COOPERATIVE RESEARCH CENTRE
FOR TEMPERATE HARDWOOD FORESTRY

ANNUAL REPORT 1991/92

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

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Executive Summary

Professor J Reid
Director

The 1991-1992 year has been one of substantial development for the Cooperative Research Centre for Temperate Hardwood Forestry. The mission of the Centre has remained unchanged and focuses on:

- the development of forest management systems to increase and sustain wood production in hardwood forests in an environmentally sensitive way
- the improvement of wood quality from hardwood forests to ensure its market suitability for efficient value-added processing
- the establishment of a national centre of excellence for postgraduate training with emphasis on research in tree genetic improvement and resource protection and
- the development of a national centre for promoting innovation in eucalypt forestry.

To achieve these aims, the Centre has established four programmes. Three involve research into aspects of the growth and management of eucalypt plantations. They are (a) Genetic Improvement, (b) Soil and Stand Management and (c) Resource Protection. The fourth involves the development of an Education and Communication Strategy. All four programmes are functioning successfully and are meeting the broad performance criteria. Some highlights include:

- a conference on "The Role and Potential of Eucalypt Plantations in Australia's Wood Supply" attended by 150 industry and research personnel
- the enrolment of 16 research higher degree and honours students in the Centre
- the first comparison of heritabilities determined from controlled crosses and open-pollinated progeny in eucalypts
- the production of open flowers in two-year-old seedlings of *Eucalyptus globulus* by a combination of chemical and environmental treatments
- the first publication of techniques for the isolation of genetic polymorphisms from chloroplast DNA of eucalypts
- the determination of the gibberellin biosynthetic pathway in eucalypts

- an indication that post-planting weed control is not required in eucalypt plantations placed on land previously occupied by eucalypt forest

- the development of a model to describe the impact of nitrogen and phosphorus supply on tree growth via effects on CO_2 assimilation and biomass partitioning

- the determination that insect tolerance has a high heritability and that there is a positive correlation between tolerant genotypes and growth and

- establishment of an Integrated Pest Management Programme to control beetle defoliators of eucalypt plantations.

The Centre has appointed over half of its new professional staff during the year. It has proved an exciting and rewarding exercise and the quality of the staff is exceptional. They include workers previously based in Australia (Drs Neil Davidson and Brad Potts), an expatriate enticed back to Australia (Dr Philip Smethurst) and a foreign expert in molecular genetics (Dr Rene Vaillancourt). However, the time taken for staff to arrive was longer than anticipated and the pool from which to choose suitably qualified staff was smaller than expected. This reinforces our view that there are substantial opportunities for students trained in our chosen specialist fields.

Together with the expertise of staff contributed by the five initial collaborators, CSIRO Division of Forestry, University of Tasmania, Australian Newsprint Mills, Associated Pulp and Paper Mills and the Forestry Commission, Tasmania, the Centre now has a large and well rounded group of experts across the major research fields of the Centre. A new party, Forest Resources, was also formally brought into the Centre from 1 January 1992 through a Deed of Novation. This was a welcome addition to the Centre and takes the industry contribution to the Centre to 20 percent. Discussions are underway to bring other major forestry companies into the Centre and to raise the industry equity to over 25 percent. These initiatives enable the researchers in the Centre access to a wider range of field trials and environments, the prospect of a greater range of supervisors for our growing group of postgraduate students, and direct access by a greater section of the industry to our research expertise, facilities and results. In addition, close collaborative links have been formed with the CRC for Hardwood Fibre and Paper Science and a specific project is being developed within the Genetic Improvement Programme aimed at developing sampling strategies for examining pulp and fibre characteristics.

A major achievement has been the completion of the $1 million CRC extension to the new CSIRO Division of Forestry building on the University of Tasmania campus at Hobart. This building was made possible by contributions from the University of Tasmania and the CSIRO. It offers excellent research, office and conference facilities. The tissue culture and tree physiology laboratories, especially, are of international quality and will provide projects in those areas with a significant boost. In addition, the University of Tasmania has made substantial alterations to the Plant Science and Molecular Biology sections to provide office space and research facilities for our new professional staff.

It was with regret that the CRC Board accepted the resignation of the Foundation Director, Dr Glen Kile, so that he could take up his appointment as Chief of the CSIRO Division of Forestry in Canberra. Dr Kile provided the inspiration and leadership which led to our support in the first round of CRC competition. Professor James Reid was appointed Director from January 1992 and Dr Philip West was appointed Deputy Director.

Description of Structure and Management

The participating bodies in the CRC for Temperate Hardwood Forestry are the CSIRO Division of Forestry, the University of Tasmania, Associated Pulp and Paper Mills, Australian Newsprint Mills Ltd, Forest Resources and the Forestry Commission, Tasmania.

The **Board of Management of the CRC** (Figure 1) is comprised of a representative from each participating institution, the Director and the Deputy Director of the CRC and an independent Chairman. There have been three changes to the Board in the past months: Dr Glen Kile replaced Mr Alan Brown as the CSIRO representative, Professor Jim Reid replaced Dr Glen Kile as Director of the CRC and Dr Phil West replaced Professor Jim Reid as Deputy Director of the CRC.

The **Management Structure of the CRC** is headed by the Board and links are depicted in Figure 2. Operation of the four programmes is directed through three committees: the Management Committee, the Industry Research Coordination Committee and the Scientific Review Committee.

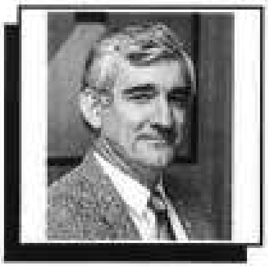
Figure 1 Board of Management of the CRC

Mr John Allwright, AO
Chairman

Professor Pip Hamilton,
Pro-Vice Chancellor/
Research,
University Of Tasmania

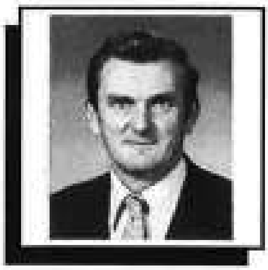
Dr Glen Kile [1],
Chief, CSIRO
Division of Forestry

Mr Ken Felton,
Commissioner,
Management,
Forestry Commission,
Tasmania



Mr Ian Whyte,
Executive Forester,
Associated Pulp and Paper
Mills

Mr Steve Balcombe,
General Manager,
Australian Newsprint
Mills Ltd



Mr Des King,
General Manager,
Forest Resources

Professor Jim Reid [2],
Director

Dr Phil West [3],
Deputy Director

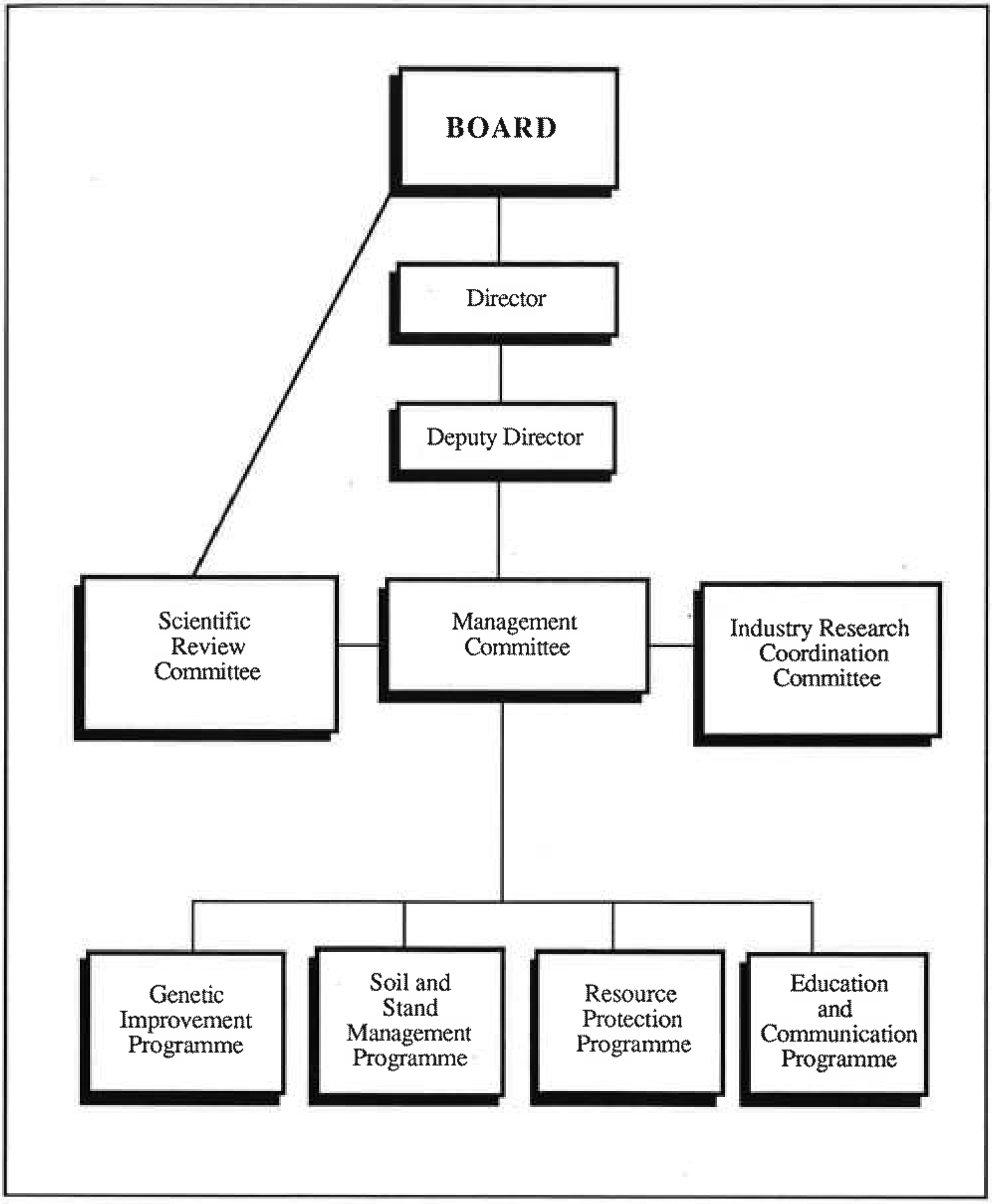
Changes to the Board:

[1] Dr Glen Kile replaced Mr Alan Brown as the CSIRO Representative.

[2] Professor Jim Reid replaced Dr Glen Kile as Director of the CRC.

[3] Dr Phil West replaced Professor Jim Reid as Deputy Director of the CRC.

Figure 2 Management Structure of the CRC



Committees

Management Committee

The **Management Committee** resolves issues associated with the day to day running of the CRC and is comprised of the Executive Officer, the Director and Deputy Director, and Programme Managers. Members are:

Ms Mary Rainbird	-	Executive Officer
Professor Jim Reid	-	Director and Programme Manager, Genetic Improvement
Dr Phil West	-	Deputy Director and Programme Manager, Soil and Stand Management
Dr John Madden	-	Programme Manager, Resource Protection
Dr Neil Davidson	-	Programme Manager, Education and Communication

Industry Research Coordination Committee

The **Industry Research Coordination Committee** was established this year by the Board. It is composed of the senior research scientists from all participating organisations. It forms the most direct and immediate contact between the industrial partners and the research workers within the Centre and provides advice on the direction of the research conducted by the Centre. Its members are:

Dr Humphrey Elliott	-	Chief, Division of Silvicultural Research and Development , Forestry Commission,Tasmania
Dr David de Little	-	Research Manager, APPM
Mr Peter Volker	-	Research Manager, ANM Ltd
Mr Keith Orme	-	Research Manager, Forest Resources
Professor Jim Reid	-	Director, CRC
Dr Phil West	-	Deputy Director, CRC and Officer in Charge, CSIRO Division of Forestry, Hobart
Dr John Madden	-	Programme Manager, CRC Resource Protection
Dr Neil Davidson	-	Programme Manager, CRC Education and Communication

Scientific Review Committee

The **Scientific Review Committee** functions to review projects in each research programme and recommends changes in emphasis or direction. The Board has agreed that this will consist of an external expert in the area of each research programme plus the Co-Director of the CRC for Hardwood Fibre and Paper Science. The Board is still to finalise two appointments to this Committee.

Cooperative Linkages

During the first year of the CRC's operation, several significant cooperative linkages have been forged both between members of the CRC parties and with outside organisations.

Interaction between partners

The transfer of the CSIRO Division of Forestry's Research Laboratories in Tasmania to the Hobart campus of the University of Tasmania in April 1992 has allowed closer links to develop between University and CSIRO staff in the CRC. This has allowed staff from both organisations to run joint, fully integrated projects and provided stimulus for joint supervision of students.

A cooperative venture between CSIRO Division of Forestry, Canberra and the CRC has shown that lowered total gibberellin levels are associated with the induction of flowering in recently grafted *E. nitens* plants. This project has also resulted in the development of techniques to reduce the time of the production of open flowers on *E. globulus* to 24 months.

Significant collaboration has been developed between the CRC and scientists in the Genetics Programme and APPM, ANM, Forestry Commission, Tasmania and CSIRO to establish significant trials to determine the heritability of morphological characteristics in a number of eucalypt species and the effects of inbreeding on the performance of *E. globulus* and *E. nitens* in plantations. This work has also resulted in the first estimates of heritabilities based upon controlled crosses rather than open -pollinated progenies.

A contact group has been formed within the Resource Protection Programme which will meet every three months to coordinate entomological research activities.

Links between CRC scientists of the Soil and Stand Management Programme and Forestry Commission and ANM Forest Management staff have resulted in the development of a bulldozer modified to reduce site damage and reduce the potential planting area taken up by windrows. These links have now also extended to cooperation in pruning and fertilisation trials in the southern forests of Tasmania.

The Education and Communication Officer recently appointed to the CRC (July 1) is contributing to a project in the Soil and Stand Management Programme on the effect of nutrient and water deficits on tree photosynthetic capacity and water use efficiency.

Interactions between CRC and outside organisations

Strong linkages are being established between this CRC and the CRC for Hardwood Fibre and Paper Science. The latter CRC will be developing technologies to allow for rapid screening of wood samples with the aim of allowing tree breeders and geneticists to screen a sufficiently large number of samples to gain reliable estimates of genetic parameters for important wood and fibre traits. That Centre will rely on advice from the Hobart Centre on suitable trials for sampling and for genetic advice and genetic analyses of data. To this end, Ms Carolyn Raymond from the CRC for Temperate Hardwood Forestry is on two of the Programme Advisory Committees of the CRC for Hardwood Fibre and Paper Science. Fifty percent of her time is allocated to a project assessing the genetic parameters associated with wood fibre traits. The Director also sits on their Scientific Review Committee.

Research

The Centre has established three research programmes investigating aspects of the growth and management of eucalypt plantations. They are Genetic Improvement, Soil and Stand Management and Resource Protection.

GENETIC IMPROVEMENT PROGRAMME

Programme Manager

Professor J Reid

INTRODUCTION

This programme aims to achieve gains in plantation productivity by developing the techniques necessary to improve the genotypes of planting stock. This requires two major research thrusts. Firstly, reliable estimates of relevant genetic parameters must be determined and used to develop efficient breeding strategies. Secondly, once genetically superior material has been identified, it must be transferred to plantations as quickly as possible either by seed or by vegetative propagation. These two needs form the basis of the two sub-programmes in this Programme.

Sub-Programme 1 — *Genetic Resources and Breeding Strategy*

Four research projects have been established within this sub-programme. These are broadly based to allow several different but potentially important breeding strategies to be examined.

Breeding programmes aim to evaluate the available genetic resources, select the best natural seed sources and progressively improve these via selection and interbreeding of superior trees to produce planting stock of constantly improving genetic quality. Breeding programmes rely on the development and critical evaluation of alternative strategies which aim to optimise the rate of genetic gain within the biological constraints imposed by the species. These rates of genetic improvement are controlled by four major factors: the degree of variation present in the population, the degree of genetic control of the trait, the generation interval and the intensity of selection employed.

Expression of genetic variation will change with tree age and size. The aim of a breeding programme is to produce trees with desired characteristics at harvest age. However, it is impractical in terms of the generation interval to wait until harvest age to assess the traits of economic importance. It is thus vital to determine the degree of variation and correlations between the expression of a trait at different ages. Optimum ages for parental and offspring selection may then be identified. The potential for reducing the generation interval by using very early selection techniques is an area of study.

Recently, it has become possible to find genetic markers at the DNA level as well as the protein level. Such markers may allow tree breeders to select for specific traits at an early age and to fingerprint individual genotypes or clones. In addition, the markers allow the genetic diversity within and between populations to be determined to ensure inbreeding effects do not become pronounced and to determine which germplasm should be added to breeding programmes.

There is considerable international interest in the use of interspecific hybridisation as a breeding strategy in *Eucalyptus*, yet little of the genetic information to effectively assess or use a hybrid breeding strategy is currently available. Of particular interest is whether hybrid vigour exists and can be exploited in breeding programmes. To fully evaluate the benefits and genetic behaviour of interspecific hybrids, adequate pure bred outcrosses are essential (particularly interprovenance crosses) but to date, these have not been incorporated in studies of eucalypt hybrids.

Major achievements of this sub-programme were:

- the first comparison of heritabilities determined from controlled crosses and open-pollinated progeny in eucalypts
- the first publication of techniques for the isolation of genetic polymorphisms from chloroplast DNA of eucalypts and
- the determination that insect tolerance has a high heritability and that there is a positive correlation between tolerant genotypes and growth.

Detailed below are reports outlining progress over the last twelve months in these four projects in this sub-programme.

Project 1

Project Leader

Ms C Raymond

Estimates of Heritability and Genetic Correlations

a) Provenance studies

Data from nine *E. regnans* provenance trials (now 10 year old) has been analysed to determine the optimal seed sources to use for establishing breeding populations for this species. Each trial contained 49 provenances collected from throughout the natural range of the species. Data analysed included diameter, height, survival, standing volume, straightness and branching quality. Large variation was found for each trait and the local seed source was not found to be the optimum for any site.

b) Insect defoliation

Large differences in levels of defoliation caused by chrysomelid beetles (*Chrysophtharta bimaculata*) have been found between different families of *E. regnans* and *E. nitens*. These differences are repeatable across seasons with the same families being repeatedly defoliated in each year. The heritability of susceptibility to defoliation is 0.30 - 0.35 and it shows a strong negative correlation with tree growth (Figure 3). The reasons for this correlation are the subject of investigation.

To identify which leaf characteristics influence susceptibility to defoliation, *E. regnans* families previously identified as being resistant or susceptible to defoliation are being studied in detail. Leaf characters studied during the last summer included colour change, expansion rate, growth and phenology. Leaves were also collected for determination of leaf oil constituents. This work is being done in collaboration with researchers from the Resource Protection Programme.

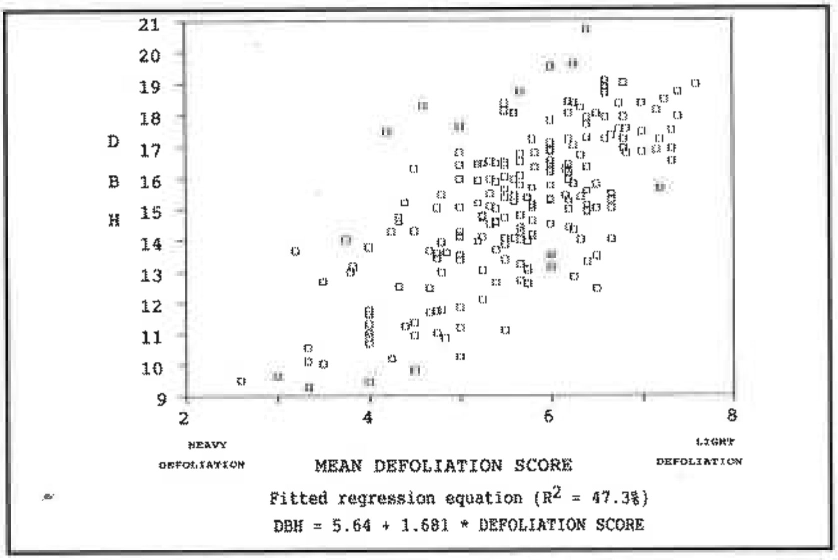


Figure 3 Relationship between diameter increment and degree of defoliation in families of *E. regnans* which were repeatedly defoliated over three consecutive summers

Project 2

Project Leader

Ms C Raymond

Age to Age Correlations

a) Register of progeny trials

Records of existing progeny trials by the collaborating parties which may be suitable for future studies are being collected with the aim of establishing a large database that may be analysed to determine age to age correlations.

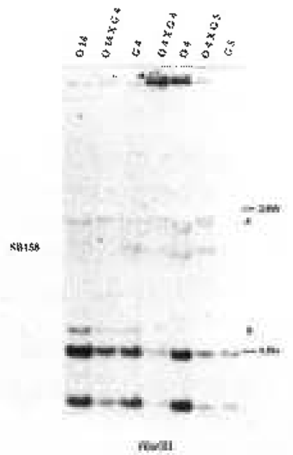
b) Early selection techniques

Collaboration is being developed with the group at CSIRO Division of Forestry in Canberra who are working on intensive seedling studies as indicators of later age growth performance. Advice on suitable field trials for evaluating later age performance and on selection of suitable seedlots is being supplied from the CRC.

Project 3

Project Leaders

Dr A West and Professor J Reid



An RFLP autoradiogram showing differences between *E. ovata*, *E. globulus* and the hybrid

Identification of Genetic Markers

Work on this project has progressed on two fronts. Firstly, strategies have been devised for the isolation and characterisation of cloned genomic DNA probes which might detect useful polymorphic markers (RFLP markers) in *Eucalyptus* populations. Several of these probes have demonstrated potential and are being tested against geographically diverse *E. globulus* specimens. Secondly, the applicability of a new process for generating and detecting polymorphic markers, the RAPD technique (Random Amplified Polymorphic DNA) has been assessed. Results so far have not been encouraging and suggest that some important technical problems need to be overcome before this approach will work well in *Eucalyptus*. Both techniques rely on the efficient and repeatable isolation of nucleic acids from eucalypt tissue and it appears that the earlier work carried out by members of this project has been successful in meeting this objective.

The project has recently received a significant boost in the appointment of a key researcher to the position of Plant Molecular Geneticist. Dr Rene Vaillancourt will join the CRC in August 1992 and his previous experience in classical and molecular plant breeding strategies at Cornell University will be a significant boost to the project.

Project 4

Project Leader

Dr B Potts

Hybrid Breeding

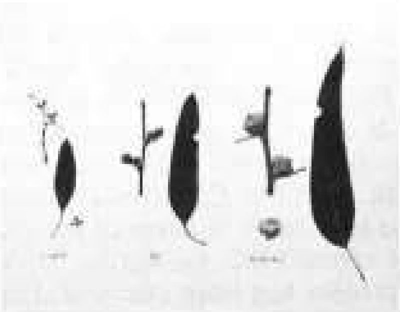
A start has been made to collect the genetic information to assess effectively whether a hybrid breeding strategy is potentially beneficial. We have initiated research to determine whether:

- traits are inherited in a similar manner in hybrids as in pure bred progenies
- parental general combining abilities are stable (i.e. GCA vs GHA)
- specific combining effects are of similar magnitude in interspecific and intraspecific combinations
- hybrid vigour exists and can be exploited in breeding programmes and
- insect predation is more severe for hybrids than their parents.

The CRC has brought together one of the largest collections of pedigreed F_1 hybrids of *Eucalyptus* (e.g. *E. nitens* x *E. globulus*, CSIRO, Tibbits' PhD and APPM hybrid trials; *E. gunnii* x *globulus*, Potts and APPM; plus numerous other miscellaneous species combinations) with parental controls. Data are being collected from these trials and used to determine the potential of hybrid breeding.

Research conducted is outlined below (a-d):

a) The relationship between cross success/heterosis and the genetic/taxonomic distance between parents



Leaves, buds and fruits of *E. gunnii*, hybrid and *E. globulus*

- Trials of a wide range of artificial F_1 hybrids established by the University of Tasmania and APPM have been assessed for height and diameter at ages three or four. Reproductive traits including flowering are being monitored and plants available for advanced generation crossing have been identified. This data will form the basis of the proposed hybrid review.

- Crosses testing new techniques of controlled pollination have been completed and seed will be collected this summer.

- Di-hybrid crosses of *E. globulus* have been undertaken to complete a three generation pedigree for RFLP linkage analysis.

- Barriers to the production of *E. gunnii* x *globulus* and *E. nitens* x *globulus* F_1 hybrid seed have been quantified and comparisons of the mortality and abnormalities in the nursery and field trials have been made.

Results show that in the hybridisation among the closely related species, *E. globulus*, *E. nitens* and *E. bicostata*, the level of deleterious abnormalities was significantly greater than in outcross and inbred controls. Abnormalities in hybrid families were clearly evident in the nursery whereas the deleterious effects of inbreeding only became significant after one year of plantation growth. An optimum level of divergence associated with inter-provenance crossing was apparent for cross success and early growth. The expression of deleterious abnormalities in specific hybrid families was not predictable on the basis of the intraspecific performance of the parents and appears to be due to a different genetic mechanism to that resulting in inbreeding depression.

b) The relative magnitude of the additive and non-additive variance components and relationship between breeding values (GCA vs GHA) in pure breed and hybrid combinations

• Genetic parameters for early seedling growth traits and juvenile leaf size and shape in a *E. globulus* x *globulus* factorial, a *E. nitens* x *globulus* factorial and a *E. nitens* x *nitens* half-diallel have been compared.

Results suggest that traits associated with growth and plant vigour had low heritabilities whereas leaf shape traits had moderate to high heritabilities. Open-pollinated estimates of narrow-sense heritabilities were generally inflated compared to those derived from controlled crossing (factorial and half-diallel) suggesting that the use of open-pollinated estimates of heritabilities may significantly inflate genetic gain estimates. The correlation between GCA and GHA values were generally poor for early growth traits and did not allow the prediction of hybrid performance on the basis of the performance of the parents in intraspecific crosses. However, the correlation was significant in traits with high heritabilities in intraspecific crosses (e.g. leaf shape traits). Specific combining effects were generally small compared to general combining effects with the ratio of additive to non-additive genetic variance generally greater than one.

c) The inheritance of traits in F_1 and advanced generation hybrids

Hybridisation of *E. gunnii* and *E. globulus* subsp. *globulus* is of particular interest as this would allow the combination of genes of one of the most freezing-resistant species in the genus with genes of one of the faster growing, high pulp yielding species. The F_1 hybrid is relatively vigorous and has been shown to be intermediate in freezing-resistance, but with slight partial dominance toward *E. globulus* . Fourteen unselected *E. gunnii* females growing in three natural stands on the Central Plateau of Tasmania have been crossed in a factorial (NC II)

Assessing an APPM trial of *E. nitens* selfs and outcrosses for insect damage

design with eight *E. globulus* pollen parents selected by APPM Forest Products on the basis of growth rate and pulp yield. One intra- and two inter-provenance outcrosses of *E. gunnii* were undertaken on each female as well as an unassisted self-pollination. Single-pair unrelated matings involving the eight *E. globulus* parents were provided by APPM as the outcross controls for *E. globulus*. A virtually complete 4 x 7 factorial of F_1 hybrids from this crossing is now being cloned (hardwood cuttings) by APPM along with *E. globulus* and E. *gunnii* outcross controls. This cloning will provide genetic material for multi-location trials as well as allow the inheritance of rooting ability in interspecific hybrids to be determined.

d) The response of insect pests to artificial hybrids

A PhD project has commenced which is concentrating on the response of pests to eucalypt hybrids with particular attention to those involving *E. globulus* and *E. nitens*. These studies are being undertaken in collaboration with APPM, Ridgely, CSIRO, and the University of Tasmania.

The research goals of project 4 for 1993 are:

• Review the performance of the wide range of F_1 hybrids established in trials near Ridgley (three to four years old).

• Detail early growth, survival and abnormalities in the CSIRO's *E. nitens* x *E. globulus* hybrid and control crosses.

• Study the inheritance of frost resistance and juvenile morphology in *E. nitens* x *E. globulus* F_1 hybrids and control crosses.

• Monitor trials of *E. gunnii* x *E. globulus* F_1 hybrids and pure parent controls.

• Commence monitoring of hybrid trials for flowering traits.

• Continue advance generation crossing.

• Determine pest loads on F_1 hybrids and parental controls in trials near Ridgley (PhD project).

Sub-Programme 2 Propagation Strategies

Two projects have been established, one examining vegetative reproduction through micropropagation and one concentrating on rapid seed production.

Elite genetic material produced in breeding programmes must be transferred into operational forestry as rapidly as possible either by seed or by clonal forestry (vegetative propagation). Clonal forestry offers the most rapid means of capturing the genetic gains of the selected genotypes in full. The alternative is to stimulate early flowering and to increase seed production. Early flowering would also reduce substantially the generation interval in breeding programmes.

A seedling of *E. nitens* may take six years to flower while a grafted ramet from a reproductively competent ortet may take three to four years. Advances in the tree breeding field are such that selection of desirable material may occur significantly before flowering and in such a context delayed flowering represents an increasingly important bottleneck. An advance of flowering of even two years would represent a cut in generation time of about 25 percent which would provide very significant economic and time savings. In conjunction with this practical aim, an understanding of the physiological base of flowering control in *Eucalyptus* is also being sought.

As superior genetic material becomes available, it will be necessary to propagate it clonally and rapidly for field evaluation. Micropropagation has the potential to provide high multiplication rates of uniform genotypes for this purpose and, further along the line, for silviculture gains. The technique involves induction of axillary and/or adventitious shoot proliferation on nodal explants followed by rooting shoots. Research in this area will also be applicable in the context of future work on genetic transformation of *Eucalyptus* since this will inevitably involve strategies for the regeneration of plants from transformed cells.

Major achievements of this sub-programme were:

- the production of open flowers in two-year-old seedlings of *E. globulus* by a combination of chemical and environmental treatments

- the determination of the gibberellin biosynthetic pathway in eucalypts

- the establishment of a large trial to quantify the effects of inbreeding in *E. globulus* and

- the transformation of a eucalypt using *Agrobacterium tumefaciens* for the first time.

Detailed reports of the projects are outlined below.

Project 5

Project Leader

Mr V Hartney

Micropropagation of Selected Clonal Material

Improved methods of micropropagation have been developed for *E. camaldulensis* and these methods are also working well for many other species, particularly for recalcitrant clones. For *E. camaldulensis*, an increased rate of shoot multiplication and improved shoot health has been achieved with no decrease in rooting percentage.

These methods are also being developed further with the commercially important pulpwood species (*E. nitens*, *E. globulus* and *E. nitens* x *globulus*). To date, similar improvements in shoot health and growth have been obtained. Details of this work are being prepared for publication.

Tissue culture of *E. ficifolia*

Research conducted outside the framework of this CRC by the CSIRO Division of Plant Industry and the CSIRO Division of Forestry has led to the successful genetic transformation of *E. camaldulensis* using *A. tumefaciens* as a gene vector. The reporter genes (GUS fluorescence and kanamycin tolerance) have been expressed in whole plants and verified by DNA extraction and southern blots. Researchers are now seeking to engineer insect resistance and floral sterility for the temperate eucalypts, *E. nitens*, *E. globulus* and *E. nitens* x *globulus* .

The research done on micropropagation in the CRC for Temperate Hardwood Forestry may have valuable application in this project.

The tissue culture laboratory facilities will be relocated from Canberra to Hobart during August/September 1992.

Project 6

Project Leader

Professor J Reid

Manipulation of Breeding Systems

a) Control of flowering

During 1991-92, several important advances were made regarding the control of flowering in eucalypts and the possible involvement of phytohormones. Techniques allowing the identification and quantification of the group of plant growth regulating hormones known as gibberellins, have been further refined for use in eucalypt species. Several key gibberellins, including gibberellins A_1, A_{19}, and A_{20} have been successfully isolated and fully identified while tentative identifications of gibberellins A_{29} and A_{53} have recently been achieved. The particular combination of compounds found suggests a mechanism of gibberellin biosynthesis, commonly referred to as the early 13-hydroxylation pathway, is in operation in expanding vegetative tissue of *E. nitens* (Figure 4). This pathway is similar to that controlling vegetative growth in a wide range of plant taxa. Quantification shows levels of these hormones lie within the range previously reported for other plant species. Work aiming to identify more structures which are known components of the early 13-hydroxylation pathway of gibberellin biosynthesis is planned in order to confirm the proposed scheme.

The isolation of gibberellin structures and the elucidation of the pathways of manufacture of active gibberellins has enabled the effect of the applied plant growth retardant, paclobutrazol, on these hormones to be assessed. A differential response as measured by a decrease in the levels of active and important pre-active gibberellins has been shown to result from varying application methods including collar (soil) drenching, foliar spraying and trunk injection. In addition, the persistence of these effects has been shown to vary with application method. Further work utilising radiolabelled paclobutrazol to compare the rates of incorporation of this plant growth retardant into new tissue when applied by different methods is in progress.

Flowering of *E. globulus* after 24 months

A cooperative venture between CSIRO Division of Forestry and the CRC has shown that lowered total gibberellin levels are associated with the induction of flowering in recently grafted *E. nitens* plants. However, monitoring gibberellin levels during the time of initiation of flower buds indicates that reduced gibberellin levels alone do not appear to be responsible for inducing bud development. It appears that cold treatment or other environmental stress factors may be co-requisites for floral initiation. A more comprehensive experiment to gain further insight into the correlation between environment, gibberellin levels and flowering is currently in progress.

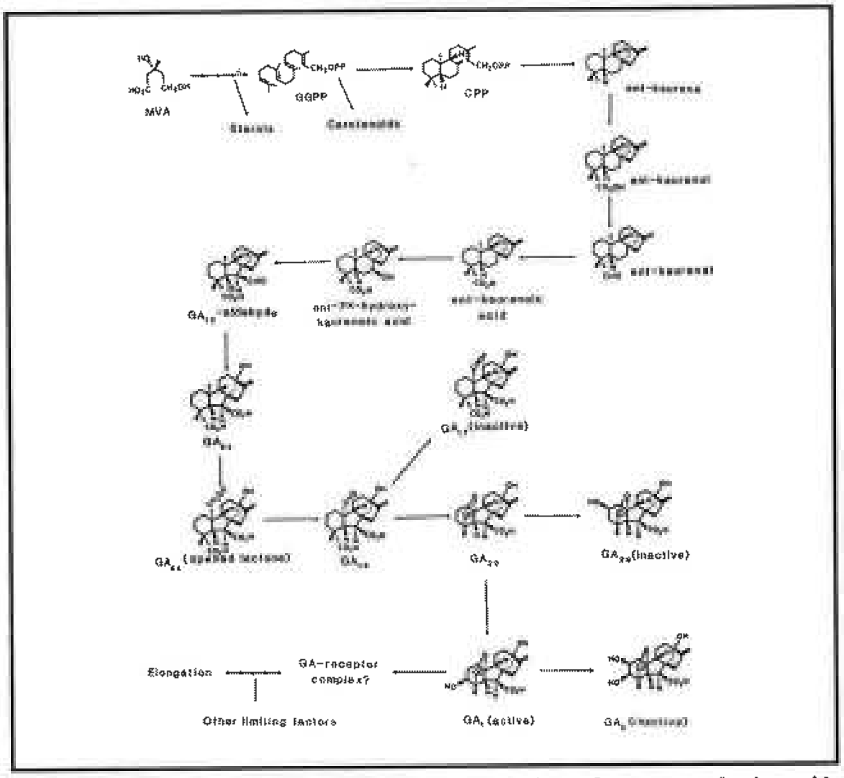


Figure 4 Biosynthesis of active gibberellins from mevalonic acid (MVA) via the early 13-hydroxylation pathway

The effect of a foliar application of paclobutrazol on flower bud production in seedling and clonal 'seedling' material is in progress, with results expected early next year. The plant material used was kindly supplied by Forest Resources at very short notice and they await results with interest, given their previous involvement in similar studies. This experiment is a follow-up of another experiment involving *E. globulus* seedlings and paclobutrazol application which returned unexpected results in late 1991. In this experiment, buds were produced on 18-month old *E. globulus* seedlings and open flowers on 24-month old seedlings.

b) Inbreeding effects in *Eucalyptus*

Experiments have been undertaken to investigate the breeding system of *E. globulus*, particularly the effects of inbreeding. Growth comparisons of controlled outcrosses, selfs and open-pollinated progenies of *E. globulus* have been made over a four year period. The deleterious effects of self-pollination on growth rate are marked in this species and are manifested after only one year's field growth in both self and open-pollinated progenies. The effects of other, less extreme forms of inbreeding are also being examined. For example, intra- and inter-provenance crosses of *E. globulus* are being compared in a CSIRO/APPM trial. No significant difference was observed for seed set, but after one year's growth, the levels of deleterious abnormalities and mortality were greater in progenies from open-pollinated and intra-provenance crosses than those from inter-provenance crosses. The extent to which inbreeding occurs in open-pollinated natural populations is being examined in a neighbourhood inbreeding experiment. Pollinators of eucalypts seem to forage in a nearest-neighbour manner which would result in most pollen transfer occurring within a single canopy and amongst neighbouring trees in the forest. However, if the deleterious effects of inbreeding are marked, there could be a significant discrepancy between pollen dispersal and realised gene flow with the products of more long distance pollen dispersal favoured. The magnitude of the effects of neighbourhood inbreeding are being examined in order to determine the optimal outcrossing distance. This has important implications for the collection of seed destined for breeding or seed production areas. Each of seven trees in natural stands were crossed with pollen collected from trees located at varying distance from the female (selfs, nearest neighbour, 250m, 500m, 1km, 10km and 100km). Seed counts and assessment of the seed viability showed the main inbreeding effect was associated with self-fertilisation after which little difference occurred with distance from the female tree. Data have been collected on germination and glasshouse growth and progenies from these crosses are currently being planted in trials on sites provided by the Forestry Commission, Tasmania and ANM.

A major inbreeding trial of *E. regnans* has been re-assessed at 13 years to examine the longer term effects of inbreeding on survival and growth rate.

SOIL AND STAND MANAGEMENT PROGRAMME

Programme Manager

Dr P West

INTRODUCTION

This programme aims to provide tools to forest growers that will allow them to manage properly the site and tree resources available to them. This should allow maximum production of the forest products desired with minimum effect on the properties of the site.

To achieve these objectives, the programme aims to develop a detailed description of the growth behaviour of eucalypts in plantation forests in relation to the environmental factors that pertain to any particular site, especially temperature and the availability of moisture and nutrients. This will allow identification of those factors that limit growth and, in turn, should lead to silvicultural treatments to ameliorate their effects.

As well as this major task, the programme is developing other tools of more immediate use for eucalypt plantation management. These include a simple system to predict wood yields from plantations on particular sites, determination of the optimum soil physical environment for seedling root development at establishment and empirical determination of growth response to fertilisers on a wide range of sites. Over the past year, several projects were undertaken which have direct application in management practice. These are described below.

The research of the programme is based around four projects. In fully developing the programme this year, these were given detailed consideration. This did not alter their principles as outlined in the Centre agreements, apart from changing the titles of three of them (see below) to better reflect their purpose.

The main achievements of this programme were:

- development of a simple model to describe the impact of nitrogen and phosphorus supply on tree growth via effects on CO_2 assimilation and biomass partitioning
- completion of work indicating that post-planting weed control is not required in eucalypt plantations grown on land previously occupied by eucalypt forest. This will reduce plantation costs
- demonstration that topsoil disturbance can be reduced during clearing operations for plantations by using excavators rather than bulldozers so helping to maintain the long term integrity of the site
- development of models to predict the light environment of tree canopies. This is essential for prediction of photosynthetic production and
- development of a model system to predict partitioning of biomass production between tree parts during growth.

Project 1

Project Leader

Dr C Beadle

Plantation Production and Water Use

This project is investigating the productivity, photosynthetic capacity and water use efficiency of eucalypts, particularly in relation to nutrient and water availability. This will be important in determining the absolute requirements of plantations for water and nutrients. Major experiments include:

a) Water use

The land base which is potentially suitable for fast-growing eucalypt plantations is limited. A study is being undertaken in co-operation with ACIAR to identify the impact of seasonal moisture stress on the performance of *E. globulus* and *E. nitens.*

The aim is to identify characteristics which will allow their planting on drought-prone sites which still have the potential for high rates of growth when adequate soil moisture is available.

The changes in maximum leaf water potential (predawn) and stomatal conductance (midday) of the two species during a series of two drought cycles were compared with those from irrigated control plots. In the first cycle predawn water potentials of -0.7 MPa were recorded in the rainfed plots of both species (11 December 1991); in the second, they fell to -1.25 and -2.0 MPa in *E. globulus* and *E. nitens*, respectively (February 1992). The controls had water potentials greater than -0.4 MPa.

The same ranking of treatments was observed for conductance; i.e. conductance was lower in irrigated *E. globulus* than *E. nitens* and the order was reversed in the rainfed plots (Figure 5).

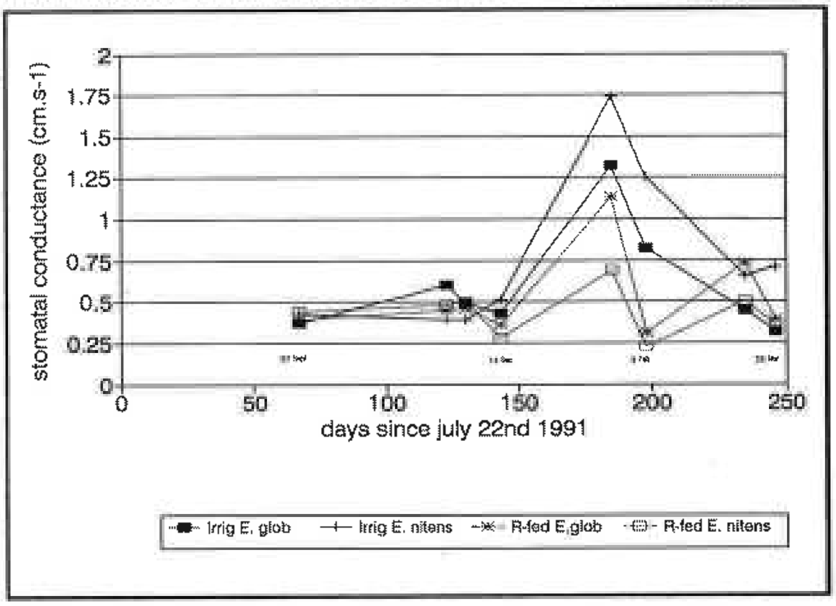


Figure 5 The midday stomatal conductance of *E. globulus* and *E. nitens* in irrigated and unirrigated plots, recorded at intervals from July 1991 to April 1992

b) Post-planting weed control

Throughout Tasmania, plantations of *E. nitens* have been established on sites which have formerly carried native eucalypt forest. An experiment has examined the effects on tree growth of post planting weed control by hand or with three levels of application of a granulated formulation of atrazine, two on a root zone basis at 8 and 16 kg ha^{-1} (equivalent to 0.9 and 1.8 kg ha^{-1} broadcast respectively), the other broad acre at 8 kg ha^{-1}. Each treatment was repeated with the addition of nitrogen as urea at 200 kg ha^{-1} N and triple superphosphate at 120 kg ha^{-1} P.

A CSIRO trial of *E. nitens* used for studies on mechanical site clearing, tree pruning and nitrogen and phosphorus fertiliser application

Post-planting application of atrazine generally reduced height and diameter growth, but only significantly where 12 kg ha^{-1} atrazine had been applied (4 kg ha^{-1} pre-planting plus 8 kg ha^{-1} post-planting) (Table 1) . Post-planting fertilisation increased tree height and diameter growth. It was concluded that post-planting applications of herbicide have no advantageous effects on the growth of *E. nitens* on native forest sites given effective pre-planting weed control. Costs incurred in post-planting weed control would be better input to secondary fertilisation where the need for such treatment has been identified.

	Total atrazine applied (kg ha^{-1})[1]				
Treatment	4[2]	4[3]	4.9	5.8	12
Height	4.57	4.50	4.00	3.90	3.56
Diameter (1.3m)	5.20	5.19	4.40	4.18	3.68

[1]all treatments received 4 kg ha^{-1} atrazine pre-planting
[2]control. (post-planting weed control)
[3]land weeding post-planting

Table 1 The impact of atrazine applied post-planting in the first year of growth on the height and diameter of *E. nitens* at age 29 months

c) Excavators for clearing

The clearing of native forest sites for plantation establishment requires the removal of large numbers of stumps and variable amounts of slash into parallel windrows set at defined intervals. Minimum disturbance to the site is essential for this operation to maintain site integrity.

In a comparison of four sites, average cost for bulldozers to push and pile was \$883 ha^{-1} compared with \$1186 ha^{-1} when used with an excavator to rake and pile and \$1222 ha^{-1} when excavators were used alone. Greater cost incurred by using an excavator was offset by reduced site disturbance and top-soil loss, and reduced area of plantable land lost under windrows (Table 2).

Treatment	Mean windrow width (m)	Windrow area[1] (ha)	Windrow area as % cleared area
Bulldozer	7.9	3.2	15.2
Excavator/bulldozer	5.1	2.0	9.6

[1]A plantation area was approximately 42 ha

Table 2 The dimensions of windrows and their proportion of cleared area using two methods of clearing: bulldozer alone and bulldozer plus excavator

Project 2

Project Leader

Mr R Cromer

Dynamics of Carbon and Nutrients

This project is studying the accumulation, allocation and cycling of carbon and nutrients in plantations, particularly in response to nutrient availability. Ultimately, this will lead to prescriptions to minimise fertiliser use by timing its application correctly. Major experiments include:

a) Response of temperate eucalypts to nutrients

An experiment planted in 1990 with *E. nitens* (5 nitrogen x 5 phosphorus treatments) at Goulds block, Dover has developed a stem distortion under heavy fertilization. This may be a trace element deficiency (e.g. Cu++) or may be an early sign of a broader problem with macronutrient (N and P) supply. On fertile pasture sites, *Pinus radiata* has developed similar severe characteristics of stem distortion. We intend to investigate this issue further and attempt to determine the cause of the problem and ameliorate the symptoms.

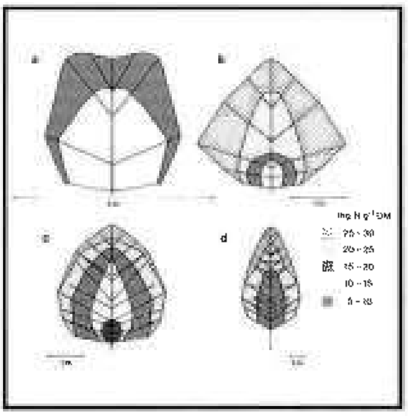


Figure 6 Contour diagram of nitrogen concentrations within the crowns of *E. grandis* saplings

Future investigations in this project will include:

- A series of nutrition experiments with a standard design and common genetic material which are to be established on a broad range of site and soil types.

- A general study of Tasmanian soils suitable for plantations using the extensive database and Geographic Information Systems available at the Forestry Commission, Tasmania.

- Investigation on two experiments with *E. nitens* which were installed by APPM on high elevation basalt soils in 1991 using a design similar to that installed at Goulds block.

b) Modelling of nutrient responses

Growth of tree seedlings is affected by nutrient availability through its influence on three main physiological processes, assimilation, biomass partitioning, and specific leaf area. Nutrient-rich seedlings have high rates of CO_2 assimilation, allocate a high proportion of carbon to foliage at the expense of roots and have thinner leaves that intercept more radiation. There is also a very strong zonation of nutrients within the crowns of eucalypts (e.g. N, Figure 6). A simple dynamic model was developed to describe growth of seedlings in response to different relative addition rates of nitrogen and phosphorus as reflected in plant nutrient status (e.g. Figure 7). The model takes into account effects of plant nutrient concentrations on partitioning, specific leaf area and light

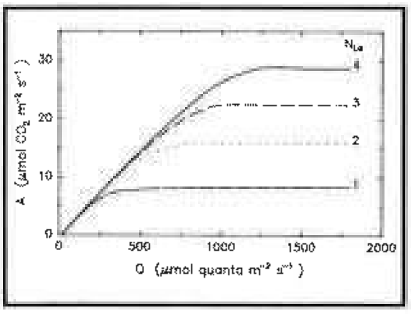


Figure 7 Light response curves predicted for leaves with different nitrogen status (1-4)

saturated assimilation rate. It was used to simulate growth of *E. grandis* seedlings in response to a range of fixed relative addition rates of phosphorus and nitrogen.

It was possible to differentiate the mechanics of the effects of nutrient status on growth. For example, if plants are deficient in nitrogen, changes in growth consequent upon improved nitrogen status are mediated primarily through effects on assimilation rate and biomass partitioning, whereas if plants have high nitrogen status, changes in growth consequent upon improved nitrogen status are mediated through effects on specific leaf area. The model will be extended for application to various other experiments conducted by the CRC.

Project 3

Project Leader

Dr P Smethurst

Soil Nutrient Supply

This project is investigating the fate of nutrients in soil, particularly how nutrient supply to roots is controlled and what the ultimate fate is of fertiliser applied to soil. A second major thrust of the project is to examine root growth in relation to soil physical factors to determine how sites should be best prepared to optimise seedling growth at time of plantation establishment. This work is being undertaken by two scientists new to the Centre: the first, Dr Philip Smethurst joined us recently (July 1991) and the second will be appointed shortly.

Project 4

Project Leader

Dr P Sands

Modelling Growth, Nutrition and Soil Water

This project interacts with other projects to produce a definitive, mathematical model of plantation growth in relation to nutrient and water availability.

a) Light environment of tree crowns

Central to the prediction of canopy photosynthesis is the determination of the light environment of the forest canopy. This work developed and investigated a model system to predict the light absorbed by and the intensity of light within tree crowns in eucalypt forest. The model predicts the movement of the sun over the forest canopy hour by hour and the passage of the sun through tree canopies so providing estimates of light intensity anywhere within the tree canopy. It was found using simulation studies that when using the model in young, vigorously growing *E. regnans* forest, tree crowns could be represented adequately as single ellipsoids rather than using more complex geometric shapes. This reduced substantially the computing time required to run the model.

b) Partitioning of biomass during tree growth

Mechanistically based models of tree growth predict biomass production resulting from photosynthesis. A central difficulty in the development of these models has been prediction of the partitioning of this new biomass to the various parts of the tree (leaves, branches, stem and roots). It has been proposed that this is determined by the functional relationships between these parts. For example, the root system must be large enough to supply the water and nutrient requirements of the canopy, hence sufficient new biomass must be allocated to roots to support any increase in canopy size. This work applied that concept and quantified the functional relationships between above-ground parts of the trees. A linear programming method was then developed to solve the mathematical system developed, to determine partitioning between above-ground tree parts during growth.

RESOURCE PROTECTION PROGRAMME

Programme Manager

Dr J Madden

INTRODUCTION

The objective of the Resource Protection Programme is to investigate the economic impact of pests and diseases on plantation establishment and growth. The research effort has been directed towards an Integrated Pest Management Programme (IPM) developed and implemented by a CRC partner, the Forestry Commission of Tasmania, for control of the Tasmanian *Eucalyptus* leaf beetle, *Chrysophtharta bimaculata* (Oliver) and includes studies on the biology and ecology of pests and their natural enemies and insect-host tree interactions. The IPM relies on efficient monitoring of plantations to detect the presence of the beetle and assess its numbers so decisions can be made to spray if required.

Research conducted in the first year of the CRC has discovered two important aspects of beetle behaviour. Firstly, an additional overwintering site of adult chrysomelid beetles has been identified. Large numbers of beetles have been found at the base of *Gahnia grandis* (cutting grass) plants and plants of similar growth habit that typically occur within open regeneration. Consequently, the dispersion of *Gahnia grandis* and its proximity to young plantations may be of importance in leaf -beetle control. Secondly, the invasion of plantations by adult beetles that occurs in the spring can be strongly directional. Feeding lines develop and these move through a stand at a fairly constant rate, resulting in bands of oviposition within the stand.

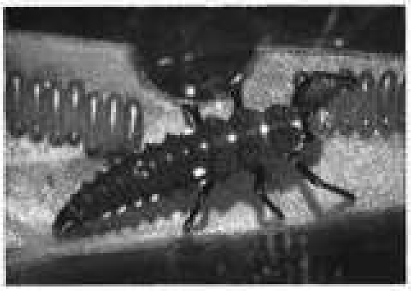
Project 1

Elucidation of Leaf Characteristics which Determine Browsing Preference and Non-preference

Project Leader

Dr J Madden

The specific attraction of insects to coloured traps indicates that colour has a primary role in attracting insects to trees at certain stages of their seasonal growth. A characteristic shift in leaf reflectance from red to yellow (attractive) and then to green has been demonstrated. The subsequent role of leaf chemicals in the acceptance of selected trees by *C. bimaculata* has been confirmed through leaf analysis and the bioassay of leaves from different species at different stages of development. The effect of leaf chemistry on feeding and oviposition has also been demonstrated for *C. bimaculata*.



Ladybird beetle instar eating *C. bimaculata* eggs.

The relationships between tree growth, adult beetle emergence and heat sum (cumulative 14-day average temperatures) have been analysed for three seasons. The results indicate that heat sum from the shortest day permits the forecast of tree performance and, in turn, beetle emergence from hibernation. These findings have relevance to monitoring beetle numbers within the IPM programme.

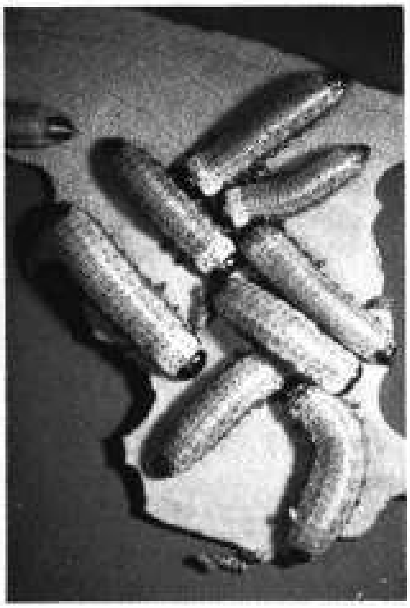
Project 2

Increase in the Efficacy of Existing and Introduced Biological Controls

Project Leaders

Dr H Elliott
Dr J Madden

One of the major objectives of the Resource Protection Programme is to increase the efficacy of the major natural predators of insect pests. Providing adults of the predator *Chauliognathus lugubris* (soldier beetle) with food after 48-hour starvation results in subsequent aggregation of field adults. This phenomenon, which can involve hundreds of beetles, is most likely affected by an aggregation or feeding pheromone. Provision of carbohydrate (sugar) in weather-proof feeding stations in the area has also resulted in greater numbers of ladybird beetles with subsequent high levels of predation of chrysomelid eggs. Trees sprayed with sucrose solutions retain greater numbers of ladybird adults and result in greater predation on resident chrysomelids than do unsprayed trees. In addition, the tackiness of the sprayed trees reduces their acceptability to chrysomelid adults, so fewer eggs are laid. Successful culture of *C. lugubris* has been achieved, permitting detailed studies of its biology, morphology and ecology. In common with *Chysophtharta bimaculata*, both cantharid and coccinellid predators exhibit distinct preferences in their response to coloured traps.



C. bimaculata larvae eating eucalypt leaves.

Insecticides based on the bacterium *Bacillus thuringiensis* var *tenebrionis* (GT) have been shown to be capable of controlling young *C. bimaculata* larvae, but further research is needed before they can be used with confidence as a control agent. It is harmless to coccinellid predators of *C. bimaculata*, but does effect *C. lugubris* to a small extent. However, this effect is minimal in comparison with that of conventional chemical insecticides.

Project 3

Project Leader

Professor M Stoddart

Vertebrate Browsing

This study will examine the potential for olfactory and gustatory repellants in plantations. Three categories of substances will be examined initially. Firstly, the secondary metabolites of *Eucalyptus* will be tested for efficacy in controlled cafeteria testing conditions with pademelon and Bennetts wallaby. Secondly, the extracts from predator odour will be examined. Thirdly, the systematic uptake by tree seedlings of ions that render the leaves bitter to the taste will be examined. Promising advances with all these categories of compounds are being made in the northern hemisphere; to date, very little research has been undertaken with marsupial browsers. This project will proceed intensively following the selection of the recipient of a PhD scholarship to be advertised in September 1992.

Project 4

Project Leaders

Dr J Madden
Dr D de Little

Sap-sucking Insects and their Effects on Young Eucalypts

Investigations on coreid bugs (sap-sucking insects) have resulted in the clarification of *Amorbus* nomenclature. The species, *Amorbus obscuricornis*, which is synonymous with *A. angustior* has been shown to be indistinguishable from *A. rubiginosus* and therefore should be referred to as *A. rubiginosus*. The occurrence of five nymphal stages in this species has been confirmed and a variability in form has been discovered which reflects habitat differences. Preliminary examinations of the chemical nature of the defensive secretions of *Amorbus* and *Gelonus* spp have commenced.

Conclusion

Current findings indicate that there is the potential to increase the effectiveness of natural enemies. When taken with the new knowledge on hibernation sites and heat-tree-insect relationships, the results should contribute significantly to increasing the efficiency of the Integrated Pest Management Programme which has already been implemented at the operational level in Tasmania.

EDUCATION AND COMMUNICATION PROGRAMME

Programme Manager

Dr N Davidson

In Australia, postgraduate training in production forestry is largely restricted to the two schools at the University of Melbourne and the Australian National University. At these schools, the capacity for postgraduate training in the areas of tree genetics and protection of forests against insect/vertebrate depredation has been limited. The main aim of the Education Programme was to expand postgraduate and postdoctoral research in these fields.

Since the inception of the CRC, there has been an expansion in postgraduate student numbers at the Plant Science and Agricultural Science Department, University of Tasmania, in research areas related to the CRC. Currently, there are 16 students enrolled in postgraduate degrees on CRC projects (Tables 3 and 4); 12 of these have enrolled since 1991. Six students are working on projects in the Genetics Programme, three in the Resource Protection Programme and seven in the Education Programme on topics relevant to the aims of the CRC (Table 3). Five students have taken up CRC scholarships, two in the Genetics Programme and three in the Resource Protection Programme. Several of these students also obtained Australian Postgraduate Research Awards (APRA) or Tasmanian University Research Scholarships, so CRC funds were used to top-up the scholarship to the advertised level. This means that more CRC scholarships can be offered. A strong push will be made to attract more high quality students from September 1992 as the University year comes to a close and students are looking for research higher degree places. The intention is to attract a further 10-15 postgraduate students, mostly from interstate. A promotional poster and pamphlet are being drafted for this purpose. Several of these students will be located in the CSIRO Forestry building to work on projects related to the Soil and Stand Management Programme and will be supervised by CSIRO staff involved in the CRC. Students in the Genetics and Resource Protection Programme are being partly supervised by staff from the Forestry Commission, Tasmania and research staff from the industrial partners.

It was also envisaged that the CRC would be involved in undergraduate teaching especially in the honours (year 4) level. A course in Forest Ecology was initiated three years ago and the first four students enrolled in the course will complete their third year in 1992. These students will continue into a fourth year of Honours in Forest Ecology in 1993. In the coming year, CRC staff (e.g. Dr N Davidson and Dr P Smethurst) will be lecturing to Forest Ecology and Plant Science students in their third year. This will familiarise potential postgraduate students with the expertise and research potential of CRC projects.

A Graduate Diploma with Honours in Forest Processes has been established (passed by the Faculty of Science and Technology in June 1992) and will provide an avenue for forestry and related personnel to upgrade their skills by the completion of a one year course involving 50 percent research and 50 percent relevant, specialised coursework.

One of the key objectives of the centre is the communication and application of the pertinent results of research by the industry partners as soon as they become available. To this end, there were two initiatives:

A seminar entitled "The Role and Potential of Eucalypt Plantations in Australia's Wood Supply" was held in Hobart on 16 June 1992. Presentations were given by 10 invited speakers (see Table 7, page 46). The seminar was attended by 150 delegates and was well received.

The groundwork is now being laid for a series of short courses/workshops (up to one week in length) to be conducted in 1992/93. The following topics are being considered:

- Tree improvement for future plantations: A role for physiology? (October 1992)
- Silvicultural practices in eucalypt plantations (March 1993)
- Insect pests of *Eucalyptus*

Table 3 Project details for students enrolled in CRC related postgraduate research

Record No:	Last Name	First Name	Title	Country	Degree	P/F Time	Field	Supervisor	Associate
1	BATTAGLIA	Mike	Mr.	Australia	Ph.D.	Full time	Botany	Prof. Jim B. Reid	
2	CASEY	Steve	Mr.	Australia	Ph.D.	Full time	Fire Regeneration	Dr. Robert S. Hill	
3	CHALMERS	Paula	Ms.	Australia	B.Sc. (Honours)	Full time	Botany	Prof. Jim B. Reid	Dr. Brad M. Potts
4	DUNGEY	Heidi	Ms.	Australia	Ph.D.	Full time	Botany/Eucalypt Genetics	Dr. Brad M. Potts	Prof. Jim B. Reid
5	HASAN	Omar	Mr.	Australia	Ph.D.	Full time	Botany	Prof. Jim B. Reid	
6	HAIFENG	Li	Mr.	Australia	Ph.D.	Full time	Entomology	Dr. John Madden	
7	HARDNER	Craig	Mr.	Australia	B.Sc. (Honours)	Full time	Plant Sci./Eucalypt Genetics	Dr. Brad M. Potts	Prof. Jim B. Reid
8	HICKEY	John	Mr.	Australia	M.Sc.	Part time	Forestry	Dr. Robert S. Hill	Dr. M.J. Brown
9	McENTEE	Anne	Ms.	Australia	Ph.D.	Full time	Eucalypt Genetics	Prof. Jim B. Reid	Dr. Brad M. Potts
10	NESBITT	Katherine	Ms.	Australia	Ph.D.	Full time	Botany	Prof. Jim B. Reid	Dr. Adrian West
11	SHOHET	Debbie	Ms.	Australia	Ph.D.	Full time	Entomology	Dr. John Madden	Dr. H. Elliott
12	STEINBAUER	Martin	Mr.	Australia	Ph.D.	Full time	Entomology	Dr. John Madden	
13	TANJUNG	Rosye	Ms.	Indonesia	M.Sc.	Full time	Botany	Dr. Robert S. Hill	
14	VOLKER	Peter	Mr.	Australia	Ph.D.	Part time	Eucalypt Genetics	Dr. Brad M. Potts	Dr. C. Dean
15	WILKINSON	Graham	Mr.	Australia	M.Sc.	Part time	Botany	Prof. Jim B. Reid	
16	WILLIAMS	Kristen	Ms.	Australia	Ph.D.		Botany	Prof. Jim B. Reid	Brown, Austin

Record No:	Topic	Year Started	Year Finishin	CRC Program	Project	Funding
1	Seed germination and establishment of E. delegatensis	1990	1992	Education		DPI-Forestry
2	Fire regeneration after logging in dry eucalypt forest	1992	1994	Education		APRA-Industry
3	Heteroblasty in E. globulus	1992	1992	Genetic Improvement	Breeding Systems	Plant Sci. Hons. Scholarship
4	The susceptibility of eucalypt hybrids to pests	1992	1995	Genetic Improvement	Hybrid Breeding	Univ. Res. Scholarship & CRC
5	Gibberellins and the control of flowering in E. globulus and E. nitens	1990	1993	Genetic Improvement	Breeding Systems	CRC
6	Phytochemistry of Eucalyptus spp. and C. bimaculata attack	1992	1992	Resource Protection		Industry
7	Inbreeding effects in E. globulus	1992	1992	Genetic Improvement	Breeding Systems	Non, CRC Casual Work
8	Long-term regeneration in logged mixed forest	1991	1994	Education		Non, F.C.T. Employee
9	Pollination ecology and gene flow	1992	1995	Education		APRA
10	Molecular markers in E. globulus	1992	1995	Genetic Improvement	Molecular Markers	APRA & CRC
11	Biological control of C. bimaculata	1991	1995	Resource Protection		APRA & CRC
12	Sap-Sucking Insects (Coreid Bugs)	1992	1995	Resource Protection		CRC
13	Mixed forest regeneration following logging and burning	1990	1992	Education		IDP & Full fees
14	Estimation of genetic parameters for Eucalypt hybrids	1992	1996	Genetic Improvement	Breeding Systems	Non
15	Genetic variation in E. obliqua	1990	1994	Education		Non, F.C.T. employee
16	Modelling Eucalyptus distribution	1991	1994	Education		DPI-Forestry

Table 4 Summary of data from postgraduate student enrolments in CRC projects (extracted from Table 3)

I. Postgraduate Students

		Number of Students
Full/Part Time:	Full time	13
	Part time	3
Degree:	BSc Honours	2
	Graduate Diploma with Honours	0
	MSc	3
	PhD	11
CRC Programme:	Genetics	6
	Soil & Stand Management	0
	Resource Protection	3
	Education	7
Supervisor:	Prof JB Reid	7
	Assoc Prof RS Hill	3
	Dr BM Potts	3
	Dr JL Madden	3
Funding:	CRC	2
	CRC & Univ. Research Scholarship	1
	CRC & APRA	2
	APRA	1
	APRA (Industry)	1
	IDP	1
	DPI (Forestry)	2
	Honours Scholarship	1
	Non, Employed in forest industry	3
	Non, Self-supporting	2

II. Undergraduate Students

Degree:	Forest Ecology	11
Short Courses:	Eucalypt Breeding	
	Resource Protection	
	Yield Prediction	

Utilisation and Application of Research, Commerciali-sation

As commercialisation of research from the CRC is at an early stage, we asked the industry collaborators to describe how their programmes would benefit from CRC research.

The responses were as follows:

Research on Integrated Pest Management (IPM) under the Resource Protection Programme has refined the strategy used in all Forestry Commission and many company eucalypt plantations to control *C. bimaculata* . Evaluation of the effects of synthetic pyrethroids and *Bacillus thuringiensis* on predators, and the effectiveness of these pesticides against *C. bimaculata* has provided information on where the different pesticides should be used and most importantly, the precise timing of application to maximise effectiveness and reduce mortality of predators.

- Dr Humphrey Elliott,
Forestry Commission, Tasmania

ANM Forest Management sees the research programmes of the CRC taking a leading role in background research related to practical forestry problems. The benefits of these are already becoming evident with a coordinated approach to installation of fertiliser trials throughout the state of Tasmania. Significant progress has also been made in understanding the population and behavioural dynamics of major defoliating insects. This should lead to more effective control strategies in the near future.

- Mr Peter Volker, ANM

APPM has had fruitful discussions with University and CSIRO partners in the Soil and Stand Management Programme on the design of nutritional trials, in the Resource Protection Programme on monitoring of chrysomelid populations and in the Genetic Improvement Programme on the vigour of *E. nitens* x *E. globulus* hybrids. In the short-term, we hope to obtain information on the following:

- standardised pollen testing and storage techniques
- Restriction fragment (RFLP) characterisation of *E. nitens*
- data on hybrid vigour and parental compatibilities
- control of cryptic endogenous contaminants in micropropagation
- micropropagation multiplication methods
- development of an Integrated Pest Management System for *Chrysophtharta* and *Paropsis* species
- effect of ectomycchorizae on growth of *E. nitens* and *E. globulus*
- information on the supply of nutrients in the soil solution throughout the year.

- Dr David de Little, APPM

One project has had immediate spin-offs for industry.

Demonstration by CSIRO research staff of the benefits of using excavators for clearing native forest sites for plantation has prompted the Forestry Commission to test a range of equipment for this purpose. A bulldozer was fitted with a tiltable semi-U root-raker blade designed to ANM Forest Management guidelines and compared with an excavator on the same site. The excavator was the more expensive machine but cleared woody debris with minimal stripping of the topsoil and produced narrow compact windrows. As a result, future site clearing will probably use machinery that retains topsoil and produces narrow windrows despite the cost because this will maximise use of existing soil nutrients and increase the available area for plantations.

Staffing and Administration

The Centre has appointed over half of its professional staff during the year. It has proved an exciting and rewarding exercise and the quality of the staff is exceptional. They include a mix of workers previously based around Australia (e.g. Drs Neil Davidson, Brad Potts), the enticement back to Australia of expatriate Australian (Dr Philip Smethurst) and a foreign expert (Dr Rene Vaillancourt). However, the time taken for staff to arrive was longer than anticipated and the pool from which to choose suitably qualified staff was smaller than expected. This has resulted in a lower than expected expenditure on salaries this year, and reinforces our view that there are substantial opportunities for students trained in our chosen specialist fields.

Advertisements have been placed for three more professional positions: Quantitative Geneticist, Root Scientist and Insect Ecologist. Interviews for Root Scientists will be held during the first week of September. This leaves only one professional staff position to be advertised.

Five students have taken up CRC scholarships: two in the Genetics Programme and three in the Resource Protection Programme.

Administrative staff were appointed from existing CSIRO Division of Forestry staff and have been fully in place since 1 January 1992. These consist of a half time Executive Officer, Ms Mary Rainbird, responsible for the budget and day to day running of the CRC; a half time Administrative Assistant, Ms Jan Marriner, to conduct purchasing; and a three quarter time Secretary to the Director, Ms Jean Richmond, who will carry out support services and communications between parties.

The three technical staff appointed so far; Mr Peter Gore, Mr Vin Patel and Ms Melina Reyes-Lijauco have been of extremely high standard. Three more technical positions are under advertisement: one for Genetics, one for Soil and Stand Management and one for Resource Protection. The remaining technical staff positions will be advertised once the corresponding professional staff are in place.

The $1 million CRC extension to the new CSIRO Division of Forestry building on the University of Tasmania campus at Hobart has been completed and all staff are now occupying their new offices. The building was made possible by contributions from the University of Tasmania and the CSIRO. It offers excellent research, office ad conference facilities. The tissue culture and tree physiology laboratories especially, are of international quality and will provide projects in those areas with a significant boost. In addition, the University of Tasmania has made substantial alterations to the Plant Science and Molecular Biology sections to provide office space and research facilities for our new professional staff. The new CRC building was opened on 5 August by Prime Minister, Mr Paul Keating.

Major equipment purchases made during the year include a high pressure liquid chromatograph for the Genetics Programme used to determine hormone levels, and a suite of computers which are networked to improved access to hardware and software within the building and to help administrative staff with purchases, stores and budget. Two cars were also bought to provide transport to field sites for new staff and students. To cater for purchase of major items of equipment, the CRC has set up a major equipment fund of $50,000 annually and proposals are put forward from all programmes.

The list of specified personnel in the CRC (Table 5) has changed slightly. It was with regret that the CRC saw the resignation of foundation Director, Dr Glen Kile, so that he could take up his appointment as Chief of the CSIRO Division of Forestry in Canberra. Dr G Kile was replaced as Director by Professor J Reid and Professor Reid was replaced as Deputy Director by Dr P West.

Dr N Davidson (Programme Manager, Education and Communication) and Dr P Smethurst (Project Leader in the Soil and Stand Management Programme) have been added to the specified personnel list, while Dr J Gorst and Dr R Menary, who did not occupy key management positions in the CRC have agreed to be removed form this list .

A full staff list is presented in Table 6.

Table 5 Specified personnel in the CRC

			Proportion of time in CRC
CSIRO Division of Forestry			
Dr PW West	-	Deputy Director (Programme Manager, Soil and Stand Management)	(0.50)
Dr CL Beadle	-	Senior Research Scientist	(0.60)
Dr RN Cromer	-	Principal Research Scientist	(0.40)
Mr VJ Hartney	-	Senior Experimental Scientist	(0.75)
Ms CA Raymond	-	Research Scientist	(1.00)
Dr PJ Sands	-	Principal Research Scientist	(1.00)
Dr P Smethurst	-	Research Scientist	(1.00)
University of Tasmania			
Professor JB Reid	-	Director (Programme Manager, Genetic Improvement)	(0.60)
Dr NJ Davidson	-	Lecturer (Programme Manager, Education & Communication)	(1.00)
Dr JL Madden	-	Reader (Programme Manager, Resource Protection)	(0.25)
Dr BM Potts	-	Research Fellow	(1.00)
Prof DM Stoddart	-	Professor of Zoology	(0.20)
Dr A West	-	Senior Lecturer	(0.10)
Forestry Commission, Tasmania			
Dr HJ Elliott	-	Chief, Division of Silvicultural Research and Development	(0.10)
ANM			
Mr PW Volker	-	Research Scientist	(0.40)
APPM			
Dr DW de Little	-	Research Manager (Forests)	(0.10)
Dr WN Tibbits	-	Research Scientist	(0.30)
Forest Resources			
Mr RK Orme	-	Research Manager	(0.30)

Table 6 List of professional CRC staff by projects

Name	Designation	Organisation	Time Allocated (%)
Director			
J Reid (Programme Manager)	Professor	UNITAS	30
Deputy Director			
P West (Programme Manager)	Scientist	CSIRO	40
Genetic Improvement			
J Reid (Programme Manager)	Professor	UNITAS	20
V Gordon	Scientist	Forest Resources	50
J Gorst	Lecturer	UNITAS	10
V Hartney	Scientist	CSIRO	70
S Hetherington	Scientist	Forest Resources	25
P Kube	Scientist	FCT	20
R Menary	Reader	UNITAS	10
K Orme	Scientist	Forest Resources	60
B Potts	Lecturer	UNITAS	100
G Rasmussen	Scientist	APPM	40
C Raymond	Scientist	CSIRO	80
D Steane	Research Assistant	UNITAS	20
W Tibbits	Scientist	APPM	30
R Vaillancourt	Scientist	UNITAS	100
P Volker	Scientist	ANM FM	40
A West	Lecturer	UNITAS	20
Support Staff Contributed (3.65)		ANM, APPM, CSIRO, UNITAS	
Support Staff CRC (1)			

Resource Protection			
J Madden (Programme Manager)	Reader	UNITAS	30
H Elliott	Scientist	FCT	10
A Greenern	Scientist	FCT	40
D de Little	Scientist	APPM	10
S Parsons	Scientist	FCT	40
C Raymond	Scientist	CSIRO	20
M Stoddart	Professor	UNITAS	20
Support Staff Contributed (1.6)		UNITAS, FCT	20
Support Staff CRC (1)			
Soil and Stand Management			
P West (Programme Manager)	Scientist	CSIRO	30
C Beadle	Scientist	CSIRO	60
R Cromer	Scientist	CSIRO	40
G Holz	Scientist	APPM	10
K Orme	Scientist	Forest Resources	10
P Sands	Scientist	CSIRO	100
P Smethurst	Scientist	CSIRO	100
C Turnbull	Scientist	CSIRO	70
Support Staff Contributed (2.0)		CSIRO	
Support Staff CRC ( )			
Education and Communication			
N Davidson (Programme Manager)	Lecturer	CRC	100
J Beattie	Senior Lecturer	UNITAS	10
R Hill	Reader	UNITAS	20
J Reid	Professor	UNITAS	10
R Wiltshire	Lecturer	UNITAS	30
Support Staff Contributed (0)			
Support Staff CRC (0.5)			

Publications by Staff Involved in CRC

Genetic Improvement

Published

Lawrence, NL, Ross, JJ, Mander, LN and Reid, JB (1991). Internode length in *Pisum*. Mutants *lk*, *lka* and *lkb* do not accumulate gibberellins. J Plant Growth Regulation 11, 35-37.

Potts, BM and Reid, JB (1991). The evolutionary significance of hybridisation in *Eucalyptus*. Evolution 44, 2151-2152.

Reid, JB and Davies, PJ (1991). The genetics and physiology of gibberellin sensitivity mutants in peas. In Progress in Plant Growth Substances 1991, (C. Karssen, L.C. Van Loon and D. Vreugdenhil eds.) pp 214-225. Kluwer, Amsterdam.

Reid JB, Ross, JJ and Hasan, O (1991). Internode length in *Pisum*: Gene *lkc*. J Plant Growth Regul 10, 11-16.

Ross, JJ and Reid, JB (1991). The response to light quality in a yellow green *Pisum* mutant. *Pisum* Genetics 23, 44-49.

Ross, JJ and Reid, JB (1992). Ontogenetic and environmental effects on GA1 levels and the implication for the control of internode length. In Progress in Plant Growth Substances 1991, (C. Karssen, L.C. Van Loon and D. Vreugdenhil eds.), pp 180-187. Kluwer, Amsterdam.

Ross, JJ, Reid, JB and Dungey, HS (1992). Ontogenetic variation in levels of gibberellin GA1 in *Pisum*. Implications for control of stem elongation. Planta 186, 166-171.

Ross, JJ, Willis, CL, Gaskin, P and Reid, JB (1992). Shoot elongation in *Lathyrus odoratus* L.: gibberellin levels in light - and dark-grown tall and dwarf seedlings, and the stereochemistry of GA81 formation. Planta 187, 10-13.

Sponsel, V and Reid, JB (1992). The effect of the growth retardant LAB 198999 and its interaction with gibberellins A1, A3, A20 in fruit growth of tall and dwarf peas. In Progress in Plant Growth Regulation (CM Karssen, LC Van Loon and D Vreugdenhil eds.), pp. 578-584. Kluwer, Amsterdam.

Steane, DA, West, AK, Potts, BM, Overden, JR and Reid JB (1991). Restriction fragment length polymorphisms in chloroplast DNA from six species of *Eucalyptus*. Aust J Bot 39, 399-414.

Tibbits, WN, Potts, BM and Savva, MH (1991). The inheritance of frost resistance in interspecific F1 hybrids of *Eucalyptus*. Theoretical and Applied Genetics 83, 126-135.

Whitham, T, Morrow, P and Potts, BM (1991). The conservation of hybrid plants. Science 254, 779-780.

In press

Behringer, FJ, Davies, PJ and Reid, JB (1992). Phytochrome regulation of stem growth and indole-3-acetic acid levels in the lv and Lv genotypes of *Pisum*. Photochem. Photobiol.

Cramp, RE and Reid JB (1992). Internode length in *Pisum*. Gene lkd. Plant Growth Regul.

Raymond, CA, Owen, JV, Eldridge, KG and Hardwood, CE (1992). Screening eucalypts for frost tolerance in breeding programs. Canadian Journal of Forest Research.

Raymond, CA, Owen, JV and Ravenwood, IC (1992) Genetic variation for frost tolerance in a breeding population of *Eucalyptus nitens*. Silvae Genetica.

Reid, JB, Ross, JJ and Swain, SM (1992). Internode length in *Pisum*. A new slender mutant with elevated levels of C19 gibberellins. Planta.

Smith, VA, Knott, CJ, Gaskin, P and Reid, JB (1992) The distribution of gibberellins in vegetative tissues of *Pisum sativum* L. Biological and biochemical consequences of the le mutation I. Plant Physiol.

Sponsel, VM and Reid, JB (1992). The use of an acyclohexanedione growth retardant, LAB 198199, to determine whether A20 biological activity per se in dark-grown dwarf (le) seedlings of *Pisum sativum*. Plant Physiol.

Taylor, RJ, Balmer, J, Cay, R, Potts, BM and Wall, LE (1991). Flora and Fauna of the Sclerophyll Ecosystems. In "Tasmanian Wilderness World Heritage Area". (ed. Smith, SJ). (Royal Society of Tasmania; Hobart).

Weller, JL and Reid, JB (1992). Photoperiodism and photocontrol of stem elongation in two photomorphogenic mutants of *Pisum sativum* L. Planta.

Unrefereed publications

Cauvin, B and Potts, BM (1991). Selection for extreme freezing resistance in *Eucalyptus*. In "Intensive Forestry: The Role of Eucalypts". Proceedings of the IUFRO Symposium, Durban, South Africa, 1991, pp. 209-220.

Potts, BM and Tibbits, WN (1991). The inheritance of frost resistance in interspecific F1 hybrids of *Eucalyptus*. In "Research Working Group No. 1 of the Australian Forestry Council, Forest Genetics". Proceedings of Eleventh Meeting, Coonawarra, March 1991. (Australian Forestry Council, Canberra.)

Raymond, CA (1991). Genetic variation in resistance to insect defoliation. Proc 11 Meeting RWG1, Coonawarra, 1991.

Raymond, CA, Balodis, V, and Dean, GH (1992). Hot water extractives and pulp yield in provenances of *Eucalyptus regnans*. Proc 46th Conference APPITA, April, 1992.

Steane, DA, Reid, JB, Nesbitt, K, Potts, BM, Thomson, R, Ovenden, JR and West, AK (1991). The use of organelle and genomic DNA to study variation patterns and hybridisation in *Eucalyptus*. In "Research Working Group No. 1 of the Australian Forestry Council, Forest Genetics". Proceedings of Eleventh Meeting, Coonawarra; March 1991. (Australian Forestry Council, Canberra.)

Wiltshire, RJE and Reid, JB (1992). The pattern of juvenility within *Eucalyptus tenuiramis* Miq. saplings. In Proceedings of a Symposium on Mass Production Technology for Genetically Improved Fast Growing Forest Tree Species (JN Marien, Cl Hubert and P.Alazard eds.). (AFOCEL/IUFRO: Bordeaux).

Whitham, T, Morrow, P and Potts, BM (1991). Plant hybrid zones as focal points for insect biodiversity: The need for preservation. Biological Conservation (submitted) (also presented to 1991 Annual Meeting, Ecological Society of America and abstract published; research reported in Science News 140, 102-103).

Whitham, T, Morrow, P and Potts, BM (1991). The response of insect pests to eucalypt hybrids. In "Research Working Group No. 1 of the Australian Forestry Council, Forest Genetics". Proceedings of Eleventh Meeting, Coonawarra; March 1991. (Australian Forestry Council, Canberra.)

Soil and Stand Management

Published

Beadle, CL and Turnbull, CRA (1992). Comparative growth rates of eucalypts in native forests and plantation monoculture. In Adlard, PG and Calder, IR (Eds) Growth and Water Use of Forest Plantations.

Kirschbaum, MUF, Bellingham, DW and Cromer, RN (1992). Growth analysis of the effect of phosphorus nutrition on seedlings of *Eucalyptus grandis*. Aust J Pl Physiol 19, 55-66.

Leuning, R, Cromer, RN and Rance, SJ (1992). Spatial distribution of foliar nitrogen and phosphorus in crowns of *Eucalyptus grandis*. Oecologia 88, 504-10.

Turnbull, CRA, Beadle, CL, Traill, JC and Richards, G (1992). Benefits, problems and costs of excavators and bulldozers used for clearing operations in southern Tasmania. Tasforests 4, 45-55.

Turnbull, CRA, Traill, JC and Beadle, CL (1991). Productivity and costs of establishment of eucalypt plantations on native forest sites in southern Tasmania. In Menzies, MI, Parrot, GE and Whitehouse, LJ (Eds) NZ Ministry of Forestry FRI Bull 156, 341-9.

West, PW and Wells, KF (1992). Method of application of a model to predict the light environment of individual tree crowns and its use in a eucalypt forest. Ecological Modelling 60, 199-231.

In press

Sands, PJ, Cromer, RN and Kirschbaum, MUF (1992) A model of nutrient response in *Eucalyptus grandis* seedlings. Aust J Pl Physiol.

Resource Protection

Published

Mensah, RK and Madden JL (1992). Factors affecting *Ctenarytaina thysanura* oviposition on *Boronia megastigma* terminal shoots. Entomol exp appl 62: 261-268.

Mensah, RK and Madden JL (1991). Resistance and susceptibility of *Boronia megastigma* cultivars to infestation by the psyllid *Ctenarytaina thysanura*. Entomol exp appl 61: 189-198.

Mensah, RK and Madden JL (1991). Techniques for mass rearing *Ctenarytaina megastigma* (Ferris and Klyver) (Hemiptera: Psyllidae). J Aust Ent Soc 30: 267-268.

Mensah, RK and Madden, JL (1992). Feeding behaviour and pest status of *Ctenarytaina thysanura* (Ferris and Klyver) (Hemiptera:Psyllidae) on Boronia megastigma (Nees) in Tasmania. J Aust Ent Soc 31: 71-78.

In press

Candy, SG, Elliott, HJ, Bashford R and Leon, A (1992). Modelling the impact of defoliation by the *Eucalyptus* leaf beetle, *Chrysophtharta bimaculata* (Olivier) (Coleoptera: Chrysomelidae) on the growth of *Eucalyptus regnans*. For Ecol Mngmt 49.

Elliott, HJ, Bashford, R, Leon, A and Candy, SG (1992). Integrated pest management of the Tasmanian *Eucalyptus* leaf beetle, *Chrysophtharta bimaculata* (Olivier) (Coleoptera: Chrysomelidae). For Ecol Mngmt 49.

Education and Communication

Published

Wiltshire, RJE, Potts, BM and Reid, BM (1991). A paedomorphocline in *Eucalyptus*: Variation in the *E. risdonii/tenuiramis* complex. Aust J Bot 39 , 545-66.

Wiltshire, RJE, Potts, BM and Reid, JB (1991). Phylogenetic and cconservation status of a rare Tasmanian endemic, *Eucalyptus morrisbyi* RG Brett. Proc Royal Soc Tas. 213-229.

In Press

Davidson, NJ and Galloway, R (1992). Productive use of salt-affected land. Eds. NJ Davidson and R Galloway, ACIAR Proceedings.

Davidson, NJ and Pate, JS (1992). Water relations of the mistletoe *Amyema fitzgeraldii* and its host *Acacia acuminata.* J Exp Bot.

Galloway, R and Davidson, NJ (1992). The response of *Atriplex amnicola* to the interactive effects of salinity and hypoxia. J Exp Bot.

Theses

Dungey, H (1991). Interspecific hybridisation between *Eucalyptus nitens* and *Eucalyptus globulus*. BSc Hons Thesis (Department of Plant Science, University of Tasmania).

McEntee, A (1991). Variation and Hybridisation in *Eucalyptus barberi*. BSc Hons Thesis (Department of Plant Science, University of Tasmania).

Nesbitt, K (1991). The development of RFLP (Restriction Fragment Length Polymorphism) Techniques in *Eucalyptus globulus*. BSc Hons Thesis (Department of Plant Science, University of Tasmania).

Wiltshire, RJ (1991). Heterochrony and heteroblasty in the *Eucalyptus risdonii/tenuiramis* complex. Ph D .

Public Presentations

Genetic Improvement

Seminar

A seminar entitled "The Role and Potential of Eucalypt Plantations in Australia's Wood Supply" was held in Hobart on 16 June 1992. Presentations were given by 10 invited speakers (Table 7). The seminar was attended by 150 delegates and was well received.

Conferences/Symposia

Hasan, O, Potts, BM and Reid, JB. Chemical promotion of flower bud inititiation in *E. globulus*. In 'Mass Production Technology for Genetically Improved Fast Growing Forest Tree Species' (AFOCEL-IUFRO Symposium ; Bordeaux)

Potts, BM, Volker, PW and Dungey, HS. Barriers to the production of hybrids in *Eucalyptus*. In 'Mass Production Technology for Genetically Improved Fast Growing Forest Tree Species' (AFOCEL-IUFRO Symposium ; Bordeaux)

Reid, J (1991). The genetics and physiology of gibberellin sensitivity mutants in peas. 14th International Conference on Plant Growth Substances, Amsterdam.

Ross, JJ and Reid, JB (1991). Parallel variation in internode length and GA1 level during ontogeny in *Pisum sativum*. 14th International Conference on Plant Growth Substances, Amsterdam.

Santes, CM, Hedden, P, Reid, JB and Garcia-Martinez (1991). Fruit development in Gibberellin deficient mutants of pea. 14th International Conference on Plant Growth Substances, Amsterdam.

Sponsel, VM and Reid JB (1991). The effect of the growth retardant Lab 198999 and its interaction with gibberellins A1, A3, A20 in fruit growth of tall and dwarf peas. 14th International Conference on Plant Growth Substances, Amsterdam.

Steane, DA, Reid, JB, Nesbitt, K, Potts, BM, Thompson, R, Ovenden, JR and West, AK (1991). The use of organelle and genomic DNA to study variation patterns and hybridisation in *Eucalyptus*. In Research Working Group No. 1 of the Australian Forestry Council, Forest Genetics. Proceedings of the Eleventh Meeting, Coonawara, March 1991, pp. 200-203. Australian Forestry Council, Canberra.

Swain, SM and Reid, JB (1991). Gibberellins and Seed Development. Aust Soc Plant Physiol, Canberra.

Swain, SM and Reid, JB (1991). The role of gibberellins in seed development. 14th International Conference on Plant Growth Substances, Amsterdam.

Willyams, D, Moolhuijzen, P, Volker, PW, Raymond, CA and Chandler, SF (1992). Micropropagation of juvenile *Eucalyptus regnans*. Proc IUFRO/AFOCEL Symposium on "Mass production technology for genetically fast growing tree species", Bordeaux, September 1992

Soil and Stand Management

Beadle, CL (1992). Physiology of temperate eucalypts. Forests & Forest Industry Seminar, Burnie, March 1992.

Beadle, CL (1992). Plantation productivity and ways of improving it. CRC Temperate Hardwood Forestry Seminar, Hobart, June 1992.

Cromer, RN, Sands, PJ, and Kirschbaum, MUF (1991). A model of nutrient response in *Eucalyptus grandis* seedlings. In Schonau, A.P.G. (Ed) Proc. IUFRO Symposium on Intensive Forestry: The Role of Eucalypts, Durban, South Africa, Vol 2, pp 622-34.

Cromer, RN and Kile, GA (1992). Hardwood Plantation Research and Development into the 21st Century. Appita Conference, March 1992, Launceston, Tasmania.

Table 7 Programme for seminar on "The Role and Potential of Eucalypt Plantations in Australia's Wood Supply"

PROGRAMME

0900	*Opening*
	Mr John Allwright (Chairman of the Board, CRC for Temperate Hardwood Forestry)
0915	*The current resource and future developments*
	Mr Ian Whyte (Executive Forester, APPM Forest Products, Hobart)
0945	*Suitability and availability of land for plantation development*
	Mr Ross Waining (Manager, Forest Resources, Launceston)
1015	*Potential of breeding for increased growth and pulp yield*
	Dr Wayne Tibbits (Acting Forest Research Manager, APPM Forest Products, Ridgley)
1045	*Morning Tea*
1115	*Plantation productivity and ways of improving it*
	Dr Chris Beadle (Senior Research Scientist, CSIRO Division of Forestry, Hobart)
1145	*Threats to productivity*
	Dr Glen Kile (Chief, CSIRO Division of Forestry, Canberra)
1230	*Lunch*
1330	*Utilisation of plantation grown wood*
	Mr Geoff Dean (Senior Research Forester, APPM Research and Technology Group, Burnie)
1400	*Economics of plantation management*
	Mrs Sarah Jennings (Forest Economist, Department of Economics, University of Tasmania, Hobart)
1430	*Environmental impacts of plantation development*
	Dr Humphrey Elliott (Chief, Division of Silvicultural Research and Development, Forestry Commission, Hobart)
1500	*Summary and the way forward*
	Mr Ian Dickenson (Chairman, Forests and Forest Industry Council)

Grants and Awards to CRC Staff

Dr C Beadle

- ACIAR

Drought studies in *E. globulus* and *E nitens*	45,703

Dr J Madden

- Forests and Forest Industries Council

C. bimaculata research	70,000

Dr B Potts and Professor J Reid

- Tasmanian Forest Research Council

E. globulus Variation	$35,000

- Australian Research Council

Eucalyptus Hybrids	$14,000

Professor J Reid

- Australian Research Council

Eucalyptus DNA	$33,000
Physiological Genetics/ Hormonal Physiology	$91,500

- CSIRO/University of Tasmania

Eucalyptus Flowering	$4,600
Prediction of Vegetation	$8,300

- Department of Primary Industry/Forestry Scholarships

Mr Mike Battaglia	21,000
Ms Kristen Williams	21,000

Professor M Stoddart

- Tasmanian Forest Research Council

Use of habitat trees by brush possums	24,000

- ARC

Analysis of odour induced stress in the marsupial sugar glider	67,000

- National Geographic

Habitat requirements and niche parameters of sympatric marsupial carnivores	12,500

- ARC

Impact of ferral house mice on Macquarie Island ecosystems	11,000

Dr P West

- Tasmanian Forest Research Council

Modelling tree stem shape	10,500

Performance Indicators

Genetic Improvement

a) Production of reliable estimates of heritabilities and of correlations between characters

- Heritabilities for eucalypts based on controlled crosses rather than open-pollinated families have been produced. It has been shown that open-pollinated estimates of narrow-sense heritabilities are generally inflated compared with those derived from controlled crossing (factorial and half-dialled) suggesting that the use of open-pollinated estimates (as used previously) may significantly over-estimate genetic gain estimates. This preliminary data will be confirmed with estimates from trials of greater age.

b) Production of F_1 and F_2 hybrid seed for field plantings

- F_1 seed has been successfully produced for a wide range of crosses and the material established in field plantings. The production of F_2 seed is on course and should be available as indicated during 1992-93.

c) Development of techniques for vegetative propagation of elite material

- Significant improvement in the methods of micropropagation have been made. Increased rates of shoot multiplication and improved shoot health have been achieved without a decrease in rooting percentage. Large field plantings should be achievable within three years as indicated.

d) Reduction of generation time and determination of the gibberellin biosynthetic pathway

- Techniques for the production of open flowers on 24-month old *E. globulus* seedlings have been developed giving a reduction of several years. In addition, preliminary data suggest that the early 13-hydroxylation pathway is the endogenous gibberellin biosynthetic pathway in vegetative tissues of eucalypts. The role of gibberellin in flowering is being investigated.

e) Techniques for finger-printing eucalypts using DNA markers

- Two papers detailing RFLP variation in chloroplast DNA have been written and significant progress has been made to isolate and characterise genomic DNA probes. Preliminary studies have used these probes to examine the geographical variations in *E. globulus* and it appears from these results that DNA finger-printing of eucalypts is feasible within the time-span provided.

Soil and Stand Management

a) Development of silvicultural practices for the judicious management of soils and stands for the short and long term management of plantation forests

- Clearing land which previously supported eucalypt forest causes major disruption to the site. Traditionally, this has been done using bulldozers and often leads to large amounts of topsoil being pushed into windrows of debris before these are burnt. Work in the programme has shown that this topsoil disturbance can be largely avoided by using excavators rather than bulldozers. This maintains the integrity of the site and its potential to sustain forest in the long term.

- Weeds in plantations compete heavily with the trees for the water and nutrients available at a site and may substantially reduce tree growth over the early years of the life of the plantation. Control of this weed growth is costly, but vital to secure the value of the investment in plantations. Work in the programme has shown that for plantation sites which previously carried eucalypt forest, it is necessary to control weed growth only prior to planting. Tree growth is not affected by the level of weed growth that occurs following planting. This negates the need for post-planting weed control on these sites which leads to appreciable cost savings.

b) Development of process-based models to predict wood yields under a wide range of silvicultural regimes

- Prediction of photosynthetic production by the tree canopy is a basic part of model systems to describe tree growth. Work in the programme developed and investigated a model system to predict the light absorbed by and the intensity of light within tree crowns in eucalypt forest.

- A central difficulty in the development of mechanistic models of tree growth is the prediction of the partitioning of new biomass produced by photosynthesis to the various parts of the tree (leaves, branches, stem and roots). Work in the programme applied the concept that functional relationships between the plant parts determines this partitioning. These relationships were represented mathematically and a method involving linear programming developed to solve the mathematical system to determine level of partitioning.

- Rate of nutrient supply influences tree growth rate through its effect on the rate of CO_2 assimilation, partitioning of biomass between above- and below-ground components and specific leaf area. Work in the programme developed a simple model to describe the impact of nitrogen and phosphorus supply on these processes.

Resource Protection

a) Determination of the factors that predispose trees to attack by defoliating insects and mammals

- Phenological changes in tree growth and leaf development and the onset of beetle attack have been found to be associated with a general shift in the spectral reflectance of trees from red to attractive yellow and then to green.

- The colour changes in the trees and the emergence of beetles are both positively correlated with mean temperature experienced at the site. These relationships will help to refine the Insect Pest Management Programme.

b) The development of biological control techniques to minimise damage caused by *C. bimaculata*

- Two species of predators have been successfully manipulated by the provision of sugar supplements in areas of potential beetle attack. These supplements have retained large numbers of predators in such areas resulting in subsequent high levels of predation. An aggregation pheromone in one species has been demonstrated.

- A new *C. bimaculata* overwintering habitat has been identified within clumps of *Gahnia grandis* and other plants of similar growth habit. These plants generally occur in young, open regenerating stands of *Eucalyptus*. This knowledge should permit the assessment of potential risk to beetle attack of plantations in different areas.

c) Assessment of the feasibility of breeding insect tolerant genotypes of *Eucalyptus* species

- The PhD study on the phytochemistry of 29 *Eucalyptus* species is currently being compiled for examination. The identification of notably monoterpene hydrocarbons, proposed biosynthetic pathways and chemical levels in F_1 hybrids and genetically identified parents will provide the basis for future work.

- Evaluation of *E. regnans* families has indicated that defoliation has an inheritance of 0.30 to 0.40 which is more than twice that recorded for growth height and diameter.

- Beetle attack results in trees of different form and trees that experience little defoliation tend to be those that commence growth earlier in the season. This latter observation is consistent with the role of foliage colour change determining the probability of beetle attack.

d) **Development of substances which inhibit browsing by vertebrates**

- The role of leaf chemicals in the acceptance of selected trees has been demonstrated for chrysomelids. The role of phytochemistry in vertebrate browsing will be considered when this project commences.

Education and Communication

Education

a) **The number of postgraduate students trained in the areas specified**

- Sixteen postgraduate students are training in the CRC; six in the Genetics Programme, three in Resource Protection and seven in the Education Programme. Twelve of these students have enroled since 1991.

b) **The number of enrolments in special courses**

- The Forest Ecology course has four students in the third year, five in the second year and two in the first year. The Graduate Diploma with Honours in Forest Processes was approved by the University in June 1992 and we will need to wait till the end of the year to gauge interest in this course.

c) **The quality and numbers of young research scientists appointed**

- The quality of recent PhD graduates appointed to the staff of the Centre has been exceptional. Further recent PhD graduates will be approved in 1992-93 in all the research programmes.

d) **The acceptance by the forestry community of students on completion of their studies**

- It is too early to say how marketable our graduates will be. However, it is clear from the response to our job advertisements that there is a shortage of qualified people in our stated specialised areas of Tree Breeding and Resource Protection and therefore students trained in these areas will be in high demand. For example, APPM has expressed an interest in employing at least two CRC graduates next year and the other companies have also expressed interest.

Communication

a) **The degree of adoption of research results by industry**

- There is a keen interest shown by industry partners in the results produced by the CRC. For example, results from the Resource Protection Programme are being included in the Integrated Pest Management Programme of Forestry Commission, Tasmania. Soil and Stand Management Programme trials using machinery which minimises soil disturbance during clearing of land for plantation are likely to result in changes in industry practice.

b) The quality and relevance of technical publications targeted to user groups

- A technical publication programme will start in the next financial year.

c) The number of seminars, field days and workshops organised

- A two-day workshop which included seminars by Dr C Beadle (The relationship between assimilation rate, leaf area index and growth of eucalypts) and by Dr P Sands (Concepts of process based modelling and its application to modelling stem height and diameter growth), and visits to laboratories and plantations was held in Burnie on March 7 and 8, 1992.

- Seminar series which include presentations by CRC staff continue to be held at CSIRO, Plant Science and Agricultural Science. An integrated CRC seminar series starts in September 1992.

d) Organise one public seminar on the role of hardwood plantations in Australian wood supply within the first 12 months of the Centre's establishment

- A seminar was held in June 1992 which attracted 150 participants (Table 7, page 46).

e) Organise first short courses in the second year of the Centre

The groundwork is now being laid for a series of short courses/workshops (up to one week in length) to be conducted in 1992/93 and may include the following topics:

- Tree improvement for future plantations: A role for physiology? (October 1992)

- Silvicultural practices in eucalypt plantations (March 1993)

- Insect pests of *Eucalyptus*

FINANCIAL REPORT

Note: At the time of printing, auditing of these reports was incomplete.

IN-KIND CONTRIBUTIONS FROM PARTNERS (1991/92) (DOLLARS IN $'000's)

TABLE 1

PARTNER		ACTUAL EXPENDITURE	PROJECTED EXPENDITURE						
		1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	GRAND TOTAL
CSIRO DIVISION OF FORESTRY									
	SALARIES	531.4	590.0	601.8	613.9	626.1	638.8	651.4	4,253.4
	CAPITAL								
	OTHER	900.4	999.4	1,019.1	1,038.9	1,059.5	1,080.2	1,101.3	7,198.8
	TOTAL	1,431.8	1,589.4	1,620.9	1,652.8	1,685.6	1,719.0	1,752.7	11,452.2
UNIVERSITY OF TASMANIA									
	SALARIES	488.5	498.3	508.2	518.4	528.8	539.3	550.1	3,631.6
	CAPITAL	40.0							40.0
	OTHER	648.7	661.6	674.9	688.4	702.1	716.2	730.5	4,822.4
	TOTAL	1,177.2	1,159.9	1,183.1	1,206.8	1,230.9	1,255.5	1,280.6	8,494.0
ANM FOREST MANAGEMENT									
	SALARIES	21.0	28.0	29.0	29.0	31.0	31.0	32.0	201.0
	CAPITAL								
	OTHER	28.0	28.0	31.0	33.0	34.0	36.0	38.0	228.0
	TOTAL	49.0	56.0	60.0	62.0	65.0	67.0	70.0	429.0
APPM									
	SALARIES	64.0	65.0	71.0	71.0	71.0	71.0	71.0	484.0
	CAPITAL								
	OTHER	107.0	67.0	73.0	73.0	73.0	73.0	73.0	539.0
	TOTAL	171.0	132.0	144.0	144.0	144.0	144.0	144.0	1,023.0

TABLE 1 CONT

IN-KIND CONTRIBUTIONS FROM PARTNERS (1991/92) (DOLLARS IN $'000's)

PARTNER		ACTUAL EXPENDITURE 1991/92	PROJECTED EXPENDITURE 1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	GRAND TOTAL
FOREST RESOURCES									
	SALARIES	39.6	100.9	103.9	107.0	110.2	113.5	116.9	692.0
	CAPITAL								
	OTHER	50.1	107.4	110.6	113.9	117.4	120.9	124.5	744.8
	TOTAL	89.7	208.3	214.5	220.9	227.6	234.4	241.4	1,436.8
FORESTRY COMMISSION - TASMANIA									
	SALARIES	47.2	47.6	48.1	48.7	49.1	49.6	50.1	340.4
	CAPITAL								
	OTHER	61.0	61.6	65.2	69.0	73.3	77.9	83.0	491.0
	TOTAL	108.2	109.2	113.3	117.7	122.4	127.5	133.1	831.4
TOTAL IN-KIND CONTRIBUTIONS									
	SALARIES	1,191.7	1,329.8	1,362.0	1,388.0	1,416.2	1,443.2	1,471.5	9,602.4
	CAPITAL	40.0							40.0
	OTHER	1,795.2	1,925.0	1,973.8	2,016.2	2,059.3	2,104.2	2,150.3	14,024.0
GRAND TOTAL IN-KIND		3,026.9	3,254.8	3,335.8	3,404.2	3,475.5	3,547.4	3,621.8	23,666.4

CASH CONTRIBUTIONS (1991/92 VALUES, IN $000,s)

TABLE 2

PARTNERS	ACTUAL EXPENDITURE 1991/92	PROJECTED EXPENDITURE 1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	GRAND TOTAL
A CSIRO Division of Forestry								
B University of Tasmania	500.0							500.0
C Forestry Commission Tasmania								
D APPM								
E ANM								
F Forest Resources								
TOTAL CASH FROM PARTICIPANTS	500.0							500.0
FUNDING FROM THE CRC GRANT	948.6	1,406.0	1,652.0	1,652.0	1,652.0	1,652.0	1,514.3	10,476.9
INTEREST	10.5	12.0	12.0	12.0	12.0	12.0	12.0	82.5
TOTAL CRC CASH BUDGET	1,459.1	1,418.0	1,664.0	1,664.0	1,664.0	1,664.0	1,526.3	11,059.4
CASH EXPENDITURE								
SALARIES	118.8	968.7	1,238.7	1,300.6	1,371.3	1,439.8	1,511.9	7,949.8
CAPITAL		500.0						500.0
OTHER	176.9	644.4	411.4	404.5	397.4	340.5	234.5	2,609.6
GRAND TOTAL (CASH)	1,163.4	-695.1	13.9	-41.1	-104.7	-116.3	-220.1	0.0
GRAND TOTAL (IN-KIND) FROM TABLE 1	3,026.9	3,254.8	3,335.8	3,404.2	3,475.5	3,547.4	3,621.8	23,666.4
TOTAL RESOURCES AVAILABLE TO CENTRE	4,190.3	2,559.6	3,349.7	3,363.1	3,370.8	3,431.1	3,401.7	23,666.4

FINANCIAL APPENDICES

ALLOCATION OF RESOURCES (CASH AND IN-KIND)

TABLE 3

PROGRAMS		ACTUAL EXPENDITURE	PROJECTED EXPENDITURE						
		1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	GRAND TOTAL
GENETICS									
CASH	SALARIES	54.9	447.6	572.3	600.9	633.6	665.2	698.6	3,673.1
	CAPITAL		231.0						231.0
	OTHER	95.7	283.9	177.4	174.4	171.4	145.3	98.2	1,146.3
	TOTAL	150.6	962.5	749.7	775.3	805.0	810.5	796.8	5,050.4
IN-KIND	SALARIES	611.7	690.2	709.3	727.7	738.0	791.7	766.7	5,035.3
	CAPITAL	22.7							22.7
	OTHER	905.6	958.8	985.7	1,006.5	1,027.1	1,049.1	1,071.5	7,004.3
	TOTAL	1,540.0	1,649.0	1,695.0	1,734.2	1,765.1	1,840.8	1,838.2	12,062.3
SOIL & STAND MANAGEMENT									
CASH	SALARIES	35.4	288.7	369.1	387.6	408.6	429.1	450.5	2,369.0
	CAPITAL		149.0						149.0
	OTHER	40.4	181.3	112.4	110.7	108.8	92.0	62.0	707.6
	TOTAL	75.8	619.0	481.5	498.3	517.4	521.1	512.5	3,225.6
IN-KIND	SALARIES	301.3	353.4	360.9	368.2	375.7	383.4	391.1	2,534.0
	CAPITAL								0.0
	OTHER	510.3	578.6	590.5	602.1	614.1	626.2	638.5	4,160.3
	TOTAL	811.6	932.0	951.4	970.3	989.8	1,009.6	1,029.6	6,694.3

ALLOCATION OF RESOURCES (CASH AND IN-KIND)

TABLE 3 cont

PROGRAMS		ACTUAL EXPENDITURE	PROJECTED EXPENDITURE						
		1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	GRAND TOTAL
RESOURCE PROTECTION									
CASH	SALARIES	20.3	165.6	211.8	222.4	234.5	246.2	258.5	1,359.3
	CAPITAL		85.5						85.5
	OTHER	31.9	141.4	101.2	99.0	96.9	86.2	60.9	617.5
	TOTAL	52.2	392.5	313.0	321.4	331.4	332.4	319.4	2,062.3
IN-KIND	SALARIES	144.0	148.7	151.6	154.1	156.8	159.4	162.0	1,076.6
	CAPITAL	6.3							6.3
	OTHER	200.0	204.8	211.2	217.4	223.9	231.0	238.4	1,526.7
	TOTAL	350.3	353.5	362.8	371.5	380.7	390.4	400.4	2,609.6
EDUCATION									
CASH	SALARIES	8.2	66.8	85.5	89.7	94.6	99.3	104.3	548.4
	CAPITAL		34.5						34.5
	OTHER	8.9	37.8	20.4	20.4	20.4	16.9	13.4	138.2
	TOTAL	17.1	139.1	105.9	110.1	115.0	116.2	117.7	721.1
IN-KIND	SALARIES	134.9	137.6	140.3	143.1	146.0	148.9	151.9	1,002.7
	CAPITAL	11.0							11.0
	OTHER	179.1	182.7	186.3	190.1	193.9	197.7	201.7	1,331.5
	TOTAL	325.0	320.3	326.6	333.2	339.9	346.6	353.6	2,345.2

ALL PROGRAMS

TABLE 4

		ACTUAL EXPENDITURE	PROJECTED EXPENDITURE						
		1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	GRAND TOTAL
CASH									
	SALARIES	118.8	968.7	1,238.7	1,300.6	1,371.3	1,439.8	1,511.9	7,949.8
	CAPITAL		500.0						500.0
	OTHER	176.9	644.4	411.4	404.5	397.4	340.5	234.5	2,609.6
	TOTAL	295.7	2,113.1	1,650.1	1,705.1	1,768.7	1,780.3	1,746.4	11,059.4
IN-KIND									
	SALARIES	1,191.7	1,329.8	1,362.0	1,388.0	1,416.2	1,443.2	1,471.5	9,602.4
	CAPITAL	40.0							40.0
	OTHER	1,795.2	1,925.0	1,973.8	2,016.2	2,059.3	2,104.2	2,150.3	14,024.0
	TOTAL	3,026.9	3,254.8	3,335.8	3,404.2	3,475.5	3,547.4	3,621.8	23,666.4
GRAND TOTAL (CASH AND IN-KIND)		3,322.6	5,367.9	4,985.9	5,109.3	5,244.2	5,327.7	5,368.2	34,725.8
TOTAL SALARIES (CASH AND IN-KIND)		1,310.5	2,298.5	2,600.7	2,688.6	2,787.5	2,883.0	2,983.4	17,552.2
TOTAL CAPITAL (CASH AND IN-KIND)		40.0	500.0						540.0
TOTAL OTHER (CASH AND IN-KIND)		1,972.1	2,569.4	2,385.2	2,420.7	2,456.7	2,444.7	2,384.8	16,633.6

CSIRO DIVISION OF FORESTRY

SALARIES

Name	Designation	Program	*% time CRC*	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	TOTAL
BEADLE, Dr. C	Scientist	SSM	60								
BOXALL, Mr B	Technician	SSM	30								
CROMER, Mr R	Scientist	SSM	40								
LASALA, Ms A	Technician	SSM	50								
MUMMERY, Mr D	Scientist	SSM	30								
OTTENSCHLAEGER, Ms M	Technician	SSM	100								
SANDS, Dr. P	Scientist	SSM	100								
TURNBULL, Mr. C	Scientist	SSM	70								
WEST, Dr P	Scientist	SSM	80								
WILTSHIRE	Scientist	SSM	50								
HAND, Mr F	Technician	Genet	100								
HARTNEY, Mr V	Scientist	Genet	70								
MONCUR, Mr M	Scientist	Genet	20								
MOROSIN,	Technician	Genet	50								
OWEN, Mr J	Scientist	Genet	40								
RAYMOND, Ms C	Scientist	Genet	80								
SVENSON, M	Technician	Genet	70								
RAYMOND	Scientist	Res Prot	20								
KILE, Dr G	Scientist	Res Prot	30								
	Total Salary			421.2	467.5	476.9	486.4	496.1	506.1	516.2	3,370.4

	Direct On-Costs	*% of total Salary*		1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	TOTAL
	Superannuation	16.7		70.3	78.1	79.6	81.2	82.9	84.5	86.2	562.8
	Productivity Benefit	3		12.6	14.0	14.3	14.6	14.9	15.2	15.5	101.1
	Long Service Leave	2.5		10.5	11.7	11.9	12.2	12.4	12.7	12.9	84.3
	Leave Loading	1.5		6.3	7.0	7.2	7.3	7.4	7.6	7.7	50.5
	Comcare	2.5		10.5	11.7	11.9	12.2	12.4	12.7	12.9	84.3
	Total On-Costs			110.2	122.5	124.9	127.5	130.0	132.7	135.2	883.0
	Total Salaries & On-Costs			531.4	590.0	601.8	613.9	626.1	638.8	651.4	4,253.4

		% of Total Salaries & On-Costs								
CAPITAL										
	Total Capital		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER										
	Divisional Administration/Support	96	510.3	566.4	577.8	589.3	601.1	613.1	625.4	4,083.4
	Institute Overheads	9	47.8	53.1	54.2	55.2	56.4	57.5	58.6	382.8
	Corporate Overheads	24	127.6	141.6	144.4	147.3	150.3	153.3	156.3	1,020.8
	Amortised Capital Costs	37	196.7	218.3	222.7	227.1	231.7	236.3	241.0	1,573.8
	Direct Operating Allocation		18.0	20.0	20.0	20.0	20.0	20.0	20.0	138.0
	Total Other		900.4	999.4	1,019.1	1,038.9	1,059.5	1,080.2	1,101.3	7,198.8
	TOTAL IN-KIND CONTRIBUTION		1,431.8	1,589.4	1,620.9	1,652.8	1,685.6	1,719.0	1,752.7	11,452.2

CRC FOR TEMPERATE HARDWOOD FORESTRY

Itemised List of In-Kind Contributions (1991/92 values, in $'000's)

UNIVERSITY OF TASMANIA

SALARIES

Name	Program	% time CRC	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	TOTAL
REID J	Genet	50								
POTTS, B	Genet	50								
Li, H	Genet	20								
DUNGEY, H	Genet	100								
CHALMERS,	Genet	50								
STEANE, D	Genet	20								
WILLIAMS,	Genet	80								
NESBITT, K	Genet	50								
GORST	Genet	10								
HASAN, O	Genet	70								
BOBBI, P	Genet	60								
CASEY,	Genet	100								
HARDNER,	Genet	50								
MENARY, B	Genet	10								
HAIG, G	Genet	10								
THOMSON, B	Genet	10								
WEST, A	Genet	20								
MADDEN, J	Prot	30								
LI, H	Prot	80								
MENSAH, R	Prot	80								
STODDART, M	Prot	20								
HILL, B	Educ	20								
REID, J	Educ	10								
BATTAGLIA, M	Educ	100								
WILLIAMS, K	Educ	100								
BEATTIE, J	Educ	10								
TANJUNG, R	Educ	100								
WILTSHIRE	Educ	30								
Total Salary			324.1	330.6	337.2	343.9	350.8	357.8	365.0	2,409.5

		% of total Salary	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	TOTAL
	Direct On-Costs									
	Payroll tax	7	22.7	23.1	23.6	24.1	24.6	25.0	25.6	168.7
	Superannuation	17	55.1	56.2	57.3	58.5	59.6	60.8	62.1	409.6
	Workers Compensation	1	3.2	3.3	3.4	3.4	3.5	3.6	3.7	24.1
	Leave Loading	1.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	33.7
	Long Service Leave	3.17	10.3	10.5	10.7	10.9	11.1	11.3	11.6	76.4
	Outside Studies	21.15	68.5	69.9	71.3	72.7	74.2	75.7	77.2	509.6
	Total On-Costs		164.4	167.7	171.0	174.4	177.9	181.5	185.1	1,222.1
	Total Salaries & On-Costs		488.5	498.3	508.2	518.4	528.8	539.3	550.1	3,631.6
CAPITAL										
	Modifications to Plant Science Building		40.0							
	Total Capital		40.0	0.0	0.0	0.0	0.0	0.0	0.0	40.0
OTHER		*% of Total Salaries & On-Costs*								
	Academic Services	25	122.1	124.6	127.1	129.6	132.2	134.8	137.5	907.9
	General Univ Services	41	200.3	204.3	208.4	212.5	216.8	221.1	225.6	1,489.0
	Dept Office Support	10	48.8	49.8	50.8	51.8	52.9	53.9	55.0	363.2
	Laboratory Rent & Equip	32	156.3	159.4	162.6	165.9	169.2	172.6	176.0	1,162.1
	Office Space	8	39.1	39.9	40.7	41.5	42.3	43.1	44.0	290.5
	Management Agency		82.0	83.6	85.3	87.0	88.8	90.5	92.3	609.6
	Total Other		648.7	661.6	674.9	688.4	702.1	716.2	730.5	4,822.3
	TOTAL IN-KIND CONTRIBUTION		1,177.2	1,159.9	1,183.1	1,206.8	1,230.9	1,255.5	1,280.6	8,493.9

CRC FOR TEMPERATE HARDWOOD FORESTRY

Itemised List of In-Kind Contributions (1991/92 values, in $'000's)

ANM FOREST MANAGEMENT

				1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	TOTAL
SALARIES Name	Designation	Program	% time CRC								
VOLKER, Mr P	Scientist	Genet	40								
TECHNICIAN	Technician	Genet	20								
	Total Salary			17.0	23.0	24.0	24.0	26.0	26.0	26.0	166.0
	Direct On-Costs	% of total Salary									
	Payroll tax										
	Superannuation										
	Workers Compensation										
	Leave Loading										
	Long Service Leave										
	Other										
	Total On-Costs	23		4.0	5.0	5.0	5.0	5.0	5.0	6.0	35.0
	Total Salaries & On-Costs			21.0	28.0	29.0	29.0	31.0	31.0	32.0	201.0
CAPITAL											
	Total Capital			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER		% of Total Salaries & On-Costs									
	Office Support			11.0	11.0	12.0	13.0	13.0	14.0	15.0	89.0
	Experiments (land rent)			10.0	10.0	11.0	12.0	12.0	13.0	14.0	82.0
	Vehicle Costs			7.0	7.0	8.0	8.0	9.0	9.0	9.0	57.0
	Total Other			28.0	28.0	31.0	33.0	34.0	36.0	38.0	228.0
TOTAL IN-KIND CONTRIBUTION				49.0	57.0	60.0	62.0	65.0	67.0	70.0	429.0

CRC FOR TEMPERATE HARDWOOD FORESTRY

Itemised List of In-Kind Contributions (1991/92 values, in $'000's)

APPM FOREST PRODUCTS

SALARIES Name	Designation	Program	% time CRC	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	TOTAL
DE LITTLE, Dr D	Scientist	Res Prot	10								
TIBBITS, Dr. W	Scientist	Genet	30								
RASMUSSEN, Ms G	Scientist	Genet	40								
HOLZ, Mr G	Scientist	Soil & Stand	10								
RAVENWOOD, Mr I	Technician	Genet	25								
JOYCE, Ms K	Technician	Genet	25								
RICE, Ms J	Technician	Genet	25								
	Total Salary			58.0	59.0	59.0	59.0	59.0	59.0	59.0	412.0
	Direct On-Costs	*% of total Salary*									
	Payroll tax	7		4.0	4.0	4.0	4.0	4.0	4.0	4.0	28.0
	Superannuation	10	(fm 93/94)	0.0	0.0	6.0	6.0	6.0	6.0	6.0	30.0
	Workers Compensation			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Leave Loading			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Long Service Leave	1.8		1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Other (Training)	1.2		1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0
	Total On-Costs			6.0	6.0	12.0	12.0	12.0	12.0	12.0	72.0
	Total Salaries & On-Costs			64.0	65.0	71.0	71.0	71.0	71.0	71.0	484.0
CAPITAL											
	Total Capital			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER		*% of Total Salaries & On-Costs*									
	Head Office Overheads			21.0	21.0	21.0	21.0	21.0	21.0	21.0	147.0
	Office Support			18.0	18.0	18.0	18.0	18.0	18.0	18.0	126.0
	Office Hire			20.0	20.0	26.0	26.0	26.0	26.0	26.0	170.0
	Laboratory Rent			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Experiments			8.0	8.0	8.0	8.0	8.0	8.0	8.0	56.0
	Purchase of NAPEFP & support PhD student			40.0							40.0
	Total Other			107.0	67.0	73.0	73.0	73.0	73.0	73.0	539.0
	TOTAL IN-KIND CONTRIBUTION			171.0	132.0	144.0	144.0	144.0	144.0	144.0	1,023.0

CRC FOR TEMPERATE HARDWOOD FORESTRY

Itemised List of In-Kind Contributions (1991/92 values, in $'000's)

FORESTRY COMMISSION TASMANIA

SALARIES Name	Designation	Program	% time CRC	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	TOTAL
ELLIOTT, Dr H	Chief, Division of Silviculture	Prot	10								
GREENER, Ms A	Research Forester	Prot	40								
PARSONS, Ms S	Research Forester	Prot	40								
KUBE, Mr P	Research Forester	Genet	20								
BASHFORD, Mr R	Technician	Prot	10								
	Total Salary			39.6	40.0	40.4	40.8	41.2	41.6	42.1	285.9
	Direct On-Costs	*% of total Salary*									
	Payroll tax	7		2.8	2.8	2.8	2.9	2.9	2.9	2.9	20.0
	Superannuation	3		1.2	1.2	1.2	1.2	1.2	1.2	1.3	8.6
	Workers Compensation	4.5		1.8	1.8	1.8	1.9	1.9	1.9	1.9	12.9
	Leave Loading	1.4		0.6	0.6	0.6	0.6	0.6	0.6	0.6	4.0
	Long Service Leave	3.1		1.2	1.2	1.3	1.3	1.3	1.3	1.3	8.9
	Other										
	Total On-Costs			7.5	7.6	7.7	7.8	7.8	7.9	8.0	54.4
	Total Salaries & On-Costs			47.2	47.6	48.1	48.7	49.1	49.6	50.1	340.3
CAPITAL											
	Total Capital			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER		*% of Total Salaries & On-Costs*									
	* Head Office overheads	34.5		14.8	15.0	16.5	18.1	19.9	21.9	24.1	130.4
	* Office Support	22.5		9.7	9.8	10.7	11.8	13.0	14.3	15.7	85.1
	* Office Hire	18		7.7	7.8	8.6	9.5	10.4	11.4	12.6	68.0
	Operational	61		28.8	29.1	29.3	29.6	29.9	30.2	30.5	207.4
	* Not applied to technical salaries										
	Total Other			61.0	61.6	65.2	69.0	73.3	77.9	83.0	490.9
	TOTAL IN-KIND CONTRIBUTION			108.1	109.2	113.3	117.7	122.3	127.4	133.0	831.1

CRC FOR TEMPERATE HARDWOOD FORESTRY

Itemised List of In-Kind Contributions (1991/92 values, in $'000's)

FOREST RESOURCES

	Name	Designation	Program	*% time CRC*	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	TOTAL
SALARIES												
	ORME, Mr K	Scientist	SSM	10								
	ORME, Mr K	Scientist	Genet	60								
	BADKIN, P	Technician	SSM	10								
	BADKIN, P	Technician	Genet	25								
	GORDON, V	Scientist	Genet	50								
	HETHERINGTON, S	Scientist	Genet	25								
	FRENCH, S	Technician	Genet	50								
		Total Salary			31.1	79.1	81.5	83.9	86.4	89.0	91.7	542.8
		Direct On-Costs	*% of total Salary*									
		Payroll tax	7		2.2	5.5	5.7	5.9	6.1	6.2	6.4	38.0
		Superannuation	5.5		1.7	4.4	4.5	4.6	4.8	4.9	5.0	29.8
		Workers Compensation	5		1.6	4.0	4.1	4.2	4.3	4.5	4.6	27.1
		Annual Leave	8		2.5	6.3	6.5	6.7	6.9	7.1	7.3	43.4
		Long Service Leave	2		0.6	1.6	1.6	1.7	1.7	1.8	1.8	10.8
		Other										
		Total On-Costs			8.5	21.8	22.4	23.1	23.8	24.5	25.2	149.2
		Total Salaries & On-Costs			39.6	100.9	103.9	107.0	110.2	113.5	116.9	692.0
CAPITAL												
		Total Capital			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER			*% of Total Salaries & On-Costs*									
		Head Office Overheads			4.8	12.1	12.5	12.9	13.3	13.7	14.1	83.3
		Office Support)										
		Office Hire)			19.1	48.6	50.0	51.5	53.1	54.6	56.3	333.1
		Laboratory Rent)										
		Experiments			26.3	46.7	48.1	49.6	51.0	52.6	54.1	328.4
		Total Other			50.1	107.4	110.6	113.9	117.4	120.9	124.5	744.8
		TOTAL IN-KIND CONTRIBUTION			89.8	208.3	214.5	220.9	227.6	234.4	241.4	1,436.8

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