovenden.) pp. 198-223. (Australian Biological Resources Study Series: Canberra.)

Potts, B.M. and Pederick, L.A. (1999). Chapter 1.1. Morphology, phylogeny, distribution and genetic diversity of eucalypts. In 'Diseases of Eucalypts and Their Management'. (Eds. P.J. Keane et al.) (CSIRO Publications: Melbourne.) (in press)

Unreferred Publications

Dungey, H.S., Dieters, M.J. and Nikles, D.G. (1999). Hybrid breeding strategies in Forestry: a review. In 'Australian Plant Breeding Conference, Adelaide, South Australia, 19-23 April 1999'. pp. 36-37.

Dutkowski, G.W. (1999). Tree Genetics and Quality. Farm Forestry Fact Sheet 13.

Potts, B.M., Dutkowski, G., Jordan, G. and Vaillancourt, R.E. (1999). Providing a population genetic framework for exploitation of eucalypt genetic resources: The case of *Eucalyptus globulus*. In 'Australian Plant Breeding Conference, Adelaide, South Australia, 19-23 April 1999'. pp. 97-101.

Vaillancourt, R.E. (1999). Molecular genetics and molecular markers. Pre-Symposium course notes CRCSPF Symposium, Hobart, 3rd February 1999. (CRC for Sustainable Production Forestry: Hobart).

Vaillancourt, R. E. and Potts, B.M. (1999). Molecular Genetics of *Eucalyptus*. (Eds.). Program and Abstracts of CRCSPF Symposium, Hobart, 4-5 February 1999. (CRC for Sustainable Production Forestry: Hobart).

Confidential Reports

Dutkowski, G. W., Bail, I., Gore, P. and Powell, M. (1998). *Eucalyptus* realised gains trials design. STBA Technical Report 98-02.

Dutkowski, G.W. (1999). Prediction of breeding values for harvest volume and basic density for seedling seed orchard OPSO5. Bunnings Treefarms.

Greaves, B.L. and Chambers, P. (1999). *Eucalyptus nitens*: The estimation of genetic parameters and breeding values for diameter and pilodyn traits in Trials VRD 56, 57 and 58. STBA.

Knight, J., Harding, K. and Copley, T. (1999). Report 3 & 4 on Stage 1: Slash x Caribbean Pine F1 hybrid structural sawing analysis, and Stage 2: Validation of models predicting sawn wood outcomes. QFRI Research Report. 42 pp.

McClure, L., Cross, M., Shepherd, M. and Henry, R. (1998). Genetic analysis of pine samples to investigate hybrid status. Commercial Report to QFRI. July 1998.

Muneri, A. and Raymond, C.A. (1999). Genetic parameters and genotype-by-environment interactions for basic density, pilodyn penetration and diameter in *E.globulus*. CRC Technical Report No. 12.

Saxena, A.K. and Kumar, V. (1999). Tree breeding and genetic improvement work in Australia. FAO Visiting Scientist Report; Cooperative Research Centre for Sustainable Production Forestry. 66pp.

Raymond, C.A., Schimleck, L.R., Muneri, A. and Michell, A.J. (1999). Genetic parameters and genotype-by-environment interactions for predicted pulp yield and pulp productivity in *Eucalyptus globulus*. CRC Technical Report No. 16.

Tilyard, P., Potts, B.M. and Vaillancourt, R. (1999). CRCSPF Establishment report Trial CRC97.01 (NFP: Trial 97/20.1, File 80.95.0442). 1997 *Eucalyptus globulus* full-sib family clonal trial Caterpillar Road, Strathblane, Tasmania. CRC Technical Report No. 14.

Theses completed

Lawrence, R. (1998). The response of dependent communities to ontogenetic and genetic change in Eucalyptus: The case of the *Eucalyptus globulus* x *nitens* hybrid system. Honours Thesis, University of Tasmania.

Turner, T. (1999). *Eucalyptus risdonii* rules. Honours Thesis, University of Tasmania.

Mellick, R (1999). Optimal primer design for PCR amplification of microsatellite loci from the Myrtaceae family. Honours minor thesis I. Southern Cross University, School of Resource Management.

Mellick, R (1999). The efficiency of cross-species transfer of microsatellite markers in Myrtaceae. Honours minor thesis II, Southern Cross University, School of Resource Science and Management.

Sustainable Management Program

Refereed publications

Battaglia, M., Cherry, M.L., Beadle, C.L., Sands, P.J. and Hingston, A. (1998). Leaf area index prediction in eucalypt plantations: accommodating the effects of water stress and temperature. Tree Physiology. 18, 521-528.

Battaglia, M. and Sands, P.J. (1998). Application of sensitivity analysis to a model of *Eucalyptus globulus* plantation productivity. Ecological Modelling 111, 237-259.

Battaglia, M., Sands, P.J. and Candy, S.G. (1999). Hybrid growth model to predict height and volume growth in young *Eucalyptus globulus* plantations. Forest Ecology Management. 120, 193-201.

Cherry, M.L., Hingston, A., Battaglia, M. and Beadle, C.L. (1998). Calibrating the LI-COR LAI-2000 for estimating leaf area index in eucalypt plantations. Tasforests 10, 75-82.

Guinto, D. F., House, A. P. N., Xu, Z.H. and Saffigna, P.G. (1999). Impacts of repeated fuel reduction burning on tree growth, mortality and recruitment in mixed species eucalypt forests of southeast Queensland, Australia. Forest Ecology and Management. 115, 13-27.

Guinto, D.F., Saffigna, P.G., Xu, Z.H., House, A.P.N. and Perera, M.C.S. (1999). Soil nitrogen mineralisation and organic matter composition revealed by 13C NMR spectroscopy under repeated prescribed burning in eucalypt forest of south-east Queensland. Australian Journal of Soil and Research. 37, 123-135.

Hovenden, M. and Warren, C.R. (1998). Photochemistry, energy dissipation and cold-hardening in *Eucalyptus nitens* and *E. pauciflora*. Australian Journal of Plant Physiology. 25, 581-589.

Hunt, M.A. and Beadle, C.L. (1998). Whole tree transpiration and water use partitioning among *Eucalyptus nitens* and *Acacia dealbata* weeds in a short-rotation plantation in north-east Tasmania. Tree Physiology. 18, 557-563.

Hunt, M.A., Unwin, G.L. and Beadle, C.L. (1999). Effects of naturally-regenerated *Acacia dealbata* on the productivity of a *Eucalyptus nitens* plantation in Tasmania. Forest Ecology and Management. 117, 75-85.

Misra, R. K. (1999). Root and shoot elongation of rhizotron-grown seedlings of *Eucalyptus nitens* and *Eucalyptus globulus* in relation to temperature. Plant and Soil. 206, 37-46.

Mummery, D., Battaglia, M., Beadle, C.L., Turnbull, C.R.A. and McLeod, R. (1998). An application of terrain and environmental modelling in a large-scale forestry experiment. Forest Ecology and Management. 118, 149-159.

Pinkard, E.A., Battaglia, M., Beadle, C.L. and Sands, P.J. (1999). Impact of physiological responses to green pruning on net biomasss production of *Eucalyptus nitens* (Deane and Maiden) Maiden. Tree Physiology. 19, 1-12.

Pinkard, E.A. and Beadle, C.L. (1998). Regulation of photosynthesis of *Eucalyptus nitens* (Deane and Maiden) Maiden following green pruning. Trees: Structure and Function 12, 366-376.

Pinkard, E.A. and Beadle, C.L. (1998). Above-ground biomass partitioning and crown architecture of *Eucalyptus nitens* (Deane and Maiden) Maiden following green pruning. Canadian Journal of Forest Research. 28, 1419-1428.

Race, D. (1999). Regional farm forestry industries: potential dimensions and possible outcomes. Australian Forestry. 62, 182-192.

Sands, P.J., Rawlins, W. and Battaglia, M. (1999). Use of a simple plantation productivity model to study the profitability of irrigated *Eucalyptus globulus*. Ecological Modelling 117, 125-141.

Smethurst, P.J., Line, M.A. and Moroni, M.T. (1998). Soil microbial biomass and activity in two eucalypt plantation soils after fertilisation. Tasforests 10: 60-73.

Smethurst, P.J. and Wang, B.P. (1998). Soil solution phosphorus and *Eucalyptus nitens* roots in NP-treated microsites in highly phosphorus-fixing soil. New Zealand Journal of Forest Science. 28, 140-151.

White, D.A., Beadle, C.L., Sands, P.J., Worledge, D. and Honeysett J.L. (1999). Quantifying the effect of cumulative water stress on stomatal conductance of *Eucalyptus globulus* and *E. nitens*. Australian Journal of Plant Physiology. 26, 17-27.

White, D.A., Beadle, C.L., Worledge, D., Honeysett, J.L. and Cherry, M.L. (1998). The influence of drought on the relationship between leaf and conducting sapwood area in *Eucalyptus globulus* and *Eucalyptus nitens*. Trees 12, 406-414.

Worledge, D., Honeysett, J.L., White, D.A., Beadle, C.L. and Hetherington, S.J. (1998). Scheduling irrigation in plantations of *Eucalyptus globulus* and *E. nitens*: a practical guide. Tasforests 10, 91-101.

In press

Garnett, T.P. and Smethurst, P.J. (1999). Ammonium and nitrate uptake by *Eucalpytus nitens*: effects of pH and temperature. Plant and Soil.

Guinto, D.F., Xu, Z.H., House, A.P.N. and Saffigna, P.G. (1999). Assessment of N_2 fixation by understorey acacias in recently burnt eucalypt forests in subtropical Australia using ^{15}N isotope dilution techniques. Canadian Journal of Forest Research.

Hunt, M.A., Beadle, C.L. and Cherry, M.L. (1999). Allometric relationships between stem variables and leaf area in planted *Eucalyptus nitens* (Deane & Maiden) Maiden and naturally regenerating *Acacia dealbata* Link. New Zealand Journal of Forest Research.

Hunt, M.A. and Hodson, S.L. (1999). Accurate area determination of complex leaves using digital image analysis. Australian Journal of Plant Physiology.

Medhurst, J.L., Battaglia, M., Cherry, M.L., Hunt, M.A., White, D.A. and Beadle, C.L. (1999). Allometric relationships for *Eucalyptus nitens* (Deane and Maiden) Maiden plantations. Trees.

Raymond, C.A. and Muneri, A. (1999). Effect of fertilser on wood properties of *Eucalyptus globulus*. Canadian Journal of Forest Research.

Smethurst, P.J. (1999). Soil solution and other soil analyses as indicators of nutrient supply. Forest Ecology and Management.

Smethurst, P.J., Matschonat, G., Ballard, L.M. and Dingle, J.K. (1999). Phase partitioning of ammonium in Australian and European forest soils. Communications in Soil Science and Plant Analysis.

Books and book chapters

Beadle, C.L. (1999). Forest production. In: 'Plants in Action' (B.J. Atwell, P.E. Kriedemann and C.G.N. Turnbull, eds) pp 404-5 and 409-10. MacMillan-Melbourne.

Downes, G.M., Beadle, C.L., Gensler, W., Mummery, D. and Worledge, D. (1999). Diurnal variation and radial growth of stems in young plantation eucalypts: a preliminary study. In: 'Tree-ring analysis' (R.Wimmer and R.E. Vetter, eds). CAB International. (In press).

Kriedemann, P.E. and Sands, P.J. (1999). Growth analysis: a quantitative approach. In: 'Plants in Action' (B.J. Atwell, P.E. Kriedemann and C.G.N. Turnbull, eds) pp 186-220. MacMillan-Melbourne

Unrefereed publications

Beadle, C.L. (1999). Farm Shelter. Farm Forestry Fact Sheet No. 9. Private Forests Tasmania.

Beadle, C.L. and Hall, M.H. (1999). Pruning. Farm Forestry Fact Sheet No 20. Private Forests Tasmania.

Beadle, C.L. and Medhurst, J.L. (1999). Thinning. Farm Forestry Fact Sheet No. 21. Private Forests Tasmania.

Cakurs, U. and Yu, B. (1998). Run-off, soil and nutrient losses - experiment 585 IMB. CRC Technical Report No.10.

Queensland RFA/CRA Steering Committee (1998). Commercial plantation land capability analysis of South East Queensland. Queensland Government and Commonwealth of Australia, Forests Taskforce, Department of Prime Minister and Cabinet, Canberra. (September 1998).

Race, D. and Buchy, M. (1998). Community participation for Australian forestry. Proceedings Australian Forest Growers Conference 'Plantation and regrowth forestry' (R. Dyason *et al.*, eds.) pp 373-382.

Raymond, C.A. (1998). Wood properties, silviculture and growth: a review of published literature for eucalypts. CRC Technical Report No. 6.

Raymond, C.A. and Muneri, A. (1998). Effect of fertiliser on wood properties and diameter of *Eucalyptus globulus*. CRC Technical Report No. 3.

Shedley, C., Battaglia, M., Baillie, C. and Smethurst, P. J. (1998). Productivity prediction system for drought-prone regions of south-western Australia. CRC Technical Report No. 11.

Smethurst, P.J. (1998). Slash management in temperate eucalypt plantations: a mini-review. CRC Technical Report No. 1.

Smethurst, P.J. (1998). Post-canopy-closure nutrient management in temperate eucalypt plantations: mini-review and research strategy. CRC Technical Report No. 2.

Jennings, S.M. and Matysek, A.L. (1999). Private forest timber supply modelling - methodology review. CRC Technical Report No. 13.

Confidential reports

Savva, M. and Beadle, C.L. Collection and analysis of data for estimates of tree growth on cleared farmland in lower rainfall areas of Tasmania. Consulting Report (Private Forests Tasmania) (September 1998 and March 1999).

Savva, M. and Beadle, C.L. Generalised allometric equations for estimating the above-ground biomass for Australia's forests and woodlands - destructive harvesting of *Eucalyptus obliqua* in Tasmania. Consulting Report (Bureau of Resource Sciences) (December 1998).

Smethurst, P.J. Revised fertiliser prescriptions for Australian Paper Plantations pine and eucalypt plantations. Client Report. (July 1998).

Theses completed

Blumfield, T. (1998). The impact of residue management techniques in the hoop pine plantations of southeast Queensland. Honours Thesis, Griffith University.

Connell, D. (1998). The comparative effects of waterlogging on the plantation eucalypts *Eucalyptus globulus, E. nitens* and *E. regnans*. Honours Thesis, University of Tasmania.

Hunt, M. (1999). Competition between plantation *Eucalyptus nitens* (Deane and Maiden) Maiden and naturally regenerating *Acacia dealbata* Link. PhD Thesis. University of Tasmania.

Mendham, D. (1998). Predicting phosphorus limitations in eucalypt plantations. PhD Thesis. University of Tasmania.

Mollon, A. (1998). The role of water stress on mixed species stands of *Eucalyptus obliqua* L'Herit. Honours Thesis, University of Tasmania.

Wiseman, D. (1998). The distribution of nitrogen in the canopy foliage of hoop pine in relation to tree growth and carbon isotope composition. Honours Thesis, Griffith University.

Resource Protection Program

Refereed publications

Beveridge, N. and Elek, J.A. (1999). *Bacillus thuringiensis* var *tenebrionis* shows no toxicity to the predator, *Chauliognathus lugubris* (F.) (Coleoptera: Cantharidae). Australian Journal of Entomology. 38, 34-39.

Bulinski, J. and McArthur, C. (1999). An experimental field study of the effects of mammalian herbivore damage on *Eucalyptus nitens* seedlings. Forest Ecology and Management 113, 241-249.

Clarke, A.R. (1998). Day-degree estimates for the immature stages of the Tasmanian eucalyptus leaf beetle *Chrysophtharta bimaculata* (Olivier) (Coleoptera: Chrysomelidae). Australian Entomologist. 25(3), 77-80.

Clarke, A.R., Paterson, S., and Pennington, P. (1998). *Gonipterus scutellatus Gyllenhal* (Coleoptera: Curculionidae) oviposition on seven naturally co-occurring *Eucalyptus* species. Forest Ecology and Management. 110, 89-99.

Clarke, A.R., Paterson, S.C., and Steinbauer, M.J. (1998). Larval trapping as a means of sampling *Paropsina* (Coleoptera: Chrysomelidae: Chrysomelinae) from *Eucalyptus* forests. Coleoptrist Bulletin. 52, 253-258.

Clarke, A.R., Shohet, D., Patel, V.S., and Madden, J.L. (1998). Over-wintering sites of *Chrysophtharta bimaculata* (Olivier) (Coleoptera: Chrysomelidae) in commercially managed *Eucalyptus obliqua* L'Heritier forest. Australian Journal of Entomology. 37, 149-154.

Crous, P.W., Wingfield, M.J., Mohammed, C. and Yuan, Z.Q. (1998). New foliar pathogens of *Eucalyptus* from Australia and Indonesia. Mycological Research 102 (5), 527-532.

Elek, J.A. (1998). Treatment of adult Coleoptera with a chitin synthesis inhibitor affects mortality and development time of their progeny. Entomologia Experimentalis Applicata. 88, 31-39.

Elek, J.A. (1999). Treatment of both the adult and immature Coleoptera with a chitin synthesis inhibitor affects mortality and development time of their progeny. Entomologia Experimentalis Applicata. 89, 125-136.

Floyd, R.B., Farrow, R.A., Farrell, G.S. and Court, M.M. (1998). Insect feeding on *Acacia mearnsii* in south-east mainland Australia. In: Turnbull, J.W., Crompton, H.R. and Pinyopusarerk, K. (eds). Recent developments in Acacia planting. ACIAR Proceedings No. 82. ACIAR. Canberra. 246-251.

Floyd, R.B. and Raymond, C.A. (1998). Insect resistance of *Eucalyptus* species in Australia. In: Perez, C.S. and Gotor, C.L.P. (eds.). Proceedings of the International Workshop on Forest Pest Management 1997. 249-257

Hunt, J. and Allen, G.R. (1998). Fluctuating asymmetry, call structure and the risk of attack from phonotactic parasitoids in the bushcricket *Sciarasaga quadrata*: (Orthoptera: Tettigoniidae). Oecologia 116, 356-364.

Matthiessen, J.N. and Learmonth, S.E. (1998). Seasonally contrasting activity of African black beetle, *Heteronychus arator* (Coleoptera: Scarabaeidae): implications for populations, pest status and management. Bulletin of Entomological Research. 88, 443-450.

Matthiessen, J.N. and Sumner, M.W. (1998). African black beetle - biological information enhances management options. Golf and Sports Turf Australia. 6, 34-44.

Mohammed, Chillali, Idder Ighili, H., Guillaumin, J.J., Mohammed, C., Lung Escarmant B. and Botton B. (1998). Variation in the ITS and IGS regions of ribosomal DNA among the biological species of European Armillaria. Mycological Research 102 (5), 533-540.

Mohammed, Chillali, Wipf, D., Guillaumin, J.J., Mohammed, C. and Botton B. (1998). Delineation of the European Armillaria species based on the sequences of the internal transcribed spacer (ITS) of ribosomal DNA. New Phytologist 138, 553-561.

Mohammed, C., Savva, M.H. and Hall, M.F. (1998). Reduction of loss from stem decay in *Eucalyptus nitens* plantations grown for saw log and veneer. In Root and Butt Rots of Forest Trees, 9th International Conference on Root and Butt Rots. Carcans-Maubuisson, France Sept.1- 7, 1997. eds. Delatour, C., Marcais, B., Guillaumin, J.J. and Lung-Escarmant, B. INRA Editions, Paris, 429-432.

Ramsden, N. and Elek, J.A. (1998). Life cycle and development rates of the leaf beetle *Chrysophtharta agricola* (Coleoptera: Chrysomelidae) on *Eucalyptus nitens* at two temperature regimes. Australian Journal of Entomology. 37, 238-242.

Steinbauer, M.J. (1998). Host plant phenotype and the impact and development of *Carmenta mimosa*, a biological control agent of *Mimosa pigra* in Australia. Biological Control. 13, 182-189.

Steinbauer, M.J. and Clarke, A.R. (1998). Field observations of dispersion, mating and development of *Amorbus obscuricornis* (Westwood) (Hemiptera: Coreidae). Australian Journal of Entomology. 37, 155-157.

Steinbauer, M.J., Clarke, A.R. and Patterson, S.C. (1998). Changes in eucalypt architecture and the foraging behaviour and development of *Amorbus obscuricornis* (Hemiptera: Coreidae). Bulletin of Entomological Research. 88, 641-651.

Wang, H., Floyd, R.B., Farrow, R.A., Hong, C., Gao, C., Lin, C., Ren, H., Farrell G.S. and Xu, T. (1998). Insect damage on *Acacia mearnsii* in China. In: Turnbull, J.W., Crompton, H.R. and Pinyopusarerk, K. (eds). Recent developments in Acacia planting. ACIAR Proceedings No. 82. ACIAR. Canberra. 240-245.

Yuan, Z.Q., Wardlaw, T. and Mohammed, C. (1999). A sclerotium-forming strain of *Botrytis cinerea* associated with shoot blight of *Eucalyptus globulus* in Tasmania. Australasian Plant Pathology 28, 94.

Yuan, Z. Q. and Mohammed, C. (1998). Ability of ascospores and conidia of *Endothia gyrosa* to infect wounds in *Eucalyptus nitens*. New Zealand Journal of Forestry Science. 28 (3), 316-324.

In press

Bulinski, J. and McArthur, C. (1999). Observer error in counts of Tasmanian macropod scats. Wildlife Research.

Hurley, M. (1999). Foliage Attributes and Growth Dynamics of Stinging Trees (*Dendrocnide* spp.) in northern Australian upland tropical rainforest: implications for herbivores. Australian Journal Botany 48(2).

Steinbauer, M.J. (1999). The population ecology of *Amorbus Dallas* (Hemiptera: Coreidae) species in Australia. Entomology Experimentalis Applicata. (in press).

Yuan, Z.Q. and Mohammed, C. (1999). The pathogenicity of different *Endothia gyrosa* isolates to two major plantation species: *Eucalyptus nitens* and *E. globulus*. Australasian Plant Pathology.

Yuan, Z.Q. and Mohammed, C. (1999). Pathogenicity of fungi associated with stem cankers of eucalypts in Tasmania, Australia. Plant Disease.

Unrefereed publications

Barry, K.M., Savva, M.H., Hall, M.F., Pearce, R.B. and Mohammed, C. (1998). To prune or not to prune? Rot is the question: Antimicrobial defence in *Eucalyptus nitens*. International Congress of Plant Pathology, Edinburgh, August 9 - 16, 1998.

Barry, K.M., Pearce, R.B. and Mohammed, C. (1998). Antimicrobial defence in *Eucalyptus nitens*. 6th Annual Research and development Topics 1998. Royal Australian Chemical Institute. University of Tasmania.

Barry, K., Pearce, R. and Mohammed C. (1999). Initial stages of antimicrobial defence in *Eucalyptus nitens* wood; an integrated study including Nuclear Magnetic Resonance Imaging. CRC Technical Report No. 15.

Bashford, R. (1999). Proceedings of the Autumn Gum Moth Workshop *Mnesampela privata* (Guenee): monitoring and control options, Mildura, 20th - 21st August, 1998.

Elek, J.A., Beveridge, N. and Ramsden, N. (1998). To Bt or not to Bt: Is a *Bacillus thuringiensis*-insecticide suitable for IPM to control leaf beetles in eucalypt plantations. Proceedings of the Sixth Australasian Applied Entomological Research Conference, September 1998, Brisbane, Australia, Vol. 1, 321-335.

Confidential Reports

Baker, S.C. (1998). Inundative release of coccinellid beetles into *Eucalyptus nitens* plantations for biological control of chrysomelid leaf beetles. CRC Technical Report No 7.

Bulinski, J. and McArthur, C. (1998). Browsing damage in Tasmania: research answers to some management questions. CRC Technical Report No.9.

Elek, J.A. and Beveridge, N. (1998). Effect of Fipronil on *Chrysophtharta bimaculata* (Olivier) (Coleoptera: Chrysomelidae) larvae and adults and ladybird, *Cleobora mellyi* (Coleoptera: Coccinellidae), adults. Report to Rhone-Poulenc chemical company.

Elek, J.A., Beveridge, N., Ringrose, C. and Ramsden, N. (1998). Evaluating the effectiveness of Acecap 97 at protecting plantation eucalypts from defoliation by larval and adult leaf beetles, *Chrysophtharta bimaculata* (Olivier) (Coleoptera: Chrysomelidae). Report to Creative Sales Inc, Nebraska, USA.

Floyd, R.B., Wylie, F.R., Old, K., Dudzinski, M. and Kile, G. (1998). Pest risk analysis of *Eucalyptus* spp. at risk from incursions of plant pests and pathogens

through Australia's northern border. Consultancy Report to AQIS.

McArthur, C. and Turner, S. (1998). Feeding trials with brushtail possums and Tasmanian pademelons: implications to forestry. CRC Technical Report No.5.

Books and Book Chapters

Simmul, T.L. and de Little, D.W. (1999). Biology of the Paropsini (Chrysomelidae: Chrysomelinae). Advances in Chrysomelidae. (ed. ML Cox). Backhuys: Leiden.

Foley, W.J., Iason, G.R., McArthur, C. (1999). Role of plant secondary metabolites in the nutritional ecology of mammalian herbivores - how far have we come in 25 years?. Nutritional Ecology of Herbivores. Proceedings of the Vth International Symposium on the Nutrition of Herbivores. (eds H-J G Jung, G C Fahey), pp 130-209. American Society of of Animal Science, Savoy, IL. U.S.

Kay, B.H., Hearnden, M.N. and Hurley, M. (1999) Safe Management and Development of the Ross River Dam, Northern Australia, in relation to Recreation and Health. 123-140 pp. In, Water Resources: Health Environment and Development. Ed. B.H. Kay, Chapman & Hall.

Theses completed

Bulinski, J. (1999). Quantifying and predicting mammalian herbivore damage in Tasmanian eucalypt plantations. PhD Thesis, University of Tasmania.

Lukacs, Z. (1999). Phenology of Autumn Gum Moth. PhD Thesis, University of Tasmania.

Rapley, L. (1998). Larval feeding and pupal diapause of the eucalypt defoliator, autumn gum moth, *Mnesampela privata* (Guen.) (Lepidoptera: Geometridae). Honours Thesis, University of Tasmania.

Yuan, Z.Q. (1998). Stem Canker diseases in Tasmania. PhD Thesis, University of Tasmania.

Public Presentations

Genetic Improvement

Dieters, M.J., Dungey, H.S., Gwaze, D.G., Nikles, D.G. (1998). Correlations between sites for pine hybrids in Australia, Swaziland and Zimbabwe. CAMCORE meeting, Venezuela (October 1998).

Dieters, M.J. (1999). Genetic improvement and gene conservation of Hoop and Klinkii Pines in PNG and Australia. Gympie, Queensland (11th June 1998).

Dungey, H.S. (1998). The Natural Forests and Scenery of Chile. Guest speaker at a meeting of the Institute of Foresters of Australia, Gympie, Queensland (13th October 1998).

Dungey, H.S. (1999). Hybrid breeding strategies in forestry: a review. Talk at Australian Plant Breeding Conference, Adelaide, South Australia (21st April 1999).

Dutkowski, G.W. (1998). ASREML Forestry Workshop, Gympie, Queensland (22-24th September 1998)

Dutkowski, G.W. (1998). ASREML Forestry Workshop, Hobart, Tasmania (22nd October 1998).

Dutkowski, G.W. (1998). Genetics of multi-stemming in *Eucalyptus globulus*. Presentation to STBA Technical Committee Meeting, Melbourne, Victoria (October 1998).

Dutkowski, G.W. (1998). STBA *Eucalyptus globulus* Breeding Strategy. Presentation to STBA Technical Review Day, Mount Gambier, South Australia. (24th November 1998).

Dutkowski, G.W. (1999). Tree Genetics and Quality. Poster at AgFest, Carrick, Tasmania (8th May 1999).

Dutkowski, G.W. (1999). Data models for tree breeding. Presentation at Meeting with ABRI, Armidale, New South Wales (27th May 1999).

Dutkowski, G.W. (1999). Data models for tree breeding. Presentation at Meeting with Melbourne University Forestry Faculty Information Technology for Forest Management, Melbourne, Victoria (28th June 1999).

Dutkowski, G.W. (1999). Issues in tree breeding. Discussion leader for Research Working Group on

Forest Genetics, Melbourne, Victoria (30th June 1999).

Dutkowski, G.W. and McRae, T. (1999). Breeding value prediction for forestry workshop, Armidale, New South Wales (26 - 28th May 1999).

Dutkowski, G.W. and Potts, B.W. (1998). Geographic variation of *Eucalyptus globulus* ssp *globulus* Presentation to STBA Technical Review Day, Mount Gambier, South Australia (24th November 1998).

Dutkowski, G.W. (1999). STBA *Eucalyptus globulus* Breeding Strategy. Presentation to STBA Technical Meeting, Melbourne, Victoria (26th February 1999).

Dutkowski, G.W. (1999). Distribution of the O'Connor *Eucalyptus nitens* base population collection. Presentation to STBA Technical Meeting, Melbourne, Victoria (26th February 1999).

Dutkowski, G.W. (1999). ASREML Forestry Workshop, Hobart, Tasmania (19th May 1999).

Dutkowski, G.W. (1999). Course: Introduction to Arcview - Making maps with Arcview, Hobart, Tasmania (20th May 1999).

Fripp, Y. and Potts, B.M. (1999). Allozyme variation in the rare and endangered Tasmanian endemic *Eucalyptus morrisbyi* Poster presented at CRCSPF Symposium 'Molecular Genetics of Eucalyptus', Hobart, Tasmania (4-5th February 1999).

Gore, P. and Dutkowski, G.W. (1998). *Eucalyptus globulus* base population. Presentation to STBA Technical Review Day, Mount Gambier, South Australia (24th November 1998).

Haines, R. (1999). Managing access to native Australian gene resources. Presentation at Research Working Group on Forest Genetics, Melbourne, Victoria (30th June 1999)

Haines, R. (1999). Potential application of biotechnology to forestry in the Pacific. Presentation at the FAO Meeting on the South Pacific Genetic Resources, West Samoa (April 1999).

Hingston, A. (1999). Techniques for determining the effectiveness of flower visitors to *E. globulus* and *E. nitens* as pollinators. Presentation at Australasian Pollination Ecologists Society (APES) biennial conference, Jurien, Western Australia (21-25th Sept. 1998).

Jackson H.D., Steane, D.A., Potts, B.M. and Vaillancourt, R.E. (1999). CpDNA evidence for the role of hybridisation in *Eucalyptus*. Talk presented at CRCSPF Symposium, 'Molecular Genetics of *Eucalyptus*', Hobart, Tasmania (4-5th February 1999).

McKinnon, G.E., Steane, D.A., Potts, B.M. and Vaillancourt R.E. (1999). Incongruence between chloroplast and species phylogenies in *Eucalyptus* subgenus *Monocalyptus'*. Poster presented at CRCSPF Symposium, 'Molecular Genetics of *Eucalyptus*', Hobart, Tasmania (4-5th February 1999).

Moran, G. (1999). Syntenic mapping and QTL location in eucalypts. Talk presented at CRCSPF Symposium, 'Molecular Genetics of *Eucalyptus*', Hobart, Tasmania (4-5th February 1999).

Moran, G. (1999). Forest Biotechnology. Talk presented to Research Working Group on Forest Genetics, Melbourne, Victoria (29th June 1999).

Potts, B. M., Hardner, C. and Vaillancourt, R. E. (1999). Integrating quantitative and molecular approaches to study forest sub-structure. Talk presented at CRCSPF Symposium, 'Molecular Genetics of *Eucalyptus*', Hobart, Tasmania (4-5th February 1999).

Potts, B. M. (1999). Providing a population genetic framework for exploitation of eucalypt genetic resources: The case of *Eucalyptus globulus*. Invited talk to Australian Plant Breeding Conference, Adelaide, South Australia. (19-23rd April 1999).

Potts, B. M. (1999). The status of, and threats to native forest gene resources. Invited talk to Research Working Group on Forest Genetics, Melbourne, Victoria (29th June 1999).

Raymond, C. (1999). Wood properties, what can breeders do? Invited talk to Research Working Group on Forest Genetics, Melbourne, Victoria (30th June 1999).

Schimleck, L.R., Michell, A.J. and Raymond, C.A. (1999). Application of PCA and SIMCA to the investigation of within-tree variation of wood

chemistry. APPITA Conference, Rotorua, New Zealand (May 1999).

Schimleck, L.R., Michell, A.J., Raymond, C.A. and Muneri, A. (1999). Rapid assessment of pulpwood quality using near-infrared spectroscopy. 9th International Conference on Near-Infrared Spectroscopy. Verona, Italy (14-18th June 1999).

Shepherd, M., Chaparro, J.X. and Teasdale, R. (1999). Genetic mapping of monoterpene composition in an interspecific eucalypt hybrid. Talk presented at CRCSPF Symposium, 'Molecular Genetics of *Eucalyptus*', Hobart, Tasmania (4-5th February 1999).

Stokoe, R., Shepherd, M., Lee, D. and Nikles, G. (1999). Investigation of a putative natural hybrid between *Eucalyptus cloeziana* and *E. acmenoides*. Poster presented at CRCSPF Symposium, . 'Molecular Genetics of *Eucalyptus*, Hobart, Tasmania (4-5th February 1999).

Steane, D.A., R. E. Vaillancourt and B. M. Potts. (1999). Phylogenetic relationships among the eucalypts: evidence from the internal transcribed spacer. Talk presented at CRCSPF Symposium 'Molecular Genetics of *Eucalyptus*', Hobart, Tasmania (4-5th February 1999).

Tibbits, W. (1999). *E. nitens* breeding. Invited talk to Research Working Group on Forest Genetics, Melbourne, Victoria (30th June 1999).

Vaillancourt, R. E., H. D. Jackson, G. McKinnon and B.M. Potts. (1999). A useful hyper-variable region within the cpDNA genome of eucalypts. Talk presented at CRCSPF Symposium 'Molecular Genetics of *Eucalyptus*', Hobart, Tasmania (4-5th February 1999).

Vaillancourt, R.E. (1999). Genetic structure of *Eucalyptus* forests. Seminar presented at RAIZ, Centro de Investigacao Florestal, RAIZ, Portugal (21st May 1999).

Vaillancourt, R.E. (1999). Genetic structure of *Eucalyptus* forests. Seminar presented at the Station de Recherches Forestieres, Laboratoire de Genetique des Arbres Forestiers, Gazinet Cedex, France. (7th June 1999)

Vaillancourt, R.E. (1999). Genetic structure of *Eucalyptus* forests. Seminar presented at CIRAD Foret, Montpellier, France. (10th June 1999)

Vaillancourt R.E. (1999). Molecular genetics and molecular markers. Symposium Course, Hobart, Tasmania (3rd February 1999).

Volker, P.W. (1999). The use of high yield silviculture in sustainable management of tropical eucalypt and acacia plantations. Talk at Technogerma 1999 Jakarta, Indonesia (1st-5th March 1999).

Sustainable Management

Adams, P.R., Smethurst, P.J., Beadle, C.L. and Mendham, D. (1998). Mechanisms of grass competition in a young *Eucalyptus globulus* plantation. 3rd International Forest Vegetation Management Conference. Sault Sainte-Marie, Canada (23rd-28th August 1998)

Battaglia, M. and Sands, P.J. (1998). Use of process-based models for silvicultural decision support: current work and future directions. Research Working Group 5 Meeting. Coffs Harbour, New South Wales (21st-23rd September 1998).

Battaglia, M. and Sands, P.J. (1998). Goal-seeking interpretation of biomass partitioning in *Eucalyptus globulus* plantations. 2nd international workshop on Functional-Structural Tree Models. Clermont-Ferrand, France. (12th-15th October 1998).

Garnett, T.P., Smethurst, P.J., Shabala, S.N. and Newman, I.A. (1998). Ammonium, nitrate and proteín fluxes around eucalypt roots measured simultaneously using ion selective electrodes. 11th International Workshop on Plant Membrane Physiology. Cambridge, England (9th-14th August 1998).

Medhurst, J.L., Pinkard, E.A. and Beadle, C.L. (1998). Changes in productivity after pruning and thinning *Eucalyptus nitens* plantations. Australian Forest Growers Conference. Southern Cross University, Lismore, New South Wales (6th-9th July 1998).

Mendham, D.S., Smethurst, P.J. Menary, R.C. and Holz, G.K. (1998). Comparison of soil phosphorus analyses for predicting P deficiency in *Eucalyptus nitens* and *E. globulus* plantations in southern Australia. North American Forest Soils Conference. Lake Tahoe, California, U.S.A. (9th-14th August 1998).

Prasalova, N., Xu, Z.H., Simpson, J.A., Saffigna, P.G. and Dieters, M. (1998). Dynamics of the spatial variability of soil properties in hoop pine progeny tests in subtropical Australia. 16th World Congress of Soil Science, Montpellier, France. (20th-26th August 1998).

Race, D. Farm forestry: lessons from Australian experiences. New England Farm Forestry Symposium, Armidale, NSW. 28th-29th May, 1998.

Race, D. Forest company-community partnerships: ingredients for success. International Institute for Environment and Development (IIED) London UK. 9th April, 1999.

Saffigna, P.G., Xu, Z.H., Pu, G.X., Guinto, D., O'Connell, A., House, A., Grove, T. Perera, S. and Rance, S. (1998). Advances in quantification of denitrification and soil organic matter quality in forest soils of Australia: role of the ^{15}N isotope and ^{13}C NMR spectroscopy. 16th World Congress of Soil Science, Montpellier, France. (20th-26th August 1998).

Sands, P.J., (1998). Application of processed-based models to forest management: experience with ProMod, a simple plantation productivity model. University of Joensuu and Metlä, Finland. September 1998.

Sands, P.J., Battaglia, M. and Mummery, D. (1998). Application of process-based models to forest management: experience with ProMod, a simple plantation productivity model. IUFRO Conference 'Processed-based models for forest management'. Lapland, Finland. (30th August- 3rd September 1998).

Smethurst, P.J. (1998). Predicting fertiliser responses in young Tasmanian eucalypt plantations. Workshop 'What's new in site management for establishment of pine and eucalypt plantations'. Mt Gambier, South Australia (20th-21st May 1998).

Smethurst, P.J. (1998). Nutrient concentrations in soil solution as indicators of nutrient-supply limitations to plant growth: a review. North American Forest Soils Conference. Lake Tahoe, California, U.S.A. (9th-14th August 1998).

Smethurst, P.J. (1999). Some aspects of solute transport theory and terminology relevant to P sorption indices. Australian Soil and Plant Analysis Council 'P Sorption Workshop'. La Trobe University, Melbourne, Victoria (19th January 1999).

Williams, K.J. and Norman, P. (1998). What Tree Where? A spatial regression approach to selecting native hardwoods for forest growers. In: *Statistical Tools for the 21st Century: An investigation of some new statistical methods for, and applications to, forest management*. (R. Denham and K. Mengerson, eds). Forest Ecosystem Assessment and Planning, Department of Natural Resources and School of Mathematical Sciences, Queensland University of Technology, Brisbane, Queensland (September 1998).

Williams, K.J., Ward, D., Mengerson, K., and Norman, P. and Buck, R. (1998). Choosing native hardwoods for commercial plantations in farm systems: Progress in spatial modelling applications. Are we only guessing? Presented at the Managing and Growing Trees Training Conference, Kooralbin, (19th-21st October 1998).

Xu, Z.H., Kuppu, Ding, W.X., Pu G.X., Perera, M. C. S., Mao, X. A., Saffigna, P. G., Simpson, J. A., Collins, P. A., Kennedy, M. J. and Ferlazzo, D.E. Influence of site establishment practices on soil fertility as revealed by conventional laboratory methods and ^{13}C- and ^{15}N-NMR spectroscopy in an Australian subtropical pine plantation. Proceedings 6th International Symposium on Soil and Plant Analysis, Brisbane, 22nd-26th March, 1999.

Xu, Z.H., Saffigna, P.G., Mathers, N.J., Guinto, D.F., Perera, M.C.S., Berners-Price, S.J., Mao, X.J., Pu G.X., Ding, W.X., House, A.P.N. and Simpson, J.A. Impacts of forest management practices on soil carbon and nitrogen pools as revealed by biological and chemical methods as well as ^{13}C- and ^{15}N-NMR spectroscopy. International Humic Substances Society Workshop, Adelaide, 21st-25th September, 1998.

Xu, Z.H., Simpson, J.A., Osborne, D.O. and Saffigna, P.G. (1998). Soil N and fertiliser N dynamics in the first 32 months following fertilisation of a subtropical pine plantation. 16th World Congress of Soil Science, Montpellier, France. (20th-26th August 1998).

Resource Protection

Allen, G.R., Hurley, M. and Elek, J.A. (1998). Entomological Research within the CRC for Sustainable Production Forestry in Tasmania. 29th

Australian Entomological Society Annual Meeting, Brisbane, Queensland (September 1998).

Allen, G.R. (1998). Larviposition, host cues and reproductive strategies in a sound locating parasitoid fly. 29th Australian Entomological Society Annual Meeting, Brisbane, Queensland (September 1998).

Baker, S.C. and Bashford, R. (1998). Release of ladybirds for biological control of the eucalyptus leaf beetle. 29th Australian Entomological Society Annual Meeting, Brisbane, Queensland (September 1998).

Elek, J.A. (1998). To Bt or not to Bt: Is a *Bacillus thuringiensis*-insecticide suitable for IPM to control leaf beetles in eucalypt plantations. 6th Australasian Applied Entomological Research Conference, Brisbane, Queensland (September 1998).

Floyd R.B. (1998). Trends in temperate hardwood forest entomology in Australia. 29th Australian Entomological Society Annual Meeting, Brisbane, Queensland (September 1998).

Hurley, M. (1998). Assessing chewing herbivore damage to stinging trees *Dendrocnide* spp. in tropical rainforest: the importance of ghost herbivores. 29th Australian Entomological Society Annual Meeting, Brisbane, Queensland (September 1998).

McArthur, C. and Foley W.J. (1999). Role of plant secondary metabolites in the nutritional ecology of mammalian herbivores - how far have we come in 25 years? 5th International Symposium on the Nutrition of Herbivores, San Antonio, Texas, U.S.A. (April 1999).

McArthur, C. (1999). Browsing research in plantations - what can we learn for the native forest browsing problem? Native Forest Browsing Workshop, Ballarat, Victoria (April 1999).

Selman, B.J. (1998). The Biology of Australian Paropsine beetles. University of Newcastle upon Tyne, England (July 1998).

Simmul, T.L. (1998). The fireblight beetle and host choice *Acacia dealbata* vs *Acacia mearnsii*. 29th Australian Entomological Society Annual Meeting, Brisbane, Queensland (September 1998).

Steinbauer, M.J. (1998). The population ecology of *Amorbus Dallas* (Hemiptera: Coreidae) species in Australia. 29th Australian Entomological Society Annual Meeting, Brisbane, Queensland (September 1998).

Steinbauer, M.J. (1998). Phil Carne prize address: Seasonal fluctuations in body weight, lipid content and the starvation-longevity of *Amorbus obscuricornis* (Westwood) and *Gelonus tasmanicus* (Le Guillou) (Hemiptera: Coreidae). 29th Australian Entomological Society Annual Meeting, Brisbane, Queensland (September 1998).

Steinbauer, M.J. (1998). *Amorbus Dallas* species (Hemiptera: Coreidae) in Australia: latent or eruptive forest herbivores of eucalypts? 19th International Symposium on Insect-Plant Relationships, Oxford, England (July 1998).

Education & Technology Transfer

Burrell, J. and Davidson, N.J. (1998). Discussion with students and visitors at 'Women in forest science' exhibition at the Hobart Library.

Davidson, N.J. (1998). CRC Research within the University of Tasmania, University Discovery Day

Davidson, N. J. (1998). CRC Research, talk to Hutchins School grade 12 students

Davidson, N. J. (1998). Getting the best out of tree plantations, 'Trees for dollars and sense' Seminars on Farm Forestry, 5/8/98, 'Bangor', Dunalley.

Davidson, N. J. (1998). Getting the best out of tree plantations, 'Trees for dollars and sense' Seminars on Farm Forestry, 6/8/98, Buckland Hall, Buckland.

Davidson, N. J. (1998). Getting the best out of tree plantations, 'Trees for dollars and sense' Seminars on Farm Forestry, 7/8/98, Hamilton Landcare Resource Centre, Hamilton.

Davidson, N. J. (1998). Getting the best out of tree plantations, 'Trees for dollars and sense' Seminars on Farm Forestry, 10/8/98, Furners Hotel, Ulverstone.

Davidson, N. J. (1998). Getting the best out of tree plantations, 'Trees for dollars and sense' Seminars on Farm Forestry, 11/8/98, Scottsdale RSL, Scottsdale

Davidson, N. J. (1998). Getting the best out of tree plantations, 'Trees for dollars and sense' Seminars on Farm Forestry, 12/8/98, Nile Hall, Nile.

Medhurst, J., Elek, J. and Mollon, A. (1998). Discussion with students and visitors at 'Women in forest science' exhibition at the University of Tasmania.

Steane, D. (1998). Women in forest science, a talk to students at Kingston Primary School.

Media Activities

Print

CRC Snippets, April 1998. CRC-SPF Women in Forestry project.

Tas Country, May 29 1998. 'Women welcome in woods'.

Tas Country, July 17 1998. Editorial on Trees for Dollars and Sense farm forestry seminars.

Onwood No 24, August 1998. 'Pruning for plantation sawlogs'.

The Mercury, February 5 1999. 'Cloning boosts humble gum tree'.

The Saturday Mercury, February 6 1999. 'DNA clue to state eucalypt refuge'.

The Advocate, February 12 1999. 'Scientists visit coast'.

National Forests and Timber, May 1999. 'Pruning a knotty problem for plantation timber'.

Onwood No 25, June 1999. 'Eucalypt plantations - not such a new idea'.

Farming Ahead, June 1999. 'Effective pruning sets a shining example'.

The British Council Australian Newsletter No. 91, April-June 1999 p 23. 'Eucs in the UK - Taking a sick tree to hospital'.

Radio and television

ABC Radio News, February 4 1999. Use of molecular biology in forestry.

ABC Radio Country Hour, February 4 1999. Interview with Dr. D Grattapaglia (Brazil) and Prof Jim Reid (as Director of the CRCSPF). Use of molecular biology in forestry.

ABC Radio National News, March 31 1999. 'Eucalypt plantations for solid wood'.

ABC Radio Perth, March 31 1999. 'Eucalypt plantations for solid wood'.

Channel 10, 'Totally Wild', May 1999. CRC participated in filming a children's TV show. Featured Jane Medhurst's study on thinned plantations.

Grants and Awards

Genetic Improvement Program

Grant/Award	Awarded for	Duration	Recipient	Amount $
STBA	Geographic patterns of variation in *E. nitens* and *E. globulus*	6 mth	G Dutkowski	$1 500
STBA	Breeding value prediction for tree breeding	1 wk	G Dutkowski	$1 400
STBA	Reproductive research	1 yr	Dr B Potts Mr P Gore	$16 000
SPIRT (ARC)	Optimising seed orchards to achieve maximum genetic gain in eucalypt plantations.	3 yr	Dr R Vaillancourt Dr M Sedgley Dr B Potts	$263 000
ARC Small grant	Chloroplast DNA as a tool for fingerprinting *Eucalyptus globulus*	1 yr	Dr R Vaillancourt Dr B Potts	$7 500
Crawford Fund	Training award for Mr Wake Yelu (PNG FRI) for training at QFRI	3 wks	M Dieters	$7000
State Forests NSW PhD stipend	Topic: Gene flow and genetic diversity in hardwood plantations in NSW	3 yr	Prof R Henry Dr M Shepherd	$129 000
Strategic initiative Fund (CRC-SPF) Dr R Vaillancourt	Gene flow between native and planted eucalypt forests	1 yr	Dr B Potts Dr W Tibbits (NET)	$15 750
Strategic initiative Fund (CRC-SPF)	Finding the origin of the Portuguese *E. globulus* landraces	1 yr	Dr R Vaillancourt Dr B Potts Dr N Borralho (RAIZ) Dr M Marques (RAIZ)	$12 000
Environment Australia	Publication of manuscript 'Vegetation of Tasmania'	1 yr	Prof J Reid	$18 000

Sustainable Management Program

Grant/Award	Awarded for	Duration	Recipient	Amount $
RIRDC/JVAP	Silvicultural decision support system for farm forestry	2.5 yr	Dr M Battaglia	$200 953
RIRDC/JVAP	Silvicultural management of blackwood (*A. melanoxylon*) for growth, form and wood quality	2.5 yr	Dr L Pinkard Dr C Beadle	$123 777
RIRDC/JVAP	Estimating the productivity of forest systems in SE Qld	2.5 yr	Dr K Williams (DNR) Mr P Ryan	$197 421
Natural Heritage Trust	Choosing native hardwoods for commercial plantations in farm systems	3 yr	Dr K Williams (DNR) Mr P Ryan	$330 000
Strategic Initiatives Fund (CRC-SPF)	Locating plantations in the landscape: cost benefit analysis	1 yr	Dr M Battaglia Mr D Mummery Mr A Smith (BTf)	$9 000
Strategic Initiatives Fund (CRC-SPF)	Evaluation of a quick test meter for measuring nutrient status in soil and plant waters	1 yr	Dr P Smethurst	$8 000

Strategic Initiatives Fund (CRC-SPF)	Seed funding for International Symposium on 'Advances in Carbon and Nutrient Cycling in Forests'	1 yr	Ass Prof P Saffigna Mr T Blumfield	$15 000
Strategic Initiatives Fund (CRC-SPF)	Quick test meter for nutrients: further evaluation and potential applications in forestry and agriculture	1 yr	Dr P Smethurst Mr P Volker (Serve-Ag)	$9 250
Strategic Initiatives Fund (CRC-SPF)	Soil water relations on wet sites in the south-east Queensland pine estate: implications for taxon selection and site preparation	1 yr	Dr M Hunt Dr K Bubb Dr B Yu Mr D Osborne Mr M Nestor	$17 000
Max Jacobs Award	Travel to the IUFRO Canopy Processes Workshop in Estonia, Finland and Sweden	1 yr	Ms J Medhurst (PhD student)	$1 000

Resource Protection Program

Grant/Award	Awarded for	Duration	Recipient	Amount $
BARK/BDMG	The management of mammal browsing damage in Tasmanian eucalypt plantations	1 yr	Dr C McArthur Mr J Bulinski	$6 500
BARK/BDMG	The spatial distribution of mammal browsing in Tasmanian eucalypt plantations	1 yr	Dr C McArthur Mr J Bulinski	$3 500
BARK/BDMG	Effects of nursery conditions on palatability of eucalypt seedlings	1 yr	Dr C McArthur Ms N Marsh	$4 200
Primary Industries Meritorious Service Award	In recognition of more than four decades dedicated service to the forest industry	1 yr	Dr G Nikles	
Consortium of forestry companies in Western Australia	Insect Pest Management Group	3 yr	Dr R Floyd	$276 116
Strategic Initiatives Fund (CRC-SPF)	Initial investigation of predictor of browsing resistance in *Eucalyptus*: chemical use and the genetic basis	1 yr	Dr C McArthur Dr I Lawler (ANU)	$40 000
Phil Carne Prize	Best student paper published in Australian Journal of Entomology in 1997/98	1 yr	Dr M Steinbauer	
Australian Entomology Society: Presentation Prize	Awarded the best oral presentation by a student at the Annual Meeting of the Australian Entomology Society	1yr	Ms T Simmul (PhD student)	
SPIRT (ARC) (FT)	The physiological and pathological implications of different pruning regimes for *E. globulus* in comparison to *E. nitens*	3 yr	Dr C Mohammed Dr L Pinkard Dr C Beadle	$62 466 $52 500
SPIRT (ARC) (FT) (NFP)	Ecologically sustainable forest management: fungal and invertebrate biodiversity	3 yr	Dr C Mohammed Ass Prof A Richardson Dr D de Little (NFP) Dr Zi Qing Yuan (UT)	$162 723 $274 981 $31 120

Strategic Initiatives Fund (CRC-SPF)	Molecular identification of wood-inhabiting fungi associated with stem decay in Tasmanian eucalypt plantations: method development	1 yr	Dr C Mohammed	$20 464
Boral Timber Tasmania	Field growth of and browsing damage to *E. nitens* seedlings	1 yr	Dr C McArthur	$2 233
North Forest Products	Investigation of the effect of 1080 in the field	1yr	Dr C McArthur Ms K le Mar	$9 199
Forestry Tasmania	Effects of nursery conditions on susceptibility of *E. nitens* seedlings to damage by possums and pademelons	1 yr	Dr C McArthur	$1 500
Forestry Tasmania	Leaf chemistry in relation to browsing damage	1 yr	Dr C McArthur	$2 500

Abbreviations:

ARC	Australian Research Council
BDMG	Browsing Damage Management Group
BARC	Browsing Animal Research Council
FWPRDC	Forest and Wood Products Research and Development Corporation
JVAP	Joint Venture Australia Partnership
RIRDC	Rural Industries Research and Development Corporation
SPIRT	Strategic Partnerships with Industry Research and Training scheme

Consultancies

Consultancy with	For	Duration	Recipients	Amount $
FAO	Training visiting scientists	12 wk	Ms C Condie	$7,200
Bunnings Treefarms	Prediction of Breeding Values Harvest Volume and Basic Density for Seedling Seed Orchard OPSO5	1 wk	Mr G Dutkowski	$4000
QDPI	Hybrid verification in *Pinus*	1 mth	Dr M Shepherd	$2000
STBA	*Eucalyptus nitens*: The estimation of genetic parameters and breeding values for diameter and pilodyn traits in Trials VRD 56, 57 and 58	4 wks	Mr P Chambers	$12 000
RIRDC	Assessing the risk of genetic pollution from farm forestry using hybrids and improved species	3 mth	Dr B Potts	$10, 000
Weyerhaeuser	Methodology to develop relative 'thru the system' economic value for selected wood properties	1 mth	Dr B Greaves (UT)	$45 000
Private Forests Tasmania	Collect and analyse data for dryland demonstration trials	4 mth	Mr M Savva (CSIRO) Dr C Beadle	$16 800
Private Forests Tasmania	Experimental design	1 wk	Dr P Smethurst	$1 500
Bureau of Resource Sciences	National Forest Inventory	4 mth	Dr C Beadle	$45 000

Performance Indicators

Cooperative Arrangements

- *Level of participation of contributors in major decisions concerning the research direction of the Centre*

Most CRC research is conducted using company trials, or trials established on company land, so companies are involved at the outset with the planning and implementation of research projects and have ownership of them. Research plans for these experiments are lodged with the companies, and these include an agreed protocol for the research. The company partners allocate staff time (in-kind contributions) to CRC research projects so effective interaction can occur. The Program Coordination Committees (PCCs) of the CRC retain an overview of these research projects. They prioritise research and set 'deliverables' (research outcomes that can be directly used by industry). The PCCs are chaired by industry staff and consist largely of the partners' staff to ensure that they are involved in deciding what research is undertaken.

- *Level of interchange of personnel among different sites and participating institutions*

There were 46 internodal visits in three months in 1998. If representative of traffic between partners in the CRC, visits would total 184 for 1998/99.

- *Proportion of joint publications with other research groups*

In the publication list, 34 of the 139 publications (79 refereed + 47 unrefereed + 13 theses = 139) were written with other research groups.

- *Number and duration of stay of visitors to the Centre from Australia and overseas*

There were six visiting scientists:-

Dr David Gwaze, Forestry Policy Coordinator with Forestry Commission Zimbabwe visited the Hybrid Breeding group at QFRI for ten weeks from July-September 1998. He conducted research on quantitative genetics and breeding of tropical pines.

Dr Dario Grattapaglia, who is internationally renowned for research on genome mapping of *Eucalyptus*, based in Brazil, visited the Genetic Improvement Program in Hobart from 1-5 February 1999, and an international collaberative research project was developed.

Dr Daniel Verhaegen (CIRAD Forêt) and Dr Alix Pernet (AFOCEL), France, visited the Genetic Improvement Program in Hobart for a week in February 1999.

Mr Brendan Murphy, (PhD student from Canterbury University, NZ) worked with the Resource Protection Program for three months studying chrysomelids in Tasmania.

Dr Caroline Preston, Dept of Soil and Forest Science, University of British Columbia, USA, visited the tropical soils research group at Griffith University and QFRI for two weeks and contributed to research on ^{13}C and ^{15}N NMR technology in study of soil nutrition.

Prof Don Field, University of Wisconsin, USA, visited Amabel Fulton's group for three days in June 1999, to discuss aspects of rural sociology relating to forestry.

Prof David Powlson, Soil Science Division, Rothamsted Experimental Station, UK, visited Griffith University for a week to discuss soil nutrition and sustainability in agriculture and forestry.

In addition, the CRC had two FAO visitors, Vinod Kumar and Akshay Saxena who spent ten weeks with the CRC and partners over the period 1 March - 21 May 1999.

A high-level Chinese delegation visited the CRC in Hobart on September 19 1998, led by Madam Prof Tiang, sister to the President of China.

- *The degree of interaction among scientific staff at dispersed locations on core activities of the research program, including:*

- *the economic importance and genetic control of growth, stem characteristics and wood properties at the quantitative and molecular levels*

There is strong interaction between the various research laboratories conducting genetic research. Project A1 'Genetics and reproductive biology of eucalypts' led by Brad Potts at the University of

Tasmania, has strong links with project A6 led by Mark Dieters at QFRI. Project A1 is conducting work at the University of Tasmania, Bunnings Treefarms (WA) and North Eucalypt Technologies (northern Tasmania). A symposium on hybrid breeding is being organised for April 2000 to provide a focus for this interaction. Project A2 has worked on research projects with the STBA/FT/FCP on geographic genetic variation in *Eucalyptus nitens*.

Project A5 'Wood quality' led by Carolyn Raymond in Tasmania has strong links with the CRC-HFPS in Melbourne in research on Silviscan, cellulose content analysis and Near Infrared Reflectance Analysis, as well as with project A3 'Molecular approaches to tree breeding' led by Gavin Moran. There are also strong links with FT and NET, with joint projects and Peter Kube from FT undertaking PhD studies with the Centre.

There are also increasing linkages between the three laboratories working on molecular genetics through Projects A3, A4 and A7: all groups contributed to a symposium on 'Molecular Genetics of *Eucalyptus*' in February 1999, and form part of the international 'Eucalypt Genome Initiative'(EGI). The EGI was initiated by the CRC to promote international cooperation in eucalypt genomics, and its first international project is now in place.

Several projects involve collaboration between the Genetic Improvement Program (GI projects A1 and A3) and the Sustainable Management Program (SM), and there is increasing linkage between GI, SM and the Resource Protection Program (RP) on the genetics of pest and disease resistance.

- *Effective mating, selection and deployment strategies in tree improvement programs*

Project A2 'Breeding strategies' led by Greg Dutkowski has strong links with most industrial partners as well as other research projects on the core research in selection and deployment strategies. This project is intimately linked with the Southern Tree Breeding Association's (STBA) *Eucalyptus* Breeding Program. It is enhanced by the co-location of the STBA's Eucalypt Program Manager, Peter Gore, on the University of Tasmania campus. Greg Dutkowski is on the Board, the Technical Committee, and the Quantitative Genetics, Data Management and Research subcommittees of the STBA, as well as being involved in the strategy reviews for the major STBA breeding programs. There have been eight presentations made to, or on behalf of, the STBA by CRC staff. Greg Dutkowski has worked with scientists from QFRI, NET, STBA and FT to introduce them to the use of the ASREML software for the analysis of their data.

There are also strong links between researchers working on tree improvement in Lismore (SCU) and Gympie (QFRI) with frequent inter-site visits. A meeting was held in Lismore in April to bring together research staff from all locations working on tropical species.

- *The dynamics and cycling of organic matter and nitrogen in soils in response to silvicultural treatments*

There has been a history of close interaction between Project B1 'Site productivity', led by Philip Smethurst and Project B2 'Management of tropical soils' led by Paul Saffigna, as they both cover organic matter and nutrient cycling. Dr Greg Holz (NET) initiated and obtained assistance from the CRC for a workshop run in June 1998 on the potential for more efficient 'slash management' in second rotation plantations. National links in these studies are assisted by Philip Smethurst being the chair of the Programme Committee for the 18th biennial conference of the Institute of Foresters of Australia 'Practising forestry today', which has a strong nutritional component.

- *Key issues which affect landowners' decision-making*

Interaction between Digby Race (ANU) and Amabel Fulton (UT) has been developed through organisation of a workshop for forest industry at the AFG Conference at Lismore to explain new strategies for persuading landholders to adopt farm forestry. They are also organising a Forestry Colloquium 'Socio-economic research to create successful farm forestry' to be held in Canberra in March 2000.

- *Prediction of productivity in response to environmental factors and management inputs*

Project B4 'Modelling plantation systems' has run workshops at CRC centres to familiarise industrial partners with the operation and application of the growth model PROMOD. In association with PFT and FT the CRC has developed a Farm Forestry Toolbox CD which incorporates PROMOD as a decision support system for farmers. In addition, Tony Smith (Bunnings Treefarms) and Michael Battaglia and Daryl Mummery (CSIRO) have been quantifying the economic return from the use of process-based site quality assessments and evaluating the appropriate pre-planting survey intensities in a range of landscape types used for plantation forestry.

- *Investigation of pathogens of forest insect pests*

There is increasing linkage between the Resource Protection, Genetic Improvement and Sustainable Management programs on the genetics of pest and disease resistance. Richard Milner has been working in collaboration with John Madden on entomopathogens of Chrysomelids.

- *Studies of the ecology and behaviour of autumn gum moth in temperate Australia*

Rob Floyd (CSIRO Canberra) has continued links with Zoltan Lukacs (UT) through his supervision of Zoltan's PhD research, and through parallel observations on the mainland. Geoff Allen in Tasmania is developing other aspects of autumn gum moth work in collaboration with Rob Floyd and Martin Steinbauer. There is a Symposium on 'Eucalypt-insect interactions' planned for February 2000.

There also exist close links amongst workers on other insect pests: Rob Floyd (CSIRO Canberra) with Tara Simmul (UT) on fireblight beetle, and Martin Steinbauer (CSIRO Canberra) and Bradley Howlett (UT) on *Eucalyptus* leaf beetle.

- *Impact of insect pests at plantation establishment*

There has been increasing recognition of the potential impact of insect pests at plantation establishment. In response to this, collaborative research has been initiated between John Matthiessen in Western Australia and Marina Hurley in Tasmania in Projects C1 and C2 with a Strategic Initiatives Fund grant (CRC-SPF). This research is investigating the biology and ecology of various species of native and introduced scarab beetles, particularly as they relate to damage to seedlings.

- *Genetic and chemical basis of eucalypt resistance to browsing*

There is strong collaboration between Projects A1 (Brad Potts) and C3 (Clare McArthur, Julianne O'Reilly) within the CRC and with Dr WJ Foley at ANU in the research investigating the genetic and chemical basis of resistance of eucalypt foliage to browsing by herbivores. The strengths of the three areas have been combined to provide some of the best trials to date for (1) measuring the degree of genetic variability of *E. globulus* foliage in relation to intake by brushtail possums and Tasmanian pademelons and (2) determining whether this variation can be described chemically through Near-Infra-Red Spectroscopy.

Research and Researchers

- *Papers in refereed journals*

In 1998/99 the Centre produced 79 publications in refereed journals, 47 unrefereed publications and 13 theses.

- *Books and book chapters covering the results of the Centre's research*

Books:-

'Vegetation of Tasmania' (1999)

'*Her*storey: Women in forest science' (1999)

Book chapters:-

'Eucalypt Biology' (Reid and Potts 1999)

'Morphology, phylogeny, distribution and genetic diversity of eucalypts' (Potts and Pederick 1999)

'Forest production' (Beadle 1999)

'Diurnal variation and radial growth of stems in young plantation eucalypts' (Downes *et al.* 1999)

'Growth analysis: a quantitative approach' (Kriedemann and Sands 1999)

'Biology of the Paropsini (Chrysomelidae: Chrysomelinae)' (Simmul and de Little 1999)

'Role of plant secondary metabolites in the nutritional ecology of mammalian herbivores - how far have we come in 25 years?' (Foley *et al.* 1999)

- *Acceptance and employment by the forestry community of students on completion of their studies*

The success of our students in obtaining employment in the forest industry was demonstrated by appointments over the last two years; Heidi Dungey (Geneticist, QFRI), Mark Hunt (Silvicultural Officer, QFRI), Natalie Papworth (Botanist, Botanical Gardens), Libby Pinkard (Communication Officer, Forestry Tasmania), Daniel Mendham (Research Scientist, CSIRO Forestry, WA); Martin Steinbauer (Postdoctoral fellow, CRC-SPF with CSIRO Entomology, Canberra), Nadia Marsh (Extension Officer, Biology and Conservation Branch, Forestry Tasmania), Xianming Wei (Postdoctoral fellow, CSIRO Plant Industry, Merbein, Victoria), Jo Dingle (Technical Officer, Forestry Tasmania).

Application of Research

- *Degree of adoption of research results by industry*

There were 25 items of CRC technology taken up by industry this year (see Industry Uptake in Utilisation and Application of Research).

- *Quality and relevance of technical publications targeted to user groups*

There were seven reports produced in the CRC Technical Report series this year. In addition there were ten technical news-sheets released ('Hot off the Seed Bed', 'Beyond the Black Stump' and 'Pest Off'), a book, 'Vegetation of Tasmania,' and a booklet '*Her*storey, Women in forest science', five Farm Forestry Fact Sheets, and 11 articles in partner news-sheets.

- *Extent of advice and consultancy services provided to industry and government*

Nine consultancies were conducted during 1998/99 (see Grants and Awards and Consultancies). Advice has been provided through participation on national committees. For example, Greg Dutkowski (GI) is on the Technical Committee of the STBA and three subcommittees of the STBA Technical Committee; he is also a member of Research Working Group 1 (RWG1, Forest Genetics); Dr Brad Potts (GIP) is a member of RGW1 and is on the subcommittee on Forest Genetic Resources; and Dr Philip Smethurst (SMP) was chairman of RWG 3, Soils and Nutrition. Clare McArthur (RPP) has close links with industry and government through the former Browsing Animal Research Council (BARC) and the Browsing Damage Management Group (BDMG) as well as direct interaction with industry (see Grants and Awards).

- *Number of presentations to companies or user groups*

There were 20 seminars specially aimed at our end-users (see Table 5, Technology Transfer Activities, Utilisation and Application of Research) in addition to the 25 seminars in our seminar program. There were also major presentations at symposium such as the 'Molecular Biology of *Eucalyptus*'. In addition there were 48 presentations to conferences and five talks to school groups and six workshops (see Public Presentations).

- *Number and financial contributions of potential users*

The CRC-SPF has twelve industry partners, which includes most of the major wood producing companies in Australia. Each partner commits cash and/or in-kind contributions to the CRC (see Financial Tables). In addition, partners may provide funds to support particular projects (see Grants and Awards). Other end-users of our technology, e.g. Greening Australia and Private Forests Tasmania, have given in-kind support in running technology transfer exercises to farmer groups.

- *Number of visitors from user groups*

As the partners in the Centre represent our main user group, many of the 184 within-CRC visits (see Performance Indicator 2 under Cooperative Arrangements) are from users of the technology we are developing. For example, in the Genetic Improvement Program in Hobart, Wayne Tibbits and Mike Powell from NET, Peter Gore and Tony McRae from STBA, David Pilbeam from BTf, Peter Kube from FT, Peter Volker from ServeAg, and Sandra Hetherington from FCP, are regular visitors. QDPI and QFRI are co-located at Gympie and have strong and frequent interactions. Other visitors who are not partners include Frances Sugden from Greening Australia, Arthur Lyons from Private Forests Tasmania, David

- *Invitations to present keynote addresses and papers at conferences*

Dr B Potts, invited speaker at the Plant Breeding Conference, Adelaide.

Prof J Reid, plenary speaker at the 16th IPGSA Meeting in Tokyo

Dr H Sarac and Prof R Henry, invited address to American Association of Cereal Chemists, 'The use of cereals in aquaculture production systems' August 1998, Cairns.

Prof R Henry, invited address to Combined Biological Sciences meeting, 'Impact of plant genome analysis in plant science, agriculture and food production', August 1998, Perth.

Prof R Henry, M Abedinia, S Sterle, S Garland, AB Blakeney, L Lewin, invited address at the Sixth International Symposium on Rice Molecular Biology, 'Application of molecular techniques to rice improvement in Australia', November 1998, Shanghai, China.

- *Number and value of competitive grants awarded*

There were 31 competitive grants awarded to CRC staff in 1998/99 for a total of $2 326 553 (see Grants and Awards).

- *Honours and awards*

There were five awards to staff or students of the CRC:

Dr G Nikles received the Primary Industries Meretorious Service Award

Ms J Medhurst received the Max Jacobs Award

Dr M Steinbauer received the Phil Carne Prize

Ms T Simmul received the Australian Entomology Society Presentation Prize

Ms Y Setiawati won a travel award from CIRAD-Forêt to visit France

Education and Training

- *Time spent by researchers on research training*

We have 60 postgraduate and honours students affiliated with the CRC. It is recognised that each student takes 5-10% of a researcher's time to supervise. This is equivalent to three to six man-years on research training.

- *Number of postgraduate students working in the Centre*

The Centre has 51 postgraduate students and nine honours students (see Tables 2 and 3).

- *Number of postgraduate students trained in the areas specified*

Genetic Improvement	22
Sustainable Management	24
Resource Protection	14

- *Number of enrolments in special courses*

A special undergraduate course, Forest Ecology has 12 students enrolled and one was enrolled in Forest Ecology honours this year. A special course on Molecular Genetics was offered in February 1999 and attracted 24 participants. In addition there was an 'Introduction to Arcview' course, run by Greg Dutkowski, three ASREML workshops run by Greg Dutkowski, a workshop on wildlife biology techniques run by Kirsten le Mar, and a field day on nutrition of tropical soils run by Paul Saffigna.

- *Quality and number of postdoctoral fellows attracted*

There were seven postdoctoral fellows who worked with the Centre in 1998/99: Dr Karen Thamarus in molecular genetics (CSIRO Canberra); Dr Martin Steinbauer in entomology (CSIRO Entomology); Dr Mervyn Shepherd in molecular biology (SCU); Dr Heidi Dungey in forest genetics (QFRI); Dr Nina Prasalova in soil nutrition (GU), Dr Frieda Henskens in canopy nitrogen dynamics (UT) and Dr Andrew Loch in pest management of blue gums (CSIRO Entomology).

- *Rate and percentage of completion of higher degrees*

14 students completed Honours or PhD this year

Hons:- Mr T Blumfield, Ms D Connell, Ms R Lawrence, Mr R Mellick, Ms A Mollon, Mr D Proctor, Ms C Turner, Ms D Wiseman.

PhD:- Mr J Bulinski, Mr M Hunt, Mr Z Lukacs, Mr D Mendham, Ms P Teixeira

Hamilton and Darcy Vickers from the Forest Education Foundation. The same rates of visitation occur at other CRC locations.

- *Number of media or trade journal presentations*

There were twelve media and/or trade journal presentations about the CRC this year.

There were also 47 unrefereed articles, technical reports and books through which it is estimated we reached 7760 end-users of CRC technology (see Technology Transfer activities).

- *Number of seminars, workshops and field days organised to transfer results to industry and the public, including the level of response*

There were 49 seminars, 12 workshops and three short courses or field days organised to transfer results to industry and the public this year. An estimated 2299 people attended these activities.

Management and Budget

- *Establish procedures to report on progress and achievements*

There have been plans set in place: Strategic Plan and Business Plan, and a set of 'deliverables' agreed upon to meet industry expectations of progress in research areas. There are also established checks and balances on the quality and quantity of research and its value to industry through Program Coordinating Committees, the Advisory Panel, the Board and the Annual Report.

- *Timely and accurate reporting of progress*

The CRC reports in a timely and accurate manner against the 'deliverables' set for industry and the milestones set by each program and project. These are reported to the Program Coordinating Committees (quarterly report on research 'deliverables'), the Advisory Panel, the Board, and in the Annual Report.

- *Extent of staff turnover*

There were changes in the Board representatives for two organisations and new program managers were appointed to two programs. Two research staff and six technical staff were appointed (see Staffing and Administration).

- *Proportion of projects completing milestones within the planned time and budget*

All projects have completed milestones within the planned time and budget with the exception of two that were agreed by industry as no longer relevant to their needs, and because they can be addressed through alternative strategies ('deliverables').

- *Accurate recording and reporting of financial transactions*

The Centre has implemented the following management and budgetary systems: triennium budgeting, monthly reporting of financial accounts (to program managers and project leaders), quarterly reporting of in-kind contributions of partner organisations (to the Board), annual external audit of the financial accounts, and an Annual Report.

Budget

Notes to and forming part of the accounts for 1997/98

Summary of significant accounting policies

All funds under the Cooperative Research Centre's control are administered through the University of Tasmania's Financial Management Information System (FMIS).

The principal accounting policies adopted in preparing the accounts of the unincorporated entity are detailed hereunder.

(a) Basis of accounting and principles of consolidation

The cash accounts have been prepared on the basis of historic costs. Cost in respect to the cash contributions and expenditure is the cash sum exchanged in the financial year determined from transactions recorded on the FMIS.

In-kind amounts are the economic values of goods and services declared by each of the joint venture partners and accepted by the entity as being valid.

(b) Interest

Interest is calculated and paid by the University based on the monthly cash balances being held on the FMIS on behalf of the entity.

(c) Assets and depreciation

Plant and equipment assets are recorded on the University's asset register in the name of the entity as they are acquired. Their entire cost is expensed in the year of purchase and depreciation is not provided for.

Capital expenditure relates to costs associated with buildings. These costs are also expensed and depreciation is not provided for.

(d) Employee entitlements

Provision has been made for pro-rata entitlements to annual and long service leave.

(e) Partner contributions

Budget estimates of contributions are taken from the original Commonwealth Agreement and actual figures are provided by the partners.

(f) Allocation from Commonwealth Grant

During 1997/98 the CRC received the usual four quarterly grant payments.

Deloitte Touche Tohmatsu

ANZ Centre
Level 9
22 Elizabeth Street
Hobart TAS 7000
GPO Box 777H
Hobart Tasmania 7001 Australia

DX 197
Telephone (03) 6237 7000
Facsimile (03) 6237 7001
www.deloitte.com.au

INDEPENDENT AUDIT REPORT TO THE COOPERATIVE RESEARCH CENTRES SECRETARIAT DEPARTMENT OF INDUSTRY, SCIENCE AND RESOURCES REPRESENTING THE COMMONWEALTH IN RESPECT OF

COOPERATIVE RESEARCH CENTRE FOR SUSTAINABLE PRODUCTION FORESTRY

FINANCIAL INFORMATION FOR THE YEAR ENDED 30 JUNE 1999

Scope

We have audited the financial information of the Cooperative Research Centre for Sustainable Production Forestry as set out in Tables 1 to 4 of the Annual Report for the year ended 30 June 1999 as required by clause 14(1)(f) of the Commonwealth Agreement. The parties to the Cooperative Research Centre are responsible for the preparation and presentation of the financial information. We have conducted an independent audit of the financial information in order to express an opinion on it to the Commonwealth.

Our audit has been conducted in accordance with Australian Auditing Standards to provide reasonable assurance as to whether the financial information is free of material misstatement. Our procedures included examination, on a test basis, of evidence supporting the amounts and other disclosures in the financial information, and the evaluation of accounting policies and significant accounting estimates. These procedures have been undertaken to form an opinion as to whether in all material respects, the financial information presents fairly in accordance with Australian accounting concepts and standards and requirements of the Commonwealth Agreement so as to present a view of the sources of funding and the application of funding of the Cooperative Research Centre for Sustainable Production Forestry and the application of which is consistent with our understanding of its financial activities during the year and its financial position. These policies do not require the application of all Accounting Standards and Urgent Issues Group Consensus Views.

While we have not performed any audit procedures upon the estimates for the next period and do not express any opinion thereon, we ascertained that they have been formally approved by the Board of Management as required under the Joint Venture Agreement.

The audit opinion expressed in this report has been formed on the above basis.

Audit Opinion

In our opinion, the financial information presented in Tables 1 to 4 presents fairly the sources of funding, the application of funding and the financial position of Cooperative Research Centre for Sustainable Production Forestry for the year ended 30 June 1999 in accordance with Australian accounting concepts and applicable Accounting Standards, the CRC Secretariat's Guidelines for Auditors, and the requirements of the Commonwealth Agreement in terms of Clauses 4, 5(1), 5(2), 5(3), 9(1), 9(5) and 12(2).

1. The multipliers adopted by the Centre to value in-kind contributions other than salary costs have a sound and reasonable basis and each partner's component of the Researcher's Contributions for the year under report has been provided at least to the value for that year committed in the Budget as specified in the Agreement.

2. The Researcher has used the Grant and the Researcher's contributions for the Activities of the Centre and in my professional opinion there appears to be no material reporting irregularities.

3. The Researcher's allocations of the budgetary resources between Heads of Expenditure has not been lower or higher than the allocation in the budget by $100,000 or 20% (whichever is the greater amount) without prior approval by the Commonwealth.

4. Capital Items acquired from the Grant and Researcher's Contributions are vested as provided in the Joint Venture Agreement.

5. Intellectual Property in all Contract Material is vested as provided in the Joint Venture Agreement and no Intellectual Property has been assigned or licensed without the prior approval of the Commonwealth.

6. Proper accounting standards and controls have been exercised in respect of the Grant and Researcher's Contributions and income and expenditure in relation to the Activities of the Centre have been recorded separately from other transactions of the Researcher.

Deloitte Touche Tohmatsu

DELOITTE TOUCHE TOHMATSU

Lyn Cox
Partner
Chartered Accountants

Hobart, 16 September 1999

TABLE 1

IN-KIND CONTRIBUTIONS FROM PARTNERS ($000's)

PARTNER		EXPENDITURE					PROJECTED EXPENDITURE										GRAND TOTAL		
		1997/98 Actual	1998/99 Actual	1998/99 Budget	Cumulative TOTAL TO DATE Actual	Agr'mt	1999/00 Budget	1999/00 Agr'mt	2000/01 Budget	2000/01 Agr'mt	2001/02 Budget	2001/02 Agr'mt	2002/03 Budget	2002/03 Agr'mt	2003/04 Budget	2003/04 Agr'mt	TOTAL 7 Years	Agreement 7 years	Difference 7 years
CSIRO FORESTRY and FOREST PRODUCTS																			
	SALARIES	652.6	691.1	668.8	1,343.7	1,324.0	677.6	618.0	694.8	618.0	712.1	618.0	729.9	618.0	748.2	618.0	4,906.5	4,414.0	492.5
	CAPITAL	0.0			0.0												0.0	0.0	
	OTHER	1,410.0	1,495.8	1,439.9	2,905.8	2,855.0	1,464.2	1,345.0	1,495.6	1,345.0	1,527.8	1,345.0	1,560.8	1,345.0	1,594.6	1,345.0	10,548.8	9,560.0	988.8
	TOTAL	2,062.6	2,186.9	2,108.7	4,249.5	4,179.0	2,142.0	1,963.0	2,190.4	1,963.0	2,239.9	1,963.0	2,290.7	1,963.0	2,342.8	1,963.0	15,455.3	13,994.0	1,461.3
CSIRO ENTOMOLOGY																			
	SALARIES	163.2	148.6	157.1	311.8	304.0	212.6	152.0	226.6	152.0	220.1	152.0	152.3	152.0	137.3	152.0	1,260.7	1,064.0	196.7
	CAPITAL	0.0			0.0												0.0	0.0	
	OTHER	239.7	254.1	267.9	493.8	546.0	374.8	273.0	398.4	273.0	392.1	273.0	288.6	273.0	260.4	273.0	2,208.1	1,911.0	297.1
	TOTAL	402.9	402.7	425.0	805.6	850.0	587.4	425.0	625.0	425.0	612.2	425.0	440.9	425.0	397.7	425.0	3,468.8	2,975.0	493.8
UNIVERSITY OF TASMANIA																			
	SALARIES	385.4	402.7	386.7	788.1	773.4	432.6	386.7	432.6	386.7	432.6	386.7	432.6	386.7	432.6	386.7	2,951.1	2,706.9	244.2
	CAPITAL	0.0			0.0	0.0		0.0		0.0		0.0		0.0		0.0	0.0	0.0	
	OTHER	703.1	825.3	763.0	1,528.4	1,464.0	816.3	763.0	816.3	763.0	816.3	763.0	816.3	763.0	816.3	763.0	5,609.9	5,279.0	330.9
	TOTAL	1,088.5	1,228.0	1,149.7	2,316.5	2,237.4	1,248.9	1,149.7	1,248.9	1,149.7	1,248.9	1,149.7	1,248.9	1,149.7	1,248.9	1,149.7	8,561.0	7,985.9	575.1
FLETCHER CHALLENGE PAPER																			
	SALARIES	34.0	21.1	33.0	55.1	53.0	25.1	28.0	25.1	28.0	25.1	28.0	25.1	28.0	25.1	25.0	180.6	193.0	-12.4
	CAPITAL	0.0			0.0												0.0	0.0	
	OTHER	186.0	171.0	166.0	357.0	332.0	184.0	161.0	184.0	161.0	184.0	161.0	184.0	161.0	184.0	161.0	1,277.0	1,137.0	140.0
	TOTAL	220.0	192.1	199.0	412.1	385.0	209.1	189.0	209.1	189.0	209.1	189.0	209.1	189.0	209.1	189.0	1,457.6	1,330.0	127.6
NORTH FOREST PRODUCTS																			
	SALARIES	263.0	252.2	100.0	515.2	200.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	1,015.2	700.0	315.2
	CAPITAL	0.0			0.0												0.0	0.0	
	OTHER	369.0	312.6	216.0	681.6	432.0	216.0	216.0	216.0	216.0	216.0	216.0	216.0	216.0	216.0	216.0	1,761.6	1,512.0	249.6
	TOTAL	632.0	564.8	316.0	1,196.8	632.0	316.0	316.0	316.0	316.0	316.0	316.0	316.0	316.0	316.0	316.0	2,776.8	2,212.0	564.8
FORESTRY TASMANIA																			
	SALARIES	137.0	157.0	136.1	294.0	195.0	172.7	112.0	190.0	124.0	209.0	136.0	229.9	149.0	252.9	164.0	1,348.5	880.0	468.5
	CAPITAL	0.0			0.0	0.0		0.0		0.0		0.0		0.0		0.0	0.0	0.0	
	OTHER	179.1	168.6	178.0	347.7	241.0	185.5	139.0	204.0	152.0	224.4	168.0	246.8	185.0	271.5	203.0	1,479.9	1,088.0	391.9
	TOTAL	316.1	325.6	314.1	641.7	436.0	358.2	251.0	394.0	276.0	433.4	304.0	476.7	334.0	524.4	367.0	2,828.4	1,968.0	860.4
AUSTRALIAN PAPER PLANTATIONS																			
	SALARIES	65.8	83.2	85.0	149.0	170.0	87.6	85.0	90.2	85.0	92.9	85.0	95.7	85.0	98.5	85.0	613.9	595.0	18.9
	CAPITAL	0.0			0.0												0.0	0.0	
	OTHER	135.5	124.9	121.0	260.4	242.0	124.6	121.0	128.4	121.0	132.2	121.0	136.2	121.0	140.3	121.0	922.1	847.0	75.1
	TOTAL	201.3	208.1	206.0	409.4	412.0	212.2	206.0	218.6	206.0	225.1	206.0	231.9	206.0	238.8	206.0	1,536.0	1,442.0	94.0
BUNNINGS TREEFARMS																			
	SALARIES	65.9	71.4	55.0	137.3	110.0	63.8	55.0	63.8	55.0	63.8	55.0	63.8	55.0	63.8	55.0	456.3	385.0	71.3
	CAPITAL	0.0			0.0												0.0	0.0	
	OTHER	107.3	113.1	115.0	220.4	230.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	795.4	805.0	-9.6
	TOTAL	173.2	184.5	170.0	357.7	340.0	178.8	170.0	178.8	170.0	178.8	170.0	178.8	170.0	178.8	170.0	1,251.7	1,190.0	61.7
PRIMARY INDUSTRIES CORP'N (QFRI)																			
	SALARIES	449.8	421.5	402.1	871.3	644.0	390.8	322.0	390.8	322.0	390.8	322.0	390.8	322.0	390.8	322.0	2,625.3	2,254.0	571.3
	CAPITAL	28.4		24.0	28.4												28.4	0.0	28.4
	OTHER	526.0	384.1	329.7	910.1	760.0	381.3	380.0	381.3	360.0	381.3	380.0	381.3	360.0	381.3	380.0	2,616.6	2,660.0	156.6
	TOTAL	1,004.2	805.6	755.8	1,809.8	1,404.0	772.1	702.0	772.1	702.0	772.1	702.0	772.1	702.0	772.1	702.0	5,670.3	4,914.0	756.3

SOUTHERN CROSS UNIVERSITY																		
SALARIES	62.9	68.0	60.0	130.9	120.0	70.8	60.0	73.6	60.0	76.5	60.0	79.6	60.0	62.6	60.0	514.2	420.0	94.2
CAPITAL	0.0			0.0												0.0	0.0	
OTHER	189.7	287.6	249.0	477.5	498.0	299.3	249.0	311.3	249.0	323.7	249.0	336.7	249.0	350.1	249.0	2,098.6	1,743.0	355.6
TOTAL	252.6	355.6	309.0	608.4	618.0	370.1	309.0	384.9	309.0	400.2	309.0	416.3	309.0	432.9	309.0	2,612.8	2,163.0	449.8
GRIFFITH UNIVERSITY																		
SALARIES	163.7	108.8	161.1	272.5	253.0	103.7	126.5	105.2	126.5	106.7	126.5	106.7	126.5	106.7	126.5	801.5	885.5	-84.0
CAPITAL	0.0	20.0		20.0		20.0		20.0		20.0		20.0		20.0		120.0	0.0	120.0
OTHER	150.6	116.5	148.3	267.1	232.8	111.0	116.4	112.6	116.4	114.1	116.4	114.1	116.4	114.1	116.4	565.9	814.8	-248.9
TOTAL	314.3	245.3	309.4	559.6	485.8	234.7	242.9	237.8	242.9	240.8	242.9	240.8	242.9	240.8	242.9	1,487.4	1,700.3	-212.9
BORAL TIMBER TASMANIA																		
SALARIES	6.4	24.5	6.4	30.9	10.0	24.5	5.0	24.5	5.0	6.9	5.0	6.9	5.0	6.9	5.0	100.6	35.0	65.6
CAPITAL	0.0			0.0	0.0		0.0									0.0	0.0	
OTHER	34.8	42.0	33.6	76.8	70.0	39.8	35.0	39.8	35.0	33.6	35.0	33.6	35.0	33.6	35.0	257.2	245.0	12.2
TOTAL	41.2	66.5	40.0	107.7	80.0	64.3	40.0	64.3	40.0	40.5	40.0	40.5	40.0	40.5	40.0	357.8	280.0	77.8
THE AUSTRALIAN NATIONAL UNIVERSITY																		
SALARIES	59.2	59.2	59.2	118.4	127.6	59.3	63.8	59.3	63.8	59.3	63.8	59.3	63.8	59.3	63.8	414.9	446.6	-31.7
CAPITAL	0.0			0.0												0.0	0.0	
OTHER	177.7	177.7	177.7	355.4	224.0	177.7	112.0	177.7	112.0	177.7	112.0	177.7	112.0	177.7	112.0	1,243.9	784.0	459.9
TOTAL	236.9	236.9	236.9	473.8	351.6	237.0	175.8	237.0	175.8	237.0	175.8	237.0	175.8	237.0	175.8	1,658.8	1,230.6	428.2
THE UNIVERSITY OF QUEENSLAND																		
SALARIES	8.6	23.6	25.0	32.2	50.0	23.6	25.0	23.6	25.0	23.6	25.0	23.6	25.0	23.6	25.0	150.2	175.0	-24.8
CAPITAL	0.0			0.0												0.0	0.0	
OTHER	10.0	47.0	47.0	57.0	94.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	292.0	329.0	-37.0
TOTAL	18.6	70.6	72.0	89.2	144.0	70.6	72.0	70.6	72.0	70.6	72.0	70.6	72.0	70.6	72.0	442.2	504.0	-61.8
AUSTRALIAN FOREST GROWERS																		
SALARIES	1.1	1.1	0.5	2.2	0.0	1.1	0.0	1.1	0.0	1.1	0.0	1.1	0.0	1.1	0.0	7.7	0.0	7.7
CAPITAL	0.0			0.0												0.0	0.0	
OTHER	0.3	0.3	0.5	0.6	2.0	0.3	1.0	0.3	1.0	0.3	1.0	0.3	1.0	0.3	1.0	2.1	7.0	-4.9
TOTAL	1.4	1.4	1.0	2.8	2.0	1.4	1.0	1.4	1.0	1.4	1.0	1.4	1.0	1.4	1.0	9.8	7.0	2.8
SOUTHERN TREE BREEDING ASS'N																		
SALARIES	6.0	6.0	0.0	12.0	0.0	6.0	0.0	6.0	0.0	6.0	0.0	6.0	0.0	6.0	0.0	42.0	0.0	42.0
CAPITAL	0.0			0.0												0.0	0.0	
OTHER		37.0	5.0	37.0	10.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0	5.0	37.0	35.0	2.0
TOTAL	6.0	43.0	5.0	49.0	10.0	6.0	5.0	6.0	5.0	6.0	5.0	6.0	5.0	6.0	5.0	79.0	35.0	44.0
SILVAGENE																		
SALARIES			0.0	0.0	0.0	0.0		0.0		0.0		0.0		0.0		0.0	0.0	0.0
CAPITAL	0.0			0.0												0.0	0.0	
OTHER	5.0	5.0	5.0	10.0	10.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	35.0	35.0	0.0
TOTAL	5.0	5.0	5.0	10.0	10.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	35.0	35.0	0.0
TOTAL IN-KIND CONTRIBUTIONS																		
SALARIES	2,524.6	2,540.0	2,336.0	5,064.6	4,334.0	2,452.0	2,139.0	2,507.2	2,151.0	2,626.5	2,163.0	2,503.3	2,176.0	2,535.6	2,191.0	17,589.2	15,154.0	2,435.2
CAPITAL	28.4	20.0	24.0	48.4	0.0	20.0	0.0	20.0	0.0	20.0	0.0	20.0	0.0	20.0	0.0	148.4	0.0	148.4
OTHER	4,423.8	4,562.8	4,262.6	8,986.6	8,242.8	4,541.8	4,083.4	4,632.7	4,096.4	4,690.5	4,112.4	4,659.4	4,129.4	4,797.2	4,147.4	32,218.2	28,811.8	3,406.4
GRAND TOTAL IN-KIND	6,976.8	7,122.8	6,622.6	14,099.6	12,576.8	7,013.8	6,222.4	7,159.9	6,247.4	7,237.0	6,275.4	7,182.7	6,305.4	7,262.8	6,338.4	49,955.6	43,965.8	5,990.0

CASH CONTRIBUTIONS ($000's)

ATTACHMENT C TABLE 2

PARTNERS	ACTUAL 1997/98 Actual	ACTUAL 1998/99 Actual	CUMULATIVE Total to date Actual	CUMULATIVE Total to date Agr'mt	PROJECTED 1999/00 Budget	1999/00 Agr'mt	2000/01 Budget	2000/01 Agr'mt	2001/02 Budget	2001/02 Agr'mt	2002/03 Budget	2002/03 Agr'mt	2003/04 Budget	2003/04 Agr'mt	GRAND TOTAL Total 7 yrs	Agr'mt 7 yrs	Diff 7 yrs
CSIRO	0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
University of Tasmania	0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
Forestry Tasmania	22.5	19.3	41.8	30.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	117	105	11.8
North Forest Products	65.1	50.0	115.1	100.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	365	350	15.1
Australian Paper Plantations	35.0	35.6	70.6	70.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	246	245	0.6
Fletcher Challenge Paper	22.4	20.8	43.2	40.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	143	140	3.2
Bunnings Treefarms	35.0	36.2	71.2	70.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	246	245	1.2
Primary Industries Corporation *	25.0	50.3	75.3	50.0	0.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	175	175	0.3
Southern Cross University	100.0	100.3	200.3	200.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	700	700	0.3
Griffith University	25.0	26.2	51.2	50.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	176	175	1.2
Boral Timber Tasmania	0.0	2.2	2.2	0.0	0.0		0.0		0.0		0.0		0.0		2	0	2.2
Australian National University	0.0		0.0	0.0	0.0		0.0		0.0		0.0		0.0		0	0	0.0
The University of Queensland	0.0		0.0	0.0	0.0		0.0		0.0		0.0		0.0		0	0	0.0
Australian Forest Growers	1.0	1.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7	7	0.0
STBA	0.0		0.0	0.0	0.0		0.0		0.0		0.0		0.0		0	0	0.0
Silvagene	0.0		0.0	0.0	0.0		0.0		0.0		0.0		0.0		0	0	0.0
TOTAL CASH FROM PARTICIPANTS	331.0	342.2	673.2	612.0	281.0	306.0	306.0	306.0	306.0	306.0	306.0	306.0	306.0	306.0	2,178.2	2,142.0	36.2
OTHER CASH																	
Interest	20.4	67.5	87.9	0.0	42.0	0.0	30.0	0.0	30.0	0.0	30.0	0.0	30.0	0.0	249.9	0.0	249.9
Non-participants	7.8	23.4	31.2	0.0											31.2	0.0	31.2
Other external funds	0.0	0.0	0.0	0.0	62.8	0.0	62.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	125.6	0.0	125.6
CRC Grant	1,718.1	2,313.0	4,031.1	3,980.0	2,299.8	2,300.0	2,322.0	2,300.0	2,345.2	2,300.0	2,368.6	2,300.0	2,392.3	2,300.0	15,759.0	15,480.0	279.0
Carry Forward				549													
TOTAL CRC CASH CONTRIBUTION	2,077.3	2,746.1	4,823.4	5,141.0	2,685.6	2,606.0	2,720.8	2,606.0	2,681.2	2,606.0	2,704.6	2,606.0	2,728.3	2,606.0	18,343.9	18,171.0	721.9
Cash carried over from previous year	741.0	1,002.6			1,338.1	-6.0	753.4	-3.0	517.3	-2.0	182.2	-2.0	-114.5	-3.0			
Less unspent balance	1,002.6	1,338.1			753.4	-3.0	517.3	-2.0	182.2	-2.0	-114.5	-3.0	497.6	0.0			
TOTAL CASH EXPENDITURE	1,815.7	2,410.7	4,226.4	5,147.0	3,270.3	2,603.0	2,956.9	2,605.0	3,016.3	2,606.0	3,001.3	2,607.0	2,116.2	2,603.0	18,587.4	18,171.0	416.4
ALLOCATION OF CASH EXPENDITURE BETWEEN HEADS OF EXPENDITURE																	
SALARIES	1,288.9	1,686.4	2,975.3	3,437.0	1,996.5	1,696.0	2,070.6	1,700.0	2,125.0	1,701.0	2,100.0	1,702.0	1,409.9	1,703.0	12,677.3	11,941.0	736.3
CAPITAL			0.0	0.0													
OTHER	526.8	724.3	1,251.1	1,710.0	1,273.8	905.0	886.3	905.0	891.3	905.0	901.3	905.0	706.3	900.0	5,910.1	6,230.0	-319.9

* PIC contributions for 1998/99 include an advance for 1999/00

SUMMARY OF RESOURCES APPLIED TO ACTIVITIES OF CENTRE ($000's)

TABLE 3

ALL PROGRAMS	Actual		Cumulative		Projected										GRAND TOTAL		
	1997/98	1998/99	Total to date		1999/00	1999/00	2000/01	2000/01	2001/02	2001/02	2002/03	2002/03	2003/04	2003/04			
	Actual	Actual	Actual	Agr'mt	Budget	Agr'mt	Budget	Agr'mt	Budget	Agr'mt	Budget	Agr'mt	Budget	Agr'mt	Total	Agr'mt	Diff
GRAND TOTAL (IN-KIND)	6,976.8	7,122.8	14,099.6	12,576.8	7,013.8	6,222.4	7,159.9	6,247.4	7,237.0	6,275.4	7,182.7	6,305.4	7,262.8	6,338.4	49,955.8	43,965.8	5,990.0
GRAND TOTAL (CASH EXPENDITURE)	1,815.7	2,410.7	4,226.4	5,147.0	3,270.3	2,603.0	2,956.9	2,605.0	3,016.3	2,606.0	3,001.3	2,607.0	2,116.2	2,603.0	18,587.4	18,171.0	416.4
TOTAL RESOURCES APPLIED TO ACTIVITIES OF CENTRE	8,792.5	9,533.5	18,326.0	17,723.8	10,284.1	8,825.4	10,116.8	8,852.4	10,253.3	8,881.4	10,184.0	8,912.4	9,379.0	8,941.4	68,543.2	62,136.8	6,406.4
ALLOCATION OF TOTAL RESOURCES APPLIED TO ACTIVITIES OF CENTRE BETWEEN HEADS OF EXPENDITURE																	
TOTAL SALARIES (CASH AND IN-KIND)	3,813.5	4,226.4	8,039.9	7,771.0	4,448.5	3,837.0	4,577.8	3,851.0	4,651.5	3,864.0	4,603.3	3,878.0	3,945.5	3,894.0	30,266.5	27,095.0	3,171.5
TOTAL CAPITAL (CASH AND IN-KIND)	28.4	20.0	48.4	0.0	20.0	0.0	20.0	0.0	20.0	0.0	20.0	0.0	20.0	0.0	148.4	0.0	148.4
TOTAL OTHER (CASH AND IN-KIND)	4,950.6	5,287.1	10,237.7	9,952.8	5,815.6	4,988.4	5,519.0	5,001.4	5,581.8	5,017.4	5,560.7	5,034.4	5,413.5	5,047.4	38,128.3	35,041.8	3,086.5

ALLOCATION OF RESOURCES BETWEEN CATEGORIES OF ACTIVITIES 1998/99

TABLE 4

PROGRAM	RESOURCE USAGE			
	Cash (1) $000's	In-kind $000's	Contributed Staff (2)	Cash Funded Staff (CRC) (2)
Research	2,258.8	6,018.8	18.5	10.5
Education	108.5	391.8	1.2	0.5
External Communications				
Commercialisation/ Tech Transfer				
Administration	43.4	712.3	2.2	0.2
TOTAL	2,410.7	7,122.8	21.9	11.2

(1) Cash from all sources, including CRC Program
(2) Person years, Professional staff (total should be as in "Research Staff Resources" table.)

RESEARCH STAFF RESOURCES (1998/99)

ATTACHMENT B

Organisation		Main activity	Total % time	% spent on Research Program GI	SM	RP	Total on Research	% spent on Education	% Spent on Commercialisation Program	% spent on CRC Administration
Fletcher Challenge Paper										
HETHERINGTON, S		R	20	5	5	10	20			
WILLEMS, A		A	2							2
Total			22	5	5	10	20			2
Australian Paper Plantations										
PONGRACIC, S		R	10	6	4		10			
CAMERON, J		R	3.7	2	1.7		3.7			
Total			13.7	8	5.7	0	13.7			
Bunnings Treefarms										
SMITH,T		R	28		28		28			
PILBEAM, D		R	22	22			22			
MADDERN, L		R	7			7	7			
BREIDAHL, R		R	2				0			2
TREDINNICK, J		R	2		1		1			1
VITLICH, M		A	3				0			3
HUNTER, S		A	5				0			5
Total			69	22	29	7	58	0		11
North Forest Products										
HOLZ, G		R	57		40		40			17
BARNES, C		R	27		27		27			
TIBBITS, W		R	48	34			34			14
DE LITTLE, D		R	62			43	43			19
JAMIESON, A		A	12							12
Total			206	34	67	43	144			62
Forestry Tasmania										
ELEK, J		R	40			40	40			
CANDY, S		R	21			21	21			
MARSH, N		R	40			40	40			
KUBE, P		R	20	20			20			
PINKARD, L		R	20		20		20			
ELLIOTT, H		R/A	10			2	2			8
NEILSEN, B		R	3		3		3			
DRIELSMA, H		R	3				0			3
Total			157	20	23	103	146			11
CSIRO Forestry & Forest Products										
RAYMOND, C		R	64	32	32		64			
BATTAGLIA,M		R	90		90		90			
MUMMERY, D		R	90		90		90			
SANDS, P		R	80		80		80			
BEADLE, C		R	80		80		80			
SMETHURST, P		R	72		72		72			
CROMER, R		R	30		30		30			
MORAN,G		R	30	30			30			
MCCORMACK, B		R	10		10		10			
MOHAMMED, C		R	10			10	10			
WILLIAMS, E		R	10	10			10			
WALLIS, A		R	5	5			5			
EVANS, R		R	5	5			5			
Total			576	82	484	10	576			

CSIRO Entomology

FLOYD,R		R	25			25	25			
MILNER, R		R	20			20	20			
MATTHIESSEN, R		R	32			32	32			
Total			77	0	0	77	77			

University of Tasmania

REID, J		R	50	10			10	10		30
VAILLANCOURT, R		R	45	45			45			
WILTSHIRE, R		R	30				0	30		
BROWN, P		R	30		30		30			
MCARTHUR,C		R	25			25	25			
DAVIDSON,N		R	25					25		
POTTS,B		R	25	25			25			
ALLEN,G		R	25			25	25			
HURLEY,M		R	25			25	25			
CLARK, R		R	20		10		10	10		
LINE, M		R	20		20		20			
JENNINGS, S		R	15		15		15			
MOHAMMED,C		R	15			15	15			
JORDAN,G		R	10				0	10		
HALLEGRAEFF, G		R	10							10
JOHNSON,C		R	10				0	10		
HOVENDEN,M		R	5	5			5			
GLENN,A		A	1				0			1
Total			386	85	75	90	250	95		41

Primary Industries Corporation

SIMPSON, JA		R	53		50		50			3
DIETERS, M		R	40	40			40			
BUBB, K		R	40		40		40			
KEENAN, R		R	7		7		7			
NIKLES, G		R	8	8			8			
WALKER, S		R	10	8			8			2
HARDING, K		R	20	20			20			
NESTER, M		R	20	5	15		20			
HUNT, M		R	25		25		25			
HOUSE, A		R	10		10		10			
LEWTY,M		R	20		10		10			10
RYAN, P		R	10		10		10			
XU, Z		R	40		40		40			
OSBORNE, D		R	30		30		30			
HAINES, R		A	50	10			10			40
Total			383	91	237		328			55

Southern Cross University

HENRY, R		R	30	20			20	10		
CODRINGTON, T		R	20	20			20			
BAVERSTOCK,P		A	5							5
Total			55	40	0		40	10	0	5

Griffith University

SAFFIGNA,P		R	30		20		20	5		5
PERARA,S		R	5				0			5
BERNERS-PRICE,S		R	20		10		10			10
YU,B		R	20		15		15			5
RICKSON,R		R	15		15		15			
PHILLIPS,I		R	5		5		5			
HUGHES,J		R	10	10			10			
KING,R		A	5				0			5
Total			105	10	65		75			30

RESEARCH STAFF RESOURCES

Attachment B cont.../3

Boral Timber Tasmania										
HAWKINS, C		R	20		20		20			
NAUGHTON, P		R	10		10		10			
Total			30	0	30		30			
Australian National University										
KANOWSKI, P		R	30	10	20		30			
RACE, D		R	25		25		25			
MAHENDRARAJAH, S		R	10		10		10			
JAMES, R		R	10		10		10	0		
Total			75	10	65		75	0	0	0
The University of Queensland										
DOLEY, D		R	25		10		10	15		
Total			25	0	10		10	15		
STBA										
GORE, P		R	10	10			10			
Total			10	10	0		10			
CRC funded										
DUTKOWSKI,G	Uni Tas	R	100	100			100			
SHEPHERD, M	SCU	R	100	100			100			
DUNGEY, H	QFRI	R	100	100			100			
THAMARUS, K	CSIRO	R	100	100			100			
DAVIDSON, N	Uni Tas	R	75		25		25	50		
PU, G	Griffith Uni	R	100		100		100			
McARTHUR, C	Uni Tas	R	75			75	75			
STEINBAUER, M	CSIRO	R	100			100	100			
STEANE, D	Uni Tas	R	60	60			60			
POTTS, B	Uni Tas	R	75	75			75			
ALLEN, G	Uni Tas	R	50			50	50			
HURLEY, M	Uni Tas	R	50			50	50			
MATYSEK,A	Uni Tas	R	40		40					
SMETHURST, P	CSIRO	R	28		28		28			
RACE, D	ANU	R	25		25		25			
FULTON, A	UniTas	R	25		25		25			
REID,J	UniTas	R	20				0			20
Total			1123	535	243	275	1053	50	0	20

SUMMARY OF CONTRIBUTIONS IN PERSON YEARS

	Total person years	Person years spent on Research program			Total on Research	Person years spent on Education Program	Person years spent on Commercialisation Program	Person years spent on CRC Administration
		Gen	*SSM*	*Prot*				
Total Contributed	21.9	4.2	11.0	3.4	18.5	1.2		2.2
Total funded by CRC	11.2	5.4	2.4	2.8	10.5	0.5		0.2
Grand total	33.1	9.5	13.4	6.2	29.1	1.7		2.4
Proportion of total professional (%) staff resources in each activity	100.0	28.7	40.4	18.6	87.7	5.1		7.2

SUPPORT STAFF

Contributed	
Organisation	Number of staff (person years)
CSIRO(FFP & ENTO)	5.96
North Forest Products	1.12
Primary Industries Corporation	2.79
Forestry Tasmania	2.12
Bunnings Treefarms	1.01
University of Tasmania	0.75
Australian Paper Plantations	0.89
SCU	0.30
Australian Forest Growers	0.50
Fletcher Challenge Paper	0.02
Boral Timber	0.06
Griffith University	0.00
Australian National University	0.00
Silvagene	0.00
STBA	0.00
The University of Queensland	0.00
Total	15.52

CRC Funded (by employing organisation)	
Organisation	Number of staff (person years)
University of Tasmania	11.4
CSIRO (FFP & Ento)	2.8
SCU	1.0
GU	0.3
PIC (QFRI)	1.0
Total	16.4

Cooperative Research Centre for Sustainable Production Forestry

Summary of Base Grant Funds 1998/99
Summary of income/expenditure

Opening Balance at 1/7/98	1,002,632
Add Income	2,746,214
Less Expenses	
Salaries	1,686,433
Consumables	633,643
Equipment	90,649
TOTAL EXPENSES	2,410,725
Closing Balance at 30/6/99	1,338,121

CSIRO - Forestry & Forest Products

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1998/99 Financial tables

Itemised List of Cash and In-Kind Contributions (in $'000's)

	SALARIES	*% time*	97/98	98/99	99/2000	2000/01	2001/02	2002/03	2003/04	TOTAL
Name	*Designation*	*CRC*	Actual	Actual	Budget	Budget	Budget	Budget	Budget	
Battaglia,M	R	90%								
Mummery,D	R	90%								
Sands, P	R	80%								
Beadle,C	R	80%								
Smethurst,P	R	72%								
Raymond,C	R	64%								
Moran,G	R	30%								
Cromer, R	R	30%								
Mohammed,C	R	10%								
Williams,E	R	10%								
McCormack,B	R	10%								
Wallis,A	R	5%								
Evans,R	R	5%								
Baillie,C	T	100%								
Murrell,J	T	50%								
Owen,J	T	10%								
Cherry,M	T	100%								
Worledge,D	T	30%								
Churchill,K	T	60%								
Kile,G	A	5%								
Nambiar,S	A	5%								
MacGillivray,G	A	25%								
Lockwood,R	A	1%								
Coles,P	A	25%								
Denton,B	T	25%								
Sprent,J	A	50%								
		Total Salary	515.5	545.9	535.4	548.8	562.5	576.6	591.0	3,875.6
Direct On-Costs		*% of total Salary*								
Productivity Benefit		3	15.5	16.4	16.1	16.5	16.9	17.3	17.7	116.3
Superannuation		18.5	95.4	101.0	99.0	101.5	104.1	106.7	109.3	717.0
Workers Compensation		1.1	5.7	6.0	5.9	6.0	6.2	6.3	6.5	42.6
Leave Loading		1.5	7.7	8.2	8.0	8.2	8.4	8.6	8.9	58.1
Long Service Leave		2.5	12.9	13.6	13.4	13.7	14.1	14.4	14.8	96.9
Other		0								
		Total On-Costs	137.1	145.2	142.4	146.0	149.6	153.4	157.2	1,030.9
		Total Salaries & On-Costs	652.6	691.1	677.8	694.8	712.1	729.9	748.2	4,906.6
CAPITAL										
		Total Capital								
OTHER		*% of Total Salaries & On-Costs*								
Divnl other support		153.4	1,001.1	1,060.2	1,039.8	1,065.8	1,092.4	1,119.7	1,147.7	7,526.7
Corporate support		32	208.8	221.2	216.9	222.3	227.9	233.6	239.4	1,570.1
Imputed Rent			200.0	200.0	200.0	200.0	200.0	200.0	200.0	1,400.0
Other operating			0.0	14.5	7.5	7.5	7.5	7.5	7.5	52.0
		Total Other	1,410.0	1,495.8	1,464.2	1,495.6	1,527.8	1,560.8	1,594.6	10,548.8
		TOTAL IN-KIND CONTRIBUTION	2,062.6	2,186.9	2,142.0	2,190.4	2,239.9	2,290.7	2,342.8	15,455.3
ALL PROGRAMS CASH CONTRIBUTIONS										

CSIRO - Entomology

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1998/99 Financial tables

Itemised List of Cash and In-Kind Contributions (in $'000's)

	SALARIES	*% time*	97/98	**98/99**	99/2000	2000/01	2001/02	2002/03	2003/04	TOTAL
Name	*Designation*	*CRC*	Actual	**Actual**	Budget	Budget	Budget	Budget	Budget	
M Steinbauer	R	100%								
PhD Student	R	100%								
Post Doc WA	R	100%								
J Matthiessen	R	32%								
R Floyd	R	25%								
R Milner	R	20%								
G Farrell	T	30%								
J Dowse	T	30%								
R Sutherland	T	30%								
M Court	T	30%								
		Total Salary	130.5	**118.3**	172.4	184.5	179.4	124.3	109.3	1,018.6
	Direct On-Costs	*% of total Salary*								
	Superannuation	20.5	26.0	**24.3**	32.2	33.7	32.6	22.4	22.4	193.6
	Comcare	1.1	1.4	**1.3**	1.7	1.8	1.8	1.2	1.2	10.4
	Leave Loading	1.5	2.0	**1.8**	2.4	2.5	2.4	1.6	1.6	14.2
	Long Service Leave	2.5	3.3	**3.0**	3.9	4.1	4.0	2.7	2.7	23.7
		Total On-Costs	32.6	**30.3**	40.3	42.1	40.8	28.0	28.0	241.9
		Total Salaries & On-Costs	163.1	**148.6**	212.6	226.6	220.1	152.3	137.3	1,260.6
	CAPITAL									
		Total Capital								
	OTHER	*% of Total Salaries & On -Costs*								
	Divnl other support	156	190.8	**198.8**	297.1	316.3	311.7	225.8	202.4	1,743.0
	Corporate support	32	48.9	**55.2**	77.7	82.1	80.4	62.8	58.0	465.2
	Less Industry Contributions				113.5	120.3	124.8	22.5		381.1
		Total Other	239.7	**254.1**	374.8	398.4	392.1	288.6	260.4	2,208.2
	TOTAL IN-KIND CONTRIBUTION		402.8	**402.7**	474.0	504.7	487.4	418.4	397.7	3,087.6
ALL PROGRAMS CASH CONTRIBUTIONS										

University of Tasmania

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1998/99 Financial tables

Itemised List of Cash and In-Kind Contributions (in $'000's)

SALARIES

Name	Designation	% time CRC	97/98 Actual	98/99 Actual	99/2000 Budget	2000/01 Budget	2001/02 Budget	2002/03 Budget	2003/04 Budget	TOTAL
J Reid	Research	50								
R Vaillaincourt	Research	45								
G Allen	Research	25								
M Hurley	Research	25								
R Clark	Research	20								
R Hill/G Jordan	Research	10								
G Hallegraeff	Research	10								
M Line	Research	20								
P Brown	Research	30								
R Willshire	Research	30								
M Hovenden	Research	5								
S Jennings	Research	15								
C Mohammed	Research	15								
CR Johnson	Research	10								
S Hunter/C Lane	Technical	5								
A Smolenski	Technical	18								
I Cummings	Technical	30								
L Johnson	Technical	1								
B Rumbold	Technical	1								
C Ashworth	Technical	1								
G Johnson	Technical	20								
C McArthur	Research	25								
N Davidson	Research	25								
A Glenn	Research	1								
B Potts	Research	25								
	Total Salary		259.1	274.7	298	298	298	298	298	2023.8

Direct On-Costs	*% of total Salary*								
Payroll Tax	7.7	18.1	21.2	22.9	22.9	22.9	22.9	22.9	154.0
Superannuation	17	44.0	46.7	50.7	50.7	50.7	50.7	50.7	344.0
Workers Compensation	0.5	2.6	1.4	1.5	1.5	1.5	1.5	1.5	11.4
Leave Loading-Academics	1.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0	3.2
Long Service Leave	3.2	8.3	9.8	9.5	9.5	9.5	9.5	9.5	64.8
Outside Study Academics		20.0	20.0	20.0	20.0	20.0	20.0	20.0	140.0
HECS student costs		30.0	30.0	30.0	30.0	30.0	30.0	30.0	210.0
Other									0.0
	Total On-Costs	126.3	128.0	134.6	134.6	134.6	134.6	134.6	927.4
	Total Salaries & On-Costs	**385.4**	**402.7**	**432.6**	**432.6**	**432.6**	**432.6**	**432.6**	**2,951.2**

CAPITAL

	Total Capital	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OTHER

	% of Total Salaries & On-Costs								
Academic Services	25.0	96.3	100.7	108.2	108.2	108.2	108.2	108.2	737.8
General Uni Services	41.0	158.0	165.1	177.4	177.4	177.4	177.4	177.4	1,210.0
Departmental office support	10.0	38.5	40.3	43.3	43.3	43.3	43.3	43.3	295.1
Laboratory rent	32.0	123.3	128.9	138.4	138.4	138.4	138.4	138.4	944.4
Office Space	8.0	30.8	32.2	34.6	34.6	34.6	34.6	34.6	236.1
CSL		84.4	84.4	84.4	84.4	84.4	84.4	84.4	590.8
Centre Agency (10% grant)		171.8	231.9	230.0	230.0	230.0	230.0	230.0	1,553.7
Research Quantum			41.9						41.9
	Total Other	703.2	825.3	816.3	816.3	816.3	816.3	816.3	5,609.8
	TOTAL IN-KIND CONTRIBUTION	1,088.6	1,228.1	1,248.9	1,248.9	1,248.9	1,248.9	1,248.9	8,561.1
ALL PROGRAMS CASH CONTRIBUTIONS			0.3						0.3

Fletcher Challenge Paper

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1998/99 Financial tables

Itemised List of Cash and In-Kind Contributions (in $'000's)

	SALARIES	% time CRC	97/98 Actual	**98/99 Actual**	99/2000 Budget	2000/01 Budget	2001/02 Budget	2002/03 Budget	2003/04 Budget	TOTAL
Name	*Designation*									
A Willems	Research	2								
S Hetherington	Research	20								
R Pyke	Technical	2								
		Total Salary	26.0	**16.0**	19.0	19.0	19.0	19.0	19.0	137.0
	Direct On-Costs	*% of total Salary*								
	Other-Total	32	8.3	**5.1**	6.1	6.1	6.1	6.1	6.1	43.7
		Total On-Costs	8.3	**5.1**	6.1	6.1	6.1	6.1	6.1	43.7
		Total Salaries & On-Costs	34.3	**21.1**	25.1	25.1	25.1	25.1	25.1	180.7
	CAPITAL									
		Total Capital	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
	OTHER	*% of Total Salaries & On -Costs*								
	Office Support		10.0	**8.0**	8.0	8.0	8.0			
	Land rent		148.5	**139.0**	150.0	150.0	150.0			
	Trial maintenance		15.0	**16.0**	16.0	16.0	16.0			
	Experiments		8.5	**6.0**	7.0	7.0	7.0			
	Other(Vehicles)		4.0	**2.0**	3.0	3.0	3.0			
		Total Other	186.0	**171.0**	184.0	184.0	184.0	180.0	180.0	1,269.0
	TOTAL IN-KIND CONTRIBUTION		220.3	**192.1**	209.1	209.1	209.1	205.1	205.1	1,449.7
ALL PROGRAMS CASH CONTRIBUTIONS			22.4	**20.0**	20.0	20.0	20.0	20.0	20.0	142.4

North Forest Products

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1998/99 Financial tables

Itemised List of Cash and In-Kind Contributions (in $'000's)

SALARIES		*% time*	97/98	**98/99**	99/2000	2000/01	2001/02	2002/03	2003/04	TOTAL
Name	*Designation*	*CRC*	Actual	**Actual**	Budget	Budget	Budget	Budget	Budget	
D deLittle	Scientist	62								
G Holz	Scientist	57								
W Tibbits	Scientist	48								
C Barnes	Scientist	27								
T Hingston	Technician	33								
I Hammond	Technician	33								
K Joyce	Technician	24								
T Williams	Technician	22								
A Jamieson	Manager	12								
		Total Salary	198.0	**169.0**						367.0
	Direct On-Costs	*% of total Salary*								
	Other-Total	33	65.3	**83.2**						148.5
		Total On-Costs	65.3	**83.2**	0.0	0.0	0.0	0.0	0.0	148.5
	Total Salaries & On-Costs		**263.3**	**252.2**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**1,015.5**
	CAPITAL									
	Total Capital		0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
	OTHER	*% of Total Salaries & On -Costs*								
	Office Support		7.0							
	Land rent		87.0	**87.0**						
	Trial maintenance		8.0	**9.0**						
	Other		267.0	**217.0**						
	Total Other		369.0	**312.6**	216.0	216.0	216.0	216.0	216.0	1,761.6
	TOTAL IN-KIND CONTRIBUTION		632.3	**564.7**	316.0	316.0	316.0	316.0	316.0	2,777.1
ALL PROGRAMS CASH CONTRIBUTIONS			65.1	**50.0**	50.0	50.0	50.0	50.0	50.0	365.1

Forestry Tasmania

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1998/99 Financial tables

Itemised List of Cash and In-Kind Contributions (in $'000's)

	SALARIES	*% time*	97/98	**98/99**	99/2000	2000/01	2001/02	2002/03	2003/04	TOTAL
Name	*Designation*	*CRC*	Actual	**Actual**	Budget	Budget	Budget	Budget	Budget	
H Elliott	Research/Admin	10								
J Elek	Research	40								
P Kube	Research	20								
S Candy	Research	21								
N Marsh	Research	40								
J Lesek	Technician	85								
R Bashford	Technician	10								
C Ringrose	Technician	25								
N Beveridge	Technician	50								
A Jenni	Technician	40								
H Drielsma	Research/Admin	3								
S Meyer	Technician	2								
L Pinkard	Research	20								
B Neilsen	Research	3								
		Total Salary	109.4	**125.4**	137.9	151.7	166.9	183.6	201.9	1,076.7
	Direct On-Costs	*% of total Salary*								
	Superannuation		13.0	**14.9**	16.4	18.1	19.9	21.8	24.0	128.1
	Workers Compensation		3.9	**4.5**	5.0	5.4	6.0	6.6	7.2	38.6
	Long Service Leave		2.7	**3.1**	3.4	3.8	4.2	4.6	5.0	26.9
	Payroll Tax		7.9	**9.1**	10.0	11.0	12.1	13.3	14.7	78.1
		Total On-Costs	27.5	**31.7**	34.8	38.3	42.1	46.3	51.0	271.7
	Total Salaries & On-Costs		**136.9**	**157.0**	**172.7**	**190.0**	**209.0**	**229.9**	**252.9**	**1,348.5**
	CAPITAL									
	Total Capital		0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
	OTHER	*% of Total Salaries & On -Costs*								
	Head office o'heads		57.0	**55.4**	61.0	67.1	73.8	81.2	89.3	484.7
	Office support		30.5	**26.4**	29.1	32.0	35.2	38.7	42.6	234.4
	Corporate Support		24.9	**28.6**	31.4	34.6	38.0	41.8	46.0	245.4
	Operational		66.7	**58.2**	64.0	70.4	77.4	85.2	93.7	515.4
	Total Other		179.1	**168.6**	185.5	204.0	224.4	246.8	271.5	1,480.0
	TOTAL IN-KIND CONTRIBUTION		316.0	**325.6**	358.2	394.0	433.4	476.8	524.4	2,828.4
ALL PROGRAMS CASH CONTRIBUTIONS			22.5	**15.0**	15.0	15.0	15.0	15.0	15.0	112.5

Australian Paper Plantations

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1998/99 Financial tables

Itemised List of Cash and In-Kind Contributions (in $'000's)

	SALARIES	*% time*	97/98	**98/99**	99/2000	2000/01	2001/02	2002/03	2003/04	TOTAL
Name	*Designation*	*CRC*	Actual	**Actual**	Budget	Budget	Budget	Budget	Budget	
S Pongracic	Scientist	10								
R Appleton	Technician	43								
M Krygsman	Technician	46								
J Cameron	Board	3.7								
		Total Salary	55.6	**72.3**	67.0	69.0	71.0	73.2	75.4	483.5
	Direct On-Costs	*% of total Salary*								
	Other-Total		10.1	**10.9**	20.6	21.2	21.9	22.5	23.2	130.4
		Total On-Costs	10.1	**10.9**	20.6	21.2	21.9	22.5	23.2	130.4
		Total Salaries & On-Costs	65.7	**83.2**	87.6	90.2	92.9	95.7	98.6	613.9
	CAPITAL									
		Total Capital	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
	OTHER	*% of Total Salaries & On -Costs*								
	Overheads		38.6	**23.3**	35.5	36.6	37.7	38.8	40.0	250.5
	Operating		96.9	**101.5**	89.1	91.8	94.5	97.4	100.3	671.5
		Total Other	135.5	**124.8**	124.6	128.4	132.2	136.2	140.3	922.0
		TOTAL IN-KIND CONTRIBUTION	201.2	**208.0**	212.2	218.6	225.1	231.9	238.9	1,535.9
ALL PROGRAMS CASH CONTRIBUTIONS			35.0	**35.0**	35.0	35.0	35.0	35.0	35.0	245.0

Bunnings Treefarms

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1998/99 Financial tables

Itemised List of Cash and In-Kind Contributions (in $'000's)

SALARIES		% time	97/98	98/99	99/2000	2000/01	2001/02	2002/03	2003/04	TOTAL
Name	*Designation*	*CRC*	Actual	**Actual**	Budget	Budget	Budget	Budget	Budget	
M Vitlich	Board	3								
J Treddinnick	Commercial Mgr	2								
S Hunter	Nursery/Research Mgr	5								
R Breidahl	Research	2								
D Pilbeam	Research	22								
T Smith	Research	28								
L Maddern	Research	7								
D Walsh	Technical	10								
J Cox	Technical	19								
M Booth	Technical	20								
V Sims	Technical	20								
Y Jansen	Technical	12								
Casual staff	Technical	15								
Nursery staff	Technical	5								
		Total Salary	54.4	**58.4**	52.2	52.2	52.2	52.2	52.2	373.8
Direct On-Costs		*% of total Salary*								
Payroll tax		6	3.3	**3.5**	3.1	3.1	3.1	3.1	3.1	22.4
Superanuation		7	3.3	**4.1**	3.7	3.7	3.7	3.7	3.7	25.6
Workers Compensation		6	3.3	**3.5**	3.1	3.1	3.1	3.1	3.1	22.4
Leave Loading		1.5	0.8	**0.9**	0.8	0.8	0.8	0.8	0.8	5.6
Long Service Leave		1.7	0.9	**1.0**	0.9	0.9	0.9	0.9	0.9	6.3
		Total On-Costs	11.5	**13.0**	11.6	11.6	11.6	11.6	11.6	82.4
		Total Salaries & On-Costs	65.9	**71.4**	63.8	63.8	63.8	63.8	63.8	456.3
CAPITAL										
		Total Capital	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
OTHER		*% of Total Salaries & On -Costs*								
Administration		30.3	31.3	**21.6**	32.0	32.0	32.0	32.0	32.0	213.0
Office Support		3.6	1.7	**2.6**	2.0	2.0	2.0	2.0	2.0	14.3
Corporate Overheads		9.1	6.0	**6.5**	6.5	6.5	6.5	6.5	6.5	45.0
Operational		48.2	34.8	**34.4**	36.0	36.0	36.0	36.0	36.0	249.3
Amortised capital costs		13.3	8.3	**9.5**	9.0	9.0	9.0	9.0	9.0	62.8
Land rent		5.6	2.1	**4.0**	2.5	2.5	2.5	2.5	2.5	18.6
Trial Maintenance		10.3	6.7	**7.4**	7.0	7.0	7.0	7.0	7.0	49.0
Consumables & Freight		2.8	1.1	**2.0**	1.5	1.5	1.5	1.5	1.5	10.6
Library		1.2	0.8	**0.9**	1.0	1.0	1.0	1.0	1.0	6.7
Computer Support		3.5	2.2	**2.5**	2.5	2.5	2.5	2.5	2.5	17.2
Other-Meetings & visits		25.2	11.0	**18.0**	13.0	13.0	13.0	13.0	13.0	94.0
Other- Ferilizers		5.2		**0.7**	2.0	2.0	2.0	2.0	2.0	10.7
Other- Wood Coring Trip				**3.0**						3.0
		Total Other	106.0	**113.0**	115.0	115.0	115.0	115.0	115.0	794.1
TOTAL IN-KIND CONTRIBUTION			171.9	**184.4**	178.8	178.8	178.8	178.8	178.8	1,250.3
ALL PROGRAMS CASH CONTRIBUTIONS			35.0	**35.0**	35.0	35.0	35.0	35.0	35.0	245.0

QFRI - Primary Industries Corporation

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1998/99 Financial tables

Itemised List of Cash and In-Kind Contributions (in $'000's)

	SALARIES	*% time*	97/98	98/99	99/2000	2000/01	2001/02	2002/03	2003/04	TOTAL
Name	*Designation*	*CRC*	**Actual**	**Actual**	**Budget**	**Budget**	**Budget**	**Budget**	**Budget**	
R Haines	Research/Administration	50								
J Simpson	Research	53								
M Dieters	Research	40								
K Bubb	Research	40								
Z Xu	Research	40								
D Osborne	Research	30								
M Hunt	Research	25								
K Harding	Research	20								
M Lewty	Research	20								
M Nester	Research	20								
S Walker	Research	10								
P Ryan	Research	10								
A House	Research	10								
G Nikles	Research	8								
A Keenan	Research	7								
P Frayne	Technician	50								
P Collins	Chemist	30								
P Toon	Technician	30								
P Pomeroy	Technician	29								
C Radddatz	Technician	25								
M Podberseck	Technician	20								
L Cox	Technician	20								
M Johnson	Technician	15								
J Huth	Technician	15								
L Stephens	Technician	15								
A Single	Publicist	10								
M Robinson	Administration	10								
T Wernneerslager	Administration	10								
	Total Salary		332.7	321.5	297.3	297.3	297.3	297.3	297.3	2,140.7
	Direct On-Costs	*% of total Salary*								
	Payroll Tax	6.2	19.0	19.9	18.4	18.4	18.4	18.4	18.4	131.1
	Superannuation	14.6	44.9	46.9	43.4	43.4	43.4	43.4	43.4	308.9
	Long Service Leave	3	6.0	9.6	8.9	8.9	8.9	8.9	8.9	60.2
	Leave Loading	1.5	27.6	4.8	4.5	4.5	4.5	4.5	4.5	54.7
	Enterprise Bargaining	4	13.3	12.9	11.9	11.9	11.9	11.9	11.9	85.6
	Salary banding	1.9	5.7	6.1	5.6	5.6	5.6	5.6	5.1	39.4
	Workers comp premium		0.7	0.0	0.7	0.7	0.7	0.7	0.7	4.2
	Total On-Costs		117.1	100.3	93.5	93.5	93.5	93.5	92.9	684.1
	Total Salaries & On-Costs		**449.8**	**421.8**	**390.8**	**390.8**	**390.8**	**390.8**	**390.2**	**2,824.8**
	CAPITAL									
	Lab Modifications		3.0							3.0
	Gas Chromatograph/Mass Spectrometer x 20%s		25.4							25.4
	Replace flow injection analyser			0.0						0.0
	Total Capital		28.4	0.0	0.0	0.0	0.0	0.0	0.0	28.4
	OTHER	*% of Total Salaries & On -Costs*								
	QFRI Technical support	3.9		16.5	15.2	15.2	15.2	15.2	15.2	92.6
	QFRI Administrative Overheads	5	22.5	21.1	19.5	19.5	19.5	19.5	19.5	141.2
	Dept administrative support	15	45.0	63.3	58.6	58.6	58.6	58.6	58.5	401.2
	Office space	10	45.0	42.2	39.1	39.1	39.1	39.1	39.0	282.5
	Laboratory/Glasshouse rent	0	45.0	0.0	39.1	39.1	39.1	39.1	39.0	240.3
	Travel & Accommodation			0.0	30.0	30.0	30.0	30.0	30.0	150.0
	Other Administrative costs	6.3		26.6	24.6	24.6	24.6	24.6	24.6	149.6
	Field Trials		303.2	176.7	100.0	100.0	100.0	100.0	100.0	979.9
	Chemical analysis		26.4	0.0	20.0	20.0	20.0	20.0	20.0	126.4
	Depreciation	9	39.0	38.0	35.2	35.2	35.2	35.2	35.1	252.8
	Total Other		526.0	384.2	381.3	381.3	381.3	381.3	381.0	2,816.6
	TOTAL IN-KIND CONTRIBUTION		**1,004.3**	**806.0**	**772.1**	**772.1**	**772.1**	**772.1**	**771.1**	**5,669.8**
ALL PROGRAMS CASH CONTRIBUTIONS			**25.0**	**50.0**	**0.0**	**25.0**	**25.0**	**25.0**	**25.0**	**175.0**

Southern Cross University

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1998/99 Financial tables

Itemised List of Cash and In-Kind Contributions (in $'000's)

	SALARIES	*% time*	97/98	**98/99**	99/2000	2000/01	2001/02	2002/03	2003/04	TOTAL
Name	*Designation*	*CRC*	Actual	**Actual**	Budget	Budget	Budget	Budget	Budget	
R Henry	Research	30								
T Codrington	Research	20								
P Carolan	Administration	10								
P Baverstock	Research	5								
V Watt	Administration	10								
D McIntyre	Administration	10								
		Total Salary	47.1	**51.0**	53.0	55.0	57.0	60.0	62.0	385.1
	Direct On-Costs	*% of total Salary*								
	Payroll Tax	7.7	3.6	**3.9**	4.1	4.2	4.4	4.6	4.8	29.7
	Superannuation	16.6	7.8	**8.5**	8.8	9.1	9.5	10.0	10.3	63.9
	Workers compensation	1.5	0.7	**0.8**	0.8	0.8	0.9	0.9	0.9	5.8
	Long Service Leave	3	1.4	**1.5**	1.6	1.7	1.7	1.8	1.9	11.6
	Leave Loading	1.3	0.6	**0.7**	0.7	0.7	0.7	0.8	0.8	5.0
	Tess	3	1.4	**1.5**	1.6	1.7	1.7	1.8	1.9	11.6
	Other- Maternity Leave	0.4	0.2	**0.2**	0.2	0.2	0.2	0.2	0.2	1.5
		Total On-Costs	15.8	**17.1**	18.0	18.0	19.0	20.0	21.0	128.9
		Total Salaries & On-Costs	**62.9**	**68.0**	**71.0**	**74.0**	**77.0**	**80.0**	**83.0**	**515.9**
	CAPITAL									
		Total Capital	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
	OTHER	*% of Total Salaries & On -Costs*								
	Academic Servs/bldgs	8.7	5.5	**5.9**	6.0	6.0	7.0	7.0	7.0	44.4
	Academic Activities- other	27.7	17.4	**18.8**	20.0	20.0	21.0	22.0	23.0	142.3
	Libraries	15.4	9.7	**10.5**	11.0	11.0	12.0	12.0	13.0	79.2
	Other academic support services	15.5	9.7	**10.5**	11.0	11.0	12.0	12.0	13.0	79.3
	Student support services	12	7.5	**8.2**	8.0	9.0	9.0	10.0	10.0	61.7
	Public services	1	0.1	**0.7**	1.0	1.0	1.0	1.0	1.0	5.7
	Buildings & grounds	16.8	10.6	**11.4**	12.0	12.0	13.0	13.0	14.0	86.0
	Admin & general	37.6	23.6	**25.6**	27.0	28.0	29.0	30.0	31.0	194.2
	Independent operations	20.4	12.8	**13.9**	14.0	15.0	16.0	16.0	17.0	104.7
	Other(Research)		89.2	**177.3**	184.0	191.0	199.0	207.0	215.0	1,262.5
	Other(Admin)		3.0	**3.6**	4.0	4.0	4.0	4.0	4.0	26.6
	Other			**1.3**	1.0	1.0	1.0	1.0	2.0	7.3
		Total Other	**189.2**	**287.7**	**299.0**	**311.0**	**323.0**	**336.0**	**350.0**	**2,095.9**
	TOTAL IN-KIND CONTRIBUTION		252.0	**355.8**	370.0	385.0	400.0	416.0	433.0	2,611.8
ALL PROGRAMS CASH CONTRIBUTIONS			100.0	**100.0**	100.0	100.0	100.0	100.0	100.0	700.0

Griffith University

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1998/99 Financial tables

Itemised List of Cash and In-Kind Contributions (in $'000's)

	SALARIES	% time	97/98	98/99	99/2000	2000/01	2001/02	2002/03	2003/04	TOTAL
Name	*Designation*	*CRC*	Actual	Actual	Budget	Budget	Budget	Budget	Budget	
P Saffigna	Research	30								
S Berners Price	Research	20								
S Perera	Research	5								
I Phillips	Research	5								
B Yu	Research	20								
R Rickson	Research	15								
J Hughes	Research	10								
R King	Board Member	5								
		Total Salary	113.5	74.5	71.0	72.0	73.0	73.0	73.0	550.0
	Direct On-Costs	*% of total Salary*								
	Payroll tax	5	5.7	3.7	3.6	3.6	3.7	3.7	3.7	27.5
	Superanuation (SSAU	17	19.3	12.7	9.9	10.1	10.2	10.2	10.2	82.6
	Superanuation (TESS)	3			2.1	2.2	2.2	2.2	2.2	10.9
	Work Cover	0.8	0.9	0.6	0.6	0.6	0.6	0.6	0.6	4.4
	In-Direct On-Costs									
	Leave Loading	1.3	1.5	1.0	0.9	0.9	0.9	0.9	0.9	7.2
	Enterprise Bargaining	2	2.3							2.3
	HECS student costs		20.5							20.5
	Long service Leave	3		2.2	2.1	2.2	2.2	2.2	2.2	13.1
	Outside Studies Program	19		14.2	13.5	13.7	13.9	13.9	13.9	82.9
		Total On-Costs	50.1	34.3	32.7	33.2	33.7	33.7	33.7	251.4
		Total Salaries & On-Costs	163.6	108.8	103.7	105.2	106.7	106.7	106.7	801.4
	CAPITAL Equipment			20.0	20.0	20.0	20.0	20.0	20.0	120.0
		Total Capital	0.0	20.0	20.0	20.0	20.0	20.0	20.0	120.0
	OTHER	*% of Total Salaries & On -Costs*								
	Academic services	28	32.7	30.5	29.0	29.5	29.9	29.9	29.9	211.3
	General University Services	49	67.1	53.3	50.8	51.5	52.3	52.3	52.3	379.6
	Deptl Other support	10	13.1	10.9	10.4	10.5	10.7	10.7	10.7	76.9
	Other Lab & Workshop Space	20	37.6	21.8	20.7	21.0	21.3	21.3	21.3	165.2
		Total Other	150.5	116.5	111.0	112.6	114.1	114.1	114.1	832.9
	TOTAL IN-KIND CONTRIBUTION		314.2	245.3	234.7	237.7	240.8	240.8	240.8	1,754.3
ALL PROGRAMS CASH CONTRIBUTIONS			25.0	25.0	25.0	25.0	25.0	25.0	25.0	175.0

Boral Timber Tasmania

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1998/99 Financial tables

Itemised List of Cash and In-Kind Contributions (in $'000's)

SALARIES									
Name	*Designation*	*% time CRC*	97/98 Actual	**98/99 Actual**	99/2000 Budget	2000/01 Budget	2001/02 Budget	2002/03 Budget	2003/04 Budget	TOTAL
C Hawkins	Research	20		**9.5**	9.5	9.5				28.5
P Naughton	Research	10	5.0	**5.4**	5.4	5.4	5.4	5.4	5.4	37.4
M Bramich	Admin	1		**0.4**	0.4	0.4				1.2
A White	Admin	5		**3.9**	3.9	3.9				11.7
		Total Salary	5.0	**19.2**	**19.2**	**19.2**	**5.4**	**5.4**	**5.4**	78.8
Direct On-Costs		*% of total Salary*								
Payroll Tax		7								
Superannuation		5.5								
Workers Compensation		5								
Leave Loading		8								
Long service leave		2								
		Total On-Costs	1.4	**5.3**	5.3	5.3	1.5	1.5	1.5	21.8
		Total Salaries & On-Costs	**6.4**	**24.5**	**24.5**	**24.5**	**6.9**	**6.9**	**6.9**	**100.6**
CAPITAL										
										0.0
		Total Capital	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
OTHER		*% of Total Salaries & On -Costs*								
Head office overheads			0.8	**3.0**	3.0	3.0	0.8	0.8	0.8	12.2
Office support			1.9	**7.4**	7.4	7.4	1.9	1.9	1.9	29.8
Operational			1.9	**7.4**	7.4	7.4	1.9	1.9	1.9	29.8
Amortised vehicle costs			0.3	**1.7**	1.7	1.7	0.3	0.3	0.3	6.3
Land rent			0.1	**0.5**	0.5	0.5	0.1	0.1	0.1	1.9
Trial maintenance			0.5	**1.9**	1.9	1.9	0.5	0.5	0.5	7.7
Experiments			1.3	**4.9**	4.9	4.9	1.3	1.3	1.3	19.9
Other			28.0	**15.2**	13.0	13.0	26.8	26.8	26.8	149.6
		Total Other	34.8	**42.0**	**39.8**	**39.8**	**33.6**	**33.6**	**33.6**	257.2
TOTAL IN-KIND CONTRIBUTION			41.2	**66.5**	**64.3**	**64.3**	**40.5**	**40.5**	**40.5**	357.8
ALL PROGRAMS CASH CONTRIBUTIONS										

The Australian National University

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1998/99 Financial tables

Itemised List of Cash and In-Kind Contributions (in $'000's)

	SALARIES	*% time*	97/98	**98/99**	99/2000	2000/01	2001/02	2002/03	2003/04	TOTAL
Name	*Designation*	*CRC*	Actual	**Actual**	Budget	Budget	Budget	Budget	Budget	
P Kanowski	Research	30								
S Mahendrarajah	Research	10								
D Race	Research	25								
R James	Research	10								
		Total Salary	48.5	**48.6**	48.6	48.6	48.6	48.6	48.6	340.1
	Direct On-Costs	*% of total Salary*								
	Payroll tax									
	Superanuation									
	Workers Compensatio									
	Leave Loading									
	Long Service Leave									
		Total On-Costs	10.7	**10.7**	10.7	10.7	10.7	10.7	10.7	74.9
	Total Salaries & On-Costs		59.2	**59.3**	59.3	59.3	59.3	59.3	59.3	415.0
	CAPITAL									
	Total Capital		0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
	OTHER	*% of Total Salaries & On -Costs*								
	Head Office Support	300								
	Other									
	Total Other		177.7	**177.7**	177.7	177.7	177.7	177.7	177.7	1,243.9
	TOTAL IN-KIND CONTRIBUTION		236.9	**237.0**	237.0	237.0	237.0	237.0	237.0	1,658.9
ALL PROGRAMS CASH CONTRIBUTIONS										0.0

The University of Queensland

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1998/99 Financial tables

Itemised List of Cash and In-Kind Contributions (in $'000's)

SALARIES		% time CRC	97/98 Actual	**98/99 Actual**	99/2000 Budget	2000/01 Budget	2001/02 Budget	2002/03 Budget	2003/04 Budget	TOTAL
Name	*Designation*									
D Doley	Research	25								0.0
		Total Salary		**19.5**						0.0
	Direct On-Costs	*% of total Salary*								
	Payroll tax)	21%								
	Superanuation)									
	Workers Compensatio)									
	Leave Loading)									
	Long Service Leave)									
		Total On-Costs		**4.0**						
	Total Salaries & On-Costs		8.6	**23.6**	23.6	23.6	23.6	23.6	23.6	150.2
CAPITAL										
	Total Capital		0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
OTHER		*% of Total Salaries & On -Costs*								
	Lab space & facilities		8.0							
	Consumables		2.0							
	Total Other		10.0	**47.0**	47.0	47.0	47.0	47.0	47.0	292.0
TOTAL IN-KIND CONTRIBUTION			18.6	**70.6**	70.6	70.6	70.6	70.6	70.6	442.2
ALL PROGRAMS CASH CONTRIBUTIONS										0.0

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1998/99 Financial tables

Australian Forest Growers — Itemised List of Cash and In-Kind Contributions (in $'000's)

	SALARIES	*% time*	97/98	**98/99**	99/2000	2000/01	2001/02	2002/03	2003/04	TOTAL
Name	*Designation*	*CRC*	Actual	**Actual**	Budget	Budget	Budget	Budget	Budget	
Administration	Admin	0.25								0.0
Publicity	Admin	0.25								0.0
		Total Salary	1.0	**1.0**	1.0	1.0	1.0	1.0	1.0	7.0
	Direct On-Costs	*% of total Salary*								
	Productivity benefit)									0.0
	Superanuation)									0.0
	Workers Compensatio	10								0.0
	Leave Loading)									0.0
	Long service Leave)									0.0
	Other)									0.0
		Total On-Costs	0.1	**0.1**	0.1	0.1	0.1	0.1	0.1	0.7
		Total Salaries & On-Costs	1.1	**1.1**	1.1	1.1	1.1	1.1	1.1	7.7
	CAPITAL									
		Total Capital	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
	OTHER									
	Publicity		0.3	**0.3**	0.3	0.3	0.3	0.3	0.3	2.1
		Total Other	0.3	**0.3**	0.3	0.3	0.3	0.3	0.3	2.1
	TOTAL IN-KIND CONTRIBUTION		1.4	**1.4**	1.4	1.4	1.4	1.4	1.4	9.8
ALL PROGRAMS CASH CONTRIBUTIONS			1.0	**1.0**	1.0	1.0	1.0	1.0	1.0	7.0

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1998/99 Financial tables

Southern Tree Breeding Association

Itemised List of Cash and In-Kind Contributions (in $'000's)

	SALARIES	*% time*	97/98	**98/99**	99/2000	2000/01	2001/02	2002/03	2003/04	TOTAL
Name	*Designation*	*CRC*	Actual	**Actual**	Budget	Budget	Budget	Budget	Budget	
P Gore	Program manager	10								0.0
		Total Salary	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
	Direct On-Costs	*% of total Salary*								
		Total On-Costs	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
	Total Salaries & On-Costs		6.0	**6.0**	6.0	6.0	6.0	6.0	6.0	42.0
	CAPITAL									
		Total Capital	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
	OTHER									
	Data			**37.0**						
		Total Other	0.0	**37.0**	0.0	0.0	0.0	0.0	0.0	37.0
	TOTAL IN-KIND CONTRIBUTION		6.0	**43.0**	6.0	6.0	6.0	6.0	6.0	79.0
ALL PROGRAMS CASH CONTRIBUTIONS			0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0

CRC FOR SUSTAINABLE PRODUCTION FORESTRY 1997/98 Financial tables

SILVAGENE

Itemised List of Cash and In-Kind Contributions (in $'000's)

	SALARIES	*% time*	97/98	**98/99**	99/2000	2000/01	2001/02	2002/03	2003/04	TOTAL
Name	*Designation*	*CRC*	Actual	**Actual**	Budget	Budget	Budget	Budget	Budget	
										0.0
		Total Salary	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
	Direct On-Costs	*% of total Salary*								
		Total On-Costs	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
	Total Salaries & On-Costs		0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
	CAPITAL									
		Total Capital	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
	OTHER									
		Total Other	5.0	**5.0**	5.0	5.0	5.0	5.0	5.0	35.0
	TOTAL IN-KIND CONTRIBUTION		5.0	**5.0**	5.0	5.0	5.0	5.0	5.0	35.0
ALL PROGRAMS CASH CONTRIBUTIONS			0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0

COOPERATIVE RESEARCH CENTRE
FOR SUSTAINABLE PRODUCTION FORESTRY

GPO Box 252-12, Hobart, Tasmania 7001, Australia
Tel (03) 6226 7947 (Internat) +61 3 6226 7947
Fax (03) 6226 7942 (Internat) +61 3 6226 7942

Internet http://www.forestry.crc.org.au