COOPERATIVE RESEARCH CENTRE
FOR SUSTAINABLE PRODUCTION FORESTRY

Annual Report 03/04

CRC
AUSTRALIA

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

Mission Statement

The role of the Cooperative Research Centre for Sustainable Production Forestry (CRC-SPF) 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-SPF 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 forest industry and the national forestry objectives.
- Ensure that all stakeholders capture the benefits of Centre research through effective technology transfer.

COOPERATIVE RESEARCH CENTRE
FOR SUSTAINABLE PRODUCTION FORESTRY

ANNUAL REPORT 2003/04

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

Australian Forest Growers

CSIRO Entomology

CSIRO Forestry and Forest Products

Department of Primary Industries Queensland

Forest Enterprises Australia Pty Ltd

Forestry Tasmania

Grand Ridge Plantations Pty Ltd

Griffith University

Gunns Limited

Norske Skog Paper Mills (Australia) Limited

Private Forests Tasmania

seedEnergy Pty Ltd

Southern Cross University

Southern Tree Breeding Association Inc

The Australian National University

The University of Queensland

Timbercorp Limited

University of Tasmania

WACAP Treefarms Pty Ltd

CONTENTS

CHAIRMAN'S REPORT

This has been another successful year for the CRC-SPF. One might expect in the seventh year of a CRC that the momentum would reduce, but this is clearly not the case. The research programme continues to yield important new results (see Major Developments), publication rates have been sustained, and most importantly of all, innovations are being transferred efficiently to industry partners.

In spite of the contribution of the CRC and its predecessor over the past 13 years, there has never been a greater need for a co-ordinated national science programme underpinning the plantation industry. The strategic partnership between Australian governments and industry *Plantations for Australia – The 2020 Vision* projects potential private investment of $2b pa in establishing new plantations, inputs of up to $660m pa to rural incomes from farm forestry, and an eventual transition to a trade surplus via value-adding processing. This transition to private ownership is progressing but concerns are expressed in some quarters about the sustainability of tree plantations within some Australian environments. This important issue can only be addressed through a focused and ongoing program of research. The experienced team of scientists employed by CRC-SPF, in networked association with the industry partners responsible for much of this plantation resource, are uniquely placed to contribute and it is essential that the industry finds ways of ensuring their continued operation.

As described in the Director's Report, strong industry support allowed the CRC to make a successful case to the Minister for continuation into an eighth year. This will allow partners to take even greater value from the research conducted by the CRC in the past 7 years. For various reasons several partners decided not to join this initiative and I would like to thank them all for their valuable contribution during the last 7 years. In particular I acknowledge the contribution of Board members from our northern node, Mr R Beck of DPIQ and Prof R Kitching of Griffith University, for their constructive approach in negotiating the complexities of their departure.

As part of the re-bid process for an ongoing Forestry CRC, the Fifth Year Review panel were invited back to examine what had been achieved by CRC-SPF since 2002. Their overall conclusion was that the CRC was continuing to perform at a high level against Commonwealth guidelines and milestones.

Major points made were:-

- "Over the period 2002-2004, the CRC maintained its excellent record of research quality and relevance established in the Fifth Year Review".
- "The CRC continues to be underpinned by postgraduate research. The morale and enthusiasm of postgraduate students were high. Postgraduate students felt that they enjoyed an ideal operating environment and benefited by the collegiality of the CRC, and industry partners strongly favoured employment of CRC postgraduates over postgraduates from outside of the CRC".
- "The panel was impressed by the uptake of research by industry. There was an improvement in this since the last review. Industry was convinced that they had received value for money from their investment. Industry considered that the CRC structure in which there was a focused and coordinated research programme over a 7-year funding period would provide them with better outcomes than any alternative model in which they acted independently."

As Chair I take pride in the outcome of this review and would like to offer my congratulations to all the staff and students whose hard work has maintained the CRC as a vibrant and effective operation.

John Kerin
Chairman

DIRECTOR'S REPORT

Last year I advised that representations were being made to DEST for approval to extend the CRC into an Eighth Year so as to take further value from a range of long term experiments and, in particular to concentrate on Technology Transfer to maximize benefit to partners. With the exception of Southern Cross University, the partners in our northern node chose not to join this initiative, but rather to stay with the original Agreement and conclude their involvement at the end of Year 7. The Board was however unanimous in its support for the wishes of the majority and there was an amicable parting of the ways on 30th June 2004. Substantial additional partner funding backed the extension request, and I am happy to report that the Minister saw fit to give his approval. The CRC-SPF will therefore terminate in June 2005.

Importantly, this extension has provided a breathing space in which we are seeking to secure funding for the longer-term future for our consortium as a platform for the new science which industry will need in order to face the competitive realities of the 21st century.

The prospect of the additional year had a substantial impact on the research programme and deliverables agreed for 2003-04. Northern node projects were completed as planned, highlights being the conclusion of the revised Hybrid Pine Breeding Strategy; adoption of new residue management and site preparation practices for hoop pine; and release of the management decision support system STEPS. All of the innovations are of direct benefit to DPIQ Forestry.

For projects involving continuing partners, the advice of the Programme Coordinating Committees was sought in prioritising against the following criteria, and each was concluded as planned or extended for final delivery in year 8:

1. Are they long-term experiments capable of providing significant new data that will generate recommendations for improved management practices?
2. Are they in accordance with recommendations from the CRC-SPF 5th Year Review which could not be addressed fully within the original time frame/work programme of the CRC?
3. Do they permit more extensive technology transfer activity than possible by June 2004, increasing rates of uptake by industry partners and promoting CRC know-how to a wider audience within the forest industry?

Following implementation of the Year 7 program as revised in this planning exercise, some particular highlights were the application of improved analytical methodologies for eucalypt breeding; extension of the CABALA site productivity model to incorporate fertiliser responses; and widespread uptake of Crown Damage Index methodology for assessing damage to young eucalypt plantations. We have continued our emphasis on Technology Transfer to ensure that these and other innovations are widely understood and adopted by industry partners.

In total there were 59 PhD, MSc and Honours students enrolled in the CRC in 2003/04. Nine students successfully completed their post-graduate degrees, with a further 4 PhD dissertations submitted. Eight of our young scientists are to be congratulated on winning awards - Julianne O'Reilly-Wapstra's Gottstein Memorial Fellowship and Alieta Eyles' University of Tasmania Deans Commendation for an outstanding PhD thesis, being particularly gratifying.

There were significant changes to CRC management during the year as we said goodbye to David Lyons and welcomed Jo Neilson as Business Manager; Dr Clare McArthur handed over Programme Management of Resource Protection to Dr Caroline Mohammed, and Dr Philip Smethurst took over from Greg Dutkowski as Technology Transfer Manager.

During the past year, as we reviewed our objectives for the remaining life of CRC-SPF, we have been particularly reliant upon very practical initiatives from our industry partners and political supporters at all levels. The continued support of the Chairman and Board, including without exception those members from organisations who have chosen not to participate in Year 8, has also contributed to a successful year. I am confident that the Management Team and all our research staff will repay this support through timely delivery of agreed outcomes as we wind-up or move into transition mode during 2004-05.

Rod Griffin
Director

MANAGEMENT

The Board

The Board of Management of the Centre comprises an independent Chair, a representative of each Core Member organisation, the Director and Deputy Director of the Centre, and the Chair of the Advisory Panel. 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 (Chair), three external scientific experts - Dr Peter Ades (University of Melbourne), Prof Roger Sands (University of Canterbury, NZ), Dr Tim New (La Trobe University), and the Chair of each Program Coordinating Committee.

Management Committee

The Management Committee assists the Director in the day-to-day running of the Centre by implementing the policies set by the Board.

The Committee comprises:

Prof Rod Griffin (Director)
Prof Robert Henry (Deputy Director)
Mrs Jo Neilson (Business Manager)
Mrs Shelley Caswell (Administrative Officer)

Program Managers:
A/Prof Brad Potts (Genetic Improvement)
Dr Chris Beadle (Sustainable Management)
Dr Caroline Mohammed (Resource Protection)
Dr Neil Davidson (Education and Technology Transfer)

CRC Board


Mr John Kerin
Chairman


Prof Rod Griffin
Director


Dr Robert Henry
Deputy Director


Dr David de Little
Chair, Advisory Panel


Mr Ron Beck
Executive Director, Forestry
Department of Primary Industries Queensland


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


Mr Ian Sandeman
General Manager, Grand Ridge Plantations Pty Ltd


Mr Ian Ravenwood
Plantation Division Manager - North West, Gunns Ltd


Dr Hans Drielsma
General Manager (Forest Management) Forestry Tasmania


Mr Ian Bail
Senior Manager, Project Services, Timbercorp Forestry
Timbercorp Ltd


Prof Peter Baverstock
Dean, Graduate Research College
Southern Cross University


Dr Clive Carlyle
Centre Director, CSIRO Forestry and Forest Products


Mr Arnold Willems
Performance Manager - Fibre
Norske Skog Paper Mills (Australia) Limited


Mr Richard Breidahl
General Manager
Plantation Operations
WACAP Treefarms Pty Ltd


Prof Roger Kitching
Chair of Ecology
Griffith University

Program Coordinating Committees

The Program Coordinating Committees meet at least twice each year to review and preview research with regard to its scientific and technological merit and to set and review research program outcomes. The committees are chaired by an industry partner representative, and consist of the Program Manager and at least three industry partner representatives. Project Leaders within the program are included as non-voting members.

Genetic Improvement Program

Dr Peter Volker (Chair)
Prof Rod Griffin (Director)
A/Prof Brad Potts (Program Manager)
Ms Helen O'Sullivan (TC)
Mr Chris Berry (NS)
Mr Simon Hunter (WACAP)
Mr Kelsey Joyce (GL)
Dr Tony McRae (STBA)
Mr Ian Last (DPIQ)
Mr Stephen Elms (GRP)
Dr Neil Davidson (Program Manager ETT)

Sustainable Management Program

Ms Sandra Hetherington (Chair)
Prof Rod Griffin (Director)
Dr Chris Beadle (Program Manager)
Mr Chris Barnes (GL)
Dr Mark Hunt (DPIQ)
Dr Paul Adams (FT)
Mr Mark Bamess (WACAP)
Mr Ian Bail (TC)
Dr Neil Davidson (Program Manager ETT)

Resource Protection Program

Dr David de Little (Chair)
Prof Rod Griffin (Director)
Dr Caroline Mohammed (Program Manager)
Mr Chris Barnes (GL)
Mr Chris Berry (NS)
Dr James Bulinski (TC)
Dr Tim Wardlaw (FT)
Dr John Mattheissen (CSIRO Ento)
Dr Ross Wylie (DPIQ)
Dr Neil Davidson (Program Manager ETT)

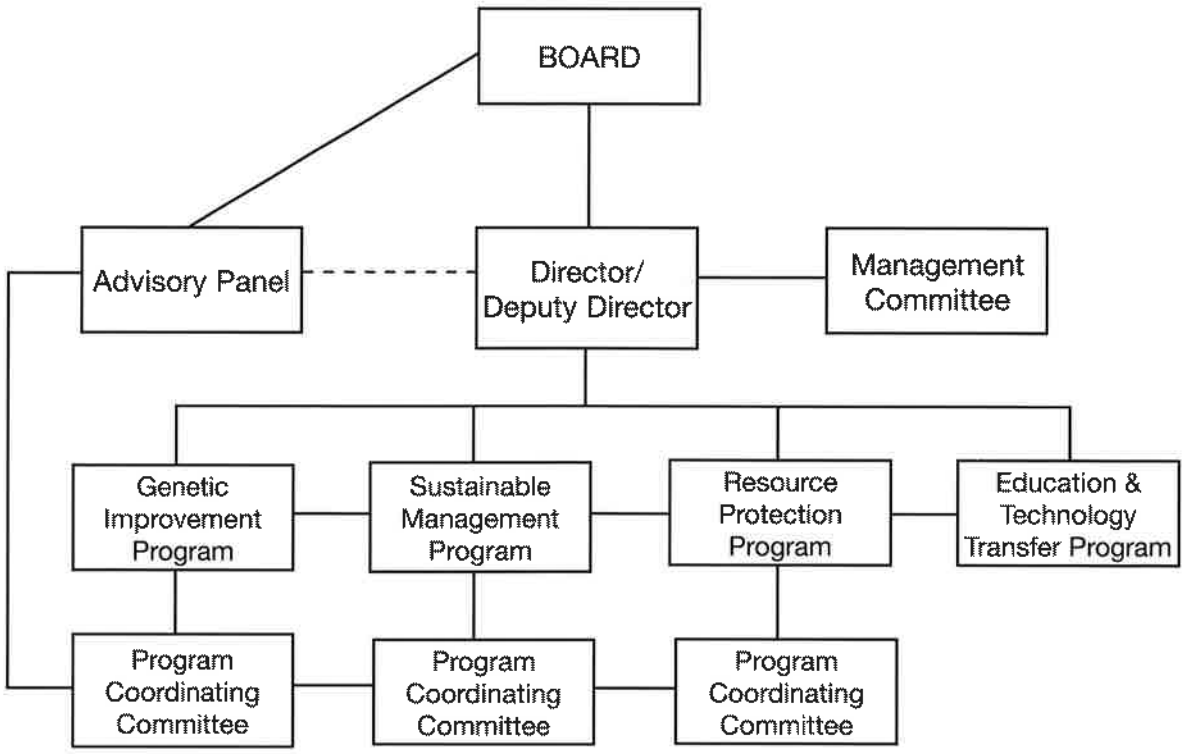


Figure 1. Management Structure

MAJOR OUTCOMES

Industry uptake

Genetic Improvement Program

High levels of uptake achieved by the Genetic Improvement Program arise from the close association between the CRC-SPF scientists and our partners involved in breeding and deployment.

In southern Australia, Projects A1 (Genetics and reproductive biology of eucalypts) and A2 (Breeding Strategies) provide research results on new seed production systems; breeding and deployment strategies; and design and implementation of the TREEPLAN® and STBA-DMS® breeding value prediction and data management systems. Most grower partners are also members of the STBA's *Eucalyptus* Breeding Program and both these SMEs are also members of the CRC and its spin-off company seedEnergy. One of the seedEnergy managers is co-located with CRC scientists on the University of Tasmania campus.

Significant contributions in 2003-04 included the following:

- New methodology for improving the estimation of genetic parameters in across-site analyses has been applied to STBA progeny trials of *E. globulus*. The simulator gSIM (see Major Development) is being used by STBA to evaluate various deployment options, and a range of add-ins for MS Excel have been developed to help partners in the optimisation of their deployment programs.

Participants in Clonal Workshop examining eucalypt clones on field tour

- Earlier CRC development of an *E. nitens* race classification and spatial analysis techniques have been applied for the first time in a contractual arrangement between core partner Gunns Ltd and the STBA.

GI Program northern node staff were mainly based at the Queensland Forest Research Institute (QFRI) and work closely with the industry partner Department of Primary Industries Queensland (DPIQ). These organisations are responsible for the breeding and deployment of sub-tropical pines in Queensland.

Over the past 6 years genetics research in Project A6 has underpinned development of a breeding strategy for the *Pinus elliottii* var *elliottii* x *Pinus caribea* var *honduriensis* hybrid. The CRC recommended a major change of strategy and the partners have recently written a new Breeding Plan which seeks to develop a synthetic hybrid between these two species for deployment in near-coastal areas of south-east and central Queensland and northern NSW.

At the request of industry partners, scientists in the Genetic Improvement Program played a pivotal role in the organisation of an international workshop reviewing the status and opportunities for clonal deployment of *E. globulus* in Australia.

Sustainable Management Program

Projects B1 (Site productivity) and B4 (Modelling production and wood quality) have respectively developed technologies for maintaining canopies and therefore growth potential throughout rotations (particularly recommendations for fertiliser management and assessing canopy leaf area), and predictive models for plantation production (particularly the development of a suite of mechanistic programs that accurately predict the growth of plantation species in response to site, environmental and soil variables and silvicultural inputs). These two projects have close relationship with the industrial partners in southern Australia (but also DPIQ) and, during the last year, have transferred the following major items of technology:

- CABALA (a dynamic version of the mechanistic model PROMOD, developed by the CRC-SPF) and PROMOD are now routinely used by forestry consultants and companies to evaluate potential

MAJOR OUTCOMES

plantation yields. CABALA was also used this year to stratify the eucalypt plantation estate of one partner for potential responsiveness to nitrogen fertilisation. Demonstration of its benefits has led to a continuing increase in the use of CABALA to determine the timing of fertiliser application by partners.

- Modellers in B4 based in Queensland have produced a decision support system (DSS) designed to support management decisions for the major subtropical and tropical pine growers in Queensland. It consists of two components, STEPS and Win-EPIFIN. STEPS is a financial package for evaluating different silvicultural scenarios. Win-EPIFN provides simulated sawing of the plantation resource. DPIQ has used STEPS V3.0 throughout the past year to perform economic analyses of exotic and native pine plantation resources across a range of locations throughout Queensland. Results from the software have guided policy decision-making for the organization.

Project B2 (Management of tropical soils) has been working for the life of the CRC on the implications for plantation management of harvesting practice and rates of breakdown of plantation residue and nutrient release in second rotation (2R) Hoop Pine plantations. This project is based in southern Queensland and is integrated closely with DPIQ and QFRI, the organisations responsible for establishment and management of plantations in Queensland. The major outcomes this year were:

- Earlier research has shown that residue retention in 2R Hoop Pine plantations increases soil organic carbon and nitrogen pools. Compaction by harvesting machinery was also shown to reduce microbial activity and nitrogen mineralisation. This year recommended changes to harvesting management and site preparation practices following harvesting are being adopted by DPIQ to reduce soil erosion and nutrient loss via leaching (also see Major Development).
- Earlier research showed fertiliser application increased ammonium-N, nitrate-N and microbial biomass in 2R Hoop Pine plantations, leading to greater productivity. Recommendations for applying nitrogen fertilisers in 2R Hoop Pine plantations are in the process of adoption this year by DPIQ.

Resource Protection Program

Projects C1 and C2 investigate the ecology of existing and potential insect pests in southern Australia and means of chemical or physical control that minimise environmental impact. These projects work closely with southern Australian partners in the CRC, with a strong presence in Tasmania, Victoria and WA.

- A 'Crown Damage Index' (CDI) has been developed which provides a standard methodology for assessing damage caused to young eucalypt trees by any biotic or environmental constraint. The CDI is important because it allows comparisons (or ranking) to be made between different types of injuries and pests using exactly the same procedure across years and locations. The CDI was developed by State Forests NSW in association with CRC-SPF and the funding from Natural Forest Inventory, Bureau of Rural Sciences and Natural Heritage Trust. Hundreds of booklets describing how to use CDI have been distributed to tree growers, plantation managers, and researchers. State Forests NSW, DPIQ and Forestry Tasmania implemented plantation health assessment using the Crown Damage Index in the 2003-04 season. The sampling protocol for the CDI is the same as that used to assess pest and pathogen populations (see below), and therefore, we now have a unified approach to assess populations of pests and pathogens as well as damage levels.
- A standardised sampling protocol has been developed to assist plantation managers to make decisions about insect control. The protocol defines the extent of sampling required at the plantation and tree level for that particular pest or pathogen. Data collected is then fed into a decision support system (DSS) designed for that pest species and gives the correct management decision for each level of infestation. Timbercorp, WAPRES, Great Southern Plantations, and Albany Plantation Forestry Ltd implemented this sampling protocol for *Gonipterus scutellatus* in the spring of 2003. Timbercorp also implemented the sampling designs for *Chrysophtharta* beetles and *Mnesampela privata* (Autumn Gum Moth) in the 2003-04 season. The DSS streamlined the decision making processes and reduced the number of plantations that were sprayed unnecessarily.

MAJOR DEVELOPMENTS

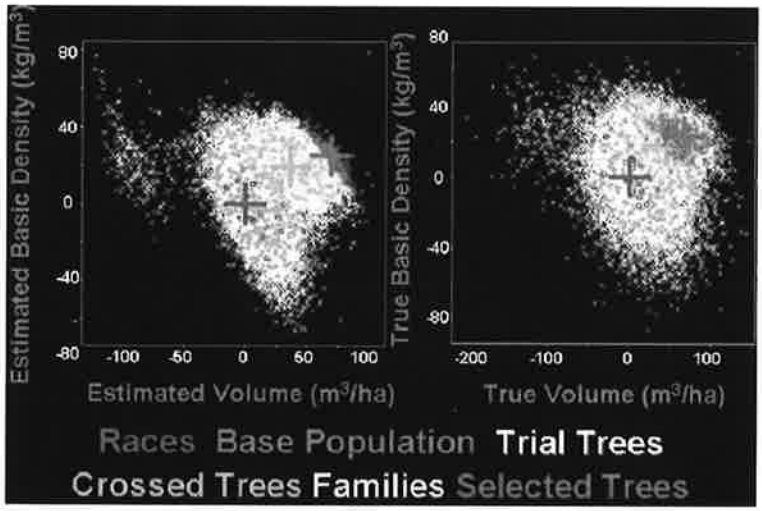
Simulation to answer the breeders questions

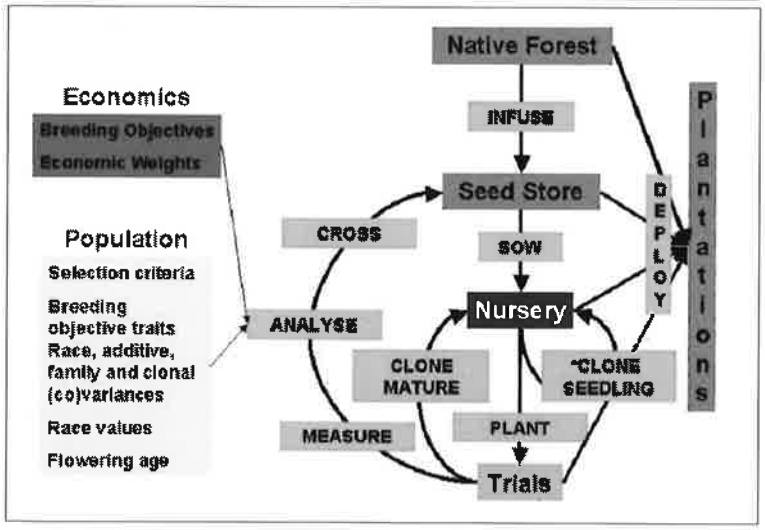
One of the most common questions asked of geneticists is "Will I make more gain if I...?". For simple scenarios these questions are easy to answer, but for the more complex situations found in modern breeding programs then the simple mass selection equations do not apply. Current breeding programs are moving into their third generation, with complex objectives and histories of infusion, selection and mating. Simulation is the only way to answer "What if?" questions in such situations and a tool is necessary to allow breeders to answer them.

Figure 2. Progress is monitored using the simulated true genetic value of trees and families. Analysis using BLUP shows that even after two generations of breeding the expected true and estimated values are the same.

gSIM has been written to allow breeders to answer these questions. It simulates the steps in modern breeding programs, starting with the definition of the economic breeding objective, the traits and the population structure. Once these are defined, then the actual steps in the breeding and deployment program are defined on an explicit time scale so that the progress of the breeding population and new plantations can be monitored. Using the population structure, the true genetic values of each genotype is sampled from a multivariate normal distribution, and this true value is used to monitor genetic progress. When a ramet of a genotype is planted then it is given a phenotypic value, which, if it is measured, becomes the basis of its genetic value estimated using ASREML. The estimated values guide future actions (Figure 2).

Figure 3. The gSIM simulator describes the steps in a modern breeding program, starting with the definition of breeding objectives, and allowing simulation of all the steps in a program.





Each step in the breeding and deployment program is described by KEYWORDs with an attendant probability of success (Figure 3). This allows simulation of the real process of breeding — not everything goes according to plan! To start (or at any later time), genotypes are INFUSEd from native forest races (or other breeding programs) as seed into the seed store. Seed is then SOWn into the nursery to become a ramet, which may be SEEDLINGCLONEd. Ramets may also enter the nursery by being CLONEMATUREd from trees in trials. The ramets are then PLANTed into trials, where they are eventually MEASUREd. Using the genetic information, the measurements are ANALYSEd and the estimated economic values used to guide CROSSing and DEPLOYment. The new seed becomes the basis of further rounds of testing and selection. Deployment can be via open pollinated seed, control cross families, or clonal forestry.

The system allows description of a wide variety of breeding and deployment strategies, both 'discrete generation' and 'rolling front'. It has been used to show that clonal forestry is competitive with mass supplementary pollinations for a simplified pulpwood export scenario only at low propagule costs. This conclusion may change if rooting success can be increased, a more profitable enterprise is modelled, or non-additive genetic variation is higher than has currently been reported.

The STBA is modelling its historic breeding program to help decide on future selection strategies. The breeding program has had multiple infusions, changes in breeding objective, and changes in the traits measured. Measures of pulp yield are not used because of their high cost and an assumed positive genetic correlation with basic density. Various estimates of this correlation range from –0.5 to 1.0, with an average of about 0.5. The simulator is being used to see at what sort of true values of the correlation are measurements of pulp yield worthwhile, and whether it is worthwhile measuring the base population trials.

MAJOR DEVELOPMENTS

Outbreaks of the autumn gum moth explained: it's all about numbers and timing

Occasionally, autumn gum moth populations reach very large numbers and larvae severely defoliate plantation trees. After 6.5 years research, two important factors explaining how outbreaks arise have been identified.

Firstly, plantations provide a nutritious resource much superior to that available in a mature eucalypt forest. As a result, moths bred on plantation trees are heavier and have higher fecundity (Figure 4A). As a consequence, the mean numbers of eggs they can lay during their lifetime increases significantly (Figure 4B).

Secondly, variation in the time of year when moths become active can significantly alter the rate of population growth. Normally, if moths emerge in autumn, their offspring can only achieve 1 generation within that year. However, if moths emerge in spring/ summer, their offspring can achieve 2 generations within that year. The determinant of this radical shift in the rate of population increase is whether larvae enter a pupal diapause or not. Caterpillars have an internal clock that is influenced by day length and which dictates pupal development. Summer caterpillars become pupae with a clock that is pre-programmed for no delay prior to adulthood; autumn caterpillars diapause, a pre-programmed delay prior to adulthood. The critical factor that determines which developmental pathway is followed is timing of the autumnal equinox relative to the growth stage of caterpillars. Plantations in which moths are known to have achieved an additional generation within the previous season are at greater risk of defoliation the following year. A newly developed model (called GumMoth) can be used to determine the numbers of generations achieved in a given plantation.

This research has implications for the future management of this insect. Firstly, although silvicultural practices aim to maximise tree growth rate, vigorous plantation eucalypts are producing fitter female moths. Secondly, monitoring the numbers of moths in newly established plantations is needed if managers are to use Gum Moth and have an indication of how quickly populations are increasing.

Eucalyptus grandis at Koorlong, near Mildura, that were totally defoliated by autumn gum moth larvae in July 1998

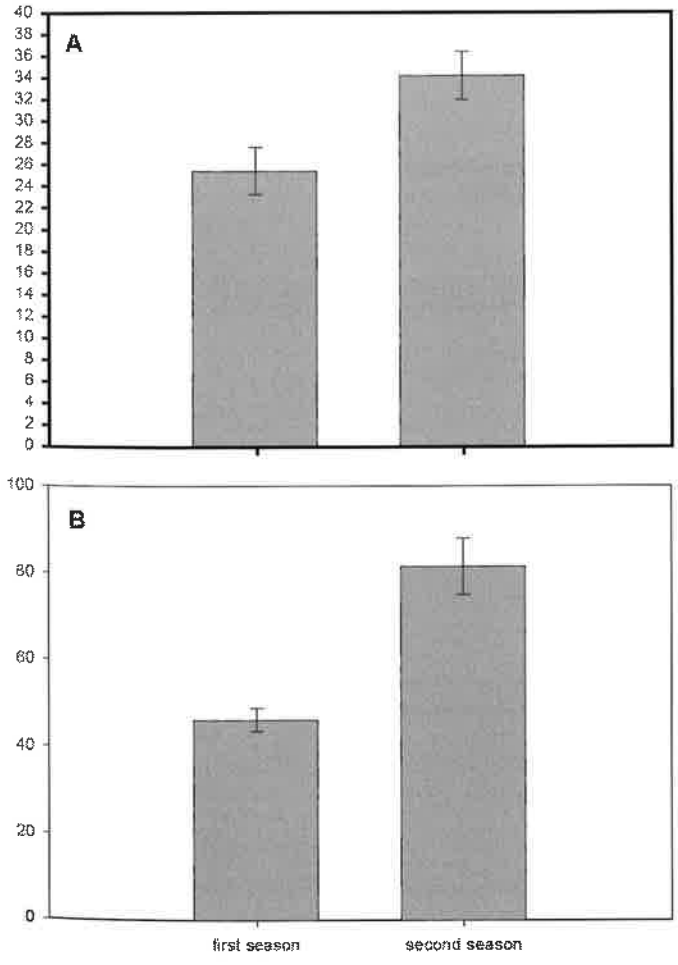


Figure 4. Weight of female autumn gum moth (all appendages removed) in successive years (A) and the size of egg clutches at the same location in successive seasons (B). Data are from an experimental planting of *E. globulus* near Canberra (all differences are statistically significant).

MAJOR DEVELOPMENTS

Soil carbon pools in adjacent natural and hoop pine plantations

Soil carbon (C) dynamics are not only important to both productivity and sustainability of terrestrial ecosystems, but also contribute significantly to global C cycling. Adjacent natural forest (NF), and first (1R) and second rotation (2R) hoop pine plantations in south-east Queensland, Australia, were selected to investigate the effects of conversion of natural forest to hoop pine plantations and forest management (harvesting and site preparation of plantation) on the size and the nature of C pools in surface (0-10 cm) soils using chemical extraction, laboratory incubation and ^{13}C cross-polarization with magic-angle-spinning nuclear magnetic resonance spectroscopy. Conversion from natural forest to hoop pine plantations not only led to the reduction of soil total C (by 19.8%), water soluble organic C (WSOC) (by 17.7%), $CaCl_2$ extractable organic C (by 38.8%), and hot water extractable organic (by 30.9%) and bioavailability of soil C (as determined by CO_2 evolved in the incubation) as shown in Figure 5, but also to a change in chemical composition of soil C with lower O-alkyl C (a single bonded chain of carbons attached to residues via an oxygen bond) and higher alkyl C (a single bonded chain of carbons attached to residues via a carbon bond) under the 1R plantation compared with NF. Note O-alkyl C is a group more readily degraded by microbes. Harvesting and site preparation did not significantly affect total soil C and most labile C pools (except for a decrease in WSOC), but led to a lower signal intensity in the alkyl C spectral region and a decrease in the ratio of alkyl C to O-alkyl C in the soil under the 2R compared with the 1R plantation. The shifts in the amount and nature of soil C following forest conversion may be attributed to changes in litter inputs, microbial diversity and activity, and the disturbance of soil during harvesting and site preparation. Detailed experimental methods and findings can be seen in the international soil science journal – Soil Science Society of America Journal (Volume 68, 282-291).

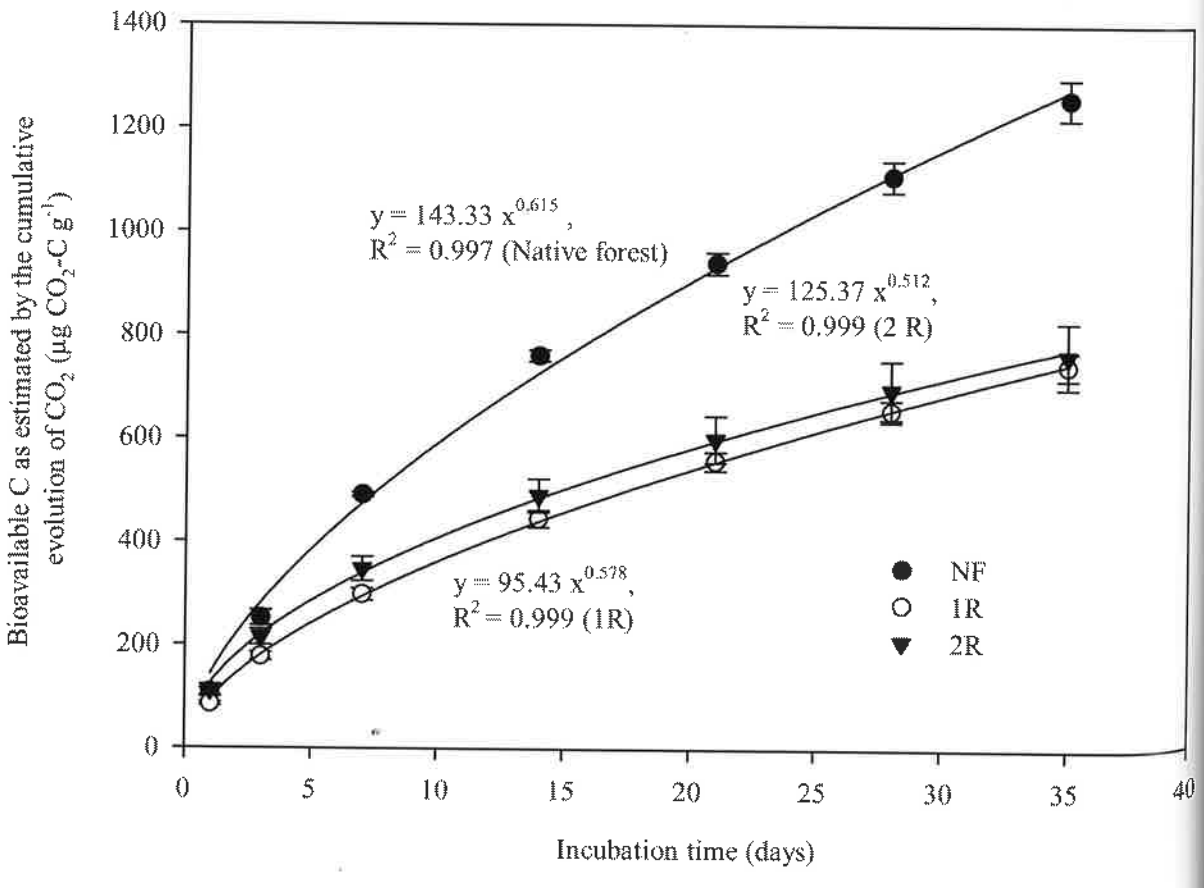


Figure 5. Bioavailable organic C in soils (0-10cm) under adjacent natural forest (NF), first (1R) and second (2R) rotation hoop pine plantations at Yarraman State Forest, south-east Queensland

MAJOR DEVELOPMENTS

Gene flow between plantations and native eucalypts

There has been a large expansion of *Eucalyptus* plantations in Australia over the last decade. As most eucalypt species are native to Australia, this has raised concerns about genetic pollution of native species gene pools. With initial support from the CRC Strategic Initiative Fund and subsequent ARC funding and consultancies, CRC-SPF scientists have been studying this issue. A review of the risks of such gene flow to Australia's native forest gene pools has been completed and a framework for assessing and minimising these risks has been developed. Hybridisation of *Eucalyptus nitens* with the Tasmanian native eucalypts is being used as a case study. *Eucalyptus nitens* is native to continental Australia but has been introduced to the island of Tasmania for plantation purposes.

In his recently completed PhD, Robert Barbour showed that hybridization between *E. nitens* and the adjacent native species *E. ovata* was occurring. In one of the most detailed studies yet undertaken in forest trees, he quantified the pattern of realized pollen dispersal from *E. nitens* plantations (Figure 6). First generation hybrids between these two species are readily identified from their seedling morphology. He assessed their frequency in 147 open-pollinated seed lots collected from native *E. ovata* trees at varying distance from plantations. This took over 2 years to complete and involved the assessment of 119,000 seedlings. F1 hybridisation averaged 7.2% within 100 m of the exotic *E. nitens*, but diminished to 0.7% by 200-300 m and continued at this low level to the limits of the sampling at 1.6 km. *Eucalyptus nitens* is exclusively pollinated by small insects (smaller than honeybees), which the study shows can disperse pollen over 1.6 km. Field trials established to assess the fitness of the exotic *E. ovata* x *nitens* F1 hybrids in the wild showed that the early-age performance of the hybrids was reduced compared to their pure E. ovata half-sibs. However, many were still alive and growing successfully two years after planting. Exotic hybrids were also found naturally established in the wild during this study, but have only been found within 300m of plantations where the pollen flow study indicated the highest level of hybridization occurs. Based on surveys of the flowering overlap of the Tasmanian eucalypt species with *E. nitens*, spatial proximity to plantations and crossability studies, Robert's thesis suggests that only a few of the 29 native eucalypt species in Tasmania are at significant risk of pollination by *E. nitens*. The risk of exotic gene flow may be further reduced if long-term studies show first and later generation hybrids have less chance of surviving to reproductive maturity in competition with the native species. Trials to assess their performance have been established and will be maintained to resolve this issue. Forestry Tasmania has incorporated this work into its Environmental Management System and the Tasmanian Forest Practices Board is looking at ways of formally integrating these results into their planning decisions.

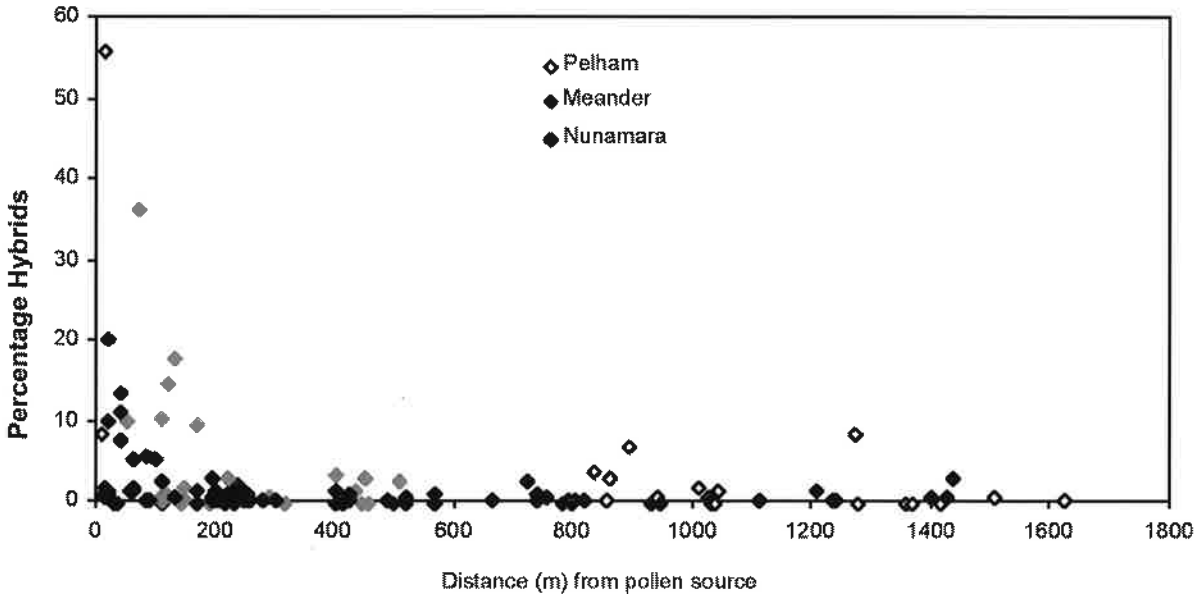


Figure 6. The percentage of *E. ovata* x *nitens* F1 hybrids detected in open-pollinated seed collected from 147 native *E. ovata* trees at various distances from the boundary of *E. nitens* plantations (pollen source) at three sites (Pelham, Meander and Nunamara). 119,000 seedlings were assessed. *E. ovata* trees were chosen to ensure they overlapped in their flowering time with *E. nitens*.

COOPERATIVE LINKAGES

The CRC-SPF has strong international linkages between the:

- Genetic Improvement Program and scientists in the USA, NZ, Chile, Argentina, Portugal, China, France, Denmark and Malaysia;
- Sustainable Management Program and scientists in the USA, Brazil, Finland, Germany, China, Sweden, Portugal, France, NZ and South Africa;
- Resource Protection Program and scientists in the USA, Canada, UK, NZ, Chile, Brazil, Sweden, Germany, Japan, Malaysia and Indonesia.

Major national links exist with a number of Australian universities, State authorities and forestry companies. Within Centre links exist between all projects and programs. The numbers of these links are depicted in the table below.

Table 1. International (IN), National (N) and Within Centre (W) Linkages

Genetic Improvement

	97/98			98/99			99/00			00/01			01/02			02/03			03/04		
	IN	N	W	IN	N	IN	N	W	W	IN	N	W	IN	N	W	IN	N	W	IN	N	W
A1	1	1	6	1	1	5	3	10	5	2	3	9	3	3	9	5	3	10	3	2	9
A2	2	4	3	1	3	1	4	8	3	2	5	7	4	4	7	5	4	7	2	6	6
A3	0	0	1	0	1	0	1	2	1	0	1	1	0	1	1	0	1	1	0	1	1
A4	1	0	1	3	1	3	2	1	1	4	3	2	1	3	1	2	3	1	4	2	4
A5	0	3	4	0	1	0	2	3	2	0	2	3	0	2	4	0	2	4	0	3	3
A6	1	3	0	1	3	4	2	2	1	3	3	1	2	2	2	4	2	2	4	1	3
A7	0	0	5	1	2	2	2	4	3	1	2	7	2	2	5	2	2	4	2	1	2
Total	5	11	18	7	12	15	16	30	16	12	19	30	12	17	29	18	17	29	14	18	24

Sustainable Management

	IN	N	W	IN	N	IN	N	W	W	IN	N	W	IN	N	W	IN	N	W	IN	N	W
B1	1	1	1	1	1	4	3	3	2	0	2	3	2	3	7	2	2	3	5	3	4
B2	1	0	0	1	0	8	4	2	0	3	2	1	6	2	9	8	4	2	8	4	2
B3	0	3	3	0	4	0	3	7	4	0	2	4	0	2	5	0	3	6	2	3	5
B4	4	1	1	3	7	5	8	5	5	4	12	11	4	9	3	3	8	8	6	5	4
Total	6	5	5	5	12	17	18	17	11	7	18	19	12	16	3	13	17	17	21	15	15

Resource Protection

	IN	N	W	IN	N	IN	N	W	W	IN	N	W	IN	N	W	IN	N	W	IN	N	W
C1	2	5	4	4	8	4	8	6	8	5	9	9	4	7	7	4	4	4	5	5	5
C2	0	3	2	0	2	2	5	5	1	1	6	5	2	6	9	2	4	2	6	8	6
C3	1	1	3	1	2	1	6	2	4	2	1	4	2	3	5	2	3	5	2	6	2
C4	1	1	2	0	1	1	2	3	3	0	1	2	1	0	3	1	1	4	1	1	3
C5	1	0	0	1	1	3	3	3	3	5	2	3	4	2	3	3	3	3	3	3	3
Total	5	11	11	6	14	11	24	19	19	13	19	23	13	18	27	12	15	18	17	23	19

Education and Technology Transfer

	4	8	2	3	7	1	6	4	3	3	6	2	4	8	4	4	6	4	2	4	4

RESEARCH

Genetic Improvement Program

Manager
A/Prof Brad Potts

Introduction

A major expansion of the plantation estate of eucalypts and pines is occurring throughout Australia. 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 sub-tropical and temperate regions demonstrate the importance of breeding and aim to increase the returns from wood production.

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 silviculture;
- 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.

Project A1

Leader
A/Prof Brad Potts

Staff
Dr Luis Apiolaza
Mr Robert Barbour
Mr Peter Buxton
Mr Peter Gore
Prof Rod Griffin
Dr Greg Jordan
Mr Kelsey Joyce
Ms Marian McGowan
Dr Briony Patterson
Mr David Pilbeam
Prof Jim Reid
Mr Paul Tilyard
Dr René Vaillancourt
Dr Dean Williams
Dr Peter Volker

Genetics and reproductive biology of eucalypts

Background

This project aims to provide the basic biological information necessary for effective exploitation and management of temperate eucalypt gene pools. 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. There is high demand for improved eucalypts for plantation establishment, and the project will study factors affecting sexual reproduction in order to optimise eucalypt seed production systems. This project is closely linked to project A4 (Molecular genetics of eucalypts), and staff supervise externally funded ARC grants.

Outcomes

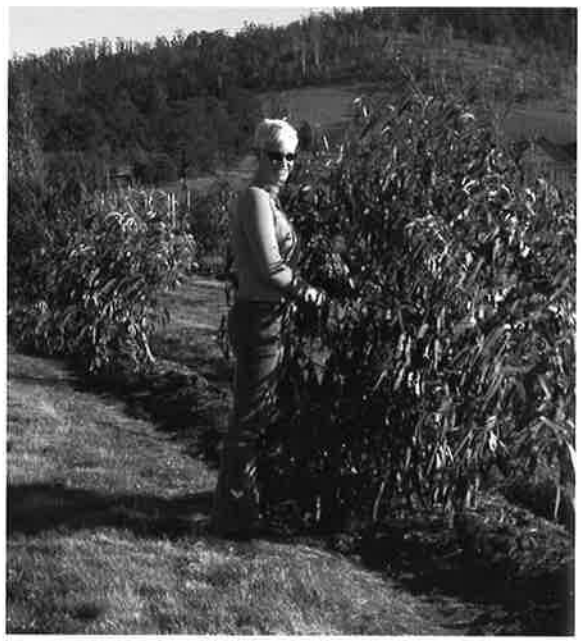
- Consistent with previous work with *E. nitens*, we have now shown that applying both paclobutrazol and fertiliser to mature *E. globulus* trees increased flower bud abundance compared to applying either treatment alone or not treating at all. This means that in managing seed orchards, fertiliser application can be used to reduce the amount of the relatively expensive paclobutrazol.
- A study using morphological mutants to assess outcrossing rates of two trees showed that the outcrossing rate was stable across four flowering seasons and three seed size classes. Storage of the seed either on the tree or in the laboratory did not alter the outcrossing rate in a consistent manner.
- The first study of the genetic control of whole tree reproductive output in a eucalypt species has been completed. Large genetic based differences between and within subraces of *E. globulus* have been shown for traits such as whole tree bud, capsule and total seed output (Figure 7) as well as the number of seeds per capsule, and seed size. Reproductive traits were generally genetically independent of growth rate and wood density indicating that selection for reproductive traits can occur without indirectly affecting breeding objective traits.

- The proportion of *E. globulus* seed damaged by the wasp *Megastigmus* sp. in a South Australian seed orchard was shown to be under strong genetic control with significant genetic differences occurring between and within subraces. The subraces with the highest percentage of damaged seed were some of those most valued by the plantation industry and which flowered later in the season.
- A study of the growth of *E. nitens* seedlots from native stands and seed orchards has shown genetic gain consistent with the degree of parental selection. Individual-tree collections from a seed orchard showed an average realised volume gain of 20% compared to natural stand seedlots tested, with individual seedlots ranging from 10% below to 42% above. However the seedlot-by-site interaction was high. Breeding values for growth previously estimated for orchard parents (individual-tree forward selection) showed only a weak relationship with parental values estimated from progeny (r = 0.21), although the estimates were made on different sites and the relationship may have been weakened by genotype-by-environment interaction.
- An assessment of the risk of pollen - mediated gene flow from *E. nitens* plantations into native forests has been undertaken (see Major Developments).

Wasp *Megastigmus* sp.

Outcomes from external grants

- Stratification immediately following sowing was shown to maximise the percentage emergence of *E. nitens* seedlings, particularly in the sub-optimal experimental treatment and in the more recalcitrant seed lot examined.



Marian McGowan in a seed orchard.

Goals

To determine

- the impact of inbreeding depression on growth and wood properties in *E. globulus*;
- genetic and environmental control of reproductive traits including self-sterility in *E. globulus*;
- the genetic merit of imported seedlots of *E. globulus* compared with those of Australian origin

Goals for external grants

- To determine the early age fitness of exotic *E. nitens* hybrids and the effects of host tree genetic variation on dependent biodiversity.
- To complete the analysis of genotype-by-environment interaction for growth of *E. globulus* within and across countries.

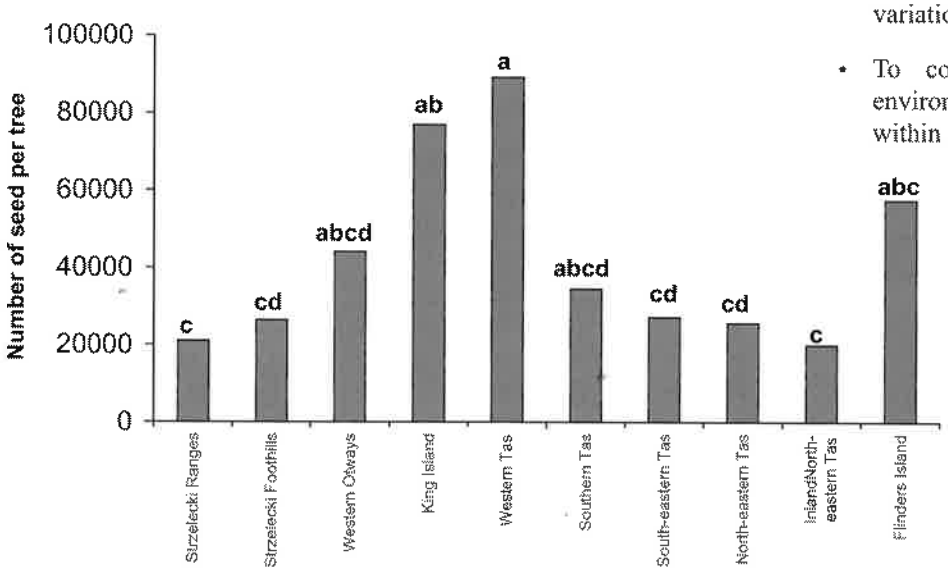


Figure 7. Average number of seed produced per tree for 10 subtraces of *E. globulus* growing in a seed orchard in South Australia.

Project A2

Leader
Mr Greg Dutkowski

Staff
Dr Luis Apiolaza
Dr Bruce Greaves
Dr Yongjun Li
Mr Simon Whittock

Breeding Strategies

Background

The project aims to maximise the profit derived from the breeding programs of CRC partners. This is achieved through more accurate statistical models, integration of economic information, and evaluation of tree breeding and deployment strategies. Most of this work is channelled through the breeding program of the Southern Tree Breeding Association (STBA), which includes most CRC industrial partners. The project closely interacts with projects A1 (Genetics and reproductive biology of eucalypts) and A5 (Wood quality).

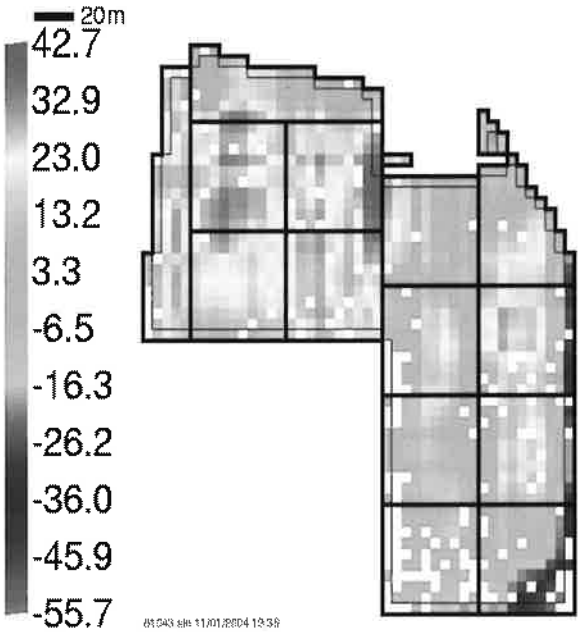


Figure 8. Spatial analysis can detect and remove various trends in the data more effectively than blocking

Board spring is being examined in *Eucalyptus globulus* progeny trials.

Outcomes

- The degree of pedigree connectivity between traits required to enable a robust estimation of across-site breeding values and genetic correlations is important for implementation of the "rolling front" breeding strategy used by the STBA. This can be achieved with at least 20% of families with 10 trees per family.
- A combined across site analysis of the STBA second generation *Eucalyptus globulus* progeny trials has enabled better estimation of genetic parameters in these small but genetically linked trials. Dominance was found to be about the same as the additive variance for growth, but lower for basic density. The genetic parameters will be used in the prediction of breeding values for the STBA.

Outcomes from external grants

- The solid wood, veneer and paper industries have been identified as potential new markets for *E. globulus* in Australia, and thus potential new breeding objectives for the STBA.
- Methods for the sampling of sawn timber traits have been developed and a large-scale sampling of a base generation progeny trial has been undertaken. Preliminary assessment has shown that differential tangential-radial shrinkage is moderately heritable, growth-stress induced spring in quarter-sawn boards is strongly heritable, whilst cup in back-sawn boards is not at all heritable. Branch score has low heritability whilst stem sweep is not heritable.
- Methods for evaluating the economic weights of revenues from 'carbon trading' schemes in the context of *E. globulus* pulpwood plantations have been developed. Financial models suggest that at current prices such revenues do not have a strong influence on the economics of growing *E. globulus* in plantations.
- A breeding strategy simulator has been written to enable evaluation of multiple objectives in breeding programs and to evaluate different measurement strategies (see 'Major Developments').

Goals

- Improve accuracy of breeding value prediction by accounting for environmental variation and population genetic structure.
- Increase profit by integrating economic information into selection.
- Evaluate the impact of tree breeding and deployment strategies.
- Support CRC partners' breeding programs.

Goal for external grant

- Develop alternative breeding objectives for *E. globulus* and study the genetic variation of new objective traits (e.g. coppicing ability, solid wood properties).

Project A3 Molecular approaches to tree improvement

Leader
Dr Gavin Moran

Staff
Ms Kylie Groom
Ms Jan Murrell
Dr Reddy Thumma
Dr Emlyn Williams

Background

The aim of this research is to understand the molecular genetic basis of traits with high commercial value, such as those for wood and fibre, and to use this knowledge to more efficiently develop improved breeds for deployment in plantations. The approach involves characterising quantitative trait loci (QTL) and candidate genes for wood and fibre traits. The traits include wood density, pulp yield, cellulose levels, fibre length and microfibril angle.

The project is closely integrated with Project A5 (Wood quality) and utilises technologies developed in the CSIRO Forest Products Laboratory in Clayton. A CSIRO fullsib progeny trial is the source of pedigree material for the QTL work on *E. nitens*. An *E. nitens* progeny trial of collaborator Forestry Tasmania was used as a source of material to relate candidate gene variation to variation in wood fibre traits.

Dr Reddy Thumma with the DNA sequencer used for SNP analysis

Outcomes

- DNA samples and wood cores from sample populations of *E. nitens* (about 300 trees) representing the main regions of Australian breeding material were used to relate variation in 25 SNP markers of the CCR gene to variation in five wood fibre traits.
- Significant associations were found between SNP and haplotype variation in microfibril angle, cellulose levels and pulp yield, consistent with QTLs previously found in either *E. globulus* or *E. nitens* mapping pedigrees.

Goals

This project does not continue into the eighth year of the CRC so no goals are outlined. Future efforts will be directed towards publishing the research reported above.

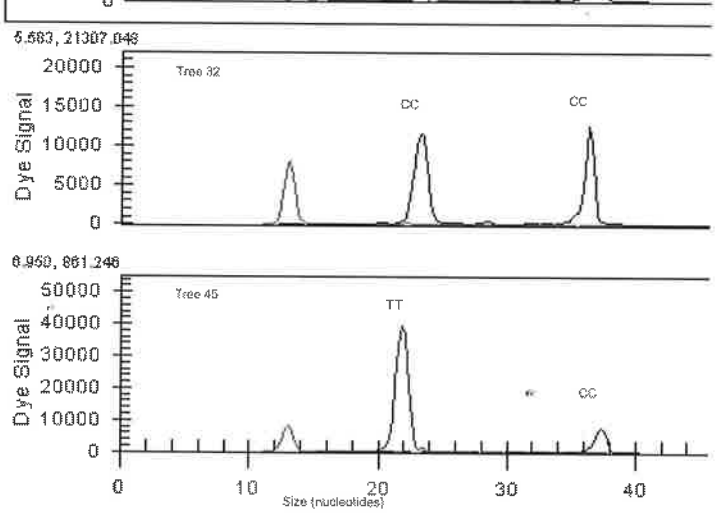


Figure 9. Genotypes of two SNP markers in three trees in the population of *E. nitens* used for the association study. The trees vary (TC, CC, TT) for the first marker (left) but are fixed (CC) for the second marker.

Project A4

Leader
Dr René Vaillancourt

Staff
Mr Jules Freeman
Mr Carl Grosser
Mr Timothy Jones
Mr Andrew Milgate
Dr Briony Patterson
Ms Fiona Poke
A/Prof Brad Potts
Mr Damien Rathbone
Dr Jim Reid
Mr Adam Smolenski
Dr Dorothy Steane
Mr James Worth

Molecular genetics of eucalypts

Background

Molecular tools are now being used in fingerprinting for quality control in breeding and deployment programs, in understanding gene flow, conducting paternity and outcrossing studies, understanding the genetic control of quantitative traits as well as providing unprecedented insights into plant genomes leading to the identification of genes of interest.
This project focuses on eucalypts and aims to use molecular markers to:

- provide a better knowledge of inbreeding, heterosis and genetic diversity in breeding and base populations of eucalypts;
- quantify factors affecting outcrossing rates patterns of gene flow, and contamination levels in seed orchards, in close cooperation with project A1 (Genetics and Reproductive Biology of Eucalypts); and
- characterise QTL (quantitative trait loci) affecting commercially important traits (e.g. growth, wood properties and pest resistance).

Outcomes

- A linkage map was completed for *E. globulus*, which contains 45 of the microsatellite markers (in 11 linkage groups) developed by the CRC-SPF, CSIRO and Genolyptus in Brazil (Figure 10 shows linkage group 7 with 4 markers). This map can be used as a "Rosetta stone" to allow comparison of the position of important genes and QTLs between different research groups.
- Three strong putative QTLs have been found for *Mycosphaerella nubilosa* resistance. With verification, these markers could lead to systems to screen seed orchards and breeding populations for *Mycosphaerella* resistance.
- A set of reference samples have been developed together with our Portuguese collaborator and used to align microsatellites in databases of *E. globulus*.
- Sequencing of the *E. globulus* chloroplast genome has been completed (160,334 base pairs). This is the first time such a big continuous piece of DNA has been sequenced in a eucalypt.

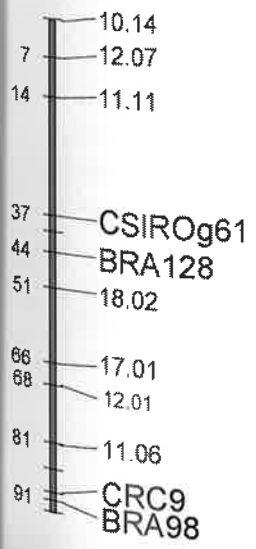


Figure 10 *Eucalyptus globulus* linkage group 7, which corresponds to linkage group 2 on the map by Thamarus et al. (2002) and linkage group 7 on the *E. grandis/urophylla* map of Brondani et al. (2002). Microsatellites are in bold, and the map includes loci developed by CSIRO, the CRC and Embrapa in Brazil. Distance (cM) between markers is on the left. Other markers are framework AFLP's.

Outcomes from an external ARC grant

- A large fraction of the *E. globulus* breeding population of the STBA has been fingerprinted using microsatellites for a study of relatedness. This information can be used by STBA for quality control during breeding operations.
- A review of genomic research in eucalypts has been completed for a workshop organised to discuss the formation of an international consortium aimed at fostering collaboration in large-scale genomic projects.
- *Eucalyptus globulus* trees found near populations of *E. cordata* often share the same or similar types of chloroplast DNA (cpDNA), but some *E. globulus* trees have cpDNA not found in *E. cordata*. This indicates that the gene pool of *E. globulus* has been significantly affected by past hybridisation.
- The mitochondrial DNA of *E. globulus* is inherited in a maternal fashion and does not appear to be a good source of markers given its low level of variation.
- The Tasmanian populations of *Eucalyptus perriniana* are distinctive enough from those on the mainland to warrant their recognition as a subspecies.

Goals

- Phenotype the *E. globulus* F_2 family used in linkage study for wood properties since it is now of appropriate age to understand better the correlation between growth, wood properties and disease resistance.
- Expand the microsatellite database of native *E. globulus*.

Goals for external grants

- Establish the relationship between hybridisation potential and phylogenetic affinity.
- Develop a set of chloroplast microsatellites using the completed *E. globulus* sequence.
- Investigate the potential of using CCR (a nuclear gene encoding for an enzyme in the lignin biosynthetic pathway) for phylogenetic studies.

Project A5 Wood quality

Leader
Dr Chris Harwood

Staff
Ms Linda Ballard
Dr Emlyn Williams
Ms Kirsty Siu
Mr Matthew Hamilton

Background

Wood quality is one of the most important determinants of profitability, 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.

PhD student Matt Hamilton assessing the volume of *E. globulus* cores.

Work is concentrating on:

- developing non-destructive sampling strategies for wood and fibre properties;
- refining 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.

This project has strong links with CSIRO Forest Products Laboratory, with some of the technologies developed there (SilviScan 2, cellulose content analysis and Near Infrared Reflectance Analysis) being implemented and applied to genetic material in member breeding programs for both *E. globulus* and *E. nitens*.

Outcomes

- A study of 104 open-pollinated families of *E. nitens* showed that wood density, and cellulose and lignin content, were under strong genetic control and stably expressed across two field trial sites in Central and North-Western Tasmania. Genetic correlations with growth traits were moderate or neutral. This means that prospects for improving wood quality in *E. nitens* plantations through breeding are excellent.
- Volumetric shrinkage and collapse, assessed from air-dried 12 mm increment cores, displayed low heritability in this study.

Goals

- Determine genetic parameters for wood traits (lignin, cellulose, pulp yield, shrinkage and collapse) and their relationship with growth traits in advanced-generation breeding population of *E. globulus*.
- Determine more effective methods of sampling for wood shrinkage and collapse in *E. globulus* and *E. nitens*.

Project A6

Leader
Dr Mark Dieters

Staff
Mr Jeremy Brawner
Mr Dominic Kain
Dr Kevin Harding
Dr Garth Nikles

Hybrid breeding

Background

The CRC-SPF and its partner organisations have access to one of the most extensive array of artificial forest tree hybrids in the world. This project has two primary aims:

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

This project focuses on the tropical pine species *P. elliottii* (PEE) and *P. caribaea* var. *hondurensis* (PCH) and their hybrids which are being deployed commercially by the Department of Primary Industries (Queensland), and interacts closely with project A7 (Molecular genetic improvement for tropical and subtropical production).

Outcomes

- Completion of analysis of data to 15 years of age (¾ rotation age) from factorial matings of PEE, PCH and their hybrids indicated the predominance of additive genetic control in hybrid populations.
- Individual-tree volume equations developed for PEE, PCH and F_1 and F_2 hybrids were strongly correlated to conical volume, but allowed better comparison of the relative productivity of these taxa. Bias at 15 years of age from the use of conical volume was found to over-estimate the volume of PCH relative to the F_1 hybrid by 13%, when there was actually no significant difference between the taxa.
- Analysis and reporting of intra- and interspecific (with PCH) half-sib families with 36 common PEE parents indicated a poor correspondence between pure-species and hybrid performance for 11yr volume ($r_{ph} = -0.05 \pm 0.17$), but much stronger correlations for stem straightness ($r_{ph} = 0.71 \pm 0.13$).
- Reciprocal effects were examined in a small set of 13 paired PEE × PCH reciprocal crosses. A strong correspondence was between the diameter and height of these families at 10 years of age, regardless of which species was used as the maternal parent. This provided support for the continued use of PEE as the maternal parent in this hybrid, which is biologically the simplest way to produce this hybrid cross.
- Documentation of a breeding plan of PEE × PCH hybrid in Queensland has been completed following extensive consultation with Queensland's DPI-Forestry.

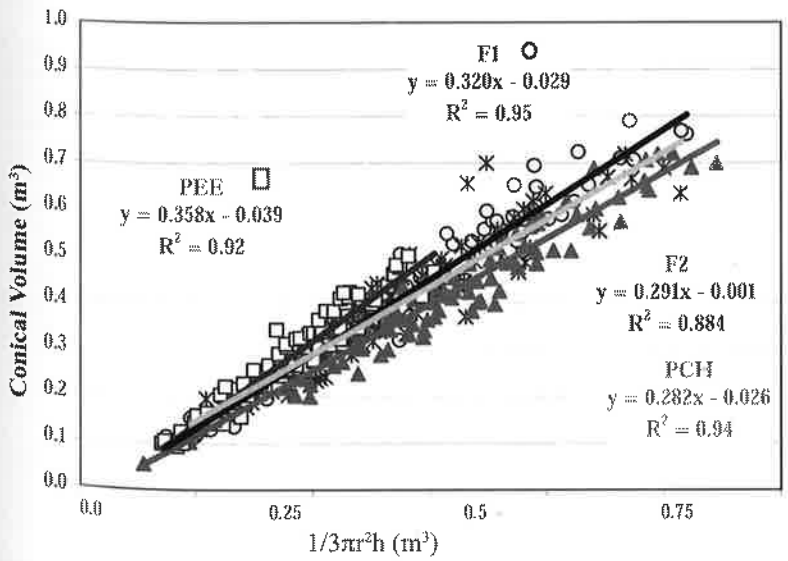


Figure 11. Regression of inside bark volume (centroid method) on conical volume (1/3 $\pi r^2 h$) – which is commonly used to represent growth in genetic evaluation of forest trees.

Work conducted in association with Project A6 of the CRC-SPF over the last 6 years has demonstrated for PEE × PCH: a) F_2 populations are comparable in mean and variance to F_1 populations through to ¾ rotation age; b) the genetic control of most quantitative traits in the hybrid populations is largely controlled by additive genetic effects (additive or additive × additive epistasis); c) the predictability of hybrid performance from pure-species performance is dependent on both the trait involved and the parental species, making the multi-trait prediction of F_1 hybrid performance problematic without the use of reciprocal hybrid testing; d) under the types of genetic architectures commonly observed in the PEE × PCH hybrid, computer simulation clearly demonstrated that gain/year will be maximised by the development of a stabilised, advanced generation synthetic hybrid. Based on these results we recommended the breeding strategy for PEE × PCH in Queensland be changed to one which seeks to develop a synthetic hybrid between these two species for deployment in near-coastal areas of south-east and central Queensland and northern NSW.

Goals

This project does not extend into the eighth year of the CRC so no goals are presented.

Project A7

Molecular genetic improvement for tropical and subtropical production

Leader
Prof Robert Henry

Staff
Mr Mike Cross
Dr Mark Dieters
Mr Peter Eggler
Ms Francis Elliott
Dr Kevin Harding
Prof Jane Hughes
Ms Rachel King
Mr Rohan Mellick
Mr Leon Scott
Dr Mervyn Shepherd
Mr Steven Smith
Mr Paul Toon

Background

Genetic improvement and sustainable management of tropical forest species is supported by the application of molecular tools in this project. The species studied include *Pinus* hybrids (*P. elliottii* var. *elliottii* x *P. caribaea* var. *hondurensis*), *Araucaria cunninghamii* (Hoop pine) and *Eucalyptus* species. The project is increasing our understanding of the genetics of complex traits such as wood properties and propagation performance. Techniques for verification of hybridisation in plantations and native populations are being developed and applied in forest management.

Outcomes

- The discovery of gene effects (QTL) that are stable across pedigrees and generations of hybrids suggests opportunities for integrating molecular breeding into hybrid improvement that are not available for species improvement. By directing selection toward adaptive characters that are divergent in parental species populations, inefficiencies anticipated with marker-aided selection within species may be overcome. QTL controlling root initiation on stem cuttings of hybrid pines were validated and displayed predictable directional effects (see picture below).

Stem cuttings of hybrid pines undergoing assessment for root initiation at the DPIQ nursery at Toolara Queensland.

- Evidence of genomic reorganisation in hybrids is revealing how natural and artificial selection can reshape the genome of exotic pines when introduced into the Australian environment. Previous comparative map analysis amongst *Australes* pines (a subsection of the genus *Pinus*) indicated high genome conservation. More extensive comparisons between hybrid and species' maps revealed hybridisation causes subtle genome disturbance as a consequence of species incompatibility.
- The molecular platform for genetic studies and molecular breeding in tropical pines was enhanced with the addition of a new marker class (expressed sequences tag polymorphism (ESTp)) to the existing genetic maps based on microsatellite loci, AFLP and candidate genes.
- A study of the population genetics and DNA sequence variation in Hoop pine revealed low genetic diversity suggesting an evolutionary history of extreme genetic stability. This explained the low efficiency of genetic mapping in Hoop pine.
- Spatial analysis indicated a lack of spatial structure in the distribution of genetic based variation in disease resistance within a *Corymbia variegata* forest at Woondum, Queensland and that the disease resistance was dispersed independently of the positive (but weak) spatial structure in neutral genetic markers.

Goals

- Evaluate genomic synteny between *Corymbia* and *Eucalyptus*
- Conduct molecular phylogenetic analysis of *Corymbia* and *Angophora*.

Sustainable Management Program

Manager
Dr Chris Beadle

Introduction

Plantations, including farm forests, can be considered a sustainable resource only if the factors necessary for production remain favourable over successive crop cycles. 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 of criteria for sustainability.

Project B1

Leader
Dr Philip Smethurst

Staff
Dr Paul Adams
Mr Richard Appleton
Mr Craig Baillie
Dr Chris Beadle
Ms Maria Ottenschlaeger
Mr Keith Churchill
Ms Sandra Hetherington
Mr Andrew Knowles
Dr Andrew Mitchell
Mr Bill Neilsen
Dr Chris O'Hara
Ms Carolyn Ringrose
Mr Julian Smith
Ms Diane Spurr
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;
- evaluate the effects of alternative slash management strategies (during the inter-rotation period) on nutrient supply and other soil conditions that affect productivity; and
- improve our understanding of water storage and access to it in relation to soil profile characteristics, rainfall, and ground water.

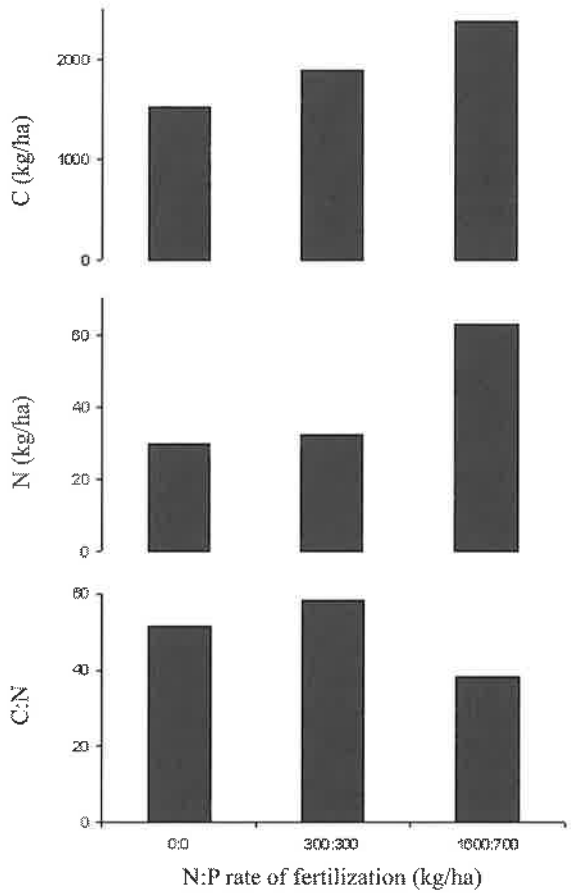


Figure 12
An intermediate rate of fertilisation (300: 300 N:P kg/ha) had small effects on C and N pools in the forest floor of an *E. nitens* plantation, but a much higher rate markedly increased these pools and decreased the C:N ratio.

Outcomes

- Near rotation-length growth responses to N fertilisation were assessed at several sites. Results indicate that earlier assessments were an under-prediction of the growth response and hence the value of N fertilisation on many ex-forest sites. At the most responsive site, 43 m^3 ha^{-1} of extra wood was grown after applying 200 kg N ha^{-1} at 3.5 years of age.
- A prototype phosphorus and base cation model (Pcats) was developed and linked to the CABALA productivity model. Tests using data from the Westfield site indicated that satisfactory simulations were possible by users skilled in nutrient dynamics. We suspect this was the first simultaneous mechanistic simulation of N and P uptake by a forest plantation.
- Limiting ratios and concentrations of base cations were identified for *E. globulus* and *P. radiata* seedlings.
- Carbon and nutrient pools in the Westfield plantation were quantified (see Figure 12).

Goals

- Summarise near-rotation length effects of initial and follow-up weed control.
- Further develop and validate CABALA-Pcats.
- Synthesise the options for fertilizer management in eucalypt plantations.
- Summarise litterfall and forest floor C and nutrient pools in a mid- to late-rotation *E. nitens* plantation.

Project B2

Management of tropical soils

Leader
Dr Zhihong Xu

Staff
Dr Tim Blumfield
Dr Sue Boyd
Dr Ken Bubb
Ms Joanne Burton
A/Prof Janet Chaseling
Dr Chenrong Chen
Mr Philip Frayne
Dr Hossein Ghadiri
Mr Jim He
Prof Peter Healy
Mr Zhiqun Huang
Prof Jane Hughes
Mr Paul Keay
Mr Issa Medraj
Ms Megan Nosovich
Mr David Osborne
Dr Ian Phillips
Dr Nina Prasolova
Prof Calvin Rose
Mr John Simpson
Mr Shane Tutua
Dr Bofu Yu
Ms Janet Zhang

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 for sustaining the productivity of subtropical pine plantations;
- evaluate the impacts of silvicultural practices on nitrogen (N) pools and dynamics in Hoop pine plantations;
- test, develop and apply advanced DNA, stable isotope and nuclear magnetic resonance for improved biological indicators of soil quality;
- quantify the effects of silvicultural practices and environmental conditions on soil N availability and on plantation N demands; and
- quantify the effects of harvesting, site preparation and seasonal conditions on soil physical processes in pine plantations.

Outcomes

- The decomposition of hoop pine logging residue (foliage, branch and stem material) was examined, using both ^{15}N stable isotope tracing technique and ^{13}C cross-polarisation and magic-angle spinning nuclear magnetic resonance (see picture of micro-plot below). For combined foliage branch and stem residue, residue-derived ^{15}N was immobilised in the 0-5 cm soil layer, with approximately 40% ^{15}N recovery in the soil by the end of the 30-month period. Total recovery of ^{15}N in residues and soil varied between 60% and 80%. Apparently, 20-40% of the residue ^{15}N was lost. When residues were combined, the rate of foliage decomposition decreased by 30% while the rate of branch and stem decomposition increased by 50% and 40% compared with rates for these components when decomposed separately. There were good correlations among O-aryl C, aryl C, carbohydrate C, phenolic C, residue mass, ^{15}N enrichment and total N. The ratio of aryl C (a single bonded chain of carbons attached to residues via an carbon bond) to O-aryl C (a single bonded chain of carbons attached to residues via an oxygen bond) can be useful as an indicator of harvest residue decomposition (see Major Development).
- The genetic variation in foliar nutrient concentration in relation to foliar carbon isotope composition ($\delta^{13}C$) and tree growth was quantified using 122 clones of ca. 4-year-old F_1 hybrids between slash pine (*Pinus elliottii* Engelm var. *elliottii*) and Caribbean pine (*Pinus caribaea* var. *hondurensis* Barr. et Golf.) grown at two sites with different water and nutrient availability. There were significant, positive correlations between clone means of foliar $\delta^{13}C$ and N concentration at the upper outer canopy in summer for the wet site, while clone foliar $\delta^{13}C$ was also positively related to clone foliar N concentration at both canopy positions in summer for the dry site. Foliar N concentration, together with foliar $\delta^{13}C$, may be useful for assisting in selection of exotic pine clones with improved nutrient- and water-use efficiency.

Goals

- This project met all agreed Commonwealth milestones by June 30 2004 and was not continued into year 8 of the CRC-SPF. Therefore no goals are presented.

A field microplot with ^{15}N-labelled hoop pine residues applied to examine the decomposition of carbon and nitrogen from the residues in a 2nd rotation hoop pine plantation.

Project B3

Leader
Dr Chris Beadle

Staff
Dr Paul Adams
Dr Philip Brown
Mr Keith Churchill
Dr Dugald Close
Dr Neil Davidson
Ms Sandra Hetherington
Dr Jeanette Hyland
Dr Ryde James
Dr Sarah Jennings
Prof Peter Kanowski
Dr S Mahendrarajah
Dr Jane Medhurst
Mr Mark Neyland
Mr Petr Otahal
Ms Maria Ottenschlaeger
Dr Libby Pinkard
Dr Digby Race
Ms Jacki Schirmer
Dr Philip Smethurst
Mr Tim Tabart
Ms Ingrid van Putten
Prof Frank Vanclay
Ms Ann Wilkinson
Ms Danielle Wiseman
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;
- develop weed management systems that minimise the use of herbicides, including the use of non-competing species as cover crops;
- develop pruning, thinning and spacing systems that are suitable for converting industrial pulpwood plantations to clearwood regimes and for farm forestry;
- assess the benefits and costs of trees on farms, and the real or perceived barriers to 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

- A nitrogen addition rate of 25 mg N per seedling was insufficient to achieve a target specification of foliar N of 15-20 g kg^{-1}at planting in *E. globulus* seedlings raised in the nursery: 50 mg N per seedlings appears sufficient to meet this specification.
- Seedling container volume but not seedling size can significantly affect the growth of *E. globulus* seedlings six months after planting.
- Experiments incorporating UV-A exclusion UV-A addition to the light spectrum showed that UV-A increases the production of secondary compounds (gallo-tannins, flavonoids and stilbenes) that act as UV-screens in leaves. Overall, *E. nitens* seems well adapted to UV-A exposure.
- Thinning a natural, dense stand and growth chamber studies showed that blackwood is very susceptible to cold-induced photoinhibition. This may be a factor contributing to poor outcomes in some planted stands.
- The structural relationships between tree organs of blackwood were generally independent of silvicultural treatment (*eg.* nurse crop removal). This is useful from a modelling perspective as these relationships can be applied with a reasonable amount of confidence to partitioning carbon amongst the various sections of the tree (see picture below).
- A study of company responses to community concerns about plantation expansion found that leading companies use a comprehensive package of strategies to build positive relationships. Positive relationships cost much less than the opportunity cost of lost business.
- A study of the timber harvesting behaviour of 386 non-industrial private forest landowners in Tasmania explored the effect of timber prices on the harvest decision, the role of landowner motivations on harvesting and management behaviour and regional differences in behaviour. While results accorded with *a priori* expectations, the use of three econometric models of timber harvesting was limited by the data set which reflected a low level of actual timber sales and a continuing paucity of stumpage price data.

Goals

- Seedling specifications for managing abiotic stresses at planting and early establishment.
- Strategies for managing multiple-lift pruning systems in eucalypt plantations managed for solid wood.
- Strategies for species selection, establishment and management of plantations to combat tree decline.
- Strategies of how forest practices may best be developed at the regional level to minimise community concerns about plantation expansion, motivate the planting of trees and enhance socio economic benefits.

Peter Sands explains his development of a decision support system for the silvicultural management of blackwood grown under a nurse crop at a Field Day at Beulah in December 2003.

Project B4

Modelling production and wood quality

Leader
Dr Michael Battaglia

Staff
Dr Roger Braddock
Dr Kerrie Catchpoole
Prof Larry Forbes
Dr Kevin Harding
Dr Mark Hunt
Ms Sharon Koh
Mr Daryl Mummery
Dr Marks Nester
Dr Tony O'Grady
Ms Rebecca Pryor
Mr Paul Ryan
Dr Peter Sands
Ms Kirsty Siu
Dr Mel Tyree
Dr Steven Underhill
Mr Dale Worledge

Background

The aims of this project are to:

- produce process-based models which

a) enable the productivity of plantations to be predicted,

b) address specific management questions,

c) have a transparent structure, and

d) allow input data to 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

- The special issue of Forest Ecology and Management featuring key papers from EucProd 2002 is now in press as volume 193. It features 17 papers and an introduction, 9 of which are authored or co-authored by staff associated with this CRC.
- A report has been submitted to the Natural Heritage Trust (FFP30558) on the silviculture of blackwood, a summary of data available on the growth and structure of blackwood stands, and a full description and proposed use of a blackwood growth model as a decision support tool.
- Modern optimisation techniques have been applied to estimate parameters in Excel-based growth models such as ProMod and 3-PG. This has entailed the development as a CRC Technical Report of guidelines for the application of 3-PG to novel species, and of software to automate aspects of parameter estimation (in conjunction with Larry Tooke, Pietermaritzburg, South Africa).
- The components of the decision support system for the subtropical softwood species, *Pinus caribaea* var. *hondurensis* were developed and evaluated. The components included STEPS V3.0, Win-EPIFN customised for *Pinus caribaea* var. *hondurensis* (included branch architecture models and wood density model), and grading software.
- A daily weather simulator was developed to convert average monthly maximum and minimum temperature and mean monthly rainfall and number of rain days to realistic daily weather data for input into CABALA.
- The pattern and distribution of fine root development in a young eucalypt plantation has been quantified over the first 12 months of development and related to water flux and stand leaf area.

Goals

- Incorporate phosphorus and base cation supply and uptake modules for CABALA as part of forest nutrition decision support system.
- Build forest management scenario-builder graphic user interface for CABALA with supporting workshop.
- Develop procedures and models for predicting the impact of loss of effective leaf area on canopy production of young plantation species as a means of predicting potential loss of wood production.

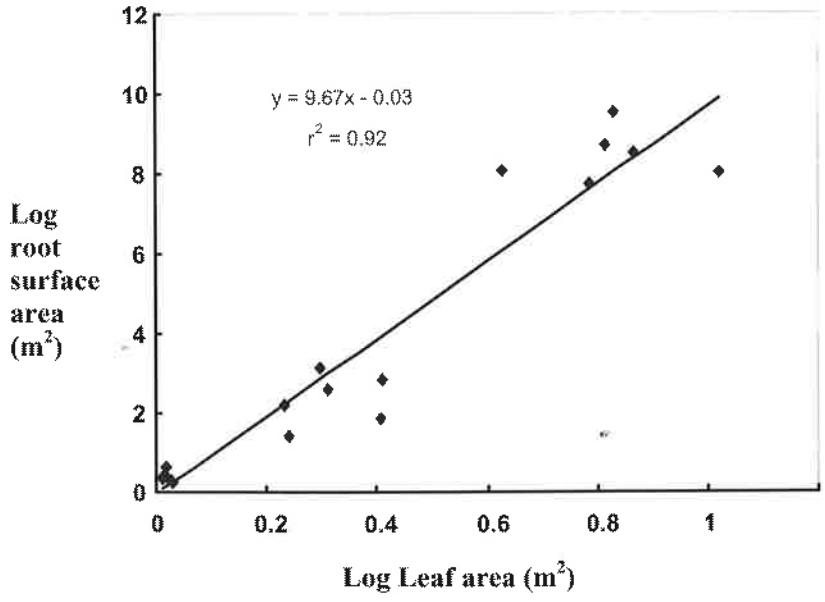


Figure 13. Relationship between root surface area and leaf area in a developing *E. globulus* plantation showing that within a plantation the two develop in concert lending support to the functional balance hypothesis in which the active surface areas of the two major sources of resource acquisition (roots and leaves) should be matched for optimum growth.

Resource Protection Program

Manager
Dr Clare McArthur
(to January 2004)
Dr Caroline Mohammed
(from February 2004)

Introduction

The Resource Protection Program aims to:

- develop a comprehensive understanding of the biology, ecology and impact of a number of key insect and vertebrate pests of eucalypt plantations in temperate Australia;
- identify and study the biology, ecology and control of a number of eucalypt fungal pathogens, to provide the basis for future development of integrated pest management (IPM) strategies;
- develop efficient and effective monitoring protocols for some pest and disease species to determine if and when control is necessary;
- develop IPM strategies for a number of key pests such as the Tasmanian leaf beetle (*Chrysophtharta bimaculata*), Autumn gum moth (*Mnesampela privata*) and several marsupial herbivores; and
- develop management techniques and products to minimise the effects of pests and diseases on the quantity and quality of forest products, consistent with the principles of sustainable forest management.

Project C1

Leaders
Dr Geoff Allen
Mr John Matthiessen

Staff
Dr James Bulinski
Dr Jane Elek
Dr Mamoru Matsuki
Dr Fredrik Östrand
Mr Vin Patel
Mr Stephen Paterson
Ms Nita Ramsden
Mr Luke Rapley
Mr Hilton Redgrove
Mr Anthony Rice
Mr Mark Short
Dr Martin Steinbauer
Mr Rex Sutherland
Ms Trudi Wharton

Biology, ecology and economic impact of insect pests

Background

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 Integrated Pest Management Strategies (IPM) can be developed. Particular emphasis in the project is centred upon *Mnesampela privata* (Autumn gum moth) across all regions of southern Australia, and the leaf beetles *Chrysophtharta agricola* and *Chrysophtharta bimaculata* in Tasmania. Other insect species currently under study include *Heteronyx* spp (Melolonthine scarab beetles) and *Heteronychus arator* (African black beetle) and the pine aphid *Essigella californica*. Areas of research include phenology, host-plant interactions, natural enemies, mating systems, monitoring protocols and impacts on tree growth.

Outcomes

- A predictive model was developed based on day-degree for *Chrysophtharta agricola*'s spring-summer phenology under field conditions. The day-degree model accurately predicted the appearance of different life stages in the field.
- Timing of oviposition and larval development in *C. agricola* and *C. bimaculata* was closely linked with the narrow window of time when the soft new season's leaves are abundant.
- There are three species of main parasitoids of *C. agricola* larvae. A species of tachinid fly is effective but is not abundant. This fly lays eggs on the fourth instar larvae. Two other species (the second tachinid fly and a braconid wasp) are abundant but not as effective as the first species. These two species lay eggs on the first three instars. Thus, the three species have roughly the same impact on populations of *C. agricola* larvae.
- Defoliation of up to 50% of the canopy by *Mnesampela privata* did not affect long-term growth rates of young *E. nitens*.
- After *M. privata* defoliation, we found no evidence of induced defence in *E. globulus* for foliar wax compounds, including benzyl n-tetracosanoate (which had been shown to be negatively correlated with defoliation by *M. privata*), essential oils, or polyphenolic groups. The level of foliar tannins tended, however, to be negatively correlated with average percentage branch defoliation.
- Host trees' physical characteristics such as tree size, leaf number per tree and overall condition of young *E. nitens* are of little importance in the host association to *Heteronyx crinitus* and *H. dimidiata*.
- Manipulation of seedlings in nurseries to harden physically or chemically may have little benefit in terms of reducing damage by *Heteronyx* beetles.
- If no insecticides have been used, wasp natural enemies in the families Ichneumonidae and Braconidae increase in abundance and species diversity as plantations age.
- Two species of natural enemy of autumn gum moth larvae (*Heteropelma scaposum* and *Habronyx pammi*, both parasitoid wasps) will live longer if they feed on honeydew from scale insects. This finding is an example of benefits from maintaining biodiversity in plantations.

- Adult beetles of 28 *Heteronyx* species were found in seven plantations of *E. globulus* from November to May in SW WA. Adult beetles emerge from soil at night when the NE wind brings hot air from the inland. Species composition varied between plantations and between traps within plantations. Phenology of some common species varied between plantations.
- Annual defoliation of up to 60% of the top 1m of *E. globulus* trees by *Gonipterus scutellatus* resulted in no significant reduction in productivity at harvest.
- CLIMEX modelling has confirmed that the fundamental niche of *Essigella californica* extends to virtually all areas in Australia where commercial pine plantations are currently established.
- *Essigella californica* shows a strong preference for yellow needles over green needles on pine.
- Adult feeding is estimated to contribute at least one quarter of the total feeding damage per batch of *C. bimaculata* eggs but may have a greater impact on tree growth because it is concentrated at the end of summer when the new generation beetles are feeding. This study shows that feeding by the adult stage should be incorporated into the model used to estimate economic impact and monitoring thresholds in the IPM system for managing *C. bimaculata*.

Goals

- Complete a study on *E. globulus* examining genetic variation in resistance to *C. agricola, M. privata,* and *G. scutellatus*.
- Complete a study on *E. globulus* and *E. nitens* examining effects of defoliation on long-term tree growth in Tasmania.
- Incorporate research findings from the Resource Protection Program on herbivores, natural enemies and pathogens in Australian tree plantations into the pest & pathogen database.

Technician Vin Patel caging autumn gum moth larvae on the branches of a 2yr old *E. globulus* to investigate the trees constitutive and induced defences (left) and the resulting damage (below).

Project C2

Leaders
Mr John Matthiessen
Dr Geoff Allen

Staff
Dr James Bulinski
Dr Jane Elek
Dr Mamoru Matsuki
Ms Helen Nahrung
Dr Fredrik Östrand
Mr Vin Patel
Mr Stephen Paterson
Ms Nita Ramsden
Mr Luke Rapley
Mr Hilton Redgrove
Mr Anthony Rice
Dr Martin Steinbauer
Mr Rex Sutherland

Insect control techniques and IPM

Background

Forest managers are looking for non-chemical options for insect control that are both effective and economically viable. Individual non-chemical control approaches may need to be used in conjunction with other options in an IPM strategy to achieve adequate control. This project is investigating a number of control options, including the use of more environmentally-friendly chemical insecticides, for incorporation into IPM strategies as well as approaches to determine the most effective time to implement such strategies. This project has also been developing standardised sampling protocols and designs which can be used by anyone involved in assessment of population levels of pests and damage by pests & pathogens. These sampling protocols and sampling designs are based on sampling theory and are designed to reduce time and effort required for assessments while increasing usability of assessment results.

Outcomes

- Both the broad-spectrum pyrethroid insecticide Dominex® and the Naturalyte® insecticide Success® reduced egg and larval populations of *Chrysophtharta agricola* and *C. bimaculata* leaf beetles immediately following spraying in an *E. nitens* plantation, and reduced the level of defoliation by larvae during the subsequent summer months.

Mamoru Matsuki

- Leaf beetles recolonised and laid more eggs within one month after spraying with Success® and within two months after spraying with Dominex®.
- The application of the broad-spectrum pyrethroid insecticide Dominex® reduced population levels of non-target species, including natural enemies, more than the application of Success®, when applied to control the leaf beetle *C. agricola* in an *E. nitens* plantation.
- The natural enemies, spiders and parasitic flies, recolonised within one month after spraying with Success® and at least two months after spraying with Dominex®. One parasitic wasp recolonised immediately after spraying with both insecticides.
- Two additional compounds from extracts of sex pheromone gland of female *M. privata* have been identified and are currently being tested in the field and laboratory for their attractiveness to male moths.
- Preliminary experiments showed that eucalypt-feeding scarabs found near Canberra (*Heteronyx chlorotica* and *H. praecox*) do not appear to exhibit aggregation behaviour.
- A region-wide risk assessment model of *G. scutellatus* was developed for SW WA. The model predicts that *G. scutellatus* will spread into the blue gum growing area currently free of this species in the next one to two years.
- The first standardised method of quantifying crown damage by pests and pathogens in young eucalypt plantations (Crown Damage Index or CDI) was developed. This is one of the first efforts to introduce a standard methodology to assess forest health issues in Australia. The field manual was published by AFFA.
- The first phase of the pest and pathogen database for eucalypt and pine plantations in Australia has been completed. The database includes existing and potential pests and pathogens in plantations. The users are able to find out (1) which pests and pathogens they are likely to encounter in their plantations and (2) which management actions are necessary in a given month in a given region.

Goals

- Complete the second phase of development of the pest and pathogen database and make it available to all CRC partners and non-CRC parties.

Project C3

Leader
Dr Clare McArthur
Dr David de Little

Staff
Mr Hugh Fitzgerald
Ms Julianne O'Reilly-Wapstra
Ms Prue Loney
Mr Stephen Paterson
Ms DJ Burton

Resistance of planting stock to vertebrate browsers

Background

A key method for reducing browser damage to eucalypts is to produce more resistant trees. This should be achievable by genetic and phenotypic manipulation of those trees. Our research is directed at identifying resistant genotypes, and predicting susceptibility of seedlings as a function of their environment. These three aspects can be incorporated into an overall strategy for predicting and reducing browser damage of eucalypts at plantation establishment. Specific aims of this project are to:

- determine the relative damage to and preferences for various plant types by browsing herbivores;
- investigate the genetic basis of resistance of eucalypts, and also the effects of varying environmental conditions on this resistance
- investigate within plant variation in resistance of eucalypts.

Outcomes

- In a captive feeding trial, intake by brushtail possums of seedlings from one relatively resistant (Blue Gum Hill) and one relatively susceptible (St Helens) population of *E. globulus* grown under two nutrient treatments (no fertiliser, plus fertiliser) was assessed. A significant genotype by fertiliser interaction indicated that the predicted genetic-based resistance of the two populations was expressed only for the non fertilised treatment (Figure 14). Under the fertilised treatment differences in resistance between the genotypes were not expressed.
- In glasshouse and captive feeding trials, wind treatments affected several characteristics of *E. globulus* and *E. nitens* seedlings. Wind reduced stem height, increased leaf biomass, increased tannin, and reduced total oils and cineole concentration of leaves. Intake by pademelons of wind-affected *E. nitens* seedlings was lower than those not affected by a wind treatment.
- In captive feeding trials, pademelons and possums showed preferences for different plant parts. Pademelons preferred the lower leaves of *E. nitens* seedlings compared to other plant parts such as middle and upper leaves. Under non fertilised conditions, possums preferred lower and middle leaves, compared to upper leaves. However, under fertilised conditions these preferences changed and possums ate significantly more of the middle leaves compared to any other plant part.

Goals

- Determine the variation in defensive chemistry in an *E. globulus* seed orchard and predict susceptibility to marsupial herbivore browsing.
- Determine the basis for resistance of plant parts within *E. nitens* seedlings by comparing the primary and secondary chemistry and physical characteristics of *E. nitens* seedlings, stratified into buds, middle and lower leaves and stems. This will be related to differences in feeding preferences by brushtail possums and pademelons.

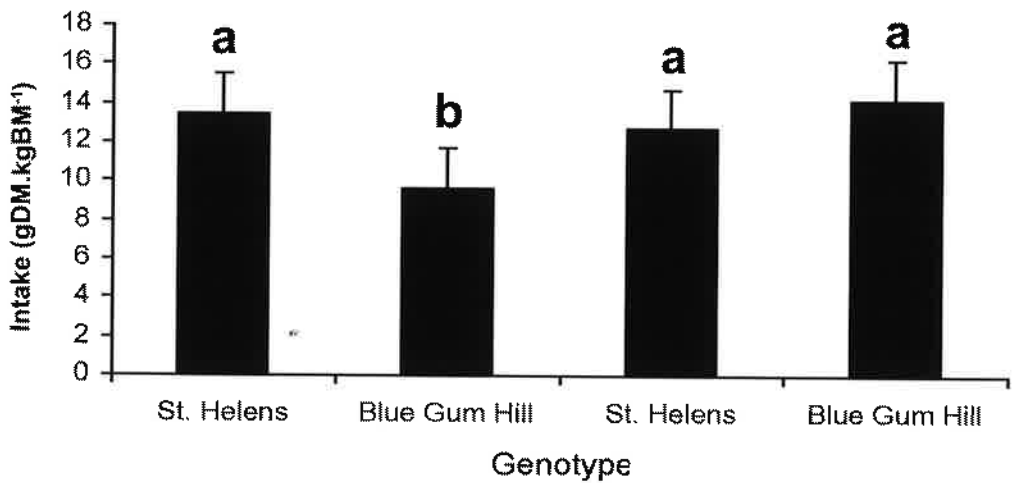


Figure 14. Intake (in grams of leaf dry matter per kilogram of animal biomass) by brushtail possums of *E. globulus* foliage, for two genotypes (St Helens and Blue Gum Hill) under two fertiliser treatments (non-fertilised and fertilised), with fertiliser addition every four days. Letters that differ indicate significant differences ($p<0.05$).

Project C4

Leader
Dr Claire McArthur
Dr David de Little

Staff
Mr Hugh Fitzgerald
Ms Alison Miller
Ms Julianne O'Reilly-Wapstra
Mr Stephen Paterson
Mr Andrew Walsh
Mr Geoff While
Ms Natasha Wiggins

Strategies to reduce vertebrate browsing damage

Background

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

- understand the interaction between browsers and the environment, and the consequences on damage to seedlings;
- investigate the impact of vegetation immediately around a seedling on its risk of being browsed;
- develop methods for monitoring damage and predicting risk; and
- design appropriate options to reduce browsing damage through various planting strategies.

Outcomes

- In the field, browsing damage to *E. globulus* seedlings appears to be related to both the type and amount of surrounding vegetation (Figure 15). Seedlings in plots with no vegetation were browsed more than seedlings surrounded by thistles. Seedlings in plots with both thistles and lupins were more heavily browsed than seedlings in plots containing thistles only, suggesting that animals are attracted to the extra food provided by lupins.
- In mixed and monoculture-type plantings of two species of eucalypt (*E. globulus* and *E. regnans*) seedlings, brushtail possums consumed significantly more *E. globulus*. However, there was no difference in overall intake of eucalypt foliage between the two types of plantings.

Goals

- Quantify relative effect of surrounding vegetation (eg. thistles and/or lupins) and tree seedling characteristics on browsing damage received by eucalypt and pine seedlings.
- Assess the effect of mixed versus monoculture plantings on browsing of *E. globulus* seedlings by brushtail possums.

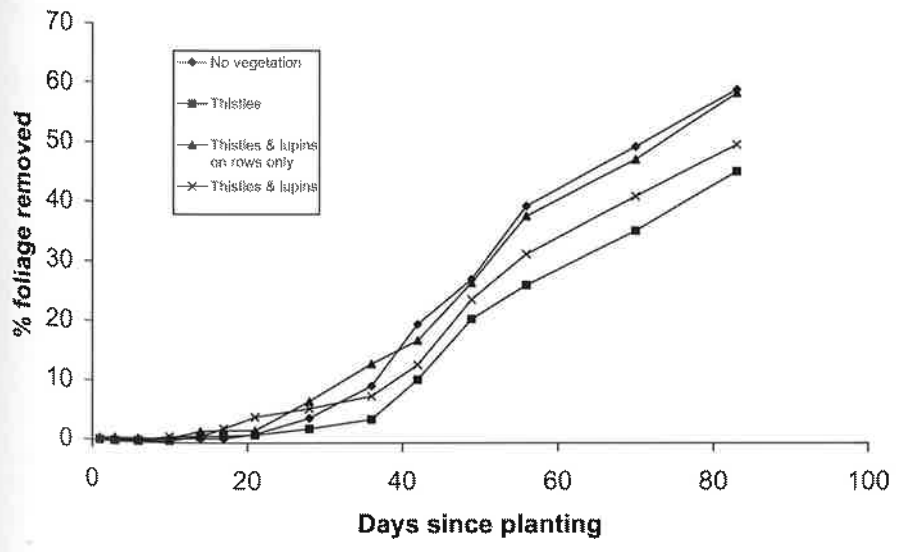


Figure 15. The percentages of damage by browsers inflicted on *E. globulus* seedlings surrounded by different vegetation.

Julianne O'Reilly-Wapstra

Project C5

Strategies to minimise loss due to fungal attack

Leader
Dr Caroline Mohammed

Staff
Dr Karen Barry
Dr Alieta Eyles
Ms Kate Harrison
Ms Anna Hopkins
Ms Liz Pietrzykowski
Dr. Libby Pinkard
Ms Anna Smith
Ms Danielle Wiseman
Ms Marie Yee

Background

The objective of this project is to develop management tools to limit the impact of microorganisms, such as stem decay fungi and leaf spot pathogens (e.g. *Mycosphaerella*).

Prescriptions are being developed in relation to the retention of habitat trees and coarse woody debris on the forest floor, with the aim of conserving the biodiversity of saproxylic fungal and invertebrate assemblages associated with Tasmanian *E. obliqua* wet sclerophyll forests.

Outcomes

- The probability that the rotation length impact of decay infections established during first lift pruning of *E. nitens* will be severe is low, but this prognosis does not necessarily extend to second lift pruning infections.
- Studies with decay fungi isolated from eucalypt plantation and forest trees have identified the major groups of fungi using a combination of molecular and classical identification techniques.
- Leaf wetness sensors have been set up to validate predictions of canopy wetness (hence conditions favouring epidemic development) using the process-based model CABALA. Spore release data, in conjunction with detailed weather and disease development information, have been collected over the past 2 years and will be used in model validation.

PhD student Elizabeth Pietrzykowski setting up leaf wetness sensors.

- Spectra have been identified that will be the most effective for application to the remote sensing of *Mycosphaerella* severity with airborne Digital Multi Spectral Videographic Imagery.
- There have been several major outcomes which will facilitate the process based modelling of disease impact. Assessment of infection levels at the leaf and crown level have been developed and tested for their objectivity, repeatability and accuracy. Field investigations of the infection physiology have shown that *Mycosphaerella* infection in *E. globulus* does not appear to result in an upregulation of photosynthesis. This is different from host response to insects and may be explained by reduced leaf-level water-use efficiency. Infection under controlled conditions has been achieved with a fungal pathogen (*Phaeophleospora eucalypti*) that is closely related to *Mycosphaerella* species and easily produces infective spores in culture. This fungus is now being used to investigate infection physiology under controlled conditions.
- An *in planta* molecular detection technique for *Mycosphaerella* species that is sensitive enough to signal asymptomatic infection has been developed in collaboration with CSIRO-FFP, Perth, WA. This has been successfully employed to enhance the outcomes of several studies including a temporal study of resistance mechanisms from a pre-visual infection stage to lesion necrosis. A major defence mechanism in the *Mycosphaerella* tolerant *E. nitens* is the efficient and substantial thickening of parenchyma cell walls with defence lignin and suberin.
- A *Mycosphaerella* workshop was held in Western Australia which included training and field testing of the methodology adopted for the assessment of *Mycosphaerella*.
- Three age classes (69, 105 and >150 years old) of *Eucalyptus obliqua* trees at Warra, southern Tasmania have been destructively sampled for fungi and insects. This study in conjunction with previous log studies will aid in understanding the successional processes of fungi and insects, the possible implications of current forest practices on this succession and the development of prescriptions (such as the retention of habitat trees) to maintain present levels of biodiversity.

Goals

- To determine if fertilization (type, quantity and timing of application) can be used to offset or prevent biotic damage especially in relation to fungal attack.

EDUCATION AND TECHNOLOGY TRANSFER PROGRAM

Manager
Dr Neil Davidson

Staff
Dr Rebecca Boyle
Dr Philip Brown
Dr Eleanor Bruce
Ms Jill Butterworth
Dr Dugald Close
Prof Rob Clark
Dr David Doley
Mr Richard Doyle
Mr Greg Dutkowski
Prof Robert Henry
Dr Mark Hovenden
Prof Jamie Kirkpatrick
Dr Sinniah Mahendrarajah
A/Prof Stuart McLean
Dr Peter McQuillan
Dr Neville Mendham
Mr Digby Race
Prof Jim Reid
Dr Alistair Richardson
Dr Sergey Shabala
Dr Philip Smethurst
Dr Robert Wiltshire

Background

The Education and Technology Transfer Program 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 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 CRC activities and the value to Australia of a sustainably managed forest industry.

Education outcomes

- The numbers of PhD, MSc and Honours students enrolled with the CRC declined from a high of 76 in 2001/02, to 59 in July 2003 (Table 2, CRC Research Students). High rates of PhD completion during 2003/04 meant that student numbers fell during the financial year to 49 in June 2004 (Table 2 and 3).
- There has been strong industry support for postgraduate programs. Ten of the enrolled postgraduate students were attracted from industry, 12 are on scholarships with industry support (APA-I, SPIRT/ARC, FFIC, LWRDC, FWPRDC, CSIRO, State Forests of NSW), and a further 20 were on competitive national scholarships (APA, ARC). Sixteen students have CRC top-ups to APA or ARC scholarships. Only 9 were supported solely by CRC-SPF PhD scholarships (see Tables 4 and 5 for details).
- The students who completed their degrees in this financial year (2003/04) were:

  Genetic Improvement Program; Robert Barbour (PhD), Gay McKinnon (PhD), Damien Rathbone (Hons), James Worth (Hons); Sustainable Management Program; Andrew Gibbons (PhD), Ross Peacock (PhD), Paul Adams (PhD), Chris O'Hara (PhD), Greg Unwin (PhD), Grant Westphalen (PhD), Cameron Shield (Hons), Andrew Laird (Hons) Resource Protection Program; Alieta Eyles (PhD), Djirilina Burton (Hons), Kate Horweg (Hons).

- Students who recently submitted a thesis for examination were:

  Genetic Improvement Program; Dominic Kain (PhD), Rachel King (PhD). Resource Protection Program; Julianne O'Reilly-Wapstra (PhD), Luke Rapley (PhD)

- Several of the CRC's PhD students received awards this year. Dr Alieta Eyles received the University of Tasmania Deans Commendation for one of the outstanding PhD theses of 2003. Dr Robert Barbour received the Student Prize from Australian Journal of Botany for the best student paper in the Journal for 2003. Four CRC PhD students completing in 2003/04 had their theses graded in the top 10% of theses assessed by examiners. Greg Dutkowski (PhD student) received the Australian Academy of Science Young Researchers Travel Award for 2003/04. Sharon Koh (PhD student) received the Wilf Crane Award, which provides travel for Sharon to develop a model on nutrient dynamics. Damien Rathbone received the Lola Jackson prize for best Honours thesis in Botany (University of Tasmania) in 2003. Julianne O'Reilly-Wapstra received a Joseph William Gottstein Memorial Fellowship for professional advancement in the forestry field. Julianne O'Reilly-Wapstra also received several awards this year to support travel to the UK. The awards were from the Maxwell Ralph Jacobs Fund, the Journal of Experimental Biology Travel Fund and the UK Society of

Dr Alieta Eyles

Table 2. CRC-SPF Research Students

First Name	Second Name	Degree	Funding	Start	Uni	Project	Supervisors	Program
Paul	ADAMS	PhD	LWRDC	1996	UT	Sources of competition from weeds in plantations	Dr N Mendham, Dr C Beadle, Dr P Smethurst	SM
Sue	BAKER	PhD	APA/CRC	2000	UT	Conservation of beetles in managed forests	A/Prof A Richardson	RP
Robert	BARBOUR	PhD	CRC	2000	UT	Gene flow between plantations and native forest	A/Prof B Potts, Dr R Vaillancourt	GI
Joanne	BURTON	PhD	GU/CRC	2002	GU	Links between carbon and nitrogen cycling processes in forest ecosystems	Dr Z Xu, Dr H Gharidi, Dr S Boyd, Prof J Hughes	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	Ind staff	1996	UT	Improvement of mixed models for prediction of breeding values in forestry	A/ProfB 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	RP
Jules	FREEMAN	PhD	UT/CRC	2001	UT	Linkage mapping and QTL analysis of Mycosphaerella resistance in *Eucalyptus globulus*	Dr R Vaillancourt, A/Prof B Potts, Dr D Steane	GI
Andrew	GIBBONS	PhD	CSIRO	1998	UT	Effect of intensive forest management on understorey and fauna in *E. delegatensis*	Dr M Battaglia, Dr R Wiltshire	SM
Carl	GROSSER	PhD	SPIRT/ARC	1999	UT	Seed orchard molecular biology	Dr R Vaillancourt, A/Prof B Potts	GI
Matthew	HAMILTON	PhD	UT/CRC	2003	UT	Breeding methodologies for improving *E nitens*	A/Prof B Potts, Dr L Apiolaza, Dr C Harwood	GI
Tammie	HARVEST	Hons		2004	UT	High altitude eucalypt dieback in wet forests	Dr N Davidson	SM
Katherine	HARRISON	PhD	CRC	2002	UT	Invertebrate assemblages associated with habitat features in *E. obliqua* forests of S Tas	Dr C Mohammed, Dr S Groves	RP
Craig	HAWKINS	MSc	Ind staff	1998	UT	Response of *Brunonia australis* to forestry practices	Dr R Wiltshire, Dr P Barker	SM
Jim	HE	PhD	APA/CRC	2001	GU	Molecular bases of soil biological properties and processes in forest ecosystems	Dr Z Xu, A/Prof J Hughes, Dr I Phillips	SM
Anna	HOPKINS	PHD	APA/CRC	2002	UT	Ecologically sustainable forest management: course woody debris	Dr C Mohammed, Dr S Groves	RP
Shaowei	HUANG	PhD		2004	SCU	Marker aided selection in tropical pines	Dr M Shepherd, Dr M Deiters	GI
Megan	JONES	PhD	SFNSW	1999	SCU	Gene flow and genetic diversity of hardwood plantations in NSW	Dr M Shepherd, Prof R Henry, Prof A Delves	GI
Tim	JONES	PhD	SPIRT/ARC	2000	UT	Genetic relationships in the breeding population of *Eucalyptus globulus*	Dr R Vaillancourt, A/Prof B Potts	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
Rachel	KING	PhD	APA	2000	GU	Genetic variation in spotted gums and susceptibility to *Ramularia* desease	A/Prof J Hughes, A/Prof B Potts, Dr D Lee	GI
Andrew	KNOWLES	PhD	CRC	2000	UT	K and Mg uptake by eucalypts and pines.	Dr S Shabala, Dr P Smethurst, Dr P Brown	SM
Sharon	KOH	PhD	CRC	2002	UT	Mathematical modelling of tree growth	Dr P Sands, Prof L Forbes, Dr M Battaglia	SM
Peter	KUBE	PhD	Ind staff	1996	UT	Breeding objectives for production of sawlogs and pulpwood from plantation-grown *E. nitens*	Dr C Raymond, Prof J Reid	GI
Andrew	LAIRD	Hons		2002	UT	Differences in photoinhibition, and protective pigments and waxes amongst eucalypts	Dr N Davidson, Dr D Close	SM
Prue	LONEY	PHD	CRC	2002	UT	Plant defences against mammalian browsing	Dr C McArthur, Dr G Jordan	RP
Marian	McGOWAN	PhD	APA/CRC	2000	UT	Reproductive biology of *Eucalyptus*	A/Prof B Potts, Dr R Vaillancourt	GI
Gay	McKINNON	PhD	ARC	2000	UT	Molecular evolution of eucalypts	Dr R Vaillancourt, A/Prof B Potts, Dr D Steane	GI
Issa	MEDRAJ	PHD	ARC	2002	GU	Molecular nutrition of Hoop Pine: characterisation of ammonium transporter genes	Prof J Hughes, Dr Z Xu, Dr F Smith	SM
Andrew	MILGATE	PhD	SPIRT/ARC	1997	UT	The genetic basis of resistance to *Mycosphaerella* in *Eucalyptus globulus*	Dr R Vaillancourt, Dr C Mohammed, Dr D de Little	GI/RP
Alison	MILLER	PHD	APA/FFIC	2003	UT	Foraging by herbivores in relation to vegetation patchiness	Dr C McArthur, Dr P Smethurst	RP/SM
Daryl	MUMMERY	PhD	CSIRO	1999	UT	Using landscape models to enhance plantation yield predictions	Dr E Bruce, Dr M Battaglia, Dr P Ryan	SM
Mark	NEYLAND	PhD	Ind staff	1998	UT	Alternative silvicultural systems for regenerating native forest	Dr N Davidson, Dr C Beadle, Mr J Hickey	SM
Megan	NOSOVICH	PhD	ARC	2003	GU	Links between carbon and nitrogen cycling processes in forest ecosystems	Dr Z Xu, Dr S Boyd, As/Prof P Healy	SM
Chris	O'HARA	PhD	APA/CRC	1998	ANU	Phosphorus fractions in forest soils	Dr J Bauhus, Dr D Khanna, Dr J Raison, Dr P Smethurst	SM
Julianne	O'REILLY-WAPSTRA	PhD	UT/CRC	2000	UT	Genetic and chemical resistance of *E. globulus* and *E. nitens* to mammalian herbivores	Dr C McArthur, A/Prof B Potts	RP
Ross	PEACOCK	PhD	Ind staff	1994	UT	Regeneration after cable logging	Dr N Davidson, Dr M Brown	SM
Ann	PERRY	PhD	APA/CRC	2000	UQ	Wood quality assessment of plantation-grown Flindersia brayleyana	Dr D Doley, Dr A Muneri	SM
Elizabeth	PIETRZYKOWSKI	PhD	APAI	2002	UT	Epidemiology and Remote Sensing of *Mycosphaerella* Leaf Blight in Plantation Forestry	Dr C Mohammed, Dr T Booth, Dr C Beadle, Dr M Battaglia, Dr E Pinkard	RP/SM
Fiona	POKE	PhD	APA/CRC	2002	UT	Lignin biosynthesis in *Eucalyptus globulus*	Prof J Reid, Dr R Vaillancourt	GI
Rebecca	PRYOR	MSc	CRC	2002	UT	Waterlogging of *Eucalyptus globulus*	Dr N Davidson, Dr M Battaglia, Dr D Close	SM
Luke	RAPLEY	PhD	UT/CRC	2000	UT	Genetic variation in susceptibility of eucalypts to insect attack	Dr G Allen, A/Prof B Potts	RP/GI
Hilton	REDGROVE	PhD	APA-I	2000	UT	The ecology of *Heteronyx* spp. beetles: establishment pests of eucalypt plantations	Dr G Allen, Dr M Hurley, Dr P McQuillan, Dr D deLittle	RP
Anthony	RICE	PhD	APA	1999	UT	The ecology and host interactions of the larval parasitoids of *Chrysophtharta agricola*	Dr G Allen	RP
Carolyn	RINGROSE	MSc		1999	UT	N mineralisation in annually N-fertilised plantations	Mr R Doyle, Mr W Neilsen, Dr P Smethurst	SM
Jackie	SCHIRMER	PhD	APA/CRC	2000	ANU	Effectiveness of conflict resolution techniques in resource management disputes	Prof P Kanowski, Dr H Ross, Dr S Dovers	SM
Leon	SCOTT	PhD	CRC	1998	SCU	Molecular genetics of hoop pine	Dr M Shepherd, Prof R Henry, Dr M Deiters, Dr G Nikles	GI
Anna	SMITH	PhD	APA/CSIRO	2002	UT	Risk and impact of *Mycosphaerella* in plantations of *E. globulus* and *E. nitens*	Dr C Mohammed, Dr C Beadle, Dr M Battaglia	RP/SM
Diane	SPURR	MSc	CRC	1999	UT	Above-ground nitrogen dynamics in *E. nitens*	Dr P Smethurst, Dr M Hovenden	SM
Paul	TOON	MSc	ARC	1998	USC	Wood properties of hybrids between *Pinus elliottii* and *P. caribea* var. *hondurensis*.	Dr H Wallace, Dr K Harding	GI
Greg	UNWIN	PhD	Ind staff	2000	UT	Response of tropical rainforest trees to stress	Dr N Davidson, Prof J Reid, Prof J Kirkpatrick, Dr C Beadle	SM
Grant	WESTPHALEN	PhD	CRC	1996	UT	Indicator species for sustainibility in native forest systems	Dr M Brown, Mr J Hickey, Dr N Davidson	SM
Trudi	WHARTON	PhD	Industry	1999	ANU	Biology and ecology of *Essigella californica* (Hemiptera: Aphididae)	Dr R Floyd, Dr P de Barro, Dr P Cooper	RP
Simon	WHITTOCK	PhD	SPIRT/ARC	2001	UT	Breeding for sustainability in *Eucalyptus globulus*	Dr L Apiolaza, A/Prof B Potts	GI
Natasha	WIGGINS	PhD	UT/CRC	2002	UT	Feeding behaviour in brushtail possums	Dr C McArthur, A/Prof S McLean, Dr R Boyle	RP
Danielle	WISEMAN	PhD	APA-I	2001	UT	Pathology and physiology of pruned *E. globulus*	Dr C Mohammed, Dr C Beadle, Dr E Pinkard	RP/SM
James	WORTH	PhD	APA	2004	UT	Nothofagus cunninghamii biogeography	Dr R Vaillancourt, Dr G Jordan, A/Prof B Potts	GI
Marie	YEE	PhD	APA/CRC	1999	UT	Saproxylic insects and their associations with wood decay in wet sclerophyll forests	Dr C Mohammed, Dr A Richardson, Dr R Taylor, Dr G Allen	RP
Janet	ZHANG	PHD	APA	2003	GU	Diversity of soil microbial populations in adjacent native forest and pine plantation	Prof B Patel, Prof Z Xu	SM

Table 3. Numbers of Postgraduate and Honours students

Year	97/98	98/99	99/00	00/01	01/02	02/03	03/04	June 04
PhD	38	40	53	56	60	49	51	41
MSc	3	11	13	13	8	8	6	7
Hons	7	9	11	5	8	6	2	1
Total	48	60	77	74	76	63	59	49

Table 4. Number of student in degrees and programs

Number of Students	
Full/Part-Time	
Full-Time	49
Part-Time	10
Total	59
Degree	
Honours	2
MSc	6
PhD	51
Total	59
CRC Program	
Genetic Improvement	19
Sustainable Management	26
Resource Protection	14
Total	59

Table 5. Funding of postgraduate students

Funding of MSc and PhD	
CRC Scholarship	9
APA Scholarship	5
CRC top-up of APA Scholarship	10
CSIRO top-up of APA Scholarship	1
ARC	4
APA-I	3
SPIRT/ARC	4
CSIRO	2
UT/CRC top-up	5
GU/CRC top-up	1
CRC Industry partners	1
SFNSW	1
LWRDC	1
FWPRDC	1
Industry employed postgraduate	6
Unfunded postgraduate	3
Total	57

Experimental Biologists Travel Fund. She also received an award from the Australasian Wildlife Management Society to travel to NZ. Anna Smith received an award from the Maxwell Ralph Jacobs Fund to support research travel. Anna Hopkins and Kate Harrison received grants from the Holsworth Wildlife Fund for research travel.

- Supervision of postgraduate and Honours students is widely distributed amongst CRC partner institutions such that 36 of the 72 supervisors of Honours, MSc and PhD projects were not staff of Australian university departments (see Table 6 for details).
- Undergraduate teaching by CRC staff encourages students to consider forestry as a choice for higher degree. Ten CRC scientists, who are not staff of university departments, contributed to 12 university courses in fields allied to their research, involving 495 students across 3 universities: Dr N Davidson in 'Plant Ecology' (UT, 20 students), Dr C McArthur and Ms J O'Reilly-Wapstra in 'Zoology II (Animal Form and Function)' (UT, 90 students), Ms J O'Reilly-Wapstra in Botany II (Ecology of Tasmania)' (UT 63 students), Dr P Smethurst in 'Soil Fertility' (UT, 18 students), A/Prof B Potts in 'Molecular evolution' (UT, 14 students), 'Field Botany' (UT, 29 students) and 'Vegetation of Tasmania' (UT, 22 students), Dr Z Xu in 'Land and Water' (GU, 80 students), Dr M Steinbauer in 'Insect Management for Forestry' (ANU, 12 students), Dr D Steane in 'Botany II' (UT, 63 students) and 'Molecular Evolution' (UT, 14 students), Dr K Barry and Ms A Hopkins in 'Microbiology and Mycology' (UT, 70 students). Dr Neil Davidson coordinates a four-year undergraduate course, 'Forest Ecology', designed for students with an interest in forestry at the University of Tasmania.
- Ten postdoctoral fellows worked with the Centre in 2003/04: Dr R Thumma in molecular genetics (UT), Dr M Steinbauer in entomology (CSIRO Ento, Canberra), Dr M Shepherd in molecular biology (SCU, Lismore), Dr D Close in tree physiology (UT), Dr D Steane and Dr B Patterson in molecular genetics (UT), Dr A O'Grady in root biomass turnover (UT), Dr Jane Medhurst (UT) on Blackwood silviculture, Dr Karen Barry on tree pathology (UT), and Dr Mamoru Matsuki on insect ecology (UT).
- The CRC hosted nine visiting scientists during 2003/04.

Genetic Improvement Program

Prof Wickneswari Ratnam, from the School of Environmental and Natural Resource Sciences, Faculty of Science and Technology, Universiti

Table 6. Supervisors of CRC research students

Supervisor	Institution	No.	Supervisor	Institution	No.
Dr G Allen	UT	4	Prof J Hughes	GU	4
Dr L Apiolaza*	FT	2	Dr M Hurley	U Melb	1
Dr P Barker*	NPWS	1	Dr G Jordan	UT	2
Dr M Battaglia*	CSIRO FFP	6	Prof P Kanowski	ANU	2
Dr H Bauhus	ANU	1	Dr P Kanna*	CSIRO	1
Dr C Beadle*	CSIRO FFP	6	Prof J Kirkpatrick	UT	1
Dr T Booth*	CSIRO FFP	1	Dr B Li**	NCSU (USA)	1
Dr S Boyd	GU	1	Dr C McArthur*	CRC/UT	4
Dr R Boyle	UT	1	A/Prof S McLean	UT	1
Dr M Brown*	FT	2	Dr P McQuilan	UT	1
Dr P Brown	UT	1	Dr N Mendham	UT	1
Dr E Bruce	UT	1	Dr C Mohammed	UT/CSIRO FFP	8
Prof R Clark	UT	1	Dr A Munari*	QFRI	1
Dr D Close*	UT	2	Mr W Neilsen*	FT	1
Dr P Couper	ANU	1	Dr G Nikles*	QFRI	1
Dr N Davidson*	CRC/UT	7	Prof B Patel	GU	1
Dr P de Barro*	CSIRO Ento	1	Dr E Pinkard*	UT	2
Dr D de Little*	Consultant	2	Dr I Philips	GU	1
Prof A Delves	SCU	1	A/Prof B Potts*	CRC/UT	13
Dr M Dieters*	QFRI/USC	2	Dr J Raison*	CSIRO FFP	1
Dr D Doley*	UQ retired	1	Dr C Raymond*	SFNSW	1
Dr S Dovers	U Melb	1	Prof J Reid	UT	3
Mr R Doyle	UT	1	Dr A Richardson	UT	2
Dr R Floyd*	CSIRO Ento	1	Dr H Ross	ANU	1
Dr W Foley	ANU	1	Dr P Ryan*	QFRI	1
Prof L Forbes	UT	1	Dr P Sands*	CSIRO FFP	1
Ms A Fulton*	Consultant	1	Dr S Shabala	UT	1
Dr A Gilmour*	NSW Ag	1	Dr M Shepherd*	CRC/SCU	3
Dr H Gharidi	GU	1	Dr P Smethurst*	CSIRO FFP	6
Dr S Groves*	FT	2	Dr F Smith*	CSIRO PI	1
Dr C Harwood*	CSIRO FFP	1	Dr D Steane*	CRC/UT	2
Dr K Harding*	QFRI	2	Dr R Taylor*	NTPWC	1
A/Prof P Healy	GU	1	Dr R Vaillancourt	UT	9
Prof R Henry	SCU	2	Dr H Wallace	USC	1
Mr J Hickey*	FT	2	Dr R Wiltshire	UT	3
Dr M Hovenden	UT	1	Prof Z Xu	GU	5

University departmental supervisors = 36

** Overseas supervisors = 1

* Supervisors not staff of university departments = 35

Total number of supervisors = 72

Dr. João da Costa e Silva visited the CRC to work on quantitative genetics of *Eucalyptus globulus* and spatial analysis

Kebangsaan Malaysia visited the CRC from April-September 2003 to work with Dr Rene Vaillancourt on 'Analysis of cambial region and developing xylem cDNA libraries for *Acacia mangium x Acacia auriculiformis* hybrids and development of molecular markers for lignin genes for selection and manipulation'.

The Genetic Improvement Program hosted Dr. João da Costa e Silva who worked on a collaborative project between the CRC-SPF and two Portugese organisations, the Universidade Técnica de Lisboa and RAIZ. He worked with A/Prof. Brad Potts and Greg Dutkowski on the quantitative genetics of *Eucalyptus globulus* and spatial analysis.

A/Prof Shaowei Huang, Forestry College, South China Agricultural University, visited the CRC between July and October 2003 and again between December and March 2004) to work with Dr M Dieters at QFRI and Dr M Shepherd at SCU on quantitative and molecular genetics of pines.

Brazilian foresters Celina do Valle and Ana Gabriela Monnerat Carvalho, from paper manufacturer Votorantim Celulose e Papel (VCP) visited Brad Potts and the CRC-SPF on the 21st January 2004.

Sustainable Management Program

Prof Ann Hagerman, from Miami University, Oxford, Ohio, USA visited the CRC from May to July 2003 to work with Dr Dugald Close and Dr Clare McArthur at CSIRO FFP on 'Biological antioxidants and the effects of plant phenolics on mammalian feeding and performance'.

Resource Protection Program

Dr Fredrik Östrand from Lund University, Lund, Sweden, visited the CRC from July 2002 to August 2003 to work with Martin Steinbauer at CSIRO Entomology Canberra on 'The improvement and efficacy of the sex pheromone of autumn gum moth'.

Rie Mihara visited for 6 months from the University of Mie, Japan to work on the chemistry of host resistance to decay fungi.

Dr Christine Stone, SF NSW has visited to assist with development of hyperspectral indicators of *Mycosphaerella* disease severity.

Table 7. Publications and Technology transfer activities

Technology transfer	2003/04
Refereed publications	91
In press	22
Books and book chapters	7
Theses	15
Confidential reports (including CRC technical reports)	53 (24)
Unrefereed publications	69
Flash sheets	19
Public presentations	120
TOTAL PUBLICATIONS	257
Symposia and conferences	96
Articles in industry news sheets	4
Seminars	26
Field days	1
Workshops and 'fests'	3
Short courses	2
National CRC meetings	1

Technology Transfer Outcomes

- During the last year the CRC has published 96 papers in refereed journals, 7 book chapters, 99 unrefereed articles and 15 theses (see Table 7 for details).
- During the last year the CRC has run a wide range of technology transfer activities for partners (see table 6). There were 120 public presentations, which included 96 conference and symposium presentations and 26 seminars. In addition the CRC ran 3 workshops, 2 short course and 1 field day. The CRC produced 46 confidential reports, 26 of which were in the CRC Technical Publication series, and 20 flash sheets ('Hot Off the Seed Bed', 'Beyond the Black Stump' and 'Pest Off'), and 4 articles in partner newspapers and news sheets. The major technology transfer events are presented in Table 8.
- With industrial partners Forestry Tasmania, State Forests NSW, STBA, Timbercorp and WAPRES, the CRC-SPF obtained funding from AusIndustry to hold a workshop to review the state-of-play in clonal propagation of *Eucalyptus* world-wide

Participants at Clonal Workshop

and examine options for clonal deployment of *Eucalyptus globulus* in Australia. A workshop "Benchmarking Clonal Propagation for the Blue Gum Plantation Industry" was held from 8-12th March 2004 at two venues (Grafton, NSW hosted by State Forests NSW and Mount Gambier, SA hosted by the STBA), with field visits enroute. Over 50 people attended various stages of the workshop which featured international speakers from Brazil (Teotonio de Assis from Aracruz Celulose S.A.), Chile (Rebeca Sanhueza, Famasa), South Africa (Flic Blakeway, Mondi) and Portugal (Nuno Borralho, RAIZ).

- As well as specific major projects (see Utilisation and Application of Research), a technology transfer plan has been developed for each research project. The plans are stored in a calendar of events that is easy to monitor and update.
- To improve communication between industry and scientists a series of small industry projects were initiated. For these projects, scientists spent a week with an industry partner working on projects of direct benefit to the industry partner. Projects covered the areas of seed orchard management, racial classification of an *E. nitens* breeding program founder parents, analysis of browsing mammal spotlighting data, evaluation of coppice management options, and development of seedling specifications.
- In addition there are two informal chat groups organised that are well attended by industry staff; 'Lab chats' (Resource Protection Program, monthly) and 'Genetics discussion group' (Genetic Improvement Program, bi-monthly).
- Documented visits to individual CRC partners and between nodes of the CRC (Hobart, Canberra, Brisbane, Gympie) total 224 person-days for 2003/04.
- A Member's Web Site launched in 2003 provides a "one-stop-shop" for all CRC information. The system is being increasingly used by both researchers and industry partners. The system offers a search and download facility of all CRC documents and events, as well as periodic emails notifying users of new documents and events in their areas of interest. Documents and events are however only available to groups nominated by the author so that intellectual property rights can be managed.

Table 8. Major events

WoodFest, a workshop discussing sampling strategies for, and genetic variation in, wood properties affecting the value of pulpwood and solid wood products from plantation-grown *E. globulus* and *E. nitens*, Clayton, Victoria 21/8/03
Annual Meeting of CRC-SPF, 'Plants to Products', Cradle Mountain, 21-23 October 2003
NutFest 2004: Fertilizer and Weed Impacts on Eucalypt Plantations in Northwest Tasmania, 10-11/3/04
Benchmarking Clonal Propagation for the Blue Gum Plantation Industry, Grafton, NSW and Mt Gambier, SA, 7-12/3/04
Proactive Forest Health, a short course for farm forestry professionals - David de Little, Geeveston 25/9/03, Lilydale 2/10/03
Valuation, a short course for farm forestry professionals - Bernard Walker, Hobart 20/8/03, Launceston 22/8/03
Growing Blackwood with Nurse Crops: a demonstration and discussion of effective blackwood management, Northern Tasmania 9/11/2003

Goals

- Maintain rates of completion of PhD projects
- Continued contribution of CRC staff outside university departments in university and technical training
- Provide efficient pathways for industry and other end users to access CRC knowledge (e.g. TT packages and web site)
- Ensure innovations arising from CRC research are adopted by the forest industry
- Maintain direct contact between scientists and industry to facilitate transfer
- Maintain an environment for research publication
- Raise awareness of CRC activities and the value of a sustainably managed forestry industry.

UTILISATION AND APPLICATION OF RESEARCH

Strategy for the Technology Transfer Program

The principal objective of the Technology Transfer Program is to transfer 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*

The Program Coordinating 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). 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 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.

2. *Early transfer of results*

The early transfer of results starts with informal interactions while research is being conducted (phone, fax, email and visits to company sites). Formal transfer starts with electronic fact-sheets (an A4 page of summary of recent research), variously 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.

Technology Transfer Officers, Greg Dutkowski and Philip Smethurst, liaise with industrial partners and researchers to develop a better understanding between these groups within the CRC and to facilitate the adoption of the technology most appropriate to each industry partner's needs.

A full list of technology transfer activities conducted by the CRC can be found on the CRC-SPF website http://www.forestry.crc.org.au and major activities are outlined in Outcomes in the Education and Technology Transfer section

Major and ongoing technology transfer projects are:-

- Eucalypt seed orchard manual stages I and II
- Insect pest monitoring information web page
- Leaf area index manual
- 1080 information package
- CABALA growth model
- Farm Forestry Toolbox
- Courses for farm forestry professionals, funded using National Heritage Trust funding under contract to Private Forests Tasmania.
- Inventory of basic density in *Eucalyptus globulus* plantations.
- Mammal browsing monitoring system

Numerous smaller projects are negotiated with individual partners, such as training in the use of LAI or quantitative genetics training.

Technology transfer plans are implemented for each research project. The plans are stored in an on-line database, which allows easy monitoring and updating, as well as feeding an on-line calendar of events.

The technology transfer team has also worked at making existing research information more easily available. The members' web site captures all CRC events and outputs so there is a "one stop shop" for all CRC information. The system offers search and download facilities for all CRC documents and events as well as periodic emails notifying users of new documents and events in their areas of interest. Documents and events are however only available to groups nominated by the author so that so that intellectual property rights can be managed.

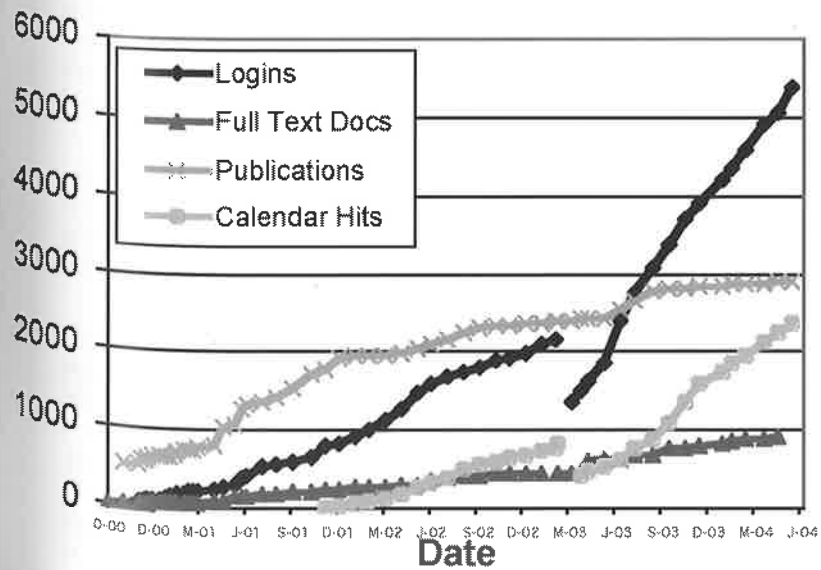


Figure 10. Partner use of the CRC Website from October 2000 to June 2004. A break in use occurred at the time the new website was launched (May 2003).

Brad Potts (right) of the Genetic Improvement Program assisting staff of Forestry Tasmania (Andrew Crowden [centre] and Alison Wooley) and the Forest Practices Board to assess the conservation values of a newly discovered outlying population of an endemic eucalypt (affin. *E. subcrenulata*) near a logging coupe in the Blue Tier in NE Tasmania (Photo: Fred Duncan).

Technology transfer also occurs through training provided by the CRC to its postgraduates. Recent PhD graduates transfer new technology to their employers. During 2003-04 there were 8 company staff enrolled in PhD and MSc courses while still employed: Peter Kube (Tree Breeder, Forestry Tasmania); Ross Peacock (Research Scientist, Dept. Planning, NSW); Craig Hawkins (Forester, Gunns Limited); Mark Neyland (Research Officer, Forestry Tasmania); Daryl Mummery (Experimental Officer, CSIRO FFP); Andrew Gibbons (Research Officer, DPIWE); Greg Unwin (Lecturer in Farm Forestry, UT); Greg Dutkowski (Quantitative Geneticist, CRC-SPF). A further 12 students are conducting research on scholarships supported by industry (APA-I, ARC Linkage, CSIRO, CRC Industry partners, LWRDC, FWPRDC, SFNSW).

The success of our students in obtaining employment in the forest industry was demonstrated by appointments this year: Dr Peter Volker (who recently completed a PhD with the CRC) is now Acting Chief Scientist and Principal Research Officer (Plantations), Dr Luis Apiolaza (CRC post-doc) is now Principal Forest Biometrician at Forestry Tasmania and Dr Dean Williams (who recently completed a PhD with the CRC) is now Research Scientist (Tree Improvement) at Forestry Tasmania. Other students who have found employment in the industry include, Jane Medhurst (Post Doctoral Fellow, UT), Julianne O'Reilly-Wapstra (Lecturer [Mammalian Browsing], UT), Andrew Gibbons (Research Officer, Threatened Species Unit, DPIWE), Luke Rapley (Post Doctoral Fellow [Insect ecology], UT), Robert Barbour (Post Doctoral Fellow [gene flow], UT).

Industrial Uptake

The new technologies developed by the research programs, which have been transferred to industrial partners and other end users, are outlined below.

Genetic Improvement Program

- CRC-SPF representation on the STBA board and technical committee of the STBA has continued to provide a direct conduit for the flow of research results into breeding and deployment of *E. globulus* and *E. nitens* in Australia.
- The simulator gSIM (see Major Development) has been used by the National Breeding Cooperative to evaluate the gains possible through measuring addition traits in breeding trials. The simulator has also been used to evaluate various deployment options.
- Add-ins for MS-Excel have been developed to help partners in the optimisation of their deployment programs. The add-ins allow extraction of breeding values from an MS-Access database into Excel (gSTBA), calculation of economic values for a wood chip export scenario (ChipEx), and their integration into a seed orchard management tool (gSOOP). The tool simulates the effects on seed quality and cost of possible management options such as culling, outcross screening, and seed collection targeted at the highest breeding value and most fecund trees.
- The previously developed *Eucalyptus nitens* race classification and spatial analysis are being used for the first time in a large breeding program progeny trial analysis contract for Gunns Ltd. by the STBA using TREEPLAN®.
- Strategies developed for improving the estimation of genetic parameters in across site analyses has been used to obtain better estimates of additive and non-additive genetic effects in the STBA second generation progeny trials of *E. globulus*.
- Research undertaken on the genetics and strategies for hybrid pine breeding in Queensland has now culminated in a major change in the breeding strategy for PEE x PCH hybrids and a new breeding plan has recently been written.
- The necessity for risk assessment and monitoring hybridization between plantation and native species initially documented by the CRC-SPF is now recognised (Duncan, F. 2003. Hybrid eyes. Forest Practices News Vol 5 No 3, 6-8). Forestry Tasmania has incorporated this work into its Environmental Management System and had developed protocols, especially in relation to

threatened species. The Tasmanian Forest Practices Board is already providing specific advice on a case by case basis based on this research and is also looking at ways of formally integrating these results into their planning decisions.

- Early and more efficient selection strategies for microfibril angle in breeding populations of blue gums should now be useable by breeders given the significant SNP/trait association. In the medium term outcomes such as these will enable Australian industry to establish high value plantations, especially for pulp and paper products based on planting stock for tailored end uses.

Sustainable Management Program

- CABALA was used to stratify the eucalypt plantation estate of one partner for potential responsiveness to N fertilisation. Demonstration of its benefits has led to a continuing increase in the application of N fertiliser by partners.
- More partners are using the Visual Guide developed by the Centre for assessing LAI.
- Recommendations for applying N fertilisers in 2R hoop pine plantations are being adopted by QDPI Forestry.
- Residue management and site preparation practices following harvesting are being adopted by QDPI Forestry to reduce soil erosion and nutrient loss via leaching.
- Nursery-scale trials of applying fertiliser exponentially to eucalypt seedlings are being undertaken by one partner. A second partner is now placing less emphasis on seedling height at planting as part of the seedling specification.
- The best practice approaches adopted in revegetation trials are being promoted by a Local Council and Greening Australia.
- Leading companies are continue to refine their strategies for working with local communities, with communities becoming more supportive of plantation forestry.
- CABALA has been used in association with forestry consultants and companies to evaluate potential plantation yields
- Farm Forestry Toolbox containing PROMOD has over 15 000 copies in circulation.
- Queensland's DPI Forestry has used STEPS V3.0 throughout the past year to perform economic analyses of exotic and native pine plantation resources across a range of locations across Queensland. Results from the software have guided policy decision-making for the organisation
- Excel-based implementation (3PGpjs) of 3-PG is widely used worldwide in forest research and management
- Pre-release version of software (PESTxl) to facilitate the application of the parameter estimation software PEST to Excel-based models is in use by the ICFR, South Africa.

Resource Protection Program

- The sampling protocol for *Gonipterus scutellatus* was implemented by Timbercorp, WAPRES, Great Southern Plantations, and Albany Plantation Forestry Ltd in the spring of 2003. The data were put into the decision support system, which streamlined the decision making process and reduced the number of plantations that were sprayed unnecessarily.
- The first version of the database on herbivores, their natural enemies, and pathogens has been used by WAPRES, Great Southern Plantations, Albany Plantations Forestry Ltd and Great Southern Plantations.
- The sampling designs for *Chrysophtharta* beetles and *Mnesampela privata* were implemented by Timbercorp in the 2003-04 season. The decision support system streamlined the decision making process and reduced the number of plantations that were sprayed unnecessarily.
- Plantation health assessment using the Crown Damage Index was implemented by State Forests NSW and Forestry Tasmania in the 2003-04 season.
- Further investigation into the use of wind in manipulating palatability of seedlings to browsing mammals has been carried out by Forestry Tasmania.
- Forestry Tasmania used sex pheromone lures to monitor populations of autumn gum moth in 4 plantations in northern Tasmania during April-May 2004.

STAFFING AND ADMINISTRATION

CRC Membership

There were no changes in membership during 2003/04. The CRC Agreement terminated on 30th June 2004 and Department of Primary Industry (Forestry) Queensland, Griffith University, The University of Queensland, Grand Ridge Plantations and CSIRO Entomology completed their obligations to the CRC and ended their membership. All other partners were parties to a successful request to Department of Education Science and Training for an 8th Year extension, and have contributed to the funding which will enable the CRC to derive further value from the cumulative investment in the research program.

Senior Staff movements

Dr Clare McArthur left to take up a position at Sydney University in January 2004 and Dr Caroline Mohammed has taken over her role as Program Manager, Resource Protection. Mrs Jo Neilson was seconded from Financial and Business Services, University of Tasmania to replace Mr David Lyons as Business Manager in August 2003. David has moved to another position within the University of Tasmania and retains active links with the CRC-SPF. Mr Greg Dutkowski has returned to his research role in Genetic Improvement and his role as Technology Transfer Manager has been assumed by Dr Philip Smethurst. Dr Yongjun Li and Dr Briony Paterson have resigned from their positions in Genetic Improvement. Dr Reddy Thumma's contract finished in January 2004. Staff whose contracts ended on 30 June 2004 include Dr Kerrie Catchpoole, Mr Jeremy Brawner and Mr Paul Keay (DPIQ), Dr Chengrong Chen (Griffith University), and Dr Martin Steinbauer (CSIRO). Mr Luke Rapley has taken up a limited term position in Resource Protection. Dr Mamoru Matsuki relocated to Albany, WA in July 2003 to work with the IPMG, and Dr Jane Medhurst was contracted as a Post-doctoral Fellow in the Sustainable Management Program.

Postgraduate students

CRC SPF students who received their PhD degrees and new students starting with the CRC in 2003/04 are presented in the Outcomes of the Education and Technology Transfer Program.

Administration

The number of meetings held by the Board and other committees during 2003/04 were as follows:

Board of Management	4
Management Committee	11
Advisory Committee	1

Program Coordinating Committees

Genetic Improvement	2
Sustainable Management	2
Resource Protection	2

SPECIFIED PERSONNEL

Title, Name and Role	Contributing Organisation	% of time in CRC
Prof Rod Griffin, Director	University of Tasmania	80
Prof Robert Henry, Deputy Director	Southern Cross University	30
Program Managers		
Dr Chris Beadle, Sustainable Management	CSIRO Forestry and Forest Products	80
Dr Clare McArthur, Resource Protection (until January 2004)	University of Tasmania	100
Dr Caroline Mohammed, Resource Protection (from February 2004)	CSIRO Forestry and Forest Products/ University of Tasmania	60
A/Prof Brad Potts, Genetic Improvement	University of Tasmania	100
Dr Neil Davidson, Education and Technology Transfer	University of Tasmania	100

PUBLICATIONS

Genetic Improvement Program

Books and book chapters

Potts BM (2004). Genetic improvement of eucalypts. In 'Encyclopedia of Forest Science'. pp. 1480-1490. (Elsevier Science: Oxford)

Raymond CR, Apiolaza LA (2004) Incorporating wood quality and deployment traits in *Eucalyptus globulus* and *Eucalyptus nitens*. In 'Plantation Forest Biotechnology for the 21st Century'. (Eds C Walter and M Carson), pp. 87-99. (Forest Research New Zealand: Rotorua, New Zealand)

Shepherd M, Jones ME (2003). *Eucalyptus*. In 'Molecular Markers in Plant Breeding and Crop Improvement'. (Eds H Lorz and G Wenzel) (Springer: Australia)

Refereed publications

Barbour RC, Potts BM, Vaillancourt RE (2003). Gene flow between introduced and native *Eucalyptus*: Exotic hybrids are establishing in the wild. *Australian Journal of Botany* **51**, 429-439.

Brawner JT, Dieters MJ, Nikles DG (2003). Correlations between pure and hybrid combining abilities of slash pine parents. *Forest Genetics* **10**, 241-248.

Costa e Silva J, Borralho NMG, Potts BM (2004). Additive and non-additive genetic parameters from clonally replicated and seedling progenies of *Eucalyptus globulus*. *Theoretical and Applied Genetics* **108**, 1113-1119.

Hingston AB, Potts BM, McQuillan PB (2004) The swift parrot *Lathamus discolour* (Psittacidae), social bees (Apidae), and native insects as pollinators of *Eucalyptus globulus* ssp. *globulus* (Myrtaceae). *Australian Journal of Botany* **52**(3) 371-379.

Hingston AB, Potts BM, McQuillan PB (2004) Pollination services provided by various size classes of flower visitors to *Eucalyptus globulus* ssp. *globulus* (Myrtaceae). *Australian Journal of Botany* **52** 353-369.

Hingston AB, McQuillan PB, Potts BM (2004). Pollinators of seed orchards of *Eucalyptus nitens*. *Australian Journal of Botany* **52**, 209-222.

Jones RC, Vaillancourt RE, Jordan GJ (2004). Microsatellites for use in *Nothofagus cunninghamii* (Nothofagaceae) and related species. *Molecular Ecology Notes* **4**, 14-16.

Kerr RJ, Dieters MJ, Tier B (2003). Simulation of comparative gains from four different hybrid breeding strategies. *Canadian Journal of Forest Research* **34**, 209-220.

Kerr RJ, Dieters MJ, Dungey HS, Tier B (2004). Simulation of hybrid breeding strategies. *Canadian Journal of Forest Research* **34**, 195-208.

Lawrence R, Potts BM, Whitham TG (2003). Relative importance of plant ontogeny, host genetic variation, and leaf age for a common herbivore. *Ecology* **84**, 1171-1178.

Lopez GA, Potts BM, Vaillancourt RE, Apiolaza LA (2003). Maternal and carry-over effects on early growth of *Eucalyptus globulus*. *Canadian Journal of Forest Research* **33**, 2108-2115.

McKinnon GE, Jordan GJ, Vaillancourt RE, Steane DA, Potts BM (2004). Glacial refugia and reticulate evolution: the case of the Tasmanian eucalypts. *Philosophical Transactions of the Royal Society of London - Series B: Biological Sciences* **359**, 275-284.

Moran GF, Thamarus KA, Raymond CA, Deyou Q, Uren T, Southerton SG (2002). Genomics of *Eucalyptus* wood traits. *Annals of Forest Science* **59**, 645-650.

Myburg AA, Griffin AR, Sederoff RR, Whetten RW (2003) Comparative genetic linkage maps of *E. grandis*, *E. globulus* and their F1 hybrid based on a double pseudo-backcross mapping approach. *Theoretical and Applied Genetics* **107** 1028-1042.

Myburg AA, Vogl C, Griffin AR, Sederoff RR, Whetten RW (2004). Genetics of postzygotic isolation in *Eucalyptus*. Whole-genome analysis of barriers to introgression in a wide interspecific cross of *E. grandis* and *E. globulus*. *Genetics* **166**, 1405-1418.

Poke FS, Vaillancourt RE, Elliott RC, Reid JB (2003). Sequence variation in two lignin biosynthesis genes, cinnamoyl CoA reductase (CCR) and cinnamyl alcohol dehydrogenase 2 (CAD2). *Molecular Breeding* **12**, 107-118.

Poke FS, Wright JK, Raymond CA (2004) Predicting extractives and lignin contents in *Eucalyptus globulus* using near infrared reflectance analysis. *Journal of Wood Chemistry and Technology* **24**, 55-67.

Potts BM, Reid JB (2003). Tasmania's Eucalypts: their place in science. *Papers and Proceedings of the Royal Society of Tasmania* **137**, 21-37.

Potts BM, Dungey HS (2004). Interspecific hybridization of *Eucalyptus*: Key issues for breeders and geneticists. *New Forests* **27**, 115-138.

Pound LM, Wallworth MAB, Potts BM, Sedgley M (2003). Pollen tube growth and early ovule development following self- and cross-pollination of *Eucalyptus nitens*. *Sexual Plant Reproduction* **16**, 59-69.

Raymond CA, Kube PD, Pinkard EA, Savage L, Bradley AD (2004). Evaluation of non-destructive methods of measuring growth stress in *E. globulus*: relationships between strain, wood properties and stress. *Forest Ecology and Management* **190**, 187-200.

Shepherd M, Cross M, Dieters MJ, Harding KJ, Kain D, Henry RJ (2003). Genetics of physical wood properties and early growth in a tropical pine hybrid. *Canadian Journal of Forest Research* **33**, 1923-1932.

Tibbits WN, Hodge GR (2004). Genetic parameters for cold hardiness in *Eucalyptus nitens* (Deane & Maiden) Maiden. *Silvae Genetica* **52**, 89-97.

Vaillancourt RE, Petty A, McKinnon GE (2004) Maternal inheritance of mitochondria in *Eucalyptus globulus*. *Journal of Heredity* **95**, 353-355.

Whittock SP, Greaves BL, Apiolaza LA (2004). A cash flow model to compare coppice and genetically improved seedling options for *Eucalyptus globulus* pulpwood plantations. *Forest Ecology and Management* **191**, 267-274.

Williams DR, Potts BM, Smethurst PJ (2004). Phosphorus fertiliser can induce earlier vegetative phase change in *Eucalyptus nitens*. *Australian Journal of Botany* **52**, 281-284.

In press

Burley J, Kanowski PJ (2004). Breeding strategies for temperate hardwoods. *Forestry* **78**.

Hingston AB, Gartrell BD, Pinchbeck G (2004). How specialized is the plant-pollinator association between *Eucalyptus globulus* ssp. *globulus* and the swift parrot *Lathamus discolor*?. *Austral Ecology* **29**.

Kube PD, Raymond CA (2004). Breeding to minimise the effects of collapse in *Eucalyptus nitens*. *Forest Genetics*.

Lorkin MH, Williams DR, Potts BM, Vaillancourt RE (2004). Stability of outcrossing rates in *Eucalyptus globulus* seedlots. *Silvae Genetica*.

Milgate AW, Potts BM, Joyce K, Mohammed CL, Vaillancourt RE (2004). Genetic variation in *Eucalyptus globulus* for susceptibility to *Mycosphaerella nubilosa* and its association with growth. *Australasian Plant Pathology*.

Schimleck LR, Kube PD, Raymond CA (2004). Genetic improvement of pulp yield in *Eucalyptus nitens* using cellulose content determined by NIRS. *Canadian Journal of Forest Research*.

Thamarus KA, Groom K, Bradley AD, Raymond CA, Moran GF (2004). Identification of quantitative trait loci for wood and fibre properties in two full sib pedigrees of *Eucalyptus globulus*. *Theoretical and Applied Genetics* **109**.

Unrefereed publications

Barbour RC, Potts BM, Vaillancourt RE (2003). Gene dispersal from *Eucalyptus* plantations. In 'XIX International Congress of Genetics'. 6-11 July, Melbourne, Victoria.

Brawner JT, Dieters MJ (2004) Reciprocal effects in Slash x Caribbean Pine F1 hybrids. Hot Off the Seed Bed 68

Dutkowski, GW (2003) SeedPicker - An Excel Spreadsheet for Seed Orchards. Hobart, Tasmania.

Dutkowski, GW (2003) ChipEx - An Excel Spreadsheet Add-In for using the ChipEx Model, Hobart, Tasmania.

Dutkowski, GW (2003) ChipEx - description of an Excel Spreadsheet Add-In for using the ChipEx Model, Hobart, Tasmania.

Dutkowski, GW (2003) gSTBA - An Excel add-in for the extraction of STBA *Eucalyptus globulus* breeding values, Hobart, Tasmania.

Dutkowski, GW (2004) BlockIt - a program to create continuous blocks of data for ASREML spatial analysis, Hobart, Tasmania.

Dutkowski, GW (2004) MissOut - a program to replace missing values in an ASREML data file with a specific value, Hobart, Tasmania.

Dutkowski, GW (2004) GSIM v1 Breeding and Deployment Strategy Simulator, Hobart, Tasmania.

Dutkowski, GW (2004) gSOOP - an open pollinated *Eucalyptus globulus* seed orchard planning tool, Hobart, Tasmania.

Dutkowski, GW (2004) ENV.FOR - A Fortran program for the extraction of information from ASREML SLN files for spatial analysis, Hobart, Tasmania.

Freeman JS, Milgate AW, Vaillancourt RE, Mohammed CL, Potts BM (2003). Genetic control of resistance to *Mycosphaerella* leaf disease in *Eucalyptus globulus*. In 'XIX International Congress of Genetics'. 6-11 July, Melbourne, Victoria.

Hamilton M, Raymond CA, Harwood CE (2004) Breeding for improved wood quality in *Eucalyptus nitens* is feasible. Hot Off the Seed Bed 72

Huang S, Shepherd M, Eggler P, Dieters MJ (2004) Species effects for QTLs associating with root strike rate in hybrid pines. Hot Off the Seed Bed 70

Huang S, Shepherd M, Eggler P, Dieters MJ, Henry RJ (2004) Species effects will increase the efficiency of marker-aided selection in hybrid populations. Hot Off the Seed Bed 70

Jones RC, Vaillancourt RE, Jordan GJ (2004). Microsatellites for use in *Nothofagus cunninghamii* (Nothofagaceae) and related species. In 'Consequences of Habitat Fragmentation'. 5-6 July, Sydney, NSW.

Jones TH, Vaillancourt RE, Potts BM (2003). Pollen movement and bi-parental inbreeding in the Tasmanian Bluegum. In 'XIX International Congress of Genetics'. 6-11 July, Melbourne, Victoria.

Jones TH, Vaillancourt RE, Potts BM (2003). Pollen movement and bi-parental inbreeding in the Tasmanian Bluegum. In 'Consequences of Habitat Fragmentation'. 5-6 July, Sydney, NSW.

Kain D, Dieters MJ, Harding K (2003) Early selection and rapid field screening to improve wood density and spiral grain. Hot Off the Seed Bed 64

King R, Hughes JM, Potts BM, Lee D (2003). Fine-scale genetic variation and the role of selection in a *Corymbia citriodora* population. In 'XIX International Congress of Genetics'. 6-11 July, Melbourne, Victoria.

Li Y, Apiolaza LA (2003). Effect of connectedness between sites on the precision of GxE interaction estimation. In 'XIX International Congress on Genetics'. 6-11 July, Melbourne, Victoria.

Lopez GA, Potts BM, Vaillancourt RE, Apiolaza LA (2003). Expresion tardia de la variacion genetica en un dialelo de *Eucalyptus globulus*. In '1st Simposio Iberoamericano de *Eucalyptus globulus*'. 30-31 October, Montevideo, Uraguay.

Lorkin MH, Pound LM, Patterson B, Wallwork MA, Sedgley M, Vaillancourt RE, Potts BM (2003). Self-incompatibility in *Eucalyptus globulus*. In 'XIX International Congress of Genetics'. 6-11 July, Melbourne, Victoria.

Lorkin MH, Potts BM, Vaillancourt RE, Williams DR, Gore PL (2004) Vulnerability of *Eucalyptus globulus* to the seed destroying wasp *Megastigmus* sp. is under genetic control. Hot Off the Seed Bed 69

Myburg A, Vogl C, Griffin AR, Sederoff RR, Whetten RW (2004). Positive and negative heterospecific genome interactions in a wide interspecific hybrid of *Eucalyptus*. In 'International Union of Forestry Research Organizations (IUFRO) Tree Biotechnology 2003 Meeting, 7-12 June, Umea, Sweden.

Patterson B, Vaillancourt RE, Gore PL, Potts BM (2003). Evaluating the efficiency of seed production systems in *Eucalyptus globulus*. In 'XIX International Congress of Genetics'. 6-11 July, Melbourne, Victoria.

Potts BM, Milgate AW, Joyce K, Mohammed CL, Vaillancourt RE, Dutkowski GW (2003) Early selection for *Mycosphaerella* resistance in *Eucalyptus globulus* can boost growth by 9%. Hot Off the Seed Bed 65

Potts BM, Barbour RC, Vaillancourt RE (2004). Assessing the risk of pollen-mediated gene flow from planted eucalypts. In 'Integrating forestry into farms, communities and catchments: Australian Forest Growers Biennial Conference, Ballarat 2004'. Ed. D Race. 3-5 May, Ballarat, Victoria.

Potts BM, Lawrence R, Minchin PR, Whitman T (2004). The extended phenotype: the case of hybridisation and heteroblasty in *Eucalyptus*. In 'XIX International Congress of Genetics', 6-11 July, Melbourne, Victoria.

Shepherd M, Eggler P, Mellick R, Cross MJ, Toon PG, Dale GT, Huang S, Dieters MJ, Henry R (2003) Stability of gene effects in heterogeneous genetic backgrounds: Genetic mapping of genes controlling root initiation in hybrid pines. Hot Off the Seed Bed 67

Steane DA, Conod N, Vaillancourt RE, Potts BM (2003). Population differentiation in a forest tree - *Eucalyptus globulus*. In 'XIX International Congress of Genetics'. 6-11 July, Melbourne, Victoria.

Thumma R, Groom K, Moran GF (2003). Nucleotide diversity of cinnamoyl COA reductase (CCR) gene in a natural population of *Eucalyptus nitens*. In 'XIX International Congress of Genetics', 6-11 July, Melbourne, Victoria.

Vaillancourt RE, McKinnon GE, Steane DA, Potts BM (2003). Molecular signature of hybridisation in eucalypts. In 'XIX International Congress of Genetics'. 6-11 July, Melbourne, Victoria. of Poster.

Vaillancourt RE, Foster SA, Steane DA, Potts BM (2003). Local differentiation in *Eucalyptus globulus*. In 'XIX International Congress of Genetics'. 6-11 July, Melbourne, Victoria.

Whittock SP, Greaves BL, Apiolaza LA (2003). An economic assessment of genetic gain coppice productivity in second rotation plantations. In 'XIX International Congress on Genetics'. 6-11 July, Melbourne, Victoria.

Whittock SP, Greaves BL, Apiolaza LA, Potts BM (2004) Dry matter increases necessary to justify increased propagule cost for *Eucalyptus globulus* plantations. Hot Off the Seed Bed 71

Williams DR, Potts BM, Moore P, McCormick N (2003) The effect of seedlot and seed treatment on *Eucalyptus nitens* seedling emergence under nursery and controlled conditions. Hot Off the Seed Bed 63

Williams DR, Potts BM, Krygsman M, Buxton P (2003) The application of both fertiliser and paclobutrazol to mature *Eucalyptus globulus* tree increases flower bud abundance. Hot Off the Seed Bed 66

Confidential reports

Brawner JT, Dieters MJ (2004). Genetic correlations between pure and hybrid combining abilities of slash pine parents. Technical Report No. 131. 11 pp. (CRC-SPF, Brisbane, Queensland)

Dutkowski GW (2003). gSTBA - Description of an Excel Spreadsheet Add-In for STBA *Eucalyptus globulus* Breeding Values. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2003). Clonal testing and deployment can substantially increase gain in *Eucalyptus globulus*. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2003). SeedPicker - Description of an Excel Spreadsheet for Seed Orchards. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Analysis of Gunns *Eucalyptus nitens* Huntsman 1986 Progeny Trial. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Analysis of Gunns *Eucalyptus nitens* Huntsman Seed Orchard. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Analysis of Gunns *Eucalyptus nitens* Hampshire Farm Progeny Trial. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Analysis of Gunns *Eucalyptus nitens* Hampshire Seed Orchard Extension. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Analysis of Gunns *Eucalyptus nitens* Hampshire Seed Orchard. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Analysis of Gunns *Eucalyptus nitens* Huntsman 1981 Progeny trial. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Analysis of Gunns *Eucalyptus nitens* Muddy Creek Spur Infusion Trial. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Analysis of Gunns *Eucalyptus nitens* Painter Rd Progeny Trial. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Analysis of Gunns *Eucalyptus nitens* Massy Greene Drive Progeny Trial. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Gunns Base Population Trial Analysis Methodology. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Analysis of Gunns *Eucalyptus nitens* Racecourse Plain Progeny Trial. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Analysis of Gunns *Eucalyptus nitens* West Ridgley Progeny Trial. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Analysis of Gunns *Eucalyptus nitens* Middlesex Rd. Infusion Trial. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Analysis of Gunns *Eucalyptus nitens* Bunkers Rd Infusion Trial. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Allocation of Gunns *Eucalyptus nitens* base population to races. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). gSIM v1 Breeding and Deployment Strategy Simulator. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Analysis of Gunns *Eucalyptus nitens* Granites Rd Infusion Trial. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Analysis of Gunns *Eucalyptus nitens* Deacons Spur4 Infusion Trial. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW (2004). Analysis of Gunns *Eucalyptus nitens* Cobbers Road Progeny trial. (CRC-SPF, Hobart, Tasmania)

Dutkowski GW, Whittock SP (2004) Gains from Clonal Breeding and Deployment. 9 pp. (CRC-SPF, Hobart, Tasmania)

Greaves BL, Dutkowski GW (2003). Pilot study for estimating the average whole tree basic density of stands of plantation-grown *Eucalyptus globulus*. Technical Report No. 117. 35 pp. (CRC-SPF, Hobart, Tasmania)

Huang S, Shepherd M, Eggler P, Dieters MJ (2004). Genes controlling strike rate are expressed across genetic backgrounds and at different degrees of inbreeding in hybrid pines. Technical Report No. 134. 22 pp. (CRC-SPF, Lismore, NSW)

Potts BM, Tilyard PA, Joyce K (2003). Plants to Products - Field Trip and Notes. (CRC-SPF, Hobart, Tasmania)

Scott L, Shepherd M, Dieters MJ, Nikles DG, Henry R (2003). Linkage mapping in hoop pine (*Araucaria cunninghamii* Ait. Ex D. Don) identifies low heterozygosity and genetic diversity. Technical Report No. 119. 34 pp. (CRC-SPF, Lismore, NSW)

Shepherd M, Mellick R, Toon PG, Dale GT, Dieters MJ (2003). Genetic variation in clonal propagation characters in tropical hybrid pines. Technical Report No. 125. 15 pp. (CRC-SPF, Lismore, NSW)

Shepherd M, Eggler P, Cross MJ, Mellick R, Dieters MJ, Toon PG, Dale GT, Henry RJ (2004). Genetic architecture of adventitious rooting in tropical hybrid pines. Technical Report No. 132. 42 pp. (CRC-SPF, Lismore, NSW)

Shepherd M, Williams CG, Cross MJ, Eggler P, Henry R (2004). The collective pine genome is characterised by synteny, paralogy and recombination shrinkage. Technical Report No. 139. 32 pp. (CRC-SPF, Lismore, NSW)

Theses

Barbour RC (2004) Gene flow from introduced *Eucalyptus* plantations into native eucalypt species. PhD, School of Plant Science, University of Tasmania, Hobart, Tasmania.

McKinnon GE (2004) Reticulate evolution on the Tasmanian eucalypts. PhD, School of Plant Science, University of Tasmania, Hobart, Tasmania.

Rathbone D (2004) Genetic differentiation in a regionally rare eucalypt, *Eucalyptus perriniana*. Honours, School of Plant Science, University of Tasmania, Hobart, Tasmania.

Worth J (2003) Chloroplast DNA variation in *Nothofagus cunninghamii*. Honours, School of Plant Science, University of Tasmania, Hobart, Tasmania.

Sustainable Management Program

Books and book sections

Eds. CL Beadle and PJ Sands (2004). Synthesis of the physiological, environmental, genetic and silvicultural determinants of growth and productivity of eucalypts in plantations. 296 pp.

Beadle CL, Sands R (2004). Physiology and Silviculture. In 'Encyclopaedia of Forest Sciences'. (Eds J Burley, J Evans, and J Youngquist) pp. 1568-1577. (Elsevier: New York, USA)

Ed. Race D (2004). Integrating Forestry into Farms, Communities and Catchments. Proceedings of the Australian Forest Growers Biennial Conference 2004. 196 pp. (Australian Forest Growers, Deakin West, Australian Capital Territory)

Smethurst PJ (2004). Tree Physiology: Nutrition. In 'Encyclopedia of Forest Sciences'. (Eds J Burley, J Evans, and J Youngquist) pp. 1616-1622. (Elsevier: New York, USA)

Refereed publications

Adams PR, Beadle CL, Mendham NJ, Smethurst PJ (2003). The impact of timing and duration of grass control on growth of a young *Eucalyptus globulus* Labill. plantation. *New Forests* **26**, 147-165.

Almeida A, Landsberg J, Sands PJ, Ambrogi MS, Fonseca SM, Barddal SM, Bertolucci FLG (2004). Needs and opportunities for using a process-based productivity model as a practical tool in *Eucalyptus* plantations. *Forest Ecology and Management* **193**, 179-196.

Almeida A, Landsberg J, Sands PJ (2004). Parameterisation of 3-PG model for fast growing *Eucalyptus grandis* plantations. *Forest Ecology and Management* **193**, 167-178.

Battaglia M, Sands PJ, Mummery DC, White DA (2004). CABALA: a linked carbon, water and nitrogen model of forest growth for silvicultural decision support. *Forest Ecology and Management* **193**, 251-282.

Beadle CL, Sands PJ (2004). Synthesis of the physiological, environmental, genetic and silvicultural determinants of growth and productivity of eucalypts in plantations. *Forest Ecology and Management* **193**, 1-3.

Beringer J, Hutley LB, Tapper NJ, Coutts-Kerley A, O'Grady AP (2003). Fire impacts on surface heat, moisture and carbon fluxes from a tropical savanna in north Australia. *International Journal of Wildfire Research* **12**, 1-8.

Chen CR, Condron LM, Sinaj S, Davis MR, Sherlock RR (2003). Effects of plant species on phosphorus availability in a range of grassland soils. *Plant and Soil* **256**, 115-130.

Chen CR, Xu ZH, Blumfield TJ, Hughes JM (2003). Soil microbial biomass during the early establishment of Hoop Pine plantation: seasonal variation and effects of site preparation. *Forest Ecology and Management* **186**, 213-225.

Chen CR, Xu ZH, Mathers NJ (2004). Soil carbon pools in adjacent natural and plantation forests of subtropical Australia. *Soil Science Society of America Journal* **68**, 282-291.

Chen CR, Condron LM, Turner BL, Mahieu N, Davis MR, Xu ZH, Sherlock RR (2004). Soil organic phosphorus mineralisation under pasture and pine determined by NaOH-EDTA extraction and solution 31P NMR spectroscopy. *Australian Journal of Soil Research* **42**, 189-196.

Close DC, Beadle CL, Brown PH, Hovenden MJ (2003) Eucalypt seedling hardiness to low temperature: A synthesis. In 'One World of Propagation - Conference of the International Plant Propagators Society'. 30 May - 1 June, Coffs Harbour, NSW.

Close DC, Beadle CL (2003). The ecophysiology of foliar anthocyanin. *The Botanical Review* **69**, 149-161.

Close DC, Beadle CL (2003). Total, and chemical fractions, of nitrogen and phosphorus in *Eucalyptus* seedling leaves: effects of species, nursery fertiliser management and transplanting. *Plant and Soil* **259**, 85-95.

Close DC, Davidson NJ (2003). Long-term waterlogging: nutrient, gas exchange and photo- and pigment-chemistry characteristics of *Eucalyptus nitens* saplings. *Russian Journal of Plant Physiology* **50**, 843-847.

Close DC, Davidson NJ (2003). Revegetation to combat tree decline in the Midlands and Derwent Valley Lowlands of Tasmania: Practices for improved plant establishment. *Ecological Management and Restoration*. **4**, 29-36.

Close DC (2003). Rural tree decline in Tasmania: A complex of factors. *The Tasmanian Naturalist* **125**, 27-31.

Close DC, Battaglia M, Davidson NJ, Beadle CL (2004). Within-canopy gradients of nitrogen and photosynthetic activity of *Eucalyptus nitens* and *Eucalyptus globulus* in response to nitrogen nutrition. *Australian Journal of Botany* **52**, 133-140.

Davidson NJ, Battaglia M, Close DC (2004). Photosynthetic response to overnight frost in *Eucalyptus nitens* and *E. globulus*. *Trees-structure and function* **18**, 245-252.

Esprey L, Smith C, Sands PJ (2004). Understanding 3-PG using a sensitivity analysis. *Forest Ecology and Management* **193**, 235-250.

Garnett TP, Shabala SN, Smethurst PJ, Newman IA (2004). Kinetics of ammonium and nitrate uptake by eucalypt roots and associated proton fluxes measured using ion selective microelectrodes. *Functional Plant Biology* **30**, 1165-1176.

Goncalves JL, Stape JL, Laclau JP, Gava JL, Smethurst PJ (2004). Silvicultural effects on the productivity and wood quality of eucalypt plantations. *Forest Ecology and Management* **193**, 45-61.

Letey J, Sojka RE, Upchurch DR, Cassel DK, Olsen K, Payne B, Petri S, Price G, Reginata RJ, Scott HD, Smethurst PJ, Triplet G (2003). Deficiencies in the soil quality concept and its application. *Journal of Soil and Water Conservation* **58**, 180-187.

Mitchell AD, Smethurst PJ (2004). Surface soil changes in base cation concentrations in fertilised hardwood and softwood plantations in Australia. *Forest Ecology and Management* **191**, 253-265.

Moroni MT, Smethurst PJ (2002). Litterfall nitrogen and phosphorus fluxes in two Tasmanian *Eucalyptus nitens* plantations. *Tasforests* **145**, 53-64.

Mummery DC, Battaglia M (2003). Rainfall representation and process-based models: an investigation of the significance of rainfall distribution on growth, risk and silvicultural efficiency using the model CABALA. *Forest Ecology and Management* **193**, 283-295.

Neyland MG, Cunningham JK (2004). Silvicultural monitoring in uneven-aged highland dry *Eucalyptus* delegatensis forests in Tasmania. *Australian Forestry* **67**, 6-13.

Neyland MG (2004). Selection, harvesting damage, burning damage and persistence of retained trees following dispersed retention harvesting in the Warra silvicultural systems trial in Tasmania. *Tasforests* **15**, 55-66.

Ngugi MR, Hunt MA, Doley D, Ryan PA, Dart P (2004). Selection of species and provenances for low-rainfall areas: physiological responses of *Eucalyptus cloeziana* and *Eucalyptus argophloia* to seasonal conditions in subtropical Queensland. *Forest Ecology and Management* **193**, 141-156.

Paul KI, Polglase PJ, O'Connell AM, Carlyle JC, Smethurst PJ, Khanna PK, Worledge D (2004). Soil water under forests (SWUF): a model of water flow and soil water content under a range of forest types. *Forest Ecology and Management* **182**, 195-211.

Paul KI, Polglase PJ, Smethurst PJ, O'Connell AM, Carlyle JC, Khanna PK (2004). Soil temperature under forests: a simple model for predicting soil temperature under a range of forest types. *Agricultural and Forest Meteorology* **121**, 167-182.

Pinkard EA (2003). Physiological and growth responses related to pattern and severity of green pruning in young *Eucalyptus globulus*. *Forest Ecology and Management* **182**, 231-245.

Resh S, Battaglia M, Worledge D, Ladiges S (2003). Coarse root biomass for eucalypt plantations in Tasmania, Australia: Sources of variation and methods for assessment. *Trees: Structure and Function* **17**, 389-399.

Smethurst PJ, Holz GK, Moroni MT, Baillie CC (2003). Nitrogen management in *Eucalyptus nitens* plantations. *Forest Ecology and Management* **193**, 63-80.

Watson TL, Close DC, Davidson NJ, Davies NW (2004). Pigment dynamics during cold-induced photoinhibition of *Acacia melanoxylon*. *Functional Plant Biology* **31**, 481-489.

White DA, Battaglia M, Macfarlane C, Mummery DC, Beadle CL (2003). Managing the trade-off between growth and risk to optimise yield and water-use of tree crops in southern Australia. *Plant and Soil* **257**, 283-296.

Whitehead D, Beadle CL (2004). Physiological regulation of productivity and water use in *Eucalyptus*. *Forest Ecology and Management* **193**, 113-140.

Williams EL, Hovenden MJ, Close DC (2003). Light energy utilisation, dissipation and attenuation in six co-occurring alpine heath species in Tasmania. *Functional Plant Biology* **30**, 1205-1208.

Xu ZH, Prasolova NV, Lundkvist K, Beadle CL, Leaman T (2003). Genetic variation in carbon and nitrogen isotope composition and nutrient concentration in the foliage of 11-year-old hoop pine families in relation to tree growth in subtropical Australia. *Forest Ecology and Management* **186**, 359-371.

In press

Blumfield TJ, Xu ZH, Mathers NJ, Saffigna PG (2004). Decomposition of post-harvest, 15N-labelled hoop pine residues in subtropical *Australia. Soil Science Society of America Journal.*

Catchpoole KJ, Nester MR (2004). A financial calculator: Software for evaluating plantation scenarios. *Australian Forestry.*

Close DC, Beadle CL, Battaglia M (2004). Foliar anthocyanin: An indicator of hardiness in eucalypt seedlings. *Forest Ecology and Management.*

Close DC, Davidson NJ (2004). Review of rural tree decline in a changing Australian climate. *Tasforests.*

Lamontagne S, Cook PG, O'Grady AP, Eamus D (2004). Determination of groundwater use in a tropical savanna riparian zone (Daly River, Australia). *Journal of Hydrology.*

Mathers NJ, Xu ZH, Boyd SE (2004). Soil nitrogen availability and humic acid composition influenced by forest residue management. *New Zealand Journal of Forest Science.*

Pu GX, Saffigna PG, Xu ZH (2004). Denitrification, leaching and immobilisation of added 15N under different residue management regimes in a young hoop pine plantation of subtropical Australia. *Nutrient Cycling in Agroecosystems.*

Unrefereed publications

Battaglia M, White DA (2003). Using models to optimise production and manage risk in pines and eucalypts. In 'Silvotecna XVIII Aumento de Rentabilidad en Plantaciones de Pinos y Eucaliptos: Mejoramiento en Calidad Plantas y Productividad de Sitios'. 11-12 November, Conception, Chile.

Blumfield TJ, Xu ZH, Mathers NJ (2003). Decomposition of 15N-labelled harvest residues in the hoop pine plantations of sub-tropical Australia. In '10th North American Forest Soils Conference'. 20-24 July, Ontario, Canada.

Burton J, Blumfield TJ, Xu ZH (2003). Using stable isotopes to investigate in situ N transformations in forest ecosystems of subtropical Australia. In '10th North American Forest Soils Conference'. 20-24 July, Ontario, Canada.

Catchpoole KJ, Nester MR (2003) STEPS Version 3.01. Software Tools for Evaluating Plantation Scenarios. User Manual. 86 pp. (Queensland Department of Primary Industries, Brisbane, Queensland)

Chen CR (2004) Impacts of harvest residue management on soil C and N pools and microbial properties in a six-year old slash pine plantation in S-E Queensland. Beyond the Black Stump 38

Close DC, Bail I, Hunter SJ, Beadle CL, McArthur C (2003) Defining and achieving seedling specifications for *Eucalyptus globulus*. Beyond the Black Stump 37

Close, DC, Beadle, CL, Brown, PH, Hovenden, MJ (2004) Eucalypt seedling hardiness to low temperature: A synthesis. In 'One World of Propagation - Conference of the International Plant Propagators Society: Combined Proceedings of the International Plant Propagators Society'. 30 May Ð 1 June, Coffs Harbour, NSW.

Esprey LJ, Sands PJ (2004) Parameterisation of the 3-PG process-based growth model for predicting the growth of *Eucalyptus grandis* plantations. ICFR Bulletin Series 05/2004 (Institute for Commercial Forestry Research, Pietermaritzburg, South Africa)

Henskens FL (2003) Turnover models more suitable for predicting N and productivity in eucalypt plantations. Beyond the Black Stump 36

Medhurst JL, Sands PJ (2003) Growing blackwood (*Acacia melanoxylon*) on farms for high-quality timber. No. FFP30558 (Natural Heritage Trust, Hobart, Tasmania)

O'Grady AP, Worledge D, Battaglia M (2003). Growth and distribution of *Eucalyptus globulus* fine roots in relation to water availability. In 'Third International Symposium on the Dynamics of Physiological Processes in Woody Roots'. September, Perth, Western Australia.

Ottenschlaeger ML, Macfarlane C, Smethurst PJ, Beadle CL (2003) Test results for the 'Visual Guide to Leaf Area Index'. Beyond the Black Stump 34

Price G, Smethurst PJ, Sparrow L, Sojka R (2003). Soil Quality - to regulate or to manage. In '16th Triennial Conference of the International Soil Tillage Research Organisation'. July, Brisbane, Queensland.

Ringrose C, Neilsen B (2003) Intensive N and P fertilisation can lead to soil acidification. Beyond the Black Stump 35

Sands PJ (2002). Modelling response to pruning and nurse crop competition: a work in progress. In 'International Workshop: Blackwood management'. Ed. AG Brown. November, Rotorua, New Zealand.

Smethurst PJ, Mendham DS, Holz GK, Menary RC, Keith H, Misra RK, Wang B (2003). Phosphorus management in *Eucalyptus nitens* plantations. In 'Phosphorus dynamics in the soil-plant continuum: 2nd International Symposium'. 21-26 September, Perth, Western Australia.

Smethurst PJ (2004). New technologies for managing temperate eucalypt and pine plantations. In 'Australian Forest Growers Conference, Ballarat, 2004'. May, Ballarat, Victoria.

Confidential reports

Baillie CC, Smethurst PJ, Appleton R (2003). Weed control and fertiliser release treatments in eucalypt plantations in Gippsland, Victoria. Technical Report No. 127. (CRC-SPF, Hobart, Tasmania)

Booth TH, Jovanovic T, Snowdon P, Mummery DC, Battaglia M, Sands PJ, Fife DN (2003). Potential productivity assessment. (Joint Venture Agroforestry Program, Canberra, ACT)

Close DC, Bail I, Hunter SJ, Beadle CL, McArthur C (2003). Defining and achieving seedling specifications for *Eucalyptus globulus*: Effects of nursery nitrogen-management, seedling size and container type on after-planting performance. Technical Report No. 129. 29 pp. (CRC-SPF, Hobart, Tasmania)

Henskens FL, Battaglia M, Ottenschlaeger ML (2003). Silvicultural decision support for farm forestry. (RIRDC, Canberra, ACT)

Koh S (2003). Review of the Composite Transport Model of Solute and Water Uptake Into Roots. Technical Report No. 123. 58 pp. (CRC-SPF, Hobart, Tasmania)

Neyland M (2003). Seedling regeneration, growth and density of *Eucalyptus obliqua* following partial harvesting in the Warra silvicultural systems trial. 1. Dispersed retention in Warra 1B. Technical Report No. 128. 29 pp. (CRC-SPF, Hobart, Tasmania)

Neyland M (2004). Seedling regeneration, growth and density of *Eucalyptus obliqua* following partial harvesting in the Warra silvicultural systems trial. 2. Dispersed retention at Warra 8C and comparison with Warra 1B. Technical Report No. 136. 22 pp. (CRC-SPF, Hobart, Tasmania)

Neyland M (2004). Seedling regeneration, growth and density of *Eucalyptus obliqua* following partial harvesting in the Warra silvicultural systems trial. 3. The first "clearfell, burn and sow" coupe, Warra 8B, age 3 years. Technical Report No. 142. 25 pp. (CRC-SPF, Hobart, Tasmania)

Race D, Schirmer J, Bail I (2004). Company responses to community concerns about plantation expansion: Lessons from industrial partners. Technical Report No. 138. 16 pp. (CRC-SPF, Canberra, ACT)

Sands PJ (2003). Models for Forest Management? Integrating determinants of growth into practical management systems. Technical Report No. 126. 29 pp. (CRC-SPF, Hobart, Tasmania)

Sands PJ (2003). Process-based Models for Forest Management? Integrating determinants of growth into practical management systems. Technical Report No. 126. 29 pp. (CRC-SPF, Hobart, Tasmania)

Sands PJ (2003). Parameterisation and application of 3-PG as a management tool for *Eucalyptus grandis* in South Africa - report on a visit to the Institute for Commercial Forestry Research, August-September 2003. Technical Report No. 124. 5 pp. (CRC-SPF, Hobart, Tasmania)

Sands PJ (2004). 3PGpjs-a user friendly interface to 3PG, the Landsberg and Waring model of forest productivity. Technical Report No. 141. 24 pp. (CRC-SPF, Hobart, Tasmania)

Sands PJ (2004). Adaptation of 3-PG to novel species: guidelines for data collection and parameter assignment. Technical Report No. 140. 29 pp. (CRC-SPF, Hobart, Tasmania)

Smethurst PJ, Churchill K, Lyons A, Clarke G, Bower DL, Campbell G (2003). *Pinus radiata* response to ripping, weed control and fertilization at four ex-pasture sites. Technical Report No. 130. 34 pp. (CRC-SPF, Hobart, Tasmania)

Smethurst PJ, Holz GK, Baillie CC (2004). Nitrogen fertilizer research in *Eucalyptus nitens* plantations. Technical Report No. 137. 35 pp. (CRC-SPF, Hobart, Tasmania)

Tabart T, Hyland J, Vanclay F (2004). Development of a methodology to measure mental models in forestry decision making processes. Technical Report No. 135. 67 pp. (CRC-SPF, Hobart, Tasmania)

Theses

Adams PR (2004) Competition for soil water and nitrogen between *Holcus lanatus* L. and young *Eucalyptus globulus* Labill. PhD, School of Agricultural Science, University of Tasmania, Hobart, Tasmania.

Gibbons AK (2003) Effect of intensive management on understorey flora in *E. delegatensis* forest. PhD, School of Plant Science, University of Tasmania, Hobart, Tasmania.

Laird A (2004) Photoinhibition of Tasmanian eucalypts in a subalpine region. Honours, School of Plant Science, University of Tasmania, Hobart, Tasmania.

O'Hara CP (2003) Phosphorus fractions in forest soils. PhD, School of Resources, Environment and Society, Australian National University, Canberra, ACT.

Peacock R (2003) Dynamics of vegetation after cable and ground-based logging. PhD, School of Plant Science, University of Tasmania, Hobart, Tasmania.

Shield C (2003) The adaptive significance of glaucousness in juvenile *Eucalyptus urnigera* leaves. Honours, School of Plant Science, University of Tasmania, Hobart, Tasmania.

Unwin G (2004) Tree response to rainfall gradient and environmental disturbance in tropical rainforests of North-Eastern Australia. PhD, School of Plant Science, University of Tasmania, Hobart, Tasmania.

Westphalen G (2003) Indicator species for sustainability in native forest systems. PhD, School of Plant Science, University of Tasmania, Hobart, Tasmania.

Resource Protection Program

Books and book sections

Stone C, Matsuki M, Carnegie AJ Ed. M Parsons (2003). Pest and Disease Assessment in Young Eucalypt Plantations: Field Manual for Using the Crown Damage Index. 30 pp. (Bureau of Rual Sciences, Canberra, ACT)

Refereed publications

Barry KM, Irianto R, Santoso E, Tujaman M (2004). Incidence of heartrot in harvest-age *Acacia mangium* in Indonesia, using a rapid survey method. *Forest Ecology and Management* **190**, 273-280.

Bulinski J, McArthur C (2003). Identifying factors related to the severity of mammalian browsing damage in eucalypt plantations. *Forest Ecology and Management* **183**, 239-247.

Close DC, McArthur C, Paterson SC, Fitzgerald H, Walsh A, Kincade T (2003). Photoinhibition: a link between effects of the environment on eucalypt leaf chemistry and herbivory. *Ecology* **84**, 2952-2966.

Elek JA, Steinbauer MJ, Beveridge N, Ebner P (2003). The efficacy of high and low volume spray applications of Mimic (tebufenozide) for managing autumn gum moth larvae *Mnesampela privata* (Lepidoptera: Geometridae) in eucalypt plantations. *Agricultural and Forest Entomology* **5**, 325-332.

Eyles A, Davies NW, Yuan ZQ, Mohammed CL (2003). Host responses to natural infection by *Cytonaema* sp. in the aerial bark of *Eucalyptus globulus*. *Forest Pathology* **33**, 317-331.

Eyles A, Davies NW, Mohammed CL (2003). Wound wood formation in *Eucalyptus globulus* and *E. nitens*: anatomy and chemistry. *Canadian Journal of Forest Research* **33**, 2331-2339.

Eyles A, Davies NW, Mitsunaga T, Mihara R, Mohammed CL (2004). Role of *Eucalyptus globulus* wound wood extractives? Evidence of superoxide dismutase-like activity. *Forest Pathology* **34**, 225-232.

Eyles A, Davies NW, Mohammed CL (2004). Traumatic oil glands induced in the wound-associated phloem of *Eucalyptus globulus:* chemistry and histology. *Trees: Structure and Function* **18**, 204-210.

Howlett BG, Clarke AR (2003). The role of foliar chemistry versus leaf-tip morphology in egg batch placement by *Chrysophtharta bimaculata* (Olivier) (Coleoptera: Chrysomelidae). *Australian Journal of Entomology* **42**, 144-148.

Hurley M, Patel V (2003). Effect of imidacloprid on the growth of *Eucalyptus nitens* seedlings. *Australian Forestry* **66**, 101-102.

le Mar K, McArthur C (2002). Location of 1080-poisoned carcasses in relation to animals' home-ranges. *Tasforests* **14**, 131-135.

le Mar K, McArthur C, Statham M (2004). Home-ranges of sympatric red-necked wallabies, red-bellied pademelons and common brushtail possums in a temperate eucalypt forestry environment. *Australian Mammalogy* **25**, 183-191.

McArthur C, Appleton R (2004). Effect of seedling characteristics at planting on browsing of *Eucalyptus globulus* by rabbits. *Australian Forestry* **67**, 25-39.

Mohammed CL, Wardlaw TJ, Smith A, Pinkard EA, Battaglia M, Glen M, Tommerup I, Potts BM, Vaillancourt RE (2004). *Mycosphaerella* leaf diseases of temperate eucalypts around the southern pacific rim. *New Zealand Journal of Forest Research* **33**, 362-372.

Nahrung HF, Allen GR, Patel VS (2004). Day-degree development and phenology modelling of the immature stages of *Chrysophtharta agricola* (Chapuis) (Coleoptera: Chrysomelidae), a pest of eucalypt plantations. *Australian Journal of Entomology* **43**, 177-183.

Nahrung HF (2004). Biology of *Chrysophtharta agricola* (Chapuis), a pest of *Eucalyptus* plantations in Victoria and Tasmania. *Australian Forestry* **67**, 59-66.

Nahrung HF (2004). Sexual selection under scramble competition: mate location, sexual receptivity and mate choice in *Chrysophtharta agricola* (Chapuis) in the field. *Journal of Insect Behaviour* **17**, 353-366.

Rapley LP, Allen GR, Potts BM (2004). Oviposition by autumn gum moth (*Mnesampela privata*) in relation to *Eucalyptus globulus* defoliation, larval performance and natural enemies. *Agricultural and Forest Entomology* **6**, 205-213.

Rapley LP, Allen GR, Potts BM (2004). Genetic variation of *Eucalyptus globulus* in relation to autumn gum moth *Mnesampela privata* (Lepidoptera: Geometridae) oviposition preference. *Forest Ecology and Management* **194**, 169-175.

Seeman OD, Nahrung HF (2003). *Parobia* gen. nov. (Acari: Podapolipidae): subelytral parasites of paropsine beetles (Coleoptera: Chrysomelidae). *Australian Journal of Entomology* **42**, 334-342.

Short M, Steinbauer MJ (2004). Floral nectar versus honeydew as food for wasp parasitoids: implications for pest management in eucalypt plantations. *Australian Forestry* **67**, 199-203.

Steinbauer MJ (2003). Using ultra-violet light traps to monitor Autumn Gum Moth, *Mnesampela privata* (Lepidoptera: Geometridae), in south-east Australia. *Australian Forestry* **66**, 279-286.

Steinbauer MJ, Kriticos DJ, Lukacs Z, Clarke AR (2004). Modelling a forest lepidopteran: phenological plasticity determines voltinism which influences population dynamics. *Forest Ecology and Management* **198**, 117-131.

Steinbauer MJ, Schiestl FP, Davies NW (2004). Monoterpenes and epicuticular waxes help female autumn gum moth differentiate between waxy and glossy *Eucalyptus* and leaves of different age. *Journal of Chemical Ecology* **30**, 1111-1135.

Wardlaw TJ, Mohammed CL, Barry KM, Eyles A, Wiseman D, Beadle CL, Battaglia M, Pinkard EA, Kube PD (2004). Interdisciplinary approach to the study and management of stem decay in eucalypts. *New Zealand Journal of Forestry* **33**, 385-398.

In press

Nahrung HF, Allen GR (2004). Maintenance of colour polymorphism in the leaf beetle *Chrysophtharta agricola* (Chapuis) (Coleoptera: Chrysomelidae). *Journal of Natural History*.

Nahrung HF, Allen GR (2004). Population dynamics of the chrysomelid leaf beetle *Chrysophtharta agricola* (Chapuis), a pest of *Eucalyptus nitens* in Tasmania. *Tasforests*.

O'Reilly-Wapstra JM, McArthur C, Potts BM (2004). Linking plant genotype, plant defensive chemistry and mammal browsing in a *Eucalyptus* species. *Functional Ecology*.

Rapley LP, Allen GR, Potts BM (2004). Genetic variation in *Eucalyptus globulus* in relation to susceptibility from attack by the southern eucalypt leaf beetle, *Chrysophtharta agricola*. *Australian Journal of Botany*.

Rapley LP, Allen GR, Potts BM (2004). Susceptibility of *Eucalyptus globulus* to *Mnesampela privata* defoliation in relation to a specific foliar compound. *Chemoecology*.

Wharton TN, Kriticos DJ (2004). The fundamental and realized niche of the Monterey Pine aphid *Essigella californica* (Essig) (Hemiptera: Aphididae): implications for managing softwood plantations in Australia. *Diversity and Distributions*.

Wharton TN, Cooper P, Floyd RB (2004). Life stage development of *Essigela californica* Essig (Aphidoidea: Lachnidae: Cinarinae). *Annals of Entomological Society of America*.

Unrefereed publications

Close DC, McArthur C (2004). Photoinhibition: a link between effects of the environment on eucalypt leaf chemistry and herbivory. In 'Plant Ecofizz 2003: Ecophysiology of Australasian Plants and Ecosystems'. 1-2 October, Melbourne, Victoria.

Elek JA, Matsuki M, Allen GR (2003). Recolonisation of insects into *Eucalyptus* plantations following spraying with A-cypermethrin and Spinosad. In '34th Australian Entomological Society and 6th Invertebrate Biodiversity Conference'. 28 September - 3 October, Hobart, Tasmania.

Harrison KS, Hopkins AJM, Grove SJ, Mohammed CL (2003). Living Trees - what lives here? Saproxlyic invertebrates and wood decay fungi in living *Eucalyptus obliqua* in Tasmania's wet sclerophyll forests. In '34th Australian Entomological Society and 6th Invertebrate Biodiversity Conference'. 29 September - 3 October, Hobart, Tasmania.

Harrison KS, Hopkins AJM, Grove SJ, Mohammed CL (2003). Artificial wounding of living *Eucalyptus obliqua* in Tasmania's wet sclerophyll forests. In 'Ecological Society of Australia Ecology 2003 Conference'. 8-10 December, Armidale, New South Wales.

Hopkins AJM, Harrison KS, Grove SJ, Warlaw TJ, Mohammed CL (2003). What Makes a Good Habitat Tree? Wood decay fungi and habitat formation in *Eucalyptus obliqua* in Tasmania's wet sclerophyll forests. In 'Ecological Society of Australia Ecology 2003 Conference'. 8-10 December, Armidale, New South Wales.

Miller A, McArthur C, Smethurst PJ (2003). Predicting the consumption of individual plants by generalist marsupial herbivores in a heterogeneous environment. In '49th Australian Mammal Society Annual Conference'. 7-9 July, Sydney, NSW. of Poster.

Mohammed CL (2003) Pruning wounds, infection and defence in plantation eucalypts. Pest Off! 23

Nahrung HF, Allen GR (2003). Mate location and mating behaviour of *Chrysophtharta agricola* (Chapuis) (Coleoptera: Chrysomelidae: Paropsini). In '34th Australian Entomological Society and 6th Invertebrate Biodiversity Conference'. 28 September - 3 October, Hobart, Tasmania.

O'Reilly-Wapstra JM, McArthur C, Potts BM (2003) Sideroxylonal: Important in resistance of *Eucalyptus globulus* to brushtail possums. Pest Off! 26

Rapley LP, Allen GR, Potts BM (2003). Autumn Gum Moth *Mnesampela privata* (Lepidoptera: Geometridae) oviposition and defoliation, and its relationship to *Eucalyptus globulus* foliar wax chemistry. In '34th Australian Entomological Society and 6th Invertebrate Biodiversity and Conservation Combined Conference'. 28 September - 3 October, Hobart, Tasmania.

Rice AD, Allen GR (2003). Host quality and host mortality risk in relation to development strategies of the parasitoid guild of larval *Chrysophtharta agricola* Chapuis (Coleoptera: Chrysomelidae). In '34th Australian Entomological Society and 6th Invertebrate Biodiversity Conference'. 28 September - 3 October, Hobart, Tasmania.

Steinbauer MJ (2003) GumMoth reveals numbers of generations and when Autumn Gum Moth were active. Pest Off! 25

Wiseman D (2003) Fertiliser produces larger branches and higher incidence of wood decay in *E. nitens*. Pest Off! 24

Yee M, Grove SJ, Mohammed CL (2004) An investigation into the potential impacts of forest practices on saproxylic beetle biodiversity. In '34th Australian Entomological Society and 6th Invertebrate Biodiversity Conference'. 28 September - 3 October, Hobart, Tasmania.

Confidential reports

Barry KM, Hall M, Mohammed CL (2003). Spread of decay from wounds in plantation *Eucalyptus nitens*: comparing effects of time and site. Technical Report No. 120. 20 pp. (CRC-SPF, Hobart, Tasmania)

Elek JA, Allen GR, Matsuki M (2004). Effects of spraying with Dominex or Success on target and non-target species and rate of recolonisation after spraying in *Eucalyptus nitens* plantations in Tasmania. Technical Report No. 133. 19 pp. (CRC-SPF, Hobart, Tasmania)

Mathiessen J, Simmul TL (2003). Management and biology of scarab beetle establishment pests. Technical Report No. 121. 36 pp. (CRC-SPF, Perth, WA)

McArthur C, Appleton R (2003). Effect of seed source and nursery conditions on survival, growth and browsing of eucalypt seedlings by swamp wallabies in plantations. Technical Report No. 122. 16 pp. (CRC-SPF, Hobart, Tasmania)

McArthur C (2004) Report on spotlight counts of animals on several Norske-Skog plantations in response to control operations. Report to Norske-Skog. Hobart, Tasmania.

Theses

Burton D (2003) Effect of wind and nutrients on seedling characteristics and palatability. Honours, School of Zoology, University of Tasmania, Hobart, Tasmania.

Eyles A (2003) Wound responses of *Eucalyptus globulus* and *E. nitens*; anatomy and chemistry. PhD, School of Agricultural Science, University of Tasmania, Hobart, Tasmania.

Horweg K (2003) Palatability of tropical and subtropical eucalypts to larvae of autumn gum moth. School of Botany and Zoology, Australian National University, Canberra, ACT.

Media activities

Print

Battaglia M (2004) Modelling plantation growth with CABALA: making models 'to boldly go where no model has gone before'. *Onwood* **44**.

Harwood CE (2004) Collaboration boosts production of clonal planting stock. *Onwood* **44**.

Mohammed CL (2003) Forest health - New solutions from new technology. *Onwood* **42**.

Dugald Close "Braving cold for tree tips" TasCountry July 2003.

Dugald Close "Techniques improve eucalypts" Australian Horticulture August 2003.

Dugald Close "Study says soil abuse at root of tree decline" The Mercury July 2003.

Dugald Close "The seedlings of success" Unitas July 2003.

Dugald Close "Practices for improved plant establishment" The Greening Australian Spring 2003.

Electronic media

"Forests in the Balance". Video. Forests and Forest Industry Council. C Beadle: interview on sustainable management of Tasmania's forests. 2004.

WIN TV, WIN Local News. BM Potts: interview about Establishment of the Calverts Hill Reserve for the rare *Eucalyptus morrisbyi*. 2004.

PUBLIC PRESENTATIONS

Presentations which also appear as conference proceedings or abstracts are cited in the Publications section of this report.

Genetic Improvement Program

Apiolaza LA, Potts BM, Gore PL (2003) Genetic control of peak flowering time of *Eucalyptus globulus*. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Barbour RC (2003) Why do tourists pull all the chicks? Gene flow out from *Eucalyptus nitens* plantations. Seminar. Hobart, Tasmania.

de Little DW (2004) Framework for Strategic Action Plan. Presentation at 'Workshop on Benchmarking Clonal Propagation for the Blue Gum Plantation Industry' 7-12 March. Mt Gambier, South Australia.

de Little DW (2004) Historical review of cloning R&D for temperate species. Presentation at 'Workshop on Benchmarking Clonal Propagation for the Blue Gum Plantation Industry' 7-12 March. Mt Gambier, South Australia.

Dieters MJ, Harding KJ (2003) Enhanced selection and breeding of hybrid pines for improved wood properties. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Dutkowski GW, Greaves BL (2003) Inventory of *Eucalyptus globulus* plantation basic density. We can do it but do we want to? Presentation at 'WoodFest' 21 Aug. 2003. Melbourne, Victoria.

Dutkowski GW, Volker PW (2003) Alternative breeding and deployment objectives for *Eucalyptus globulus*. Presentation at 'WoodFest' 21 Aug. 2003. Melbourne, Victoria.

Dutkowski GW (2004) Scientific tests show ... the stats of TREEPLAN. Presentation at 'STBA Treeplan Workshop' 13 March 2004. Mount Gambier, South Australia.

Dutkowski GW (2004) Can cloning carry the cost? Presentation at 'Workshop on Benchmarking Clonal Propagation for the Blue Gum Plantation Industry' 7-12 March. Mt Gambier, South Australia.

Freeman JS, Milgate AW, Vaillancourt RE, Mohammed CL, Potts BM (2003) Genetic resistance to *Mycosphaerella* leaf disease in *Eucalyptus globulus*. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Griffin AR (2004) Pros and cons of clonal forestry. Presentation at 'Workshop on Benchmarking Clonal Propagation for the Blue Gum Plantation Industry' 7-12 March. Grafton, NSW.

Hamilton M, Potts BM, Apiolaza LA, Harwood CE (2003) Breeding to minimise checking in *Eucalyptus nitens*. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Hamilton M (2003) Breeding *Eucalyptus nitens* for improved solid-wood properties. Seminar, Hobart, Tasmania.

Harwood CE (2003) Improving solid wood properties of eucalypts. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Harwood CE (2003) Recent results from CRC Project A5 Wood Quality. Presentation at 'WoodFest' 21 Aug. 2003. Melbourne, Victoria

Harwood CE (2004) Review of cloning technology in Australia to date. Presentation at 'Workshop on Benchmarking Clonal Propagation for the Blue Gum Plantation Industry' 7-12 March. Grafton, NSW.

Henry RJ (2003) Molecular breeding in tropical pines. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Huang S (2004) Obtaining benefits from marker-aided breeding of hybrid pines with an overview of forestry in southern China. Seminar, Gympie, Queensland.

Hunter SJ (2004) Cloning R&D at WAPRES. Presentation at 'Workshop on Benchmarking Clonal Propagation for the Blue Gum Plantation Industry' 7-12 March. Mt Gambier, South Australia.

Jones TH, Vaillancourt RE, Potts BM (2003) Pollen movement and bi-parental inbreeding in the Tasmanian Bluegum. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Li Y, Apiolaza LA (2003) Effect of connectedness between sites on precision of estimated GxE interaction. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Lorkin MH, Pound LM, Patterson B, Wallwork MA, Sedgley M, Vaillancourt RE, Potts BM (2003) Self-incompatibility in *Eucalyptus globulus*. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

McKinnon GE (2004) Hybridisation Matters - Historical process in the Tasmanian eucalypts. Seminar, Hobart, Tasmania.

Moran GF, Thumma R (2003) Molecular breeding for improved wood properties in eucalypts. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Patterson B, Vaillancourt RE, Potts BM (2003) Evaluating seed production systems in *Eucalyptus globulus*. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Pilbeam DJ (2004) STBA breeding and deployment. Presentation at 'Workshop on Benchmarking Clonal Propagation for the Blue Gum Plantation Industry' 7-12 March. Mt Gambier, South Australia.

Poke FS, Reid JB, Vaillancourt RE (2003) The effect of SNPs on lignin in *Eucalyptus globulus*. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Potts BM (2003) Death of the Cider Gum: A lesson for the management of biodiversity. Poster at 'XIX International Congress of Genetics' 6-11 July. Melbourne, Victoria.

Potts BM (2003) Genetic opportunities. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Potts BM (2003) Death of the Cider Gum: A lesson for the management of biodiversity. Poster at 'Workshop on Consequences of Habitat Fragmentation' 5-6 July. Sydney, NSW.

Potts BM, Barbour RC, Vaillancourt RE (2003) Identifying the risks of genetic pollution of native eucalypt gene pools. Seminar for CSIRO FFP. Canberra, ACT.

Potts BM (2003) Death of the Cider Gum: A lesson for the management of biodiversity. Poster at 'Endangered Species CD Launch'. RTBG, Hobart, Tasmania.

Potts BM (2004) Genetic parameters (non-additive). Presentation at 'Workshop on Benchmarking Clonal Propagation for the Blue Gum Plantation Industry' 7-12 March. Mt Gambier, South Australia.

Ratham W (2003) The impact of logging on the genetic diversity of tree species. Seminar. Hobart, Tasmania.

Shepherd M, Eggler P, Mellick R, Cross M, Toon PG, Dale G, Huang S, Dieters MJ (2003) Stability of gene effects (QTL) in extreme genetic backgrounds: Mapping genes controlling adventitious root formation in hybrid pines. Poster at 'CRC-SPF Annual Meeting 2003' 21 October 2003- 23 October 2003, for CRC-SPF. Cradle Mountain, Tasmania.

Shepherd M, Eggler P, Mellick R, Cross MJ, Toon PG, Dale GT, Huang S, Dieters MJ (2003) Stability of gene effects (QTL) in extreme genetic backgrounds: Mapping genes controlling adventitious root formation in hybrid pines. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Shepherd M (2004) Simplified genetic structures of hybrids aid marker aided selection in trees. Centre for Plant Conservation Genetics Seminar, Lismore, NSW.

Steane DA, Conod N, Vaillancourt RE, Potts BM (2003) Population differentiation in a forest tree - *Eucalyptus globulus*. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Tilyard PA, Potts BM, Brereton R, Mallick SA, James D (2003) The Tasmanian Blue Gum is an unreliable food source for the Swift Parrot. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Vaillancourt RE (2003) Optimising seed production systems in Eucalypts. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Vaillancourt RE, Foster SA, Steane DA, Potts BM (2003) Local differentiation in *Eucalyptus globulus*. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Weller JL (2003) Lighting the green fuse - comparative genetics and the control of flowering. Seminar, Hobart, Tasmania.

Whittock SP, Greaves BL, Apiolaza LA (2003) An economic assessment of genetic gain and coppice productivity in second rotation plantations. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Whittock SP (2004) Economic models - propagule cost and gain. Presentation at 'Workshop on Benchmarking Clonal Propagation for the Blue Gum Plantation Industry' 7-12 March. Mt Gambier, South Australia.

Sustainable Management Program

Battaglia M (2003) Silvicultural decision support to underpin precision forestry. Invited talk at 'Research Working Group 2 workshop "Modelling forests from leaves to landscape"' 1-3 December. Melbourne, Victoria.

Battaglia M, White DA (2003) Using models to optimise production and manage risk in pines and eucalypts. Invited talk at 'Silvotecna XVIII Aumento de Rentabilidad en Plantaciones de Pinos y Eucaliptos: Mejoramiento en Calidad Plantas y Productividad de Sitios' 11-12 November. Conception, Chile.

Battaglia M (2003) Modelling plantation production and quality: a retrospective and a prospective. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Beadle CL (2003) Pruning and thinning. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Blumfield TJ, Xu ZH, Mathers NJ (2003) Decomposition of 15N-labelled harvest residues in the hoop pine plantations of sub-tropical Australia. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Blumfield TJ, Xu ZH, Mathers NJ (2003) Decomposition of 15N-labelled harvest residues in the hoop pine plantations of sub-tropical Australia. Poster at '10th North American Forest Soils Conference' 20-24 July. Ontario, Canada.

Burton J, Blumfield TJ, Xu ZH (2003) Using stable isotopes to investigate in situ N transformations in forest ecosystems of subtropical Australia. Poster at '10th North American Forest Soils Conference' 20-24 July. Ontario, Canada.

Burton J, Blumfield TJ, Xu ZH, Ghadiri H (2003) Using 15N stable isotopes to investigate *in situ* N transformations in forest ecosystems of sub-tropical Australia. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Catchpoole KJ, Nester MR, Harding KJ (2003) Developing a decision support system for predicting wood value. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Chen CR, Xu ZH, Blumfield TJ, Hughes JM (2003) Soil microbial biomass during the early establishment of hoop pine plantation: seasonal variation and impacts of site preparation. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Chen CR, Xu ZH, Blumfield TJ, Hughes JM (2003) Soil microbial biomass during the early establishment of hoop pine plantation: Seasonal variation and impacts of site preparation. Poster at '10th North American Forest Soils Conference' 20-24 July. Ontario, Canada.

Close DC (2003) Tree establishment in treeless agricultural landscapes in the Midlands of Tasmania. Presentation at '15th Annual Conference of the Society for Ecological Restoration International'. Austin, Texas, USA.

Close DC, Bail I, Hunter SJ, Beadle CL, McArthur C (2003) Defining and achieving seedling specifications for *Eucalyptus globulus*: Effects of nursery nitrogen-management, seedling size and container type on after-planting performance. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Close DC, Davidson NJ (2003) Effect of waterlogging on nutrition, photoinhibition and sustained xanthophyll engagement in *Eucalyptus nitens* saplings. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Davidson NJ (2003) Causes of Rural Tree Decline and Potential Ways of Revegetating Affected Areas. Hobart, Tasmania.

Davidson NJ (2003) Research at the CRC for Sustainable Production Forestry. Presentation to Year 12 class, The Hutchins School.

Davidson NJ (2004) The water cycle and the development of salinity. Presentation to SOSE class, Calvin Christian School.

Davidson NJ (2004) The impact of salinity on the lives of people in Pakistan. Presentation to Chemistry class, Calvin Christian School.

He J, Xu ZH, Hughes JM (2003) Soil bacterial communities under different forest ecosystems in Queensland. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Jarvis P (2003) Carbon forestry. Seminar. Hobart, Tasmania.

Knowles A, Smethurst PJ (2003) Base cation ratios affect the growth of *Eucalyptus globulus* seedlings. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Laird A (2003) Photoinhibition and its role in subalpine eucalypt ecology. Seminar. Hobart, Tasmania.

Linder S (2003) Manipulating forest ecosystem carbon sinks by silvicultural management. Seminar. Hobart, Tasmania.

Mitchell AD, Smethurst PJ (2003) Changes in the base cation composition of soil solutions resulting from the application of N and P fertilizers. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Mitchell AD, Smethurst PJ (2003) Cation deficiencies in fertilised *Eucalyptus globulus* seedlings. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Mummery DC, Battaglia M (2003) Producing weather inputs for process-based models. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

O'Grady AP, Worledge D, Tyree M, Battaglia M (2003) How hard do trees suck? Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

O'Grady AP, Tyree M, Battaglia M, Worledge D (2003) Hydraulic characteristics of *Eucalyptus globulus* in South East Tasmania. at 'Ecophizz' October 2003. Melbourne, Victoria.

Race D (2003) Working partnerships: Engaging communities in plantation forestry. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Sands PJ (2003) Models for Forest Management? Integrating determinants of growth into practical management systems. Invited and funded talks for ICFR and Mondi Forests. Pietermaritzburg, South Africa.

Shield C (2003) The adaptive significance of juvenile glaucousness in *Eucalyptus urnigera* on Mt Wellington. Seminar. Hobart, Tasmania.

Smethurst PJ (2003) Soil and Nutritional Management Applications from CRC Research. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Smethurst PJ, Mendham DS, Holz GK, Menary RC, Keith H, Misra RK, Baoping W (2003) Phosphorus management in temperate eucalypt forests. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Spurr D, Pryor R, Davidson NJ, Battaglia M (2003) The effect of waterlogging on plantation eucalypt species. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Xu ZH (2003) Sustainable Management of Subtropical Pines: An overview of research project B2 - Management of Tropical Soils in the past six years. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Resource Protection Program

Allen GR (2003) Entomology research outcomes - Eastern Australia. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Barry KM (2003) Stem decay and defect in eucalypt plantations. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Barry KM, Hall M, Mohammed CL (2003) Monitoring decay incidence and spread from pruning wounds of *Eucalyptus nitens*: We learn as they grow. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Barry KM (2004) Heartrot and rootrot in Indonesian *Acacia mangium*: summary of research on surveys, fungal identification and heartwood extractives. Seminar, Mie University, Tsu, Japan.

Deflorio G (2004) Wood decay dynamics in the sapwood of living trees - *In vivo* and *in vitro* studies on the role of wood substrate on decay development. Seminar. Hobart, Tasmania.

Eyles A, Davies NW, Mohammed CL, Mitsunaga T, Mihara R (2003) Eucalyptus wound wood extractives show antimicrobial and antioxidant activity (a case study with *E. globulus* and *E. nitens*). Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Harrison KS, Hopkins AJM, Grove SJ, Mohammed CL (2003) Living trees - what lives here? Saproxylic insects and wood decay fungi in living *Eucalyptus obliqua* in Tasmania's wet sclerophyll forests. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Loney P, McArthur C, Jordan GJ (2003) The effect of leaf structure on herbivory by brushtail possums. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Loney P, McArthur C, Jordan GJ (2003) The effect of leaf structure on herbivory by brushtail possums. Poster at '49th Australian Mammal Society Annual Conference' 7-9 July, for Poster. Sydney, NSW.

Mathiessen J (2003) Entomology research outcomes Ð Western Australia. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Matsuki M (2003) Effects of eucalypt leaf chemistry on leaf consumption by herbivores, and the relationship between phenology of leaf production and insect populations. Seminar for QDPI. Brisbane, Queensland.

Matthiessen JN, Simmul TL (2003) Biology and management of *Heteronyx elongatus*. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

McArthur C (2003) Seedlings for managing mammal browsing. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Miller A (2003) Predicting the consumption of individual plants by generalist marsupial herbivores in a heterogeneous environment. Introductory PhD seminar. Hobart, Tasmania.

Miller A, McArthur C, Smethurst PJ (2003) Predicting the consumption of individual plants by generalist marsupial herbivores in a heterogenous environment. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Mohammed CL (2003) Introduction to fungal diseases. Presentation at 'Forest Health Workshop'. Manjimup, WA.

Mohammed CL (2003) Forest health - past and future perspectives for research. Presentation at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

O'Reilly-Wapstra JM (2003) Reducing the effects of brushtail possums using natural plant resistance. Presentation at '3rd International Wildlife Management Congress' 1-5 December, Christchurch, New Zealand.

O'Reilly-Wapstra JM (2003) Preferences of brushtail possums for *Eucalyptus globulus*: a genetic, chemical and evolutionary context. Final PhD Seminar. Hobart, Tasmania.

O'Reilly-Wapstra JM, McArthur C, Potts BM (2003) Sideroxylonal reduces possum browsing of *Eucalyptus globulus*. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Pietrzykowski E, McArthur C, Fitzgerald H (2003) Effects of vegetation patch characteristics on damage to *Pinus radiata* seedlings by marsupial herbivores. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Pietrzykowski E (2003) Risk and remote sensing of *Mycosphaerella* leaf blotch in eucalypt plantations. Workshop at 'Forest Health Workshop'. Manjimup, WA.

Pietrzykowski E, Booth TH, Battaglia M, Stone C, Mohammed CL, Pinkard EA, Wardlaw T, Smith A (2003) Is the risk of an epidemic too high? Case study: Risk and remote sensing of *Mycosphaerella* leaf blight. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Pinkard EA (2003) Foliar pests - new solutions from new technology. Presentation at 'Forest Health Workshop'. Manjimup, WA.

Smith A (2003) Development of an in planta PCR detection system for *Mycosphaerella* spp. of Eucalypts. Workshop at 'Forest Health Workshop'. Manjimup, WA.

Smith A (2003) Crown Damage Index. Workshop at 'Forest Health Workshop'. Manjimup, WA.

Smith A, Glen M, Tommerup I, Langrell S, Mohammed CL (2003) Rapid, *in planta* detection of pre-visual disease symptoms: a *Mycosphaerella* example. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Smith A, Wardlaw T, Pinkard EA, Battaglia M, Pietrzykowski E, Mohammed CL (2003) Is the Crown Damage Index damaged by scorer variation? Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Wiggins NL, McArthur C (2003) The benefits of choice. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Wiseman D, Hall M, Baillie CC, Smethurst PJ, Beadle CL, Pinkard EA, Mohammed CL (2003) Tree nutrition influences wood decay. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

Yee M (2003) Dead wood is good: insights into the ecology and management of saproxylic communities in Tasmania's wet eucalypt forests. Seminar. Hobart, Tasmania.

Yee M (2003) Dead wood is good: Xylobiont beetles in Tasmania's wet sclerophyll forests. Seminar in 'Freiburger Entomologischer Arbeitskreis Seminar Series'. Freiburg im Breisgau, Germany.

Yee M, Grove SJ, Mohammed CL (2003) Bed and breakfast for bugs, are we closing shop? Beetles in the rotted wood of Tasmania's wet sclerophyll forests. Poster at 'CRC-SPF Annual Meeting 2003' 21-23 October 2003. Cradle Mountain, Tasmania.

GRANTS AND AWARDS

Grant / Award	Awarded for	Duration	Recipients	Amount $
Genetic Improvement Program				
IRGS grant	DNA 'barcoding' systems for plants: Towards a proof of concept with *Eucalyptus*	1 year	A/Prof B Potts Dr R Vaillancourt	$23,100
Australian Research Council Linkage Grant	Unravelling the relationship between growth and wood properties in temperate eucalypts	3 years	Dr R Vaillancourt A/Prof B Potts Prof J Reid Dr N Borralho Dr J Gion	ARC $330,000 Industry $98,000
Australian Research Council Discovery Grant	Genetic impacts on eucalypt forest biodiversity	3 years	A/Prof B Potts Prof T Whitham	$240,000
Australian Research Council Linkage Grant	Assessing the risk of genetic pollution from *Eucalyptus globulus* and *Corymbia* plantations	3 years	A/Prof B Potts Dr R Vaillancourt	ARC $270, 000 Industry 60,000
Australian Research Council RIEF	Upgrade of Infrared Analytical Facility	1 year	A/Prof B Potts and others	$101,000
University of Tasmania Honours Prize	Lola Jackson Award, for best Honours thesis in Botany for 2003		D Rathbone	$250
Australian Journal of Botany's 2003 Student Prize	PhD paper published - The first report of exotic hybrids between a plantation and native forest eucalypt species establishing in the wild		R Barbour	$250
Australian Academy of Science Young Researchers Award	Testing Approaches for the Simple Prediction of Breeding Values in Forest Trees Across progeny Trial Sites with Heterogenous Variances	6 weeks	G Dutkowski	$7,500
AusIndustry	Clonal workshop on *Eucalyptus globulus*	5 days	Prof R Griffin	$43,728
ACIAR	Eucalypt Genomics Workshop	3 days	Prof R Griffin	$30,000
University of Tasmania, Faculty of Science, Engineering and Technology - Major Equipment	Purchase of a Tetrad thermal cycler		Dr R Vaillancourt Prof J Reid A/Prof B Potts J Weller J Ross A/Prof G Hallegraeff Dr A Richardson J Bowman K Sanderson S Jarman A Smolenski	$21,920 and $19,000
Australian Research Council Linkage Grant	Wood quality improvement for spotted gum	3 years	Prof R Henry	$362,000

Sustainable Management Program

Australian Research Council Linkage Grant ID: LP0454287	Cellular automata model of forest stands to predict size-class distribution and survival	3 years	Dr M Adams Dr R McMurtrie Dr M Battaglia Dr M Tyree	ARC $323,000 Industry $150,000
Natural Heritage Trust and Clarence Council	Best management and design guidelines for wastewater irrigation	1 year	Dr P Smethurst	$157,000 (in part)
RIRDC-JVAP	Assembling the pieces: restoration, design and landscape ecology (Conference, Austin , Texas)	1 week	Dr D Close	$2,000
Gottstein Fellowship	Riparian Forestry in USA and Germany	3 months	Dr P Smethurst	$6,000
Wilf Crane Memorial Award	Travel for PhD: modelling root uptake dynamics	3 months	S Koh Dr P Sands	$1,300

Resource Protection Program

Australian Research Council Linkage Grant	Info-chemicals for the environmentally sustainable management of autumn gum moth & scarab beetle pests of blue gum plantations	3 years	Dr G Allen Dr N Davies Dr J Elek	$260,000
Australian Research Council Linkage Grant ID: LP0453591	Determining generic indicators of stress in eucalypt leaves for application to the remote sensing of canopy condition and productivity modelling	3 years	Dr K Barry, Dr C Mohammed Dr C Beadle Dr M Battaglia Dr C Stone Dr A Carnegies Dr M Martin Dr N Davies	ARC $197,000 Industry $75,000
FWPRDC	Fertilisation and forest health: preventing or offsetting biotic leaf loss in eucalypt plantations	2 years	Dr C Mohammed Dr M Battaglia Dr E Pinkard Dr P Smethurst	$150,000
Holsworth Wildlife Research Fund	Resistance of *E. nitens* to mammalian herbivores		P Loney	$3,500
Holsworth Wildlife Research Fund	Interactions between mammalian herbivores and eucalypt plantations		N Wiggins	$2,300
Journal of Experimental Biology	Journal of Experimental Biology Travel Fund		J O'Reilly-Wapstra	£2,210
Joseph William Gottstein Memorial Fellowship	Professional advancement in the forestry field		J O'Reilly-Wapstra	$5,500
Society of Experimental Biologists	Company of Biologist Travel Fund		J O'Reilly-Wapstra	£300
Maxwell Ralph Jacobs Fund	Travel Fund		J O'Reilly-Wapstra	$1,500

Australasian Wildlife Management Society	Travel support to attend the International Wildlife Management Congress, NZ.		J O'Reilly-Wapstra	$400
Holsworth WildLife Fund	Research and travel		A Hopkins	$3,000
Holsworth WildLife Fund	Research and travel		K Harrison	$3,000
Warra grant, Forestry Tasmania	Research		K Harrison	$2,000
Warra grant, Forestry Tasmania	Research		A Hopkins	$2,000
Maxwell Ralph Jacobs Fund	Travel Fund	2 months	A Smith	$2,500
Forestry Tasmania PhD top-up	Research	3 years	K Harrison	$5,000
Dean's Commendation, University of Tasmania	An outstanding PhD thesis in 2003		A Eyles	
TOTAL				$2,968,044

CONSULTANCIES

With	For	Duration	Recipients	Amount $
WAPRES	Orchard-wide estimate of outcrossing rates in *E. globulus*	1 year	Dr R Vaillancourt	$3,000
Prof P Sanger (SCU)	Facilitation of ACIAR workshop "DNA marker techniques"	5 days	Dr M Shepherd	$5,000
Prof P Sanger (SCU)	Facilitation of ACIAR workshop "DNA marker techniques"	5 days	Dr M Shepherd	$5,000
QLD Dept Natural Resources and Mines: TAP (Technical Advisory Panel)	Pioneer Valley Groundwater Consultancy, Resource and Environmental Management	1 year	Dr P Howe Dr P Cook Dr A O'Grady J Hillier	$33,000
Various Forest Companies	Plant and soil analyses	1 year	A Wilkinson	$34,000
UTas Consulting	Seed Orchard Valuatioff for URS Forestry	2.5 days	G Dutkowski	$2,400
TOTAL				$82,400

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. 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 Coordinating 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 representatives and consist largely of the partners' staff to ensure that they are involved setting research priorities.

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

Documented visits to individual CRC partners and between nodes of the CRC (Hobart, Canberra, Brisbane, Gympie) totalled 224 person-days for 2003/04.

- ***Proportion of joint publications with other research groups***

62 (24%) of the 257 technical publications (book chapters, refereed publications, in-press, unrefereed publications, confidential reports, theses) were written with other research groups.

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

There were a large number of visitors to the CRC, and to CRC-arranged seminars. Those who took part in the CRC Visitor Program and had extended visits to the CRC to collaborative research were:

Prof Wickneswari Ratnam, from the School of Environmental and Natural Resource Sciences, Faculty of Science and Technology, Universiti Kebangsaan Malaysia visited the CRC from April-September 2003 to work with Dr Rene Vaillancourt on 'Analysis of cambial region and developing xylem cDNA libraries for *Acacia mangium x Acacia auriculiformis* hybrids and development of molecular markers for lignin genes for selection and manipulation'.

The Genetic Improvement program hosted Dr. João da Costa e Silva who is working on a collaborative project between the CRCSPF and two Portugese orgnaisations, the Universidade Técnica de Lisboa and RAIZ. He was working with A/Prof. Brad Potts and Greg Dutkowski on the quantitative genetics of *Eucalyptus globulus* and spatial analysis.

A/Prof Showei Huang, Forestry College, South China Agricultural University, visited the CRC between July and October 2003 and again between December to March 2004) to with Dr M Dieters at QFRI and Dr M Shepherd at SCU on quantitative and molecular genetics of pines.

Brazilian foresters Celina do Valle and Ana Gabriela Monnerat Carvalho, from paper manufacturer Votorantim Celulose e Papel (VCP) visited Brad Potts and the CRC-SPF on the 21st January 2004.

Prof Ann Hagerman, from Miami University, Oxford, OHio. visited the CRC from May to July 2003 to work with Dr Dugald Close and Dr Clare McArthur at CSIRO FFP on 'Biological antioxidants and the effects of plant phenolics on mammalian feeding and performance'.

Dr Fredrik Östrand from Lund University, Lund, Sweden, visited the CRC from July 2002 to August 2003 to work with Martin Steinbauer at CSIRO Entomology Canberra on the improvement and efficacy of the sex pheromone of autumn gum moth.

Rie Mihara visited for 6 months from the University of Mie, Japan to work on the chemistry of host resistance to decay fungi.

Dr Christine Stone, SF NSW has visited to assist with development of hyperspectral indicators of *Mycosphaerella* disease severity.

- ***The degree of interaction among scientific staff at dispersed locations on core activities of the research program, included:***
  - *the economic importance and genetic control of growth, stem characteristics and wood properties at the quantitative and molecular levels*

The genetics program is structured to ensure close interaction between projects both within and across nodes of the CRC. The quantitative and molecular genetics projects are paired to ensure synergies between these different fields. For example, the northern node projects A6 and A7 closely interact on work on tropical hybrid pines, A1 and A4

work closely together on the molecular genetics of temperate eucalypts, and A3 and A5 interact in studying the genetic control and mapping of wood property genes in *Eucalyptus globulus* and *E. nitens*.

The breeding strategies project A2 integrates research in the other temperate projects for strategy development. There is also regular interaction between the various groups working in the same field across different nodes. They are linked by common technologies, and technological advances made in one project are usually directly relevant to the other projects. For example, the quantitative genetics projects interact on the application of genetic models and use of specialised programs (e.g. ASREML) for estimating genetic parameters and breeding values.

Collaboration between the two molecular projects A4 and A7 is occurring in the use of AFLP molecular markers in a eucalypt mapping populations and molecular relationships within and between *Corymbia* and *Eucalyptus*. Project A2 works with scientists from QFRI, GL, STBA, CSIRO and FT on the use of ASREML software for the analysis of their data. Project A1 links with projects A6 and A7 on problems associated with eucalypt genetics and hybridisation, which are common to temperate and sub-tropical eucalypts. For example, there was joint supervision of a PhD project on *Corymbia* genetics between GU and UT.

Project A1 is conducting research projects on the genetics of *E. globulus* across Australia in southern (UT and FT) and northern Tasmania (GL), in Western Australia (WACAP), and in Victoria (GRP). Aspects of this work are being undertaken in collaboration with the STBA. Project A2 also works closely with STBA on the development of data management and analysis systems, as well as breeding, deployment and analysis strategies. For example, a study of genetic parameters in the first series of second generation breeding trials of *E. globulus* has been completed along with a contact analysis of GL *E. nitens* breeding population.

Project A5 has strong links with CSIRO scientists in Melbourne in research on Silviscan, cellulose content analysis and Near Infrared Reflectance Analysis, as well as with project A3 in Canberra. There are also strong links with FT and GL and the project is also working with the STBA on studying genetic parameters of specific wood property traits

Several projects involve collaboration between Genetic Improvement Program (GI) projects A1 and A5 and the Sustainable Management Program (SM), and there is considerable linkage between GI, SM and the Resource Protection Program (RP) on the genetics of pest and disease resistance and the modelling on disease risk and impact.

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

Project A2 provides research results from the southern node projects for the breeding and deployment strategies of industry. It has strong links with most industrial partners and is closely integrated with STBA's *Eucalyptus* Breeding Program (to which many of the temperate partners belong) and its spin-off company SeedEnergy. This link is enhanced by the co-location of one of the managers of SeedEnergy, Peter Gore, on the University of Tasmania campus. The CRC has representation on the STBA Board (Greg Dutkowski), and on the Technical Committee, and Research, Quantitative Genetics and Data Management Sub-Committees (Greg Dutkowski, Dr Yongjun Li and Dr René Vaillancourt), which has assisted in the transfer of technology from the program to this and other partners. Project A1 interacts closely with STBA and its members in providing research to back new seed production systems being developed for *E. globulus*. It also collaborates with STBA and its spin-off company seedEnergy on research into self-incompatibility and flowering time in arboreta and seed orchards across Australia. Project A2 has been closely involved with scientists in the STBA in the design and implementation of TREEPLAN® and STBA-DMS® breeding value prediction and data management systems. The project A6 is based within and closely interacts with DPIQ and QFRI, the organisation responsible for the breeding and deployment of sub-tropical pines in Queensland. This year the Genetic Improvement program was involved in the organization of a major workshop reviewing the status and opportunities for clonal deployment of *E. globulus* in Australia.

- *pruning and thinning*

Dr Jane Medhurst (University of Tasmania) and Mr Andy Warner (PFT) organised a blackwood field day for 40 delegates in north-west Tasmania for growers throughout the State. The procedures required to ensure successful tending of blackwood grown with a nurse crop were demonstrated.

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

Dr Philip Smethurst used the response of plantations to nutrient supply on the Gunns plantation estate as a basis for teaching their field staff how to manage fertiliser practice on the estate.

- forestry extension as a tool for assisting forest owner, farmer and stakeholder decision-making

Dr Digby Race (ANU) assisted in the organisation of the 2004 Australian Forest Growers Conference "Integrating forestry into farms, communities and catchments" and was the editor of the proceedings.

Dr Neil Davidson and Dr Dugald Close have been working with the Midlands Tree Committee, Southern Midlands Council and Tasmanian farmers to develop protocols for establishing trees in areas affected by rural tree decline.

Brad Potts was invited to join the Giant Trees Consultative Committee which was established to advise Forestry Tasmania on the management of Tasmania's giant trees.

- prediction of productivity in response to environmental factors and management inputs

A special issue of Forest Ecology and Management in this area featuring key papers from EucProd 2002 is being published as volume 193. It features 17 papers and an introduction, 9 of which are authored or co-authored by staff associated with this CRC.

Dr Peter Sands was invited to work with scientists at the Institute of Commercial Forestry Research in South Africa to help them develop a productivity prediction system.

- measurement of leaf area index in the field

Ms Maria Cherry ran a second series of training courses in the use of the Visual Guide for measuring leaf area index both in Tasmania for staff at Norske Skog and in the Green Triangle (South Australia and Victoria) for Timbercorp staff.

- investigation of pathogens of forest insect pests

This research in Tasmania has essentially concluded following the retirement of Dr John Madden (now honorary CRC Fellow). Industry was satisfied with the progress that has been made and was keen for other areas to be pursued.

- studies of the ecology and behaviour of insect herbivores in temperate Australia

There has been a high degree of collaboration between locations in research on insect herbivores Dr M. Matsuki (CRC and IPMG, WA) and Dr M Steinbauer (CRC Canberra) collaborated in analyses of research on Autumn Gum Moth. Dr M. Matsuki (CRC and IPMG, WA) and John Matthiessen (Perth W.A.) collaborated on a study of the phenology, distribution and biodiversity of *Heteronyx* beetles in blue gum plantations in WA. Dr M. Matsuki (CRC and IPMG, WA), Dr J. Bulinski (Timber Corp WA), and S. Hunter (WAPRES, WA) collaborated on a study developing the weevil population assessment scheme. Dr M. Matsuki (CRC and IPMG, WA), Dr Jane Elek (Forestry Tasmania), and Dr Geoff Allen (CRC Hobart) are working together on recolonisation of insect pests after chemical control in Tasmania. Dr M. Matsuki (CRC and IPMG, WA), Greg Dutkowski (CRC, Hobart), and Jill Butterworth (CRC, Hobart) are developing a database on herbivores, their natural enemies, and pathogens in Australian plantations. Research on key insect pests in W.A. forestry involves Timbercorp and WAPRES (W.A.) with J Matthiessen (Perth W.A.). An e-group (email group) between all researchers in RPP and interested forestry companies is maintained for rapid communication of information relating to insect pests and other factors affecting tree health.

- impact of insect pests at plantation establishment

H Redgrove and Dr G Allen (UT) have been investigating the biology of *Heteronyx* beetles and their effect on establishment of *E. nitens* plantations with Dr D de Little (Forest Health Consultant).

- genetic and chemical basis of eucalypt resistance to browsing

Ms J O'Reilly-Wapstra completed her PhD thesis, which was on genetic variation of resistance of *E. globulus*, in collaboration with Dr C McArthur (supervisor) and A/Prof B Potts (co supervisor, Genetic Improvement Program). Projects from the vertebrate browsing section of RP in Hobart closely interact with the GI program in research related to resistance breeding and three PhD students are jointly supervised.

- *investigation of pathogens of plantation trees*

Research on stem decay, mechanisms of tree defence and wound tissue formation has continued between Dr C Mohammed (CSIRO, UT), and Dr T Wardlaw (FT). *Mycosphaerella* research has also progressed with collaboration between C Mohammed and several companies in Tasmania (Dr D de Little, GFP; T Wardlaw, FT) and Western Australia (Dr J Bulinksi, Timbercorp).

Research and researchers

- ***Papers in refereed journals***

In 2003/04 the Centre produced a total of 257 publications, 91 published in refereed journals and 22 in press, as well as 69 unrefereed publications and 15 theses.

- ***Book chapters covering the results of the Centre's research***

Seven book chapters were written in 2003/04 (see Publications).

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

There were 5 invited presentations in 2003/04:

Potts BM, Barbour R and Vaillancourt RE (2004). Assessing the risk of pollen-mediated gene flow from planted eucalypts. Talk abstract In 'Integrating forestry into farms, communities and catchments' (Ed. Digby Race). Pp. 80. Proceedings of Australian Forest Growers Biennial Conference, Ballarat 3-5 May 2004 (Invited presentation)

Smethurst P (2004) Talk abstract In 'Integrating forestry into farms, communities and catchments' (Ed. Digby Race). Pp. 80. Proceedings of Australian Forest Growers Biennial Conference, Ballarat 3-5 May 2004 (Invited presentation)

Mohammed CL, Close DC, Rapley L, Battaglia M and Beadle C (2004) 'Understanding tree responses to stress: Manipulating for maximum profit'. Talk abstract In 'Integrating forestry into farms, communities and catchments' (Ed. Digby Race). Pp. 80. Proceedings of Australian Forest Growers Biennial Conference, Ballarat 3-5 May 2004

Steinbauer, M (CRC, Canberra) Invited paper at 'Chemical Ecology of Insect-Plant Interactions Symposium', Australian Ecological Society's Annual General Meeting, Armidale, NSW, December 2003.

Potts, BM (2004). Genetic improvement of eucalypts. In 'Encyclopedia of Forest Science'. pp. 1480-1490. (Elsevier Science: Oxford) (Invited review)

- ***Number and value of competitive grants awarded***

Twenty nine competitive grants were awarded to CRC staff during the last financial year, totalling $2,968,044. Several of these were prestigious, highly competitive ARC awards such as ARC Discovery.

- ***Honours and awards***

Alieta Eyles, Dean's Commendation, University of Tasmania for an outstanding PhD thesis in 2003

Robert Barbour, Australian Journal of Botany's 2003 Student Prize

Greg Dutkowski, Australian Academy of Science Young Researchers Award for Testing Approaches for the Simple Prediction of Breeding Values in Forest Trees Across Progeny Trial Sites with Heterogenous Variances

Dr Philip Smethurst, Gottstein Fellowship for investigation of Riparian Forestry in USA and Germany

Sharon Koh, Wilf Crane Award for PhD travel to study modelling root uptake dynamics

Julianne O'Reilly-Wapstra, Joseph William Gottstein Memorial Fellowship for professional advancement in the forestry field

Julianne O'Reilly-Wapstra, Maxwell Ralph Jacobs Fund to support travel to UK

Julianne O'Reilly-Wapstra, Journal of Experimental Biology Travel Fund to support travel to the UK.

Julianne O'Reilly-Wapstra, Society of Experimental Biologists Travel fund to support travel to the UK.

Julianne O'Reilly-Wapstra, Australasian Wildlife Management Society travel support to travel to N.Z.

Anna Smith, Maxwell Ralph Jacobs Fund to support research travel

Anna Hopkins, Holdsworth Wildlife Fund award for research travel.

Kate Harrison, Holsworth Wildlife Fund award for research travel.

Damien Rathbone, University of Tasmania Lola Jackson Award, for best Honours thesis in Botany for 2003

Education and training

- ***Time spent by researchers on research training***

There are 51 PhD, 6 MSc and 2 Honours students enrolled with CRC-SPF. It is recognised that each student takes 5–10% of a researcher's time to supervise. This is equivalent to 2.95–5.9 person-years on research training.

- ***Number of postgraduate students working in the Centre***

The Centre has 57 postgraduate students and 2 Honours students (see Table 3).

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

Genetic Improvement	19
Sustainable Management	26
Resource Protection	14

- ***Number of enrolments in special courses***

Forest Ecology, a special undergraduate course in Plant Science at the University of Tasmania had five students enrolled. In addition there was an Annual Meeting of the CRC and a wide range of workshops and field days organised to train staff, including 2 special training workshops or 'Fests' (see list under Outcomes in Education and Technology Transfer). The total number of enrolments for all these courses was 282.

- ***Quality and number of postdoctoral fellows attracted***

Ten postdoctoral fellows worked with the Centre in 2003/04: Dr R Thumma in molecular genetics (CSIRO FFP, Canberra), Dr M Steinbauer in entomology (CSIRO Ento, Canberra), Dr M Shepherd in molecular biology (SCU, Lismore), Dr D Close in tree physiology (UT, Hobart), Dr D Steane and Dr B Patterson in molecular genetics (UT, Hobart), Dr A O'Grady in root biomass turnover (UT, Hobart), Dr Jane Medhurst (UT Hobart) on Blackwood silviculture, Dr Karen Barry on tree pathology (UT, Hobart), and Dr Mamoru Matsuki on insect ecology (UT, Hobart).

- ***Rate and percentage of completion of higher degrees***

Fifteen students completed this year, 9 PhD and 6 Honours:

Robert Barbour (PhD), Gay McKinnon (PhD), Andrew Gibbons (PhD), Ross Peacock (PhD), Paul Adams (PhD), Chris O'Hara (PhD), Greg Unwin (PhD), Grant Westphalen (PhD), Alieta Eyles (PhD). Damien Rathbone (Hons), James Worth (Hons), Cameron Shield (Hons), Andrew Laird (Hons), Djirilina Burton (Hons), Kate Horweg (Hons).

- ***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 this year: Dr Peter Volker (who recently completed PhD with the CRC) is now Acting Chief Scientist and Principal Research Officer (Plantations), Dr Luis Apiolaza (CRC post-doc) is now Principal Forest Biometrician at Forestry Tasmania and Dr Dean Williams (who recently completed a PhD with the CRC) is now Research Scientist (Tree Improvement) at Forestry Tasmania. Other students who have found employment in the industry include, Jane Medhurst (Postdoctoral Fellow, UT), Julianne O'Reilly-Wapstra (Lecturer [Mammalian Browsing], University of Tasmania), Andrew Gibbons (Research Officer, Threatened Species Unit, DPIWE), Luke Rapley (Post Doctoral Fellow [Insect ecology], University of Tasmania), Robert Barbour (Post Doctoral Fellow [gene flow], University of Tasmania).

Application of research

- ***Degree of adoption of research results by industry***

Twenty six items of CRC technology were 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.***

Fifty three technical reports were produced by the Centre, 24 of which were in the CRC Technical Report series. In addition, 19 technical news sheets were released ('Hot off the Seed Bed', 'Beyond the Black Stump' and 'Pest Off'), and four articles appeared in newsletters of member organisations.

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

Six consultancies were conducted during 2003/04 (see Grants and Awards and Consultancies). Advice was also provided through participation on national committees. For example, Greg Dutkowski (GI) is a member of the STBA Board, on the Technical

Committee of STBA and three subcommittees of the STBA Technical Committee, and is also a member of Research Working Group 1 (RWG1, Forest Genetics). Dr Brad Potts (GI) is a member of RGW1, and is on the subcommittee for Forest Genetic Resources, on the Biodiversity Advisory Panel for the Tasmanian Government 'State of the Environment Report'. Dr Clare McArthur (RP) has close links with industry and government through the Browsing Damage Management Group (BDMG), as well as direct interaction with industry (see Grants and Awards). Dr Neil Davidson (SM) and Dr Dugald Close (SM) have had close interaction with organisations advising farm foresters through collaborative work on plantation establishment to combat rural tree decline.

- ***Number of presentations to companies or user groups***

The CRC-SPF ran a wide range of technology transfer activities for partners during 2003/04. These included 114 public presentations including 96 conference or symposia presentations and 26 seminars as well as 3 CRC-run workshops, 2 short courses and 1 field day.

- ***Number and financial contribution of potential users***

The CRC-SPF has twenty members, including most of the major wood producing companies in Australia. Each partner commits cash and/or in-kind contributions to the Centre (see financial tables). In addition, partners may provide funds to support particular projects (see Grants and Awards). Private Forests Tasmania and other end-users of our technology, e.g. Greening Australia, 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 224 person-days involved in within-CRC visits (see Performance Indicator 2 under Cooperative Arrangements) are visits by users of the technology we are developing.

- ***Number of media or trade journal presentations***

In the last year, 4 articles relating to Centre activities appeared in newspapers and industry newsletters, and 3 segments in the electronic media (1 radio and 2 television).

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

In 2003/04 CRC-SPF held an Annual Meeting, gave 114 public presentations (96 conference or symposia presentations and 2 seminars), and ran three workshops, two short courses and one field day, to transfer results to industry and the public. An estimated 1741 people attended these activities.

Management and budget

- ***Establish procedures to report on progress and achievements***

Plans in place include a Strategic Plan and Business Plan, and a set of 'deliverables' agreed upon to meet industry expectations of progress in research areas. The quality and quantity of research is monitored and reviewed, and its value to industry assessed 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 project and program. 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 16 changes to staffing, during 2003/04 (see Staffing and Administration).

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

All projects completed their milestones within the planned time and budget, with the exception of two that were agreed by industry as no longer relevant to their needs.

- ***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 2003/2004

It is anticipated that the CRC will continue for an eighth year until 30 June 2005 with additional cash funding from DEST and some of the existing partners. At September 2004, when this report was finalised, signatures had been received from all participants and the contract returned to DEST for execution.

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, excluding outstanding debtors at 30 June each year.

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. During 2003/04 DEST agreed to extend the Commonwealth Agreement for an additional year so that the CRC SPF will continue until 30 June 2005.

(f) Allocation from Commonwealth Grant

During 2003/2004 the CRC received the usual four quarterly grant payments.

(g) Management comment to Qualifications in Audit Report

(i) Australian Plantation Timber were expelled from the CRC during 2002/03.

(ii) The marginal decrease in Forestry Tasmania In Kind contributions is offset by previous years.

(iii) Gunns Ltd In Kind and Cash contributions are offset by takeover of North Forest Products and combining both memberships as agreed by the Board.

(iv) Queensland Department of Primary Industries and Fisheries In Kind contributions are offset by their contributions over 7 years participation and the 2003/04 cash commitment was paid during the 2002/03 financial year.

(v) Timbercorp marginal decrease in In Kind contributions is offset by their overall contribution to the CRC.

Deloitte.

Audit Report

INDEPENDENT AUDIT REPORT TO THE DEPARTMENT OF EDUCATION, SCIENCE AND TRAINING REPRESENTING THE COMMONWEALTH
(RE: COOPERATIVE RESEARCH CENTRE FOR SUSTAINABLE PRODUCTION FORESTRY)

Scope

We have audited the financial statement of the Cooperative Research Centre for Sustainable Production Forestry ("the Centre") as set out in Tables 1,2,3 and 4 of the Annual Report for the year ended 30 June 2004. The parties to the Centre are responsible for the preparation and presentation of the financial statement and for ensuring compliance with the CRC Commonwealth Agreement ("the Agreement"). We have conducted an independent audit of the financial statement and of compliance with the requirements of the Agreement in terms of clauses 4(1) and 4(2) 'Contributions', 5(1), 5(2) and 5(3) 'Application of the Grant and Contributions', 9(1) and 9(5) 'Intellectual Property' and 12(2) and 12(4) 'Financial Provisions' in order to express an opinion on it to the parties to the Centre and the Department of Education, Science and Training representing the Commonwealth.

The financial statement has been prepared by the parties to the Centre for the purposes of fulfilling their annual reporting obligations under clause 14(1)(e) of the Agreement for distribution to the Department of Education, Science and Training representing the Commonwealth. We disclaim any assumption of responsibility for any reliance on this report or on the financial statement to which it relates or to any person other than the parties to the Centre and the Department of Education, Science and Training representing the Commonwealth, or for any purpose other than that for which it was prepared.

Our audit has been conducted in accordance with Australian Auditing Standards and included such tests and procedures as we considered necessary in the circumstances. These procedures have been undertaken to form an opinion whether, in all material respects:

1. Researcher contributions and contributions from Partners (excluding Supporting Partners) equalled or exceeded the amount of the grant and the amount of contributions committed to in the budget (clauses 4(1) and 4(2));
2. The grant and contributions were used only for the activities of the Centre (clause 5(1));
3. The total yearly expenditure on activities of the Centre under each Head of Expenditure did not differ by more than 20% or $100,000 (whichever is the greater amount) from the allocation in the budget without prior approval by the Commonwealth (clause 5(2));
4. Capital items acquired from the grant and the contributions on acquisition vest as provided for in the Agreement (clause 5(3));
5. The intellectual property on all contract material vests as provided for in the Agreement (clause 9(1));
6. The researcher did not assign or license intellectual property in any contract material having the potential for commercialisation without imposing on the assignee, licence conditions and did not do so without the prior approval of the Commonwealth (clause 9(5));
7. The researcher ensured that proper accounting standards and controls were exercised in respect of the grant and that contributions, income and expenditure in relation to the activities of the Centre were recorded separately from other transactions of the researcher (clause 12(2));
8. The researcher ensured that cash contributions were paid into and expended from the Centre account (clause 12(4)); and
9. The financial statement presents fairly the sources of funding, the application of that funding and the financial position of the Centre for the financial year in accordance with the cash basis of accounting.

Inherent Limitations

Because of the inherent limitations of any compliance procedure it is possible that errors and irregularities may occur and not be detected. An audit is not designed to detect all weaknesses in the Centre's compliance with the Agreement as an audit is not performed continuously throughout the period and the audit procedures performed on the Centre's compliance with the Agreement are undertaken on a test basis.

Any projection of the evaluation of the compliance with the Agreement to future periods is subject to the risk that the procedures over compliance with the Agreement may become inadequate because of changes in conditions or circumstances, or that the degree of compliance with them may deteriorate.

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

Qualifications
The following Partners (excluding Supporting Partners) did not contribute amounts equal to or in excess of the amount of the contributions committed to in the budget as required by clause 4(2):

	In Kind Contributions		*Cash Contributions*	
Partners	***Amount Contributed $ '000***	***Amount Committed $'000***	***Amount Contributed $ '000***	***Amount Committed $'000***
Australian Plantation Timber	0	200	6	50
Forestry Tasmania	347	367		
Gunns Ltd	146	316	27	50
Norske Skog Paper Mills	128	189		
Queensland Department of Primary Industries and Fisheries	440	702	0	25
Timbercorp	283	293		

Qualified Audit Opinion
In our opinion, except for the effects on the financial statement of the Cooperative Research Centre for Sustainable Production Forestry, if any, and the extent of non-compliance with the requirements of the Agreement, arising from the matters referred to in the qualification paragraph, for the financial year ended 30 June 2004, in all material respects:

1. Researcher contributions and contributions from Partners (excluding Supporting Partners) equalled or exceeded the amount of the grant and the amount of contributions committed to in the budget (clauses 4(1) and 4(2));
2. The grant and contributions were used only for the activities of the Centre (clause 5(1));
3. The total yearly expenditure on activities of the Centre under each Head of Expenditure did not differ by more than 20% or $100,000 (whichever is the greater amount) from the allocation in the budget without prior approval by the Commonwealth (clause 5(2));
4. Capital items acquired from the grant and the contributions on acquisition vest as provided for in the Agreement (clause 5(3));
5. The intellectual property on all contract material vests as provided for in the Agreement (clause 9(1));
6. The researcher did not assign or license intellectual property in any contract material having the potential for commercialisation without imposing on the assignee, licence conditions and did not do so without prior approval of the Commonwealth (clause 9(5));
7. The researcher ensured that proper accounting standards and controls were exercised in respect of the grant and that contributions, income and expenditure in relation to the activities of the Centre were recorded separately from other transactions of the researcher (clause 12(2));
8. The researcher ensured that cash contributions were paid into and expended from the Centre account (clause 12(4)); and
9. The financial statement presents fairly the sources of funding, the application of that funding and the financial position of the Centre for the financial year in accordance with the cash basis of accounting.

Deloitte Touche Tohmatsu

DELOITTE TOUCHE TOHMATSU

L.T Cox
Partner
Chartered Accountants
Hobart, 28 September 2004

Budget Tables

ATTACHMENT A

Co-operative Research Centre for Sustainable Production Forestry
Summary of Base Grant Funds 2003/2004

Opening Cash Balance at 1/7/03	**1,163,247**
Add Income	2,993,355
Less Expenditure	
Salaries, scholarships and associated costs	1,849,068
Consumables	800,030
Equipment	20,090
Total Expenditure	2,669,188
Closing Cash Balance at 30/6/04	**1,487,414**

All STAFF RESOURCES (2003/2004) ATTACHMENT B

Organisation	Main Activity	Total % Time	% Spent on Research Program GI	SM	RP	Total on Research	% Spent on Educn	% Spent on Commln Program	% Spent on CRC Admin
Australian Forest Growers									
D Geddes	E	1					1		
Total		1	0	0	0	0	1	0	0
CSIRO Entomology									
J Matthiessen	R	30			30	30			
R Sutherland	T	100			100	100			
Total		130	0	0	130	130	0	0	0
CSIRO Forestry & Forest Products									
D Mummery	R	90		90		90			
M Battaglia	R	90		90		90			
C Beadle	R	80		80		80			
P Sands	R	80		80		80			
P Smethurst	R	72		72		72			
C Harwood	R	25	12.5	12.5		25			
G Moran	R	30	30			30			
B McCormack	R	10		10		10			
E Williams	R	10	10			10			
C Mohammed	R	10			10	10			
R Evans	R	5	5			5			
C Baillie	T	100		100		100			
M Ottenschlaeger	T	100		100		100			
K Churchill	T	60		60		60			
J Murrell	T	50	50			50			
D Worledge	T	30		30		30			
B Denton	T	25				0			25
J Owen	T	10	10			10			
J Sprent	A	50				0			50
P Coles	A	25				0			25
G MacGillivray	A	25				0			25
S Nambiar	A	5				0			5
C Carlyle	A	5				0			5
S Midgley	A	2				0			2
R Lockwood	A	1				0			1
Total		990	117.5	724.5	10	852	0	0	138
Department Primary Industries Qld									
J Simpson	R	55		55		55			
T Smith	R	40		40		40			
M Nester	R	25		25		25			
S Trueman	R	25	25			25			
K Bubb	R	15		15		15			
V Debuse	R	15		15		15			
M Hunt	R	13	5	8		13			
P Ryan	R	10		10		10			

All STAFF RESOURCES (2003/2004) ATTACHMENT B

Organisation	Main Activity	Total % Time	% Spent on Research Program GI	SM	RP	Total on Research	% Spent on Educn	% Spent on Commln Program	% Spent on CRC Admin
D Osborne	R	10		10		10			
I Last	R	10	5	5		10			
D Lee	R	5	5			5			
K Harding	R	5	5			5			
P Keay	T	50		50		50			
J Cook	T	25	25			25			
P Frayne	T	15		15		15			
P Toon	T	10	10			10			
T Wemmerslager	A	5				0			5
S Underhill	A	10	5	5		10			
Total		343	85	253	0	338	0	0	5
Forest Enterprises Australia									
R Jacobson	R	2					2		
D Barker	R	1					1		
T Cannon	A	2					2		0
Total		5	0	0	0	0	5	0	0
Forestry Tasmania									
J Elek	R	40			40	40			
A Walsh	R	40			40	40			
P Volker	R	15	15			15			
L Apiolaza	R	16			16	16			
P Adams	R	10		10		10			
J Lesek	T	65	65			65			
T Kincade/ D Burton	T	40			40	40			5
C Ringrose	T	25		25		25			5
S Grove	R/A	5				0			5
T Wardlaw	R/A	20				0			20
J Hickey	R/A	3				0			3
H Drielsma	R/A	3				0			3
Total		282	80	35	136	251	0	0	41
Grand Ridge Plantations									
P Buxton	R	20	20			20			
B McGennisken	R	15	4	7	4	15			
R Appleton	R	7	1	5	1	7			
S Elms	A	11	2	2		4			7
I Sandeman	A	5				0		5	
H Davis	A	2		1		1			1
Total		60	27	15	5	47	0	5	8
Griffith University									
J Chaseling	R	30		30		30			
P Healy	R	20		20		20			
J Hughes	R	20		10		10			
S Boyd	R	10		10		10			
I Phillips	R	5		5		5			
H Ghadiri	R	5		5		5			
R Kitching	A	5							5
Total		95	0	80	0	80	0	0	5

All STAFF RESOURCES (2003/2004)

ATTACHMENT B

Organisation	Main Activity	Total % Time	% Spent on Research Program GI	SM	RP	Total on Research	% Spent on Educn	% Spent on Commln Program	% Spent on CRC Admin
Gunns Limited									
C Barnes	A	5		2	2	4			1
K Joyce	T	20	7	7	6	20			
I Blanden	A	3				0			3
I Ravenwood	A	10	3			3			7
Total		38	10	9	8	27	0	0	11
Norske Skog Paper Mills									
S Hetherington	R	6		2	1	3	1		2
C Berry	R	5	1	2		3	1		1
M Rush	T	4			1	1	1	2	
B Burns	T	1			1	1			
A Willems	A	2				0			2
Total		18	1	4	3	8	3	0	5
SeedEnergy									
P Gore	R	10	10			10			
D Boomsma	R	2	2			2			
Total		12	12	0	0	12	0	0	0
Southern Cross University									
R Henry	R	30	20			20	5		5
D Tikel	R	20	20			20			
E Evans	A	10				0			10
V Watt	A	10				0			10
D Scurr	A	10				0			10
P Baverstock	A	5				0			5
Total		85	40	0	0	40	5	0	40
Southern Tree Breeding Association									
T McRae	R	13	13			13			
D Pilbeam	R	10	10			10			
M Powell	R	1	1			1			
Total		24	24	0	0	24	0	0	0
The Australian National University									
P Kanowski	R	30				0	30		
D Race	R	25		25		25			
W Foley	R	12.5				0	12.5		
R James	R	10				0	10		
Total		77.5	0	25	0	25	52.5	0	0
Timbercorp									
J Bulinski	R	20			20	20			
I Bail	R/A	18		3		3			15
H O'Sullivan	R	11	11			11			
G Samsa	R	11		11		11			
R Piggott	R	1		1		1			
Q Clasen	R	1		1		1			
A Tys	R	1		1		1			
T Browning	A/R	3				0			3

All STAFF RESOURCES (2003/2004) ATTACHMENT B

Organisation	Main Activity	Total % Time	% Spent on Research Program GI	SM	RP	Total on Research	% Spent on Educn	% Spent on Commln Program	% Spent on CRC Admin
A Soanes	T	4		2	2	4			
M Anning	T	2		1	1	2			
R Mitchell	T	2		1	1	2			
D Shelden	T	2		1	1	2			
Total		76	11	22	25	58	0	0	18
University of Tasmania									
B Potts	R	50	50			50			
C McArthur	R	25			25	25			
G Allen	R	50			50	50			
N Davidson	R/E	50		25		25	25		
R Vaillancourt	R	45	45			45			
R Wiltshire	R	5				0	5		
S Jennings	R	15		15		15			
C Mohammed	R	25			25	25			
G Jordan	R	15				0	15		
K Barry	R	5			5	5			
J Reid	A	5	3			3	3		
M Hovenden	E	5				0	5		
A Richardson	A/E	15				0	10		5
P Brown	E	5				0	5		
D Close	E	10				0	5		
P McQuillan	E	5				0	5		
S Shabala	E	5				0	5		
E Bruce	E	5				0	5		
L Forbes	E	5				0	5		
R Doyle	E	5				0	5		
N Mendham	E	5				0	5		
S McLean	E	5				0	5		
R Boyle	E	5				0	5		
F Vanclay	R	5				0	5		
L Pinkard	E	10				0	5		
R Griffin	R/A	20	5			5			15
P Lane	A	5				0			5
R Clark	A	10				0	5		5
G Hallegraeff/A Koutoulis	A	5				0			5
A Smolenski	T	25	15	5	5	25			5
L Johnson	T	10	5	5		10			
T Jackson	T	10	5	5		10			
G Johnson/C Carver	A	20				0			20
C Philips	A	5				0			5
B Rumbold	A	5				0			5
S Jones	A	5				0			5
A Glenn	A	2				0			2
Total		502	128	55	110	293	128	0	77
WACAP Treefarms									
M Barness	R	25		2	23	25			
S Hunter	R	25	5	3	7	15			10
Nursery/Casual Staff	T	15	5	5	5	15			
R Breidahl	R	5	0	1		1			4

All STAFF RESOURCES (2003/2004) ATTACHMENT B

Organisation		Main Activity	Total % Time	% Spent on Research Program GI	SM	RP	Total on Research	% Spent on Educn	% Spent on Commln Program	% Spent on CRC Admin
B Humble/S Martyn		R	2	2			2			
P Durrell		R	2	2			2			
C Palmer		A	2							2
K Oshima/S Tomita		A	2							2
Total			80	15	10	35	61	0	0	19
CRC Funded										
J Brawner	DPI Qld	R	100	100			100			
P Keay	QFRI	T	50		50		50			
K Catchpoole	QFRI	R	100		100		100			
C Chen	QFRI	R	100		100		100			
Y Li (until 20/2/04)	Utas	R	100	66			66			
M Matsuki	Utas	R	100			100	100			
A O'Grady	Utas	R	100		100		100			
M Shepherd	SCU	R	100	100			100			
M Cross (until 31/12/03)	SCU	T	80	40			40			
M Steinbauer	CSIRO Ento	R	50			50	50			
M Steinbauer	Utas	R	50			50	50			
R Thumma (until Jan 04)	CSIRO FFP	R	100	50			50			
K Groom (until Jan 04)	CSIRO FFP	T	100	50			50			
K Siu	CSIRO FFP	T	20	20			20			
D Kain (8 mths)	ANU	R	100	66			66			
D Steane	Utas	R	80	80			80			
B Patterson (until 30/11/03)	Utas	R	55	23			23			
B Potts	Utas	R	50	50			50			
C McArthur (until 26/1/04)	Utas	R	50			29	29			
I Van Putten (until 18/7/03)	Utas	R	40		3		3			
P Smethurst	CSIRO FFP	R	28		28		28			
D Race	ANU	R	25		25		25			
G Jordan (until 31/12/03)	Utas	R	16	8			8			
J Medhurst (Feb- June 04)	Utas	R	20		7		7			
I Cummings(6mnths)	Utas	T	30	15			15			
G Dutkowski	Utas	E	100	50			50	50		
J Neilson	Utas	A	100				0			100
S Caswell	Utas	A	80				0			80
J Butterworth	Utas	E/A	100				0	100		
P Tilyard	Utas	T	100	100			100			
L Ballard	Utas	T	60	30	30		60			
J Smith	Utas	T	100		100		100			
A Wilkinson	Utas	T	100		100		100			
V Patel (1/7-30/10/03)	Utas	T	100			25	25			
V Patel(1/11-30/6)	Utas	T	50			38	38			
S Paterson	Utas	T	100			100	100			
H Fitzgerald	Utas	T	100			100	100			
N Davidson	Utas	E	50		25		25	25		

All STAFF RESOURCES (2003/2004) ATTACHMENT B

Organisation		Main Activity	Total % Time	% Spent on Research Program GI	SM	RP	Total on Research	% Spent on Educn	% Spent on Commln Program	% Spent on CRC Admin
R Griffin(1/1-30/6/04)	Utas	A	80				0			40
R Griffin(30/6-31/12/03)	Utas	A	40				0			20
Total			2904	848	668	492	2008	175	0	240
			2423				2008			

SUMMARY OF CONTRIBUTIONS IN PERSON YEARS

	Total Person Years (inc support staff)	Person Years Spent on Research Program GI	SM	RP	Total on Research Programs	Person Yrs Spent on Educn Program	Person Yrs Spent on Commln Program	Person Yrs Spent on CRC Admin
Total Contributed	28.1	5.5	12.3	4.6	22.4	1.9	0.1	3.7
Total funded by CRC	24.2	8.5	6.7	4.9	20.1	1.8	0.0	2.4
Grand total	52.3	14.0	19.0	9.5	42.5	3.7	0.1	6.1
Proportion of total professional (%) staff resources in each activity	100.0	26.7	36.3	18.2	81.3	7.0	0.1	11.6

SUPPORT STAFF 2003/04(inc in above SummaryTable)

Contributed	
Organisation	Number of Staff (Person Years)
CSIRO (FFP & Ento)	3.50
Department of Primary Industries Qld	0.10
Forestry Tasmania	1.30
Gunns Limited	0.20
University of Tasmania	0.45
Southern Cross University	0.30
Timbercorp	0.10
WACAP Treefarms	0.19
Total	6.14

CRC Funded	
Organisation	Number of Staff (Person Years)
University of Tasmania	10.8
CSIRO (FFP & Ento)	0.7
Southern Cross University	0.4
Department of Primary Industries Qld	0.5
Total	12.4

Financial Information - Table 1 In-Kind Contributions (dollars in $'000)

	Actual														Projected		Totals to 2003-04			Totals for 8 years		
	1997-98		1998-99		1999-00		2000-01		2001-02		2002-03		2003-04		2004-05							
	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Projected	Agr'mt	Actual	Agr'mt	Diff	Actual/ Proj	Agr'mt	Diff
CORE PARTICIPANTS																						
Australian Plantation Timber Ltd (INACTIVE)																						
Salaries	0	0	0	0	0	0	83	83	0	83	0	83	0	83	0	0	83	332	-249	83	332	-249
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	118	117	0	117	0	117	0	117	0	0	118	468	-350	118	468	-350
Total	0	0	0	0	0	0	201	200	0	200	0	200	0	200	0	0	201	800	-599	201	800	-599
CSIRO																						
Salaries	816	825	840	803	896	770	783	770	989	770	988	770	905	770	593	593	6,217	5,478	739	6,810	6,071	739
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	1,650	1,721	1,750	1,680	1,721	1,618	1,694	1,618	1,855	1,618	1,799	1,618	1,681	1,618	1,005	1,005	12,150	11,491	659	13,155	12,496	659
Total	2,466	2,546	2,590	2,483	2,617	2,388	2,477	2,388	2,844	2,388	2,787	2,388	2,586	2,388	1,598	1,598	18,367	16,969	1,398	19,965	18,567	1,398
Forestry Tasmania																						
Salaries	137	93	157	102	188	112	156	124	158	136	151	149	157	164	147	147	1,104	880	224	1,251	1,027	224
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	179	115	169	126	240	139	199	152	185	168	183	185	190	203	178	178	1,345	1,088	257	1,523	1,266	257
Total	316	208	326	228	428	251	355	276	343	304	334	334	347	367	325	325	2,449	1,968	481	2,774	2,293	481
Grand Ridge Plantations Pty Ltd (INACTIVE)																						
Salaries	66	85	83	85	58	85	67	85	34	85	61	85	52	85	0	0	421	595	-174	421	595	-174
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	136	121	125	121	108	121	120	121	13	121	287	121	155	121	0	0	944	847	97	944	847	97
Total	202	206	208	206	166	206	187	206	47	206	348	206	207	206	0	0	1,365	1,442	-77	1,365	1,442	-77
Griffith University (INACTIVE)																						
Salaries	164	127	109	126	110	126	83	126	89	127	127	127	111	127	0	0	793	886	-93	793	886	-93
Capital	0	0	20	0	20	0	20	0	20	0	20	0	20	0	0	0	120	0	120	120	0	120
Other	151	116	117	116	118	116	89	116	95	117	136	117	119	117	0	0	825	815	10	825	815	10
Total	315	243	246	242	248	242	192	242	204	244	283	244	250	244	0	0	1,738	1,701	37	1,738	1,701	37
Gunns Limited																						
Salaries	263	100	252	100	155	100	218	100	210	100	66	100	55	100	70	70	1,219	700	519	1,289	770	519
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	369	216	313	216	158	216	128	216	100	216	92	216	91	216	98	98	1,251	1,512	-261	1,349	1,610	-261
Total	632	316	565	316	313	316	346	316	310	316	158	316	146	316	168	168	2,470	2,212	258	2,638	2,380	258

	Actual														Projected		Totals to 2003-04			Totals for 8 years		
	1997-98		1998-99		1999-00		2000-01		2001-02		2002-03		2003-04		2004-05							
	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Projected	Agr'mt	Actual	Agr'mt	Diff	Actual/ Proj	Agr'mt	Diff
Norske Skog Paper Mills (Australia) Ltd																						
Salaries	34	25	21	28	24	28	30	28	24	28	15	28	16	28	38	38	164	193	-29	202	231	-29
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	186	171	171	161	199	161	188	161	143	161	122	161	112	161	153	153	1,121	1,137	-16	1,274	1,290	-16
Total	220	196	192	189	223	189	218	189	167	189	137	189	128	189	191	191	1,285	1,330	-45	1,476	1,521	-45
Queensland Department of Primary Industries and Fisheries (INACTIVE)																						
Salaries	450	322	422	322	417	322	460	322	487	322	510	322	276	322	0	0	3,022	2,254	768	3,022	2,254	768
Capital	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	0	28	28	0	28
Other	526	380	384	380	427	380	383	380	380	380	363	380	164	380	0	0	2,627	2,660	-33	2,627	2,660	-33
Total	1,004	702	806	702	844	702	843	702	867	702	873	702	440	702	0	0	5,677	4,914	763	5,677	4,914	763
Southern Cross University																						
Salaries	63	60	68	60	70	60	71	60	75	60	88	60	90	60	93	93	525	420	105	618	513	105
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	190	249	288	249	301	249	307	249	361	249	468	249	314	249	380	380	2,229	1,743	486	2,609	2,123	486
Total	253	309	356	309	371	309	378	309	436	309	556	309	404	309	473	473	2,754	2,163	591	3,227	2,636	591
Timbercorp Limited																						
Salaries	0	0	0	0	21	24	115	94	89	94	92	94	84	94	65	65	401	400	1	466	465	1
Capital	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2	0	2
Other	5	0	5	0	5	62	273	221	196	221	223	199	199	199	132	132	906	902	4	1,038	1,034	4
Total	5	0	5	0	28	86	388	315	285	315	315	293	283	293	197	197	1,309	1,302	7	1,506	1,499	7
University of Tasmania																						
Salaries	385	387	403	387	411	387	455	387	472	387	506	386	535	386	505	505	3,167	2,707	460	3,672	3,212	460
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	703	701	825	763	792	763	829	763	845	763	875	763	901	763	947	947	5,770	5,279	491	6,717	6,226	491
Total	1,088	1,088	1,228	1,150	1,203	1,150	1,284	1,150	1,317	1,150	1,381	1,149	1,436	1,149	1,452	1,452	8,937	7,986	951	10,389	9,438	951
WACAP Treefarms Pty Ltd																						
Salaries	66	55	71	55	63	55	56	55	61	55	64	55	60	55	25	25	441	385	56	466	410	56
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	107	115	113	115	113	115	116	115	116	115	115	115	120	115	35	35	800	805	-5	835	840	-5
Total	173	170	184	170	176	170	172	170	177	170	179	170	180	170	60	60	1,241	1,190	51	1,301	1,250	51
Total in-kind from core participants																						
Salaries	2,444	2,079	2,426	2,068	2,413	2,069	2,577	2,234	2,688	2,247	2,668	2,259	2,341	2,274	1,536	1,536	17,557	15,230	2,327	19,093	16,766	2,327
Capital	28	0	20	0	22	0	20	0	20	0	20	0	20	0	0	0	150	0	150	150	0	150
Other	4,202	3,905	4,260	3,927	4,182	3,940	4,444	4,229	4,289	4,246	4,663	4,241	4,046	4,259	2,928	2,928	30,086	28,747	1,339	33,014	31,675	1,339
Total	6,674	5,984	6,706	5,995	6,617	6,009	7,041	6,463	6,997	6,493	7,351	6,500	6,407	6,533	4,464	4,464	47,793	43,977	3,816	52,257	48,441	3,816

Total	6,674	5,984	6,706	5,995	6,617	6,009	7,041	6,463	6,997	6,493	7,351	6,500	6,407	6,533	4,464	4,464	47,793	43,977	3,816	52,257	48,441	3,816

	Actual														Projected		Totals to 2003-04			Totals for 8 years		
	1997-98		1998-99		1999-00		2000-01		2001-02		2002-03		2003-04		2004-05							
	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Projected	Agr'mt	Actual	Agr'mt	Diff	Actual/ Proj	Agr'mt	Diff
SUPPORTING PARTICIPANTS																						
Australian Forest Growers																						
Salaries	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0	0	7	0	7	7	0	7
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	1	0	1	0	1	0	1	0	1	1	1	0	1	1	1	1	7	-6	2	8	-6
Total	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	8	7	1	9	8	1
Forest Enterprises Australia Pty Ltd																						
Salaries	0	0	0	0	0	0	5	0	4	0	2	0	6	0	0	0	17	0	17	17	0	17
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	1	1	2	0	2	0	2	1	2	2	2	2	9	-7	4	11	-7
Total	0	0	0	0	0	1	6	2	4	2	2	2	7	2	2	2	19	9	10	21	11	10
Gunns Limited																						
Salaries	6	5	25	5	28	5	15	5	0	5	0	5	0	5	0	0	74	35	39	74	35	39
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	35	35	42	35	13	35	11	35	0	35	0	35	0	35	0	0	101	245	-144	101	245	-144
Total	41	40	67	40	41	40	26	40	0	40	0	40	0	40	0	0	175	280	-105	175	280	-105
Private Forests Tasmania Pty Ltd																						
Salaries	0	0	0	0	10	4	6	8	11	8	3	8	0	8	2	2	30	36	-6	32	38	-6
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	17	8	0	16	4	16	1	16	0	16	0	0	22	72	-50	22	72	-50
Total	0	0	0	0	27	12	6	24	15	24	4	24	0	24	2	2	52	108	-56	54	110	-56
Seedenergy Pty Ltd																						
Salaries	0	0	0	0	0	0	0	0	11	9	19	9	31	9	21	21	61	27	34	82	48	34
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	2	2	3	2	2	2	3	3	7	6	1	10	9	1
Total	0	0	0	0	0	0	0	0	13	11	22	11	33	11	24	24	68	33	35	92	57	35
Serve-Ag Pty Ltd (INACTIVE)																						
Salaries	0	0	0	0	11	4	9	7	0	7	0	7	0	7	0	0	20	32	-12	20	32	-12
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	22	6	12	11	0	11	0	11	0	11	0	0	34	50	-16	34	50	-16
Total	0	0	0	0	33	10	21	18	0	18	0	18	0	18	0	0	54	82	-28	54	82	-28

	Actual														Projected		Totals to 2003-04			Totals for 8 years		
	1997-98		1998-99		1999-00		2000-01		2001-02		2002-03		2003-04		2004-05							
	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Projected	Agr'mt	Actual	Agr'mt	Diff	Actual/ Proj	Agr'mt	Diff
Southern Tree Breeding Association																						
Salaries	6	0	6	0	15	0	26	0	26	0	28	0	27	0	35	35	134	0	134	169	35	134
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	5	37	5	0	5	0	5	0	5	0	5	0	5	49	49	37	35	2	86	84	2
Total	6	5	43	5	15	5	26	5	26	5	28	5	27	5	84	84	171	35	136	255	119	136
The Australian National University																						
Salaries	59	64	59	64	63	64	67	64	72	64	106	64	109	63	51	51	535	447	88	586	498	88
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	178	112	178	112	188	112	202	112	215	112	317	112	327	112	71	71	1,605	784	821	1,676	855	821
Total	237	176	237	176	251	176	269	176	287	176	423	176	436	175	122	122	2,140	1,231	909	2,262	1,353	909
The University of Queensland (INACTIVE)																						
Salaries	9	25	24	25	24	25	25	25	25	25	14	25	0	25	0	0	121	175	-54	121	175	-54
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	10	47	47	47	47	47	47	47	47	47	26	47	0	47	0	0	224	329	-105	224	329	-105
Total	19	72	71	72	71	72	72	72	72	72	40	72	0	72	0	0	345	504	-159	345	504	-159
Total in-kind from supporting participants																						
Salaries	81	94	115	94	152	102	154	109	150	118	173	118	174	117	109	109	999	752	247	1,108	861	247
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	223	200	304	200	287	215	273	229	268	231	348	231	330	231	126	126	2,033	1,537	496	2,159	1,663	496
Total	304	294	419	294	439	317	427	338	418	349	521	349	504	348	235	235	3,032	2,289	743	3,267	2,524	743
TOTAL IN-KIND CONTRIBUTIONS																						
Salaries	2,525	2,173	2,541	2,162	2,565	2,171	2,731	2,343	2,838	2,365	2,841	2,377	2,515	2,391	1,645	1,645	18,556	15,982	2,574	20,201	17,627	2,574
Capital	28	0	20	0	22	0	20	0	20	0	20	0	20	0	0	0	150	0	150	150	0	150
Other	4,425	4,105	4,564	4,127	4,469	4,155	4,717	4,458	4,557	4,477	5,011	4,472	4,376	4,490	3,054	3,054	32,119	30,284	1,835	35,173	33,338	1,835
GRAND TOTAL IN-KIND (T1)	**6,978**	**6,278**	**7,125**	**6,289**	**7,056**	**6,326**	**7,468**	**6,801**	**7,415**	**6,842**	**7,872**	**6,849**	**6,911**	**6,881**	**4,699**	**4,699**	**50,825**	**46,266**	**4,559**	**55,524**	**50,965**	**4,559**

Financial Information - Table 2

Cash Contributions (dollars in $'000)

	Actual														Projected		Totals to 2003-04			Totals for 8 years		
	1997-98		1998-99		1999-00		2000-01		2001-02		2002-03		2003-04		2004-05							
	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Projected	Agr'mt	Actual	Agr'mt	Diff	Actual/ Proj	Agr'mt	Diff
Core participants																						
Australian Plantation Timber Ltd (INACTIVE)	0	0	0	0	0	0	50	50	0	50	10	50	6	50	0	0	66	200	-134	66	200	-134
CSIRO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Forestry Tasmania	23	15	19	15	15	15	12	15	18	15	15	15	15	15	30	30	117	105	12	147	135	12
Grand Ridge Plantations Pty Ltd (INACTIVE)	35	35	35	35	35	35	35	35	35	35	35	35	35	35	0	0	245	245	0	245	245	0
Griffith University (INACTIVE)	25	25	26	25	25	25	19	25	25	25	31	25	25	25	0	0	176	175	1	176	175	1
Gunns Limited	65	50	50	50	30	50	20	50	25	50	25	50	27	50	20	20	242	350	-108	262	370	-108
Norske Skog Paper Mills (Australia) Ltd	22	20	21	20	20	20	20	20	20	20	20	20	20	20	10	10	143	140	3	153	150	3
Queensland Department of Primary Industries and Fisheries (INACTIVE)	25	25	50	25	0	25	25	25	25	25	50	25	0	25	0	0	175	175	0	175	175	0
Southern Cross University	100	100	100	100	100	100	100	100	100	100	100	100	100	100	42	42	700	700	0	742	742	0
Timbercorp Limited	0	0	0	0	0	13	50	50	63	50	50	50	50	50	9	9	213	213	0	222	222	0
University of Tasmania	0	0	3	0	0	0	0	0	0	0	0	0	100	0	265	265	103	0	103	368	265	103
WACAP Treefarms Pty Ltd	35	35	36	35	35	35	35	35	35	35	35	35	35	35	9	9	246	245	1	255	254	1
Total cash from core participants	330	305	340	305	260	318	366	405	346	405	371	405	413	405	385	385	2,426	2,548	-122	2,811	2,933	-122
Supporting participants																						
Australian Forest Growers	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	7	7	0	8	8	0
Forest Enterprises Australia Pty Ltd	0	0	0	0	0	1	2	3	4	3	3	3	3	3	3	3	12	13	-1	15	16	-1
Gunns Limited	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2	0	2
Private Forests Tasmania Pty Ltd	0	0	0	0	0	10	18	20	3	20	3	20	3	20	3	3	27	90	-63	30	93	-63
Seedenergy Pty Ltd	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	3	1	0	1	4	3	1
Serve-Ag Pty Ltd (INACTIVE)	0	0	0	0	0	0	1	1	1	1	0	1	0	1	0	0	2	4	-2	2	4	-2
Southern Tree Breeding Association	0	0	0	0	0	0	0	0	0	0	0	0	5	0	18	18	5	0	5	23	18	5
The Australian National University	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
The University of Queensland (INACTIVE)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total cash from supporting participants	1	1	3	1	1	12	22	25	9	25	7	25	13	25	28	28	56	114	-58	84	142	-58
Other cash																						
Non-participants													21	0	42	42	21	0	21	63	42	21
External grants													4	0	0	0	4	0	4	4	0	4
Contract research													33	0	0	0	33	0	33	33	0	33
Commercialisation													0	0	0	0	0	0	0	0	0	0
Education													0	0	0	0	0	0	0	0	0	0
Interest													75	0	20	20	75	0	75	95	20	75
New from existing starting cash													-34	0	0	0	-34	0	-34	-34	0	-34
Total other cash	769	0	91	0	294	0	143	0	135	0	181	0	99	0	62	62	1,712	0	1,712	1,774	62	1,712
CRC grant																						
Total grant	1,718	1,680	2,313	2,300	2,328	2,300	2,347	2,300	2,385	2,300	2,430	2,300	2,468	2,300	400	400	15,989	15,480	509	16,389	15,880	509

	Actual														Projected		Totals to 2003-04			Totals for 8 years		
	1997-98		1998-99		1999-00		2000-01		2001-02		2002-03		2003-04		2004-05							
	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Projected	Agr'mt	Actual	Agr'mt	Diff	Actual/ Proj	Agr'mt	Diff
Grand totals																						
Total CRC cash contribution (T2)	2,818	1,986	2,747	2,606	2,883	2,630	2,878	2,730	2,875	2,730	2,989	2,730	2,993	2,730	875	875	20,183	18,142	2,041	21,058	19,017	2,041
Cash carried over from previous year (UB for previous year)			1,003		1,338		1,743		1,923		1,814		1,163		1,487	1,446						
(less) Unspent balance (UB)	1,003		1,338		1,743		1,923		1,814		1,163		1,487		0							
Total cash expenditure (T3)	1,815	1,986	2,412	2,606	2,478	2,630	2,698	2,730	2,984	2,730	3,640	2,730	2,669	2,730	2,362	2,321	20,183	18,142	2,041	21,058	19,017	2,041
Allocation of cash expenditure between heads of expenditure																						
Salaries	1,289	1,740	1,686	1,687	1,503	1,698	1,757	1,700	1,899	1,701	2,488	1,702	1,849	1,703	1,399	1,399	12,471	11,931	540	13,870	13,330	540
Capital	0	0	0	0	0	0	0	0	0	0	89	0	0	0	0	0	89	0	89	89	0	89
Other	527	795	724	915	974	905	940	905	1,085	905	1,063	905	820	900	963	922	6,133	6,230	-97	7,096	7,152	-56
Total	**1,816**	**2,535**	**2,410**	**2,602**	**2,477**	**2,603**	**2,697**	**2,605**	**2,984**	**2,606**	**3,640**	**2,607**	**2,669**	**2,603**	**2,362**	**2,321**	**18,693**	**18,161**	**532**	**21,055**	**20,482**	**573**
For 2003-04 financial year	Cash totals include an adjustment of $34k for errors in unspent balance brought forward and outstanding debtors from previous years																					

Financial Information - Table 3
Resources (dollars in $'000)

	Actual														Projected		Totals to 2003-04			Totals for 8 years		
	1997-98		1998-99		1999-00		2000-01		2001-02		2002-03		2003-04		2004-05							
	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Projected	Agr'mt	Actual	Agr'mt	Diff	Actual/Proj	Agr'mt	Diff
Summary of resources applied to activities of centre																						
Grand total (in-kind) from table 1 (T1)	6,978	6,278	7,125	6,289	7,056	6,326	7,468	6,801	7,415	6,842	7,872	6,849	6,911	6,881	4,699	4,699	50,825	46,266	4,559	55,524	50,965	4,559
Grand total (cash expenditure) from table 2 (T3)	1,815	1,986	2,412	2,606	2,478	2,630	2,698	2,730	2,984	2,730	3,640	2,730	2,669	2,730	2,362	2,321	18,696	18,142	554	21,058	20,463	595
Total resources applied to activities of centre (T1+T3)	8,793	8,264	9,537	8,895	9,534	8,956	10,166	9,531	10,399	9,572	11,512	9,579	9,580	9,611	7,061	7,020	69,521	64,408	5,113	76,582	71,428	5,154
Allocation of total resources applied to activities of CRC between heads of expenditure																						
Total salaries (cash and in-kind)	3,814	3,913	4,227	3,849	4,068	3,869	4,488	4,043	4,737	4,066	5,329	4,079	4,364	4,094	3,044	3,044	31,027	27,913	3,114	34,071	30,957	3,114
Total capital (cash and in-kind)	28	0	20	0	22	0	20	0	20	0	109	0	20	0	0	0	239	0	239	239	0	239
Total other (cash and in-kind)	4,952	4,900	5,288	5,042	5,443	5,060	5,657	5,363	5,642	5,382	6,074	5,377	5,196	5,390	4,017	3,976	38,252	36,514	1,738	42,269	40,490	1,779
Total	8,794	8,813	9,535	8,891	9,533	8,929	10,165	9,406	10,399	9,448	11,512	9,456	9,580	9,484	7,061	7,020	69,518	64,427	5,091	76,579	71,447	5,132

Financial Information - Table 4
Allocation of resources between categories of activity for the 2003-04 financial year (dollars in $'000)

	Resource usage			
Programme	Cash ($'000) [1]	In-kind ($'000)	Contributed staff (FTE) [2]	Cash funded staff (FTE) [2]
Research	2,171	5,618	22.4	20.1
Education	186	484	1.9	1.8
External communications	0	0	0.0	0.0
Commercialisation/Tech. transfer	3	7	0.1	0.0
Administration	309	802	3.7	2.4
Total	2,669	6,911	28.1	24.3
	(T3)	(T1)		
[1] Cash from all sources, including CRC programme				
[2] Full time equivalent staff, excluding students				

ABBREVIATIONS

A/Prof	Associate Professor
AFFA	Commonwealth Department of Agriculture, Fisheries and Forestry Australia
AFG	Australian Forest Growers
AGBU	Animal Genetics and Breeding Unit
AGRF	Australian Genome Research Facility
ANIC	Australian National Insect Collection
ANU	The Australian National University
APA-I	Australian Postgraduate Award - Industry
ARC	Australian Research Council
ASREML	Quantitative genetics computer program
CALM	Department of Conservation and Land Management
CFTT	Centre for Forest Tree Technology
CRC-SPF	Cooperative Research Centre for Sustainable Production Forestry
CSIRO Ento	CSIRO Entomology
CSIRO FFP	CSIRO Forestry and Forest Products
CSIRO PI	CSIRO Plant Industry
DELM	Department of Environment and Land Management
DPIQ	Department of Primary Industries Queensland
DPIWE	Department of Primary Industries, Water and Environment
ETT	Education and Technology Transfer Program
FEA	Forest Enterprises Australia Pty Ltd
FFIC	Forests and Forest Industry Council
ForSA	Forestry South Australia
FR	Forest Research, New Zealand
FT	Forestry Tasmania
FWPRDC	Forest and Wood Products Research and Development Corporation
GI	Genetic Improvement Program
GL	Gunns Limited
GRP	Grand Ridge Plantations Pty Ltd
GU	Griffith University
HVP	Hancock Victorian Plantations
ICFR	Institute for Commercial Forestry Research
IUFRO	International Union of Forest Research Organisations
JVAP	Joint Venture Agroforestry Project
MLURI	Macauley Land Use Research Institute, Scotland
NHT	Natural Heritage Trust
NS	Norske Skog Paper Mills (Australia) Limited
NTPWC	Northern Territory Parks and Wildlife Commission
NZ	New Zealand
PFT	Private Forests Tasmania
QFRI	Queensland Forestry Research Institute
RAIZ	Instituto de Investigacao de Floresta e Papel, Portugal
RIRDC	Rural Industries Research and Development Corporation
RP	Resource Protection Program
SCU	Southern Cross University
sE	seed*Energy* Pty Ltd

SF NSW	State Forests of New South Wales
SM	Sustainable Management Program
SPIRT	Strategic Partnership with Industry – Research and Training
STBA	Southern Tree Breeding Association Incorporated
TC	Timbercorp Limited
TFGA	Tasmanian Farmers and Graziers Association
UA	University of Adelaide
UM	University of Melbourne
UNE	University of New England
UQ	The University of Queensland
USC	University of the Sunshine Coast
USDA	United States Department of Agriculture
UT	University of Tasmania
UWA	University of Western Australia
UWS	University of Western Sydney
WACAP	WACAP Treefarms Pty Ltd
WAPRES	WA Plantation Resources

COOPERATIVE RESEARCH CENTRE
FOR SUSTAINABLE PRODUCTION FORESTRY

Private Bag 12, Hobart, Tasmania 7001, Australia

Tel (03) 6226 7947 (Internat) + 61 3 6226 7947

Fax (03) 6226 7942 (Internat) + 61 3 6226 7942

CRCForestry@ffp.csiro.au

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